Title: "Understanding nurses' decision-making when managing weaning from mechanical ventilation: a study of novice and experienced critical care nurses in Scotland and Greece."

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Abstract

Background: Prompt and accurate identification of the patient's ability to sustain reduction of ventilatory support has the potential to increase the likelihood of successful weaning. Nurses' information processing during the weaning from mechanical ventilation (MV) has not been well described.

Aim and objectives: To examine how nurses collect and use cues from respiratory assessment to inform their decisions as they wean patients from ventilatory support.

Design: A descriptive ethnographic study exploring critical care nurses' decision-making processes when weaning mechanically ventilated patients from ventilatory support in the real setting.

Methods: Novice and expert Scottish and Greek nurses from two tertiary intensive care units were observed in real practice of weaning MV and were invited to participate in reflective interviews near the end of their shift. Data were analysed thematically using concept maps based on information processing theory. Ethics approval and informed consent were obtained.

Results: Scottish and Greek critical care nurses acquired patient-centred objective physiological and subjective information from respiratory assessment and previous knowledge of the patient, which they clustered around seven concepts descriptive of the patient's ability to wean. Less experienced nurses required more encounters of cues to attain the concepts with certainty. Subjective criteria were intuitively derived from previous knowledge of patients' responses to changes of ventilatory support. All nurses used focusing decision-making strategies to select and group cues in order to categorise information with certainty and reduce the mental strain of the decision task.

Conclusions: Nurses used patient-centred information to make a judgment about the patients’ ability to wean. Decision-making strategies that involve categorisation of patient-centred information can be taught in bespoke educational programmes for MV and weaning.

Relevance to clinical practice: Advanced clinical reasoning skills and accurate detection of cues in respiratory assessment by critical care nurses will ensure optimum patient management in weaning MV.

Keywords: decision-making, critical care nurses, mechanical ventilation, weaning, observation, cognitive process.

Summary box

'What does this paper contribute to the wider global clinical community?'

- Decision-making when weaning mechanical ventilation is highly complex, and prompt and accurate identification of the patient's readiness to wean has the potential to increase the likelihood of successful weaning. Understanding of nurses' respiratory assessment would make better use of their knowledge and skills to improve patient outcome.
- Nurses did not focus only on the criteria provided in weaning guidelines but collected patient-centred information from objective physiological and subjective criteria using focusing decision-making strategies in all stages of the weaning process.
- The principles of information processing can be used to guide bespoke educational programmes on mechanical ventilation to advance critical care nurses' clinical reasoning skills and improve optimum decision-making and patient care.

INTRODUCTION

Although the literature on mechanical ventilation and weaning process is extensive, data on how critical care nurses make decisions about the management of these practices is limited. Over the last decade, the introduction of goal-directed approaches and guidelines (i.e. sedation and ventilator weaning bundles, automated weaning systems) has supported nurses' decision-making and resulted in reductions of patient time spent on mechanical ventilation and improved survival rates (Girard & Ely 2008). Despite these advances, current research highlights significant variation and inconsistency in clinicians' weaning decisions and practices, which has been shown to adversely impact upon safety and patient outcomes (Rose & Nelson 2006). Although some variation is to be expected, it becomes a problem when application of interventions (i.e. weaning protocols) leads to ineffective outcomes for the patient (Anders-Ericsson *et al*. 2007). This suggests that clinical guidelines alone cannot ensure optimum decisions and patient management.

Given the irreducible uncertainty in the complex practice of weaning mechanical ventilation, critical care nurses need to be well equipped with decision-making skills to deliver safe, effective care and prevent adverse events and errors. To improve nurses' judgement and decision making, it is necessary to understand how nurses think and use the information available to inform their decisions and solve a problem (Anders-Ericsson *et al*. 2007). The processes that nurses use to conduct respiratory assessment to inform their decisions about the patient's ability to wean off the ventilator have not been explored. Such in depth understanding may enable educators to develop decision-making and clinical reasoning skills for graduate nurses to improve their performance on mechanical ventilation practice.

BACKGROUND

A number of studies have explored how nurses make judgements and decisions in clinical practice, examining the processes of clinical reasoning (McCarthy 2003, Souder & O'Sullivan 2000). Previous research into clinical reasoning by critical care nurses has not been extensive. Recent studies have described factors that influence nurses' decisions, such as knowledge and experience (Anders-Ericsson *et al.* 2007), and how clinical decisions are made in everyday practice in relation to pain management (Mardegan 1997), recognising delirium (Souder & O'Sullivan 2000), pulmonary pressure monitoring (Aitken 2000), sedation management (Aitken *et al*. 2008) and management of post-operative patients (Hoffman *et al*. 2009). Investigators have used a variety of quantitative and qualitative methods, including observation, questionnaires, prospective or retrospective verbal protocols or mixed methods (Lundgren-Laine & Salantera 2010).

According to Simmons (2009) clinical reasoning is a complex process that uses cognition, metacognition, and discipline specific knowledge to gather and analyse patient information, evaluate its significance and weigh alternative actions in order to solve a problem. Nurses are required to make a diagnosis with a certain range of confidence based on 'gold standard' evidence and the signs/ symptoms presented. Since the introduction of weaning protocols and algorithms during the last decade, decision-making in weaning mechanical ventilation is based on information processing and the use of 'gold standard' parameters included in weaning algorithms to increase the certainty of a successful weaning trial and subsequent extubation.

Based on information processing theory, nurses gather cues or patient information from conceptual and sensory sources, which they store and process in the short term memory (STM) and integrate with pre-existing knowledge stored in the long term memory

(LTM) to make a decision (Newell & Simon 1972). STM has limited working capacity to handle incoming information, so data collected are combined into four to seven chunks to overcome the small working capacity (Elstein & Bordage 1988). In contrast, the LTM has a large capacity to handle and store information relatively permanently. Knowledge stored in the LTM is unlocked by patient cues coming into the STM and is used to aid the STM processing (Newell & Simon 1972).

The collection of cues can be influenced by a number of factors including personal beliefs and assumptions (McCarthy 2003), the nature of the decision task (Newell & Simon 1972) and experience (Benner 2001). Differences in the way expert and novice nurses collect and use cues have been examined with some differences being reported. Most studies have compared expert and novice nurses' acquisition and use of information in a simulated or natural environment informed by various decision-making models (Anders-Ericsson *et al*. 2007). Although findings have not been consistent in all settings (Hoffman *et al*. 2009), expert nurses were seen to collect and cluster fewer cues with high diagnostic accuracy and on a wider range of aspects of the patient's presenting symptoms focusing on these that are relevant to the hypothesis made (Aitken 2003). Novice nurses collected greater number of cues, concentrated only on the presenting symptoms of the patient and were less proactive in collecting relevant information and anticipating problems (Nojima *et al*. 2003), because of their inability to discriminate between salient and non-salient cues. In order to understand better how nurses collect and use cues to make decisions, this study was designed to answer the following questions:

1. What cues do novice and expert critical care nurses cluster together to make a decision about the management of patients who wean off mechanical ventilation?

2. What strategies do novice and expert critical care nurses use to evaluate the cues presented by the patient when making decisions about the management of patients who wean off mechanical ventilation?
3. Are there any differences between novice and expert critical care nurses in the use of cues when they make decisions about the management of patients who wean off mechanical ventilation?

This study represents part of a larger ethnographic study that aimed to understand nurses' real world decision-making of the weaning process and the dynamics of the clinical environment in different settings that affected nurses' decision-making. The article examines nurses' decision-making processes and cue collection from respiratory assessment to inform their decisions as they wean patients from ventilatory support. There was no attempt made to measure the overall quality of the decisions made.

Theoretical framework and definition of terms

The basis of making a nursing diagnosis lies on the accurate identification and perception of information received by observation of the patient and the ability to assign a valid meaning to this information (Matthews & Gaul 1979). Bruner *et al.* (1956) described the cognitive process of selecting and using information to attain a concept with certainty using the minimum account of mental strain and memory capacity. Concepts can be conjunctive (when there are several cues jointly presented) or disjunctive (when there is any one cue present). Nursing diagnoses are considered disjunctive and are highly probabilistic (Gordon 1972), meaning that arriving at one diagnostic category does not exclude other diagnostic categories. Nurses' ability to process information to attain a concept and categorise is key to the diagnostic task.

The terms used in this article are defined both theoretically and operationally. Cues are the discriminable observable features of a condition which may vary in time. Operationally they are defined as signs and symptoms of a patient (e.g. breath sounds, heart rate, and patient history). Cue clustering or grouping is the arbitrary arrangement of cues into sets, which have common properties. Operationally, cue grouping is the process of cue arrangement to derive a nursing diagnosis. A concept is a network of thoughts that is formed in the mind as a result of clustering the various cues. It normally takes the form of a diagnosis based on the presence of signs and symptoms. A nursing diagnosis theoretically is defined as an inferential judgement made about the state of the patient based on the attainment of concepts when categorising cues; operationally is the identification of the state of the patient based on the grouping of cues. A decision-making strategy is the pattern of cue selection and grouping used to attain a concept, which can be based on either the use of each cue (scanning strategy) or the number of cues (focusing strategy) that can be held in memory at one time when categorising information. Operationally a decision-making strategy is the manner that nurses process the information in their memory to reduce the cognitive strain and make a decision, and usually reflects the demands of the complex situation.

There is limited evidence on the use of this theory to understand nurses' thinking process; mainly in assessing and managing pulmonary artery pressure monitoring (Aitken 2003), sedation (Aitken *et al*. 2008) and haemodynamic monitoring (Hoffman *et al*. 2009). These studies highlighted that the behaviour of the decision-maker depends on the definition of the nursing task, the depth of understanding the nurse seeks to achieve, the number and kinds of attributes attained and the order in which they are encountered when assessing the patient, the frequency and immediacy of validation of the hypotheses made and the anticipated outcomes of the decisions made.

METHODS

The study was a descriptive ethnographic study that compared the decision-making processes between novice and expert nurses in two ICUs, with differences in the philosophy of care, nursing education, resources and organisational structure. It was conducted in two tertiary hospitals in Greece and Scotland between 2007 and 2008. In Greece, nursing education and philosophy of care is based on a biomedical model compared to the holistic nursing curriculum in the UK, which is translated in the care provision.

The ethnographic approach (Spradley 1980) used allowed the close observation and engagement with the critical care nurses as they cared for patients who were mechanically ventilated for more than 48 hours. A purposive sample of 13 registered critical care nurses with a variety of experience who worked full-time and were involved in bedside weaning of mechanical ventilation were invited to participate. Nurses were selected using criteria informed by Benner's (2001) definition of expert and novice nurse. Expert nurses (n=8) were considered those who had both more than 6 years' experience in ICU and a critical care certificate or relevant postgraduate degree; novice nurses (n=5) were considered those with less than 5 years' experience in ICU, new graduates, recently commenced in ICU, or did not have a speciality certificate.

Data collection

Each participant (n= 13) was observed in clinical practice for 2-3 hours and a reflective interview was conducted at the end of their shift. The observer recorded in fieldnotes all activities that the participant undertook in their normal working role while caring for a patient that required assessment and management of MV. A 30-minute reflective interview with the bedside nurse was conducted once to examine the thinking process using prompts from the observational data. Questions used during the reflective interviews were designed to stimulate recall of specific instances, starting with the open question "*how did you find your patient's breathing today and how did you decide on weaning*". The 13 reflective interviews were recorded and transcribed verbatim. Interviews with Greek nurses were first translated to English by the researcher before analysis and reviewed by an independent reviewer fluent in both Greek and English for accuracy of translation.

Data analysis

Observational data were analysed thematically to inductively identify the decision activities and cues used in the various stages of the weaning process and develop a decision taxonomy. Reflective interviews were independently analysed by the researcher. Transcripts were reviewed and only those sections relating to weaning mechanical ventilation decisions were analysed. Each transcript was read, with weaning segments being highlighted. Cues were then identified and added progressively to a concept map (Novak & Gowin 1984) for each nurse participant. Each concept map summarised the thinking process and included the concepts attained and how they linked together. Findings from all novice nurses and all expert nurses were grouped together to facilitate comparison.

Rigour

Concurrent use of observational notes and reflective interviews allowed cross checking of the data credibility during analysis. This increased the rigour and trustworthiness of the data (Spradley 1980). All data were collected and primarily analysed by the same researcher (KK), who has critical care experience but was not a member of staff in either ICU to increase consistency. An independent experienced researcher familiar with the area of practice and the methodology used analysed sections of the reflective interviews independently and consensus was reached after discussion with KK.

Ethical considerations

The local Research and Development departments and the Local Research Ethics Committees of each hospital approved access to the settings. Nurses' participation was voluntary and informed consent was obtained prior to data collection. Patient consent was waived by the Ethics Committees because patients were not directly involved in the data collection and no identifiable patient information was used. Patients' privacy and confidentiality was respected, all data were anonymised and observation was discontinued if the nurse thought data collection would compromise patient care.

FINDINGS

Eight Scottish and five Greek nurses volunteered to participate. Eight nurses with more than 6 years of ICU experience and a critical care certificate qualification or relevant postgraduate degree were considered expert, and 5 were considered novice (table 1). One Greek nurse with 6 years of experience but no postgraduate qualification was considered in the novice cohort. Most participants were female; no Greek male nurses volunteered to participate.

(Insert table 1 about here)

Concept maps were created from 13 weaning episodes. Three concept maps (two Scottish, one Greek) referred to patients not able to wean from mechanical ventilation (pre-weaning phase); eight (five Scottish and three Greek) to patients able to sustain reduction of ventilatory support (weaning phase); and two (one Scottish, one Greek) to patients able to extubate (extubation phase).

Concepts and cues attained

Nurses in both samples attained a number of concepts that related to assessment, planning, management and evaluation decisions, as well as the decision to seek help (table 2). There were no differences in the type of concepts attained between Scottish and Greek nurses. (Insert table 2 about here)

Both Scottish and Greek nurses collected initial cues from assessment to make the nursing diagnosis that the patient was "*weanable"*. Then, they identified additional cues and combined them to confirm or reject the concept of a "*weanable*" patient. This was defined by seven main concepts; *gas exchange*, *work of breathing*, *level of consciousness*, *lung condition*, *knowledge of patient*, *cardiovascular stability* and *signs of infection*. Not all participants used each concept to define the "*weanable*" patient with some concepts being more discerning in the specific phases of weaning. The transition of the patient from a pre-weaning phase to a weaning phase was determined by the resolving *lung condition*. Decisions about adjusting the ventilatory support and extubation were determined predominantly by *gas exchange*, *work of breathing* and *lung condition*. Table 3 presents the cues with their mean values that defined each concept attained by the nurses. (Insert table 3 about here).

Decision-making strategies

The concept maps presented graphically how nurses combined the cues of all seven concepts to make the diagnosis of a "*weanable*" patient and then adjusted the ventilatory support at each phase of the weaning continuum. To attain these concepts, they validated the accuracy and appropriateness of the cues in three ways;

a) by comparing the value of the cue to a threshold value set by medical staff as illustrated by this Scottish nurse who reduced the oxygen delivered to the patient:

"*… well the doctors set the parameters of a PaO2 of about 9-10kPa [68-75mmHg], because the lady has a previous history of emphysema" (nurse A, patient 1)*.

b) by consistency between the values of cues of gas exchange and work of breathing; this Greek nurse compared PaCO2, tidal volume and respiratory rate before and after changing the ventilatory settings:

"I increased the support to 15cmH20 at 14:00 …, because the PaCO2 was 7.98kPa [60mmHg]. Tidal volume and respiratory rate didn't change. I did another gas at 14:00, and PaCO2 was 7.31kPa [55mmHg]. I didn't change the support as he was still taking 360ml volume and 30 breaths (nurse I, patient 11).

c) by consensus with the medical staff as illustrated by this Scottish nurse aiming to proceed with extubation:

“We all thought he was going to be extubated, and then the consultant came round and said there was no reason to wait…” (nurse D, patient 2).

Pre-weaning phase

In the three weaning episodes where no weaning was initiated, two Scottish and one experienced Greek nurse used a Conservative Focusing strategy in their decision-making. The commonality in their decision-making strategies was that all three nurses focused on cues of poor lung condition (increased oxygen requirements due to lung consolidation) of the patient, poor gas exchange (low PaO2) and previous knowledge that the patient became hypoxic in earlier attempts to reduce the oxygen and ventilatory support. Grouping these cues together they rejected the concept of the “*weanable*” patient, and did not change the ventilatory settings.

“*We had not changed his support at all, we’ve put him up to 32cmH20 over 12cmH20 yesterday, in view of his consolidation” (nurse C, patient 2).*

Another commonality in nurses’ thinking was clustering the cues of work of breathing with the level of consciousness to decide on reducing or increasing the sedation level. The one Scottish and the Greek nurse observed that agitation compromised the patients’ breathing pattern and decided to increase the sedation; the other Scottish nurse decided to reduce the sedation to allow the patient to take deeper, spontaneous breaths.

“…I increased her sedation a little bit, trying to get her to settle to see if that would improve her oxygenation” (nurse B, patient 1).

“…It was not long after the physiotherapy that the patient became breathless... and suddenly stopped ventilating” (nurse K, patient 12).

"…his tidal volumes weren't that great even though he is on quite a lot of support, and that was part of the sedation level. So, I turned the sedation down…and the tidal volumes did not change" (nurse C, patient 2).

Weaning phase

Once the patient had entered the weaning phase and had resumed spontaneous breathing, the decisions made related to adjusting the level of oxygen (fiO2), positive pressure support settings (PS, PEEP) and mode of ventilation (change to T-piece or CPAP). Eight weaning episodes, five in the Scottish and three in the Greek samples, related to the weaning phase. Six Scottish and Greek nurses used a Conservative Focusing strategy to attain the concept of a "*weanable*" patient and two Scottish nurses with less than 5 years' experience used a Focus Gambling strategy.

Nurses that used a Conservative Focusing strategy, irrespective of their experience, clustered together cues that defined the concepts of resolving or resolved lung condition, gas exchange and work of breathing. They, then, decided to change either the oxygen level or the level of ventilatory support gradually focusing on positive or negative values of the cues of gas exchange and work of breathing (mainly respiratory rate and tidal volume) to decide on further reductions of ventilatory support.

"…he was making good tidal volumes, good saturations, he was oxygenating well, so he was probably not needing so much support, so I reduced again the PS to 21 over 5" (nurse F, patient 6).

"I will probably do another one [blood gas] in the next little while, and see can I make further changes, I certainly like to if I could" (nurse G, patient 10).

"…and if PO2 was higher than 9kPa [68mmHg] or 10kPa [75mmHg]…that was the plan to reduce the oxygen to about 40% and then start to reduce the PEEP, because the patient is obviously on a high PEEP of 10" (nurse A, patient 1) .

The nurses who used a Focus Gambling strategy focused on positive cues of gas exchange and work of breathing to reduce simultaneously both the oxygen and ventilatory support and awaited for the patient's response. If further observation revealed positive cues of gas exchange and work of breathing, they would continue reducing the oxygen and the ventilatory support.

"*So, I did pop him down to 45% and reduce his pressure support from 20 over 8 to 18 over 8 at about 10:30 am…so I was just aiming to wean him down as much as possible to see if he will tolerate, although, earlier this morning we didn't know the reason for his poor respiratory function*" *(nurse E, patient 3)*.

In both ICUs no specific guidance was provided for adjusting the level of ventilatory support, apart from threshold levels for gas exchange and work of breathing cues prescribed by the medical staff. Nurses used these thresholds to compare the value of the observed cues and proceed to reduction of ventilatory support. Changes of the level of ventilatory support were observed to be made in an impromptu manner and were between 2-5cmH20 for positive pressure support and 5% for oxygen level with every decision made by the nurse.

Extubation

The two experienced Scottish and Greek nurses used a Focus Gambling strategy to make the diagnosis that the patient was able to extubate. They clustered together the cues of stable work of breathing, improved gas exchange, improved lung condition, level of consciousness (be awake) and previous knowledge of patient (previous successful T-piece or CPAP trial). However, both nurses searched for consensus by the medical staff prior to proceeding to extubation.

"…he had been on CPAP since yesterday, and his respiratory rate was stable, so I presumed that he was for extubation…" (nurse D, patient 2).

“I stopped his sedation at 11 and put him on T-piece for 15 minutes to have a trial off the ventilator, and his respiratory rate was 22, SpO2 of 98% and a very strong cough, so I decided to extubate him” (nurse M, patient 16).

DISCUSSION

All nurses in the sample attained 7 main concepts descriptive of the "*weanable*" patient. They collected objective physiological cues of gas exchange, work of breathing, resolving lung condition and level of consciousness and subjective criteria of patients' tolerance and response to previous reduction of ventilatory support to inform their decisions. Yet, nurses grouped together these criteria to provide a patient-centred assessment of the patient and make the diagnosis of a "weanable" patient. The objective physiological criteria that nurses referred to in their thinking are part of the international guidelines for weaning mechanical ventilation (MacIntyre 2013), which suggests that they are the basis of local practice and are embodied in critical care nurses' thinking processes. Given the lack of existence of specific plans for weaning, nurses used a trial and error approach to change ventilatory support, which was depicted in both Focus Gambling and Conservative Focusing decision-making strategies used. In every change they made they looked for both objective physiological and subjective criteria to decide on how much more to proceed with ventilatory support reduction. Blackwood *et al.* (2010) suggest that strategies to optimise weaning should be holistic and individualised to the needs of the patient. Nurses in this study addressed patients' weaning individually using only the prescribed thresholds for gas exchange and work of breathing as a guide. There is lack of consensus on how patients mechanically ventilated more than 48 hours should be weaned off ventilatory support. Prolonged weaning is very much about trial and error (Crocker 2009), and there is no algorithm, guideline or set of rules that fits all patients' individual needs (Crocker & Scholes 2009, Kydonaki *et al* 2013); therefore, optimum decision-making relies on nurses' advanced skills of clinical reasoning.

In this study, all nurses used focusing decision-making strategies. Less experienced nurses, though, required more encounters of cues to attain the concepts with certainty. This is in contrast with Hoffman *et al*.'s (2009) study in haemodynamic decision-making, in which novice nurses collected less and of narrow range attributes compared to experts. A common characteristic was nurses' ability, irrespective of experience, to discriminate and classify defining cues obtained from initial assessment in order to reduce the complexity of the decision task. Concepts and their defining cues were not linked together in a linear manner but rather decision-making revolved around these seven concepts. This is in agreement with Andersson *et al*. (2012) comparison of novice and experienced paediatric critical care nurses and in contrast to recent studies that demonstrated that only expert nurses have this advanced ability compared to novice nurses that seem to concentrate on the presenting symptoms only (Hoffman *et al*. 2009). Andersson *et al*. (2012) also differentiated between nurses with specialised training and long experience who used a hypothesis-oriented approach in their clinical reasoning and concluded that they tried to grasp the wholeness of the presented case, only when they seemed to 'know'. Similarly, in Cederwall *et al.* (2014) study all Swedish expert nurses used a holistic patient-centred approach to assess and plan the weaning process.

In this study, both Scottish and Greek nurses irrespective of their experience demonstrated elements of intuitive 'knowing' in their thinking process. Intuitive judgement was observed in subtle decisions to change ventilatory settings that hindered a level of uncertainty. They made inferences based on similar patterns of gas exchange or work of breathing when appropriate triggering cues were observed. They used both scientific knowledge and aesthetic knowing to make a judgement about the patient's tolerance of subtle ventilatory changes in all phases of weaning. Knowing how to reduce the patient's discomfort and endotracheal tube intolerance when the patient is awake but not ready for extubation required an advanced level of sensory-motor knowledge, as described by Mahner & Bunge (1997). Similarly, knowing what the various auditory cues sound like in chest auscultation and how this may affect the patient's work of breathing demonstrated an advanced perceptual knowledge.

One could argue that the level of academic expertise of nurses could provide an explanation of their skill of 'chunking' information, since the majority of nurses were educated at a Bachelor's level and more than half had a critical care certificate. Researchers that have assessed individual differences in nurses' performance and patient outcome, reported that the educational level was the most important determinant of patient outcome and that average length of experience was unrelated (Thompson & Stapley 2011). In this study, we did not measure patient outcome, so no inference could be made in relation to patient outcome. The suggestion made is that expertise is not merely a matter of the amount and complexity of the accumulated knowledge or the ability to recognise patterns; it also reflects acquired cognitive mechanisms that allow the nurse to keep refining and modifying representation even after extensive experience in the domain (Thompson *et al*. 2013). Such mechanisms may be taught with interactive training focusing on irrelevance and accuracy (Anders-Ericsson *et al*. 2007).

Whether the nursing programmes in both countries support the development of advanced cognitive mechanisms in clinical reasoning is debatable. In Greece, the majority of graduate nurses today are graduates of 3-year nursing programmes offered at the Institutes of Technological Education (TEI), characterised by technically and not theory-oriented curricula, minimal training in autonomous patient evaluation, and clinical decision-making (Papathanassoglou *et al*. 2005). The TEI degrees have recently been upgraded to Bachelor's level. The Bachelor's degree, offered by only two universities in Greece, is a novelty to nursing education and focuses on autonomous patient evaluation, nursing diagnosis and nursing process skills, as well as on clinical decision-making (UoA-SoN 2003). In contrast, the 4-year nursing programmes offered in most Scottish institutions emphasise on holistic care, individual professional accountability and clinical decision-making (Bakalis *et al*. 2003). The fact that Greek nurses demonstrated advanced clinical reasoning could be attributed to the continuous development programme on mechanical ventilation and weaning that was organised and delivered regularly by the medical team in that ICU.

Limitations

Reflection on concurrent real-life decision-making sessions might have a negative effect on task performance in the case of high-complexity tasks (van den Haak *et al*. 2003). We acknowledge this limitation of the study and a possibility that not all decisions were uncovered in relation to patients' weaning process. Nevertheless, the use of participant observation and reflective interviews aimed to optimise the collection of rich and in-depth data on nurses' thinking process and offered strength in the quality and rigour of data. The study involved a small number of participants, for which the distinction between expert and novice nurses was based on arbitrary criteria and decision-making was examined in one type of nursing care; thus, generalisation is considered inappropriate. In ethnographic research observation bias is unavoidable; thus, the researcher used a reflective diary to capture and distinguish her personal prejudices in decision-making from the participants.

Recommendations

Recommendations deriving from this study relate mainly to future research and education. The principles of the information processing and concept attainment may be used in combination with critical appraisal of incidents and reflective practice to develop bespoke educational programmes for advancing critical care nurses' decision-making skills. The concepts of mechanical ventilation and weaning can be taught and built in interactive training programmes focusing on identifying irrelevant and accurate cues and how these can be optimally grouped together to inform judgement. Learning of decision-making strategies and how they link to patient outcome would increase nurses' skills of clinical reasoning. It is suggested that such educational programmes may be offered at post-registration level and as part of critical care nurses' foundation period. Additional research linking decision-making strategies to patient outcomes and on designing and assessing interventions likely to improve judgement and decision processes is also required.

CONCLUSION

The current study demonstrated that critical care nurses in both ICUs used advanced cognitive skills to collect and group patient-centred information to make the diagnosis of a “weanable” patient using focusing decision-making strategies, with the main difference that novice nurses required more encounters of cues to attain the concepts with certainty. Such knowledge may inform decision-making strategies that will optimise patient outcome.

RELEVANCE TO CLINICAL PRACTICE

This study foreshadows the need to focus on strengthening nurses' clinical reasoning and decision-making skills. Advanced clinical reasoning skills will strengthen nurses' autonomous decision-making and will improve their performance in weaning mechanical ventilation practice. Further link of decision-making strategies to patient outcomes will inform optimum care of the weaning patients.

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Tables

Table 1. Nurses participating in reflective interviews in both samples

Demographic characteristics of nurses participating in reflective interviews		Scotland N=8	Greece N=5
Age (years)	21-30	2	2
	31-40	3	3
	41-50	3	0
Gender	M	3	0
	F	5	5
Nursing experience in ICU (years)	<5	3	1
	6-15	5	4
Qualifications	Nursing Diploma (3-years)	4	0
	BSc Nursing (4-years)	4	5
	MSc Nursing	0	1
	Critical care certificate	5	2

Table 2. Taxonomy of decisions made at each phase of weaning process and main concepts attained for both Scottish and Greek nurses

Decision taxonomy	Non-weaning phase	Weaning phase	Extubation or T-piece
Assessment	1. Gas exchange, 2. Work of breathing, 3. Lung condition, 4. Cardiovascular stability,	1. Gas exchange, 2. Work of breathing, 3. Resolving lung condition, 4. Cardiovascular	1. Gas exchange, 2. Work of breathing, 3. Resolved lung

	5. Level of consciousness	stability, 5. Level of consciousness, 6. Knowledge of patient, 7. Resolving infection	condition, 4.Cardiovascular stability, 5. Level of consciousness, 6. Knowledge of patient 7. Resolved infection
Planning	To check gas exchange, To reduce fiO2, To normalise CO2, To restart sedation if agitated, To drain fluid from chest, To think of tracheostomy formation	To consider extubation, To mobilise patient, No further ventilatory reduction, To reduce fiO2, PS, PEEP gradually, To increase ventilatory support, To do physiotherapy, To adjust sedation for patient comfort, To remove chest drain, To do CT scan	To give nebulisers, To mobilise patient, To stop sedation, To extubate
Management	No change of ventilatory support, To stop	To reduce ventilatory support by 5%,	To extubate, To stop sedation,

	physiotherapy, To increase ventilatory support, To use humidification, To reduce fiO2 by 5%, To stop sedation, To increase sedation, To encourage deep breaths, To hyperventilate (hand-bagging)	To change mode of ventilation No change of ventilatory support, Do not extubate, To mobilise patient, To give a bolus of sedation to manage anxiety, To reduce/ stop sedation, To suction	To reduce fiO2, To reduce support to minimum, To change to T-piece, To give nebulisers
Evaluation	By consistency of attributes of gas exchange and work of breathing By recourse to ultimate criterion (threshold value of attributes of gas exchange or work of breathing)	By consensus by the doctor By consistency of attributes of gas exchange and work of breathing	By consistency of attributes of gas exchange and work of breathing By consensus by doctor
Seeking help	When patient stopped breathing	To review blood gases To review and confirm ventilatory changes made by nurse	To confirm extubation

		To extubate or keep on CPAP To confirm level of positive pressure support reduction To change mode of ventilation	

Table 3. Concepts and their cues with their mean values attained by Scottish and Greek nurses.

Concepts	Pre-weaning phase cues	Weaning phase cues	Transition to T-piece trial or extubation cues
Gas exchange	fiO2 < 0.6 PaO2 > 10kPa/ [75mmHg] PaCO2 < 6kPa/ [45mmHg] SpO2 >94%	fiO2 < 0.6 PaO2 > 8kPa/ [60mmHg] PaCO2 < 6kPa/ [45mmHg] (in some cases PaCO2 < 9kPa/ [68mmHg]) SpO2 > 94% (in cases of COPD SpO2 > 88% was acceptable)	fiO2 level reduced significantly the last 24 hours fiO2 < 0.5 Acceptable PaO2 and PaCO2 for the patient depending on lung condition SpO2 > 94% PEEP < 10cmH20

		PEEP < 15cmH20	
Work of breathing	Able to take spontaneous breaths	Breathing pattern and use of accessory muscles f < 35 (in some cases f < 40) Vt > 350ml RSBI and PaO2/FiO2 rarely used	Breathing pattern and use of accessory muscles f < 35 Vt > 400ml Cough reflex present, Strength of cough
Level of consciousness	Patient gains partial consciousness when sedation reduced or stopped	Minimal amount of sedation GCS = 7-10/10 Anxiety/Agitation Pain Comfort and adequate sleep Neuropathy	Sedation stopped GCS = 9-10/10 Alert and cooperative Anxiety / Agitation Pain Comfort and adequate sleep ET tube tolerance
Lung condition	Underlying condition resolving Severe pneumonia, ARDS, fibrosis, COPD, emphysema Chest X-ray results	Underlying condition resolved or resolving Pulmonary oedema Severe pneumonia, ARDS, fibrosis, COPD, emphysema	Underlying condition resolved Quality of secretions Cough reflex present

		Quality of secretions Cough reflex present Chest X-ray results	
Knowledge of patient	Severe lung condition resolving or not No spontaneous breaths Patient old and frail Episodes of desaturation	Patient stable when ventilatory support reduced Oxygen requirements have reduced Problems with secretions clearance	Oxygen requirements reduced significantly Patient stable on minimal ventilatory support (CPAP 5cmH20 or T-piece)
Cardiovascular stability	Cardiovascular stability with a small amount of inotrope support or without inotrope support	Cardiovascular stability with a small amount of inotrope support or without inotrope support Lack of arrhythmias Fluid overload	Cardiovascular stability, no inotrope support Lack of arrhythmias
Infection	Pyrexia Level of WBC Amount and quality of secretions	Pyrexia Level of WBC Amount and quality of secretions	Pyrexia Level of WBC Amount and quality of secretions