Mechanical ventilator weaning in the context of critical care nursing

A descriptive, comparative study of nurses' decisions and interventions related to mechanical ventilator weaning

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**Purpose of the study**
The purpose of this Ph.D. study was to explore the decisions and interventions of critical care nurses in relation to mechanical ventilator weaning, in order to improve mechanical ventilator treatment and reduce the potential risks inherent in prolonged mechanical ventilation. The specific aims were to (1) describe the competencies and qualifications of critical care nurses related to mechanical ventilator weaning, (2) describe and compare contextual factors which influence nurses' participation in decision making related to mechanical ventilator weaning at four different sites, and (3) describe the nature and extent of nurses' participation in decision making and its impact on the process of mechanical ventilator weaning.

**Theories and theoretical frameworks for the study**
The theoretical frameworks employed in the study were the Weaning Continuum Model, used to describe and compare the mechanical ventilation trajectories, the Synergy Model, developed in order to describe and compare the performance of the nurses, and the organizational decision theories of Henry Mintzberg and James March, which were included in order to explore the decision making processes during the case trajectories.

**Design - sites, settings, and participants**
The study had an overall descriptive and comparative case study research design and qualitative as well as quantitative methods were employed. The design was predominantly prospective, while some data were generated by retrospective chart review. The study had an instrumental multiple-case multi-center design with triangulation of methods and sources. The settings were four university hospitals in Copenhagen, Denmark, and the sites were the intensive care units. The entire nursing and medical staff at the four sites participated in the study, and 14 mechanical ventilator trajectories (cases) were included in the study.

**Research methods and methods of analysis**
The research methods applied in the study were observation, interviews, questionnaire, and analysis of documents including laws, policy statements, and patient records. Observation took place in the intensive care units at the bedside, during medical rounds, and during interdisciplinary conferences. Interviews were conducted with key informants (head physician and nurse manager, n=8), and staff nurses and physicians (n=95). All interviews were semi-structured, most were individual, but some focus group interviews were conducted (n=16). The demographic profile of the nurses was generated by a questionnaire (n=145). The methods of analysis were qualitative as well as quantitative. The quantitative methods included descriptive statistics. The qualitative analysis was carried out on two levels, the chronological narrative of events in the case trajectories, and analysis of the various contextual factors that influence the events in the narrative.

**Findings**
The findings were reported in relation to the context, the cases, and the decisions. The context-related findings show that the conditions and circumstances for nurses at the four sites are similar on a formal level, while local variations exist in relation to physical layout, patient categories, personnel categories, staffing ratios, patient assignment practices, meeting practices, mechanical ventilation practices, and mechanical ventilator equipment. Nurses lack formal competencies in relation to mechanical ventilation, and the formal competencies do not increase as the qualifications increase, but there is an acceptance that nurses' informal competencies increase with experience. Critical care education for nurses is not mandatory, and the education is viewed by many as a reward rather than a prerequisite for work in critical care.
The case-related findings show that the stages of weaning are difficult to identify, and confusion exists regarding the onset of weaning. Goals and methods for weaning are not always clear, which results in competing weaning strategies and frequent mode changes. Only a small proportion of ventilator changes are ordered in writing, and the exact number of executed ventilator changes is difficult to gauge. Staff-to-patient continuity is such that the patients on average encounter new staff about half of the time they are in ICU and the same nurse and physician rarely conduct rounds together more than once during each patient trajectory. The study suggests that nurse potential is somewhat predictive of nurse performance, and that the strongest indicator for quality nursing performance is knowledge of the field of critical care.

The decision-related findings show that nurses participate in collaborative decision making by asking, consulting, suggesting, recommending, informing or persuading the physicians. The range of nurses' participation modalities covers a continuum which spans from independent action to following orders. It has been found that mechanical ventilator weaning is not effectuated by a series of discrete decisions, but rather by a process of experimentation, where the response of the patient is continuously tested. In this respect the nurses play a pivotal role, as they continuously test the patients and make adjustments, which are sanctioned by the physicians immediately or later. The study suggests that mechanical ventilator weaning is often discovered rather than planned and that nurses and physicians believe that they act according to a set of shared implicit norms, albeit such norms fail to exist.

**Conclusions and implications**

Mechanical ventilator weaning is a process of continuous communication between nurses and physicians, constituting a process of experimentation where actions are not always preceded by articulated goals. The process of weaning is dependent upon mutual adjustment among decision makers but this process is hampered by the lack of common understanding of implicit norms for action.

Among implications for clinical practice is the suggestion that guidelines or protocols for weaning should be implemented in order to lay down mutual norms. It is also suggested that the most complex mechanical ventilation patients should be weaned by a team approach. It is necessary that nurses acquire formal authority to act in a weaning team and that the weaning teams should consist of specially qualified nurses and physicians. It is also suggested that nurses and physicians should receive systematic education in order to share a common understanding of the concepts of weaning.

Among implications for further research are studies that look at various aspects of the use of weaning teams and guidelines for practice and focus on outcomes related to the duration of mechanical ventilation, duration of weaning, rate of complications, and long-term survival.
Resumé på dansk
Formål med undersøgelsen
Formålet med dette ph.d.-projekt var at undersøge intensivsygeplejerskers beslutninger og handlinger i forbindelse med aftrapning af respiratorbehandling, med henblik på at forbedre forløbet og undgå de mulige komplikationer der knytter sig til langvarig respiratorbehandling. De præcise mål for undersøgelsen var at (1) beskrive intensivsygeplejerskers kompetencer og kvalifikationer i forbindelse med aftrapning af respiratorbehandling, (2) beskrive og sammenligne kontekstuelle faktorer som påvirker sygeplejerskers muligheder for at deltage i beslutningsprocesser vedrørende aftrapning af respiratorbehandling, og (3) beskrive karakteren og omfanget af sygeplejerskers deltagelse i beslutninger om aftrapning af respiratorbehandling, og dens indflydelse på denne behandling.

Teorier og teoretiske rammer for undersøgelsen
De teoretiske rammer der blev anlagt i undersøgelsen var aftrapningsmodellen (the Weaning Continuum Model), som blev brugt til at beskrive og sammenligne aftrapningsforløbene, synergimodellen, som blev brugt til at beskrive og sammenligne sygeplejerskernes adfærd, og Henry Mintzbergs og James Marchs beslutningsteorier for organisationer der tjente til at belyse beslutningsprocesserne i caseforløbene.

Design – undersøgelsessteder og deltagere

Forskningsmetoder og analysemetoder

Resultater
Resultaterne blev opgjort i relation til kontekst, caseforløbene, samt beslutningerne. De kontekstrelaterede resultater viser at vilkårene for sygeplejersker på de fire afdelinger ligner hinanden på det formelle niveau, mens der forekommer lokale variationer i relation til fysiske forhold, patientkategorier, personalekategorier, normering, allokering af personale, modedeltagelse, aftrapningsmetoder, og respiratorformer. Sygeplejersker mangler formelle kompetencer i forhold til respiratorbehandling og de formelle kompetencer øges ikke i takt med at sygeplejerskerne
opkvalificeres. Men det er accepteret at sygeplejerskers uformelle kompetencer stiger med erfaringen. Specialuddannelsen i intensivsygepleje er frivillig og mange betragter uddannelsen som en belønning i højere grad end en forudsætning for at arbejde i intensivafdelingen.

De caserelaterede resultater viser at stadierne i aftrapningsforløbet er vanskelige at identificere og at der hersker forvirring om hvornår aftrapningen påbegyndes. Mål og metoder for aftrapning er ikke altid synlige, hvilket resulterer i konkurrierende aftrapningsstrategier og hyppig ændring af modus. Kun en lille andel af respiratorændringerne er ordineret skriftligt, og det præcise antal ændringer er vanskeligt at gøre op. Kontinuitet mellem personale og patient har et sådant niveau, at patienterne i gennemsnit omgives af nyt personale halvdelen af indlæggelsestiden på intensivafdelingen. Det er yderst sjældent at den samme læge og sygeplejerske går stuegang på den samme patient mere end en gang i et patientforløb. Undersøgelsen peger på at sygeplejepotentialet i nogen grad kan bruges til at forudsige sygeplejerskernes adfærd, og at den stærkeste indikator for kvalitet i sygeplejen er sygeplejerskens uddannelse og erfaring i intensiv terapi.

De beslutningsrelaterede resultater viser at sygeplejersker deltager i fælles beslutningstagning ved at spørge, konsultere, foreslå, anbefale, informere eller overbevise lægerne. Sygeplejerskernes deltagelse strækker sig fra selvstændig handling til udførelse af delegerede opgaver. Undersøgelsen har vist at aftrapning af respiratorbehandling ikke forløber ved hjælp af uafhængige beslutninger, men ved en eksperimentel proces, hvor patientens reaktion vedvarende afprøves. I denne sammenhæng spiller sygeplejerskerne en afgørende rolle, idet de løbende afprøver patienterne og foretager justeringer, som santoneneres af lægen samtidig eller senere. Det antydes i undersøgelsen at aftrapning af respiratorbehandling ofte opdages i højere grad end planlægges og at læger og sygeplejersker tror at de handler i henhold til fælles normer, som imidlertid ikke eksisterer.

**Konklusioner og implikationer**

Aftrapning af respiratorbehandling er en proces med løbende kommunikation mellem sygeplejersker og læger i form af afprøvning af patientens reaktioner, hvor handlinger ikke altid sker i forhold til tidligere fastlagte mål. Aftrapningsprocessen afhænger af gensidig tilpasning blandt beslutningstagerne, men denne proces svækkes af manglende fælles normer for praksis.

Blandt implikationerne for klinisk praksis er et forslag om at der indføres protokoller eller retningslinier, der fastlægger fælles normer for praksis. Det foreslås også at de mest komplekse respiratorpatienter aftrappes af et aftrapningsteam. Det er nødvendigt at sygeplejersker opnår formel kompetence til at indgå i et sådant aftrapningsteam, og det anbefales at disse teams består af særligt kvalificerede sygeplejersker og læger. Det foreslås tillige at sygeplejersker og læger systematisk undervises i et fælles sæt af begreber og termer for respiratorbehandling og aftrapning.

Blandt implikationerne for fremtidig forskning anbefales undersøgelser der retter sig mod brugen af aftrapningsteams og retningslinjer for aftrapning, og at disse fokuserer på resultater såsom varighed af aftrapningsforløbet, varighed af aftrapningsforløbet, forekomst af komplikationer samt overlevelsprognosen på længere sigt.
Abbreviations

AACN: American Association of Critical-Care Nurses
ARDS: Acute Respiratory Distress Syndrome
BiPAP: Bi-level (biphasic) Positive Airway Pressure
COPD: Chronic Obstructive Pulmonary Disease
CPAP: Continuous Positive Airway Pressure breathing
- CPAP external system: Face mask NIV CPAP. Intermittent or continuous with a harness
- CPAP internal system: CPAP via ventilator
- NIV CPAP: Non-invasive CPAP
ET-tube: Endo-tracheal tube, oral tube, nasal tube, tracheostomy tube
I:E ratio: Inspiration-Expiration ratio
MAR: Medication administration record
MV: Minute ventilation ($V_E$)
MVW: Mechanical ventilator weaning
NG-tube: Naso-gastric tube
NSG III: Third National Study Group on Weaning from Mechanical Ventilation
PC: Pressure Control ventilation
PEEP: Positive End Expiratory Pressure
- Closed system: PEEP valve on ventilator expiration tube
PIP: Peak Inspiratory Pressure
PRVC: Pressure Regulated Volume Controlled ventilation
PWRT: Prescribed Weaning Readiness Threshold
PS: Pressure Support ventilation
SAT: Arterial oxygen saturation
SB: Spontaneous breathing (unassisted breathing)
- Open system: Spontaneous breathing (SB) through ET-tube without PEEP or CPAP
- T-piece: Spontaneous breathing through ET-tube
SBT: Spontaneous Breathing Trials (ventilator weaning)
SIMV: Synchronized Intermittent Mandatory Ventilation
TV: Tidal volume ($V_T$)
VC: Volume Control ventilation
VS: Volume Support ventilation
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References
1. Introduction

The following is a descriptive and comparative study of nurses' decisions and interventions in relation to mechanical ventilator weaning. The two basic assumptions at the onset of the study were: (1) Prolonged mechanical ventilation increases the risk of serious patient complications, particularly pneumonia, which lead to increased morbidity and mortality, and (2) highly qualified nursing reduces the duration of mechanical ventilator weaning, which, in turn, decreases morbidity and mortality.

1.1. Mechanical ventilator weaning

Mechanical ventilation is used for intubated patients in the intensive care unit (ICU). Most patients can be extubated or weaned from mechanical ventilation without difficulty, while approx. 20 percent represent a complex challenge for the ICU staff (Hanneman 1999). It has been estimated that weaning takes up about 40 percent of the mechanical ventilator trajectory (Marelich et al. 2000). Prolonged mechanical ventilation is often associated with life-threatening complications, which means that weaning should be carried out as expeditiously as possible (Tobin & Alex 1994). The main issues which are addressed in research related to mechanical ventilator weaning (MVW) are (Cook et al. 2000):
- When should weaning be initiated?
- What criteria should be used to initiate the weaning process?
- What are the most effective methods of weaning from mechanical ventilation?
- What are the optimal roles of non-physician health care professionals in facilitating safe and expeditious weaning?
- What is the value of clinical practice algorithms and computers in expediting weaning?

The focus of the present study is on the roles of non-physician health care professionals, which in this case means the role of critical care nurses. It has been established in a previous study that high quality of nursing reduces the duration of mechanical ventilator weaning in relation to COPD patients, but it has not been demonstrated exactly how high quality of nursing translates into action (Thorens et al. 1995). In order to get a more accurate picture of the role of the nurse in the process of mechanical ventilator weaning, the present study explores critical care nurses' decisions and interventions.

Nurses have not traditionally been considered to be part of the decision making body in relation to mechanical ventilator weaning, but studies are emerging which suggest that nurses do participate in decision making and that this may positively influence the process. The nursing diagnosis "Dysfunctional Ventilatory Weaning Response" has been defined and validated by the North American Nursing Diagnosis Association, NANDA (Carpenito 1997:716; Logan & Jenny 1990). Outcomes managed approaches to weaning are being led by nurses in the United States (Burns et al. 1998), and studies of nurse led protocol weaning in England and the United States, have demonstrated a reduction in the duration of mechanical ventilation (Crocker 2002;Marelich et al. 2000). A national survey in Sweden of weaning from mechanical ventilation shows that critical care nurses are in a unique position for adapting a holistic approach to weaning, and the study identifies a number of measurable parameters which improve the quality of care (Mårtensson & Fridlund 2002). An Australian survey of clinical decision making has shown that critical care nurses occasionally alter the patients' mechanical ventilation independently in order to meet the needs of their patients (Bucknall & Thomas 1996). Although nurses participate in decision making, there is a high degree of variability in nurses' participation, as it is found that decision frequencies are linked to nurses' critical care experience, appointment level, and nursing shifts (Bucknall 2000).
1. Introduction

In a study of expertise in critical care nursing it was demonstrated that many decisions were made by negotiation between nurses and physicians (Benner et al. 1996). In an earlier study of treatment and outcome from intensive care in 5030 patients, it was found that mutual decision making between physicians and nurses positively influenced patient morbidity and mortality (Knaus et al. 1986). These findings suggest that mechanical ventilator weaning is not merely determined by physicians' decisions, but especially, by collaborative decisions made by physicians and nurses.

1.2. Research into mechanical ventilator weaning

Research into mechanical ventilator weaning has traditionally been carried out by physicians, but studies are increasingly being conducted by nurses as well. Most of the nursing research in critical care has been done in USA, where mechanical ventilator weaning has been placed among the top priorities for critical care nursing research in the 1980's and 1990's (Leino-Kilpi & Souminen 1997; Lewandowski & Kositsky 1983; Lindquist et al. 1993). The past decade has seen more Scandinavian studies in critical care nursing, many of them related to the patients' perspective of critical illness and mechanical ventilation (Axèll 2001; Bergbom-Engberg & Haljamäe 1989; Gjengedal 1994). Critical care nursing and nurses' decisions in relation to mechanical ventilator weaning have yet to be systematically explored in Denmark.

One reason for nurses to engage in research in mechanical ventilation is that most of the respiratory care is handled by nurses. There are no respiratory therapists or technicians in Denmark, and the physical therapists who participate with manual ventilation at some hospitals, work predominantly on day shifts. Physicians are not with the patients on a continuous basis and critical care patients need respiratory care and ventilator adjustments around the clock.

The area of responsibility covered in this study lies in the gray zone joining the fields of nursing and medicine where blurring of the disciplinary boundaries has been observed, especially by nurses (Benner et al. 1999; Bucknall & Thomas 1996; Gjerberg & Kjølsrød 2001; Parse 1998). The Danish Department of Health has recently acknowledged the existence of shifting disciplinary boundaries and has recommended an upward movement of the boundaries, rather than downward, in order to recruit the potential competence of all personnel (Sundhedsministeriet 2001). It remains, that as long as the boundaries are unclear, the responsibility of the individuals may be uncertain. The decision to alter mechanical ventilation falls into the gray area of practice. Mechanical ventilation is a medical treatment formally regulated by physicians. This treatment, however, requires constant reassessment and readjustment, and it is in all practicality often the nurses who are left to make many of the decisive interventions.

As a response to earlier studies regarding nurses' decisions and interventions related to mechanical ventilation, the present study uses triangulation of sources and methods within the research strategy known as case study research. The present study differs from other studies of mechanical ventilator weaning in the following ways:

- Weaning is described as a process in context. Literature on mechanical ventilation and weaning is often decontextualized and prescriptive, where this study is context related and descriptive.
- Weaning is viewed from the perspective of nursing. Mechanical ventilator weaning has traditionally been viewed from the perspective of medical science, and has focused on the patient's physiological readiness to wean and the optimal weaning method. This study looks at the nurses' ongoing responses to the patients, as dynamic interventions during a trajectory.
- Weaning is researched by the case study method, which is a research strategy more common in social sciences and evaluation research than in health sciences. The questions in the present
1. Introduction

study call for a research design which investigates contemporary phenomena as they evolve. A case study research design was chosen in order to describe the weaning process as a real-time phenomenon in its real-life context. When choosing case study research, a narrow research strategy is sacrificed in the pursuit of a broader picture.

1.3. The purpose, aims, and objectives of the study
The purpose of the study is to gain knowledge about critical care nursing and its role in mechanical ventilator weaning in order to optimize mechanical ventilator treatment and minimize the potential risks of prolonged mechanical ventilation. The specific aims of the study are to:
(1) Describe the competencies and qualifications of critical care nurses related to mechanical ventilator weaning.
(2) Describe and compare contextual factors which influence nurses' participation in decision making related to mechanical ventilator weaning at four different sites.
(3) Describe the nature and extent of nurses' participation in decision making and its impact on the process of mechanical ventilator weaning.

The clinical significance of the problem
Nurses' contribution to the mechanical ventilator weaning trajectory needs to become visible in order to be appreciated, improved, controlled, financed, researched, and taught. Mechanical ventilator weaning needs to be understood, not only on the technical and pathophysiologic level, but also, on the individual human level.

The specific objectives of the study
This study is directed toward describing the decisions and interventions of critical care nurses in relation to mechanical ventilator weaning of adult critical care patients with acute respiratory failure. What needs to be explored is not only what nurses do in relation to mechanical ventilator weaning, but also, the conditions and circumstances in which the nurses perform. The following hypotheses have guided the study.

The study hypotheses
(1) Nurses' competencies related to mechanical ventilator weaning increase as nurses' qualifications increase.
(2) Nurses' prospects of participating in decision making related to mechanical ventilator weaning vary across the four sites in the study according to contextual factors.
(3) Mechanical ventilator weaning is facilitated when nurses actively participate in decision making.

The hypotheses are investigated for their own merit, but they are also instrumental, as it is assumed that in the process of exploring these hypotheses, further insights and findings will emerge which go beyond the original hypotheses in understanding the role of the nurse in the process of mechanical ventilator weaning. The first two hypotheses will be explored in relation to the context of mechanical ventilator weaning, while the third hypothesis will be addressed in relation to the cases in the study and the decisions in relation to mechanical ventilator weaning.
2. Background, theory, and definitions
In this chapter the background literature will be presented and central concepts will be defined. The theory presented in this section represents the underpinnings for the research instruments developed for this study.

2.1. Mechanical ventilation - theoretical perspectives and definitions
Mechanical ventilation is respiratory support on a continuing basis using a machine rather than manually ventilating the patient. Various types of respiratory support have been described in recent history, and actual experiments with artificial inflation of the lungs has been attempted since the 1660's (Colice 1994; Sykes & Young 1999). In 1929 the "iron lung" was introduced. The patient was placed in a tank and given intermittent negative pressure around the chest wall to replace or assist the work of breathing. Mechanical ventilation for acute respiratory failure was started in Copenhagen during the 1952 polio epidemic (Ibsen 1952). Although modern ventilators since the 1950's have worked by intermittent positive pressure ventilation (IPPV), breathing air into the patient, the spatial metaphor still lingers in the Danish language, "the patient is in the respirator".

The early ventilators controlled the patient's breathing which meant that the patient had to comply with the volume and frequency set on the machine. As this could be uncomfortable and frightening for the conscious patient, sedation has become an integral part of mechanical ventilation. The ventilators have gradually become more "smart", or physiological, which means that the patient-interactive machines are programmed to follow the lead of the patient. The ventilators of the 1970s were predominately volume controlled (VC). Up through the 1980s and 1990s the ventilators have evolved to include a wider range of modes such as pressure control (PC), pressure support (PS), volume support (VS), synchronized intermittent mechanical ventilation (SIMV), pressure regulated volume control (PRVC) and other variations, but there is no consensus regarding an optimum ventilator mode for any disease state (Slutsky 1994).

Mechanical ventilators have been produced in different countries with a variety of features. Among the most frequently used ventilators in Denmark are Siemens' "Servo" and Dräger's "Evita" series. In 1972 the Servo 900 series was introduced with Servo 900 A and 900 B which had VC as the only mode of choice. The volume control knob read "Preset insp. minute volume" and till this day many Danish nurses equate the word "preset" with "volume". In 1981 Servo 900 C was introduced with a greater choice of modes, VC, PC, PS, SIMV, and CPAP (continuous positive airway pressure). In 1993 the Servo 300 series was introduced with two additional modes, PRVC and VS. The Servo 900 C and Servo 300 were targeted, not only at controlling and assisting the patient's ventilation, but also at weaning the patient from the ventilator (Hansen & Heslet 1996). The Servo 300 series has been expanded to include Servo 300 AL with "auto-mode" which automatically switches between controlled ventilation and the equivalent triggered mode when the patient starts breathing (Sykes & Young 1999). Finally, the Servo' series (Servo' Infant, Servo' Adult, Servo' Universal) with a plethora of modes and options has been introduced in 2001 (Siemens 2001). Although Servo is the most common ventilator in Denmark, some hospitals have other types of ventilators in use, such as the highly sophisticated Evita series. Evita 2 has IPPV, SIMV, MMV (mandatory minute volume), CMV (controlled mechanical ventilation), ASB (assisted breathing), BiPAP (biphasic positive airway pressure), and CPAP on its menu of modes. Evita 4 is more advanced than Evita 2 with the option of more extensive patient monitoring.

The indication for mechanical ventilation is acute or chronic respiratory failure. There are two types of failure which may both be present: Ventilatory failure and hypoxemic failure. Ventilatory failure
2. Background, theory, and definitions

is caused by decreased ventilatory drive or muscle weakness, while hypoxemic failure is caused by ventilation-perfusion problems in the lungs (Sykes & Young 1999). As mechanical ventilation is neither therapeutic nor curative, it should be withdrawn whenever the underlying pathophysiologic rationale for initiating mechanical ventilation is no longer present (Slutsky 1994).

The duration of mechanical ventilation has been one way to classify ventilator trajectories. The Third National Study Group on Weaning from Mechanical Ventilation (NSG III) appointed by the American Association of Critical-Care Nurses (AACN), has defined short-term mechanical ventilation as three days or less (Hanneman et al. 1994, 1998), while long-term mechanical ventilation is ventilatory support required for longer than 3 days (Burns et al. 1995; Burns 1998). Long-term mechanical ventilation is associated with various complications, especially pneumonia.

Among complications during mechanical ventilation are respiratory distress due to patient-ventilator dys-synchrony (impaired synchronization or asynchrony), where the patient appears to be fighting the ventilator (Tobin & Fahey 1994). This is seen when the patient's inspiratory efforts fail to follow the rhythm of the ventilator, or vice versa (Slutsky 1994). Some patients remain on ventilator support long enough to develop psychological or physiological ventilator-dependency and eventually become difficult to wean (Criner & Isaac 1994).

2.1.1. Mechanical ventilator weaning – concepts and definitions

The following concepts have been used in the study as a guiding framework for understanding mechanical ventilator weaning as an evolving process.

Mechanical ventilator weaning has been defined in various ways. In the strictest terms ventilator weaning is "a slow decrease in the amount of ventilator support, with the patient gradually assuming a greater proportion of overall ventilation", and a broader definition is "the overall process of discontinuing ventilator support" (Tobin & Alex 1994). Mechanical ventilator weaning is defined in this study as the process of withdrawing a patient from mechanical ventilation after 24 hours of ventilatory support (Hanneman 1998, Knebel et al. 1998).

The endpoints of the mechanical ventilator weaning trajectory may be difficult to pinpoint. One view is that weaning is initiated immediately upon the onset of mechanical ventilation (Cook et al. 2000; Slutsky 1994), while another is that weaning may be preceded by a preweaning stage (Knebel et al. 1994; Knebel et al. 1998). Discontinuation of mechanical ventilation is as ambiguous a term as initiation. Successful mechanical ventilator weaning is defined in this study as continuous independence from ventilator support for a 24 hour period (Marelich et al. 2000).

Timing and methods of weaning vary. Two main issues which are routinely addressed by physicians are: When is the patient ready to start weaning, and how should weaning be done? (Colice 1994). Numerous physiologic criteria have been suggested to determine when the patient is ready to wean, but none have been infallible (Cook et al. 2000). Similarly numerous techniques have been suggested to determine the best weaning strategy, but it has yet to be shown which strategy is superior (Slutsky 1994). It is more important to understand the relative merits of the various strategies, than to determine the best technique (Tobin & Alex 1994). Among methods for discontinuing mechanical ventilation are abrupt discontinuation, spontaneous breathing trials (SBT), intermittent mandatory ventilation (IMV), volume support, and pressure support ventilation. As most ventilator patients are sedated during mechanical ventilation, it is often necessary to wean from sedation before weaning from mechanical ventilation.
Nursing interventions related to weaning. Difficult to wean patients account for about 20 percent of weaning trajectories, while most patients are weaned from the ventilator without delay (Hanneman 1999). Logan & Jenny have developed the nursing diagnosis "Dysfunctional Ventilatory Weaning Response", which is defined as "the temporary state in which a patient cannot adjust to lowered levels of mechanical ventilator support which delays or halts the weaning process" (Logan & Jenny 1990). Among the key concepts for weaning is "knowing the patient": "Weaning collaboration involves specific roles for both the nurses and the [patients]. The nurse must know the patients, manage their energy, and assist them with the work of weaning" (Carpenito 1997:725). Similarly, Benner et al. have described "coaching" as an important nurse-patient interaction which promotes weaning (Benner et al. 1996).

The following are examples of nursing interventions that differ from the traditional interventions which prevail in the medical literature about mechanical ventilator weaning (Carpenito 1997):
- Explain the weaning process to the patient and jointly negotiate progressive weaning goals
- Reinforce self-esteem, confidence, and control through normalizing strategies such as grooming, dressing, mobilizing, and social conversation about things of interest to the patient
- Permit shared decision making about details of care
- Maintain the patient's confidence by adopting a weaning pace that ensures success and minimizes setbacks
- Promote trust in the staff and environment
- Reduce negative effects of anxiety and fatigue
- Delegate the most skilled staff to wean patients who have experienced moderate to severe responses or who are at high risk for doing so
- Remain visible in the room to reinforce feelings of safety
- Optimize comfort status to increase participation
- Negotiate elements of the weaning process with other clinicians to maximize the probability of weaning success

The prescribed nursing interventions presented above are of a human interactive nature and involve nurse-patient collaboration. The present study will include direct observation of the interaction between nurse and patient in order to explore nurses' decisions and interventions related to weaning.

2.1.2. The weaning continuum – concepts and definitions
The organizing framework for the cases in the present study is the AACN NSG III "Weaning Continuum Model", figure 2.1. (Knebel et al. 1998). According to the Weaning Continuum Model mechanical ventilator weaning is described as a continuum consisting of three stages of weaning: The preweaning stage, the weaning process stage (weaning stage), and the weaning outcome stage. The model includes two points of transition, the weaning readiness threshold when weaning may be initiated, and the outcome stage when weaning is completed. The original weaning model is one-dimensional depicting the phases of weaning along a horizontal time line (Knebel et al. 1994). The refined model is two-dimensional depicting stages, as the patient progresses to higher levels while moving horizontally on the time line (Knebel et al. 1998), figure 2.1. Short-term weaning is generally linear, while long-term weaning describes peaks and valleys (Hanneman 1998). In the present study the Weaning Continuum Model offers points of reference when describing events in the mechanical ventilation trajectory. The model includes the entire trajectory from the time of intubation until the weaning outcome, which may be complete or incomplete weaning.
The endpoints of the weaning continuum are defined in the present study as (1) initial intubation and (2) weaning outcome (incomplete weaning, spontaneous breathing for at least 24 hours, or death). If the mechanical ventilation trajectory is less than 24 hours there is no weaning continuum. If the patient reaches the weaning readiness threshold immediately following intubation there may be no preweaning stage. Spontaneous breathing and extubation do not necessarily coincide. As the endpoints of the weaning stages may be unclear, the entire mechanical ventilation trajectory has been included in the present study.

The core events which constitute the weaning continua are defined in the present study as: Endpoints, stages, and transitions (thresholds). Other events are: Alteration of airway (intubation, reintubation, tracheotomy, extubation, decannulation, and accidental extubation), change of mode, change of ventilator setting (FiO2, RF, volume, pressure, PEEP, I:E-ratio). The ventilator modes are categorized as shown in table 2.1.: Control (controlled mechanical ventilation), support (assisted spontaneous breathing), or unassisted (unassisted spontaneous breathing). In order to explore the transition from the preweaning stage to the weaning stage, the prescribed weaning readiness threshold (PWRT) is defined in the present study as: "FiO2<0.5, PEEP<10, SAT>95, patient cooperative, secretions minimal, and cough spontaneous". PWRT was constructed by the researcher by consulting the head physicians at each site during the pilot study.

Table 2.1. Mechanical ventilator mode categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Control</th>
<th>Support</th>
<th>Unassisted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>VC, PC, PRVC</td>
<td>VS, PS, SIMV, BiPAP</td>
<td>CPAP, SB</td>
</tr>
</tbody>
</table>

Weaning progress. In order to follow the progress of the weaning continuum, the concepts of progress, plateau and reversal are introduced. Reversal day is a day of increased ventilator dependence, plateau day is a day of unchanged ventilator dependence, and wean day is a day of progress as seen by decreased ventilator dependence and more patient ventilatory participation (Curley & Fackler 1998). The weaning progress can be depicted as peaks, plateaus, and valleys, as seen in figure 2.1. In the present study the weaning progress is calculated daily according to the criteria shown in table 2.2.
Table 2.2. Weaning progress criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Reversal day</th>
<th>Plateau day</th>
<th>Wean day</th>
</tr>
</thead>
<tbody>
<tr>
<td>FiO2</td>
<td>&gt; 10% increase</td>
<td>&lt; 10% change</td>
<td>&gt; 10% decrease</td>
</tr>
<tr>
<td>PEEP</td>
<td>&gt; 10% increase</td>
<td>&lt; 10% change</td>
<td>&gt; 10% decrease</td>
</tr>
<tr>
<td>Peak pressure (PIP)</td>
<td>&gt; 10% increase</td>
<td>&lt; 10% decrease</td>
<td>&gt; 10% decrease</td>
</tr>
<tr>
<td>Time off vent (SBT)</td>
<td>&lt; SBT time</td>
<td>no SBT time change</td>
<td>&gt; SBT time</td>
</tr>
</tbody>
</table>

Weaning pattern. The entire weaning continuum may be described in terms of the weaning pattern. The possible weaning subsets are sprint, consistent, or inconsistent weaning trajectories, which are defined as follows: The sprint pattern of weaning consists of only wean days, the consistent pattern consists of wean days and plateau days, and the inconsistent pattern consists of wean days, plateau days, and reversal days (Curley & Fackler 1998; Hanneman 1998). These concepts are used in the present study in order to describe and compare the cases.

2.2. Decision making – theoretical perspectives and definitions

The focus of the present study is nurses' decisions and interventions in relation to mechanical ventilator weaning. In order to narrow down the scope of the study, the focus is directed towards nurses' decisions and interventions related to ventilator setting changes during the mechanical ventilator weaning trajectory.

Mechanical ventilator weaning (MVW) is a process of continuous assessment and adjustment guided by clinical decisions (Knebel et al. 1994), (Colice 1994:31). In order to understand the process of MVW it is helpful to introduce some theory on decision making. Although many studies have looked at the organization of hospitals in Denmark, e.g. the FLOS network (www.flos.cbs.dk), none of these studies have looked specifically at decision making at intensive care units.

In a broad perspective, decision making is defined by Enderud as making a choice among alternative ways of acting (Enderud 1976:10). The decision process consists of a sequence of considerations and actions (phases in the process) which result in a decision. The particular decisions and interventions in this study are decisions directed toward ventilator setting changes, e.g. change of FiO2, pressure, volume, mode, respiratory rate, PEEP, and I:E ratio.

In the following, the theoretical perspectives of decision making will be presented in the context of organizations, i.e. hospitals, followed by the specific decision-theories, which constitute the framework for the present study.

2.2.1. Organization theory – concepts and definitions

Mechanical ventilator weaning decisions are clinical decisions, which are made within the organization of a hospital. More specifically within the intensive care unit, which serves as the context in the present study. This means that decisions are often collaborative, incorporating the views of participants from different professions and levels in the hospital hierarchy. Although decision making takes place at all levels of an organization, the type of decision is particular to the level in the hierarchy. In traditional organizations decisions are specialized in such a way that the top level focuses on strategy, the middle level focuses on issues of coordination, and the lower level focuses on day-to-day operational activities (Hatch 1997:110). Clinical Mechanical ventilator weaning decisions are day-to-day, or moment-to-moment, operational activities.

According to Mintzberg, an organization consists of the following five parts: The strategic apex, the middle line, the operating core, the technostructure, and the support staff (Mintzberg 1983:11).
Applying this theory to the organization of hospitals, the hospital directors are at the strategic apex, department heads are at the middle line, while nurses, physicians and other professional groups working directly with patients are at the operating core, figure 2.2.

Mintzberg argues that the configuration of an organization results in pulls in five directions. The strategic apex pulls for centralization in order to control decision making, striving for a simple structure. The middle line managers pull to Balkanize the structure, resulting in a divisional form. The operating core pulls for professionalization, which is a pull for a professional bureaucracy. The technostructure pulls for standardization, striving for a machine bureaucracy. Finally, the support staff pull for collaboration in decision making, thus favoring the adhocracy configuration, figure 2.2. the Organization Model.

A hospital is a professional bureaucracy where the power is in the hands of the professionals, primarily the physicians, but to some extent also the nurses (Borum 1997:268). The technostructure is small because the professional bureaucracy coordinates through standardization of skills rather than standardization of work processes. The support staff is rather elaborate in order to assist the professionals at the operating core. Hospitals are not run by administrators alone, but also have professionals at the strategic apex. Physicians who work in the middle line as department heads (administrators) often maintain their position at the operating core as professionals. Nurses, on the other hand, who move to the middle line as head nurses (administrators), discontinue their work at the operating core. This may mean that physicians exert a stronger pull toward the professional bureaucracy than the head nurses, who may pull toward a divisional form.

Each hospital unit has a complex power structure at the operating core, due to the abundant number of professional groups, who are organized in individual hierarchies (Borum 1997). The operating core is dominated by the physicians as the main professional group, and the nurses who are regarded as semi-professionals. Nurses divide their activities between patient care at the operating core and activities of assisting and coordinating as support staff. Applying the theory of organizational pulls, the staff nurses will negotiate their position by pulling towards professional bureaucracy or adhocracy, according to their professional identity.

Goals and values vary according to the level of hospital hierarchy. While the operating core works for "what is best for the patient", the strategic apex must work for "what is possible given the resources" (Holm 2000). Physicians who hold positions at the middle line as well as the operating core must negotiate this conflict of interest and balance resources with quality of care. Thus, nurses, physicians, patients, and administrators have competing interests and perspectives (Bentsen & Borum 2000).
2.2.2. Decision theory – concepts and definitions
Before we proceed to decision making in the present study, some general concepts must be introduced in order to gain an understanding of the particular issues, which are to follow.

Traditional economists have held that organizational decision making is driven by the *rational model* (the problem solving model). The rational model is an idealized model which assumes that there is a clear goal, that decision makers have full knowledge of all alternatives, and that the consequences of all alternatives is known (Enderud 1976:30). The rational model can be described as a linear model progressing from problem definition, evaluation of alternatives, selection of alternative, implementation of choice, to monitoring of results. The process may be described as circular if it includes a feedback control element (Hatch 1997:273).

In 1957 political scientist Herbert Simon questioned the rational model because it assumed decision makers to possess knowledge of all the alternatives and the resulting consequences, whereas, in reality, decision makers often have imperfect information about alternatives and consequences. As Mary Douglas puts it, the rational model attributes to the rational agent grotesquely unrealistic capacities for handling information (Douglas 1986:47). Also, the rational model ignores the internal politics of the organizational system. Simon labeled the limited knowledge of the decision makers *bounded rationality*. The two implications of bounded rationality are firstly, that limited knowledge leads to *uncertainty*, and, secondly, that conflicting goals lead to *ambiguity*. While more information may reduce uncertainty, additional information increases ambiguity because it adds to the points on which to disagree (Hatch 1997:275).

The issue of uncertainty and ambiguity has been elaborated by James Thompson in 1967, who illustrated four decision making situations in a two-by-two matrix (Hatch 1997; Mintzberg et al. 1990), figure 2.3. When decision-collaborators agree on goals and methods, uncertainty and ambiguity are minimal, and the (boundedly) *rational model* is likely to be used in the decision process. If, on the other hand, the participants disagree on goals as well as methods, decisions are made randomly, termed as the *garbage can model*. When participants disagree primarily on goals, the participants with the most powerful positions dominate the decision process. The decision makers may then manipulate the process by engaging in politics, called the *coalition method*, e.g. nurses may collaboratively challenge the physicians. Finally, when participants agree solely on the goals, the decisions tend to be made incrementally by *trial-and-error*. All four types of decision making occur within any organization, and may even occur at the same time.

![Figure 2.3. The Decision Matrix](image)

James G. March goes closer to the anatomy of decision making and distinguishes between decisions which are *choice-based* and decisions which are *rule-based* (March 1994). Choice-based decisions are based on the logic of consequence, making choices among alternatives and regarding prior preferences, while rule-based decisions pursue the logic of appropriateness. The decision maker
may use a maximizing or satisficing procedure of decision making. Maximizing requires knowledge of all the alternatives and consequences and involves choosing the best alternative, while satisficing is more common as the decision maker chooses among fewer alternatives until a given target is met. Finally, decisions are described as independent (single person) or collaborative (multiple person) decisions. In the present study collaborative decisions are often interdisciplinary.

In 1985 Nils Brunsson introduced the concept of decision irrationality. Brunsson argued that organizational action depends upon more than the cognitive act of making a decision. Decisions also depend on motivation and commitment (Brunsson 1985). According to Brunsson decision makers often consider few alternatives, ignore negative consequences of favored alternatives, and define selection criteria in order to achieve action rationality rather than decisional rationality. The point being made is that decision making procedures are irrational in an action perspective and that action is often based on ideology rather than logic. This is because decision rationality is based on the flawed assumption that the decision maker always has a clear goal and possesses the full knowledge of all choices. Ideologies of participants provide an alternative which is necessary in order to get things done.

The rational model has been used as a framework for nursing since the 1950s in the form of the nursing process, which consists of nursing diagnoses (clinical decisions), nursing interventions, and nursing outcomes. The process has been promoted for professional and political reasons, as a critical thinking process, which is dynamic and cyclic (feedback control element), client-centered, goal-directed, and problem-oriented (Wilkinson 1996:6). Clinical nurses have criticized the nursing process because actual decisions are less linear than the theoretical framework, but the process has seen a comeback as the basis for nursing classification systems (Bowker & Star 2000), and with the introduction of evidence based practice which, again, requires the clinicians to describe their decisions in rational terms (Guyatt & Rennie 2002). It may be concluded, that the nursing process is useful as an analytical model (decisional rationality), but fails to illustrate the clinical decision-process (action rationality).

In the present study, mechanical ventilator weaning can be described as a technology, which is an activity or process with a goal or an outcome (Hatch 1997:150). Intensive technologies are defined as activities or processes which require coordination of the special abilities of two or more expert systems, e.g. nurses and physicians. Extreme intensive technologies are characterized by high task variability, and require mutual adjustment, teamwork, and joint decision making. Intensive technologies such as mechanical ventilator weaning require nurse-physician collaboration. The traditional view of nurse-physician collaboration is sequential task interdependence where the unidirectional work flow requires the nurse to receive directions from the physician in order to act. Intensive technologies, however, rely on complementary work flows where decisions require reciprocal task interdependence. There are times when mechanical ventilator weaning will require mutual adjustment, teamwork, and joint decision making. If not, the process may be overtaken by the randomness of the garbage can model.

The organizational theories brought forth show that other factors are at work in the decision process than pure rational thought. In the present study theories of organizations and decisions will serve as a framework for the analysis of nurses’ independent and collaborative decisions. The decisions will be structured according to the rational model for analytical reasoning, and will include several of the following categories: Decision (content), indication (signs and symptoms), choice (alternative),
rationale (strategy), risk (consequence), preference (interest), and outcome (target), see "Appendix 10.7. The Independent and Collaborative Decisions".

2.3. Critical care nursing - theoretical perspectives and definitions

The field of critical care, or intensive care, has evolved as a branch of anesthesiology, and is becoming an independent medical subspecialty in some countries (Viby-Mogensen & Husum 1997). In Denmark departments of critical care and anesthesiology are joined, but the education for nurses is different in the two subspecialties (Sundhedsstyrelsen 1996). Nurse anesthetists are required to be certified, while critical care certification is still not mandatory. As critical care medicine has evolved, so has critical care nursing. The patients are more severely ill and the treatments more complex as new therapies become available. The care of the patients is predominantly handled by nurses, but there are other groups, such as nursing aides, nursing students, and medical students, who are involved in patient care.

Competencies and qualifications in critical care nursing. The concepts of competencies and qualifications, which are often used interchangeably, have been defined in many ways in the literature. In this study formal competencies refer to the formal authority to make certain decisions. This is what Mintzberg calls formalized behavior (Mintzberg 1983). The particular competencies in focus in the present study are: The formal authority to make decisions and perform interventions related to mechanical ventilator setting changes. Informal competencies are defined as decisions and interventions which do not necessarily fall within the professional boundaries, but which are tacitly accepted at the workplace. Formalized behavior (authority), may be described in Department of Health (DOH) policies or local hospital policies.

Formal qualifications refer to the experiential and educational accomplishments (skills and knowledge) which are required (in writing) for a particular job (H:S Direktionen 1998). The definition of formal qualifications in this study includes the experience and education, which is required in order to make decisions related to mechanical ventilator setting changes. Informal qualifications include experience and education which are not mandatory, but which enhance the quality of performance. The formal qualifications for nurses to work in the critical care area is basic nursing education, while the formal DOH qualifications for nurses to enter the critical care certification program are basic nursing education, two years of nursing experience, and six months of introduction in a critical care area (Sundhedsstyrelsen 1997b).

Theoretical frameworks in critical care nursing. Theories are increasingly being generated about, and within, critical care nursing. Benner et al. have added to the understanding of critical care nursing by describing nurses’ expertise and clinical wisdom through nursing narratives (Benner et al. 1996; Benner et al. 1999). One central theme which has emerged in critical care nursing is the concept of "knowing the patient", which is a sign of nursing expertise (Baggs et al. 1992; Curley 1998; Jenny & Logan 1992; Tanner et al. 1993). A related domain of nursing is understanding the patient's experience of critical illness or mechanical ventilation (Axéll 2001, Gjengedal 1994, Bergbom-Engberg Haljamäe 1989). In relation to mechanical ventilator weaning Logan & Jenny (1990) have described the nursing diagnosis "Dysfunctional Ventilatory Weaning Response". As mechanical ventilator weaning has been among the highest-ranked research priorities identified by the American Association of Critical-Care Nurses (AACN), the Third National Study Group on Weaning from Mechanical Ventilation (NSG III) suggested a conceptual model for weaning, the Weaning Continuum Model, as an organizing framework for scientific inquiry in order to promote a common language for understanding the weaning process (Knebel et al. 1994, 1998). Through the
1990's AACN developed the Synergy Model of Certified Practice in critical care nursing which links certified nursing practice to patient outcomes (Curley 1998). The Synergy Model and the Weaning Continuum Model are used as organizing frameworks in the present study.

The Synergy Model of Certified Practice has been developed by the AACN Certification Corporation and is still in the process of being reviewed and validated (Curley 1998; Greenberg et al. 1999; Sechrist et al. 2000). The Synergy Model is the only comprehensive model which has been developed for critical care nursing. The purpose of the model is, like the Weaning Continuum Model, to provide nurses with a vocabulary to describe their practice. The Synergy Model has been designed by consensus of expert nurses who have combined prescriptive and descriptive theories of nursing, and constructed a framework in which to describe the characteristics of the patient and the competencies of the nurse. The purpose of developing the model was to link certified practice to patient outcomes in the acute setting. The core concept of the model is that the needs and characteristics of the patients and families influence and drive the competencies of the nurses.

Synergy is a sign of good nursing.

It can be inferred, that according to the Synergy Model, there is no absolute measure of nursing quality, such as formal education or length of experience. The competencies of the nurse reflect a dynamic integration of knowledge, skills, experience, and attitudes which are viewed in the light of the patients' needs (Curley 1998). A relatively inexperienced nurse can create synergy if her actions exactly correspond to the needs of the patient, while a highly experienced nurse can provide poor nursing care, if her actions fail to follow the characteristics of the patient. The Synergy Model consists of eight patient characteristics and eight nurse competencies, each representing a continuum of levels of functioning. There is no specific relation between a particular patient characteristic and a particular nurse competency. The fundamental categories are shown in table 2.3. while the model is presented in "Appendix 10.1. The Synergy Model" (AACN 2000).

Table 2.3. The Synergy Model of Certified Practice – fundamental categories

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Nurse competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resiliency</td>
<td>Clinical judgment</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Advocacy/moral agency</td>
</tr>
<tr>
<td>Stability</td>
<td>Caring practices</td>
</tr>
<tr>
<td>Complexity</td>
<td>Collaboration</td>
</tr>
<tr>
<td>Resource availability</td>
<td>Systems thinking</td>
</tr>
<tr>
<td>Participation in care</td>
<td>Response to diversity</td>
</tr>
<tr>
<td>Participation in decision making</td>
<td>Clinical inquiry/innovator/evaluator</td>
</tr>
<tr>
<td>Predictability</td>
<td>Facilitator of learning of patient/family or educator</td>
</tr>
</tbody>
</table>

The Synergy Model is a descriptive model of nurse performance. In order to construct a predictive model for critical care nursing, viz. the Nurse Potential, the following concepts are introduced: Knowing the field, knowing the ward, and knowing the patient.

2.3.1. "Knowing the field" – concepts and definitions
Knowledge of the field is generated by basic nursing education, critical care nursing education, and critical care experience. The following is a brief description of the educational trajectory of critical care nurses.
2. Background, theory, and definitions

Basic nursing education in Denmark has seen major changes in 1953, 1979, and 1990. The 1990 program was a 3.75 year hospital diploma program, and a new 3.5 year baccalaureate program has been introduced in year 2001. In 1976 a one year critical care course for nurses was introduced, and in 1996 the critical care course was expanded by a year and upgraded to a national specialty certification program endorsed by the Department of Health. Neither course has been mandatory. The 1976 critical care course was locally planned and executed in different parts of the country. The content of the course varied from place to place, and there were no formal criteria for the institutions offering the education. The course consisted of 120 hours of theory classes and a pass-fail written exam (Sundhedsstyrelsen 1996).

In 1996 the old critical care course was replaced by the national specialty certification in critical care nursing (Sundhedsstyrelsen 1997a; Sundhedsstyrelsen 1997b). The course description states that the specialty certification is necessary, arguing that critical care has become more complex and that basic nursing education does not prepare the nurse sufficiently to meet the demands of critical care nursing (Sundhedsstyrelsen 1996). Yet the course is not required. The Department of Health recommends that the nurse should work for two years in medical/surgical nursing prior to applying for work in a critical care area. The new course is a nationally formalized two year program consisting of (1) Introduction period (six months), (2) Theoretical period with 207 hours of classes and a multiple choice exam (six months), (3) Clinical period with an exchange program to different subspecialties in critical care and a written essay (12 months). There are several options for nurses with the old education to upgrade to the new certificate: (1) following the theory classes, (2) independent study, or (3) Internet study. Critical care nursing education is financed by the workplace, and the additional cost to the hospital corresponds to the annual salary of a nurse. During the two years of training the nurse should not be counted as full staff.

Knowing the field is defined in the present study as a combination of critical care nursing education and critical care experience. Knowing the field is operationalized by critical care certification status and number of years in ICU. Please see "Appendix 10.2. The Code Sheet".

2.3.2. "Knowing the ward" – concepts and definitions
Knowledge of the ward indicates familiarity with the workplace and colleagues. It is assumed that familiarity with the workplace promotes intercollegial and interdisciplinary collaboration and teamwork. It is also assumed that collaboration and teamwork have a positive impact on patient outcomes.

According to Mitchell et al. good nurse-physician collaboration can be positively related to patient outcomes, and is associated with low mortality ratio, lack of new complications, and high patient satisfaction (Mitchell et al. 1989). Knaus et al. have shown that the interaction and communication among ICU staff directly influences patient outcomes and that the impact can be measured (Knaus et al. 1986). Baggs et al. have found that nurses and physicians have different perceptions of collaboration and teamwork because their relationship is asymmetrical. According to Baggs et al. physicians do not recognize collaboration with nurses as long as physicians have the authority to write orders. Nurses, on the other hand, recognize situations as collaborative and associate them with positive patient outcomes (Baggs et al. 1992).

Nurses perceive their profession as different from, and parallel to, medicine, while physicians perceive nursing as a lower degree in the same track as medicine (Buresh & Gordon 2000). According to Buresh & Gordon these varying perceptions may give rise to conflicts, which may
weaken the potential strength of the two disciplines collaborating as expert systems in the same area of practice. Benner et al. state that disciplinary boundaries between medicine and nursing are blurring, creating a gray zone where the relative roles are poorly defined (Benner et al. 1996).

Knowing the ward is defined in the present study as the nurse's familiarity with the particular workplace and relationship to colleagues. A nurse who is assigned to charge duty is assumed to be familiar with the ward and to have collaborative skills. Knowing the ward is operationalized by number of years at the present ICU and by assignment to charge duty. Please see "Appendix 10.2. The Code Sheet".

2.3.3. "Knowing the patient" – concepts and definitions
Knowing the patient is a descriptive phenomenon which encompasses the nurse's ability to interpret the patient's responses and to communicate with the patient (Benner et al. 1999:182). Benner et al. suggest that knowing the patient is paramount to the nurses' ability to coach the patient for the work of mechanical ventilator weaning. According to Tanner et al. (1993), a survey of nurses shows that knowing the patient incorporates the aspects shown in table 2.4.

Table 2.4. Aspects of Knowing the Patient

<table>
<thead>
<tr>
<th>In-depth knowledge of the patient's patterns of responses</th>
<th>Knowing the patient as a person</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Responses to therapeutic measures</td>
<td>- Personality</td>
</tr>
<tr>
<td>- Routines, habits, and coping resources</td>
<td>- Normal modes of expression</td>
</tr>
<tr>
<td>- Physical capabilities and endurance</td>
<td>- Likes, dislikes</td>
</tr>
<tr>
<td>- Body topology and characteristics</td>
<td>- Habits and practices</td>
</tr>
</tbody>
</table>

It may readily be assumed that it requires substantial time and effort for the nurse to know the patient at the level outlined by Tanner et al. The concept of knowing the patient is, however, widely used in critical care nursing literature. Chase states that close attention to an individual patient, known to the nurse as "my patient", is seen as a way of knowing the patient which differs from the way the physician knows the patient (Chase 1995). The nurses' unique perspective of the patient is similarly described by Baggs et al. who explains that physicians focus on diseases and health problems, while nurses focus on human responses (Baggs et al. 1992). And Benner et al. add that differences in the extent to which nurses and physicians know their patient is a common source of conflict (Benner et al. 1996:292). Jenny & Logan agree that nurses operate with knowledge of the patient which is different from the physicians' knowledge and that this explains why nurses may disagree with the physicians on the weaning approach (Jenny & Logan 1992).

Ekman & Segesten suggest that nurses feel initiated when they get to know the patients, which they do by seeing them directly rather than hearing or reading about them (Ekman & Segesten 1995). Benner et al. relate the concept of knowing the patient to nursing expertise as well as to continuity (Benner et al. 1996) (p.145, 191). According to these explanation models, knowing the patient is linked to nursing expertise (knowing the field) as well as spending time with the patient (continuity), but studies fail to show exactly when the nurse-patient relationship has evolved to the point when the nurse knows the patient. Morse has shown that the duration of contact between nurse and patient will influence the commitment of the nurse, but fails to define the duration of contact beyond "brief", "short", "lengthy", and "excessive" (Morse 1992). Likewise, continuity is a concept which is common to nursing but lacks clear definition. Continuity is one of the goals of primary nursing, which is a staffing system in which one nurse is responsible for the total care of a patient around the clock as long as the patient is at that ward (Kozier et al. 1992).
Knowing the patient is defined in the present study as the nurse's familiarity with the particular patient and family. A nurse who is assigned to be primary nurse is assumed to be familiar with the patient. Knowing the patient is operationalized by the number of days a particular nurse has been assigned to the patient and by assignment as primary nurse. Please see "Appendix 10.2. The Code Sheet".

2.3.4. Nurse potential – concepts and definitions
The previous sections have presented three concepts which are assumed to predict good nursing performance. In this final section the nurse potential, which is a construct developed for the present study, will be defined.

Thorens et al. have demonstrated that a high nursing index has a positive effect on mechanical ventilator weaning, by developing an index of nursing which compared the effective workforce of the nurses (number and qualifications) with the ideal workforce required by the number of patients and the severity of their diseases (Thorens et al. 1995). A high nursing index, which was associated with a shorter mechanical ventilator weaning trajectory for COPD patients, was a predictive indicator of patient outcomes and indirectly good nursing performance. Thorens et al. state that their study shows that nurses have a positive effect on outcome, but fails to show exactly what nurses do.

In the present study the predictive indicator of good nursing performance is the nurse potential, which is a composite measure of (1) knowing the field, (2) knowing the ward, and (3) knowing the patient. The descriptive indicator of nurse performance is determined by the Synergy Model. It is the ambition of this study to illuminate more specifically what nurses do; in particular to describe what kind of decisions nurses make and how nurses participate in the decision process related to mechanical ventilator weaning. In the present study the nurse potential and nurse performance will be compared in order to determine to what extent performance may be predicted.

Nurse potential is operationalized in the present study as a composite score comprising the nurse's certification status, time in ICU, time in the present ward, assignment to charge duty, assignment to primary nursing, and time with the patient. Nurse performance is operationalized as a composite score comprising the nurse's eight competencies according to the Synergy Model. Please see "Appendix 10.2. The Code Sheet".

On the final pages of this chapter the research questions and hypotheses are shown in relation to the research methods and instruments, table 2.5. The rationale for the rather detailed schema is to show that each research question dictates a particular research method. The paragraph number, which precedes each question, is intended to guide the reader through the chapters with research findings, Chapters 5, 6, and 7.
2. Background, theory, and definitions

2.4. Outline of the hypotheses and questions in the study
The study hypotheses and questions are illustrated in table 2.5. The table illustrates that the different questions require different methods, sources, and instruments.

Table 2.5. Outline of the hypotheses and research questions in the study

<table>
<thead>
<tr>
<th>Hypothesis (1): Nurses' competencies related to mechanical ventilator weaning increase as nurses' qualifications increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research questions</td>
</tr>
<tr>
<td>Questions pertaining to the formal competencies and qualifications of the nurses.</td>
</tr>
<tr>
<td>5.1.1. How are nurses' formal competencies r/t mechanical ventilator weaning described?</td>
</tr>
<tr>
<td>5.1.1. How are nurses' formal qualifications r/t mechanical ventilator weaning described?</td>
</tr>
<tr>
<td>Questions pertaining to the informal competencies and qualifications of the nurses.</td>
</tr>
<tr>
<td>5.1.2.1. How do nurses and physicians perceive the purpose of critical care nursing certification?</td>
</tr>
<tr>
<td>5.1.2.2. How do nurses and physicians describe the defining characteristics of highly skilled nurses?</td>
</tr>
<tr>
<td>5.1.2.3. How do nurses and physicians perceive the relative complexity of certain ventilator settings?</td>
</tr>
<tr>
<td>5.1.2.3. How do nurses and physicians perceive the range of nurses' independent ventilator decisions?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hypothesis (2): Nurses' prospects of participating in decision making related to mechanical ventilator weaning vary across the four sites in the study according to contextual factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research questions</td>
</tr>
<tr>
<td>Questions pertaining to the contextual variations of the four study sites.</td>
</tr>
<tr>
<td>5.2.1. How do the patient categories vary? 5.2.1. How do the personnel categories vary?</td>
</tr>
<tr>
<td>5.2.1. How do the qualifications of the nurses vary?</td>
</tr>
<tr>
<td>5.2.2. How do nurse-to-patient staffing ratios vary? 5.2.2. How do staffing practices vary?</td>
</tr>
<tr>
<td>5.2.2. How do meeting practices vary?</td>
</tr>
<tr>
<td>5.2.3. How do mechanical ventilation practices vary? 5.2.3. How does the mechanical ventilator equipment vary?</td>
</tr>
</tbody>
</table>
2. Background, theory, and definitions

| Hypothesis (3): Mechanical ventilator weaning is facilitated when nurses actively participate in decision making |
|-------------------------------------------------|---------------------------------------------------------------|
| **Research questions**                                           | **Methods and sources**                                           | **Instruments**                                           |
| Questions pertaining to the weaning continuum and ventilator changes during the mechanical ventilator weaning trajectories. | Observe nurses and physicians at the bedside. Observational interviews. Review and compare flow sheet and patient record. | Registration sheet. |
| 6.1.1. How do the weaning stages evolve through the mechanical ventilator trajectories? | | |
| 6.1.2. How do executed ventilator changes relate to written ventilator change orders? | | |
| 6.1.3. How does the weaning onset relate to the prescribed weaning readiness threshold? | | |
| 6.1.4. How does sedation relate to mechanical ventilation? | | |
| Questions pertaining to continuity and performance during the mechanical ventilator weaning trajectories. | Observe nurse assignments at the bedside. Record work patterns of nurses and physicians. Cross-check with time sheets. | Registration sheet. |
| Questions pertaining to nurses' participation in decision making during the mechanical ventilator weaning trajectories. | Observe and interview nurses at the bedside, at rounds, and at conferences. Observational interviews. | Registration sheet. |
| 7.1. How are ventilator setting changes documented? | Observe and interview nurses at the bedside, at rounds, and at conferences. Observational interviews. Record decisions related to mechanical ventilator weaning at the bedside, rounds, and conferences. | Registration sheet. |
| 7.2. How do nurses participate in mechanical ventilator weaning decision making? | Observe and interview nurses at the bedside, at rounds, and at conferences. Observational interviews. | |

As it was pointed out in Chapter 1, the above hypotheses will be explored not only for their own merit, but they are assumed to be instrumental in generating new insights about mechanical ventilator weaning that go beyond the hypotheses as they are presented here.
3. Research strategy and design

This chapter gives an introduction to case study research, which is the research strategy chosen for the present study. In the first part of the chapter case study research is presented in more general terms, while the second part of the chapter focuses on the more specific application of the method to the study at hand. The hypotheses presented in the introductory chapter show that the study calls for a method of research which can handle descriptions and comparisons of patient trajectories as well as the contextual factors which may determine the destiny of these trajectories. The questions put forth in the present study require a method in which contemporary phenomena may be studied in their real-life context. The phenomena in question are decisions, interventions, and social processes.

As other studies have indicated, there is a need for studies which combine research methods in order to get a more complete picture of mechanical ventilator weaning. There is a need for contextual studies which show the activities of groups as well as individuals (Chase 1995). Case study research responds particularly well to the type of broad complex questions posed, it employs several research methods and sources of evidence, using a relatively small number of cases (Ragin 1999). In the pursuit of the most suitable research strategy in which to accommodate the specific objectives in the study, the choice fell upon case study research.

3.1. Case study research

Case study research has not been as commonly used in health sciences as it has been in social sciences, but the method is gaining recognition and has been applied in a variety of disciplines, e.g. evaluations of health services (Himmelstrup 2000; Keen & Packwood 1995), community nursing (Bergen & While 2000), critical care nursing (Manias & Street 2000), education (Stake 1995), health education (Twinn & Lee 1997), public health (Fredslund 2001), evaluation research (Patton 1987), experimental psychology (Yin 1994), city planning (Flyvbjerg 1991), and organizational and management studies (Bakka & Fivesdal 1993; Borum et al. 1992; Maaløe 1996).

3.1.1. Definitions of case study research

Case study research is a comprehensive research strategy which encompasses design, data collection, and analysis of an empirical inquiry (Yin 1994). The method is used where broad, complex questions are addressed in complex circumstances, and where the researcher has little or no control over the events. This is seen in opposition to experiments where the researcher has control over certain factors. Case study research concerns ill-defined interventions in real-life situations which are investigated by multiple sources and methods. Different perspectives on particular events are captured when the interventions concern several interest groups, e.g. nurses, patients, or physicians. Case study research has been described by a number of authors. In the present study the main sources are Robert Yin (Yin 1993; Yin 1994; Yin 1999) and Robert Stake (Stake 1994; Stake 1995; Stake 2000).

Yin defines a case study as "an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis" (Yin 1994:13).
3. Research strategy and design

In the present study the contemporary phenomena under study are decisions and interventions during the mechanical ventilator trajectory. The boundary between the mechanical ventilator trajectory and the illness trajectory of the patient is not always clearly evident. Any patient response which causes a ventilator change is part of the case, while patient responses related to other processes, such as hemodynamic measures, are usually not part of the case. The context variables in the present study are social processes and personnel characteristics at the study sites, while the case variables are specific ventilator changes during a ventilator trajectory.

Stake states that a case study is not a methodological choice, but a choice of object to be studied (Stake 1994:236). This view has been refuted by Yin, as the definition is too broad, and because, according to this definition, any study of entities qualifying as objects, could constitute a case study regardless of the chosen methodology. Yin does, however, concur with the notion that a case study is chosen when other methods are inappropriate in relation to the object being studied.

3.1.2. Features of case study research
Case study research designs may vary according to single-case or multiple-case designs (Yin 1994:38). Classic ethnographic case studies are "single-case studies" of families, tribes or communities. "Multiple-case studies" are pursued in order to describe a larger phenomenon, e.g. decisions or social processes. "Intrinsic case studies" focus on the particular case being studied, whereas the "instrumental case studies" examine a case in order to form a local theory or reach a general insight. When doing a multiple-case study, "cross-case analysis" may be done in order to contrast and compare the findings from the individual cases. Case studies include replication of results across multiple sites, settings or participants in order to increase generalizability and external validity (Gomm et al. 2000;Huberman & Miles 1994;Stake 1994;Yin 1994).

Case study research may be retrospective, prospective, qualitative, or quantitative. The design may be exploratory, descriptive, or explanatory. Exploratory studies address very broad research questions, descriptive studies address "who" and "what" questions, while explanatory studies address questions as "why". The sources of evidence are usually several of the following: Documentation, archival records, direct observation, participant observation, interviews and physical artifacts. Case study research is used when "making sense of a relatively small number of cases, usually between one and 50" (Ragin 1999).

The present study is a multiple-case study consisting of fourteen mechanical ventilator weaning trajectories. The study is an instrumental case study which examines the cases in order to reach general insights regarding the social processes and personnel characteristics which impact the course of mechanical ventilator weaning. The study is descriptive and comparative as it aims to describe the cases and events while the variables are contrasted and compared. The design is prospective in that the mechanical ventilator weaning trajectories are followed prospectively, but also retrospective as the patients' illness trajectories are included. The design is qualitative in that the participants' perceptions and intentions are explored, and quantitative in that the potential and performance of the nurses are given numerical values.

3.1.3. Critical discussions of case study research
Case study research was formerly regarded as a less desirable form of inquiry than experiments or surveys, but this perception has changed as more case study research is being conducted and recognized. When studying people, programs, or social processes, case study research often becomes the most appropriate method of inquiry. In this connection, Flyvbjerg has reevaluated
some common misconceptions and oversimplifications of case study research, which are shown in table 3.1. (Flyvbjerg 1991).

<table>
<thead>
<tr>
<th>Common misconceptions of case study research</th>
<th>Flyvbjerg's corrections to common misconceptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General theoretical (context free) knowledge is superior to specific practical (contextual) knowledge</td>
<td>1. Predictive theories and universals do not exist in the study of humans and society. Specific contextual knowledge is of more value than the futile search for predictive theories and universals</td>
</tr>
<tr>
<td>2. It is not possible to generalize from a single case, therefore case study research cannot contribute to scientific knowledge</td>
<td>2. It is often possible and advantageous to predict from a single case, and case study research may contribute to scientific knowledge through generalization as a supplement or alternative to other methods. Formal generalization in science is overrated whereas &quot;the power of the good example&quot; is underrated</td>
</tr>
<tr>
<td>3. Case study research is most useful for hypothesis generation, i.e. the first phase of a study, while other methods are better for theory testing and theory development</td>
<td>3. Case study is well suited for, but not limited to, hypothesis generation as well as theory testing</td>
</tr>
<tr>
<td>4. Case study research has a tendency (is biased) toward verification, i.e. accepting the preconceptions of the researcher</td>
<td>4. There is no evidence of bias, but experience suggests that case study research has a tendency toward falsification of preconceptions rather than verification</td>
</tr>
<tr>
<td>5. It is difficult to summarize specific case studies in general terms and theories</td>
<td>5. The case study research process is more difficult to summarize, than the results. What is actually difficult to summarize is reality itself more than case study research</td>
</tr>
</tbody>
</table>

Yin addresses the following prejudices against the case study method (Yin 1994). The first concern is the assumption that case study research is lacking in rigor. One explanation is that case study research is confused with case study teaching, where cases are intentionally altered in order to demonstrate a particular point. Case study research, however, should be as rigorous as any other kind of research. The second concern is lack of scientific generalization. In this connection, Yin points out that a case is not a "sample" in a statistical sense, but rather in an analytical sense, where the single or multiple case study is generalized to theoretical propositions. And finally, there is a complaint that case study research is too time consuming and results in massive and unreadable documents. Yin addresses the methodological problems in his books and gives suggestions as to how to conduct case study research (Yin 1993; Yin 1994).

Among the misunderstandings surrounding case study research is the labeling of the research method. Yin states that a common flaw is "to confuse case studies with ethnographies or with participant-observation" (Yin 1994), while Stake states that "case studies have become one of the most common ways to do qualitative inquiry, but they are neither new nor essentially qualitative" (Stake 2000). Case study research has been conducted for years assuming various other names.

Bergen & While explore the use of case study design and discuss questions that challenge the robustness of the method, especially the Yinian method in relation to (1) case versus context, (2) case versus unit of analysis, (3) external validity, (4) triangulation, and (5) relation to theory (Bergen & While 2000). They find that Yin's conceptualization of case study research is more
comprehensive than that of other authors, and conclude that case study research is as credible and robust as other more familiar approaches.

1. Case versus context. The first discussion is that of the case and its context. In this regard it makes more sense to discuss the phenomenon in its context, as the case represents a particular case, while the phenomenon represents the general concept. In his key definition, Yin states that the boundaries between the phenomenon and context are not clearly evident, while, on the other hand, Yin discusses how to clearly "define the case" (Yin 1994). This contradiction gives rise to the question of whether the case is defined differently in itself and in relation to its context. Bergen & While conclude that case-related and context-related data are not treated in the same way. A way of looking at it is that the boundaries of the general phenomenon (a mechanical ventilator weaning trajectory) may be ambiguous, while the boundaries of the particular case (this mechanical ventilator weaning trajectory) can be operationalized.

2. Case versus unit of analysis. Another definitory question addressed by Bergen & While is the matter of the "case" versus the "unit of analysis". In multiple-case designs, the individual case is termed the "primary unit of analysis". In studies with a unit smaller than the case, the case becomes the "main unit of analysis" and the next analytical level becomes the "subunit of analysis" (Yin 1994:41). Some designs include a unitary or "single unit of analysis" while others include multiple units termed "embedded units of analysis" (Yin 1994:21). Stake states that the primary unit of analysis must be clearly defined and that the object of study should be a specific, unique, bounded system (Stake 1994:237).

The main unit of analysis in the present study is the mechanical ventilator weaning trajectory, and the sub-unit of analysis is nurses' individual and collaborative decisions related to mechanical ventilator weaning. According to table 3.2, the present study has a Type 4 case design.

Table 3.2. Types of case designs

<table>
<thead>
<tr>
<th></th>
<th>Single case designs</th>
<th>Multiple case designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single unit analysis</td>
<td>TYPE 1</td>
<td>TYPE 2</td>
</tr>
<tr>
<td>(Holistic)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple unit analysis</td>
<td>TYPE 3</td>
<td>TYPE 4</td>
</tr>
<tr>
<td>(Embedded)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Bergen & While add to the discussion of case designs by distinguishing between the "sampling unit" (source of data collection) and the "unit of enquiry" (the subject or variable measured), table 3.3 (Bergen & While 2000).

Table 3.3. Sampling unit and unit of enquiry

<table>
<thead>
<tr>
<th>Sampling unit (source of data collection)</th>
<th>Unit of enquiry (subject or variable measured)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data points</td>
<td>Multiple sources of evidence</td>
</tr>
<tr>
<td></td>
<td>Contextual variables</td>
</tr>
<tr>
<td></td>
<td>The case</td>
</tr>
</tbody>
</table>

3. External validity. Bergen & While point out that the "sampling unit" leads to an understanding of the external validity of the case study design: "knowing whether a study's findings are generalizable beyond the immediate case study" (Yin 1994:35). Replication of results across sites establishes external validity (Keen & Packwood 1995), just as multiple participants in multiple settings increase generalizability (Huberman & Miles 1994:435). The instrumental case study increases the
3. Research strategy and design

Yin addresses four kinds of validity. *Construct validity* (correct operational measure for the concepts being studied), *internal validity* (establishing causal relationships in explanatory studies), *external validity* (establishing the domain to which a study's findings can be generalized), and *reliability* (e.g. data collection can be repeated with same results). Yin advocates that multiple-case designs should follow a replication logic, not a sampling logic (Yin 1994). Cases must be selected in order to (a) predict similar results (literal replication), or (b) produce contrasting results for predictable reasons (theoretical replication). Sampling logic, which is used in epidemiology and analytical statistics, relies on the sample to resemble the mother population. In case study research the sample is not randomly chosen, and is therefore not necessarily representative. Case study research relies on strategic and purposeful sampling in order to describe the phenomenon under study.

4. Triangulation. As case study research builds on multiple sources of evidence, it must be made clear what kind of triangulation is used (data triangulation, investigator triangulation, theory triangulation or methodological triangulation) and for what purpose (confirmation or completeness) (Knafl & Breitmayer 1991; Powers & Knapp 1990). Confirmation (convergent validity) means that several sources of data converge around a particular theory and strengthens the finding. In its original meaning in the late 1950s triangulation was used to ensure that the variance reflected in a study was that of the trait or treatment and not that associated with the measures (Huberman & Miles 1994). Triangulation is used as a means of cross-validation, in order to eliminate bias of one-sided methodology. Denzin states that "by combining multiple observers, theories, methods and data sources, researchers can hope to overcome the intrinsic bias that comes from single-methods, single-observer, and single-theory studies" (Denzin 1990).

Completeness means that several sources of data are necessary in order to "fill in the gaps", and get a complete picture. In triangulation several methods may be used sequentially or simultaneously, provided the analysis is kept separate and the methods are not muddled (Morse 1994). When results in multiple data collection methods yield consistent findings the confidence and credibility of results are increased. Yin favors convergence, which means that confirmation occurs where data converge around a particular theory or proposition and strengthens its claim. Triangulation makes it possible to view the same phenomenon from different perspectives (e.g. nurse or patient).

In the present study sources and methods are triangulated, as triangulation is an integral part of the case study design. One reason for combining methods was that the phenomena under study (decisions and interventions), were difficult to capture by any one method. When describing human activity there is always a gap between what people think they do and what they actually do (Baumann et al. 1991). This is not due to unreliable informants, but rather, to the fact that different perspectives often lead to different perceptions of reality.

Triangulation has been applied in the present study with the purpose of confirmation as well as completeness. Confirmation (convergent validity) was particularly important in order to increase the strength of the findings related to the main unit of enquiry, while completeness has enriched the contextual data. Confirmation means that the different sources of data have produced similar results, or contrasting results for predictable reasons. Confirmation was reached by cross-validating...
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data from various sources where data would converge around a theory, e.g. confirm the hypothesis that nurses make independent ventilator decisions. Completeness was accomplished by using different research methods as a division of labor where the most appropriate method was used for each set of data, e.g. obtaining demographic data on the nurses by combining questionnaires, staffing schedules, and key informant interviews.

5. Relationship to theory. Yin points out that case study research differs from related research such as ethnography and grounded theory in that theory is developed prior to the study (Yin 1994:27). Yin maintains that any case study must have propositions (hypotheses) or at least a clear purpose to guide data collection. This notion follows the philosophy of Karl Raimund Popper, who claims that any kind of research must begin with formulation of hypotheses (Popper 1963). Yin states that case studies can be theory-testing or theory-generating as he adheres to the understanding that a positive example does not establish or generalize a case, whereas a single case as a negative example can limit generalizability by falsification. This standpoint is consistent with Popper's theory of falsification. If a preconceived theory is falsified by a negative example, the hypothesis will be rejected. It follows, that the hypothesis must be formulated in such a way that it may be falsified.

3.1.4. Sampling in case study research

In case study research sampling is purposeful and strategic, not randomized. The object is to find information-rich cases for in-depth study. The following types of purposeful sampling may be used (Patton 1987:52):

1. Extreme or deviant case sampling. Finding unusual or special cases e.g. outstanding successes or failures.
2. Maximum variation sampling. Capturing central themes or events that cut across program variation.
3. Homogeneous sampling. Contrasting to maximum variation sampling.
4. Typical case sampling. Describing the most common or average case.
5. Critical case sampling. Important in that what is in this case is in every case (or most cases) and what is not in this case is in no case (or few cases).
6. Snowball or chain sampling. An approach for locating information-rich key informants.
7. Criterion sampling. Finding cases which meet predetermined criteria.
8. Confirmatory or disconfirming cases. Including additional samples which fit or don't fit an emerging pattern.
9. Sampling politically important cases. Additional sampling strategy when a limited number of cases are studied.
10. Convenience sampling. A fast and convenient strategy which is common, but not desirable.

In the present study the goal was to combine maximum variation sampling with typical case sampling in order to see the range of nurses' independent and collaborative decisions related to mechanical ventilator weaning. In some situations there were few choices and convenience sampling was used.
3. Research strategy and design

3.1.5. Analytic levels in a case study
A particular case study research method was presented at Flyvbjerg's Ph.D. course on "Case Study Research and Narratology" at Aalborg University in 1999. At this course, the case was described to have several *plots*, which represent descriptions on different *analytic levels*. The first plot is the narrative of a chronological *chain of events*. The "story" is told by *eventualization* (description of events), wherein "the doer is extracted from the deeds". The second plot may contain a thicker description and analysis of the history, context, participants, actions, non-actions, decisions, and outcomes (Flyvbjerg 1991:150). The first plot describes the "smaller case", or the "story", e.g. the rationale for a particular ventilator change. The second plot offers the "big picture", or "the story within the story", where the focus may rest upon power struggles among professionals.

In the present study the cases (the weaning continua) represent the main unit of enquiry. The events in the cases construct the story. The decisions behind each event represent the sub-unit of enquiry. The context (the four sites) represent the super-unit of enquiry. When the decisions are analyzed in relation to the case and context they construct the story within the story.

3.2. Research design in the present study
As it has been stated, the present study has an instrumental multiple-case design, wherein "the mechanical ventilator weaning trajectory" constitutes a case. The theoretical framework for analyzing the case is the Weaning Continuum Model, and the theoretical framework for analyzing the performance of the nurses is the Synergy Model. Nurses decisions and interactions with physicians are analyzed according to theories of organizations and decision making. The study has a multiple site, multiple case design with multiple units of analysis, involving four hospital sites and 14 cases.

3.2.1. The sampling units in the present study
The main unit of analysis is the weaning trajectory while the subunits of analysis are nurses' decisions related to mechanical ventilation. The sources of data collection are shown in table 3.4.

**Table 3.4. The sampling units in the present study**

<table>
<thead>
<tr>
<th>Sampling unit (source of data collection)</th>
<th>Sources of evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data points</td>
<td></td>
</tr>
<tr>
<td>Site I</td>
<td>Key informants</td>
</tr>
<tr>
<td></td>
<td>Observation/registration (bedside, rounds, conferences)</td>
</tr>
<tr>
<td>Site II</td>
<td>Nurses</td>
</tr>
<tr>
<td></td>
<td>Interviews (individual, group)</td>
</tr>
<tr>
<td>Site III</td>
<td>Physicians</td>
</tr>
<tr>
<td></td>
<td>Documents (charts, progress notes, flow sheets, policies)</td>
</tr>
<tr>
<td>Site IV</td>
<td>Patients</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The sampling units are triangulated so that there are multiple data points and multiple sources of evidence which converge for confirmation. The main units of enquiry, the cases, were selected with the purpose of describing the nurses' decisions in a variety of situations. The aim was to find different types of trajectories in order to illustrate the scope of nurses' decisions. It was difficult to predict the course of a weaning trajectory, but the 14 cases in the study covered the various case samples shown in table 3.5. (Flyvbjerg 1991:150).
Table 3.5. The case samples

<table>
<thead>
<tr>
<th>Case Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical case</td>
<td>The critical case illustrates the core events (endpoints, weaning stages and transitions) in a particularly illuminating way.</td>
</tr>
<tr>
<td>Typical case</td>
<td>The typical case in this study is any weaning scenario which is frequently observed.</td>
</tr>
<tr>
<td>Extreme case</td>
<td>The extreme or deviant case illustrates an unusual trajectory.</td>
</tr>
<tr>
<td>Simple case</td>
<td>The simple case is a weaning scenario that holds just enough core events to constitute a weaning process.</td>
</tr>
<tr>
<td>Complex case</td>
<td>The complex case is a weaning scenario that contains a number of recurring core events. The weaning pattern may be inconsistent with several events such as types of intubation, types of ventilators, and modes of ventilation.</td>
</tr>
<tr>
<td>Maximum variation case</td>
<td>The maximum variation case is a case that shows many possible variations of the events in the weaning trajectory: Many types of airways, ventilators, modes, weaning strategies, or frequent recycling between ventilator treatment and spontaneous breathing.</td>
</tr>
</tbody>
</table>
4. Research methods and avenues of analysis

The research methods required for gathering different types of data were briefly indicated in the previous chapter. In this chapter each research method will be described separately including a discussion of validity and data analysis.

The present study consisted of a pilot study and a main study. The pilot study extended over a period of three months from January to March 1999. The main study lasted one year from April 1999 through March 2000, taking three months at each of the four sites. It was estimated that three months at each site would suffice to gather the required data, and the study went as planned.

All the research instruments were constructed by the researcher, specifically for this study, and the study was conducted by a single researcher. The instruments were tested and adjusted during the pilot study period. It was also determined during the pilot study which time of day would be most advantageous for direct observation. Table 4.1. shows the time spent at each site during the pilot study.

Table 4.1. Time spent at each site during the pilot study

<table>
<thead>
<tr>
<th></th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days</td>
<td>6</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Hours</td>
<td>15</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>24</td>
</tr>
</tbody>
</table>

What determined the actual time spent at each site was that the required data was obtained. In the course of the main study more hours were clocked at Site 1 than at the other sites. This can be attributed to the fact that it was the first site and that routines were being established, and that interviews were difficult to schedule at this site because of high acuity. By the same token, fewer hours were spent at Site 2 because census was low and interviews could be scheduled without difficulty. Table 4.2. shows the time spent on field study at each site during the main study.

Table 4.2. Time spent at each site during the main study

<table>
<thead>
<tr>
<th></th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Days</td>
<td>40</td>
<td>24</td>
<td>29</td>
<td>30</td>
<td>132</td>
</tr>
<tr>
<td>Hours</td>
<td>78</td>
<td>61</td>
<td>71</td>
<td>73</td>
<td>283</td>
</tr>
</tbody>
</table>

4.1. Selection of research settings and participants

The four sites in the study were selected for several reasons. Firstly, a multi-site design was chosen in order to strengthen the findings of the study. Secondly, the particular university teaching facilities offered a high quality of treatment and care, which was necessary in this study. And lastly, the nurses at the sites expressed an interest in promoting nursing research in the critical care area. A project group was established which included two nurses from each of the four sites. The group facilitated the process of gaining access to the sites and obtaining permission to conduct the study at each of the four hospitals.

The participants in the study fell into two categories: Hospital staff (nurses and physicians) and patients (cases). All participants were selected by purposeful sampling in order to get information-rich cases for study in depth. Patients and expert nurses were selected by snowball sampling, a method which consisted of asking people with local knowledge to assist in locating informants or critical cases (Benner et al. 1999:557, Powers & Knapp 1990:137, Patton 1987:56).
4. Research methods and avenues of analysis

4.1. Selection of patients
The plan was to include a total of eight patients, two at each of the four sites, and follow their ventilator trajectories from the time of intubation to the time of spontaneous breathing. As it turned out, several of the patients who were included in the study died before weaning was completed. This made it necessary to include more patients than originally planned and a total of 14 patients (cases) were included, four at each of the Sites 1, 2 and 4, and two at Site 3.

- **Inclusion criteria**: Intensive care patients, who were adults over 18 years of age, and who were treated with mechanical ventilation for acute respiratory failure. Patients who were expected to be weaned successfully from mechanical ventilation and who would be mechanically ventilated for at least 24 hours. Ideally there would be one consistent and one inconsistent weaning trajectory at each site.

- **Exclusion criteria**: Patients intubated for anesthesia and extubated less than 24 hours after intubation, e.g. planned CABG patients.

4.1.2. Selection of hospital staff
There was no definite number of hospital staff participants to be included in the study. All nurses and physicians currently working at the four sites, who were not on leave, were included. Nursing aides who were assigned to care for a study-patient were included for observational interviews.

- **Key informants**: The Nurse Manager and the Head Physician at each site (n=8).

- **Participants**: Staff nurses and physicians were selected for various parts of the study. Nurses and physicians who were assigned to the study-patients were interviewed and observed (n=95) at the bedside, during rounds and during conferences. Experienced nurses and staff physicians were selected for "target interviews" about mechanical ventilation practices (n=23). New nurses and staff physicians were selected for focus group interviews about the qualities of good critical care nurses (n=16). All nurses working at the four sites, who were not on leave, were included in a questionnaire covering nurse demographics (n=145).

4.2. Data collection methods
The methods used in this study were observation, interviews, questionnaire and analysis of documents. Sources and methods were triangulated in order to strengthen the findings.

4.2.1. Entering and exiting the field
Prior to starting the fieldwork each of the four sites was provided with an outline of the study. At the onset of each three month period of fieldwork the nurses and physicians were invited to hear about the project. I acknowledged that my presence to some extent would influence the work of the nurses, but I made my role clear which made it possible for me to interview the participants during times of observation. This was necessary because it was found that postponing interviews for several days reduced the quality of information. When a nurse was involved with a new patient the details of an earlier patient quickly faded.

In the course of the study there were no participants who refused to be included in the study and no participants who declined interviews. There was great interest and cooperation from all participants.

One advantage of being the only researcher in this study was that interrater variation was eliminated. The drawback, on the other hand, was the risk of systematic bias. I had to carefully reflect on whether I had any special interests vested when recording the performance of the participants. Did I expect the experienced nurses to display a superior performance? Did I expect
non-certified nurses to make more mistakes? Would I benefit from portraying nurses positively or negatively? In order to reduce bias, my observation instruments were designed to maintain an appropriate methodological rigueur. The coded data were operationalized in order to reduce or eliminate on-the-spot judgment calls.

When exiting the field all staff members were invited again to hear about the project and ask questions. This provided an opportunity to thank the participants for their cooperation and interest, while it also gave the participants an opportunity to give me some feed-back.

4.2.2. Observation of nurses, physicians and patients

Direct observation was chosen in order to gather real-time information about events in their natural context. Observation offered a temporal immediacy which was particularly important in this study where nurses' decisions were in focus. The other sources of evidence in this study lacked the proximity to the events that direct observation could provide.

Nurses' decisions and interventions in relation to mechanical ventilator weaning fall outside of the formal boundaries of nursing. The ambiguous nature of these activities made some nurses averse to describing what they actually did. There was a risk that nurses might exaggerate or understate their actions. Did I want to hear what they did or what they were supposed to do? By using direct observation in conjunction with interviews it was possible to pick up tacit aspects of nursing practice (e.g. independent ventilator changes) and ask nurses to clarify the meaning of their activities by conducting "observational interviews" (Benner et al. 1999:559), which are informal "on-the-spot" interviews (Chase 1995). Direct observation was semi-structured and data were recorded on the registration sheet.

Following Spradley's (1980:58) familiar vernacular, data were gathered by participant observation. This terminology indicates that there may be different degrees of involvement, from complete participation to nonparticipation. Spradley stresses that being an insider (participant) and an outsider (observer) at the same time limits the capacity to observe. Therefore I chose to be the outsider, and to simply use the word observation, or direct observation, to indicate "non-participant observation". As I have been a critical care nurse myself for the best part of ten years, I was no stranger to the field of critical care in general. I had the knowledge of the field which this study required. On the other hand, I had not worked at any of the study-sites beforehand, so I was a stranger to the particular sites. This brought on the advantage that I did not have the same "blind spots" as the participants in the study.

4.2.2.1. Observation instruments in the present study

The following instruments were designed for direct observation and tested in the pilot study, see table 2.5. "Outline of the hypotheses and research questions in the study":
- **Code sheet**: The code sheet included definitions and operationalization of coded data to be observed. The code sheet was used for reference. See "Appendix 10.2. The Code Sheet".
- **Registration sheet**: The registration sheet was used during observation for recording coded data. In addition to the coded data the field notes contained *unstructured data*: Observational notes, theoretical notes, methodological notes, and personal notes (Polit & Hungler 1999:369). On days between patient observation I kept a daily log in the field notes. The registration sheet contains the "raw data". See "Appendix 10.3. The Registration Sheet".

Ingrid Egerod

Mechanical ventilator weaning in the context of critical care nursing
- **Data sheet**: The data sheet was the computerized spread sheet for the coded data. All coded data from the registration sheet were transferred to the Excel™ data sheet. The narrative data were categorized later and some of them were coded and added to the data sheet.

<table>
<thead>
<tr>
<th>Table 4.3. The observation instruments in the present study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Code sheet</strong></td>
</tr>
<tr>
<td>Each item to be recorded is numbered and defined for reference.</td>
</tr>
</tbody>
</table>

**Coded data on the registration sheet**

- **Trajectory data**: The first part of the registration sheet consisted of demographic patient data which were recorded only once for each patient: Site, sex, age, diagnosis, ICU days, intubation days, ventilator days, indication for mechanical ventilation, type of ventilator, initial ventilator settings, and weaning outcome.

- **Daily data**: The second part of the registration sheet was recorded daily: Weaning stage, sedation, analgesia, patient characteristic score (PCS), patient needs score (PNS), patient readiness for transition, nurse-patient ratio, reason for nurse allocation, nurse potential score (NPS), and nurse performance score (NCS).

- **Decision data**: The third part of the registration sheet was a description of individual decisions related to mechanical ventilation. Several decisions were recorded daily: Decision category, venue, person (collaboration), type of order, and outcome. The narrative data later yielded the categories: Decision type, indication, time, setting, site, choice, rationale, and strategy. Each ventilator change on the flow sheet represented a decision. As it was impossible to observe all decisions, the particular decisions which were observed, were described in detail.

**Unstructured data on the registration sheet**

- **Observational notes**: contained conversations or events which might be linked to other patients than the cases included in the study.

- **Theoretical notes**: contained interpretations or meanings formed on the spot which I didn't want to forget.

- **Methodological notes**: often contained my ideas to improve data collection.

- **Personal notes**: were reflections on my role as researcher, e.g. my confusion when I couldn't identify different personnel who didn't wear nametags.

**4.2.2.2. The process of data collection during direct observation**

During the pilot study it was decided that direct observation would be best in the morning between 08:00 - 12:00. This time was chosen because it included bedside nursing, morning medical rounds, and noon interdisciplinary conference, where many decisions on mechanical ventilation are made. Direct observation was conducted 2-3 hours a day, 3-4 days a week.

**Nurse-patient interface**: The nurse's immediate response to the patient was observed at the bedside. On each day of observation I would ask the bedside nurse to give me a synopsis of the patient's condition and to state if the nurse had made, or planned to make, any ventilator changes during the current shift. This information was cross-checked with the progress notes and the flow sheet. If ventilator changes were made, and if the nurse was available for an observational interview, each decision was recorded in detail on the registration sheet. If there were inconsistencies or
inaccuracies on the flow sheet the nurse would be asked to clarify. The interaction between nurse and patient was recorded on the registration sheet according to the Synergy Model. See chapter 2.

**Nurse-physician interface.** During morning medical rounds the decisions and communication patterns between the nurse and physician were recorded on the registration sheet in order to clarify the relative contributions of the nurses and physicians. The morning rounds were chosen in stead of the evening rounds because the physician usually dictated the progress note immediately after morning rounds, which provided a means to cross-check decisions made during rounds. Evening rounds were not as structured as morning rounds and were not systematically documented in the patient record.

**Physician-patient interface.** During the noon interdisciplinary conference the decisions and communication patterns among nurses and physicians regarding mechanical ventilation were recorded on the registration sheet. The conference provided information about physicians' strategies and treatment plans, but conference decisions were rarely documented in the patient record.

Intradisciplinary nursing conferences were not regularly scheduled, but were observed when possible.

**4.2.2.3. Analysis of observational data**

The coded observational data were transferred to the Excel™ data sheet. The data were validated by myself for random or systematic error by double-checking data on the registration sheet against the data sheet. The data which represented a score (patient need, nurse potential, nurse performance) were recalculated and checked for errors of range and consistency. One method was to put data in charts and look for outliers or inconsistencies while another method was recalculation.

**Trajectory data** described the cases, the main unit of enquiry. Data have been written as short case histories which describe the cases in terms of events related to mechanical ventilation. The mode patterns were described graphically along a time-line of clinical progress in order to illustrate days of controlled breathing, assisted spontaneous breathing and spontaneous breathing (Knebel et al. 1998; Marelich et al. 2000). The trajectory data have been combined with data from the flow sheet in order to describe the trajectories during times that were not observed.

**Daily data** described the context for mechanical ventilator decisions. Data have been described graphically in order to illustrate patterns of staff allocation and continuity, which could influence the nurses' decision activity. Nurse potential score, nurse performance score, and patient needs score were transferred to the SPSS system (Statistical Package for the Social Sciences), where the gamma correlation was calculated. The gamma test was chosen because none of the data sets had normal distributions. Nurse performance and patient needs have been described as a function of nurse potential in order to describe the impact of nurse potential. Nurse potential is a composite score of the nurses' knowledge of the field, ward, and patient. This method of scoring was developed specifically for the present study. Nurse potential was analyzed as a function of each of its three components in order to see which component had most impact on the combined score. Nurse performance and patient need were analyzed as a function of each of the three components of nurse potential in order to determine the impact on nurse performance and patient needs.

**Decision data** described the sub-unit of enquiry. The coded decision data were transferred to the Excel™ code sheet for calculations. The pre-coded categories were: decision category, decision
place, decision makers, decision order, and decision outcome. The distribution of decisions was illustrated in cross-tables as a function of: Site, case, length of trajectory, decision category, decision place, decision person, decision order, decision outcome, and nurse potential. The distributions have been analyzed and discussed separately.

Each decision was sub-coded and transferred to the data sheet according to the "decision process": Category, indication, choice, rationale, strategy, and outcome. Each of the recorded 113 decisions were compiled on a narrative list and were structured according to this schema, see "Appendix 10.7. The Independent and Collaborative Decisions". Each decision was evaluated for complexity. Narrative examples of each type of decision were selected and cross-tabulations of relations between variables were calculated.

The "decision category" was differentiated into its sub-categories: airway, communication, sedation, ventilator change, and weaning. Each sub-category was described in a cross-table as a function of nurse potential, decision makers, length of trajectory, decision place. Narrative examples of each type of decision were selected.

4.2.3. Interviews with nurses and physicians
The interviews in this study were predominantly directed toward knowledge and fact, rather than experiences and emotions. The interview questions were quantitative as well as qualitative and included demographical data as well as views and perceptions of the informants. The hypotheses indicated the need for different types of interviews which are described below. Table 4.4. gives an overview of all interviews which were conducted except the informal observational interviews. The planned interviews which were not conducted are marked as NA (not applicable).

<table>
<thead>
<tr>
<th>Interview type</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>Total number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key informant - nurse</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 taped</td>
<td>8</td>
</tr>
<tr>
<td>- physician</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 taped</td>
<td></td>
</tr>
<tr>
<td>Individual - nurse</td>
<td>2 taped</td>
<td>1 taped</td>
<td>3 not taped</td>
<td>3 not taped</td>
<td>11</td>
</tr>
<tr>
<td>- not taped</td>
<td>2 not taped</td>
<td>3 not taped</td>
<td>3 not taped</td>
<td>3 not taped</td>
<td></td>
</tr>
<tr>
<td>Individual - physician</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 not taped</td>
<td>1 not taped</td>
<td>6</td>
</tr>
<tr>
<td>- not taped</td>
<td>2 not taped</td>
<td>3 not taped</td>
<td>3 not taped</td>
<td>3 not taped</td>
<td></td>
</tr>
<tr>
<td>Target - nurse</td>
<td>1 not taped</td>
<td>4 not taped</td>
<td>7 not taped</td>
<td>5 not taped</td>
<td>22</td>
</tr>
<tr>
<td>- physician</td>
<td>0 NA</td>
<td>2 not taped</td>
<td>2 not taped</td>
<td>1 not taped</td>
<td></td>
</tr>
<tr>
<td>Focus group - nurses</td>
<td>1 taped</td>
<td>1 taped</td>
<td>1 not taped</td>
<td>1 not taped</td>
<td>6</td>
</tr>
<tr>
<td>- physicians</td>
<td>1 taped</td>
<td>0 NA</td>
<td>1 taped</td>
<td>0 NA</td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>8</td>
<td>15</td>
<td>17</td>
<td>13</td>
<td>53</td>
</tr>
</tbody>
</table>

The interviews in this study cover various interview methodologies: Semi-structured, individual vs. group, quantitative vs. qualitative interviews. None of the interviews were structured in the strictest sense leaving no flexibility to the interview (Fontana & Frey 1994:363). The interviews were all
4. Research methods and avenues of analysis

semi-structured with interview guides. All interviews were predominantly qualitative with some quantitative facts included. Most were individual while a few were group.

The prescheduled interviews were taped while more spontaneous interviews or shorter interviews were handwritten. The key informant interviews were relatively long, lasting 30-60 minutes, and were taped so I could go back and clarify data. The "target interviews" were not taped because they followed a fairly structured guide which ranked data and had room for comments. The focus group interviews were taped when possible because there was only one researcher who acted as moderator; there was not a second researcher taking notes. All taped interviews were transcribed verbatim in full by the researcher.

4.2.3.1. The categories of interviews

The goal of the key informant interview was to collect the following contextual data about each site in an efficient way: Patient categories, number of beds, equipment, staffing ratio, staffing policies, hiring policies, and mechanical ventilator weaning guidelines. The key informants were the Nurse Manager and the Head Physician at each site, who were selected because they were the most likely subjects to have the information I was seeking. They were given a topic guide before the interview in order to be prepared to provide the quantitative data I requested.

The goal of the individual interviews with nurses and physicians was to obtain information about patient trajectories in addition to the data the observational interviews provided. These interviews were mostly unstructured and aimed at filling in the gaps at all three levels of enquiry, context, main unit, and sub-unit. The informants were chosen among the nurses and physicians who had been assigned to the study-patients. The observational interviews were structured around each ventilator decision. The interview guide for the observational interview was part of the observational registration sheet.

The goal of the target interview was to describe the implicit understanding (unwritten practice) of mechanical ventilation among nurses and physicians. This interview was added to the study just as I was finishing my field work at Site 1, when it became evident that there were no explicit mechanical ventilator guidelines. The informants were selected among experienced nurses (recommended by peers) and physicians, who were most likely to have knowledge of the topic. They were asked to rate seven ventilator parameters according to relative complexity and to state which parameters nurses changed independently. The parameters were: FiO2, pressure level (PC/PS), volume (VC/VS), Mode, Frequency, PEEP, or I:E ratio. Each parameter was ranked according to complexity while allowing for several parameters to get the same score, e.g. pressure and volume changes may be perceived as equally complex.

The goal of the focus group interview was to uncover perceptions of the qualities of a good critical care nurse. The informants were selected among new nurses (< 1 year experience) and staff physicians because these two groups had experience working with highly skilled critical care nurses. Focus group interviews were chosen because group dynamics were expected to uncover more information than individual interviews. It was not possible to conduct two focus group interviews at all sites. At Site 2 there were not enough physicians at the ward to constitute a group. At Site 3 it was not possible to get a group of physicians together, but two individual interviews were carried out. At Site 4 there were fewer new nurses to choose from as most nurses were certified or certifying.
4.2.3.2. Analysis of interview data

The key informant interviews yielded contextual demographical data which was arranged in tables in order to compare the four sites. Printouts of staffing plans, staffing schedules, and local policies and procedures, were used to validate the information obtained from the key informant interviews.

The data from the individual interviews were categorized for qualitative analysis. The data provided an overall understanding of patient trajectories and local practices and were used to fill in gaps which other methods had missed. The observational interviews provided information on the sub-unit level of enquiry, and focused on clarification of decisions related to mechanical ventilation. The observational interviews were conducted as part of the observational data and were analyzed as part of the "decision data". Some of the data were coded and combined with observational data for quantitative analysis, while other were presented in narrative form. These data were cross-validated for consistency with the patient record and flow sheet.

The target interviews have been presented as context data. The interviews were conducted as in-depth interviews regarding the informants' views and perceptions of implicit mechanical ventilator practices. The data were analyzed qualitatively and quantitatively. As the four sites lacked explicit guidelines for mechanical ventilation, cross-validation was not possible. Rank-order data have been presented graphically and narrative data have been categorized and reduced to a set of principles.

The focus group interviews have also been presented as context data. The data have been sorted in two groups: The nurses' and the physicians' perceptions of good critical nursing qualities. The data are presented in narrative text.

4.2.4. Categories of documents in the present study

The mute evidence used in this study, consisted of two kinds of texts (1) laws and policy statements, and (2) patient records. Both categories of documents are considered "legal", but the character of the texts differ. The documents are: (1) Laws and policy statements from the sites and the Department of Health (Sundhedsstyrelsen 1996;Sundhedsstyrelsen 1997a;Sundhedsstyrelsen 1997b;Sundhedsstyrelsen 1998), and (2) Nurses' progress notes, doctors' progress notes, and flow sheets from the Patient records of the 14 study-patients.

The first category, laws and policies, are published text, which have been carefully edited and printed. These documents are decontextualized and were analyzed directly at face value. The second category, patient records, are unpublished texts, which are hand written or electronically written documents about the patient's progress. These documents are written on the spot in haste, without any editing or correction, and require contextual interpretation as they may contain errors or implicit meanings.

The patient record is also called the medical record. The term "patient record" indicates that the record may contain documents from fields other than medicine. The parts of the patient record included in this study were the nurses' progress notes, the doctors' progress notes, and the flow sheets. During each case trajectory the following documents were copied for further analysis: The doctor's daily progress note regarding respiration, the nurse's daily progress note regarding respiration, and the respiratory flow sheet. The patient identity was replaced by a code.
4. Research methods and avenues of analysis

4.2.4.1. Analysis of documents
The laws and policy statements from the Department of Health have been included in order to answer the questions:
- How are nurses' formal competencies r/t mechanical ventilator weaning described?
- How are nurses' formal qualifications r/t mechanical ventilator weaning described?

The patient record and flow sheet have been included in order to answer questions such as:
- How do executed ventilator changes relate to written ventilator change orders?
- How are ventilator setting changes documented?

The flow sheet items were recorded hourly either on paper or computer by the nurse. Some items on the computerized flow sheet were automatically recorded by the patient data management system. Direct observation revealed that the "flow sheets" at all four sites were wrought with errors and inconsistencies, which made it difficult to identify ventilator settings and changes. For this reason the analysis was conducted in two parts. The first part was aimed at describing the types of errors and inconsistencies on the flow sheets. The second part was aimed at reconstructing the ventilator trajectories, using contextual data, in order to get a picture of the actual ventilator settings.

The physician's progress notes were either dictated or hand written by the physician during rounds, and transcribed later by a secretary. The "respiratory" notes were analyzed and compared with the nurses' "respiratory" notes. The nurses' progress notes are either hand written or written on the computer by the nurse. The nurses' notes were usually written at the end of the shift many hours after rounds. The best way to interpret the patient record was to cross-check different sources and to follow trends. This way the context helps to understand the text and to uncover inconsistencies.

4.2.5. Questionnaire for nurse demographics
A questionnaire was used to collect the nurses' demographic data: Age, length of nursing experience, length of critical care experience, length of time at current site, and educational status. The key informants (Nurse Managers) were not able to accurately supply this information. The questionnaires were given to all nurses working at the four sites, except nurses on leave. The questionnaire at Site 1 was printed on green paper with a description of the study on the back side. The initial response rate was low, so the format was altered. The questionnaire was now printed on better paper and a separate sheet with information about the study was added. A total of 181 questionnaires were distributed and 145 were returned, yielding a final response rate of 80 percent after posting reminders. The remaining nurses who did not respond were either away on vacation or had not met the researcher in person. It was evident that the nurses most eager to respond were those who had actually spoken to the researcher and for whom the questionnaire and the project had meaning. All questionnaire data were recorded and transferred to a spread sheet by the researcher. All data were double-checked by the researcher.

4.2.5.1. Analysis of questionnaire data
The items on the questionnaires were transferred to the Excel™ data sheet and the material was calculated by site and then combined to a table including all the data in terms of mean, median and range. Educational level was given by numbers and percent in four mutually exclusive categories: Nurses not certified, nurses with old certification only, nurses with new certification only, and nurses with old and new certification. In order to see at a glance how many nurses were certified, the category "nurses with either new or old certification" was added to the table.
In addition to the demographic table, the following data were inferred, using the information from the questionnaire: Mean age of the nurses at graduation, mean age of the nurses when completing the critical care course, mean number of years from graduation to critical care certification, mean age when entering critical care, mean age when entering current ICU, and mean number of years in critical care before starting the critical care course.

4.3. Ethical considerations

Participants in observational and interview studies are always apt to be vulnerable and therefore utmost care must be taken to avoid any harm to the people involved. In some cases absolute anonymity may be guaranteed and in other cases it may be impossible to rule out any kind of recognition. The participants in this study are hospital staff (nurses and physicians) and patients. The case trajectories in the study have been altered slightly in order to protect the patients from recognition. The nurses' demographic data has been reduced to tables of averages which means that no particular nurse stands out. In relation to observations and interviews it has not been possible to promise absolute anonymity, but the data have been treated in such a way that recognition should be very difficult.

Participation in this study was not expected to pose a risk to the patients. I have taken care not to interfere with patient care or medical rounds. I have asked the participants if they had time for observational interviews and I have scheduled the other interviews according to the wishes of the participants. The patients were given code numbers on the registration sheet and the data sheet in order to protect the patients from identification. I have kept one single list of the patient's names in a secured place in order to be able to retrieve patient records and double-check data. This proved to be necessary.

The department heads, the nurse manager and head physician at each site, were given a copy of the research proposal. After meetings at each site I was granted permission to conduct the study at all of the four sites. The directors of nursing at all four hospitals were also given a copy of the research proposal and were informed about the study. A one-page written form with information about the project was given to each nurse in the four units. Another information document was handed out along with the questionnaire, and yet another was made available to the patients. I was given verbal consent from all participants in the study to conduct interviews. The study has been submitted to, and acknowledged by, the scientific ethical committee for the municipality of Copenhagen and Copenhagen County. The Act on Processing of Personal Data has been advised of the study.
5. Context findings

The findings in this chapter relate directly to the study-questions and will be presented in the same chronological order as the hypotheses and study-questions have been presented earlier (table 2.5.). The purpose of presenting findings related to contextual variations is to provide an understanding of the conditions and circumstances that surround and influence nurses' decisions related to mechanical ventilator weaning. The first part of this chapter describes nurses' competencies and qualifications, while the second part of the chapter offers cross-site comparisons of contextual factors at the four sites in the study.

5.1. Findings related to nurses' competencies and qualifications

In the following, nurses' formal and informal competencies and qualifications are explored in order to determine how competencies relate to qualifications. In the first section we will look at the formal competencies and qualifications, while the following sections will deal with the informal competencies and qualifications as perceived by the participants in the study. The aim is to gain an understanding of how competencies and qualifications influence nurses' participation in decision making.

Methods and sources

The formal competencies and qualifications were determined by interviewing the key informants at each site and by crosschecking with hospital policies and policies from the Department of Health (DOH). Also, direct observation and review of educational materials during the critical care course were done in order to determine nurses' level of knowledge related to mechanical ventilator weaning. The informal competencies and qualifications were explored by interviewing nurses and physicians and asking them to discuss: (1) the critical care nursing certification as a formal qualification for working in critical care, (2) the characteristics (informal competencies) of highly skilled nurses, (3) the relative complexity of certain ventilator settings, and (4) the range of nurses' independent ventilator decisions (informal competencies).

5.1.1. Formal competencies and qualifications of the nurses

How are nurses' formal competencies related to mechanical ventilator weaning described? DOH policies do not describe the specific authority of the nurse in relation to mechanical ventilator weaning (Sundhedsstyrelsen 1997a; Sundhedsstyrelsen 1997b). DOH guideline for administration of medications states that physicians may, with few exceptions, delegate any treatment tasks to authorized or unauthorized health personnel without regard to the helper's educational level or background (Sundhedsstyrelsen 1998). It is the responsibility of the physician to ensure that the helper has been properly instructed in order to safely carry out the task. Any verbal order must be put into writing as soon as possible.

The four sites in the study did not have formal job-descriptions for critical care staff nurses, and there were no written protocols in use for mechanical ventilator weaning. This meant that formally all ventilator changes should be ordered by a physician. When a physician ordered a ventilator change, the order followed the patient, not the nurse, and any nurse caring for that patient could in principle carry out that order. There was no formal evidence that the physician ensured that any particular nurse had been properly instructed. There was no demarcation of varying nursing levels at the four sites in the study, which meant that all nurses had the same formal competencies.

How are nurses' formal qualifications related to mechanical ventilator weaning described? Formal qualifications refer to required experience and education (skills and knowledge) for a particular job.
The four sites in the study did not require nurses to take the critical care certification course. If, however, nurses did take the certification course, the DOH policies regarding critical care nursing education specifically state that the course curriculum should include systematic theory of respiratory failure and mechanical ventilation strategies (Sundhedsstyrelsen 1997b). DOH policy states that the aim of the critical care course is to qualify the nurse for work in critical care because the basic nursing education is inadequate (Sundhedsstyrelsen 1997b). This means that certification does not increase the formal competency of the nurse, but rather, that a nurse without certification is not considered qualified to work in ICU according to the DOH (Sundhedsstyrelsen 1997a). In this regard, the critical care course is interpreted as a formal qualification for work in ICU.

5.1.2. Informal competencies and qualifications of the nurses

5.1.2.1. Perceptions of nurse preparation

How do nurses and physicians perceive the purpose of critical care nursing certification? Nurses' and physicians' perceptions of the purpose of the critical care nursing education were explored in order to determine the relation between certification, competency, and qualifications. The study showed that there was consensus among nurses and physicians in that the critical care course primarily served as a personal benefit to the nurses. It was assumed by the participants that certified nurses gained greater job-satisfaction and self-esteem through increased knowledge. The participants agreed that certification was part of a retention strategy, which would benefit the hospitals. The participants were ambivalent as to whether certification should lead to increased formal competencies, and none of the participants explicitly related certified practice to better patient outcomes. In this way the benefit of certified practice was related to the nurse rather than to the patient. Many nurses regarded it as a privilege to be offered the critical care course after putting in years in ICU. Critical care certification was regarded as a reward rather than a prerequisite for work in critical care.

Level of nursing: Physicians and nurses stated that there was not necessarily a difference between certified and non-certified practice. Some participants went as far as to say that there was not necessarily a difference between the care provided by nurses and nursing aides, because the nursing aides' level of experience made up for nurses' level of education. The nurses generally valued experience more than education, while the physicians valued education, but did not feel that education could qualify nurses to make independent treatment related decisions, e.g. ventilator changes, without medical guidance.

Professional boundaries: The nurses did not necessarily feel that certification should increase their formal competencies. Most nurses reproved the mismatch between qualifications and competencies, but not all nurses wanted more responsibility. The nurses and physicians were generally not concerned about the overlapping boundaries between their disciplines. Rather, the participants tacitly accepted the fact that nurses had a degree of freedom to act independently outside their formal boundaries. In this way the physicians did not lose their domain of authority and the nurses did not gain too much responsibility.

Interdisciplinary collaboration: One physician held that "the competency of the nurse increases when the physician knows the nurse", and went on to explain that nurses' competency should not be gained permanently through education (formal qualifications), but should be bestowed ad hoc (informally) at the discretion of the individual physician. This, however, would only apply to verbal orders, as written orders followed the patient, not the nurse. Several physicians stated that weaning was facilitated when the physician knew the nurse, and one physician said: "I am not afraid of
giving an order [for ventilator changes] when I know the nurse". Again, it was more important for the physician to know the nurse personally, than to rely upon the formal qualifications of the nurse.

Certification: The physicians viewed the present as a time of transition and expected that critical care specialization would ultimately become mandatory. One physician professed, "in ten years all nurses will be certified", and expressed that there was a general trend toward professional specialization and certification, e.g. certification has been mandatory for nurse anesthetists for years. The nurses, however, for pragmatic reasons (i.e. high cost, high turnover), did not expect that certification would become mandatory any time in the immediate future.

5.1.2.2. Perceptions of nurse performance

Methods and sources

Groups of inexperienced nurses and groups of physicians participated in focus group interviews in order to discuss the defining characteristics of highly skilled critical care nurses. The purpose was to explore how experience relates to informal competencies. The themes have been analyzed and presented according to the categories in the Synergy Model, tables 5.1. and 5.2.

How do nurses and physicians describe the defining characteristics of highly skilled nurses? The physicians emphasized the cognitive aspects of knowledge and good judgment combined with signs of collaboration, cooperation, reliability and openness. Although physicians valued independence, it was clear that nurses who failed to follow orders came across to the physicians as stubborn and less highly skilled. The nurses emphasized the intuitive aspects of anticipation, preparedness, and knowing "where the patient is", which mirrored the skills that the inexperienced nurses had yet to acquire.

Table 5.1. The defining characteristics of highly skilled nurses according to the physicians

| Clinical judgment | - Ability to anticipate and set priorities | - Good judgment: Know when to work independently and when to ask the physician |
| - Good knowledge of critical care | - Good observation skills, motivated |
| - Know professional boundaries [toward physician], not get out of step | - Vigilant and able to withhold intervention while assessing the patient (not acting rashly) |
| Advocacy/moral agency | - Maintain a good relation to patient's family and act as patient advocate |
| - Know personal boundaries [toward patient], not display feelings |
| Collaboration | - Ability to collaborate, a team player |
| - Ability to cooperate, be trustworthy, reliable, accountable, committed |
| - Ability to follow orders and remain loyal towards joint decisions |
| - Work independently within a framework set by the physician |
| - Work independently, but stick with prior agreements |
| Systems thinking | - Sensitive to the needs of the entire ward |
| Clinical inquiry | - Ability to "let go" of "fixed ideas" - a flexible mindset |
| - Ability to understand the physician and go beyond personal knowledge |
| - Flexible, not stubborn, open to new suggestions, open-minded |
Table 5.2. The defining characteristics of highly skilled nurses according to the nurses

<table>
<thead>
<tr>
<th>Clinical judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ability to anticipate what will happen - know &quot;where the patient is&quot;</td>
</tr>
<tr>
<td>- Ability to think ahead, be prepared, have things ready</td>
</tr>
<tr>
<td>- Ability to distinguish pain from restlessness</td>
</tr>
<tr>
<td>- Ability to stay calm with reserves of energy</td>
</tr>
<tr>
<td>- Have a good grasp of situation, be on top of things, know the rules</td>
</tr>
<tr>
<td>Advocacy/moral agency</td>
</tr>
<tr>
<td>- Maintain a good relation to patient's family</td>
</tr>
<tr>
<td>Caring practices</td>
</tr>
<tr>
<td>- Have an instinctive feel for the patient - know &quot;where the patient is&quot;</td>
</tr>
<tr>
<td>Collaboration</td>
</tr>
<tr>
<td>- Ability to anticipate the reaction of the physician</td>
</tr>
<tr>
<td>Systems thinking</td>
</tr>
<tr>
<td>- Make the ward function and help out where it is needed</td>
</tr>
</tbody>
</table>

5.1.2.3. Perceptions of ventilator complexity and nurse authority

The most frequently used ventilator setting changes were explored in order to gauge the complexity of nurses' independent ventilator decisions.

Methods and sources

Individual target interviews with experienced nurses and senior physicians were conducted in order to determine their perceptions of the relative complexity of hypothetical ventilator changes and the informal authority of the nurses related to mechanical ventilation. The participants were asked to:

1. Rank the different ventilator parameters (setting changes) according to relative complexity.
2. Indicate which of these ventilator changes nurses are capable of performing.
3. (Nurses were asked) Have you at some point performed any of these ventilator changes independently?
4. (Physicians were asked) Which of these ventilator changes do nurses perform independently?

The interview guide contained seven items, which the respondents were asked to discuss and rank. The items were changes of FiO2, Pressure, Volume, Mode, Frequency, PEEP, and I:E ratio. Each item was discussed in relation to range, e.g. high-range FiO2 or low-range FiO2. More than one item could be given the same rank. It was generally assumed by all participants, that nurses routinely performed the least complex ventilator alterations independently, and that physicians consistently made the most complex changes. The "target" of the interview was to discuss which alterations nurses actually performed, not what they were permitted to or ordered to perform.

How do nurses and physicians perceive the relative complexity of certain ventilator settings?

The study shows that there is generally consensus among nurses and physicians regarding the relative complexity of ventilator setting changes, figures 5.2. and 5.3. The lowest rank is given to the least complex ventilator change, while the highest rank is given to the most complex change. There was little variation across the four sites, but the strength of the findings does not lie in the numbers, as the data is insufficient for statistical analysis. The findings are evaluated by the content of the target interviews, which were conducted according to the interview guide, please see "Appendix 10.4. The Complexity of the Ventilator Changes".
How do nurses and physicians perceive the range of nurses’ independent ventilator decisions?
While cross-site, cross-disciplinary consensus was high regarding the relative complexity of the ventilator changes, there was disagreement regarding which alterations nurses actually performed. According to the survey, nurses make more ventilator changes than physicians perceive that they make. Figure 5.4. shows the nurses' perceptions, and figure 5.5. shows the physicians' perceptions. The blue column indicates which alterations are made by nurses, while the red column shows which alterations are made by the physicians. These findings vary across the disciplines as well as across the sites, giving nurses more informal authority at Sites 1 and 3, less at Site 4, and less yet at Site 2.

**Figure 5.4. Nurses' perception of nurses' range of decision making**

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Ingrid Egerod

Mechanical ventilator weaning in the context of critical care nursing
5. Context findings

When nurses alter mechanical ventilation, the focus is directed toward (1) a task (a ventilator change) or (2) a target (an expected patient response). The boundaries for the nurses' informal range of authority are self-imposed because independent interventions are not formally prescribed. This means that the informal competencies of the nurses are idiosyncratic. The findings from the target interviews have been categorized, and show that nurses and physicians perceive that nurses' decisions related to mechanical ventilator changes are contingent upon the factors shown in table 5.3.

Table 5.3. Factors influencing nurses' mechanical ventilator weaning decisions

<table>
<thead>
<tr>
<th>Qualifications</th>
<th>The education and experience of the nurse.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaboration</td>
<td>The nurse's ability to predict the response of the physician, prior agreements.</td>
</tr>
<tr>
<td>Tradition/values</td>
<td>The personal preference of the nurse or physician.</td>
</tr>
<tr>
<td>Degree of change</td>
<td>The change related to range, direction and size of increment.</td>
</tr>
<tr>
<td></td>
<td>- The <strong>range</strong> of change (high or low range, more dependent or less dependent)</td>
</tr>
<tr>
<td></td>
<td>- The <strong>direction</strong> of change (increasing or decreasing the ventilator support)</td>
</tr>
<tr>
<td></td>
<td>- The <strong>size</strong> of change (large or small increments of change)</td>
</tr>
<tr>
<td>Complexity of change</td>
<td>The features of the situation.</td>
</tr>
<tr>
<td></td>
<td>- The <strong>patient's condition</strong> (critical or stable)</td>
</tr>
<tr>
<td></td>
<td>- The <strong>patient's prior ventilator experience</strong> (setting tried before)</td>
</tr>
<tr>
<td></td>
<td>- The <strong>trajectory</strong> (current stage of weaning)</td>
</tr>
<tr>
<td></td>
<td>- The time of day (day, evening, or night shift)</td>
</tr>
<tr>
<td>Consequences</td>
<td>The risk to the nurse or the patient.</td>
</tr>
<tr>
<td>Equipment</td>
<td>The characteristics of the ventilator.</td>
</tr>
</tbody>
</table>

The responses of the nurses and physicians varied at each site and across the sites. The participants agreed on the relative complexity of the parameters, but disagreed on the particular circumstances regarding range, direction, size, patient condition, patient's prior experience and stage of weaning. The nurses and physicians perceived that an unwritten guideline regarding the rules for alteration of mechanical ventilation and mechanical ventilator weaning existed. The findings in the present study demonstrate that implicit norms for mechanical ventilation do not exist, as each participant had a different perception of the unwritten guideline. A more detailed account of the target interviews is presented in "Appendix 10.4. The Complexity of Ventilator Changes".
5. Context findings

5.1.3. Summary of the competencies and qualifications of the nurses

Policy review and key informant interviews: The competencies and qualifications of the nurses were explored in order to evaluate the first study hypothesis. The study has shown that the formal competencies of the staff nurses do not change over time at the four sites in the study, which means that the formal competencies do not increase when the formal qualifications increase. Critical care certification is not required at the four study sites. According to the DOH, critical care certification does not increase the formal competencies of the nurse, but rather, a nurse without certification is not considered qualified to work in ICU. This makes certification a formal qualification for work in ICU. In this respect, it can be argued that the hospitals do not follow the recommendations of the DOH. According to written hospital policies, nurses do not have any particular formal competencies in relation to mechanical ventilator weaning, but the critical care course does include systematic theory of respiratory failure and mechanical ventilation.

Individual interviews: The participants' perceptions of the critical care course show that certification was regarded as a personal benefit to the nurses rather than a formal qualification. Certification was viewed as a reward rather than a prerequisite for work in critical care. Certified practice was not related to patient outcome. The physicians perceived the competencies of the nurses to be a function of how well the physician knew the nurse, rather than a function of their formal qualifications. The participants tacitly accepted the fact that nurses had a degree of freedom to act independently outside their formal boundaries, which meant that the physicians did not lose their domain of authority and the nurses did not gain too much responsibility. This truce increased the nurses' informal competencies to make decisions related to mechanical ventilator weaning.

Focus group interviews: The defining characteristics of highly skilled nurses were described by the physicians in terms of cognitive abilities, while inexperienced nurses highlighted intuition. The perceived virtues of highly skilled nurses reflected the shortcomings of lesser nurses in the eyes of the informant. The physicians described highly skilled practice in terms of independence combined with the ability to cooperate, follow orders, and work within a framework set by the physicians, while inexperienced nurses emphasized the ability to stay calm and think ahead, reflecting skills they had yet to learn.

Target interviews: The findings regarding ventilator complexity and nurse authority suggest interdisciplinary cross-site consensus regarding the relative complexity of certain ventilator changes, but disagreement regarding the range of nurses' decisions related to mechanical ventilator weaning. Experienced nurses appeared to work more independently than physicians would acknowledge. The boundaries for the nurses' informal range of authority are determined ad hoc, either by individual physicians or by virtue of the personal judgment of the individual nurse, which means that the informal competencies of the nurses are idiosyncratic. The participants perceived that implicit norms for mechanical ventilator weaning existed, but the study demonstrated that such implicit norms did not exist.

Hypothesis (1), "Nurses' competencies related to mechanical ventilator weaning increase as nurses' qualifications increase", is partially supported by the findings in the study. The formal competencies of the nurses do not increase as the formal qualifications increase, but the informal competencies increase gradually as the formal and informal qualifications increase.
5. Context findings

5.2. Cross-site comparison of the four sites in the study
This part provides cross-site comparisons of the four sites in the study on three levels. The first level is demographic and includes patient categories, personnel categories, and nurses' professional characteristics. The second level is organizational and includes staffing ratio, staffing principles, and meeting practices. The third level is clinical and includes mechanical ventilation practices and mechanical ventilator equipment.

Methods and sources
The following findings are based on key informant interviews, direct observation and review of hospital documents. The description of nurses' professional characteristics is based on a questionnaire. The data in this section are analyzed and presented for contrast and comparison.

5.2.1. Variations at the demographic level at the four sites
The four ICUs in the study are located at teaching hospitals which are part of the University of Copenhagen hospital system. Sites 1 and 2 are located within the city of Copenhagen while Sites 3 and 4 are located in Copenhagen County. Site 1 is one of several ICUs at Rigshospitalet (1181 beds), which was established in 1757 in central Copenhagen and moved outside the city moats in 1910. The hospital was rebuilt in the 1970's, and the ICU was rebuilt and moved to the third floor in 1996. Site 2 is the only ICU at Hvidovre Hospital (890 beds), which was built in the 1970's. Site 3 is the only ICU at Amtssygehuset i Herlev (711 beds), which was also built in the 1970's. And finally, Site 4 is the only ICU at Amtssygehuset i Gentofte (839 beds), which was built in the 1920's. The ICU is currently being expanded and renovated.

How do the patient categories vary at the four sites? The most common patient categories at the four sites are shown in table 5.4. The most complex patients are found at Site 1.

Table 5.4. Patient categories at the four sites

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
</table>

How do the personnel categories vary at the four sites? The categories of staff at each site are shown in table 5.5. Ward clerks, secretaries, orderlies, and housekeepers are not shown in the table.

Table 5.5. Personnel categories at the four sites

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians Registered nurses Nursing aides Bioanalyst Clinical pharmacist Physical therapist</td>
<td>Physicians Registered nurses Nursing aides</td>
<td>Physicians Registered nurses Nursing aides Bioanalyst</td>
<td>Physicians Registered nurses Nursing aides Physical therapist</td>
</tr>
</tbody>
</table>

How do the qualifications of the staff nurses vary at the four sites? The key informants were not able to supply sufficiently accurate information regarding the nurses' professional characteristics in order to make a comparative description. The required information was obtained by using a
context findings which was given to all nurses who were not on leave at the time of the study. The questionnaire included the items shown in table 5.6. A total of 181 questionnaires were distributed and 145 were returned, yielding a response rate of 80 percent, as shown in table 5.7.

Table 5.6. Questionnaire for nurses

<table>
<thead>
<tr>
<th>Variables</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>All sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name (optional)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Year of graduation</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Years in critical care</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Years at current site</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Do you have the old certification?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Do you have the new certification?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Are you currently taking the new certification course?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Are you currently upgrading with qualifications from the old course?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Nurses who had the old certification and were either upgrading or recertifying were put in the same category for analysis, in order to ensure that the categories "first-time certification" and "upgrade/recertification" were mutually exclusive. The demographic profile of the nurses at the four sites is shown in table 5.7. The term "certification" refers to either the old or the new critical care course. Some nurses had both the old and new certification, while other nurses had neither.

Table 5.7. Demographic profile of the nurses at the four sites (n=145)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
<th>All sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response rate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questionnaires Number (percent)</td>
<td>60 (100%)</td>
<td>27 (100%)</td>
<td>37 (100%)</td>
<td>57 (100%)</td>
<td>181 (100%)</td>
</tr>
<tr>
<td>Responses</td>
<td>46 (77%)</td>
<td>24 (89%)</td>
<td>27 (73%)</td>
<td>48 (84%)</td>
<td>145 (80%)</td>
</tr>
<tr>
<td>Years of age Mean (median)</td>
<td>37.2 (35.0)</td>
<td>35.9 (35.0)</td>
<td>38.5 (37.0)</td>
<td>37.1 (36.0)</td>
<td>37.2 (36.0)</td>
</tr>
<tr>
<td>Years in nursing Mean (median)</td>
<td>12.0 (10.0)</td>
<td>10.0 (8.0)</td>
<td>12.0 (10.0)</td>
<td>12.4 (11.0)</td>
<td>11.8 (10.0)</td>
</tr>
<tr>
<td>Years in critical care Mean (median)</td>
<td>7.5 (4.0)</td>
<td>4.6 (3.5)</td>
<td>7.3 (7.0)</td>
<td>6.8 (5.0)</td>
<td>6.7 (4.8)</td>
</tr>
<tr>
<td>Range</td>
<td>0 – 35</td>
<td>0 – 18</td>
<td>0 – 32</td>
<td>0 – 30</td>
<td>0 – 35</td>
</tr>
<tr>
<td>Years at present site Mean (median)</td>
<td>4.2 (2.5)</td>
<td>3.1 (2.0)</td>
<td>4.7 (3.5)</td>
<td>5.4 (4.0)</td>
<td>4.6 (3.0)</td>
</tr>
<tr>
<td>Range</td>
<td>0 – 27</td>
<td>0 – 18</td>
<td>0 – 22</td>
<td>0 – 24</td>
<td>0 – 27</td>
</tr>
<tr>
<td>Certified Nurses Number (percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not certified</td>
<td>20 (43%)</td>
<td>14 (58%)</td>
<td>7 (26%)</td>
<td>18 (38%)</td>
<td>59 (41%)</td>
</tr>
<tr>
<td>Old certification only</td>
<td>17 (37%)</td>
<td>8 (33%)</td>
<td>14 (52%)</td>
<td>22 (46%)</td>
<td>61 (42%)</td>
</tr>
<tr>
<td>New certification only</td>
<td>6 (13%)</td>
<td>2 (8%)</td>
<td>0 (0%)</td>
<td>3 (6%)</td>
<td>11 (8%)</td>
</tr>
<tr>
<td>Old and New certification</td>
<td>3 (7%)</td>
<td>0 (0%)</td>
<td>6 (22%)</td>
<td>5 (10%)</td>
<td>14 (10%)</td>
</tr>
<tr>
<td>Old or New certification</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number certified</td>
<td>26 (57%)</td>
<td>10 (42%)</td>
<td>20 (74%)</td>
<td>30 (62%)</td>
<td>86 (59%)</td>
</tr>
<tr>
<td>Nurses certifying Number (percent)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Certifying 1st time</td>
<td>5 (11%)</td>
<td>6 (25%)</td>
<td>2 (7%)</td>
<td>15 (31%)</td>
<td>28 (19%)</td>
</tr>
<tr>
<td>Upgrading</td>
<td>1 (2%)</td>
<td>2 (8%)</td>
<td>10 (37%)</td>
<td>16 (33%)</td>
<td>29 (20%)</td>
</tr>
<tr>
<td>Certifying or upgrading</td>
<td>6 (13%)</td>
<td>8 (33%)</td>
<td>12 (44%)</td>
<td>31 (65%)</td>
<td>57 (39%)</td>
</tr>
<tr>
<td>Not certified and not certifying</td>
<td>15 (33%)</td>
<td>8 (33%)</td>
<td>5 (19%)</td>
<td>3 (6%)</td>
<td>31 (21%)</td>
</tr>
</tbody>
</table>

Table 5.7. shows that the median age of the total population is 36, and 31% of the nurses younger than 36 years (n=71) are certified, while 86% of the nurses 36 years or older (n=74) are certified. The mean age of certification is 35 years (n=28) for first-time certification, and 38 years (n=29) for nurses upgrading. The table shows that half of the nurses in the population have worked three years or less at the current site, which is evidence of high turnover, especially at Sites 1 and 2.
Ingrid Egerod  Mechanical ventilator weaning in the context of critical care nursing

Table 5.8. Cross-site comparison of ICU experience

<table>
<thead>
<tr>
<th></th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurses' mean number of years of ICU experience</td>
<td>7.5</td>
<td>4.6</td>
<td>7.4</td>
<td>6.8</td>
</tr>
<tr>
<td>Percent of nurses with &gt; 10 years ICU experience</td>
<td>24%</td>
<td>8%</td>
<td>22%</td>
<td>29%</td>
</tr>
</tbody>
</table>

The data in tables 5.7. and 5.8. show that Site 2 differed from the other three sites in that the nurses were younger, had less nursing experience, had less critical care experience, had less experience at the current ward, and fewer of the nurses were certified. By contrast, approximately 25 percent of the nurses at Sites 1, 3, and 4, had ten years or more critical care experience.

The mean age of the total population was 37, and a mere 14 percent of the nurses were more than 45 years of age. The following findings can be inferred from the nurse questionnaire database and represent an estimate of averages:

1. The mean age when graduating from nursing school is 25 years of age.
2. The mean age when completing the critical care course is 37 years of age.
3. The mean number of years from graduation to critical care certification is 12 years.
4. The mean age when entering critical care is 30 years of age.
5. The mean age when entering the current intensive care unit is 32 years of age.
6. The mean number of years in critical care before starting the critical care course is 5 years.

The nurse questionnaire database shows that some nurses are actually certified sooner and others later, but the estimate clearly demonstrates that the mean age at certification, 37 years, coincides with the mean age of the population, 37 years, which also marks the turning point when nurses start to move away from the critical care area.

5.2.2. Variations at the organizational level at the four sites

How do the nurse-to-patient staffing ratios vary at the four sites? The staffing ratios were in a state of flux at the time of the study. All sites were going through major transitions. Site 1 was in the process of expanding from 12 to 16 beds, while Site 2 had just reduced from 8 to 6 beds. Site 3 was planning to expand from 6 to 8 beds, and Site 4 was preparing to expand from 12 to 16 beds after the time of the study. Table 5.9. shows the number of beds and number of nurses working at the time of the data collection. The table shows that the nurse-to-patient ratio varied at the four sites, and that especially Site 2 and Site 3 had different nurse-to-patient ratios, while they had similar nurse-to-room ratios. The layout of the unit, expressed in terms of nurse-to-room ratio, affects the skill mix, expressed in terms of nurse-to-patient ratio. This was recognized at Site 4, where the nurse manager stated that one experienced nurse should be assigned to each triple-capacity room, while Site 3 had to assign an experienced nurse to each single-capacity room. In this way the skill-mix could compensate for lower nurse-to-patient ratio.

Table 5.9. Nurse-to-patient and nurse-to-room ratios at the four sites

<table>
<thead>
<tr>
<th>Capacity and staff*</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of beds (patients)</td>
<td>12</td>
<td>6</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Number of patient rooms</td>
<td>8</td>
<td>4</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Number of nurses</td>
<td>60</td>
<td>27</td>
<td>37</td>
<td>57</td>
</tr>
<tr>
<td>Number of nursing aides</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Nurse-to-patient ratio</td>
<td>5.0</td>
<td>4.5</td>
<td>6.2</td>
<td>4.8</td>
</tr>
<tr>
<td>Nurse-to-room ratio</td>
<td>7.5</td>
<td>6.8</td>
<td>6.1</td>
<td>14.3</td>
</tr>
</tbody>
</table>

*The numbers in table 5.9. do not reflect the distribution of nurses working full-time and part-time.
5. Context findings

How do staffing practices vary at the four sites? Staffing practices are explored because they are linked to concepts of "continuity" and "knowing the patient", which are regarded to be important to nurses' decision making process. Site 1 used a modified version of primary nursing, which is a staffing system in which one nurse is responsible for the total care of a patient with goal of providing comprehensive, individualized, and consistent care. At Site 1 primary nursing was reduced to signify that one or several nurses more consistently were assigned to a particular patient.

The key informants at all four sites stated that prior to each shift the nurse in charge makes out the patient assignments. None of the sites used written staffing standards and there was no demarcation of the nurses' individual levels of skill related to patient care, only in relation to teaching. Key informants regarded continuity as paramount to staffing practices, but none of the informants were able to define the concept of continuity. Examples of continuity were given as:

- Days in a row (consecutive continuity): Same nurse on consecutive days or shifts.
- Recurring days (cumulative continuity): Same nurse on recurring days.
- Primary nursing (personal continuity): One nurse with primary responsibility.
- Nursing teams (shared continuity): Several nurses with primary responsibility.
- Documentation practices (written continuity): Same patient record for all nurses.

Table 5.10. shows the staffing principles according to the key informants. The choices are prioritized and show that the perceived staffing principles are dissimilar at the four sites. None of the categories were defined.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Expertise</td>
<td>Teaching</td>
<td>Continuity</td>
<td>Continuity</td>
</tr>
<tr>
<td>2</td>
<td>Primary nurse</td>
<td>Continuity</td>
<td>Expertise</td>
<td>Expertise</td>
</tr>
<tr>
<td>3</td>
<td>Continuity</td>
<td>Expertise</td>
<td>Teaching</td>
<td>Teaching</td>
</tr>
<tr>
<td>4</td>
<td>Teaching</td>
<td></td>
<td></td>
<td>Special skill</td>
</tr>
<tr>
<td>5</td>
<td>Special request</td>
<td></td>
<td></td>
<td>Special request</td>
</tr>
</tbody>
</table>

The key informant at Site 1 stated that the most complex patient needed the most highly skilled nurse, while the key informant at Site 2 said that the principle was to assign a less experienced nurse to the most complex patient, with some degree of supervision, so that the new nurse could learn the ropes. The key informants at Sites 3 and 4 prioritized continuity over expertise.

How do meeting practices vary at the four sites? The purpose of this question is to explore venues of interdisciplinary collaboration. According to the key informants, most mechanical ventilator decisions were made at (1) the bedside, (2) morning medical rounds, and (3) noon interdisciplinary conference. It was found that the morning medical rounds were conducted at the bedside and outside the patient-rooms where the paper flow sheet was located at Sites 1 and 3. At Sites 2 and 4 the rounds were conducted in the patient-rooms because there was a computer at each bedside. The conference rooms were located in varying proximity to the patient-rooms at the four sites, which meant that the nurses' chances of attending interdisciplinary conferences varied because they were contingent upon the physical layout. At Site 1 the conference room was situated at such a distance from the patient-rooms that only one nurse could participate in interdisciplinary conferences at a time. At Site 2 the conferences were held in a glassed-in room facing the patient-rooms and most nurses participated in the conference. At Site 3 the conference room was one hall away from the patient-rooms, but much care was taken to include as many nurses as possible. At Site 4 the nurses did not participate in noon conferences.
The interdisciplinary conferences varied at the four sites. At Site 1 there were more physicians than nurses present and the conference was seen as an opportunity to teach junior physicians. The nurses entered by turn when their patient was being discussed, and felt that this was "token" collaboration. At Site 2 more nurses than physicians were present. The staff nurse or physician would present their patient, and the decisions made at rounds were discussed. At Site 3 an equal number of nurses and physicians were usually present and either staff nurse or physician would present their patient and decisions made at rounds. This was an opportunity for interdisciplinary teaching and discussions.

5.2.3. Variations at the clinical level at the four sites

How do mechanical ventilation practices vary at the four sites? The four sites in the study had different mechanical ventilator equipment and also different informal strategies for ventilator treatment and weaning. None of the four sites used protocols for mechanical ventilator weaning or for the timing of tracheotomy. Table 5.11. shows the preferred weaning strategies at the four sites, according to the head physicians. Sites 1, 3, and 4 had a primary and competing weaning strategies. The competing strategy was described at Site 4 more as the result of a battle of wills, than as an option to individualize the strategy according to the needs of the patient.

Table 5.11. Informal mechanical ventilator weaning strategies at the four sites

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary strategy:</strong></td>
<td><strong>Primary strategy:</strong></td>
<td><strong>Primary strategy:</strong></td>
<td><strong>Primary strategy:</strong></td>
</tr>
<tr>
<td>PRVC to VS with decreasing volume.</td>
<td>PC to PS with decreasing pressure.</td>
<td>PC to PS with decreasing pressure.</td>
<td>VC with SBT.</td>
</tr>
<tr>
<td><strong>Competing strategy:</strong></td>
<td><strong>Competing strategy:</strong></td>
<td><strong>Competing strategy:</strong></td>
<td><strong>Competing strategy:</strong></td>
</tr>
<tr>
<td>PRVC to PS with decreasing pressure.</td>
<td>None. VC and PRVC are never used.</td>
<td>None. VC and PRVC are never used.</td>
<td>PC to PS with decreasing pressure.</td>
</tr>
</tbody>
</table>

How does the mechanical ventilator equipment vary at the four sites? Table 5.12. shows the type and number of ventilators at each site. According to the physicians the advantage to having only one type of ventilator is that all staff members are familiar with every machine, which increases patient safety. On the other hand, the advantage to having a variety of ventilator types is that it increases the learning opportunities for junior physicians. At Site 3, the choice of ventilator could be up to the nurse, if the patient was intubated in the emergency room. At Site 4, Servo 900 A and B were used for open-heart patients, while Servo 900 C was reserved for more complex patients.

Table 5.12. Mechanical ventilation equipment at the four sites

<table>
<thead>
<tr>
<th>Ventilators</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type (number)</strong></td>
<td>Servo 300 (20)</td>
<td>Servo 900 B (2)*</td>
<td>Evita 2 (1)</td>
<td>Servo 900 A or B (10)*</td>
</tr>
<tr>
<td>Servo 900 C (4)</td>
<td>Servo 900 C (4)</td>
<td>Servo 4 (2)</td>
<td>Servo 900 C (6)</td>
<td></td>
</tr>
<tr>
<td>Servo 300 (3)</td>
<td>Servo 300 (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Ventilator/patient** | 20/12 = 1,7 | 9/6 = 1,5 | 8/6 = 1,3 | 16/12 = 1,3 |

*Ventilators with volume control only.

Table 5.12. shows that the mechanical ventilation equipment was dissimilar at the four sites in the study and that this had an impact on the range of decisions related to mechanical ventilator weaning. The onset of weaning is more imperceptible when using the more advanced ventilators, because PS with gradual pressure reduction may be viewed as a comfort measure as well as a weaning strategy, or both. The older ventilators are not constructed for weaning and it is more obvious that weaning starts when spontaneous breathing trials are initiated.
5. Context findings

5.2.4. Summary of the cross-site comparisons of the four sites in the study

The cross-site comparisons were carried out in order to evaluate the second study hypothesis. The findings show that the conditions and circumstances for nurses' decision making vary according to contextual factors at the demographic, organizational, and clinical levels. Lack of standardization made the four sites dissimilar and prone to reliance upon local traditions and personal preferences.

**Questionnaire:** The nurses' professional characteristics were similar at the four sites in that the mean age was approximately 37, coinciding with the age when the nurses completed the critical care course as well as the age when the nurses chose to leave the critical care area. The professional characteristics were dissimilar in that Sites 3 and 4 had the highest percentage of certified critical care nurses and the lowest rate of turn-over, while Site 2 had the youngest nurses with the least amount of experience and education. Sites 1 and 4 had the greatest proportion of nurses with more than ten years of ICU experience.

**Key informant interviews and direct observation:** Variations in staffing practices, meeting practices, mechanical ventilation practices and equipment had an impact on nurses' prospects of participating in decisions related to mechanical ventilator weaning. The use of primary nursing at Site 1 increased the chances of upholding better nurse-to-patient continuity, and thereby a stronger background for decision making. The high nurse-to-room ratio at Site 4 made it possible to staff each room with a highly competent nurse at all times, who could maintain a higher level of skill and decision making potential. The practice of including nurses in the interdisciplinary conferences at Sites 1, 2, and 3 increased the nurses' chances of participating in decision making. Special care was taken at Sites 2 and 3 to include the nurses at the conferences. The use of several different weaning strategies, coupled with more advanced equipment at Sites 1 and 3 increased the range of nurses' decision potential, but the variation in equipment at Site 3 also increased the risk of unfamiliarity with a particular ventilator.

The findings suggest that nurses' prospects of participating in mechanical ventilator weaning decisions at the four sites were similar at a formal level due to unvarying formal competencies, but dissimilar at an informal level, where practices varied according to local traditions, personal preferences, and inhomogeneous competencies and qualifications of the nurses.

It cannot be concluded that any one site was superior in all respects regarding the nurses' prospects of participating in decision making. The nurses at Site 4 had more experience and educational preparation, but were not invited to participate in interdisciplinary conferences. The nurses at Site 1 had less preparation and a higher rate of turn-over, but compensated by using primary nursing. The nurses at Site 2 had the least experience and preparation, but more nurses participated in interdisciplinary conferences than at any other site. It can be summarized, that nurses' prospects of participating in mechanical ventilator decisions vary at the four sites in the study.

Hypothesis (2), "Nurses’ prospects of participating in decisions related to mechanical ventilator weaning vary across the four sites in the study according to contextual factors", is partially supported by the findings in the study. At the formal level the nurses' prospects of participating in decision making are similar at the four sites because all nurses have the same formal competencies and because mechanical ventilation is not formally within the boundaries of nursing practice. At the informal level the nurses' prospects of participating in decision making vary according to the contextual factors: nurses' experience and educational preparation, staffing practices, meeting practices, mechanical ventilation practices, and mechanical ventilator equipment.
6. Case findings

The findings in this chapter represent the main unit of enquiry in the study. The cases are the 14 mechanical ventilator weaning trajectories at the four sites. In the first section of this chapter each case is presented separately in order to provide a background for understanding the following sections, which include the daily mode variations, the weaning progress, the sedation practices, the staffing patterns and the nurse potential. The main hypothesis under investigation in this chapter is hypothesis (3): "Mechanical ventilator weaning is facilitated when nurses actively participate in decision making". Each ventilator change is an event in the mechanical ventilator weaning trajectory and represents a "ventilator decision".

6.1. Case review – The cases

How do the weaning stages evolve through the mechanical ventilator trajectories? The purpose of this question is to gain familiarity with the individual cases and to illustrate some of the main events in each trajectory. The following case review shows that each mechanical ventilator trajectory may include more than one weaning continuum and that the stages of weaning are not clearly defined.

Methods and sources

The data in this chapter derive from direct observation and chart review. The findings are analyzed and presented by individual case review. The cases are described in terms of complexity: Critical, typical, extreme, simple, complex, and maximum variation (table 3.5.). Chapter 7 provides a more comprehensive description of collection and analysis of the flow sheet data. The cases are presented by a brief patient history including events related to the trajectory. The cases are illustrated by the daily mode pattern each morning at 06:00 in order to give a visual impression of the trajectories. For additional information regarding the mode variations and the weaning progress, please look at "Appendix 10.5. The Mode Variations" and "Appendix 10.6. The Weaning Progress and Patterns".

Case 1 (Site 1)

Female aged 52 admitted for liver transplant. Post surgical course complicated by bleeding disorders, neuropathy, and ventilator dependency. Initial (oral) intubation (day 1), tracheotomy (day 60), sustained unassisted breathing (day 71), decannulation (day 106), transfer to ward (day 110). ICU length of stay 110 days, intubation 106 days (oral and tracheal airway), mechanical ventilation 71 days, tracheotomy 50 days. Figure 6.1.1. shows a maximum variation case consisting of one weaning continuum with unclear points of transition. Outcome: Spontaneous breathing.

Figure 6.1.1. Mode at pattern daily at 06:00 Case 1
6. Case findings

Case 2 (Site 1)
Female aged 55 admitted with severe burns. Course complicated by CO poisoning, inhalation trauma, blast trauma, burn toxins, edema, and ARDS. Exsanguination and death following necrectomy (day 15) two weeks status post burn accident. Initial (oral) intubation (day 1), brief spontaneous breathing (day 12), and death (day 16). ICU stay 16 days, intubation 16 days, mechanical ventilation 16 days. Figure 6.1.2. shows a typical case consisting of one weaning continuum and few events. Outcome: Death.

Figure 6.1.2. Mode at pattern daily at 06:00 Case 2

Case 3 (Site 1)
Male aged 42 admitted with burns and CO poisoning. Treated twice in decompression chamber. (Continuum A) Initial (oral) intubation (day 1), CPAP via ventilator (day 4), extubation (day 8). (Continuum B+C) Intubation for surgery (day 16), extubation (day 18), reintubation (day 19), extubation (day 21), (Continuum D) intubation for surgery (day 23), extubation (day 25). The patient was transferred to the regular ward between day 10 and 15. ICU stay 20 days, mechanical ventilation 19 days, intubation 19 days. This is a maximum variation case consisting of three weaning continua, two of which follow surgeries. Figure 6.1.3. shows the three weaning continua, A, B+C, and D. Outcome: Spontaneous breathing.

Figure 6.1.3. Mode at pattern daily at 06:00 Case 3
Case 4 (Site 1)
Male aged 59 admitted with pancreatitis, uremia and respiratory distress. Medical treatment was complicated by sepsis, ascites, and exacerbation of respiratory distress. History of drinking. Initial (oral) intubation (day 1), accidental extubation and reintubation (day 13), accidental extubation and reintubation (day 14), tracheotomy (day 14), death (day 18). ICU stay 18 days, mechanical ventilation 18 days. Figure 6.1.4. shows an extreme case, illustrating an unusual trajectory, consisting of one weaning continuum with several accidental extubations. The transition to the weaning stage is unclear. Outcome: Death.

Figure 6.1.4. Mode at pattern daily at 06:00 Case 4

Case 5 (Site 2)
Female aged 71 admitted with paralytic ileus, sepsis, and respiratory distress one month status post nephrectomy. Course complicated by multi-organ failure. Initial intubation (day 1), tracheotomy (day 8), death (day 12). ICU stay 14 days, intubation 12 days, mechanical ventilation 12 days. Figure 6.1.5. shows a simple case consisting of one weaning continuum and only few events. Outcome: Death.

Figure 6.1.5. Mode at pattern daily at 06:00 Case 5
Case 6 (Site 2)
Female aged 85 transferred from other hospital with pneumonia, currently on chemotherapy. Patient transferred due to high census at other facility. Patient included in study due to low census at Site 2. Terminal mechanical ventilator weaning initiated at Site 2 because of malignancy. Arrival (day 1), death (day 4). ICU stay 4 days, intubation 4 days, mechanical ventilation 4 days. Figure 6.1.6. shows a simple case consisting of one weaning continuum and only few events. The weaning attempts are not visible judging by the 06:00 mode only. Daily ventilator reduction is evident in "Appendix 10.5. The Mode Variations". Outcome: Death.

Figure 6.1.6. Mode at pattern daily at 06:00 Case 6

Case 7 (Site 2)
Female aged 72 admitted with acute MI. History of MI ten years before which was thrombolyzed. Patient not thrombolyzed this time. Initial (oral) intubation (day 1), supported breathing (day 2), extubation (day 3). ICU stay 4 days, intubation 3 days, mechanical ventilation 3 days. Figure 6.1.7. shows a critical case, consisting of one weaning continuum, which illustrates the core events. Outcome: Spontaneous breathing.

Figure 6.1.7. Mode at pattern daily at 06:00 Case 7
6. Case findings

Case 8 (Site 2)
Female aged 62 admitted with respiratory distress and hypercapnia, COPD, status post respiratory arrest and brief intubation. History of smoking. On admission non-invasive BiPAP, intubated later same day. Initial (oral) intubation (day 1), extubation (day 3), reintubation (day 5), tracheotomy (day 5), unassisted breathing (day 9), decannulation and transfer to ward (day 12). ICU stay 12 days, intubation 11 days, mechanical ventilation 8 days. Outcome: Spontaneous breathing.

Figure 6.1.8. shows a critical case consisting of two weaning continuia, first a "fast track" wean chased by a "sink-or-swim" extubation (day 3), then an incremental "slow sprint" wean (days 5-9).

Figure 6.1.8. Mode at pattern daily at 06:00 Case 8

Case 9 (Site 3)
Male aged 69 admitted with appendicitis was discharged without surgery and readmitted with perforated appendix. Complicated postoperative course with abdominal wound rupture and periods of psychosis. (Continuum A) Initial intubation (day 1), extubation (day 7), (Continuum B) reintubation (day 8), extubation (day 25), (Continuum C) reintubation (day 27), spontaneous breathing (day 28), extubation (day 30). ICU stay 33 days, intubation 27 days, mechanical ventilation 26 days. Figure 6.1.9. shows a maximum variation case consisting of three weaning continuia. Outcome: Spontaneous breathing.

Figure 6.1.9. Mode at pattern daily at 06:00 Case 9
Case 10 (Site 3)
Male aged 68 admitted with COPD, IDDM, and atrial fibrillation. History of smoking. Slow and difficult wean resulting in death after transferring to the regular ward. Initial intubation (day 1), accidental extubation (day 5). Spontaneous breathing 10h, then oral intubation (day 5). Tracheotomy (day 6). Patient married in ICU (day 18). Decannulation and spontaneous breathing (day 19). Transfer to ward (day 19). Death (day 20). ICU stay 19 days, intubation 19 days, mechanical ventilation 17 days. Figure 6.1.10. shows a maximum variation case which can be viewed as either one or two weaning continua. Outcome: Spontaneous breathing 12h and subsequent death.

Figure 6.1.10. Mode at pattern daily at 06:00 Case 10

Case 11 (Site 4)
Female aged 62 admitted with COPD, asthma and smoker's lung. Course complicated by ulcer around tracheotomy, aspergillosis, and finally death. Initial (oral) intubation (day 1), ventilator exchange due to ventilator breakdown (day 3), spontaneous breathing trials (day 5), extubation (day 6), nasal intubation (day 6), tracheotomy (day 6), replacement of tracheotomy tube (day 14), death (day 20). ICU stay 19 days, intubation days 19 days, mechanical ventilation 19 days. Figure 6.1.11. shows a complex case consisting of one weaning continuum. Outcome: Death.

Figure 6.1.11. Mode at pattern daily at 06:00 Case 11
Case 12 (Site 4)
Female aged 57 admitted with exacerbation of COPD with pneumonia and sepsis. History of smoking and drinking. Initial (oral) intubation (day 1), accidental extubation (day 3), reintubation (day 3) oral, extubation (day 6), reintubation (day 6) nasal, tracheotomy (day 7), spontaneous breathing (day 11), decannulation (day 13). ICU stay 13 days, intubation 12 days, mechanical ventilation 10 days. Nurses respond well to patient diversity. The patient needs to smoke in bed and so the nurses give the patient an imaginary cigarette, light the patient's imaginary cigarette, and empty the imaginary ash tray. This is done for days until the patient is weaned from the ventilator. Figure 6.1.12. shows a critical case consisting of one weaning continuum. Outcome: Spontaneous breathing.

Figure 6.1.12. Mode at pattern daily at 06:00 Case 12

Case 13 (Site 4)
Female aged 75 admitted with exacerbation of COPD, pneumonia and possible pulmonary embolus. History of smoking. Initial (oral) intubation (day 1), spontaneous breathing (day 5), extubation (day 6). ICU stay 8 days, intubation 6 days, mechanical weaning 6 days. Figure 6.1.13. shows a typical case consisting of one weaning continuum and few events. Outcome: Spontaneous breathing.

Figure 6.1.13. Mode at pattern daily at 06:00 Case 13
Case 14 (Site 4)
Female aged 22 transferred intubated from other facility one week after motor vehicle accident. Mechanical ventilator weaning initiated at other facility. Initial intubation (day 1), tracheotomy (day 5), transport (day 7), unassisted breathing (day 10), extubation (day 11). Total ICU stay 11 days, intubation 11 days, mechanical ventilation 10 days. Outcome: Spontaneous breathing. Weaning interrupted by transport day 7.

Figure 6.1.14. shows a critical case which can be viewed as one or two weaning continua. The first weaning attempt was cut short because the patient had to be transported on day 7. The second weaning attempt went smoothly.

Figure 6.1.14. Mode at pattern daily at 06:00 Case 14

6.1.1. Summary of the findings related to the cases
This section familiarizes the reader with the study cases and shows that each trajectory may consist of one or more weaning continua. The study includes simple, complex, typical, critical, extreme, and maximum variation cases. Figures 6.1.1.-6.1.14. are complemented by the figures in "Appendix 10.5. The Mode Variations" and "Appendix 10.6. The Weaning Progress and Patterns".

The data show that the weaning stages, transitions, and endpoints lack definition. Some trajectories lack the preweaning stage because ventilator support is decreased immediately following intubation, while other trajectories include a more palpable preweaning stage. Some patients are extubated before the outcome stage is reached, defined in the Weaning Continuum Model as 24 hours of spontaneous breathing, while other patients breathe spontaneously longer than 24 hours before final extubation or decannulation. Five patients died before weaning was completed. The trajectories do not show clear thresholds or transition points defining the weaning stage.

Nine of the 14 study patients ultimately have a tracheotomy, and the procedure is performed at varying times during the courses of mechanical ventilation. Five patients have the procedure after one week, while four have the procedure within the course of the first week.

The figures in this section have shown the mode setting once a day at 06:00. This setting is the one most frequently documented by the physicians as the patient status in the daily progress notes following morning rounds. The next section will demonstrate that the mode is changed frequently throughout the trajectory.
6. Case findings

6.2. Case review – executed and ordered ventilator changes

How do executed ventilator changes relate to written ventilator change orders? The purpose of this question is to illustrate the disparity between what is possible for the physician to order, and what interventions are demanded of the nurses, who are in close and continuous proximity to the patient. This chapter is directed toward addressing the third study hypothesis, which states that mechanical ventilator weaning is facilitated when nurses actively participate in decision making. The number of mode changes, which are executed without a written order, are assumed to be an expression of nurses' active participation in decision making.

Due to inaccurate charting, it is not possible to count all the ventilator changes made during each trajectory (see chapter 7). It is, however, possible to reconstruct the number of mode changes, because these are usually more systematically documented. The relationship between ordered and executed mode changes gives an indication of how other ventilator settings are changed. It was shown in chapter 5 (section 5.1.2.3.) that nurses independently change FiO2, pressure, volume and mode on a regular basis, and less frequently change respiratory rate, PEEP and I:E ratio. In observational interviews nurses give various reasons for changing the mode several times a day, e.g. testing the patient in order to assess the patient status, changing to a more dependent mode during nighttime or bathing, or changing to a less dependent mode during weaning. Frequent mode changes may be a sign that nurses and physicians do not always adhere to prior agreements and that the negotiated strategies may be unclear, but it may also be a sign of dynamic nursing care.

The number of daily mode changes (number of times the mode is changed) and the number of daily mode variations (number of different modes in use each day) are presented in each case trajectory, in order to show the activity surrounding the ventilator mode. The methods and sources combine direct observation, observational interviews, and chart review. The data have been analyzed and presented in such a way that days with one mode change consist of two mode variations. Spontaneous breathing (SB) is counted as a mode. The distribution of daily mode changes, daily mode variations, and modes in use during the trajectories are shown in table 6.2.1. The modes in use support the data in table 5.11. which shows the varying ventilator strategies across the sites.

<table>
<thead>
<tr>
<th>Site</th>
<th>Case</th>
<th>Daily mode changes Mean (range)</th>
<th>Daily mode variations Mean (range)</th>
<th>Modes in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1.2 (0 – 5)</td>
<td>1.7 (1 – 3)</td>
<td>PRVC, PS, VS, CPAP, SB</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.6 (0 – 4)</td>
<td>1.4 (1 – 3)</td>
<td>PC, PS, VS, SB</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1.8 (0 – 4)</td>
<td>2.6 (1 – 4)</td>
<td>PRVC, PS, VS, CPAP, SB</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>0.4 (0 – 2)</td>
<td>1.4 (1 – 3)</td>
<td>PRVC, PS, VS</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>0.8 (0 – 2)</td>
<td>1.5 (1 – 2)</td>
<td>PC, PS</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>1.0 (0 – 2)</td>
<td>1.8 (1 – 2)</td>
<td>PC, PS</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>0.5 (0 – 1)</td>
<td>1.5 (1 – 2)</td>
<td>PC, PS, SB</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>0.9 (0 – 2)</td>
<td>2.4 (1 – 3)</td>
<td>PC, PS, SB</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>1.6 (0 – 5)</td>
<td>2.0 (1 – 4)</td>
<td>VC, PS, SIMV, CPAP, SB</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>0.9 (0 – 2)</td>
<td>1.7 (1 – 3)</td>
<td>VC, PC, PS, SIMV, SB</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>1.6 (0 – 5)</td>
<td>1.8 (1 – 4)</td>
<td>VC, PC, PS</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>1.8 (0 – 5)</td>
<td>1.8 (1 – 3)</td>
<td>VC, PC, PS, SB</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>1.1 (0 – 4)</td>
<td>1.5 (1 – 2)</td>
<td>VC, SB</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>1.0 (0 – 4)</td>
<td>1.6 (1 – 3)</td>
<td>VC, PS, BiPAP, SB</td>
</tr>
</tbody>
</table>

Table 6.2.1. Cross-case distribution of mode changes and variations

Table 6.2.2. shows how many mode changes are executed during each trajectory and how many mode changes are ordered in writing. Although the numbers are small, the data suggest a similar
pattern at all four sites in the study, viz. proportionally few written orders to executed changes. The table shows a particularly small proportion of mode orders at Site 1, which can be explained by the unusually long ventilator trajectory in Case 1. This patient had copious competing medical issues, which put problems of mechanical ventilation on the back burner. The higher proportion of written orders at Site 2 converges with the finding that the nurses at this site were less experienced.

Chart review has demonstrated that specific written orders for ventilator changes, other than mode changes, are rare. This suggests that the proportion of written orders to executed changes is even smaller for changes of FiO2, pressure, and volume than for ventilator mode. Even orders for respiratory rate, PEEP, and I:E ratio are rare. Ventilator setting changes which are not covered by a written order may be the result of independent or collaborative decisions, i.e. verbal orders. An implicit norm among nurses is that an order is not required for a change to a mode which has previously been used for the same patient, see "Appendix 10.4. The Complexity of Ventilator Changes". The written mode change orders often reflect competing weaning strategies by different physicians treating the same patient, representing a battle of wills, especially at Site 4. Physician's orders are usually only written once a day, which is inadequate for dynamic care. In order to negotiate this temporal problem, some orders are worded ambiguously, leaving the nurse with several options for independent action throughout the day or night, e.g. "Try PS".

Table 6.2.2. Number of written mode orders versus executed mode changes

<table>
<thead>
<tr>
<th>Site</th>
<th>Case</th>
<th>Number of mode orders</th>
<th>Number of mode changes</th>
<th>Percent written mode orders</th>
<th>Examples of written orders to change ventilator mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>9</td>
<td>132</td>
<td>7%</td>
<td>Day 35: &quot;Continue VS/PS weaning&quot;</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>No mode orders</td>
<td>Day 9: &quot;May change to PS&quot;</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>0</td>
<td>27</td>
<td>No mode orders</td>
<td>Day 6: &quot;Continue weaning via VS&quot;</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>4</td>
<td>9</td>
<td>25%</td>
<td>Day 4: &quot;Continue PS&quot;</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>0</td>
<td>4</td>
<td>No mode orders</td>
<td>Day 1: &quot;Continue current mode&quot;</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>1</td>
<td>2</td>
<td>Day 3: &quot;Try PS&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>1</td>
<td>9</td>
<td>Day 20: &quot;Ventilator pause on CPAP&quot;</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>4</td>
<td>46</td>
<td>16%</td>
<td>Day 10: &quot;Try SIMV&quot;</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>6</td>
<td>17</td>
<td>Day 5: &quot;Try spontaneous breathing via ventilator&quot;</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>5</td>
<td>30</td>
<td>19%</td>
<td>Day 3: &quot;Try ventilator pauses&quot;</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>5</td>
<td>23</td>
<td>Day 2: &quot;Change to tube-CPAP&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>2</td>
<td>7</td>
<td>Day 2: &quot;Spontaneous breathing as much as possible&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>1</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>41</td>
<td>329</td>
<td>12%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.2.1. Summary of the findings related to executed and ordered ventilator changes
The study shows that approximately 12 percent of the executed mode changes are covered by written orders. The proportion varies from site to site, and the numbers are small, but the pattern is consistent; most mode changes are not ordered in writing. It may be inferred that this pattern is consistent for all ventilator changes. Direct observation has shown that the mode is frequently changed by nurses who act without an order, or with a verbal order only. As it has been shown, some written orders are worded such that they invite individual interpretation, rendering the nurse several degrees of freedom, i.e. when to change the mode, and which mode to choose depending on the patient response. The study shows that the ventilator mode is often changed at least once a day, and that on average there are two modes in use daily. The preferred modes vary at the four sites, reflecting the variation in ventilator equipment, variation in patient population, and, finally, the varying individual preferences of the nurses and physicians.
6. Case findings

6.3. Case review – the onset of weaning

How does the weaning onset relate to the prescribed weaning readiness threshold? The purpose of this question is to explore who initiates mechanical ventilator weaning and what indications guide the decision to start weaning. This is done by looking at the patient's transition from the preweaning stage to the weaning stage. The observed weaning readiness in the 14 cases is compared with the prescribed weaning readiness threshold (defined in Chapter 2 as: \( \text{FiO}_2 < 0.5 \), PEEP < 10, SAT > 95, patient cooperative, secretions minimal, and cough spontaneous), in order to determine what factors are perceived as important before weaning is initiated.

In the previous section written ventilator mode-change orders were described. In this section written mechanical ventilator weaning orders are presented in the context of the trajectories. The weaning patterns (inconsistent, consistent, and sprint) and the weaning progress (reversal, plateau, and progress) are presented in table 6.3.1. in order to show the relative complexity of each of the 14 cases. As it was seen in section 6.1.1. the weaning trajectories may consist of more than one weaning continuum. Data refer to figures found in "Appendix 10.6. The Weaning Progress and Patterns". The definitions of weaning progress and weaning patterns are presented in Chapter 2.

Table 6.3.1. The weaning patterns and progress

<table>
<thead>
<tr>
<th>Site</th>
<th>Case</th>
<th>Weaning pattern</th>
<th>Reversal</th>
<th>Plateau</th>
<th>Progress</th>
<th>Weaning outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Inconsistent</td>
<td>31%</td>
<td>32%</td>
<td>37%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Inconsistent</td>
<td>33%</td>
<td>20%</td>
<td>47%</td>
<td>Death</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Consistent</td>
<td>-</td>
<td>20%</td>
<td>80%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistent</td>
<td>20%</td>
<td>-</td>
<td>80%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sprint</td>
<td>-</td>
<td>-</td>
<td>100%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Inconsistent</td>
<td>29%</td>
<td>30%</td>
<td>41%</td>
<td>Death</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>Inconsistent</td>
<td>25%</td>
<td>42%</td>
<td>33%</td>
<td>Death</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>Consistent</td>
<td>-</td>
<td>33%</td>
<td>67%</td>
<td>Death</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>Sprint</td>
<td>-</td>
<td>-</td>
<td>100%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>Inconsistent</td>
<td>50%</td>
<td>-</td>
<td>50%</td>
<td>Incomplete weaning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Slow sprint”</td>
<td>-</td>
<td>-</td>
<td>100%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>Inconsistent</td>
<td>25%</td>
<td>21%</td>
<td>54%</td>
<td>Incomplete weaning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistent</td>
<td>-</td>
<td>54%</td>
<td>46%</td>
<td>Incomplete weaning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sprint</td>
<td>-</td>
<td>100%</td>
<td></td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>Inconsistent</td>
<td>25%</td>
<td>-</td>
<td>75%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistent</td>
<td>31%</td>
<td>23%</td>
<td>46%</td>
<td>Incomplete weaning</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>Inconsistent</td>
<td>39%</td>
<td>33%</td>
<td>28%</td>
<td>Death</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>Inconsistent</td>
<td>17%</td>
<td>25%</td>
<td>58%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>Inconsistent</td>
<td>20%</td>
<td>-</td>
<td>80%</td>
<td>Spontaneous breathing</td>
</tr>
<tr>
<td>14</td>
<td>14</td>
<td>Consistent</td>
<td>17%</td>
<td>33%</td>
<td>50%</td>
<td>Incomplete weaning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sprint</td>
<td>-</td>
<td>100%</td>
<td></td>
<td>Spontaneous breathing</td>
</tr>
</tbody>
</table>

Case 1 (Site 1)

Case 1 had an inconsistent weaning pattern with almost equal proportions of reversal, plateau and progress. The onset of the weaning stage was unclear, but the first reference to weaning in the chart was on day 24 when a physician wrote: "Weaning may start when FiO2 is consistently < 0.5". FiO2 remained too high until day 35 when a physician wrote: "Continue mechanical ventilator weaning VS/PS, perhaps PRVC tonight". The order indicates that weaning was already in progress in the daytime and that the nurses were at liberty to choose among the three ventilator modes. The flow sheet shows that weaning was initiated earlier, when FiO2 < 0.5, and continued after FiO2 again exceeded this threshold. Figure 10.6.1. in "Appendix 10.6. The Weaning Progress and Patterns" indicates that the patient experiences more consistent progress after day 33.
Due to the inconsistent weaning pattern the physicians were observed to say to the nurses in regard to weaning: "Do whatever you think best". At Site 1 the nurses were invited to react dynamically to the patients' responses. In this case the prescribed weaning readiness threshold was difficult to maintain and the nurses were at liberty to use their discretion and wean whenever possible.

**Case 2 (Site 1)**
The weaning pattern was inconsistent and the first reference to weaning was on day 9 when a physician wrote: "Wean from sedation. If possible change to PS". The order appeared to have a probing nature and mechanical ventilator weaning was not explicitly articulated. The patient reached the prescribed weaning readiness threshold on day 10 and the following day a physician wrote: "Keep the patient on spontaneous breathing whenever possible". The patient was weaned successfully from the ventilator, but there were no explicit weaning orders due to competing medical issues. The patient finally died due to non-respiratory complications.

**Case 3 (Site 1)**
The patient went through three weaning continua due to multiple surgeries; consistent, inconsistent, and sprint. During each continuum the patient was successfully weaned without reference to weaning in the chart. The patient did not meet the prescribed weaning readiness threshold during the weaning stage, as PEEP remained at 10, but weaning progress dominated the trajectory.

**Case 4 (Site 1)**
The first reference to weaning was on day 7 when a physician wrote: "Continue ventilator weaning via VS". Weaning was already in progress and the patient never reached the prescribed weaning readiness threshold, because PEEP remained at 10. There was a three-day transition period between the preweaning and weaning stages. After tracheotomy day 14 weaning was not referred to again, as the patient began to deteriorate due to non-respiratory complications.

**Case 5 (Site 2)**
The patient briefly reached the prescribed weaning readiness threshold on day 2 and a physician ordered: "Discontinue sedation. Change to pressure support". PS was ordered daily, but weaning was never articulated. The trajectory was inconsistent with the mode wavering between PC and PS. All attempts at reducing pressure failed as the patient began to deteriorate due to non-respiratory complications.

**Case 6 (Site 2)**
Weaning was never referred to in the chart, and the patient's condition was soon considered to be terminal. The patient never reached the prescribed weaning readiness threshold. On the final night the nurse decided to change the mode from PC to PS because "it looks easier for the patient".

**Case 7 (Site 2)**
The first reference to weaning was on day 3 when a physician wrote: "Weaning from sedation and mechanical ventilation has been initiated". The order was written the day after weaning had been initiated by a nurse, and the patient had reached the prescribed weaning readiness threshold.

**Case 8 (Site 2)**
The first reference to weaning was on day 3 when a physician wrote following morning rounds: "PS has been attempted and is tolerated. Extubation may be considered later today or tomorrow". A
nurse had briefly tested the patient on PS the day before. After the noon conference the physician wrote: "It was decided at the noon conference to extubate today". The weaning stage lasted five hours during which the pressure was reduced hourly from PC22 to PS8 to extubation just before the change of shift. A nursing aide caring for the patient verbally protested the rapid weaning strategy and wrote: "Extubated at 14:30. Hudson 7/7 may be reduced if SAT>93, frequent CPAP, suctioned for copious secretions". The patient did not meet the prescribed weaning readiness threshold due to low SAT and copious secretions. The patient was reintubated followed by a tracheotomy on day 5, and the next weaning continuum had a more gradual weaning strategy. On day 6 a physician wrote: "Change to PS and later CPAP when tolerated". The nurse wrote: "Ventilator weaning resumed" and the patient was weaned at a "slow sprint" and met the prescribed weaning readiness threshold.

Case 9 (Site 3)
The patient reached the prescribed weaning readiness threshold on day 2 and the physician wrote: "Has slept on VC, change to PS as patient triggers ventilator". On day 3 the physician wrote: "Reduce pressure support. Remain intubated as long as daily peritoneal lavage is required". The first reference to weaning was on day 7 when a physician wrote: "Mechanical ventilator weaning and extubation later today". Although the patient had been considered by the nurses to be at the weaning stage for days, the physician regarded only the hours prior to extubation as the weaning stage as long as peritoneal lavage was required. During the second weaning continuum the patient reached the prescribed weaning readiness threshold on day 9. This time weaning was postponed by the physicians until the presence of bowel sounds. The nurses did reduce ventilator support, but this was not considered weaning until after day 11. On day 15 a physician ordered: "Reduce pressure support by 2-4 cm each day". On day 19 CPAP and spontaneous breathing trials were ordered and the patient was slowly and consistently weaned.

Case 10 (Site 3)
The mode was changed on day 2 when a physician wrote: "Change to PS, it is too early to extubate". The first reference to weaning was on day 8: "Continue mechanical ventilator weaning". At this time the prescribed weaning readiness threshold had been reached and the nurses had been reducing ventilator support daily.

Case 11 (Site 4)
On day 2 a physician wrote without reference to weaning: "Spontaneous breathing gives bronchospasms, ..., postpone extubation until tomorrow". This indicates that weaning had been attempted. The following days the patient was ventilated on PS alternating with VC and SBTs. The patient reached the prescribed weaning readiness threshold on day 4. Weaning continued and the mode was changed frequently between PC, VC, and PS depending on the preferences of the individual physicians. The mode was changed up to five times daily until day 14 when the mode more consistently remained on PC and weaning was abandoned.

Case 12 (Site 4)
The prescribed weaning readiness threshold was reached on day 2, but the patient did not consistently remain at the threshold, as FiO2 was intermittently more than 0.5 and SAT was intermittently less than 95. The weaning pattern was inconsistent which may be caused by the ever changing weaning strategies among different physicians. VC with SBT was ordered on day 3. Weaning via PS was ordered on day 5. VC with SBT resumed on day 8.
Case 13 (Site 4)
The prescribed weaning readiness threshold was reached on day 2 and a physician wrote without reference to weaning: "Discontinue sedation and change to CPAP". On day 3 VC with SBT were ordered. The first reference to weaning was on day 5: "Is currently weaning from ventilator". On day 6 the patient was extubated.

Case 14 (Site 4)
The first weaning continuum took place at another facility. The second weaning continuum was at Site 4. The prescribed weaning readiness threshold was reached on day 2. There was no reference to weaning, but a physician wrote: "Spontaneous breathing as much as possible". The first reference to weaning was on day 9 when a physician wrote: "Mechanical ventilator weaning". This was a patient status rather than an order. On day 11 the patient was decannulated.

6.3.1. Summary of the findings related to the onset of weaning
The first endpoint of the weaning stage, the weaning onset, did not always coincide with the prescribed weaning readiness threshold constructed for this study. In some cases it may have been advantageous for the patient if the nurses and physicians had adhered to a standard threshold for weaning (e.g. Case 8), while in other cases, a standard may have postponed weaning indefinitely (e.g. Case 1). The data show that all weaning readiness criteria are rarely met before weaning is initiated, and that non-respiratory factors may postpone weaning in a patient who has reached the threshold. Moreover, weaning is not always articulated in the face of competing medical issues.

The findings demonstrate the difficulty in determining (1) the onset of weaning, (2) the indications for weaning, and (3) the decision maker (who initiates weaning). Most importantly, the nurses and physicians rarely articulated whether ventilator reduction was aimed at weaning, patient comfort, or other ventilation strategies such as normoventilation. A mode change from PC to PS may be sign of weaning, but not necessarily. Nurses often started to reduce ventilator support (e.g. decrease FiO2) immediately following intubation. The fact that all 14 cases consisted of more weaning progress than reversal may be a sign of the ongoing ventilator reduction performed by the nurses, whether for weaning purposes or under a different pretext.

In some cases mechanical ventilator weaning was ordered proactively, but more often than not, weaning was ordered retroactively, e.g. "continue to wean". Weaning may have been initiated independently by a nurse or be the result of a collaborative decision and verbal order. Sometimes ventilator reduction was initiated by a nurse and subsequently "labeled" weaning by a physician. It can be argued, that in many cases, weaning was "discovered" rather than "planned", which means that the weaning stage is largely determined by ex post facto rationalization rather than by prospective planning and standard criteria.

The terminology used to describe weaning was inconsistent among the nurses and physicians, and the study has demonstrated a lack of mutual understanding of implicit norms. A central finding was that some physicians defined weaning readiness as "readiness to reduce ventilator support" (first endpoint of the weaning stage), while other physicians described weaning readiness as "readiness for extubation" (second endpoint of the weaning stage). The delayed order to "start weaning" after the fact, may be the result of the ill defined terminology, or may alternatively indicate a retrograde sanctioning of an intervention already preformed by the nurse. The inconsistency in terminology makes it difficult for the staff to agree upon a common strategy for weaning, or a weaning readiness threshold, and obscures the actual onset of weaning.
6.4. Cross case review – sedation practices
How does sedation relate to mechanical ventilation? Sedation plays an important role in decisions related to mechanical ventilator weaning because the clinician is often faced with the choice of adjusting sedation or mechanical ventilation in the weaning process. In the present study sedation is included to the extent that it poses an alternative to making a mechanical ventilator setting change, and also to the extent that the consequence of how sedation is managed may have an impact on the success or failure of mechanical ventilator weaning. The terminology used to describe sedation was similar at the four sites in the study. It is presented here, because it may have an impact on the decision to alter sedation (manipulate the patient) or alter ventilation (manipulate the ventilator).

Methods and sources
Sedation practices and terminology were explored by observation, observational interviews with nurses and physicians, and by chart review. In this section the nurses are referred to as experienced if they have five years or more ICU experience (n=73), and less experienced if they have less than five years ICU experience (n=72). The findings have been analyzed according to rational logic: indications, interventions, and outcomes related to sedation.

Findings related to the sedation practices at the four sites in the study
On a formal level, the four sites in the study had similar sedation practices, as sedative therapy was prescribed by the physicians and administered by the nurses. None of the sites used protocols for sedation or sedation level assessment tools. The key informants agreed that the patients should be sedated as lightly as possible, with the goal of promoting patient comfort, breathing, and safety.

On an informal level, the sedation practices varied according to individual preferences and local traditions. All study patients were sedated in connection with intubation and mechanical ventilation. The term "sedation" was used by the nurses and physicians as an overall designation to indicate sedative or analgesic therapy for the mechanically ventilated patient. This was evidenced by physicians' orders, which often read: "sedate with fentanyl and midazolam", thus classifying analgesics and sedatives together. Neuromuscular blocking agents were rarely used.

Indications for sedation
Tube irritation. The indications for sedation were worded in ambiguous terms in several ways. The terms "tube irritation" or "tube intolerance" were commonly used by nurses as well as physicians, and were characterized by one physician as unclear, because they failed to describe the underlying cause of the problem, and the symptoms could be confused with various kinds of restlessness: "Restlessness may have many causes, and the patients are not systematically assessed for the cause of their symptoms, which could be related to excessive secretions, pain, anxiety, dyspnea, or confusion. The treatment for these symptoms could be as different as suctioning, analgesia, human contact, ventilator setting change, and reality training".

Not following the ventilator. Another common indication for sedation was the term "not following the ventilator", as it was the general premise that the patient should "follow the ventilator". Several physicians, however, stressed that it should be the other way around: The ventilator should "follow the patient": "The newer ventilators are designed to follow the patients physiologically, whereas the older ventilators lacked this flexibility". Although the term "not following the ventilator" states the problem, the term is unclear because it is normative, yet runs counter to local policy. As a consequence, treatment could vary according to the degree of literal interpretation of the terminology.
Fighting the ventilator. When a patient failed to follow the ventilator, the nurses used metaphors like "fighting the ventilator", which could suggest non-compliant behavior. Some physicians preferred the more neutral term "patient-ventilator asynchrony". If the problem was interpreted as non-compliance, the patient would be sedated. If, on the other hand, the problem was interpreted as asynchrony due to inappropriate ventilator settings, the settings would be changed.

Relieving the nurses. One indication for sedation, which was given by the physicians, not the nurses, was "relieving the nurses". According to the physicians, it could be more advantageous for the patients to have constant supervision by the nurses than to be sedated. One physician said: "I dare not say this aloud, but the best thing would be for the nurse to stay with the patient. What the patient needs is human contact, not sedation". In this case sedation was used as a substitute for human contact.

Interventions related to sedation
Choice of agent. The four sites used a similar array of sedative medications, but the individual participants had personal preferences. A combination of drugs was common e.g. propofol or midazolam were used in combination with fentanyl or morphine. Propofol was used at all four sites, while Site 2 did not use midazolam. The mechanical ventilator weaning strategy had an impact on the choice of sedation, as some situations required the patient to be more cooperative than others. An experienced nurse said: "Sedation and mechanical ventilation are intricately related. If one is altered, this may start a chain reaction. I switched the patient from propofol to morphine because the patient was receiving lipids and didn't need the fat emulsion from the propofol as well. The morphine slowed down the respiratory rate, and ... the tidal volumes increased dangerously. Then I changed the ventilator mode ...".

Dosage. The medication dosage was often determined by the nurses. On dosing the medication, one nurse said: "I gave her just a 'pinch' of fentanyl. I knew the patient didn't need propofol for tube irritation as long as I was there". Nurses used cooking metaphors to describe intuitive titration of drugs, e.g. "the patient was sprinkled lightly with fentanyl". One experienced nurse reduced the dose of midazolam during her day shift because she knew that the night nurses were apt to over-sedate. She said: "By reducing the daytime dose, I save the patient from getting 50 mg of midazolam. As this medication is slowly excreted, it will help the patient to wake up later". Another experienced nurse described the havoc caused by physicians who alter sedation or ventilation without notifying the nurse: "The most important job in critical care nursing is to maintain the equilibrium of the patient, and any change could tip the scales. It takes the nurse the rest of the day to figure out what has been done to the patient and to get the patient back on track. Less experienced nurses often end up over-compensating for a change made independently by a physician". When physicians gave an order to wean or discontinue sedation, the nurses took it as a sign that mechanical ventilator weaning would be initiated.

Administration of sedation. The sedation orders did not always specify a particular method of administration (e.g. continuous infusion or intermittent bolus injections), and specific orders were not consistently documented. One physician was opposed to using continuous infusions of sedatives and said: "There is a tendency to over-sedate patients. It is so easy to increase the drip from 2 to 5 to 10 to 15 to 20 mg/hour. This is dangerous because sedation prolongs ventilator time. It is better to use bolus doses, it is easier to control. If the patient has a continuous drip, it is necessary to score the response with something like the Ramsay scale, but we don't use that here".
6. Case findings

Although sedative agents were formally prescribed, the physicians occasionally regretted the way sedation was administered by the nurses. The nurses pointed out that sedation was not always clearly ordered, and that there was lack of consensus among physicians regarding sedation practices. The occurrence of inaccurate sedation orders was corroborated by patient record review.

Some nurses independently tested the patient before sedation was withdrawn. Experienced nurses were seen to reverse sedation in order to assess the patient, whereas the less experienced nurses were less likely to do this unprompted. Temporary interruption of sedation was generally not documented by the nurses. According to the physicians experienced nurses sedated less, because they knew how to deal with conscious patients, whereas less experienced nurses, who were seen to be absorbed in sorting out the technology, kept the patients sedated longer and deeper.

Sometimes the nurses chose to alter mechanical ventilation rather than sedation. In one situation, an experienced nurse explained that the patient's condition left her the choice of increasing sedation or changing the ventilator mode. The nurse weighed the alternatives and chose to change the mode without an order, because sedation would result in hypotension. The nurse said: "You have to know what you are doing here. The patient is fragile. She has a cardiac condition and propofol would dilate her too much ... I know the patient and know exactly what she can tolerate. It is always a fine balance between degree of sedation and ventilation". If there was a choice of changing the ventilator settings or increasing sedation, the experienced nurses were skilled enough to change the ventilator settings, while the less experienced nurses were more likely to increase sedation.

**Outcomes related to sedation**

Nurses and physicians did not always share a common goal for sedation. Less experienced nurses expressed the short-term goal of ensuring patient comfort, while experienced nurses and physicians shared the long-term goal of minimizing sedation in order to expedite extubation.

**Tube acceptance**. At all four sites the most common order for the desired level of sedation was to sedate to "tube acceptance", which could entail either light or heavy sedation, as it could take a small or a large dose of medication to alleviate the underlying problem. Symptoms and success criteria (goals and methods) were not defined. Some nurses documented tube acceptance as a respiratory issue (following the ventilator), while others considered it to be a neurological issue (level of consciousness). One physician felt strongly that it was a pain issue (patient comfort) and should be approached with analgesics, while other physicians felt less strongly, and described tube acceptance as a sign of patient comfort or compliance.

**Just below the surface**. At all four sites the most common term used for the actual level of sedation was "just below the surface". Less experienced nurses were uncertain about the meaning of the term, while the experienced nurses appeared to be confident of the meaning, albeit each nurse defined it differently. The physicians, who also used the term, were not any closer to providing a definition. Some nurses stated that the term meant that the patient could be awakened fairly easily by discontinuing the sedative infusion or by shaking the patient lightly. The term was generally described as a lighter form of sedation, and the antonyms were the spatial metaphors "way below the floor boards" or "far away", which indicated heavy sedation or profound unconsciousness. The terms form a continuum where near means conscious and far away means unconscious. Among other metaphors used by the participants were "tilting", "falling", or "crashing", indicating that the patient's departure from the vertical to the horizontal position was a negative sign.
Tube seeking. The nurses used the term "tube-seeking" or "reaching for the tube" to indicate risk of accidental self-extubation, which could be a sign of under-sedation. Four accidental extubations occurred during the study.

Well sedated. In the nurses' progress notes a less experienced nurse used the term "well sedated", and added that there was no cough reflex when suctioning. Another less experienced nurse wrote "heavily sedated", and added that the patient had no reactions at all. One experienced nurse conceded that "well sedated, heavily sedated, or deeply sedated" could all mean "over-sedated" which could mask a physiological or psychological reason for the patient's lack of response: "The patient may have suffered a stroke or may be in a state of psychological withdrawal for all we know... I don't sedate too hard if I can avoid it".

Indications, interventions, and outcome
The study has shown that uncertainty exists regarding the indications, interventions, and outcomes of sedation. The findings in this section are outlined in the empirical sedation schema table 6.4.1.

<table>
<thead>
<tr>
<th>Indication (Clinical problem)</th>
<th>Intervention (Clinical decision)</th>
<th>Outcome (Clinical end-point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient related</td>
<td>Sedation agent</td>
<td>Sedation level</td>
</tr>
<tr>
<td>Tube irritation</td>
<td>Propofol or Midazolam</td>
<td>Tube acceptance</td>
</tr>
<tr>
<td>Restlessness</td>
<td>Fentanyl or Morphine</td>
<td>Just below the surface</td>
</tr>
<tr>
<td>Ventilator related</td>
<td>Sedation dose</td>
<td>Tube seeking/under-sedated</td>
</tr>
<tr>
<td>Patient-ventilator related</td>
<td>Determined by physician or nurse</td>
<td>Well sedated/over-sedated</td>
</tr>
<tr>
<td>Not following the ventilator</td>
<td>Intuitive titration</td>
<td></td>
</tr>
<tr>
<td>Fighting the ventilator</td>
<td>Sedation administration method</td>
<td></td>
</tr>
<tr>
<td>Context related</td>
<td>Continuous infusions</td>
<td></td>
</tr>
<tr>
<td>Relieving the nurses/</td>
<td>Intermittent boluses</td>
<td></td>
</tr>
<tr>
<td>Substitute for human contact</td>
<td>Purges</td>
<td></td>
</tr>
</tbody>
</table>

6.4.1. Summary of the findings related to sedation practices
Sedation is an integral part of mechanical ventilator weaning, but it is still an ambiguous practice. The study has shown that ambiguous terminology paves the way to flexible interpretation, which increases nurses' range of decision making, while at the same time, maintaining physicians' domain of authority. One important finding is that the choice of altering either sedation or mechanical ventilation represents common alternatives with varying consequences, and that the unclear terminology may promote a decision counter to the best interests of the patient. Sedation is usually ordered with a wide margin of nurse discretion, which means that technically, a change of sedation is within the boundaries of delegated practice, while a ventilator change may require overstepping these boundaries. The study shows that in some instances less experienced nurses choose the safer route and alter sedation, while more experienced nurses are willing to take risks and choose to alter ventilation. The range of decision making is self-imposed by the nurses, which means that sedation practices are somewhat idiosyncratic. This corroborates the finding in section 5.1.2.1. that the participants tacitly accept the fact that nurses have a degree of freedom to act independently outside their formal boundaries. The issues of (1) inconsistent terminology, (2) inconsistent sedation strategies, (3) inconsistent informal competencies of the nurses, and (4) uncertainty regarding the stages of weaning, show that sedation and mechanical ventilation should always be managed in concert and that interdisciplinary collaboration is necessary.
6. Case findings

6.5. Cross case review – staffing patterns and continuity
How do observed staffing patterns translate into continuity? The purpose of this question is to explore the actual patterns of staffing throughout the 14 trajectories in order to get an impression of the continuity and collaboration that may have influenced decision making. Continuity is valued by the nurses as a means to facilitate nurses' decision making process by way of knowing the patient. Nurse-physician collaboration is assumed to be positively related to continuity because physicians give nurses more leverage when they know the nurse, as seen in section 5.1.2.1. By the same token, nurses make more decisions when they know the physician, as seen in table 5.3. and "Appendix 10.4. The Complexity of Ventilator Changes".

6.5.1. Observed staffing principles
Methods and sources
The nurse-to-patient ratio and the staffing principles were observed at each of the four sites. The method of data collection was by recording on the registration sheet during direct observation, as there was no other way to obtain this information. Each item represents an observational interview about the rationale for the current ratio and assignment. None of the four sites kept permanent records of daily nursing assignments, and when there was more than one nurse to a patient it was difficult to discern their relatives roles, e.g. preceptor/supervisor, orientee/trainee, or nurse primarily responsible for the patient. Even when the nurses signed or initialed the progress notes or flow sheets there was no way to distinguish between nurses who were training and supervising, or to know how many nurses had been assigned to the patient.

Findings related to observed staffing principles
The high turn-over and ongoing training of new staff resulted in high nurse-to-patient ratios, especially on day shift. Some nurses would alternately supervise new nurses and be supervised as part of the certification course. The dual roles of teacher/trainee were taxing for many of the nurses, who longed to "just take care of the patients". The nurse questionnaire database (5.2.1.) shows that the proportion of nurses who are either in the process of certifying or who have worked less than one year in critical care, exceeds 50 percent of the nurses at all four sites, explaining the high volume of intradisciplinary supervision which may have an impact on nurses' decision making.

Table 6.5.1. shows the distribution of nurse-to-patient ratios during direct observation. The numbers are small, but show that all sites experienced nurse-to-patient ratios on day shifts in excess of 1:1 due to high volume training of nursing staff. During night shift the nurse-to-patient ratios went down to 1:1 or 1:2.

<table>
<thead>
<tr>
<th>Nurse-patient ratio during day shift</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio 1:1</td>
<td>19</td>
<td>2</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Ratio 2:1</td>
<td>6</td>
<td>5</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Ratio 3:1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Days recorded (total 64 days)</td>
<td>26</td>
<td>7</td>
<td>19</td>
<td>12</td>
</tr>
</tbody>
</table>

Table 6.5.2. shows the patient assignment rationales given by the bedside nurses. The table shows that only Site 1 used primary nursing and staffed according to nursing expertise. Site 2 and 3 predominantly staffed with training in mind, while Site 4 assigned nurses according to continuity and training. Again, the numbers are small, but illustrate the competing considerations which go into patient assignments, some of which benefit the patient while others benefit the nurse. The perceived staffing principles were shown in table 5.10.
6. Case findings

Table 6.5.2. Observed staffing principles during day shift (n=64)

<table>
<thead>
<tr>
<th>Staffing principle during day shift</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Continuity</td>
<td>10</td>
<td>1</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>Expertise</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Primary nurse</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Training</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Special skills or requests</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Days recorded (total 64 days)</td>
<td>26</td>
<td>7</td>
<td>19</td>
<td>12</td>
</tr>
</tbody>
</table>

6.5.2. Observed staffing patterns and continuity

Methods and sources

Physician-patient continuity was easily reconstructed by recording the name of the physician who had documented morning rounds that day. Nurse-patient continuity was more tenuously reconstructed by recording the names of nurses on each shift (day, evening, night), who had signed the progress notes or flow sheet. These data were compared with observational field notes in order to determine which nurse was primarily responsible for the patient. On shifts where several nurses were assigned to the same patient, the more senior nurse was recorded. This was done by consulting the staffing schedule and by cross-check interviews.

It was not possible to reconstruct nurse-patient continuity at Site 1. The nurses did not sign the documents and there was no permanent record of patient assignments. In the following, only the physician-patient continuity will be presented at Site 1, while the nurse-patient continuity will be added at the following sites. On many shifts there were several nurses to a patient. As only one nurse is recorded, the actual continuity may be slightly higher than what is shown in the following. The continuity in each case trajectory will be described by the number of times a nurse or physician has been assigned to the patient. This number will be expressed as percentage of the trajectory time.

Cross-case comparison of staffing patterns and continuity

When consecutive continuity is recorded, the first day is not counted, as this represents a day where the staff member is new to the patient. If that staff member recurs at a later time, the second day is counted as cumulative continuity. This gives the three following mutually exclusive categories of continuity which add up to 100 percent of the trajectory:

1. Time without continuity: The patient meets the staff member for the first time
2. Time with consecutive continuity: The patient meets the same staff member as the day before
3. Time with cumulative continuity: The patient meets a staff member again later in the trajectory

In addition to these categories it is shown how many times the same nurse and the same physician perform morning rounds together more than once during the patient trajectory.

Findings related to observed staffing patterns and continuity

Table 6.5.3. shows that nurses have more consecutive than cumulative shifts, indicating that nurses rarely return to a patient after a series of consecutive shifts. This finding is corroborated by analysis of assignment sheets and may be explained by the high volume of nurses in training who are assigned to new patients for training purposes. This pattern defies the principle of continuity, which is regarded as important for the patient. The distribution of consecutive nursing shifts was similar on all shifts (day, evening, night) at all four sites.
6. Case findings

### Table 6.5.3. Cumulative and consecutive continuity of the nurses at Sites 2, 3, and 4 (n=314)

<table>
<thead>
<tr>
<th>Site</th>
<th>Case</th>
<th>Number of nursing shifts (n=314)</th>
<th>Number of nurses</th>
<th>Time without continuity</th>
<th>Time with consecutive continuity</th>
<th>Time with cumulative continuity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>34</td>
<td>20</td>
<td>59%</td>
<td>35%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>8</td>
<td>6</td>
<td>75%</td>
<td>25%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>9</td>
<td>5</td>
<td>56%</td>
<td>44%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>27</td>
<td>13</td>
<td>48%</td>
<td>37%</td>
<td>15%</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>71</td>
<td>29</td>
<td>41%</td>
<td>44%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>54</td>
<td>29</td>
<td>54%</td>
<td>33%</td>
<td>13%</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>41</td>
<td>18</td>
<td>42%</td>
<td>46%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>39</td>
<td>14</td>
<td>36%</td>
<td>54%</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>18</td>
<td>8</td>
<td>44%</td>
<td>56%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>13</td>
<td>8</td>
<td>61%</td>
<td>31%</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
<td>47%</td>
<td>42%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Table 6.5.4 shows that physicians have more cumulative than consecutive shifts, reflecting that there are fewer physicians to go around. The same physician and the same nurse would conduct morning rounds together more than once roughly 7 percent of the time, which is consistent with the key informants' statement that there are no formal "patient care teams" assigned to the patients at any site. The numbers suggest that the longer the trajectory, the greater the chance of continuity. Assignment sheets show that continuity rarely occurs during the first days of a trajectory. This, again, suggests that continuity occurs by default rather than by design.

### Table 6.5.4. Cumulative and consecutive continuity of the physicians at the four sites (n=284)

<table>
<thead>
<tr>
<th>Site</th>
<th>Case</th>
<th>Number of days (n=284)</th>
<th>Number of physicians</th>
<th>Time without continuity</th>
<th>Time with consecutive continuity</th>
<th>Time with cumulative continuity</th>
<th>Days with the same physician and same nurse on rounds more than once</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>110</td>
<td>29</td>
<td>26%</td>
<td>25%</td>
<td>49%</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>16</td>
<td>8</td>
<td>50%</td>
<td>25%</td>
<td>25%</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>26</td>
<td>17</td>
<td>65%</td>
<td>15%</td>
<td>20%</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>15</td>
<td>10</td>
<td>67%</td>
<td>6%</td>
<td>27%</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>12</td>
<td>5</td>
<td>42%</td>
<td>25%</td>
<td>33%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>67%</td>
<td>11%</td>
<td>22%</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>29</td>
<td>14</td>
<td>48%</td>
<td>21%</td>
<td>31%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>18</td>
<td>9</td>
<td>50%</td>
<td>28%</td>
<td>22%</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>11</td>
<td>19</td>
<td>9</td>
<td>47%</td>
<td>32%</td>
<td>21%</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>13</td>
<td>9</td>
<td>69%</td>
<td>31%</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>6</td>
<td>6</td>
<td>100%</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>5</td>
<td>4</td>
<td>80%</td>
<td>0</td>
<td>20%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td></td>
<td>65%</td>
<td>16%</td>
<td>19%</td>
<td></td>
</tr>
</tbody>
</table>

The continuity of nurses could not be assessed at Site 1, which is why some data in table 6.5.4. are NA (not applicable).
6.5.3. Summary of the findings related to staffing patterns and continuity

The nurse-to-patient ratios are high during day shift, reflecting that more than half of the nurses are to some extent in training. The relatively small sample (n=64) suggests that teaching gets priority over patient continuity at Sites 2, 3, and 4. High nurse-to-patient ratios may influence nurses’ participation in decision making negatively by drawing the attention from the patient to the trainee, or positively, by furnishing the preceptor with an audience.

The observed staffing patterns show that the degree of continuity varies from patient to patient, but the staffing patterns appear to be similar across the sites and suggest that intubated patients, who are often sedated, confused, or delirious, must also contend with unfamiliar staff half of the time they are in ICU. Although continuity is a declared goal at all four sites, the concept lacks definition. This means that it is not possible to determine what is considered to be acceptable or desirable continuity, or whom continuity is meant to benefit. A high percentage of consecutive continuity does not mean that the same nurse is assigned to the same patient most of the time. It only indicates the proportion of time when the patient sees the same person two days in a row.

Cumulative continuity for nurses at Sites 2, 3, and 4 is lower than consecutive continuity, which means that nurses generally fail to return to a patient at a later time after a series of consecutive shifts. It appears that nurses are progressively assigned to new patients in order to meet new challenges. Continuity could not be assessed at Site 1 due to lack of documentation. A modified form of primary nursing, which means that the same nurse is assigned to the same patient throughout the trajectory, was used at Site 1.

By contrast to the nurses, cumulative continuity is more predominant than consecutive continuity among physicians. The higher recurrence of physicians throughout the trajectory may be explained by the small number of physicians to go around. The rare occurrence of the same physician and the same nurse conducting rounds together more than once shows that little effort is made to ensure interdisciplinary continuity and collaboration.

Lack of interdisciplinary continuity in the face of high nursing turn-over do not explain the mismatch between the number of ordered and executed ventilator changes. The previous sections have shown that most ventilator changes are made without a written order. This, coupled with the current findings, suggests that the lack of written orders cannot be attributed to high continuity and collaboration among the staff assigned to the patient. In fact, the uncertainty regarding the endpoints of the weaning stage can be explained by the ever changing actors in the arena of mechanical ventilator weaning. Whether this finding has an impact on patient outcomes falls outside of the scope of this study.
6.6. Cross case review – nurse potential, nurse performance, and patient needs

How does nurse potential relate to nurse performance and patient needs? **Nurse potential** expresses a prediction of nurses' competencies, while **nurse performance** describes the actual competencies of the nurses. In other words, potential predicts performance, and the two are compared in order to determine which components of nurse potential have the greatest impact on nurse performance. It is assumed that nurse potential has an impact on nurses' participation in decision making.

**Methods and sources**

Nurse potential is a composite score consisting of (1) the nurse's qualifications and experience (knowing the field), (2) the nurse's familiarity with the ward (knowing the ward), and (3) the nurse's familiarity with the patient (knowing the patient), see section 2.3. Nurse performance is a composite score consisting of the eight nurse competencies according to the Synergy Model, see "Appendix 10.1. The Synergy Model". The Synergy Model is used because it describes the characteristics of certified practice. During direct observation the patient and the nurse have been given a score according to the Synergy Model and Nurse Potential. The scores have been transferred to the data sheet and have been analyzed and presented in order to show the correlation among the concepts, where correlation refers to the possible association between two sets of variables, and the correlation coefficient shows the degree of association. The scores were recorded in 64 situations (n=64) and data were transferred to the SPSS system where the gamma correlation coefficient was calculated.

The gamma correlation coefficient is defined in this study as follows: $\gamma < 0.15$ shows a weak positive correlation, $0.15 \leq \gamma < 0.30$ shows a moderate positive correlation, and $\gamma \geq 0.30$ shows a strong positive correlation (Kreiner 1999:211). The conventions regarding the degree of association according to the gamma coefficient vary, and they are different from those of other correlation coefficients which measure the degree of linear association between two sets of variables.

**Findings related to nurse potential, nurse performance, and patient needs**

In this section the daily scores for nurse potential, nurse performance, patient need, and synergy will be compared in order to determine the degree of association among the variables. Table 6.6.1 shows a strong positive correlation between nurse potential and nurse performance.

As nurse potential is a composite score, each component has been calculated separately in order to determine which component may have the strongest impact on potential. The table shows that knowing the field and ward weigh more than knowing the patient, suggesting that experience and certified practice, as well as familiarity with the ward and interdisciplinary collaboration, are more important predictors of quality performance than familiarity with the patient. It can be inferred that the patient may receive better nursing care from a highly skilled nurse than from a nurse whose only merit is previous assignment to that patient. In table 6.6.1. NA refers to "not applicable" data.

**Table 6.6.1. Gamma test values related to nurse potential and nurse performance (n=64)**

<table>
<thead>
<tr>
<th>Gamma test</th>
<th>Potential</th>
<th>Performance</th>
<th>Patient need</th>
<th>Synergy</th>
<th>Field</th>
<th>Ward</th>
<th>Patient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential</td>
<td>NA</td>
<td>0.660</td>
<td>-0.142</td>
<td>0.818</td>
<td>0.982</td>
<td>0.947</td>
<td>0.656</td>
</tr>
<tr>
<td>Performance</td>
<td>0.660</td>
<td>NA</td>
<td>-0.152</td>
<td>0.940</td>
<td>0.823</td>
<td>0.632</td>
<td>0.523</td>
</tr>
<tr>
<td>Patient need</td>
<td>-0.142</td>
<td>-0.152</td>
<td>NA</td>
<td>-0.486</td>
<td>-0.222</td>
<td>-0.250</td>
<td>0.044</td>
</tr>
<tr>
<td>Synergy</td>
<td>0.818</td>
<td>0.940</td>
<td>-0.486</td>
<td>NA</td>
<td>0.939</td>
<td>0.781</td>
<td>0.561</td>
</tr>
</tbody>
</table>
Returning to the relationship between potential and performance, all three components of nurse potential have a strong positive correlation with nurse performance, but in this case, the relatively low value of knowing the patient may be attributed to the lack of nurse-patient continuity. This is consistent with the findings in the previous section, which show that continuity is not systematically upheld.

Patient need is a measure of the degree of patient dependency, according to the Synergy Model. Patient need has been related to the individual components of nurse potential, and table 6.6.1. shows a moderate negative correlation with "knowing the field" and "knowing the ward" and no correlation with "knowing the patient". This suggests that less experienced nurses are systematically assigned to more dependent patients, which is consistent with the findings in section 5.2.2. and 6.3., which show that training of nurses may take precedence over experience and continuity at Sites 2, 3, and 4. While recording the data, care was taken to assure that if more than one nurse was assigned to a patient, the potential of the most experienced nurse was recorded on the registration sheet. This was done in order to ensure that a nurse with low potential would not be recorded if that nurse was being supervised by a nurse with higher potential, which could skew the findings. The lack of association between patient need and "knowing the patient" corroborates the earlier finding that there is no systematic effort to ensure nurse-patient continuity. The data suggest somewhat random assignments in regard to nurse potential and patient need, and also indicate that a highly complex patient may be assigned to any nurse working in the ward.

Finally, we focus on synergy, which is a sign of quality nursing. Table 6.6.1. shows a strong positive correlation between nurse potential and synergy, and nurse performance and synergy, and a strong negative correlation between patient need and synergy. This suggests, again, that the least qualified nurses are assigned to the most dependent patients, which is also demonstrated by the lack of correlation between nurse potential and patient need, and nurse performance and patient need.

Key informants have stated that patient assignments are always made after great deliberation and never at random. Table 5.10 and table 6.5.2. have shown the contrast between perceived and observed staffing principles due to competing considerations and lack of staffing standards. The present findings show that it may make a considerable difference to the patient how assignments are made, because nurses' potential (competency) increases as qualifications increase.

6.6.1. Summary of the findings related to nurse potential, nurse performance, and patient needs

The numbers are small, but there is a strong positive correlation between nurse potential and nurse performance, suggesting that nurse potential may have some predictive power in regard to nurse performance. The fact that the findings in this section converge with the findings in the previous sections increases the validity of the findings. The findings show that less experienced nurses are often assigned to the most dependent patients, as training of nurses takes priority over continuity and certified practice. The study shows, firstly, that continuity has less impact on nurse performance than certified practice, and, secondly, that continuity is not systematically upheld. Familiarity with the ward appears to be a stronger predictor of good performance than familiarity with the patient. Critical care certification and experience appear to have a greater impact on nurse potential, nurse performance, and synergy, than familiarity with the ward and the patient, which means that the patients are better off with a highly skilled nurse than with any nurse who happened to have been assigned to that patient earlier.
6. Case findings

6.7. Chapter summary – summary of the case findings
This chapter has shown that each ventilator trajectory may include more than one weaning continuum, and that the weaning stage is difficult to pinpoint because the endpoints are unclear. Mechanical ventilator weaning is not usually initiated as the result of a discrete decision, or commitment, to start weaning; weaning is more imperceptible in nature and is often discovered to be in progress as the result of nurses' continuous efforts to reduce ventilator support.

There is a mismatch between the number of ventilator changes recorded in the physician's progress notes and the number of ventilator changes recorded on the flow sheet. The study suggests that most ventilator changes are the result of collaborative decision making among nurses and physicians, and to a lesser extent the result of physicians' independent decisions and specific delegations. It has been demonstrated that the ventilator mode is routinely changed several times daily at all four sites and in all 14 cases, which increases the external validity of the study. The frequent mode changes reflect the continuing activity related to weaning, and demonstrate the gap between ordered and executed ventilator changes.

The four sites had similar sedation practices; indications, interventions and outcomes of sedation were unclear. The staff were often faced with the choice of altering sedation or ventilation, and the chosen alternative depended upon the experience and preferences of the nurse at the bedside. It has been demonstrated that sedation and ventilation are intricately related and must always be considered in unison. Physicians delegate sedation with a wide degree of autonomy to the nurses, who are faced with choices related to alternative drugs, dosages, and methods of administration of sedation.

The nurses were not consistently assigned to the patients on the basis of their level of skill or on continuity. Competing considerations were teaching and supervising coupled with the nurses' need to meet new challenges rather than familiar patients. Staff continuity was low at all four sites, judging by the proportion of the time the patient was faced with meeting a new member of staff.

The study suggests that the potential of the nurse has an impact on nurse performance, and that although knowing the ward and patient are important, the most important factor is the experience and education of the nurse. This is because expertise facilitates the other components of nursing potential. Nurses with high potential are able to participate more readily in decision making and make an impact on mechanical ventilator weaning. In fact, it would not be possible to carry out dynamic mechanical ventilator weaning without the participation of the experienced nurses. As mechanical ventilator weaning is a practice which requires ongoing decision making throughout the day, nurses play a vital role due to their consistent proximity to the patient.

Hypothesis (3): "Mechanical ventilator weaning is facilitated when nurses actively participate in decision making" is supported by the findings in the study. Mechanical ventilator weaning is often the result of retrospective discovery rather than prospective planning. If nurses "worked by the rules" and passively waited for physicians to make the decisions and write the orders, the process of weaning would be impeded. The extent of nurses' participation varies according to the potential of the nurse and contextual factors at each site.
7. Decision findings

The decisions pertaining to individual ventilator changes are the sub-unit of enquiry in the present case study, and at the crux of the thesis. The first part of this chapter describes the ventilator settings as they are documented on the flow sheet. The second part of the chapter gives a description of nurses' independent and collaborative decisions related to mechanical ventilator weaning.

7.1. Variations in monitoring and recording

How are ventilator setting changes documented? During the course of the study it became evident that the flow sheets and progress notes were not reliable sources of information regarding ventilator changes without further interpretation. The documentation was riddled with systematic and random error to the extent that it became necessary to subject the flow sheet to scrutiny and analysis. The flow sheet data could not be used verbatim, but had to be reconstructed in context. To this end, the participants in the study helped interpret the data by clarifying inconsistencies.

The analysis of the flow sheet is relevant to the current trend of conversion from manual to computerized charting systems. The study demonstrates that the type of errors which are eradicated in manual charting are replaced by a new type of errors which are particular to computerized documentation, and the findings illustrate some of the pitfalls to the various methods of charting. The analysis of nurses' documentation practices are included in this study because the process of charting influences decision making, as it is assumed that putting things into writing compels the practitioner to reflect.

Methods and sources

This part of the study is based on retrospective analysis of flow sheets and patient records combined with contemporary data derived from direct observation and observational interviews. The following is a cross-site analysis in which the flow sheets at the four sites are compared.

Flow sheet variations

Inconsistent format. The main variation in charting format was that Site 1 and 3 used paper flow sheets, and that Site 2 and 4 used computerized flow sheets. The flow sheets at the four sites varied in structure, size, shape, color, content, capacity, terminology, and sequence of items. The average number of daily items on either type of flow sheet was around 2000 items in all categories. Among the core categories were vital signs, ventilator settings, fluids, lab results, and nursing care. The flow sheets at each site had a different selection of fixed categories for daily charting.

The computerized flow sheets contained up to 6000 possible items, but as some canceled out others, only approximately 2000 were active at any one time. The computerized flow sheets were able to accommodate a greater number of items than the paper sheets, but many were interdependent, e.g. the category "PS/PC setting" was activated when the mode was either "PS" or "PC". The process of manually activating certain categories of items paved the way for inconsistencies, e.g. instances where "mode" and "setting" failed to correspond as in "Mode VC, setting PS 14".

Nurses attempted to highlight ventilator changes on the flow sheet, but some changes were not highlighted, while some highlighted items were not ventilator changes, but rather and indication of a change of shift or a patient status. The inconsistent practice of highlighting added to the misunderstandings rather than providing clarification. Table 7.1. shows the terminology and sequence of items for the ventilator settings on the flow sheets. Sites 3 and 4 had a separate column for "ordered" ventilator settings, while this information was not provided at Sites 1 and 2.
### Table 7.1.1. The flow sheets at the four sites

<table>
<thead>
<tr>
<th>Site 1 paper flow sheet</th>
<th>Site 2 computerized</th>
<th>Site 3 paper flow sheet</th>
<th>Site 4 computerized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ventilator mode</td>
<td>Ventilation form</td>
<td>Vent. form</td>
<td>read FiO2</td>
</tr>
<tr>
<td>Preset / level</td>
<td>FiO2</td>
<td>FiO2</td>
<td>read Return volume</td>
</tr>
<tr>
<td>FiO2</td>
<td>Saturation</td>
<td>Frequency</td>
<td>read Frequency</td>
</tr>
<tr>
<td>SAT</td>
<td>Respiration frequency</td>
<td>Volume</td>
<td>read Insp. pressure</td>
</tr>
<tr>
<td>Resp. frequency</td>
<td>PS/PC setting</td>
<td>Insp. / pause time</td>
<td>read PEEP</td>
</tr>
<tr>
<td>Tidal vol.</td>
<td>MV expiratory</td>
<td>T-high / T-low</td>
<td>read Insp. /pause time</td>
</tr>
<tr>
<td>Return volume</td>
<td>Tidal volume exp.</td>
<td>Pressure/P-high</td>
<td>read Insp. Tidal</td>
</tr>
<tr>
<td>Ventilator pressure</td>
<td>Peak pressure</td>
<td>PEEP/P-low</td>
<td>read Exp. Tidal</td>
</tr>
<tr>
<td>PEEP</td>
<td>PEEP</td>
<td></td>
<td>read Press. Control</td>
</tr>
<tr>
<td>Insp. time %/Insp. rise time %</td>
<td></td>
<td>Ordered by:</td>
<td>read Press. Support</td>
</tr>
<tr>
<td>Pause time %</td>
<td>Ins. / Pause time</td>
<td>FiO2</td>
<td>ordered Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td>ordered FiO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Exp. time vol.</td>
<td>ordered Preset</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Return vol.</td>
<td>ordered Frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peak pressure</td>
<td>ordered Insp./pause time</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean pressure</td>
<td>ordered Exp. Tidal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>End pressure (PEEP)</td>
<td>ordered PEEP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spont. min. vol.</td>
<td>ordered Press. Support</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spontaneous frequency</td>
<td>ordered Press. Control</td>
</tr>
</tbody>
</table>

**Inconsistent values.** The values on the flow sheet were recorded inconsistently by the nurses because the same values could pertain to different items. The value "10" could indicate a pressure of 10 cm H2O or a volume of 10 liters. It could be a physician's order (decision), or an executed ventilator change (intervention) that was not ordered. Or a value could indicate either a specific task (intervention), target (outcome), or limitation (undesired response). Finally, a value could indicate the patient's actual response, calculated response, or simply an error, e.g. "FiO2 0,1", which was common. Sometimes the context could reveal the meaning. Due to varying equipment at Site 3 the nurses did not understand all the terms on the flow sheet, e.g. T-high, T-low, P-high, and P-low.

**Invisible values.** The paper flow sheets had the advantage that most values could be seen at a glance on a single page, while the computerized flow sheets provide greater detail at the expense of quick reference; the more detail, the less context. Human error could cause mistakes on the paper flow sheets. In order to overcome human error, the computerized flow sheets were linked to a patient data management (PDM) system that automatically recorded certain values, e.g. FiO2, PEEP, respiratory rate, or tidal volume. FiO2 and PEEP had a tendency to "fluctuate" hourly, which meant that it was impossible to determine whether fluctuations were a sign of intentional changes or mechanical variations. Tidal volume was seen to "freeze" for days in a row, creating a type of error particular to the computerized flow sheet. The PDM system would record the actual respiratory rate hourly, while the nurses rarely recorded the preset respiratory rate nor changes in the preset rate.

**Invisible changes.** The consequence of the ambiguous values was that it became difficult to determine (1) when a ventilator change was made, (2) what the change was, and (3) how the decision was made. Some nurses stated that they consistently record a "reading" in order to show what support the patient was actually "receiving", while other nurses stated that they only record "interventions" in order to document what was "ordered", e.g. "FiO2 0,47" is a reading, while "FiO2 0,5" is most likely to signify an order, decision, or intention.
The physicians were found to chart "settings", "readings", and "orders" indiscriminately in their progress notes. The physicians interchangeably charted "patient status" and "physician's orders", leaving the interpretation up to the nurses, who gained freedom to act independently. When physicians charted a ventilator change that had not been ordered, as the patient status, they tacitly sanctioned decisions and interventions made independently by nurses. Some physician's orders were "counter orders", e.g. "do not alter mode", which demonstrates the tacit agreement, that nurses may change the ventilator mode if not ordered explicitly not to. When nurses charted ventilator changes on the flow sheet, which were not delegated by a physician, they would do so anonymously, and they would avoid attracting attention to the intervention by failing to provide a rationale in the nurse's progress notes.

**Saving and retrieving.** The paper flow sheets were bulky to save and retrieve. At Site 1 the flow sheets were not saved together with the patient record, which made retrieval cumbersome, but not impossible. At Site 3 it was easy to retrieve the complete patient record and paper flow sheet. The computerized flow sheets were printed out daily and saved by the ward clerks. Chart retrieval during the course of the study demonstrated that the printouts of the computerized flow sheets were usually incomplete and randomly assembled, and that the data were not permanently saved on the computer. It was not possible to retrieve the computerized patient records in full at Sites 2 and 4.

**Staff identification.** The paper flow sheets had shortcomings with reference to identification of the nurse responsible for the patient. At Site 1 there was no space for nurses to initial, while at Site 3 there was a space, but the nurses failed to consistently identify themselves. The computerized flow sheets made identification mandatory, but it was still difficult to identify the nurse in charge of the patient, because nurses would chart for each other, and several nurses caring for the same patient would share the charting. The end result was that a different nurse could have initialed every hour of the day, making it equally difficult to identify the nurse in charge of the patient.

### 7.1.1. Summary of the findings related to variations in monitoring and recording

This section has demonstrated the difficulties of identifying ventilator changes; the central events in the study. On the flow sheet, ventilator changes were indistinguishable from mechanical variations, and ventilator changes made independently by the nurses were indistinguishable from changes that were ordered by a physician.

- Ventilator change
- Mechanical variation
- Intentional change
- Fluctuating values
- Frozen values
- Written order
- Joint decision
- Nurse decision

As demonstrated in section 6.2, it was possible to reconstruct the number of *mode changes* and extrapolate the finding, that only a fraction of executed ventilator changes are preceded by an order. The review of the flow sheets and charts has shown that physicians occasionally revert to issuing "counter orders", and that this is an indication of a tacit understanding regarding nurses' informal competencies, that nurses may alter mechanical ventilation unless told explicitly not to. The flow sheets have shown that "fluctuating" values conceal intentional changes, while "frozen" values conceal hourly fluctuations. The nurses' inconsistent practice of highlighting ventilator changes was found to provide extraneous and erroneous information and add to the confusion. Computerized documentation has solved problems particular to paper documentation, but has introduced new problems of its own. As ventilator changes are tricky to spot in retrospect, the next section will present the decisions as they are made in real-time.
7. Decision findings

7.2. Nurses' independent and collaborative decisions
How do nurses participate in mechanical ventilator weaning decision making? The executed ventilator changes are, as it has been shown, recorded with some inaccuracy on the flow sheet, while the decisions themselves are even more elusive. Some decisions are recorded as physicians' orders, but many are never put into writing. Physicians' orders do not reflect nurses' participation in the decision process, and the information in the nurses' progress notes is equally sparse. The first part of this section shows the findings related to the coded data during direct observation, while the second part gives examples of the independent and collaborative decisions made by the nurses in relation to mechanical ventilator weaning constructed from the narrative data.

Methods and sources
In order to capture clinical decisions, observations were made at the bedside, during rounds, and during interdisciplinary conferences. These structured observations were supplemented and reinforced by observational interviews. The structured observation instrument, the registration sheet, was used to record the observational interviews. The instrument comprised coded as well as narrative data for describing each decision. The coded data describe the decision context: Site, case, day, category, place, person, order, outcome, nurse potential, and decision complexity. The codes were defined on the code sheet and data were transferred to an Excel™ data sheet. The narrative data describe the decision content: Decision, indication, choice (alternatives and consequences), rationale (interests), strategy, and outcome.

After the narrative data were recorded, some data were subsequently reduced to more general categories and added to the data sheet. The narrative decision categories were: Airway related, communication related, sedation related, ventilator change, and weaning related decisions. The narrative indication categories were: Clinical indicators and paraclinical indicators. Clinical indicators are the patient's tangible signs and symptoms, while paraclinical indicators are seen indirectly, e.g. x-rays or lab-results. Finally, the decisions were ranked by complexity and outcome. A decision was categorized as simple if there was only one alternative and the outcome was predictable. A decision was complex in situations where there were several alternatives and the consequences were less predictable. The decisions were then sorted by outcome. The outcome was successful if the expected result was obtained, while the outcome was a failure if the expected result did not occur. The code sheet is shown in "Appendix 10.2. The Code Sheet" and the registration sheet is shown in "Appendix 10.3. The Registration Sheet".

At the onset of each observation session, the nurse assigned to the patient was asked if there had been any ventilator changes on her shift, or if she planned to suggest any changes at rounds. This information was compared with information on the flow sheet and the patient record. In addition to this, the nurse was interviewed at a convenient time about the ventilator changes. Although the main focus of the study was (A) nurses' decisions about (B) mechanical ventilation, some borderline decisions were recorded, such as (a) decisions made collaboratively with nurses, patients or physicians, and (b) decisions indirectly or more remotely related to mechanical ventilation. A total of 113 decisions were recorded in this fashion. "Appendix 10.7. The Independent and Collaborative Decisions" provides a list of the decisions in full.

7.2.1. Findings related to the coded data
Nurse potential versus decision complexity. As it was shown in 6.1.6. each nurse was given a "nurse potential" score during direct observation. As decisions were identified, each decision was
categorized as simple or complex. Table 7.2.1. shows a cross-tabulation of the binary data consisting of complex and simple decisions related to nurse potential.

The gamma correlation coefficient is calculated as: $\gamma = \frac{ad - bc}{ad + bc}$. This means that $\gamma = \frac{(55 \times 30) - (11 \times 17)}{(55 \times 30) + (11 \times 17)} = 0.80$ and shows a strong positive correlation between high nurse potential and complex decision making. As stated in 6.1.6. the gamma correlation coefficient is defined in this study as follows: $\gamma < 0.15$ shows a weak positive correlation, $\gamma = 0.15 - 0.30$ shows a moderate positive correlation, and $\gamma > 0.30$ shows a strong positive correlation (Kreiner 1999).

### Table 7.2.1. Relationship between nurse potential and decision complexity

<table>
<thead>
<tr>
<th>Nurse potential &gt; 3</th>
<th>Complex decision</th>
<th>Simple decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>11</td>
<td>66</td>
</tr>
<tr>
<td>Nurse potential ≤ 3</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>$\gamma = 0.80$</td>
<td>72</td>
<td>41</td>
</tr>
</tbody>
</table>

In order to determine the relative impact of the individual components of nurse potential on decision complexity, the components have been calculated separately. There is a strong positive correlation between a high nursing potential score in relation to all three of its components, and complex decision making: "knowing the field" ($\gamma = 0.90$), "knowing the ward" ($\gamma = 0.74$), and "knowing the patient" ($\gamma = 0.70$). The findings are in accordance with the findings in 6.1.6. which suggest that knowing the field has more impact on nurse performance than knowing the ward and patient. These findings are not surprising in themselves, but must be considered, because the nurses in the present study explicitly valued continuity (which was lacking), while they downplayed the significance of critical care certification (which was present).

### Nurse potential versus collaboration

Table 7.2.2. shows a moderate positive correlation between high nurse potential and collaborative decision making. The study shows that highly experienced nurses not only seek collaboration with the physicians, they also seek collaboration with the patients. This finding is consistent with the Synergy Model which describes collaboration and patient participation as a mark of good nursing and certified practice.

### Table 7.2.2. Relationship between nurse potential and collaboration

<table>
<thead>
<tr>
<th>Nurse potential &gt; 3</th>
<th>Collaborative</th>
<th>Independent</th>
<th>66</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>25</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Nurse potential ≤ 3</td>
<td>23</td>
<td>24</td>
<td>47</td>
</tr>
<tr>
<td>$\gamma = 0.26$</td>
<td>64</td>
<td>49</td>
<td>113</td>
</tr>
</tbody>
</table>

### Collaboration versus decision complexity

It has been shown above, that a high nursing potential is positively associated with complex decision making and collaboration. This time collaboration is related to decision complexity, and table 7.2.3. shows a poor correlation between the two. This finding suggests that nurses' independent and collaborative decisions related to mechanical ventilator weaning, are similar in complexity. This study, however, does not reflect physician's independent decisions, which may be more complex than collaborative interdisciplinary decisions.

### Table 7.2.3. Relationship between collaboration and decision complexity

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>Complex decision</th>
<th>Simple decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative</td>
<td>31</td>
<td>18</td>
</tr>
<tr>
<td>Independent</td>
<td>41</td>
<td>23</td>
</tr>
<tr>
<td>$\gamma = -0.02$</td>
<td>72</td>
<td>41</td>
</tr>
</tbody>
</table>
Decision venue versus decision complexity. Table 7.2.4. shows the relationship between complexity of decisions made during rounds and conferences or at the bedside. The table shows a weak positive correlation ($\gamma = 0.12$) between decision venue and decision complexity, which suggests that the decisions made during rounds and conferences are only slightly more complex than decisions made at the bedside. Decisions made at the bedside are usually ventilator changes that have short-term outcomes, e.g. "decrease pressure support to PS 10 if tolerated", while decisions made during conferences have more long-term outcomes, e.g. "postpone weaning until bowel sounds are present". Decisions with long-term outcomes may be more complex because more factors (alternatives and consequences) are considered.

<table>
<thead>
<tr>
<th>Table 7.2.4. Relationship between decision venue and decision complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex decision</td>
</tr>
<tr>
<td>Rounds and conferences</td>
</tr>
<tr>
<td>Bedside</td>
</tr>
<tr>
<td>$\gamma = 0.12$</td>
</tr>
</tbody>
</table>

Type of order versus decision complexity. Table 7.2.5. shows a moderate to strong positive correlation between the complexity of the decision and the presence of a written order. Written orders are usually based on decisions made during rounds. This means that written orders may represent decisions in more complex situations with longer term outcomes than nurses' independent or collaborative decisions made at the bedside; verbal orders are more predictable.

<table>
<thead>
<tr>
<th>Table 7.2.5. Relationship between type of order and decision complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex decision</td>
</tr>
<tr>
<td>Written order</td>
</tr>
<tr>
<td>No written order</td>
</tr>
<tr>
<td>$\gamma = 0.34$</td>
</tr>
</tbody>
</table>

Decision venue versus collaboration. Table 7.2.6. shows a strong positive correlation ($\gamma = 0.94$) between decision venue and collaboration, which means that most of the decisions nurses made during rounds and conferences were collaborative while most of the decisions nurses made at the bedside were independent.

<table>
<thead>
<tr>
<th>Table 7.2.6. Relationship between decision venue and collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative</td>
</tr>
<tr>
<td>Rounds and conferences</td>
</tr>
<tr>
<td>Bedside</td>
</tr>
<tr>
<td>$\gamma = 0.94$</td>
</tr>
</tbody>
</table>

7.2.2. Findings related to the narrative data
In the following, some of the individual decisions will be presented in order to illustrate the content and reasoning behind the nurses' independent and collaborative decisions. The findings are presented in the order of rational logic (indication/decision, intervention, outcome): Narrative decision categories, narrative indication categories, and narrative outcome categories.

Table 7.2.7. shows the distribution of narrative decision categories according to the variables of the narrative data: Nurse potential, collaboration, time of trajectory, and decision venue. The table shows the distribution of the 113 recorded decisions in each narrative decision category: Airway related, communication related, sedation related, ventilator change related, and weaning related.
Table 7.2.7. Distribution of decision categories according to variables of the narrative data (n = 113)

<table>
<thead>
<tr>
<th>Narrative decision categories</th>
<th>Nurse potential</th>
<th>Collaboration</th>
<th>Trajectory</th>
<th>Venue</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 &lt; 3</td>
<td>3 = 3</td>
<td>Nurse - nurse</td>
<td>Nurse - physician</td>
</tr>
<tr>
<td>Airway related</td>
<td>8 7 4 9 2 1 14 8 7 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>6 4 7 2 1 2 8 10 0 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sedation related</td>
<td>10 4 7 6 1 4 10 9 5 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ventilator change</td>
<td>29 24 31 20 2 11 42 39 14 0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaning related</td>
<td>13 8 9 12 0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Narrative decision categories versus nurse potential. Table 7.2.7. shows that the distribution of decision categories is similar for experienced and less experienced nurses. Examples of decisions made by nurses with varying potential are given below.

Decision # 25 (Site 1, case 2, day 8): The decision is an independent nursing decision (no order) to stop sedation with the ultimate goal of ventilator weaning (sedation related). The indication is that the patient does not appear to be in distress and follows the ventilator (clinical). The rationale is to assess the patient's neurological status, to encourage weaning, and to communicate with the patient. The strategy is to avoid sedating more than necessary, and the outcome is successful. The nurse conversationally informs the physician during rounds that sedation has been discontinued, and the physician sanctions this decision. The physician knows the nurse and trusts her judgment as they have worked together for many years. The nurse has the highest nurse potential score \((15+5+5)/3 = 5\), as the nurse has more than 20 years in critical care, more than ten years at this ward, has critical care certification, and is primary nurse for the patient.

Decision # 24 (Site 1, case 2, day 5): The decision is an independent nursing decision (no order) to increase preset volume (ventilator change). The indication is an arterial blood gas which shows high pCO2 (paraclinical). The rationale is that increased volume will decrease pCO2, and the strategy is to keep increasing volume if necessary. The outcome is successful, but the plan of indefinitely increasing volume is potentially harmful to the patient. The nurse has the lowest nurse potential score \((1+1+1)/3 = 1\), as the nurse is new to the field, ward and patient.

Narrative decision categories versus collaboration. Table 7.2.7. shows that among the recorded decisions, 58 were made by nurses independently or in collaboration with other nurses, 49 were made with physician participation, and six were made in collaboration with patients. Patient participation is a valued goal according to the Synergy Model, but only few patient decisions were observed, e.g. to postpone tracheotomy, discontinue sedation, resume spontaneous breathing trials, or increase FiO2. The study shows that the nurses do not systematically seek patient collaboration. Some nurses state that the patient should be sedated until mechanical ventilator weaning is initiated, and for that reason postpone establishing patient contact. Examples of collaborative decisions are given below.

Decision # 13 (Site 1, case 2, day 1): The decision is the nurse's suggestion to reduce FiO2 from 1,00 to 0,60 (ventilator change). The indication is SAT 100% (paraclinical). The rationale is to keep FiO2 as low as possible maintaining SAT as high as possible, and the strategy is to decrease FiO2 and monitor SAT. The nurse suggests this FiO2 change during rounds and the physician rejects the
suggestion because the patient has to resolve CO-poisoning before FiO2 is reduced. In this case, the physician issues a specific "counter order", recognizing the fact that nurses frequently reduce FiO2 without an order, as they automatically reduce support whenever possible. The nurse has an intermediate nurse potential score (\[(5+5+1)/3 = 3.7\]), as the nurse is experienced in the field and ward, but lacks experience with the patient. The nurse consults the physician before reducing FiO2, because she doesn't know the patient. A less experienced nurse may not have known to ask first, which might have jeopardized the patient's safety. The general (unwritten) rule is to reduce FiO2 whenever possible, but exceptions exist at Site 1 where FiO2 1.0 is ordered for inhalation injury patients and at Site 4 where FiO2 1.0 is used extensively for post CABG patients.

**Decision # 11** (Site 1, case 1, day 45): The decision is to bag the patient (airway related). The indication is atelectasis (paraclinical), and the choice is to bag and risk barotrauma, or not to bag and risk proliferating atelectasis. The rationale is to recruit areas of lung and the strategy is to negotiate with the patient. The nurse suggests bagging the patient and the physician agrees with the decision while the patient disagrees. The nurse does not discuss the decision with the patient, but the physician opens negotiations with the patient by ensuring good contact and a trusting relationship: "I am your friend ... we will do everything for you ... if we do, then you must hang on...". The nurse has an intermediate nurse potential score (\[(5+3+3)/3 = 3.7\]), as the nurse is experienced in the field, and has intermediate knowledge of the ward and patient. In this case the physician knows the patient better than the nurse does and is able to use this knowledge to the patient's advantage.

**Decision # 8** (Site 1, case 1, day 41): The decision is to discontinue sedation (sedation related). The indication is the patient's request not to be sedated (clinical). The patient has been sedated at night in order to sleep, conserve energy, and follow the ventilator. The choice is to follow the patient's request and risk a slower wean, or to reject the patient's request in order to expedite weaning. The rationale is to collaborate with the patient when it is possible and the strategy is to collaborate and reduce sedation and, perhaps, increase ventilator support. The nurse has an intermediate nurse potential score (\[(5+1+3)/3 = 3\]), as the nurse is experienced in the field, is new at the ward, and has cared for the patient before. The nurse recognizes the importance of collaborating with the patient on the patient's terms.

**Decision # 102** (Site 4, case 13, day 5): The decision is to postpone tracheotomy (airway related). The indication is a patient request not to have a tracheotomy (clinical). The choice is to comply with the patient, or to comply with "protocol", viz. the recommended treatment. The rationale is to follow the patient when it is possible and the strategy is to wean the patient from the ventilator before tracheotomy becomes absolutely necessary. The nurse has the highest nurse potential score (\[(5+5+5)/3 = 5\]), as the nurse is experienced with the field, ward, and patient. The nurse recognizes the importance of collaborating with the patient on the patient's terms.

**Narrative decision categories versus time of trajectory.** Table 7.2.7. suggests that decisions made during the first three days and may be different from the decisions made later in the trajectory. This is supported by the Weaning Continuum Model in which the type of decisions change through the trajectory. In the present study decisions during the first three days are related to mostly to ventilator changes and sedation, while later, decisions evolve around ventilator changes, weaning, and airway management. Examples of decisions according to the time of trajectory are given below.
7. Decision findings

Decision #12 (Site 1, case 2, day 1): The nurse's independent decision on the first day of mechanical ventilation is to increase preset volume (ventilator change). The indication is that ABG shows high pCO\textsubscript{2} and the patient is triggering the ventilator (paraclinical). The choice is to increase sedation or volume, and the rationale is that more volume is what the patient needs, and the strategy is to find the ventilator setting that matches the patient's needs. The nurse is getting to know the responses of the patient. The nurse has an intermediate nurse potential score ([5+5+1]/3 = 3,7). The nurse is highly experienced with the field and ward, but does not know the patient.

Decision #81 (Site 3, case 9, day 24): The decision on the 24\textsuperscript{th} day of mechanical ventilation is to put patient on "closed PEEP" and put the patient back on the ventilator before assessing the ABG (weaning related). The indication is that the patient looks fatigued and should not be off the ventilator too long. The nurse does not rely on the clinical picture and chooses to draw an ABG (paraclinical). The rationale is to avoid exhausting the patient while weaning, and the strategy is to extend SBTs as long as tolerated by the patient and check the ABG. The nurse is not aware that the physician has given a verbal order to a previous nurse to wean with "short" SBTs and "long" restitution periods; the terms "long" and "short" are not defined. The nurse has an intermediate nurse potential score ([5+3+1]/3 = 3). The nurse is experienced in critical care, knows the ward, but does not know the patient. The patient is in transition from assisted breathing (weaning stage) to spontaneous breathing (outcome stage). The nurse is the patient's 24\textsuperscript{th} nurse in as many days.

Narrative decision categories versus decision venue. During direct observation nurses' independent decisions were observed to be made at the bedside, the collaborative decisions were made predominantly during rounds, while physicians' independent decisions were made at the interdisciplinary conference. Most decisions emerged as a part of discussions or conversations among nurses and physicians. Decisions made at the conferences were usually vaguely stated and left the participants with a variety of alternatives for action. The participants at the conferences would discuss different strategic options, but decisions were rarely summed up and put into writing. The patient record rarely contained a note from the interdisciplinary conference.

In some situations there was a conflict of interest when nurses' and physicians' goals collided, e.g. if the nurses' goal was patient comfort, and the physicians' goal was efficient ventilator weaning. At a conference discussing Case 1, a physician stated that the nurses were "caring the patient to death", indicating that the nurses were impeding weaning efforts by "feeling sorry for the patient" rather than viewing the situation professionally. When the ventilator was removed from the patient's room, the patient would become anxious, and the nurses would feel sorry for the patient and bring back the ventilator, thereby aggravating the patient's ventilator dependency. During the interdisciplinary conference it was clearly stated by the physician, that the ventilator should be removed from the patient and could only be returned by physician's order.

When nurses met a new physician at the bedside, they were apt to ask the physician rhetorical questions, e.g. seek permission for predictable ventilator changes, in order to establish a good rapport with the physician with the ultimate goal of gaining the physician's trust and obtaining more autonomy at a later time. The nurses termed the strategy "acting dumb".

Table 7.2.7. shows that decisions made at the bedside were mostly related to ventilator setting changes and patient communication. Decisions at rounds were mostly related to ventilator setting changes and airway maintenance (bagging, tube change), while respiratory decisions at conferences
were more proactive and often related to overall sedation and weaning strategy. The two decisions which were recorded during conferences are shown below.

Decision # 61 (Site 2, case 7, day 3): The decision is a collaborative decision to discontinue propofol (sedation related). The indication is that the patient is ready to wean from mechanical ventilation (clinical). The choice is to use either propofol or fentanyl for "tube irritation", the rationale is to use fentanyl in order to keep the patient awake in order to extubate, and the strategy is to change from propofol to fentanyl. The nurse had independently been weaning Pressure Support by increments of 2 cm H2O every hour and informed the physician that the patient would soon be ready for extubation. During noon conference the physicians decided to discontinue propofol and extubate. The nurse had a low-medium nurse potential score ([5+1+1]/3 = 2.3), as the nurse is highly experienced in critical care, but does not know the ward or the patient. The physician's progress note states that the plan is to wean the patient from propofol and pressure support, but the physician does not document extubation. The trajectory is a "sprint" weaning pattern which is so uneventful that it barely warrants documentation. Although it appears that the physicians made the decisions, it was actually the experienced nurse in collaboration with a student nurse, who made the recommendations and performed the smooth process of weaning. The outcome was successful.

Decision # 65 (Site 2, case 8, day 3): The physicians decided on a "fast wean" and "sink-or-swim" extubation within four hours to be completed before the afternoon change of shift. The decision was to decrease the pressure rapidly (ventilator change). The indication was that the patient was awake and cooperative (clinical). The choice was to extubate before the change of shift and risk reintubation, or to postpone extubation and risk ventilator dependency. Physicians at Site 2 prefer to extubate on day shift, the rationale being that extubation is safer during day shift with more backup staff. The strategy was to wean the patient from the ventilator as fast as possible. The ventilator was set at PC 22 and the order was to rapidly reduce pressure by large hourly increments: PC 22 to PS 19 to PS 12 to PS 8, then extubate. The nursing aide assigned to the patient was concerned about the rapid course and tried to persuade the physicians at the noon conference to wean the patient more gradually. The request was denied and the patient was weaned and extubated within four hours and subsequently had to have frequent CPAP treatment in order to loosen and clear secretions. After two days the patient had become exhausted and was reintubated and got a tracheotomy. The patient was then weaned more slowly by reducing pressure by intervals of 2 cm H2O each day for a week. The outcome was successful in the short-term perspective, but a failure in the long-term perspective.

Narrative indication categories versus collaboration. The data suggest that nurses as well as physicians use more clinical than paraclinical indicators and, it was observed, that physicians try to encourage the nurses to use arterial blood gasses more discriminately and to rely more on the clinical picture. Table 7.2.8. shows a weak negative correlation between physician participation and paraclinical indications, which suggests that nurses may be slightly more partial to paraclinical indications, especially arterial blood gasses, than physicians. Examples of decisions using various indications are given below.

<table>
<thead>
<tr>
<th>Collaborative decisions</th>
<th>Paraclinical</th>
<th>Clinical</th>
<th>(\gamma = -0.10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\frac{12}{37} = 49)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\frac{18}{46} = 64)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\frac{30}{83} = 113)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Decision # 27 (Site 1, case 2, day 9): The nurse's independent decision is to "test" the patient by changing ventilator mode to Volume Support for half an hour and see how it goes (ventilator change). The indication is that the patient is waking up (clinical). The choice is to change the mode and let the patient wake up, or to sedate the patient and maintain the current ventilator mode with the risk of postponing weaning. The rationale is that it is uncomfortable for the patient to be awake on a control mode, the strategy is to keep the patient awake if possible, and the outcome is successful and marks the patient's transition to the weaning stage. The nurse has the highest nurse potential score ([5+5+5]/3 = 5), as the nurse is experienced with the field, ward, and patient. The nurse orients the patient to time and place, and explains what is happening. The nurse is comfortable with waking up the patient and with changing the mode to VS, which is the physicians' preferred weaning mode at Site 1, but which the less experienced nurses resist using.

Decision # 37 (Site 1, case 3, day 6): The nurse's independent decision is to bag the patient (airway related). The indication is that the physician had stated earlier that the x-ray shows atelectasis (paraclinical). The choice is to bag the patient and risk over-distension of the lungs, or not to bag the patient and risk more atelectasis. The rationale is that oxygen and bagging will recruit collapsed areas of lung, and the strategy is to bag the patient rather than to increase PEEP. The intervention is successful and represents the transition to the weaning stage. The nurse has the highest nurse potential score ([5+5+5]/3 = 5), as the nurse is experienced with the field, ward, and patient, and feels comfortable bagging the patient without an order.

Decision # 54 (Site 2, case 5, day 6): The decision is to reduce pressure (ventilator change). The indication is that the patient is comfortable (clinical). The rationale is to reduce ventilator support and the strategy is to encourage patient participation. The nurse consults the physician prior to making the change. The nurse has an intermediate nurse potential score ([3+3+3]/3 = 3), as the nurse has some experience with the field, ward and patient. The decision represents the final attempt at weaning before the patient reverts to the preweaning stage and dies six days later.

Outcome versus nurse potential. Table 7.2.9. shows a strong negative correlation between high nurse potential and outcome success. The explanation may be that experienced nurses make more decisions in complex and unpredictable situations, including testing the patient, in order to find the best ventilator settings, while less experienced nurses make more decisions in predictable situations where the outcome is certain. Table 7.2.1. has shown a strong positive correlation between high nurse potential and complex decision making. In this section outcome failure refers to short term outcomes, e.g. the patient did not tolerate SBT and mechanical ventilation was resumed. For this reason the finding may illustrate how experienced continuously test the patients in order to assess their current status and capabilities. An example of a predictable outcome coupled with low nurse potential is shown below.

Table 7.2.9. Relationship between outcome and nurse potential

<table>
<thead>
<tr>
<th>Nurse potential</th>
<th>Outcome success</th>
<th>Outcome failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 3</td>
<td>54</td>
<td>12</td>
</tr>
<tr>
<td>&lt; 3</td>
<td>43</td>
<td>4</td>
</tr>
</tbody>
</table>

\( \gamma = -0.41 \)

<table>
<thead>
<tr>
<th>Nurse potential</th>
<th>Outcome success</th>
<th>Outcome failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \gamma = -0.41 )</td>
<td>97</td>
<td>16</td>
</tr>
</tbody>
</table>

Decision # 82 (Site 3, case 9, day 25): The decision is to turn down the alarm limits (ventilator change) and the indication is that the ventilator alarm frequently goes off and bothers the nurse and the patient. The choice is to reduce the alarm settings and the rationale is that it is too complicated to find a better ventilator setting. The strategy is to temporarily reduce the alarm limits and increase...
them when the nurse leaves the room. The outcome is successful in that the problem is solved for the time being, but the intervention is potentially dangerous for the patient because the nurse may forget to reset the alarm and the patient may be at risk if the alarm does not sound when the patient is not receiving sufficient ventilation. The nurse has the lowest possible nurse potential score\((\frac{1+1+1}{3} = 1)\), as the nurse is new to critical care, the ward and the patient. The nurse does not know her own limits and is not being supervised by an experienced nurse.

**Outcome versus collaboration.** Table 7.2.10. shows a weak to moderate negative correlation between collaborative decisions and outcome success. The study has shown that collaborative and independent decisions are similar in complexity (table 7.2.5.), which may account for similar outcome success. Again, the explanation may be that experienced nurses and physicians make similar decisions and take similar risks. An example of successful outcome related to an independent nursing decision given below.

<table>
<thead>
<tr>
<th>Table 7.2.10. Relationship between outcome and collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collaborative decisions</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Independent decisions</td>
</tr>
<tr>
<td>(\gamma = -0.15)</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Decision # 90** (Site 3, case 10, day 17): The patient has terminal COPD, and the nurses and physicians have jointly decided at the noon conference to withdraw mechanical ventilation. It is decided that the nurse should arrange a family conference where a physician would inform the family of the decision to withdraw mechanical ventilator treatment. The nurse who is coordinating the patient care has the authority to decide when in the course of the day the family should be informed, when the terminal weaning should be started, and which nurse should be present during the family conference. The nurse is precepting a new nurse who has been one month in ICU. The decision is to let the new nurse participate in the family conference (communication related) while the experienced nurse stays with the patient. The indication is that the new nurse has not experienced a family conference. The choice is to let the new nurse participate in the conference in place of the experienced nurse who knows the family. The rationale is that the orientee needs to learn. The strategy is to expose the orientee to new situations. The outcome is successful in that the orientee meets her learning objectives. From a different standpoint, the outcome is unsuccessful, because the family needed the support of the experienced nurse more than the patient did at that time. When the family returned from the conference they could not hide their grief from the patient, who was now faced not only with the grief of the family, but also faced with the challenge of trying to breathe on his own during a crisis. The experienced nurse could have chosen to participate in the family conference and help the family and the patient deal with their emotions before the terminal ventilator weaning was initiated. The nurse made a choice which favored the nurse orientee, not the patient and family. The nurse had a high potential score\((\frac{5+1+5}{3} = 3.7)\), as the nurse was experienced with the field and patient, but was new to the ward. Perhaps a nurse more familiar with the ward and the physicians would have chosen a different alternative with less severe consequences.

**Ventilator changes versus nursing care.** Many of the ventilator changes observed were temporary ventilator changes related to performing bedside nursing care. It was observed that nurses would temporarily alter the ventilator in order to position the patient, systematically alternating sides in order to prevent bedsores. Nurses would temporarily increase ventilator support in order to promote rest and sleep or would temporarily alter support during mobilization and physical therapy. Nurses
would dress and cover the patients adequately to protect their integrity, and would groom the patients in order to help them to feel human enough to pursue ventilator weaning. Nurses would temporarily discontinue the ventilator in order to help the patient speak to visitors through the tracheotomy. In a myriad of ways nurses worked around the mechanical ventilator in order to perform the basic nursing care, which was necessary to keep the patients from withdrawing from the world and giving up. Most of these temporary measures were neither articulated nor documented and therefore remain invisible. All these subtle ventilator changes were performed as a parallel practice to the "official" strategy of mechanical ventilator treatment and weaning. Nurses stated that they found it too commonplace or cumbersome to document how they make it through the morning nursing care, which includes bedbath, grooming, linen change, mobilization, feeding, tube changes, dressing changes, and intensive monitoring. The nurses have no systematic vocabulary in which to describe what they do, without reverting to extended narratives. Performing nursing care to an intubated patient is, perhaps, at the very core of what critical care nursing is all about, and it is the most invisible practice of all.

7.2.3. Summary of the findings related to nurses' independent and collaborative decisions
The most important factor in relation to nurses' decision making is knowledge of the field of critical care. Knowing the ward and the patient are important, but knowing the field is the strongest predictor of good nursing performance, because expertise facilitates knowing the ward and patient. The findings in this section suggested that nurses with high potential made more decisions in complex situations than did nurses with lower potential.

Nurses' independent and collaborative decisions were found to be similar in complexity. Decisions made during rounds and conferences were only slightly more complex than decisions made at the bedside, while decisions that were ordered in writing were more complex than verbal orders and nurses' independent decisions. Nurses' decisions during rounds and conferences were predominantly collaborative, while independent decisions were made at the bedside. The study suggested that experienced nurses, in accordance with the Synergy Model, seek out the opinions of others in order to collaborate with physicians and patients. Figure 7.1. below shows how the variables in the study roughly relate to each other.

Figure 7.1. The relationship among the variables in the study
The narrative decision categories were similar among experienced and less experienced nurses. Independent nursing decisions focused more on ventilator changes while collaborative decisions focused on ventilator changes and weaning strategies. Nurses and physicians alike used more clinical indicators for decisions than paraclinical indicators. Decisions made within the first three days of the ventilator trajectory focused on ventilator changes while decisions later in the trajectory diversified around airway maintenance, ventilator changes, and weaning. Independent nursing decisions at the bedside focused on ventilator changes and communication, while decisions made during rounds were related to ventilator changes and airway maintenance.

An interesting finding was that experienced nurses had a higher incidence of outcome failure than less experienced nurses. The reason may be that less experienced nurses take fewer risks and make more simple and predictable decisions. Experienced nurses and physicians, on the other hand, make more decisions in more complex and less predictable situations with less outcome success, which makes the finding consistent by theoretical replication. Also, it may be argued that less experienced nurses set short-term goals, while more experienced nurses and physicians set longer-term goals.

The study has shown that physicians write "counter orders", which signify a tacit acknowledgment of the nurses' freedom to act if not told explicitly not to. There is a tacit agreement that nurses continuously act to reduce ventilator support if no counter orders are issued. Nurses usually inform the physicians after they have made and independent intervention. When nurses act independently the physicians usually sanction the action by recording the current status of the ventilator settings in the progress notes.

The examples of decisions in this section show that collaborative decisions may be initiated by the nurse or the physician. Nurses participate in decision making by asking, consulting, suggesting, recommending, informing or persuading the physicians. Likewise physicians seek out the opinions of the nurses based on their closer and more consistent contact with the patient. Nurses' participation in decision making spans the continuum from acting independently to following orders. All these nuances of collaboration are invisible, whether the decision is based on a tacit agreement, or results in a written order. One of the main findings is that most mechanical ventilator weaning decisions are collaborative and emerge as a part of continuing conversations among nurses and physicians.

Hypothesis (3), "Mechanical ventilator weaning is facilitated when nurses actively participate in decision making", is supported by the findings in the study. Mechanical ventilator weaning is a collaborative practice, and nurses' participation in decision making spans the continuum from independent action to following orders. The extent of nurses' participation varies according to the potential of the nurse and contextual factors at each site.
8. Discussion

The present study offers a systematic and detailed description of the content, range, and context of nurses' decisions and interventions regarding mechanical ventilator weaning, including a look at the potential of the nurses who participate in decision making. The application of case study research methodology and organizational decision theories to the medical domain of mechanical ventilator weaning has not previously been done; the current subject matter is usually explored within the paradigm of medical science using randomized clinical trials as the golden standard for research. Although some descriptive and qualitative studies have been undertaken, the findings in the current study add a new perspective to the previously published studies, and it is assumed that the new findings complement rather than replace earlier knowledge regarding mechanical ventilation.

The study questions and hypotheses presented in Chapter 2 have guided the study and have brought about new knowledge about mechanical ventilator weaning. The first and second hypotheses have established a baseline for the following discussion, which will be a further exploration of the findings related to the third hypothesis. The first hypothesis, that nurses' competencies related to mechanical ventilator weaning increase as nurses' qualifications increase, was partially supported by the findings in the study. The formal competencies of the nurses do not increase as the formal qualifications increase, but the informal competencies increase gradually as the formal and informal qualifications increase. The second hypothesis, that nurses' prospects of participating in decisions related to mechanical ventilator weaning vary across the four sites in the study according to contextual factors, was also partially supported by the findings in the study. At the formal level the nurses' prospects of participating in decision making were similar at the four sites because all nurses have the same formal competencies and because mechanical ventilation is not formally within the boundaries of nursing practice. At the informal level the nurses' prospects of participating in decision making varied according to contextual factors.

The third hypothesis, that mechanical ventilator weaning is facilitated when nurses actively participate in decision making, was supported by the findings in the study. Mechanical ventilator weaning is often the result of retrospective discovery rather than prospective planning. If nurses "worked by the rules" and passively waited for physicians to make the decisions and write the orders, the process of weaning would be impeded. The extent of nurses' participation varies according to the potential of the nurse and contextual factors at each site. It was found that mechanical ventilator weaning is a collaborative practice, and that nurses' participation in decision making spans the continuum from independent action to following orders. The three main findings, related to the third hypothesis, that will be discussed in this chapter are: (1) Mechanical ventilator weaning is often the result of retrospective discovery, which will be discussed in "8.1. How weaning is discovered", (2) mechanical ventilator weaning is a collaborative practice, which will be discussed in "8.2. How nurses participate in decision making", and (3) mechanical ventilator weaning is an intensive technology, which will be discussed in "8.3. How nurses and physicians interact in the organization". Finally, there will follow a discussion of theory, methodology, and limitations.

8.1. How weaning is discovered

The anatomy of the mechanical ventilator weaning trajectory has been explored, employing the Weaning Continuum Model, which was presented in Chapter 2, as a framework and vocabulary for the present enquiry (Knebel et al. 1998). In accordance with the inherent assumptions of the conceptual framework, the 14 cases in the study have shown that actual weaning continua are less linear and predictable than the theoretical model. This leads to the first part of this discussion,
which is about the understanding of the onset of weaning: When is weaning initiated? What criteria are used to initiate the weaning process? And what is the purpose of ventilator reduction?

None of the sites in the study used formal weaning criteria to determine the best time to start mechanical ventilator weaning. In the absence of formal weaning criteria, the decisions to initiate, continue, or abort weaning were more or less intuitive. As a benchmark for discussing the onset of weaning, a prescribed weaning readiness threshold (PWRT) was constructed by the researcher for the present study, and it was found that the weaning stages in the 14 study cases were initiated at varying times before or after this threshold was reached. Moreover, the study showed that weaning was continued even when setbacks occurred, and the patient deteriorated below the initial point of transition. In this respect, the cases in the present study depart from the theoretical model, because, according to the model, weaning should cease if the patient's status deteriorates below the readiness threshold. This finding can be explained by theoretical replication in that neither the onset of weaning, nor the cessation of weaning, were consistently articulated.

In the present study weaning was initiated while some of the criteria in the PWRT were unmet, i.e. while FiO2 and PEEP were too high, but weaning was not initiated in situations where none of the criteria were met. If weaning is defined to begin at the onset of mechanical ventilation, rather that at the readiness threshold, most of the weaning readiness criteria would be unmet at the onset of weaning. Therefore the concept of a weaning readiness threshold makes more sense if weaning is regarded to start at some point later than intubation.

In Case 1 in the present study, weaning did not start at the time of intubation because the patient was intubated for surgery and remained unstable for an extended period of time before weaning was initiated. In this case it makes sense to consider a preweaning stage. An order was eventually given to start weaning when FiO2 < 0.5. This order indicates the readiness threshold. It took a while before the patient reached this threshold, and data indicate that ventilator reduction was in progress for weeks before weaning was formally acknowledged. Ventilator reduction prior to the threshold was regarded as stabilizing the patient, while ventilator reduction after the threshold was regarded as weaning. After weaning had started, the patient deteriorated below the threshold, but weaning was sustained. In Case 8 weaning and extubation were carried out well ahead of the PWRT, at a time when saturation was inadequate and secretions were excessive. The rationale being that patients with chronic COPD may have only a small window of opportunity to be liberated from mechanical ventilation, and that prolongation of ventilation may preclude the possibility for weaning. As the first attempt at weaning failed, the second weaning continuum was initiated when the PWRT was reached, and a consistent strategy of incremental pressure reduction rendered weaning a success. In Case 9 weaning was withheld until well beyond the PWRT. The patients were eventually successfully weaned, and the reason may be that the nurses did not stand idle and wait for the official go-ahead. The patients were, so to speak, packaged and ready, when the physicians declared that it was time to start weaning.

The case review in section 6.3. shows that weaning was not ordered prospectively in the chart in the 14 study cases. The order to wean was given retrospectively, after the fact, and was not a prerequisite for initiation of weaning. This form of decision making has been described by Mintzberg and Waters, who proposed the view of organizational decision making: "that decisions are difficult to uncover because sometimes they don’t exist..." (Mintzberg et al. 1990). The point being made is that the implicit assumption that actions are preceded by decisions may not always hold. Actions, it is argued, may occur without a commitment to act. Also, it is stated, social systems
can act even without consensus. "In effect, 'decisions', like strategies, can emerge inadvertently". This may explain the difficulty in the present study of finding orders (decisions) which correspond to ventilator changes (actions). The process of mechanical ventilator weaning may be likened to the view of Nicolaides: "It is evident on the basis of [my] analysis that an organizational decision is in reality a constellation or a galaxy of numerous individual decisions. Some of these decisions are 'registered' in the organizational activities, while others remain hidden in the inner sanctum of the human psyche. When and where a decision begins and ends is not always clear" (quote from Mintzberg et al.). This, again, may illustrate the phenomenon which has emerged in the present study, that mechanical ventilator weaning is discovered, rather than planned; the onset of weaning is often determined by ex post facto rationalization, rather than by prospective planning.

The study has shown that nurses and physicians alike were uncertain of the definition of weaning onset. Some perceived the transition to occur at initial ventilator reduction, while others regarded the onset of weaning to come at a later time. Incremental ventilator reduction is usually in progress from the time of intubation, but the act of ventilator reduction is not always regarded as weaning. The purpose of ventilator reduction is determined by the situation, and it has been shown in the present study that nurses continuously test the patient's response and attempt to reduce ventilator support by reducing FiO2, pressure, volume, respiratory frequency or PEEP. Nurses do not usually label ventilator reduction as weaning until it has been thus labeled by a physician, which shows that mechanical ventilator weaning is not always determined by a conscious commitment to wean. The physicians do not always label the activity of ventilator reduction as weaning until the hours just prior to extubation, although a weaning-like activity has been in progress for days. This indicates that the onset of mechanical ventilator weaning may be a question of terminology as well as technique, and that the goals and methods are often undetermined. The various conceptualizations of the onset of weaning span the gamut of the weaning continuum.

Several conceptualizations of the weaning continuum have emerged in the present study. In the following examples, A is intubation, B is the onset of weaning, and C is the end of the weaning stage, which may or may not coincide with extubation. Example 1 matches the Weaning Continuum Model, while Example 2 shows that the onset of weaning starts at intubation, and Example 3 shows that weaning starts soon before discontinuation of ventilator support.

A ----------------------- B --------------------------------- C -------------------------------- Example 1

A/B --------------------------------------------------------- C -------------------------------- Example 2

A ---------------------------------------------------------- B/C ------------------------------- Example 3

The Weaning Continuum Model has provided a good framework for understanding the varying conceptualizations of weaning. The study has shown that not only is the onset of weaning unclear, but so is the aim of ventilator reduction. Some acts of ventilator reduction are perceived by the participants as more weaning-like than others. Reduction of FiO2 just after intubation is usually regarded as stabilizing the patient rather than weaning, while reduction of FiO2 later in the trajectory may be regarded as the onset of weaning, as seen in Case 1. A change of mode from PC to PS will normally constitute the onset of weaning, but in Case 6 this intervention was described as a comfort measure. When the rationale for reduction of ventilator support is not clearly articulated, the avenues for collaboration are narrowed, and decisions may become more erratic with the ever changing staff tending to the patient.
The fact that nurses continuously work to reduce ventilator support is demonstrated in the present study by the presence of counter orders, which are issued when physicians wish to harness the independent initiatives of the nurses. Counter orders also acknowledge the fact that nurses may act unless told specifically not to, which is a form of recognition of nurses' informal competencies. An example of a counter order is the order to postpone weaning until a given parameter presents itself, e.g. presence of bowel sounds. The counter orders also serve as a means of communication among physicians, because orders and plans are often documented in much the same way in the physician's progress notes. In situations where an order not to wean has been issued, the nurses have been observed to continue to reduce ventilator support without labeling it as weaning. This is not a sign of misconduct per se, but rather a sign that nurses follow the patient's responses and seek to answer dynamically to the needs of the patients.

One of the most comprehensive reviews of mechanical ventilator weaning is the Evidence Report "Criteria for Weaning From Mechanical Ventilation", which was prepared by the US Agency for Healthcare Research and Quality (Cook et al. 2000). Deborah Cook, MD, led the investigation, which reviewed several thousand articles in the world literature regarding ventilator weaning. The report states that: "Differences in clinicians' intuitive threshold for reduction or discontinuation of ventilatory support have a greater impact on failure of spontaneous breathing trials, or on reintubation, than do modes of weaning. When clinicians set a high threshold, many patients who could tolerate weaning remain on mechanical support longer than is necessary". The conclusion in the report concurs with the finding in the present study, that the threshold for weaning is unclear. The report suggests that the intuitive threshold for ventilator reduction is unreliable, as it may be a disadvantage for patients to have to postpone weaning until a given threshold is reached. The report also suggests that clinicians apply different implicit norms for weaning. It may therefore be surmised, that the patients in the present study benefit from the ongoing ventilator reduction, which is carried out under another pretext, before weaning is articulated or discovered.

Ventilator reduction, however, is not always appropriate, as seen in Case 3, where the nurse is instructed not to reduce FiO2 below 1,0 until the patient has recovered from smoke inhalation. The questions of ventilator reduction and when to start weaning may depend on the equipment at hand. Older ventilators may restrict the options to weaning by volume control alternating with spontaneous breathing trials, where the onset of weaning is determined by the patient's ability to tolerate spontaneous breathing trials. On the newer ventilators, however, there may be a fine line between adjusting the ventilator to the needs of the patient and intentional weaning, and the aims are not mutually exclusive. The Evidence Report states that: "The issue of the optimal start of weaning is confounded by alternative definitions of weaning: one reasonable conceptualization is weaning beginning with the onset of mechanical ventilation. Research to date suggests the best answer to "when to start weaning" is to develop a protocol implemented by nurses and respiratory therapists that begins testing for the opportunity to reduce support very soon after intubation and reduce support at every opportunity" (Cook et al. 2000). The present study has shown that nurses routinely test the patients in order to reduce ventilator support, and that this is started soon after intubation. The activity is not based on a protocol and it is not always labeled as weaning. In this respect the nurses play a pivotal role, as they continuously monitor, assess, and test the patients, and make adjustments, which are sanctioned by the physicians immediately or at a later time. It has been found that mechanical ventilator weaning is not effectuated by a series of discrete decisions, but rather, by a process of experimentation, where the response of the patient is continuously tested.
8. Discussion

8.2. How nurses participate in decision making

One of the main findings in the study is that mechanical ventilator weaning is a collaborative practice. Direct observation and observational interviews have shown that nurses routinely partake in complex decision making, weighing several alternatives and consequences, before acting. The study suggests that the complexity of the decisions is linked to the potential of the nurse, as less experienced nurses make decisions in more predictable situations, while more experienced nurses take more risks by acting in less predictable situations. While previous studies have documented that quality nursing has a positive effect on weaning (Thorens et al. 1995), the present study goes beyond this stance, and describes how nurses contribute to the process.

The ongoing ventilator reduction, which is not articulated as weaning and which is not ordered in writing, is usually the result of a continuous conversation among nurses and physicians. The study has demonstrated that the individual nurses and physicians around the patient are in flux, but the conversation is sustained across patient assignments with alternating actors. It has been observed that physicians rarely give mechanical ventilator orders without discussing them with the nurse first, and that most weaning orders are the result of collaboration. A previous study of critical care nursing has pointed out that the concept of "physicians' orders" no longer indicates a unidirectional mandate from physician to nurse (Benner et al. 1996). The authors of the study state that the style of physicians' orders has changed from precise mandates to guidelines or parameters; and the responsibility of the nurse is to make all the moment-by-moment clinical judgments and to know when to alert the physician of changes. In another study of critical care nursing, it is stated that "physicians' orders" have come to be recognized as a form of nurse-physician communication and that physicians depend on nurses to generate data and make the first evaluation. Physicians frequently rely on nurses to suggest meanings in data or treatment approaches, and nurses do not merely participate by making suggestions (Chase 1995). According to Benner et al. critical care nurses must be skilled in "making their case" when negotiating with physicians, which means persuading the physician to change the therapy (Benner et al. 1996:303). The findings in the above studies corroborate the nurses' decision-participation modalities that have emerged in the present study. The present study is the first to systematically investigate critical care nurses' contribution to mechanical ventilator weaning decisions, and it has shown that nurses participate in decision making by: Asking, consulting, suggesting, recommending, informing or persuading the physicians.

The fact that mechanical ventilator weaning orders are scarce in the formal documentation, does not necessarily imply that weaning has not been ordered or discussed. Mechanical ventilator weaning requires a form of communication, which is not always possible to document; it is a process of negotiation and agreement. Informally, weaning is a process of mutual adjustment among professionals, while formally, weaning is a process of direct supervision. The above concepts are defined as: "Mutual adjustment achieves the coordination of work by the simple process of informal communication", and "Direct supervision achieves coordination by having one person take responsibility for the work of others, issuing instructions to them and monitoring their actions" (Mintzberg 1983:4). Mechanical ventilator weaning is not included in the nurses' formal repertoire of independent competencies, and therefore weaning must formally be supervised by the physicians. The way weaning works in practice is through a process of informal communication, as it has been observed in the study. Mechanical ventilator weaning is a technology, which requires mutual adjustment, teamwork, and joint decision making. The weaning process relies upon complementary work flows where decisions require reciprocal task interdependence, at least as long as rules and standard procedures are lacking. One main point is that it would not be practically possible to perform the process of weaning by direct supervision and written orders for every alteration of
mechanical ventilation. The process of weaning builds upon a good measure of trust among the participants, because moment-by-moment alterations are impossible to supervise and document.

When nurses at the four sites in the study made independent ventilator decisions, they believed that they acted according to an *unwritten guideline* for mechanical ventilator weaning. Section 5.1.2.3. has shown that individual interviews with the participating nurses refuted this belief, as no two nurses had the same understanding of what the unwritten rules entailed. This phenomenon may be explained by the findings in a study of rapid decision making among ICU nurses and physicians, which has shown that *individual preferences* dominate practice when there are no protocols for practice. In this study, a "false consensus effect" was described, which was evidenced by a tendency to see one's own behavior as typical in the absence of a "golden standard" (written protocol) for action (Baumann et al. 1991). Certainty on the individual level in the face of uncertainty on the common level, was termed "the micro-certainty, macro-uncertainty phenomenon", meaning that the participants were confident of their own decisions although they did not have a common standard. This phenomenon was widely in evidence at the present study sites. Each nurse was certain that she acted according to a common set of rules, albeit the rules did not exist. Mechanical ventilator weaning requires the flexibility of mutual adjustment and informal communication, but this form of collaboration requires that the participants agree on the implicit norms for action.

The false consensus effect and reliance upon implicit norms is a common phenomenon in organizations. Sociologist Diane Vaughan has studied the dark side of organizations, in which issues of routine nonconformity are described as the systematic production of organizational deviance (Vaughan 1999:298): "Routine nonconformity, mistake, misconduct, and disaster are not anomalous events, but systematic products of complex structures and processes ... Debunking myths of operator error and individual wrong-doing, this review affirms that policy for preventive strategies must go beyond individuals to institutional and organizational factors that shape individual cognition and action". What Vaughan says is that organizations are set up in such a way that routine nonconformity cannot be avoided. Similarly, one of the main points which is being made in the present thesis, is that nurses do not willfully act in defiance, but rather, that mechanical ventilator weaning is a technology which is dependent upon the active participation of critical care nurses, who in turn must act outside of their professional boundaries.

The fact that nurses act outside of their professional boundaries is not unknown, and attempts are currently being made to clarify the professional roles and rationalize the mechanical ventilator weaning process by introducing written weaning protocols, or practice guidelines. The American College of Chest Physicians, the Society for Critical Care Medicine, and the American Association for Respiratory Care formed a task force, headed by Deborah Cook, MD, to produce "Evidence-Based Guidelines for Weaning and Discontinuing Ventilatory Support" for managing the ventilator-dependent patient during the discontinuation process (MacIntyre et al. 2001). Likewise, the American Association of Critical Care Nurses has issued a series of evidence-based protocols for practice, compounded by Suzanne M Burns, RN, for the "Care of the Mechanically Ventilated Patient" (Chulay & Burns 1998). Studies are emerging, which show the effect of protocolled practice. Marelich et al. studied the effect of a *ventilator management protocol* in ICU on the duration of mechanical ventilation, and found that a multidisciplinary protocol was effective in reducing the duration of mechanical ventilation, and that the protocol was associated with a decrease in incidence of ventilator associated pneumonia in trauma patients (Marelich et al. 2000). Kollef et al. have found that *protocol-guided weaning* from mechanical ventilation performed by nurses and respiratory therapists is safe and leads to extubation more rapidly than physician-
8. Discussion

In a review of clinical protocols as a means of reducing ventilation time, Price compares nurse-led and physician-led care, and concludes that it is unclear whether it is the nurse-led aspect or the clinical protocol, which has the positive effect on weaning time (Price 2001). These studies show that written protocols may positively influence ventilator weaning, and that more studies are needed in order to clarify the relative roles of the nurses and physicians. Studies are needed to show the long term effect of more efficient weaning in terms of complications, morbidity and mortality.

In the present study, the lack of formal guidelines, and the use of unclear terminology for the mechanical ventilator weaning process, demonstrates that goals and methods for weaning are ambiguous, e.g. "Continue mechanical ventilator weaning VS/PS, perhaps PRVC tonight". This order furnishes the nurses with the choice of two alternative weaning methods, as well as the choice to continue or interrupt weaning during the night, which leaves the nurses with a trial-and-error solution. This kind of order is interpreted by the nurses as a guideline, because it leaves room for broad interpretation and has no time-limit. Written orders of this kind may appear ambiguous to the uninitiated, but the nurse and physician who were present when the orders were articulated, have more implicit knowledge than the reader. Some orders are worded ambiguously in order to give the nurses options throughout the next 24 hours. The written orders represent only the tip of the iceberg and merely serve the purpose of documenting the decisions, which are made during rounds. As orders are usually written once daily and the patient requires continuing readjustment it is not possible to document all decisions and agreements.

Agreements, which are negotiated by nurses and physicians are not necessarily evident for the next change of shift. Despite the fact that decisions are made jointly around the clock, the communication is upheld by a constantly changing crew. If goals and methods are not articulated at each change of shift, there will be a loss of information, and decisions may become erratic. The theoretical decision types: rational, incremental, political, and random, which were presented in Chapter 2 in the Decision Matrix, have all been observed in the present study (Mintzberg et al. 1990). The study has demonstrated a number of ambiguities in relation to decisions, orders, competencies and terminology. These findings are, according to March, not unusual in organizations, which are characterized by complex interactions among a number of participants who are simultaneously involved in different activities (March 1994:198). March goes on to say that the erratic character of decision making may be understood by viewing the decision process in context. In accordance with what March has described in other settings, the present study has found that participation in decision making is fluid and the decision makers continuously change.

Decision making may be described as an act of rationality or rule following (March 1994:207). The present study has demonstrated that nurses' participation in mechanical ventilator weaning follows both types of decision making, and that the range of nurses' participation in the decision process covers a continuum, which spans from independent decision making to following orders. The rational vision of decision making includes choosing among alternatives, while the rule following vision includes adhering to physicians' orders or protocols. In relation to mechanical ventilator weaning nurses lack the formal competencies to make independent decisions. One way of utilizing the potential of the nurses is to introduce written weaning protocols, which will expand the nurses' radius of action and also enable nurses to work within their professional boundaries. Mechanical ventilator weaning protocols need not reduce the decision process from choice-based to strictly rule-based decision making as long as the protocols are implemented as guidelines.
8. Discussion

Sedation practices may be illustrated in much the same way as mechanical ventilator weaning. The study shows that uncertainty exists regarding the indications, interventions, and outcomes for sedation (Egerod 2002). This means that goals and methods are unclear, which leads to confusion and irrational decision making, as it was demonstrated in section 6.4. According to these findings, it could be argued, that sedation standards, which clarify the goals and methods for sedation, could lead to more rational reasoning, and the question is again, whether rational decision making leads to better patient outcome. According to sociologist Nils Brunsson organizational decisions are inherently irrational, and irrationality is necessary for action (Brunsson 1985; Brunsson 2002). March states, in agreement with Brunsson, that organizational decision making is a combination of conversation and action, and that discussions rarely yield clear conclusions (March 1994). This finding is in accordance with the present study, where it was found that discussions held at interdisciplinary conferences were rarely summed up and documented. Even during medical rounds, the final decisions were not clearly articulated. Although it is reasonable to assume that physicians have more knowledge than nurses about the alternatives and consequences of mechanical ventilation, the issues which are discussed at the interdisciplinary conference and medical rounds, often leave the nurses with a smorgasbord of possibilities to choose among.

In summary, the present study demonstrates that nurses actively participate in the decision process related to mechanical ventilator weaning. One of the main findings is that mechanical ventilator weaning is a collaborative practice. Another important finding is that nurses and physicians believe that they act according to a set of implicit norms, and that the implicit norms do not exist. The following findings have an impact on mechanical ventilator weaning:

- Lack of consensus regarding the rules for practice leads to uncoordinated weaning
- Lack of articulated goals and methods for weaning lead to erratic decision making
- Lack of staffing consistency leads to incomplete information transfer and information-loss

It is suggested, that practice guidelines and staffing standards should be implemented in order to clarify the rules for practice as well as ensuring continuity, collaboration, and teamwork. Mechanical ventilator weaning should not be burdened with excessive documentation and control. It would be a better course to systematize and upgrade the knowledge of the practitioners and to trust the judgment of the participants in formal weaning teams.

8.3. How nurses and physicians interact in the organization

The present study has demonstrated that weaning is an intensive technology, which involves immediate reciprocal coordination between nurse and physician. Mechanical ventilator weaning does not involve sequential task interdependence, where nurses must wait for instructions from the physicians before they act, and physicians rarely act without informing the nurses. It has been observed that physicians rarely manipulate the ventilator independently, because it is unsafe for the patient if the nurse is not aware of changes. When nurses manipulate the ventilator, they generally inform the physician immediately before, or as soon as possible after the activity. According to Hatch, intensive technologies, which involve immediate reciprocal coordination, require teamwork (Hatch 1997). The present study has shown that teamwork, beyond the span of an eight hour shift, does not exist at the four sites in the study. This means that information must pass through a great number of people and that some information may be misunderstood or lost.

Various approaches to weaning range from uncoordinated day-to-day care to multidisciplinary case management (Knebel et al. 1994). Studies have suggested that systematic weaning, such as the use of multidisciplinary weaning teams, result in improved cost and quality outcomes for patients requiring prolonged mechanical ventilation (Cohen et al. 1991; Cohen 1994; Henneman 2001). The
ideal situation for weaning, as a dynamic intensive technology, is to ensure staff continuity which ensures teamwork. The four sites in the present study had an uncoordinated approach to weaning. They did not use formal weaning teams and the goals and methods for weaning were articulated ambiguously. Lack of teamwork was demonstrated in section 6.5. as a low degree of continuous and cumulative staff-patient continuity, coupled with the fact that the same nurse and physician rarely conducted rounds on the same patient more than once during a trajectory. The staffing pattern in the present study was not conducive to a systematic approach to weaning.

The kind of decision making between a dominant professional group and a subordinate semi-professional group, which has been the focus of attention in this thesis, is not unusual; on the contrary. The social processes have been studied extensively in various organizations, including hospital settings. The context of the present study is the hospital ICU, which is at the operating core of a professional bureaucracy (Borum 1997; Mintzberg 1983). Mintzberg (1983:198) states that professional bureaucracies comprise parallel administrative hierarchies: "... one democratic and bottom-up for the professionals and a second machine bureaucratic and top-down for the support staff". In this context, the nurses must negotiate their dual roles as (1) professionals, i.e. making independent and collaborative decisions as part of the operating core, and (2) assistants to the physicians, i.e. following orders as support staff. This illustrates the difference between choice-based and rule-based decision making. The focus group interviews in the present study, section 5.1.2.2., show that the physicians expect highly skilled nurses to follow orders, adhere to prior agreements, and to work within a framework set by the physicians. According to this view the expert nurses are regarded as compliant support staff. At the same time, physicians espouse the nurses' ability to act independently, thus regarding the nurses in some professional capacity.

Mintzberg (1983:206) points to the down-side of the professional bureaucracy where "there is virtually no control of the work aside from that by the profession itself, no way to correct deficiencies that the professionals themselves choose to overlook". The present study has demonstrated a number of deficiencies such as the uncertainties regarding how many ventilator changes were made, by whom they were made, the onset of the weaning stage, the choice of weaning strategy, the target sedation level, etc. One main issue which has been overlooked in the medical literature, is the extent of the nurses' participation in the decision-process related to mechanical ventilator weaning. The target interviews, section 5.1.2.3., demonstrated that nurses and physicians disagreed about the range of nurses' decisions related to ventilator changes. Experienced nurses exercised a wider range, and a greater amount, of independent ventilator changes than were perceived or acknowledged by the physicians. This demonstrates that mechanical ventilator weaning is perceived as a process of direct supervision, while it is carried out as a process of mutual adjustment. In this way nurses and physicians overlook the actual dynamics of mechanical ventilator weaning. Nurses and physicians appear to uphold a truce in which nurses are given a degree of autonomy without gaining responsibility, while physicians delegate part of their practice without losing their domain of authority.

The present study has shown similarities at the four sites in the study. The terminology used to describe mechanical ventilation and sedation was ill-defined, but similar at all four sites. The informal competencies of the nurses were self-imposed, but similar, at all four sites. Mintzberg points out that in the professional bureaucracy the professionals bring the standards into the organization, not the other way around (Mintzberg 1983:202). This means that the standards are set by the professionals independently of the organization, which may explain how implicit terminology and meanings live their own lives independently of the individual hospital. This
finding suggests that the results of the present study may be generalizable to more hospitals in the country.

Although hospitals are still regarded as professional bureaucracies, pulls are seen in the direction of machine bureaucracy as well as adhocracy. With the introduction of accreditation, quality assurance, benchmarking, and standards, the organizations are encroaching on the inherent authority of the physicians; the physicians are being de-professionalized with a pull towards machine bureaucracy. According to Mintzberg the introduction of a more sophisticated technical system, such as computers and protocols, "reduce the professional's autonomy by forcing him to work in multidisciplinary teams, as he does in the Adhocracy" (Mintzberg 1983:203). The present study showed an absence of formalized multidisciplinary teams, which can be seen as an indication that the four study sites were still largely run as professional bureaucracies. On an informal level there was a softening of the disciplinary boundaries, which was confirmed by the invitation of the nurses to participate in interdisciplinary conferences at three of the four sites. Yet the nurses at Site 1 felt that their presence at interdisciplinary conferences was only a sign of "token" collaboration, as the nurses were outnumbered and the physicians called the shots. At Sites 2 and 3, the nurses enjoyed a greater feeling of equality, as there were usually as many nurses as physicians present.

Other studies paint a more dismal picture of nurse-physician collaboration. Manias, who has done a case study addressing the effects of power and contextual relations on decision making in ICU, has described how nurses who are invited by the physicians to attend interdisciplinary conferences feel that they remain invisible in the decision process (Manias 2000). Manias found that in situations where nurses were encouraged to contribute to the presentation of patient data, the physicians played a gatekeeping role in an attempt to mitigate the nurses' contribution. The described social interaction may be another manifestation of the nurses' dual roles as professionals and support staff. Nurses as well as physicians attempt to negotiate this paradox by assuming symmetrical roles in situations where the roles are inherently asymmetrical, e.g. in the present study, the nurses and physicians attempted some degree of symmetry during interdisciplinary conferences. But these findings can be explained by the fact that the professional roles are in flux and should be viewed in a historical context.

Nurses have not earlier been considered as part of the decision making body. It is a relatively new role for nurses to be invited to partake in interdisciplinary conferences, and it is to be expected that it will take time for the nurses to adjust to their new role. Nurses do not have the same educational preparation for this kind of activity as physicians, who have a strong background in diagnostic reasoning. The movement into the decision making arena may be considered as a stage in the evolving process where interdisciplinary boundaries are eroding and various professions are called upon to participate in complex decision making. In a historical perspective, nursing has evolved from being an unskilled occupation towards semi-professionalism or professionalism (Moloney 1992). Although nurses are still struggling to attain professional status, the historical trajectory of nursing seems to imply that nursing is moving toward a more professional stance.

As long as nurses are regarded as support staff they will tend to pull toward the adhocracy configuration, while the physicians strive to maintain the professional bureaucracy. One property of the adhocracy is that it fuses experts drawn from different disciplines into smoothly functioning ad hoc project teams (Mintzberg 1983:254). Nurses espouse collaboration and teamwork, while physicians may be less eager to collaborate as long as they maintain the formal authority to make clinical decisions (Baggs et al. 1992). This means that nurses need to have some degree of formal
authority in order to function as experts (or professionals) in a team. According to Mintzberg the
experts are distributed throughout the structure in the adhocracy; in the support staff and managerial
ranks as well as the operating core (Mintzberg 1983:257). In this configuration the power over
decision making flows to anyone in the adhocracy, and the distinction between line and staff blurs.
"It no longer makes sense to distinguish those who have the formal power to decide from those who
have only the informal right to advise" (ibid.:261). In the present study it has been shown that in
relation to mechanical ventilator weaning nursing has been an unknown factor in the physician-
ventilator equation. It is not always possible to distinguish the decisions of the physicians, who have
the formal power, from the decisions of the nurses, who only have the informal right to advise, as
most decisions are unwritten, collaborative and anonymous. The degree of nurses' participation is
invisible in daily practice, as it requires observational studies to uncover social processes of this
kind.

The present study has suggested that the potential of the nurse has an impact on nurses' mechanical
ventilator weaning decisions. Literal replication is found when the findings in the target interviews
converge with the observational findings that show that less experienced nurses make decisions in
more predictable situations, where the outcome is generally successful. More experienced nurses
and physicians make decisions in more complex and less predictable situations, with lower outcome
success. It is seen that experienced nurses and physicians take greater risks in order to achieve
longer-term goals, which also explains why physicians fail to order obvious or predictable
interventions. One upshot of these findings is that less experienced nurses are able to handle their
self-imposed informal competencies without endangering the patients. The main finding is that
experienced nurses and physicians make collaborative decisions about mechanical ventilator
weaning and that the process of weaning is facilitated by the active participation of the nurses.

In summary, the study has shown that the interaction between nurses and physicians is determined
by the organizational structure and that the present structure does not leave room for a formal
acknowledgment of the contribution of nurses. Teamwork is necessary for mechanical ventilation,
and teamwork requires that nurses, as support staff or professionals, acquire some degree of formal
authority in order to fill their roles as active participants in the mechanical ventilator weaning team.

8.4. Discussion of theory, methodology, and limitations
The main theoretical frameworks for the present study are the Weaning Continuum Model, the
Synergy Model, and Mintzberg's and March's theories of organizational decision making. Case
study research is often applied to studies of organizational decision making, as decisions are best
studied as processes in context. Mechanical ventilator weaning has not previously been studied by
case study research, but the Weaning Continuum Model has proven to be especially applicable as it
is a processual model. The findings in the study have shown literal as well as theoretical replication
of the model; literal replication because all the study cases could be described by the model, and
theoretical replication because the controversies regarding the onset of weaning could be explained
by different conceptualizations of the model. Finally, the Synergy Model has been used in order to
compare the potential and performance of critical care nurses involved in mechanical ventilator
weaning. The model has been found to be appropriate because it is descriptive and lends a
vocabulary with which to explore the competencies of the nurses. Although the Synergy Model has
been used as a theoretical framework in the literature, it has not been the object of extensive
empirical research. The present study supports the theoretical concepts of the model, as it has been
suggested that nurse potential and nurse performance correlate. This means that the most complex
patients benefit from the care of experienced and certified nurses.
The case study approach leads to analysis on two levels. The first level is the simple narrative in which the events are described chronologically, i.e. the case trajectories illustrated in section "6.1. Case review – The cases". The second level adds some meat to the bone as the events are related to issues of history, context, action, non-action, decisions, conflicts, and outcomes (Flyvbjerg 1991). Most of the decisions recorded in this study appeared to be rational from the standpoint of the decision maker. But in a wider context, the rational standpoint may have to yield due to differences between the goals of the various decision makers in the process. In this perspective, some of the decisions were made by the coalition method, as the nurses pursued their own interests and values rather than following the strategy of the physicians (or the patients). We have seen that some decisions were made by trial-and-error when nurses were given several options, and some decisions were random due to poorly articulated goals and methods. The decisions in "Appendix 10.7. The Independent and Collaborative Decisions" were constructed by the researcher in response to the observational interviews in the study, and would not have been documented in this manner independently of the study. None of the recorded decisions were described in rational terms in the nurses' progress notes.

In a debate among scholars of management, Pettigrew questions how decision making should be analyzed, by asking if the decision-episode should be the unit of analysis, and by asking whether a decision can be analyzed away from the context of the series of decisions in which decisions are embedded (Mintzberg et al. 1990). The issue is that of finding the optimal level of analysis. Pettigrew emphasizes that decision making should be understood as a continuous process in context and encourages the form of research which is contextualist and processual in character. How then have the decisions in the present study been analyzed? It has been the intention to view the decisions in context by providing a case study design in which the main unit of analysis is the case, i.e. the mechanical ventilator weaning trajectory. This provides a narrative of events, where the sub-unit of analysis is the decision to make a ventilator change, which does not preclude the possibility that each ventilator change is the result of a continuous process of decision making by a variety of decision makers. As it will be shown, each decision has been decontextualized and recontextualized in the process of analysis in order to focus on similar issues across the material (Malterud 2001).

Each of the recorded decisions has been decontextualized and analyzed as a separate entity in order to tease out the type of rationale behind each decision episode. This method produces only a rough picture of the decision process, but it demonstrates the main issue, viz. that nurses participate in decision making. The present thesis is not so much a study of the individual or social psychology of the decision process, as it is a study aimed at illuminating the mechanisms behind decision making in the process of mechanical ventilator weaning. The question of how nurses participate in mechanical ventilator weaning decisions has been answered extensively in the present study, and the answers have been two pronged: (1) The decision participation modalities, which include independent decision making, collaborative practice and rule-following, and (2) the decision content, which includes, among other things, alteration of ventilator settings and adjustment of sedation. The study has shown that nurses participate in the decision-process, but also, that the degree of participation and the quality of the decisions vary according to the potential of the individual nurse. The most important factor in relation to nurses' participation was found to be the nurses' knowledge and experience of critical care. This finding is not controversial in itself, but the surprising element lies in the fact that the qualifications of the nurse do not influence the formal competencies.
In addition to qualitative analysis, the decisions have been explored by simple numerical correlation of the coded and narrative data. The aim of calculating correlations in the analysis was to complement the findings from the qualitative analysis. The qualitative analysis demonstrated that nurses participate in decision making, while the quantitative analysis added information about consistent patterns in the material, such as the finding that nurses with higher potential made more complex and collaborative decisions than nurses with lower potential. Some researchers have their misgivings about combining qualitative and quantitative data in the primary analysis, and it is suggested that the methods should not be aggregated until the secondary analysis, where a meta-analysis is performed on the results, not the primary data (Malterud 2001). The risk of combining the methods is that primary analysis may not be prepared to handle contradictory findings without favoring one method over the other. The finding that nurses with high potential had more outcome failure than nurses with lower potential seemed to contradict the overall finding that nurses with high potential were the better decision makers. This finding was interpreted to support the finding that nurses with higher potential made decisions in more complex situations, which explained the phenomenon by theoretical replication. But this is still a controversial finding which warrants further investigation.

In the present study the nurse potential and nurse performance were correlated by the gamma correlation coefficient using the SPSS system for calculations, while the decision correlates were calculated by cross-tabulation of the binary data, again using the gamma correlation coefficient. The two methods of calculation render approximately the same results. The association between binary data is the most primitive type of correlation and the association among variables is not linear (Kreiner 1999:190). The strength of association was defined for the study according to the recommendations of Kreiner (ibid.:211). If the present study had been based primarily on sampling logic, a larger sample would have been chosen and a more sophisticated method of calculation would have been relevant. The calculated findings are regarded here as tendencies, which need further investigation in order to increase their reliability.

Each case has been analyzed individually prior to the cross-case analysis. In the case review the decisions have been viewed in context, which has demonstrated the difficulty in pinpointing the exact onset of weaning. The internal validity is increased by the fact that several methods of investigation brought about the same results; e.g. nurses continuously seek to reduce ventilator support and collaborate with physicians in decision making. The cases in the present study were dissimilar in a number of ways regarding age, sex, site, diagnosis, duration, treatment, equipment, etc. Nevertheless, cross-case analysis showed that the social processes, which were explored in the study, were similar across the 14 cases and across the four sites. The social processes in question are the processes of decision making and collaboration among nurses and physicians. The fact that the social processes were invariably similar increases the external validity, which means that the range for application of the findings is assumed to go beyond the immediate context of the study (Malterud 2001). The multiple-case design was aimed at providing insight into the process of weaning. The cases all demonstrated similar contextual findings, or dissimilar findings for predictable reasons. The sites were similar in their lack of staffing protocols and formalized weaning teams, and the similarities also included the informal terminology for weaning and sedation. The preparation of the nurses varied in much the same way at all four sites in the study, and there was no one case, which stood out as being different regarding nurses' participation in the decision process in relation to mechanical ventilator weaning.
Triangulation of sources and methods was chosen in order to clarify meaning and verify the repeatability of the observations. The trinity of observation, interviews, and document review has become a classic approach within the qualitative paradigm and especially in case study research. The methods chosen for this study focused on nurses in natural settings, in order to bring invisible and taken-for-granted aspects of nursing practice into light. In combining different sources and methods it became evident that any one method alone would have been insufficient for this study. A multi-center multiple-case design was chosen in order to compare and contrast the findings and support the data by literal or theoretical replication. Comparing the four sites has made it possible to show that the formal conditions for critical care nurses are similar, while informal conditions, e.g. preferred methods of weaning and equipment vary at the four sites. The scope of a multi-center study could be enhanced by including more sites or diversifying the sites by combining rural and city hospitals, teaching and non-teaching hospitals, or hospitals in different national or international locations. The four sites chosen for this study were similar in that they were all part of the same university hospital system, and it was this very similarity which went to underscore the idiosyncrasies of weaning methods at the four sites in the study.

Direct observation in natural settings is time-consuming. Other methods of research were considered, such as video taping, which was ruled out for practical reasons, as it would limit the number of places which could be observed. The study required full access to all patient rooms, observation units, and conference rooms. The timeframe for direct observation was limited to the dayshift. It is suggested that a future study could focus nurses' decisions at other times of day in order to explore temporal variations. Among limitations to direct observation is the Rosenthal phenomenon, where the researcher is biased by personal interest, attitudes or emotions (Polgar & Thomas 1991). This was kept in mind throughout the study and effort was made to avoid this pitfall. The study was not intended to favor any one group, e.g. nurses or physicians, but being a nurse myself, I had to be particularly alert. Another limitation is the Hawthorne effect where the participants alter their behavior because they are being observed (Powers & Knapp 1990). This effect is difficult to avoid, but it is assumed that the participants gradually become accustomed to the presence of the researcher and resume their usual behavior. Finally, is the Pygmalion effect, where the researcher gives some participants more attention than others, which improves their performance (Canestrari 1996). It was evident that the more experienced nurses showed more interest in the study than the less experienced nurses. The experienced nurses were great sources of information, whereas the less experienced nurses preferred to avoid scrutiny. This can be explained by the fact that the less experienced nurses found it stressful to be continuously supervised as a part of their training, and being the focus of attention during an observational study was just another encroachment upon their integrity. The experienced nurses, however, were stimulated by the attention they got and the chance to discuss their decisions and interventions.

The individual interviews with nurses and physicians were conducted as soon as possible after the event which was to be explored. Initially the plan had been to wait until a patient trajectory was completed before interviewing the nurses, but the pilot study showed that the participants quickly forgot details when they moved on to other patients. The study has shown that nurses rarely return to a patient to whom they have been assigned earlier, which means that most of the information is forgotten by the end of the ventilator trajectory. For this reason, on-the-spot observational interviewing was the best choice in order to obtain information regarding immediate decisions. Due to the spontaneous nature of the interviews only few were taped. The quality of the field notes was upheld by using an observation instrument, but it is recommended that interviews are generally taped in order to ensure internal validity.
The target interviews explored the complexity of the ventilator settings and the range of nurses' informal authority to make ventilator changes. The interviews included 17 experienced nurses and five experienced physicians. The participants were purposefully selected among the most experienced practitioners in order to obtain knowledge about the range of the nurses' decisions. Each site had one or two physicians who were recommended as particularly experienced clinicians at that site. In order to establish the fact that nurses and physicians did not agree on the range of nurses' authority, it was sufficient to interview one physician at each site. It was necessary to interview more nurses in order to gain more knowledge about the range of their decisions. Nurses and physicians ranked the complexity of ventilator changes similarly at the four sites, but the small number of participants did not enable statistical replication; the strength of the data derives from the in-depth qualitative interviews.

The focus group interviews explored how inexperienced nurses and physicians perceived highly skilled nurses. Focus groups are a form of interview that capitalizes on communication between research participants in order to generate data, and the aim is to use group interaction (Kitzinger 1995). The best way to conduct a focus group interview is by having two researchers, one who coordinates the interview and another who takes notes. In the present study there was only one researcher present, but some of the interviews were taped. For practical reasons, the focus group interviews lasted only roughly 30 minutes, while longer interviews would have been preferable. Although the findings were similar at the four sites in the study, it is suggested that focus group interviews should be at least one hour in duration in order to reach optimal group interaction. The focus group interviews did not generate remarkable results and have for that reason not been central to the analysis.

Key informant interviews were conducted in order to obtain factual data in an efficient manner. The interviews were taped and transcribed verbatim. This yielded reliable data which were central for the context findings in the study. All key informants were very open and helpful, and the only drawback was that the nurse managers failed to keep accurate records of the nurses' educational status. This was overcome by using a questionnaire to obtain these data. Collaboration with all of the participants was good throughout the study. It is a positive sign, that the participants at all four sites were willing to collaborate in all aspects of the study. The only situation in which collaboration left more to be desired was in answering the questionnaires.

The questionnaire was necessary in order to describe the profile of the nurses, because the nurse managers were unable to provide sufficient demographic data for the nurses. The nurses who had not had personal contact with the researcher found the survey less meaningful, and failed to return the questionnaire. It became necessary to post reminders in order to obtain a minimum desirable response rate of 80% for the entire population (Polit & Hungler 1999). The nurse managers were asked why some nurses failed to return the questionnaire, and they explained that apart from the nurses who were away on vacation, some nurses just didn't get around to answering, while others expressed concern that they might somehow be exposed. Some of the nurses chose to volunteer either their name or age, but not both. The attempts of concealing information and reluctance to returning the forms may be a sign that some nurses feared exposure. The nurses who returned the questionnaire after the reminder did not differ from the nurses who had answered in the first place, but there is no reliable information regarding the remaining 20 percent who failed to return the questionnaire. A higher score could, perhaps, have been reached if more effort had been put into informing the participants in person.
The aim of the above discussion of limitations has been to provide a critical perspective to the process of research and to offer suggestions for future studies. The present study as a whole is considered to be valid and reliable due to an appropriate research design and converging methodologies. There is reason to believe that many of the findings in the study can be generalized to other settings where the same background conditions exist. The first hypothesis was supported in that nurses' formal competencies remain unchanged while their qualifications increase. This finding can be explained by nurses' general reluctance to seek more responsibility. When professional boundary issues at organizations exist, these are usually resolved by each group acting on their own behalf. Nurses have not put a strong collaborative effort into gaining more formal authority in critical care, and it is unlikely that physicians will take the initiative to increase the formal authority of the nurses. Consequently it is assumed that the phenomenon of nurses' unchanging formal competencies is generalizable beyond the immediate context of the study.

The second hypothesis was supported on the informal level, because contextual variations influence nurses' prospects of participating in decision making. On the formal level, however, the same traditional background conditions exist, that nurses are consistently at the bedside and physicians are on call. Nurses' close proximity to the patients puts them in a unique position to continuously monitor the patients and gather information about their condition. In response to this information nurses continuously make decisions and interventions that are typically sanctioned by the physicians at a later time. This pattern can be assumed to exist at other hospitals because the basic roles of nurses and physicians are similar and because mechanical ventilator weaning requires moment-to-moment decision making. The third hypothesis, that nurses facilitate mechanical ventilator weaning by actively participating in decision making, was supported. Nurses' independent and collaborative decisions at the bedside are based on the most current patient information, and the physicians implicitly recognize that nurses' contribution is indispensable to decision making in relation to mechanical ventilator weaning. This pattern of interaction is a general feature of decision making which applies beyond the context of the hospitals investigated.

Finally, regarding the question of relevance, the present study has added a new perspective to mechanical ventilator weaning by describing interactions, professional roles, and interdisciplinary collaboration in organizations. Among recommendations for future research stated in the report "Evidence-Based Guidelines for Weaning and Discontinuing Ventilatory Support", are testing institutional infrastructures in order to put into practice what is known about optimal methods to wean patients from mechanical ventilation (MacIntyre et al. 2001). The present study provides some new insight into such institutional infrastructures and describe some avenues of research, which address decisions that are made at the crossroads among several professional disciplines. According to Deborah Cook, most research into weaning from mechanical ventilation has analyzed factors predictive of sustained extubation, or evaluated alternative methods to hasten the safe liberation from mechanical ventilation. "In contrast to primarily deductive quantitative research, qualitative research aims to develop theoretical insights that describe and explain phenomena such as interactions, experiences, roles, perspectives, and organizations" (Cook 2001). Review of qualitative research related to ventilator weaning demonstrates an increasing acknowledgment of research, which is conducted from a variety of perspectives and scientific paradigms.
9. Conclusions and implications

9.1. Conclusions and implications for clinical practice

The study has demonstrated that mechanical ventilator weaning is not primarily a process of discrete decisions and explicit orders made by the physicians and delegated to the nurses to act upon. Weaning is a process of continuous communication between nurses and physicians. It is a process of experimentation, where many decisions are made retrospectively. Weaning is a fluid process where decisions are not always articulated and where tacit agreements evolve by mutual understanding among the decision makers. And this is, according to theories of organizational decision making, how decision making should be. Decision making of this kind, however, requires that all decision makers should agree upon a set of mutual implicit norms. For this reason, it was an important finding in the study, that agreement did not exist regarding the implicit norms for mechanical ventilator weaning. One of the visible manifestations of this finding was confusion regarding the terminology for the process of weaning.

In light of this finding, one of the implications for clinical practice is that nurses and physicians need to acquire an explicit mutual understanding of the norms for practice. This may be achieved by implementing guidelines or protocols for mechanical ventilator weaning, which may be supplemented by systematic education for nurses and physicians regarding the common concepts for weaning. Patients with predictable weaning trajectories, such as postoperative patients, may be weaned by the application of a weaning protocol. It is suggested, however, that patients with more complex and less predictable trajectories should be weaned by a team approach.

The implementation of weaning teams is suggested because patients benefit from a coordinated approach that uses the combined skills and expertise of a multidisciplinary team. Teamwork is based on mutual adjustment, which is dependent upon informal communication rather than supervision. Physicians as well as nurses should agree upon a system of trust, in which one practitioner does not override the decisions of another. It is recommended that the process of weaning should not be burdened by excessive control and documentation, but rather, that weaning should be improved by implementing weaning teams, consisting of specially qualified nurses and physicians.

Many of the structures and processes used in the hospital system promote hierarchical and discipline-specific decision making. In order to overcome traditional structures, it is necessary that nurses obtain a degree of formal authority, in order to fill their roles in a team approach. One of the inherent problems of critical care nursing is that nurses must function outside of their professional boundaries in order to meet the needs of the patients. In order to address this problem it is necessary to clarify the formal boundaries of nursing in relation to mechanical ventilator weaning. The study has demonstrated that nurses have varying informal competencies according to their educational and experiential qualifications. As a consequence, it is suggested that only the most skilled nurses should be assigned to wean the most complex patients.

Implementation of weaning teams should reduce the problem of information-loss due to an excess of personnel tending to the same patient. It is suggested that the most important agreements among the members of the weaning team should be documented, in order to record the overall strategy for the process of weaning. This would also make it possible to capitalize on the learning potentials which come from experience and add to the evolving knowledge of weaning. One of the deterrents to continuity of care at the four sites in the study, was the ongoing training of new staff due to high turnover. It is suggested that trainees should be included in the weaning team, but the roles of the
team members should be made clear, so it is obvious who is in training and who carries the responsibility.

Finally, it is assumed that the patient will benefit from a consistent weaning team, because the patient and team members will get to know one another. Including the patient in decisions and care should become easier when personal rapport is established. The study has shown that patient participation falls behind the norms articulated in the Synergy Model. A more consistent team of personnel should be able to include the needs and values of the patient and the family in the overall process of weaning and recovery in ICU.

9.1. Conclusions and implications for future research
The present study, which has complemented rather than refuted earlier studies, has explored the institutional infrastructures which may have a bearing upon the process of mechanical ventilator weaning, and it has been concluded that weaning can benefit from implementation of formal weaning teams and guidelines for practice. Future research should include a look at various aspects of the use of weaning teams and guidelines in terms of quality and cost. It is recommended that future research focuses on the impact of weaning teams on the duration of mechanical ventilation, duration of weaning, rate of complications, and long-term survival. It is also important to explore the impact of weaning teams on patient participation and to study the impact of patient participation on the outcome of weaning.

The Weaning Continuum Model has been instrumental in understanding the cases in the present study. More research is needed to validate the framework in various settings using different weaning strategies and various types of ventilators, as the onset of weaning may depend on the type of ventilator in use. Newer ventilators are developed more specifically with weaning in mind, and the weaning readiness threshold loses its significance if weaning is assumed to start at intubation. Weaning does, however, not always start with the onset of mechanical ventilation, as many ventilator courses are determined by competing medical issues and anesthesia, which all prolong the preweaning stage and reintroduce the question of weaning readiness. Finally, research is needed to explore the benefits and risks of using a variety of different mechanical ventilators in the same ICU.

The Synergy Model for Certified Practice was used in order to compare the potential and performance of critical care nurses in relation to mechanical ventilator weaning. It was found that the concepts in the model need further definition in order to be operationalized in various contexts. The present study has recommended that nurses who work on the formal weaning teams should be specially prepared for this responsibility. One way of determining the required level of nursing skill could be the implementation of the nurse potential, which was introduced in the study. The nurse potential needs further research in various settings, and may with some modifications prove to be a viable way to determine the objective requirements for nurses to work on a formal weaning team.

The organizational decision theories of Henry Mintzberg and James March have proven to be applicable to the setting of a hospital ICU. It may be recommended that future studies of institutional infrastructures include organizational decision theories in order to address questions such as the optimal configuration of a weaning team, team interaction, hierarchical structures, meeting practices, and need for documentation. Decision making is a complex process which warrants further research in natural and simulated settings.
Basic Information About the Synergy Model of Certified Practice

The core concept of the reconceptualized model of certified practice—the Synergy Model—is that the needs or characteristics of patients and families influence and drive the characteristics or competencies of nurses.

All patients have similar needs and experience these needs across wide ranges or continuums from health to illness. Logically, the more compromised patients are, the more severe or complex are their needs. The dimensions of a nurses practice are driven by the needs of a patient and family. This requires nurses to be proficient in the multiple dimensions of the nursing continuums. When nurse competencies stem from patient needs and the characteristics of the nurse and patient synergize, optimal patient outcomes can result.

Patient Characteristics

Each patient and family is unique, with a varying capacity for health and vulnerability to illness. When seeking healthcare, each person brings a set of unique characteristics to the care situation. These patient characteristics span the continuum of health and illness:

Resiliency— the capacity to return to a restorative level of functioning using compensatory coping mechanisms; the ability to bounce back quickly after an insult.
- Level 1 - Minimally resilient - Unable to mount a response; failure of compensatory / coping mechanisms; minimal reserves; brittle
- Level 3 - Moderately resilient - Able to mount a moderate response; able to initiate some degree of compensation; moderate reserves
- Level 5 - Highly resilient - Able to mount and maintain a response; intact compensatory / coping mechanisms; strong reserves; endurance

Vulnerability—susceptibility to actual or potential stressors that may adversely affect patient outcomes.
- Level 1 - Highly vulnerable - Susceptible; unprotected; fragile
- Level 3 - Moderately vulnerable - Somewhat susceptible; somewhat protected
- Level 5 - Minimally vulnerable - Safe; out of the wood; protected, not fragile

Stability— the ability to maintain a steady-state equilibrium.
- Level 1 - Minimally stable - Labile; unstable; unresponsive to therapies; high risk of death
- Level 3 - Moderately stable - Able to maintain steady state for limited period of time; some responsiveness to therapies
- Level 5 - Highly stable - Constant; responsive to therapies; low risk of death

Complexity— the intricate entanglement of two or more systems (e.g. body, family, therapies).
- Level 1 - Highly complex - Intricate; complex patient / family dynamics; ambiguous / vague; atypical presentation
- Level 3 - Moderately complex - Moderately involved patient / family dynamics
- Level 5 - Minimally complex - Straightforward; routine patient / family dynamics; simple / clear cut; typical presentation

Resource availability—extent of resources (e.g. technical, fiscal, personal, psychological, social) the patient, family and community bring to the situation.
- Level 1 - Few resources - Necessary knowledge and skills not available; necessary financial support not available; minimal personal / psychological supportive resources; few social systems resources
- Level 3 - Moderate resources - Limited knowledge and skills available; limited financial support available; limited personal / psychological supportive resources; limited social systems resources
- Level 5 - Many resources - Extensive knowledge and skills available and accessible; financial resources readily available; strong personal / psychological supportive resources; strong social systems resources

Participation in care—extent to which the patient and family engage in aspects of care.
- Level 1 - No participation - Patient and family unable or unwilling to participate in care
- Level 3 - Moderate level of participation - Patient and family need assistance in care
- Level 5 - Full participation - Patient and family fully able to participate in care

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Participation in decision making--extent to which the patient and family engage in decision making.
Level 1 - No participation - Patient and family have no capacity for decision-making; requires surrogacy
Level 3 - Moderate level of participation - Patient and family have limited capacity; seeks input/advice from others in decision-making
Level 5 - Full participation - Patient and family have capacity, and makes decision for self

Predictability--a summative characteristic that allows one to expect a certain trajectory of illness.
Level 1 - Not predictable - Uncertain; uncommon patient population / illness; unusual or unexpected course; does not follow critical pathway, or no critical pathway developed
Level 3 - Moderately predictable - Wavering; occasionally-noted patient population / illness
Level 5 - Highly predictable - Certain; common patient population / illness; usual and expected course; follows critical pathway

For example:
A healthy, uninsured, 40 year old woman undergoing a pre-employment physical could be described as an individual who is (a) stable (b) not complex (c) very predictable (d) resilient (e) not vulnerable (f) able to participate in decision making and care, but (g) has inadequate resource availability.

On the other hand: a critically ill infant with multisystem organ failure can be described as an individual who is (a) unstable (b) highly complex (c) unpredictable (d) highly resilient (e) vulnerable (f) unable to become involved in decision making and care, but (g) has adequate resource availability

Nurse Characteristics
Nursing care reflects an integration of knowledge, skills, experience and attitudes needed to meet the needs of patients and families. Thus, continuums of nurse characteristics are derived from patient needs. The following are levels of expertise ranging from competent (1) to expert (5):

Clinical judgment--clinical reasoning, which includes clinical decision making, critical thinking, and a global grasp of the situation, coupled with nursing skills acquired through a process of integrating formal and experiential knowledge.
Level 1 - Collects basic-level data; follows algorithms, decision trees, and protocols with all populations and is uncomfortable deviating from them; matches formal knowledge with clinical events to make decisions; questions the limits of one's ability to make clinical decisions and delegates the decision-making to other clinicians; includes extraneous detail
Level 3 - Collects and interprets complex patient data; make clinical judgments based on an immediate grasp of the whole picture for common or routine patient populations; recognizes patterns and trends that may predict the direction of illness; recognizes limits and seeks appropriate help; focuses on key elements of case, while shorting out extraneous details
Level 5 - Synthesizes and interprets multiple, sometimes conflicting, sources of data; makes judgment based on an immediate grasp of the whole picture, unless working with new patient populations; uses past experiences to anticipate problems; helps patient and family see the "big picture"; recognizes the limits of clinical judgment and seeks multi-disciplinary collaboration and consultation with comfort; recognizes and responds to the dynamic situation

Advocacy/moral agency--working on another’s behalf and representing the concerns of the patient, family, and community; serving as a moral agent in identifying and helping to resolve ethical and clinical concerns within the clinical setting.
Level 1 - Works on behalf of patient; self assesses personal values; aware of ethical conflicts / issues that may surface in clinical setting; makes ethical / moral decisions based on rules; represents patient when patient cannot represent self; aware of patients’ rights
Level 3 - Works on behalf of patient and family; considers patient values and incorporates in care, even when differing from personal values; supports colleagues in ethical and clinical issues; moral decision-making can deviate from rules; demonstrates give and take with patient’s family, allowing them to speak / represent themselves when possible; aware of patient and family rights
Level 5 - Works on behalf of patient, family, and community; advocates from patient’s / family’s perspective, whether similar to or different from personal values; advocates ethical conflict and issues from patient / family
Appendix 10.1. The Synergy Model

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Caring practices—the constellation of nursing activities that are responsive to the uniqueness of the patient and family and that create a compassionate and therapeutic environment, with the aim of promoting comfort and preventing suffering. These caring behaviors include, but are not limited to, vigilance, engagement, and responsiveness.

**Level 1** - Focuses on the usual and customary needs of the patient; no anticipation of future needs; bases care on standards and protocols; maintains a safe physical environment; acknowledges death as a potential outcome

**Level 3** - Responds to subtle patient and family changes; engages with the patient as a unique patient in a compassionate manner; recognizes and tailors caring practices to the individuality of patient and family; domesticates the patient's and family's environment; recognizes that death may be an acceptable outcome

**Level 5** - Has astute awareness and anticipates patient and family changes and needs; fully engaged with and sensing how to stand alongside the patient, family, and community; caring practices follow the patient and family lead; anticipates hazards and avoids, and promotes safety throughout patient's and family's transitions along the health care continuum; orchestrates the process that ensures patient's / family's comfort and concerns surrounding issues of death and dying are met

Collaboration—working with others (e.g. patients, families, healthcare providers) in a way that promotes and encourages each person's contributions toward achieving optimal and realistic patient goals. Collaboration involves intra- and interdisciplinary work with all colleagues.

**Level 1** - Willing to be taught, coached and / or mentored; participates in team meetings and discussions regarding patient care and / or practice issues; open to various team members' contributions

**Level 3** - Seeks opportunities to be taught, coached, and / or mentored; elicits others' advice and perspectives; initiates and participates in team meetings and discussions regarding patient care and / or practice issues; recognizes and suggests various team members' participation

**Level 5** - Seeks opportunities to teach, coach, and mentor and to be taught, coached and mentored; facilitates active involvement and complementary contributions of others in team meetings and discussions regarding patient care and / or practice issues; involves / recruits diverse resources when appropriate to optimize patient outcomes

Systems thinking—the body of knowledge and tools that allow the nurse to appreciate the care environment from a perspective that recognizes the holistic interrelationship that exists within and across healthcare systems.

**Level 1** - Uses a limited array of strategies; limited outlook - sees the pieces or components; does not recognize negotiation as an alternative; sees patient and family within the isolated environment of the unit; sees self as key resource

**Level 3** - Develops strategies based on needs and strengths of patient / family; able to make connections within components; sees opportunity to negotiate but may not have strategies; developing a view of the patient / family transition process; recognizes how to obtain resources beyond self

**Level 5** - Develops, integrates, and applies a variety of strategies that are driven by the needs and strengths of the patient / family; global or holistic outlook - sees the whole rather than the pieces; knows when and how to negotiate and navigate through the system on behalf of patients and families; anticipates needs of patients and families as they move through the health care system; utilizes untapped and alternative resources as necessary

Response to diversity—the sensitivity to recognize, appreciate, and incorporate differences into the provision of care. Differences may include, but are not limited to, individuality, cultural differences (e.g. in child rearing, family relations), spiritual beliefs, gender, race, ethnicity, disability, family configuration, lifestyle, socioeconomic status, age values, and alternative medicine involving patients and their families and members of the healthcare team.

**Level 1** - Assesses cultural diversity; provides care based on own belief system; learns the culture of the health-care environment

**Level 3** - Inquires about cultural differences and considers their impact on care; accommodates personal and professional differences in the plan of care; helps patient / family understand the culture of the health-care system

**Level 5** - Responds to, anticipates, and integrates cultural differences into patient / family care; appreciates
and incorporates differences, including alternative therapies, into care; tailors healthcare culture, to the extent possible, to meet the diverse needs and strengths of the patient / family

**Clinical inquiry or Innovator/Evaluator**—the ongoing process of questioning and evaluating practice, providing informed practice, and innovating through research and experiential learning. The nurses engages in clinical knowledge development to promote the best patient outcomes.

- **Level 1** - Follows standards and guidelines; implements clinical changes and research-based practices developed by others; recognizes the need for further learning to improve patient care; recognizes obvious changing patient situation (e.g., deterioration, crisis); needs and seeks help to identify patient problem
- **Level 3** - Questions appropriateness of policies and guidelines; questions current practice; seeks advice, resources, or information to improve patient care; begins to compare and contrast possible alternatives
- **Level 5** - Improves, deviates from, or individualizes standards and guidelines for particular patient situations or populations; questions and / or evaluates current practice based on patients' responses, review of the literature, research and education / learning; acquires knowledge and skills needed to address questions arising in practice and improve patient care; (The domains of clinical judgment and clinical inquiry converge at the expert level; they are not separable)

**Facilitator of learning of patient/family educator**—the ability to facilitate patient and family learning.

- **Level 1** - Follows planned educational programs; sees patient / family education as a separate task from delivery of care; provides data without seeking to assess patient's readiness or understanding; has limited knowledge of the totality of the educational needs; focuses on a nurse's perspective; sees the patient as a passive recipient
- **Level 3** - Adapts planned educational programs; begins to recognize and integrate different ways of teaching into delivery of care; incorporates patient's understanding into practice; sees the overlapping of educational plans from different healthcare providers perspectives; begins to see the patient as having input into goals; begins to see individualism
- **Level 5** - Creatively modifies or develops patient / family education programs; integrates patient / family education throughout delivery of care; evaluates patient's understanding by observing behavior changes related to learning; able to collaborate and incorporate all healthcare providers’ and educational plans into the patient / family educational program; sets patient-driven goals for education; sees patient / family as having choices and consequences that are negotiated in relation to education

For example:
If the gestalt of a patient were stable but unpredictable, minimally resilient, and vulnerable, primary competencies of the nurse would be centered on clinical judgment and caring practices, (which includes vigilance). If the gestalt of a patient were vulnerable, unable to participate in decision making and care, and inadequate resource availability, the primary competencies of the nurse would focus on advocacy and moral agency, collaboration, and systems thinking.

Although all 8 competencies are essential for contemporary nursing practice, each assumes more or less importance depending on a patient's characteristics. Synergy results when a patient's needs and characteristics are matched with the nurse's competencies.

**Assumptions Guiding the Synergy Model**
These characteristics must be viewed in context. Various assumptions regarding nurses, patients, and families guide the Synergy Model:

- Patients are biological, psychological, social, and spiritual entities who present at a particular developmental stage. The whole patient (body, mind and spirit) must be considered.
- The patient, family and community all contribute to providing a context for the nurse-patient relationship.
- Patients can be described by a number of characteristics. All characteristics are connected and contribute to each other. Characteristics cannot be looked at in isolation.
- Similarly, nurses can be described on a number of dimensions. The interrelated dimensions paint a profile of the nurse.
- A goal of nursing is to restore a patient to an optimal level of wellness as defined by the patient. Death can be an acceptable outcome, in which the goal of nursing care is to move a patient toward a peaceful death.

[www.aacn.org/certification/SynergyModel](http://www.aacn.org/certification/SynergyModel) [Unedited version from the internet accessed January 2003]
## Appendice 10.2. The Code Sheet

**Ingrid Egerod**  Mechanical ventilator weaning in the context of critical care nursing

### Code sheet (1): Trajectory data

**Patient number**

1. **Ward**

<table>
<thead>
<tr>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rigshospitalet</td>
<td>Hvidovre Hospital</td>
<td>Herlev</td>
<td>Gentofte</td>
</tr>
</tbody>
</table>

2. **Sex**

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
</tbody>
</table>

3. **Age**

<table>
<thead>
<tr>
<th>[number]</th>
</tr>
</thead>
</table>

4. **Diagnosis**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical</td>
<td>Surgical</td>
<td>Trauma</td>
<td>Burn</td>
</tr>
</tbody>
</table>

5. **ICU days - length of stay in critical care**

[<number days>] Admission date – Discharge date

6. **Intubation days - length of intubation**

[<number days>] Initial intubation – Final extubation/decannulation

7. **Ventilation days - length of ventilator treatment**

[<number days>] Initial ventilation – discontinuation and independence for 24-h

8. **Indication for mechanical ventilation – etiology of respiratory failure**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgery</td>
<td>Obstruction</td>
<td>Pneumonia</td>
<td>Infection</td>
<td>Secretions</td>
<td>COPD</td>
<td>ARDS</td>
<td>Other</td>
</tr>
</tbody>
</table>

9. **Ventilator type**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo 900 A or B</td>
<td>Servo 900C, Evita 2</td>
<td>Servo 300, Evita 4</td>
</tr>
</tbody>
</table>

10. **Initial mode**

11. **Initial FiO2**

12. **Initial RF**

13. **Initial volume/pressure**

14. **Initial peak pressure**

15. **Initial PEEP**

16. **Main weaning strategy**

17. **Weaning outcome**

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incomplete weaning or death</td>
<td>Complete weaning</td>
</tr>
</tbody>
</table>

### Analgesic

<table>
<thead>
<tr>
<th>Morphine</th>
<th>Fentanyl</th>
<th>Midazolam</th>
<th>Propofol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haldid</td>
<td>Dormicum</td>
<td>Diprivan</td>
<td></td>
</tr>
<tr>
<td>Sufenta</td>
<td>Versed</td>
<td>Recofol</td>
<td></td>
</tr>
</tbody>
</table>

### Sedative

<table>
<thead>
<tr>
<th>Morphine</th>
<th>Fentanyl</th>
<th>Midazolam</th>
<th>Propofol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haldid</td>
<td>Dormicum</td>
<td>Diprivan</td>
<td></td>
</tr>
<tr>
<td>Sufenta</td>
<td>Versed</td>
<td>Recofol</td>
<td></td>
</tr>
</tbody>
</table>
### Code sheet (2): Daily data

#### Patient number

<table>
<thead>
<tr>
<th>Stage</th>
<th>Pre-weaning</th>
<th>Weaning</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Weaning progress

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Progress day = 1</th>
<th>Plateau day = 0</th>
<th>Reversal day = -1</th>
</tr>
</thead>
<tbody>
<tr>
<td>FiO2</td>
<td>&gt; 10% decrease</td>
<td>&lt; 10% change</td>
<td>&gt; 10% increase</td>
</tr>
<tr>
<td>PEEP</td>
<td>&gt; 10% decrease</td>
<td>&lt; 10% change</td>
<td>&gt; 10% increase</td>
</tr>
<tr>
<td>Time off vent</td>
<td>&gt; SBT time</td>
<td>no SBT time</td>
<td>&lt; SBT time</td>
</tr>
<tr>
<td>MV (Ve)</td>
<td>change toward target</td>
<td>no change</td>
<td>change from target</td>
</tr>
<tr>
<td>Peak pressure (PIP)</td>
<td>&gt; 10% decrease</td>
<td>&lt; 10% decrease</td>
<td>&gt; 10% increase</td>
</tr>
</tbody>
</table>

#### Sedation

| Propofol, Midazolam or other | None |

| Dose |

#### Analgesia

| Fentanyl, Morphine or other | None |

| Dose |

#### Patient characteristic score (PCS)

\[ 6 - \text{PNS} = (1-5) \]

#### Patient need score (PNS)

**Patient need:** Score \([1-40]/x = [1-5],\) where \(x\) = number of categories observed \([1-8]\)

- Resiliency: 5 = age > 80 years, 3 = age 50-80 years, 1 = age < 50 years
- Vulnerability: 5 = > 5 risk factors, 3 = 2-4 risk factors, 1 = 0-1 risk factors
- Stability: 5 = RN does not leave pt., 3 = RN leaves if covered, 1 = RN leaves freely
- Complexity: 5 = > 4 organ failures, 3 = 1-3 organ failures, 1 = No organ failures
- Resource availability: 5 = staff, 3 = staff + family, 1 = staff, family + pt fight for pt
- Participation in care: 5 = no participation, 3 = family participation, 1 = patient participation
- Participation in decision making: 5 = no part., 3 = family part., 1 = patient participation
- Predictability: 5 = rare condition., 3 = known condition, 1 = common condition

#### Patient readiness for transition

<table>
<thead>
<tr>
<th>Not ready = 0</th>
<th>Ready to wean = 2</th>
<th>Ready to discontinue = 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedated</td>
<td>FiO2 &lt; 0,5</td>
<td>Minimal secretions</td>
</tr>
<tr>
<td>FiO2 &gt; 0,5</td>
<td>PEEP &lt; 10</td>
<td>Good cough</td>
</tr>
<tr>
<td>PEEP &gt; 10</td>
<td>SAT &gt; 95</td>
<td>Cooperative</td>
</tr>
<tr>
<td></td>
<td>FiO2 &lt; 0,3</td>
<td>Minimal secretions</td>
</tr>
<tr>
<td></td>
<td>PEEP &lt; 0,5</td>
<td>Good cough</td>
</tr>
<tr>
<td></td>
<td>RF &lt; 30</td>
<td>Cooperative</td>
</tr>
</tbody>
</table>

#### Nurse-patient ratio

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1:1</td>
<td>2:1</td>
<td>3:1</td>
</tr>
</tbody>
</table>

#### Nurse-patient assignment

<table>
<thead>
<tr>
<th>Default</th>
<th>Continuity</th>
<th>Expertise</th>
<th>Primary nurse</th>
<th>Training</th>
<th>Special skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Nursing potential score (NPS)

\[ \text{score} = (3-15)/3 = (1-5) \]

- Knowing the field
  - < 1 year in field = 1
  - 1-3 years w/o cert. = 3
  - > 3 years or certification = 5
- Knowing the ward
  - < 1 year at ward = 1
  - 1-3 years at ward = 3
  - > 3 years or charge duty = 5
- Knowing the patient
  - 1 day with patient = 1
  - 2-3 days with patient = 3
  - > 3 days or primary nurse = 5
30. Nurse competency score (NCS) - Nurse performance

<table>
<thead>
<tr>
<th>Nurse performance</th>
<th>Score [1-40]/x = [1-5], where x = number of categories observed [1-8]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical judgment</td>
<td>1 = follow protocol, 3 = follow own judgment, 5 = follow patient</td>
</tr>
<tr>
<td>Advocacy</td>
<td>1 = knows pt rights, 3 = knows pt values, 5 = uses pt values</td>
</tr>
<tr>
<td>Caring practices</td>
<td>1 = informs, 3 = informs + orients, 5 = informs, orients, establishes contact</td>
</tr>
<tr>
<td>Collaboration</td>
<td>1 = participate in meeting, 3 = uses other's values, 5 = uses other professions</td>
</tr>
<tr>
<td>Systems thinking</td>
<td>1 = few strategies, 3 = negotiates, 5 = uses all resources</td>
</tr>
<tr>
<td>Response to diversity</td>
<td>1 = own values, 3 = patient to own values, 5 = patient values</td>
</tr>
<tr>
<td>Clinical inquiry</td>
<td>1 = follow standard, 3 = critical of practice, 5 = individualizes</td>
</tr>
<tr>
<td>Facilitator of learning</td>
<td>1 = sees pt as passive, 3 = uses pt knowledge, 5 = individualizes</td>
</tr>
</tbody>
</table>

31. Synergy (clinical sensitivity)

- NCS < (PNS – 0.5) = 0
- NCS > (PNS – 0.5) = 1

32. Number ventilator changes this day

**Code sheet (3): Decisions data**

Patient number

33. **Decision category**

| Ventilator change = 1 | Ventilation related = 2 | Other = 3 |

34. **Decision venue**

| Bedside = 1 | Rounds = 2 | Conference = 3 |

35. **Decision maker**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>Nurse and nurse</td>
<td>Nurse and patient</td>
<td>Nurse and physician</td>
<td>Physician</td>
</tr>
</tbody>
</table>

36. **Type of order**

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>No order - independent decision</td>
<td>Verbal order - collaborative decision</td>
<td>Written order</td>
</tr>
</tbody>
</table>

37. NA

38. NA

39. **Outcome**

| Success = 1 | Failure = 0 |

**Narrative data**

**Decision**

1. airway related
2. communication related
3. sedation related
4. ventilator change
5. wean related

**Indicator**

1. clinical
2. paraclinical

**Choice**

**Rationale**

**Strategy**

**Outcome**
### Trajectory data

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ward</td>
<td>Ward</td>
</tr>
<tr>
<td>2</td>
<td>Sex</td>
<td>Sex</td>
</tr>
<tr>
<td>3</td>
<td>Age</td>
<td>Age</td>
</tr>
<tr>
<td>4</td>
<td>Diagnosis</td>
<td>Diagnosis</td>
</tr>
<tr>
<td>5</td>
<td>Length of stay in critical care</td>
<td>Length of stay in critical care</td>
</tr>
<tr>
<td>6</td>
<td>Length of intubation</td>
<td>Length of intubation</td>
</tr>
<tr>
<td>7</td>
<td>Length of ventilator treatment</td>
<td>Length of ventilator treatment</td>
</tr>
<tr>
<td>8</td>
<td>Indication for ventilation</td>
<td>Indication for ventilation</td>
</tr>
<tr>
<td>9</td>
<td>Ventilator type</td>
<td>Ventilator type</td>
</tr>
<tr>
<td>10</td>
<td>Initial mode</td>
<td>Initial mode</td>
</tr>
<tr>
<td>11</td>
<td>Initial FiO2</td>
<td>Initial FiO2</td>
</tr>
<tr>
<td>12</td>
<td>Initial frequency</td>
<td>Initial frequency</td>
</tr>
<tr>
<td>13</td>
<td>Initial volume/pressure</td>
<td>Initial volume/pressure</td>
</tr>
<tr>
<td>14</td>
<td>Initial Peak Pressure</td>
<td>Initial Peak Pressure</td>
</tr>
<tr>
<td>15</td>
<td>Initial PEEP</td>
<td>Initial PEEP</td>
</tr>
<tr>
<td>16</td>
<td>Main weaning strategy</td>
<td>Main weaning strategy</td>
</tr>
<tr>
<td>17</td>
<td>Weaning outcome</td>
<td>Weaning outcome</td>
</tr>
</tbody>
</table>

### History

- **Reason for admission**

### Social status

### Progress
### Daily data

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Date and time</th>
<th>Ventilator day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>18 Stage of weaning</th>
<th>19 Weaning progress</th>
<th>20 Sedation</th>
<th>21 Dose</th>
<th>22 Analgesic</th>
<th>23 Dose</th>
<th>24 Patient characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>25 Patient need</th>
<th>26 Readiness for transition</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Resiliency</td>
<td>FiO2</td>
</tr>
<tr>
<td>- Vulnerability</td>
<td>secretions</td>
</tr>
<tr>
<td>- Stability</td>
<td>PEEP</td>
</tr>
<tr>
<td>- Complexity</td>
<td>cough</td>
</tr>
<tr>
<td>- Resource Availability</td>
<td>SAT</td>
</tr>
<tr>
<td>- Participation in care</td>
<td>awake</td>
</tr>
<tr>
<td>- Participation in decisions</td>
<td></td>
</tr>
<tr>
<td>- Predictability</td>
<td></td>
</tr>
</tbody>
</table>

### Registration sheet 3. Nursing competency daily.

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Date and time</th>
<th>Ventilator day</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>27 Staffing ratio</th>
<th>28 Staffing principle</th>
<th>29 Nurse potential</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>30 Nurse characteristics</th>
<th>31 Synergy</th>
<th>32 Number ventilator changes today</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Clinical judgment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Advocacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Caring Practices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Collaboration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Systems Thinking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Response to diversity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Clinical inquiry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Facilitator of learning</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Decision data

<table>
<thead>
<tr>
<th>Patient number</th>
<th>Date</th>
<th>Ventilator day</th>
<th>Decision number</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NURSE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicator</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choices</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rationale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strategy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33 Decision category</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 Decision place</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35 Collaboration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36 Order</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37 Consequence</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>PATIENT</strong></td>
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<tr>
<td>38 Patient response</td>
<td>Before</td>
<td></td>
<td>After</td>
</tr>
<tr>
<td>39 Outcome</td>
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</table>
Appendix 10.3. The Registration Sheet

Narrative data
Patient number (#)  Date/time

Observational notes

Theoretical notes

Methodological notes

Personal notes
The target interviews

The following provides examples of the nurses' and physicians' responses to the target interviews regarding the complexity of each ventilator setting and the authority of the nurse to make a ventilator change. The data, which are presented according to the individual ventilator settings, demonstrate the range of interpretations of the informal competencies of the nurse and refutes the belief that a tacit guideline (unwritten rules) exists for mechanical ventilator weaning.

FiO2. All participants agreed that FiO2 is the first parameter a nurse learns to change, as this is the least complex. The risk to the nurse and patient is small, because the patient response can be readily monitored via pulse oximetry and blood gasses. Nurses automatically reduce FiO2 unless the physician specifically orders the nurses not to. Some physicians state that nurses should be free to change low-range FiO2, while other physicians find it safer if nurses only alter high-range FiO2.

Pressure. The participants agreed that the next parameter a nurse learns to change is pressure level in pressure modes. Nurses state that only experienced nurses should alter pressure and that each nurse must decide when she is competent to perform this task. Some nurses require a physician's order to change low-range pressure while others request an order for high-range pressure changes. Some nurses require a physician's order to change pressure in large increments, while they feel comfortable independently reducing pressure by small increments. Some nurses prefer extubation to reducing low-range pressure. Nurses feel more comfortable altering pressure if the patient is "officially" being weaned from ventilation, and most of the nurses perceive that there exists a tacit guideline they may follow when weaning is initiated. Some physicians feel that nurses can freely reduce pressure in PS mode.

Volume. The participants agreed that the next level of complexity is alteration of volume. Nurses were more comfortable with volume changes at Site 4 where VC was the standard mode, while nurses at other sites stated that they had little experience with volume changes. Nurses who made volume changes generally stated that they changed volume before consulting the physician, while the physicians stated that nurses should ask first. Physicians are more restrictive regarding volume changes than pressure changes, while the difference is more subtle among nurses. This is explained by the fact that pressure is indirectly monitored during volume changes, while volume is directly monitored during pressure changes.

Mode. The next level of complexity is mode changes. Nurses are comfortable changing mode, but usually among modes which the patient has tried before. Physicians are more restrictive regarding mode changes and generally don't find that nurses should change mode without an order. Nurses consult the physicians less during evening and night shifts where mode changes are more common. If nurses change to a mode, which is new to a patient, they do so after "testing" the patient first.

Respiratory frequency. The next level of complexity is respiratory frequency. Only very experienced nurses state that they change respiratory frequency. Nurses state that RF is not set in PS mode, while physicians state that RF must always be set. Nurses state that RF is complex and that they would rather change volume or pressure first. Physicians generally state that RF requires an order.

PEEP. The next level of complexity is PEEP. Nurses state that they rarely alter PEEP, especially at Site 4 where PEEP is rarely used. Only very experienced nurses change PEEP. Physicians require an order for nurses to alter PEEP.
I:E ratio. The last ventilator change is I:E ratio, which is assumed by the participants to be very complex because it is rarely altered. Very experienced nurses "test" the patient and alter I:E-ratio when other options have failed. Although physicians regard I:E ratio to be off bounds for nurses, several nurses indicated that they had changed I:E independently. Chart review showed that most alterations of I:E ratio were not ordered in writing.
The mode variations
The following set of figures depicts the daily modes when the patient is most dependent upon the ventilator and least dependent upon the ventilator. The purpose of including these figures is to show that the stages of weaning may appear to vary according to the time of day. In addition to this, the figures provide information, which may suggest the onset of weaning and the duration of the weaning stage. Figures 10.5.1.-10.5.14 are intended to complement the figures shown in chapter 6, figures 6.1.1.-6.1.14.

On the figures below the dots in each subset are connected by a line. This is not meant to indicate that there is continuity between the settings in each subset. The connecting lines are only added in order to highlight the pattern, which is otherwise difficult to visualize.

Figure 10.5.1. Daily mode variations Case 1

Figure 10.5.2. Daily mode variations Case 2
Appendix 10.5. The Mode Variations

Figure 10.5.3. Daily mode variations Case 3

Figure 10.5.4. Daily mode variations Case 4

Figure 10.5.5. Daily mode variations Case 5
Figure 10.5.6. Daily mode variations Case 6

<table>
<thead>
<tr>
<th>ICU day Case 6 (Site 2)</th>
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- Control = 1
- Support = 2
- Unassisted = 3

Most dependent
Least dependent

Figure 10.5.7. Daily mode variations Case 7

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<th>ICU day Case 7 (Site 2)</th>
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- Control = 1
- Support = 2
- Unassisted = 3

Most dependent
Least dependent

Figure 10.5.8. Daily mode variations Case 8

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<th>ICU day Case 8 (Site 2)</th>
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</table>

- Control = 1
- Support = 2
- Unassisted = 3

Most dependent
Least dependent
Appendix 10.5. The Mode Variations

Figure 10.5.9. Daily mode variations Case 9

Figure 10.5.10. Daily mode variations Case 10

Figure 10.5.11. Daily mode variations Case 11
Figure 10.5.12. Daily mode variations Case 12

<table>
<thead>
<tr>
<th>ICU day</th>
<th>Case 12 (Site 4)</th>
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<tbody>
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<td>1-13</td>
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</table>

Control = 1  
Support = 2  
Unassisted = 3

Most dependent  
Least dependent

Figure 10.5.13. Daily mode variations Case 13

<table>
<thead>
<tr>
<th>ICU day</th>
<th>Case 13 (Site 4)</th>
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</thead>
<tbody>
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<td>1-8</td>
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</table>

Control = 1  
Support = 2  
Unassisted = 3

Most dependent  
Least dependent

Figure 10.5.14. Daily mode variations Case 14

<table>
<thead>
<tr>
<th>ICU day</th>
<th>Case 14 (Site 4)</th>
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</thead>
<tbody>
<tr>
<td>1-11</td>
<td></td>
</tr>
</tbody>
</table>

Control = 1  
Support = 2  
Unassisted = 3

Most dependent  
Least dependent
The weaning progress and patterns

The **weaning progress** is depicted on the figures with a peak to indicate progress, a valley to indicate reversal, and a horizontal line to indicate plateau. The **weaning patterns** are described as inconsistent (peaks, valleys and plateaus), consistent (peaks and plateaus), or sprint (peaks only).

The mode categories on the ordinate axis indicate control (1), support (2), and unassisted breathing (3). The arrows at the base of the figures indicate the **stages of weaning**. The figures show the weaning progress as it evolves though the weaning continua. The purpose of these figures is to show that weaning is sustained through periods of plateau and reversal.

**Figure 10.6.1.** Mode pattern daily at 06:00 and weaning progress Case 1

**Figure 10.6.2.** Mode pattern daily at 06:00 and weaning progress Case 2
Figure 10.6.3. Mode pattern daily at 06:00 and weaning progress Case 3

Figure 10.6.4. Mode pattern daily at 06:00 and weaning progress Case 4

Figure 10.6.5. Mode pattern daily at 06:00 and weaning progress Case 5
Appendix 10.6. The Weaning Progress and Patterns

Figure 10.6.6. Mode pattern daily at 06:00 and weaning progress Case 6

Figure 10.6.7. Mode pattern daily at 06:00 and weaning progress Case 7

Figure 10.6.8. Mode pattern daily at 06:00 and weaning progress Case 8
Figure 10.6.9. Mode pattern daily at 06:00 and weaning progress Case 9

![Figure 10.6.9. Mode pattern daily at 06:00 and weaning progress Case 9](image)

Figure 10.6.10. Mode pattern daily at 06:00 and weaning progress Case 10

![Figure 10.6.10. Mode pattern daily at 06:00 and weaning progress Case 10](image)

Figure 10.6.11. Mode pattern daily at 06:00 and weaning progress Case 11

![Figure 10.6.11. Mode pattern daily at 06:00 and weaning progress Case 11](image)
Figure 10.6.12. Mode pattern daily at 06:00 and weaning progress Case 12

Figure 10.6.13. Mode pattern daily at 06:00 and weaning progress Case 13

Figure 10.6.14. Mode pattern daily at 06:00 and weaning progress Case 14
List of 113 decisions
The decisions, indications, choices, rationales, and strategies on this list derive from direct observation and observational interviews with nurses at the bedside. The complexity of the decision is determined by the number of choices, risks, and the predictability of the response. The nurse potential is shown as [Total score] ([field] + [field] × [field]).

# 1. Case 1, day 40, decision 1
Decision: Mode change PRVC to PS.
Indication: Sedation discontinued. Patient waking up, breathing, triggering.
Choice: PRVC with sedation, or PS without sedation.
Rationale: Resume weaning.
Strategy: Patient to initiate breathing and follow ventilator. Patient to rest at night and wean by day.
Nurse potential: 3,7 (5+3+3)
Complexity: 2 (nurse)
Outcome: 1

# 2. Case 1, day 40, decision 2
Decision: Reduce FiO2 0.5 to 0.4.
Indication: ABG shows high pO2.
Choice: Reduce FiO2.
Rationale: Keep pO2 within normal range.
Strategy: Reduce FiO2.
Nurse potential: 3,7 (5+3+3)
Complexity: 1 (nurse)
Outcome: 1

# 3. Case 1, day 40, decision 3
Decision: Temporarily increase FiO2 from 0.45 to 0.50.
Indication: ABG shows decreasing pO2 after patient turned on right side.
Choice: Turn patient on back and risk bedsores or increase FiO2 temporarily.
Rationale: Patient is on "turning schedule" to prevent bedsores. The patient has left-sided atelectasis. When patient is on right side the function of the best lung is compromised.
Strategy: Keep SAT and pO2 within normal range and reduce risk of pressure sores.
Nurse potential: 3,7 (5+3+3)
Complexity: 2 (nurse)
Outcome: 1

# 4. Case 1, day 40, decision 4
Decision: Sedate patient at nighttime.
Indication: Patient lacks energy, needs sleep.
Choice: Sedate and discontinue weaning at nighttime, or risk patient exhaustion and weaning failure.
Rationale: Conserve patient's energy.
Strategy: Promote rest and sleep by sedating and discontining weaning at nighttime.
Nurse potential: 3,7 (5+3+3)
Complexity: 2 (nurse-nurse)
Outcome: 0 (patient refuses sedation)

# 5. Case 1, day 40, decision 5
Decision: Collaborate with patient about weaning plan.
Indication: Patient is awake and oriented.
Choice: Decide for patient, or enable patient participation.
Rationale: Weaning is facilitated when patient collaborates.
Strategy: The nurse informs the patient about the weaning plan in an impersonal way and fails to ensure eye-contact. The patient is not able to communicate disagreement with the nurse or ask questions because the nurse does looks away. Collaboration fails.
Nurse potential: 3,7 (5+3+3)
Complexity: 2 (nurse-patient)
Outcome: 0

# 6. Case 1, day 41, decision 1
Decision: Mode change PS to PRVC during nighttime.
Indication: High RF and small TV.
Choice: Discontinue weaning and conserve energy, or continue weaning and risk exhaustion.
Rationale: PRVC increases TV and reduces RF which increases physical resource availability.
Strategy: Change mode to reduce RF.
Nurse potential: 3,0 (5+1+3)
Complexity: 2 (nurse)
Outcome: 1

# 7. Case 1, day 41, decision 2
Decision: Reduce FiO2 0.55 to 0.30.
Indication: SAT 100%.
Choice: Reduce FiO2.
Rationale: FiO2 as low as possible in order to normoventilate.
Strategy: Reduce FiO2.
Nurse potential: 3,0 (5+1+3)
Complexity: 1 (nurse)
Outcome: 1

# 8. Case 1, day 42, decision 1
Decision: Avoid nighttime sedation.
Indication: Patient does not wish to be sedated.
Choice: Decide for patient, or enable patient participation.
Rationale: Promote patient participation.
Strategy: Collaborate with patient. "Do you want to have something to help you sleep?". "No. Is it correct that you do not wish anything?". "Yes". The patient answers adequately.
Nurse potential: 3,0 (5+1+3)
Complexity: 2 (nurse-patient)
Outcome: 1

# 9. Case 1, day 42, decision 2
Decision: Not to interfere with the physicians.
Indication: Patient is awake and can hear the ultrasound consultant discussing a bad prognosis with the head physician in front of the patient.
Choice: Act as patient advocate and prevent patient anxiety, or avoid confrontation with physicians and prevent nurse anxiety.
Rationale: Prevent patient anxiety which can prevent recovery.
Strategy: Nurse chooses to remain silent. The head physician eventually takes the initiative to inform the consultant that the patient is awake and oriented and suggests a conference outside the room.
Nurse potential: 3,0 (5+1+3)
Complexity: 1 (physician)
Outcome: 0

# 10. Case 1, day 44, decision 1
Decision: Increase sedation and seek help from a more experienced nurse.
Indication: Patient bleeding from mouth and is anxious.
Choice: Cope with the situation alone, or seek help.
Rationale: Lack of knowledge and experience.
Strategy: Let the experienced nurse take over, control the situation, and comfort the patient.
Nurse potential: 1,7 (3+1+1)
Complexity: 2 (nurse-nurse)
Outcome: 1

# 11. Case 1, day 46, decision 1
Decision: Cooperate with patient during manual ventilation.
Indication: Left-sided atelectasis. Patient awake and alert.
Choice: Manually ventilate with patient cooperation, or risk increased atelectasis.
Rationale: Patient cooperation facilitates treatment and recruitment of lung areas.
Strategy: The nurse informs the patient of the immediate task, but fails to ensure contact, introduce herself, orient the patient, or enable patient participation. The patient does not respond. The physician introduces himself: "Remember me, I'm your friend", establishes contact, and negotiates with the patient: "We will do everything for you, but you must hang on". The patient responds to the physician with a smile and moves her legs.
Nurse potential: 3,7 (5+3+3)
Complexity: 2 (nurse-patient)
Outcome: 1

# 12. Case 2, day 1, decision 1
Decision: Increase PRVC 7 to PRVC 8.
Indication: ABG shows pCO2 too high – patient triggering ventilator.
Choice: Increase sedation, or change ventilator.
Rationale: Greater TV will help the patient follow the ventilator.
Strategy: Ventilator change.
Nurse potential: 3,7 (5+5+1)
Complexity: 2 (nurse)
Outcome: 1

# 13. Case 2, day 1, decision 2
Decision: Decrease FiO2 from 1.0 to 0.6.
Indication: SAT 100% for several hours.
Choice: Decrease FiO2 and prevent oxygen toxicity, or clear out CO.
Rationale: Prevent oxygen toxicity.
Strategy: FiO2 should be as low as possible guided by SAT according to nurse. Physician does not give permission to decrease FiO2 because CO is still not cleared out.
Nurse potential: 3,7 (5+5+1)
Complexity: 2 (nurse-physician)
Outcome: 1

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Mechanical ventilator weaning in the context of critical care nursing
# 14. Case 2, day 1, decision 3
Decision: Increase PRVC to 10,5 l.  
Indication: Patient triggering ventilator.  
Choice: Increase sedation, or increase volume.  
Rationale: Patient-ventilator synchrony.  
Nurse potential: 3,7 (5+5+1)  
Complexity: 2 (nurse-physician)  
Outcome: 1  

# 20. Case 2, day 3, decision 1  
Decision: Mode change PC to PRVC.  
Indication: Inspiration time 50% to 40%.  
Choice: Sedation, or ventilator change.  
Rationale: Mode change to improve ventilation.  
Nurse potential: 4,3 (5+5+3)  
Complexity: 2 (nurse-physician)  
Outcome: 1  

# 21. Case 2, day 4, decision 1  
Decision: Increase FiO2 0,8 to 0,85.  
Indication: SAT low.  
Choice: FiO2 change.  
Rationale: Prevent hypoxemia.  
Nurse potential: 2,3 (1+1+3)  
Complexity: 1 (nurse-physician)  
Outcome: 1  

# 22. Case 2, day 4, decision 2  
Decision: Reduce FiO2 0,85 to 0,8.  
Choice: FiO2 change.  
Rationale: Maintain FiO2 as low as possible to avoid oxygen toxicity.  
Nurse potential: 2,3 (1+1+3)  
Complexity: 1 (nurse-physician)  
Outcome: 1  

# 23. Case 2, day 4, decision 3  
Decision: Decrease FiO2 0,8 to 0,75.  
Indication: SAT 94.  
Choice: FiO2 change.  
Rationale: Keep SAT > 90. Nurse initiated verbal order.  
Nurse potential: 2,3 (1+1+3)  
Complexity: 1 (nurse-physician)  
Outcome: 1  

# 24. Case 2, day 5, decision 1  
Decision: Increase preset volume.  
Indication: Hypercapnia.  
Choice: Increase volume.  
Rationale: Reduce pCO2 by increasing volume.  
Nurse potential: 1,0 (1+1+1)  
Complexity: 1 (nurse)  
Outcome: 1  

# 29. Case 2, day 10, decision 1  
Decision: Mode change VS to PS.  
Indication: Patient restless on VS.  
Choice: Mode change.  
Rationale: Nurse prefers PS because pressure is easier to read the pressure directly on the ventilator.  
Nurse potential: 1,7 (1+1+3)  
Complexity: 1 (nurse)  
Outcome: 1  

# 26. Case 2, day 8, decision 2  
Decision: Change from Propofol to Midazolam.  
Indication: Propofol is a lipid emulsion.  
Choice: Give lipids via sedation, or via nutrition.  
Rationale: Avoid lipids in sedative because sedation will be temporarily discontinued.  
Nurse potential: 5,0 (5+5+5)  
Complexity: 2 (nurse-physician)  
Outcome: 1 
# 30. Case 2, day 11, decision 1  
**Decision:** Increase PS 10 to PS 14.  
**Indication:** Patient is anxious.  
**Choice:** Increase pressure.  
**Rationale:** Patient feels that she is not getting enough air.  
**Strategy:** The nurse tries to "talk the patient through" and says: "Are you scared?", "Now you will get more air. Don't panic!". The nurse asks the patient's family to come in so the patient won't feel alone.  
**Nurse potential:** 1.7 (1+1+3)  
**Complexity:** 1 (nurse)  
**Outcome:** 1

# 31. Case 3, day 2, decision 1  
**Decision:** Increase sedation.  
**Indication:** Patient is fighting ventilator.  
**Choice:** Increase sedation and patient comfort, or risk accidental extubation.  
**Rationale:** Sedate so patient can follow ventilator.  
**Strategy:** Optimal breathing to induce rest without sedating too much. There is no better ventilator setting.  
**Nurse potential:** 5.0 (5+5+5)  
**Complexity:** 2 (nurse-physician)  
**Outcome:** 1

# 32. Case 3, day 2, decision 2  
**Decision:** Mode change from PRVC to PS.  
**Indication:** Patient is not following ventilator.  
**Choice:** Increase sedation, or ventilator change.  
**Rationale:** Patient-ventilator synchrony.  
**Strategy:** Mode change.  
**Nurse potential:** 5.0 (5+5+5)  
**Complexity:** 2 (nurse)  
**Outcome:** 1

# 33. Case 3, day 4, decision 1  
**Decision:** Mode change PS to CPAP.  
**Indication:** Normal pCO2, RF and oxygenation. Patient meets weaning criteria, deflation of cuff shows respiration around tube (indicating sufficient respiration), and no edema.  
**Choice:** Wean in order to establish contact with patient before surgery.  
**Rationale:** Reduce mechanical ventilation and extubate before surgery if possible.  
**Nurse potential:** 4.3 (5+5+3)  
**Complexity:** 2 (nurse-physician)  
**Outcome:** 1

# 34. Case 3, day 4, decision 2  
**Decision:** Mode change CPAP to spontaneous breathing.  
**Indication:** Good breathing.  
**Choice:** Keep patient ventilated, or maintain spontaneous breathing before surgery.  
**Rationale:** Wean in order to maintain respiratory muscles.  
**Strategy:** Spontaneous breathing and perhaps extubation.  
**Nurse potential:** 4.3 (5+5+3)  
**Complexity:** 2 (nurse)  
**Outcome:** 0

# 35. Case 3, day 6, decision 1  
**Decision:** Nurse suggests Fentanyl.  
**Indication:** RF 40 on CPAP. Good TV, little dead-space, good oxygenation.  
**Choice:** Decrease RF with Fentanyl, or give ventilator support.  
**Rationale:** Fentanyl can slow RF. Mode change to PS will not alter RF. Mode change to PRVC requires sedation.  
**Strategy:** Increase sedation.  
**Nurse potential:** 5.0 (5+5+5)  
**Complexity:** 2 (nurse-physician)  
**Outcome:** 1

# 36. Case 3, day 6, decision 2  
**Decision:** Mode change CPAP to PS.  
**Indication:** ABG shows high pCO2 and low pO2.  
**Choice:** Give ventilator support, or increase FiO2.  
**Rationale:** Increasing FiO2 won't change pCO2 which is low due to Midazolam. PS will bring down pCO2 by reversing shallow breathing.  
**Strategy:** Give ventilator support. Keep pCO2 and pO2 within normal range.  
**Nurse states that reverting to an earlier ventilator mode does not require a physician's order.**  
**Nurse potential:** 5.0 (5+5+5)  
**Complexity:** 2 (nurse)  
**Outcome:** 1

# 37. Case 3, day 6, decision 3  
**Decision:** Bag patient.  
**Indication:** X-ray shows atelectasis.  
**Choice:** Bag patient and risk barotrauma, or risk increasing atelectasis.  
**Rationale:** Recruit collapsed lung areas.  
**Strategy:** Give oxygen and manual ventilation.  
**Nurse potential:** 5.0 (5+5+5)  
**Complexity:** 2 (nurse)  
**Outcome:** 1

# 38. Case 4, day 7, decision 1  
**Decision:** Mode change VS to CPAP.  
**Indication:** High MV, high RF, low TV, waking up.  
**Choice:** Maintain VS, or try CPAP.  
**Rationale:** Weaning – testing the patient to bring down RF and MV.  
**Strategy:** Unassisted breathing.  
**Nurse potential:** 3.7 (5+3+3)  
**Complexity:** 2 (nurse)  
**Outcome:** 0

# 39. Case 4, day 7, decision 2  
**Decision:** Mode change CPAP to PS.  
**Indication:** High RF, low TV.  
**Choice:** VS and high MV, or PS.  
**Rationale:** PS may reduce RF.  
**Strategy:** Weaning – testing the patient.  
**Nurse potential:** 3.7 (5+3+3)  
**Complexity:** 2 (nurse)  
**Outcome:** 0

# 40. Case 4, day 7, decision 3  
**Decision:** Physician reduces VS by 1 liter.  
**Indication:** Good respiration – ready to wean.  
**Choice:** Reduce volume.  
**Rationale:** Weaning.  
**Strategy:** The physician does not collaborate with the nurses. Nurses state that when physicians alter ventilation it can take the nurse the rest of the day to figure out what happened and to get the patient back on track.  
**Nurse potential:** 3.7 (5+3+3)  
**Complexity:** 1 (physician)  
**Outcome:** 0

# 41. Case 4, day 8, decision 1  
**Decision:** Reduce VS 1 liter.  
**Indication:** Good SAT, good MV, good TV.  
**Choice:** Reduce VS.  
**Rationale:** Weaning.  
**Strategy:** Weaning via VS.  
**Nurse potential:** 1 (1+1+1)  
**Complexity:** 1 (nurse)  
**Outcome:** 1

# 42. Case 4, day 8, decision 2  
**Decision:** Reduce FiO2.  
**Indication:** Patient breathing well.  
**Choice:** Reduce FiO2.  
**Rationale:** Weaning.  
**Strategy:** Reduce FiO2.  
**Nurse potential:** 1 (1+1+1)  
**Complexity:** 1 (nurse)  
**Outcome:** 1

# 43. Case 4, day 8, decision 3  
**Decision:** Manual ventilation.  
**Indication:** X-ray shows atelectasis.  
**Choice:** Bag the patient.  
**Rationale:** Recruit lung.  
**Strategy:** Recruiting lung by pressure, oxygen and suction.  
**Nurse potential:** 1 (1+1+1)  
**Complexity:** 1 (nurse-physician)  
**Outcome:** 0

# 44. Case 4, day 9, decision 1  
**Decision:** Mode change VS to PRVC.  
**Indication:** Temporary sedation during cystoscopy procedure.  
**Choice:** Maintain weaning during procedure, or temporarily discontinue weaning.  
**Rationale:** Ensure sedation and good ventilation during procedure.  
**Strategy:** Postpone weaning.  
**Nurse potential:** 3.0 (5+1+3)  
**Complexity:** 2 (nurse-physician)  
**Outcome:** 1

# 45. Case 4, day 9, decision 2  
**Decision:** Increase PEEP 10 to 12.  
**Indication:** Bagging is insufficient to reduce atelectasis.  
**Choice:** Increase PEEP, or promote atelectasis.  
**Rationale:** Reduce atelectasis.  
**Strategy:** Keep high pressure in lung to avoid increasing atelectasis. PEEP over 10 rarely used. Nurse asks physician for permission which is granted.  
**Nurse potential:** 3.0 (5+1+3)  
**Complexity:** 2 (nurse-physician)  
**Outcome:** 1
# 46. Case 4, day 12, decision 1
**Decision:** Mode change VS to PS.
**Indication:** High RF, high peak pressure.
**Choice:** Wean via VS, or PS.
**Rationale:** Pressure easier to control via PS.
**Strategy:** Change to PS. Many nurses prefer PS over VS because it is easier to monitor. The physicians prefer VS because it guarantees volume. The nurse and physician negotiate PS.
**Nurse potential:** 3,7 (5+1+5)
**Complexity:** 2 (nurse-physician)
**Outcome:** 1

# 47. Case 4, day 12, decision 2
**Decision:** Withhold sedation during day.
**Indication:** Patient responds sluggishly.
**Choice:** Keep the patient sedated and passive, or awake and restless.
**Rationale:** Ensure contact with patient.
**Strategy:** Only sedate at night.
**Nurse potential:** 3,7 (5+1+5)
**Complexity:** 2 (nurse-physician)
**Outcome:** 1

# 48. Case 4, day 12, decision 3
**Decision:** Reduce PS 14 to PS 12.
**Indication:** ABG good on PS 14.
**Choice:** Reduce pressure.
**Rationale:** Weaning.
**Strategy:** Give as little ventilator support as possible.
**Nurse potential:** 3,7 (5+1+5)
**Complexity:** 1 (nurse)
**Outcome:** 1

# 49. Case 4, day 12, decision 4
**Decision:** Bag and suction.
**Indication:** X-ray shows atelectasis.
**Choice:** Increase ventilator pressure, or bag.
**Rationale:** Recruit lung and maintain ventilator setting.
**Strategy:** Reopen closed lung areas.
**Nurse potential:** 3,7 (5+1+5)
**Complexity:** 2 (nurse-physician)
**Outcome:** 1

# 50. Case 4, day 13, decision 1
**Decision:** Mode change VS to PS.
**Indication:** High peak pressure, high RF.
**Choice:** Wean via VS, or PS.
**Rationale:** Pressure is easier to control on PS.
**Strategy:** Change the mode. There is no common strategy regarding the mode.
**Nurse potential:** 3,7 (5+1+5)
**Complexity:** 2 (nurse)
**Outcome:** 1

# 51. Case 5, day 5, decision 1
**Decision:** Reduce pressure PC/25 to PC/22.
**Indication:** Patient in sitting position—needs less support while sitting.
**Choice:** Temporarily after ventilation in order to accommodate the patient's needs.
**Rationale:** Less support, more ventilator independence. More relaxed breathing.
**Strategy:** Ventilator change, pressure reduction.
**Nurse potential:** 3,0 (5+1+3)

# 52. Case 5, day 5, decision 2
**Decision:** Mode change PC to PS.
**Indication:** Patient waking, patient-ventilator asynchrony.
**Choice:** Change pressure level, or change mode.
**Rationale:** PS will promote patient-ventilator synchronization.
**Strategy:** Mode change.
**Nurse potential:** 3,0 (5+1+3)
**Complexity:** 2 (nurse-physician)
**Outcome:** 1

# 53. Case 5, day 6, decision 1
**Decision:** Reduce pressure level PS/24 to PS/22.
**Indication:** High RF, low pH.
**Choice:** Increase sedation or ease pressure (atypical reaction). Normally the pressure is increased when pH is low.
**Rationale:** Relax patient.
**Strategy:** Change pressure level.
**Nurse potential:** 3,0 (3+3+3)
**Complexity:** 1 (nurse-physician)
**Outcome:** 1

# 54. Case 5, day 6, decision 2
**Decision:** Continue to reduce pressure level.
**Indication:** Follow the patient's lead.
**Choice:** Pressure reduction.
**Rationale:** Increase ventilator independence.
**Strategy:** Pressure reduction.
**Nurse potential:** 3,0 (3+3+3)
**Complexity:** 1 (nurse-physician)
**Outcome:** 1

# 55. Case 5, day 12, decision 1
**Decision:** Try PS mode.
**Indication:** No respiratory problems.
**Choice:** Change mode.
**Rationale:** Start weaning.
**Strategy:** Test patient's reaction.
**Nurse potential:** 1,7 (1+1+3)
**Complexity:** 1 (physician)
**Outcome:** 0

# 56. Case 5, day 12, decision 2
**Decision:** Change PS to PC.
**Indication:** Rapid shallow breathing, low pH. Crashing.
**Choice:** Change mode.
**Rationale:** Patient too weak for PS.
**Strategy:** Resume PC. Go back on physician's order.
**Nurse potential:** 1,7 (1+1+3)
**Complexity:** 1 (nurse)
**Outcome:** 1

# 57. Case 6, day 6, decision 1
**Decision:** Clarify how aggressively the patient should be treated.
**Indication:** Unclear what the family knows about prognosis.
**Choice:** Enable family to participate in decisions.
**Rationale:** Ethical reasoning.
**Strategy:** Facilitate active involvement from physician. The nurse wants to know "where we have the family".
**Nurse potential:** 2,3 (5+1+1)
**Complexity:** 1 (nurse-physician)
**Outcome:** 1

# 58. Case 6, day 6, decision 2
**Decision:** Decide what is optimal sedation for patient during weaning.
**Indication:** Patient-ventilator asynchrony.
**Patient heavily sedated.
**Choice:** Heavy sedation and more ventilator support, or lighter sedation and mode change (PC to PS). If lighter sedation, then BP increases, then reduce dopamine, then go to PS, then increased RF, then poor ABG and perhaps back to PC.
**Rationale:** As light sedation as possible.
**Strategy:** Balance sedation and ventilation. Nurse follows the patient's lead and the principle of lighter sedation and ventilator change.
**Nurse potential:** 2,3 (5+1+1)
**Complexity:** 2 (nurse)
**Outcome:** 1

# 59. Case 7, day 3, decision 1
**Decision:** Increase Propofol to tube tolerance.
**Indication:** Tube irritates during bedbath and turning.
**Choice:** Sedate more, or reposition less.
**Rationale:** Sedation as light as possible with tube acceptance.
**Strategy:** Increase sedation. Nurse negotiates with physician, who uses sedative, not analgesic for tube acceptance.
**Nurse potential:** 2,3 (5+1+1)
**Complexity:** 2 (nurse-physician)
**Outcome:** 1

# 60. Case 7, day 3, decision 2
**Decision:** Temporarily increase pressure level during bath.
**Indication:** Heavier sedation requires more pressure support.
**Choice:** Sedate less, or increase pressure level.
**Rationale:** Adequate ventilation during bedbath.
**Strategy:** Increase sedation and pressure level. Nurse views this as a momentary setback to weaning.
**Nurse potential:** 2,3 (5+1+1)
**Complexity:** 2 (nurse)
**Outcome:** 1

# 61. Case 7, day 3, decision 3
**Decision:** Stop Propofol and start Fentanyl.
**Indication:** Tube irritation.
**Choice:** Sedative, or analgesic.
**Rationale:** Analgesic for pain.
**Strategy:** Change medication in order to wean and extubate. Problem will be resolved when patient is extubated.
**Nurse potential:** 2,3 (5+1+1)
**Complexity:** 2 (physician)
**Outcome:** 1
# 62. Case 7, day 3, decision 4
Decision: Wean and extubate this shift.
Indication: Patient waking up and breathing spontaneously.
Choice: Talk patient through, or increase ventilator support.
Rationale: Patient ready for extubation.
Strategy: Prevent hyperventilation. Wean and prepare to extubate.
Nurse potential: 2,3 (5+1+1)
Complexity: 2 (nurse)
Outcome: 1

# 63. Case 7, day 3, decision 5
Decision: Sit patient up in bed.
Indication: Hyperventilation.
Choice: Increase ventilator support, or reposition.
Rationale: Patient participation facilitates weaning.
Strategy: Reposition with help from orderly.
Nurse potential: 2,3 (5+1+1)
Complexity: 2 (nurse-physician)
Outcome: 1

# 64. Case 7, day 3, decision 6
Decision: Inform and orient the patient.
Indication: Establish contact with patient and put patient at ease.
Choice: Do things for the patient, or enable the patient in participation.
Rationale: Patient participation facilitates weaning.
Strategy: Information: “[Name] – are you there? We are cleaning your mouth a little”. Nurse seeks contact. Orientation: “You are at [place] …. my name is [nurse] …. you have a tube in your throat. That is why you can’t talk right now. We are going to get you off the ventilator. Breath slowly. Your husband will be here soon … Squeeze my hand so I know if you have pain … Squeeze if you have pain … Squeeze in you are afraid … You have some little heart problems. We will straighten them out … I have washed your hair … You can go to sleep and we will see to it that you get well … The sun is shining…”
Nurse potential: 2,3 (5+1+1)
Complexity: 2 (nurse)
Outcome: 1

# 65. Case 8, day 10, decision 1
Decision: Wean and extubate.
Indication: Patient awake on PC 22.
Choice: Slow wean, or sink-or-swim extubation.
Rationale: Fast wean and extubation maintains respiratory muscles.
Strategy: Wean by fast reduction of pressure level PC 22 to PS 8 in four hours. Physician’s decision. Nursing protesting decision, but overruled by physicians at the conference.
Nurse potential: 3,0 (3+5+1)* Nursing aide Complexity: 2 (physician)
Outcome: 0

# 66. Case 8, day 11, decision 1
Decision: Slow wean.
Indication: Last extubation was unsuccessful.
Choice: Slow wean.
Rationale: Patient did not tolerate rapid pressure reduction.
Strategy: Reduce pressure level by 2 cm H2O daily.
Nurse potential: 1,7 (1+1+3)
Complexity: 1 (nurse-physician)
Outcome: 1

# 67. Case 9, day 8, decision 1
Decision: Stop sedation, wake patient in order to extubate.
Indication: No respiratory problems, patient ready for extubation.
Choice: Wake patient who is possibly psychotic, or sedate patient and risk weaning setback.
Rationale: No respiratory problems.
Strategy: Wake patient and give epidural anesthesia to facilitate breathing.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse-physician)
Outcome: 0

# 68. Case 9, day 8, decision 2
Decision: Postpone weaning until abdomen less taut.
Indication: Abdominal distention.
Choice: Wean now with less lung space, or later with more lung space.
Rationale: Weaning should have a chance of success.
Strategy: Clean out impacted bowel in order to facilitate breathing. The less experienced nurses have not given the patient the enema the doctor ordered as they have not learned how to give a traditional enema. They fail to realize the importance of the physician’s order, because constipation is regarded as a nursing care problem. The nurses record in progress notes “enema not given” without an explanation. This postpones weaning.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (physician)
Outcome: 0

# 69. Case 9, day 9, decision 1
Decision: Wean via PS.
Indication: Tolerates PS well when tested.
Choice: Maintain ventilation and analgesia, or extubate with risk of reintubation.
Rationale: Extubate in order to prevent ventilator dependence.
Strategy: Rapid extubation.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (physician)
Outcome: 1

# 70. Case 9, day 9, decision 2
Decision: Change mode VC to PS.
Indication: Patient triggering and fighting vent.
Choice: Increase sedation, or change mode.
Rationale: Establish normoventilation.
Strategy: Mode change.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse)
Outcome: 1

# 71. Case 9, day 11, decision 1
Decision: Change airway from oral to nasal.
Indication: Sores and pain in mouth.
Choice: Oral intubation with less risk of sinus infection, or nasal intubation and less pain.
Rationale: Patient comfort promotes weaning.
Strategy: Nasal intubation.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse-physician)
Outcome: 1

# 72. Case 9, day 11, decision 2
Decision: Change ventilator Servo 900 C to Servo 300.
Indication: Labored spontaneous breathing via ventilator and nasal tube # 7.
Choice: Replace ventilator.
Rationale: Spontaneous breathing easier with Servo 300 because of a lighter valve.
Strategy: Reduce resistance. After two days Servo 900 C is reinstated because a more seriously ill patient needs the Servo 300.
Nurse potential: 4,3 (5+5+3)
Complexity: 1 (nurse)
Outcome: 1

# 73. Case 9, day 11, decision 3
Decision: Postpone weaning until the next day.
Indication: Abdominal pain.
Choice: Wean and risk failure because of pain, or postpone weaning until success is probable.
Rationale: Increase chances of successful wean
Strategy: Continue sedation with Propofol.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse-physician)
Outcome: 1

# 74. Case 9, day 12, decision 1
Decision: Reduce FiO2 – ask physician later.
Indication: SAT 98.
Choice: Reduce FiO2.
Rationale: Reduce FiO2 when possible.
Strategy: Normal respiration.
Nurse potential: 3,7 (5+5+1)
Complexity: 1 (nurse)
Outcome: 1

# 75. Case 9, day 12, decision 2
Decision: Postpone weaning.
Indication: Patient not ready according to ABG.
Choice: Postpone weaning, or risk failure to wean.
Rationale: Patient in too much pain to wean.
Strategy: Wean as soon as possible. Reduce abdominal pressure and relieve pain before patient is awakened.
Nurse potential: 3,7 (5+5+1)
Complexity: 2 (nurse-physician)
Outcome: 1

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# 76. Case 9, day 18, decision 1
**Decision:** Withhold suctioning and order coagulation parameters.
**Indication:** Fresh bleeding from trachea.
**Choice:** Order parameters now, or wait for physician.
**Rationale:** Get the results as quickly as possible.
**Strategy:** Suction carefully and get surgical consult.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 2 (nurse)

**Indication:** Patient has psychological feeling of breathing on his own though still getting positive pressure. Patient looks worse.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 2 (nurse-physician)

# 77. Case 9, day 20, decision 1
**Decision:** Change trigger sensitivity from -2 to 0.
**Indication:** Patient has difficulty initiating breaths and is getting tired.
**Choice:** Reduce resistance.
**Rationale:** Facilitate weaning.
**Strategy:** Follow the patient’s lead.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (physician)

# 78. Case 9, day 20, decision 2
**Decision:** Assess weaning by patient response, not para-clinical parameters.
**Indication:** Too many ABGs are drawn.
**Choice:** Discontinue A-line.
**Rationale:** Nurses go by A-line and make fewer changes. If the nurses follow the patient they will make more timely changes.
**Strategy:** Discontinue A-line.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (physician)

# 79. Case 9, day 22, decision 1
**Decision:** Reduce the duration of spontaneous breathing trials.
**Indication:** Patient tires if the restitution period is too short.
**Choice:** Increasingly longer spontaneous breathing trials with risk or tiring patient, or more frequent shorter trials with longer rest periods in between.
**Rationale:** Avoid exhaustion.
**Strategy:** Shorter SBT. Physician orders “ad hoc” breathing trials.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 2 (physician)

# 80. Case 9, day 22, decision 2
**Decision:** Weaning via “closed PEEP” four hours at a time.
**Indication:** Spontaneous breathing.
**Choice:** PEEP valve on tubing, rather than PEEP setting on ventilator or separate CPAP bottle system.
**Rationale:** PEEP valve does not require much maintenance and ventilator can leave the room. This has a psychological benefit for the patient. PEEP via ventilator is “heavy” and the ventilator is still visible to the patient, so patient perceives he is still mechanically ventilated. CPAP system is noisy and cumbersome.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 2 (nurse-physician)

# 81. Case 9, day 24, decision 1
**Decision:** Put patient on “closed PEEP” and get an ABG.
**Indication:** Nurse not comfortable with the clinical assessment alone.
**Choice:** Draw ABG, but put patient back on ventilator before ABG result.
**Rationale:** Weaning via SBT without tiring the patient. Assess ABG to be sure.
**Strategy:** Nurse is not aware that the physician ordered short SBTs with long restituation periods. It is not charted.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (nurse)

# 82. Case 9, day 25, decision 1
**Decision:** Reduce set minute volume alarm to 3 liters/minute.
**Indication:** Ventilator alarm goes off all the time.
**Choice:** Change the alarm settings.
**Rationale:** Turn down alarm because it is bothersome.
**Strategy:** Prevent the alarm from going off.
**Outcome:** 1
**Nurse potential:** 1.0 (1+1+1)
**Complexity:** 1 (nurse)

# 83. Case 9, day 25, decision 2
**Decision:** Avoid frequent suctioning.
**Indication:** Bleeding from trachea.
**Choice:** Refrain from suctioning.
**Rationale:** Reduce bleeding.
**Strategy:** Refrain from suctioning.
**Outcome:** 1
**Nurse potential:** 1.0 (1+1+1)
**Complexity:** 1 (nurse)

# 84. Case 9, day 27, decision 1
**Decision:** Decannulation.
**Indication:** Spontaneous breathing 24h. Patient looks ready.
**Choice:** Decannulation.
**Rationale:** Breathing is easier with natural airway.
**Strategy:** Decannulate.
**Outcome:** 1
**Nurse potential:** 1.0 (1+1+1)
**Complexity:** 1 (physician)

# 85. Case 9, day 27, decision 2
**Decision:** Draw ABG.
**Indication:** Nurse does not trust clinical assessment.
**Choice:** ABG.
**Rationale:** Have results ready at rounds.
**Strategy:** Draw ABG.
**Outcome:** 1
**Nurse potential:** 1.0 (1+1+1)
**Complexity:** 1 (nurse)

# 86. Case 9, day 29, decision 1
**Decision:** Get help for reintubation.
**Indication:** Pulmonary bleeding.
**Choice:** Get help.
**Rationale:** Ensure breathing.
**Strategy:** Have physician reintubate via trach.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (nurse)

# 87. Case 9, day 29, decision 2
**Decision:** Reintubate with cuffed tube.
**Indication:** Bleeding back from throat.
**Choice:** Ensure breathing.
**Strategy:** Intubate with cuffed tube.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (nurse)

# 88. Case 9, day 29, decision 3
**Decision:** Notify the family that the patient looks worse.
**Indication:** Patient is experiencing respiratory problems.
**Choice:** Be on the safe side and call the family.
**Rationale:** If the patient should die it would have been wrong not to have notified the family.
**Strategy:** Call the family now.
**Outcome:** 1
**Nurse potential:** 3.0 (5+3+1)
**Complexity:** 1 (nurse)

# 89. Case 10, day 11, decision 1
**Decision:** Follow the weaning plan.
**Indication:** Head physician is not following the plan.
**Choice:** Follow head physician, or follow plan.
**Rationale:** Plan is important for patient.
**Strategy:** Reduce PS by 2 cm H2O daily.
**Outcome:** 0
**Nurse potential:** 5.0 (5+5+5)
**Complexity:** 2 (physician)

# 90. Case 10, day 17, decision 1
**Decision:** Nurse preceptor decides to send new nurse to family conference with the physician. The family knows the preceptor well, but she decides to give the orientee this experience, thus prioritizing the orientee ahead of the patient.
**Indication:** Orientee needs experience.
**Choice:** Meeting the needs of the orientee, or the needs of the patient and family.
**Rationale:** The family conference is a good learning experience for the new nurse.
**Strategy:** Expose orientee to new situations.
**Outcome:** 0 (weaning fails)
**Nurse potential:** 3.7 (5+1+5)
**Complexity:** 2 (nurse-physician)

# 91. Case 10, day 17, decision 2
**Decision:** Preceptor changes patient from PS to “closed PEEP” immediately following the family conference where the family learns that the patient is terminal.
**Indication:** Family crying making patient anxious.
Choice: Start weaning now while patient and family are coping with the news, or wait till later on the next shift.
Rationale: Best to make changes on day shift when staffing is good.
Strategy: Start weaning immediately.
Nurse potential: 3,7 (5+5+1+5)
 Complexity: 2 (nurse)
Outcome: 0

# 92. Case 10, day 18, decision 1
Decision: Sedate patient for the night.
Indication: Patient restless.
Choice: Sedate and risk weaning failure, or calm patient by other means than sedation.
Rationale: Overcome patient distress.
Strategy: Sedate with Propofol and Fentanyl and attempt to reverse the effect later (without effect).
Nurse potential: 3,7 (5+5+1+5)
 Complexity: 2 (nurse)
Outcome: 0

# 93. Case 10, day 18, decision 2
Decision: Call the family when patient looks worse.
Indication: Patient weak, arhythmia, pale.
Choice: Call the family.
Rationale: Family present if patient dies.
Strategy: Call the family before it is too late.
Nurse potential: 3,7 (5+5+1+5)
 Complexity: 1 (nurse)
Outcome: 1

# 94. Case 11, day 4, decision 1
Decision: Mode change PS to VC.
Indication: Breathing impaired by morphine.
Choice: Mode change.
Rationale: Morphe suppresses breathing.
Strategy: Volume control.
Nurse potential: 1,7 (1+1+3)
 Complexity: 1 (nurse)
Outcome: 1

# 95. Case 11, day 19, decision 1
Decision: Postpone weaning.
Indication: Patient not ready for weaning.
Choice: Risk of prolonged ventilation, or risk of dying.
Rationale: Weaning would compromise patient now.
Strategy: Stabilize patient hemodynamically.
Nurse potential: 5,0 (5+5+5)
 Complexity: 2 (nurse-physician)
Outcome: 1

# 96. Case 12, day 10, decision 1
Decision: Determine the timing of SBT.
Indication: Clinical picture and ABG.
Choice: Frequent SBT, or less frequent SBT with longer pauses.
Rationale: Restitution necessary to avoid tiring patient.
Strategy: Increase duration of SBT in order to reach spontaneous breathing faster.
Nurse potential: 5,0 (5+5+5)
 Complexity: 2 (nurse)
Outcome: 1

# 97. Case 12, day 11, decision 1
Decision: Determine the duration of SBT.
Indication: Clinical picture and ABG.
Choice: Long SBT vs. long restitution.
Rationale: Restitution necessary to avoid tiring patient.
Strategy: Long restitution necessary.
Nurse potential: 3,7 (5+5+1)
 Complexity: 2 (nurse)
Outcome: 1

# 98. Case 13, day 2, decision 1
Decision: Continue sedation with Propofol.
Indication: Reaching for tube. Just under the surface. Can be awakened.
Choice: Sedation, or establish contact and risk accidental extubation.
Rationale: Sedate for safety in order to facilitate weaning and avoid accidental extubation.
Strategy: Keep airway open.
Nurse potential: 4,3 (5+5+3)
 Complexity: 2 (nurse)
Outcome: 1

# 99. Case 13, day 2, decision 2
Decision: Use alphabet board to communicate.
Indication: Patient needs information and communication.
Choice: Read lips, or use board.
Rationale: Board gives better communication.
Strategy: Communicate with patient in order to facilitate weaning.
Nurse potential: 4,3 (5+5+3)
 Complexity: 2 (nurse)
Outcome: 1

# 100. Case 13, day 3, decision 1
Decision: Determine the duration of restitution period following SBT.
Indication: Patient needs rest.
Choice: Short SBT, or SBT till patient tires.
Rationale: SBT is more successful if patient does not tire.
Strategy: SBT after rest. Restitution period before patient tires.
Nurse potential: 3,7 (5+5+1)
 Complexity: 2 (nurse)
Outcome: 1

# 101. Case 13, day 4, decision 1
Decision: SBT 15 minutes at a time.
Indication: Patient not tired.
Choice: SBT till tired, or stop SBT after 15 minutes.
Rationale: Shorter SBT facilitates weaning.
Strategy: Stop SBT after 15 minutes.
Nurse potential: 4,3 (5+5+3)
 Complexity: 2 (nurse)
Outcome: 1

# 102. Case 13, day 5, decision 1
Decision: Postpone tracheotomy.
Indication: Patient does not want tracheotomy.
Choice: Comply with patient, or comply with "order".
Rationale: Patient participation facilitates weaning and alleviates anxiety.
Strategy: Postpone tracheotomy.
Nurse potential: 5,0 (5+5+5)
 Complexity: 2 (nurse)
Outcome: 1

# 103. Case 13, day 5, decision 2
Decision: Wean with CPAP via ventilator.
Indication: Ready for unassisted breathing.
Choice: Try CPAP.
Rationale: Wean as fast as possible.
Strategy: Try CPAP.
Nurse potential: 5,0 (5+5+5)
 Complexity: 1 (physician)
Outcome: 1

# 104. Case 13, day 6, decision 1
Decision: Fast extubation.
Indication: Patient awake and smiling.
Choice: Risk too early extubation, or risk ventilatory complications.
Rationale: Better for patient if early extubation successful.
Strategy: Extubate.
Nurse potential: 3,7 (5+5+1)
 Complexity: 2 (physician)
Outcome: 1

# 105. Case 13, day 6, decision 2
Decision: Inform patient of good ABG.
Indication: Patient needs information and encouragement.
Choice: Encourage patient.
Rationale: Encouragement facilitates breathing.
Strategy: Support and encouragement.
Nurse potential: 3,7 (5+5+1)
 Complexity: 1 (nurse-physician)
Outcome: 1

# 106. Case 13, day 6, decision 3
Decision: Temporarily increase FiO2.
Indication: Low SAT while positioned on side.
Choice: Temporarily increase FiO2.
Rationale: Ensure adequate oxygenation.
Nurse potential: 3,7 (5+5+1)
 Complexity: 1 (nurse)
Outcome: 1

# 107. Case 13, day 7, decision 1
Decision: Suggest mobilization during rounds.
Indication: Mobilization loosens secretions.
Choice: Make suggestions during rounds.
Rationale: Loosen secretions.
Strategy: Mobilize and reposition patient.
Nurse potential: 3,7 (5+5+1)
 Complexity: 1 (nurse-physician)
Outcome: 1
# 108. Case 14, day 8, decision 1
Decision: Change mode VC to PS.
Indication: Patient is waking and balking the ventilator.
Choice: Increase sedation, or change mode.
Rationale: Facilitate patient-ventilator synchrony.
Strategy: Change mode and wake patient.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (physician)
Outcome: 1

# 109. Case 14, day 8, decision 2
Decision: Increase PS 12 to PS 14.
Indication: Patient experiences dyspnea.
Choice: Continue weaning, or ensure patient comfort.
Rationale: Ensure comfort.
Strategy: PS altered temporarily.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse)
Outcome: 1

# 110. Case 14, day 8, decision 3
Decision: Change from PS to SB on open system (no PEEP).
Indication: Patient restless on PS.
Choice: Increase ventilator support, or try SB.
Rationale: Promote weaning.
Strategy: Nurse explains to the physician, that the patient does not like PS and prefers VC. Patient pleads for VC, but physician insists on SB. Patient has a tracheostomy. The physicians state that nurses are often too soft at critical moments when the patient has to breathe on his own. The physician succeeded in getting the patient off the ventilator.
Nurse potential: 4,3 (5+5+3)
Complexity: 2 (nurse-patient)
Outcome: 1

# 111. Case 14, day 9, decision 1
Decision: Comfort patient experiencing dyspnea.
Indication: Patient anxious and hyperventilating.
Choice: Maintain SB, or revert to ventilator.
Rationale: Comforting relieves anxiety.
Strategy: Talk the patient through.
Nurse potential: 5,0 (5+5+5)
Complexity: 2 (nurse-patient)
Outcome: 1

# 112. Case 14, day 9, decision 2
Decision: Increase oxygen.
Indication: Patient anxious.
Choice: Increase oxygen, or accept low SAT.
Rationale: Oxygen ensures normal respiration.
Strategy: Give oxygen and offer sedative. Patient does not want sedative.
Nurse potential: 5,0 (5+5+5)
Complexity: 2 (nurse-patient)
Outcome: 1

# 113. Case 14, day 11, decision 1
Decision: Decannulation.
Indication: SB two days good cough.
Choice: Tracheostomy facilitates suctioning but increases risk of infection.
Rationale: Normalize breathing.
Nurse potential: 5,0 (5+5+5)
Complexity: 2 (nurse-physician)
Outcome: 1
Appendix 10.8. References

References


Appendix 10.8. References


