

**Title; A comparison of novice and expert nurses' cue collection during clinical decision-making: verbal protocol analysis.**

Dr. Kerry A. Hoffman, RN, PhD  
Lecturer  
University of Newcastle  
Kerry.Hofman@newcastle.edu.au

**Professor Leanne M Aitken, RN, PhD**  
Chair in Critical Care Nursing  
Research Centre for Clinical and Community Practice Innovation,  
Griffith University & Princess Alexandra Hospital  
l.aitken@griffith.edu.au

**Professor Christine Duffield RN, PhD (UNSW)**  
Director, Centre for Health Services Management,  
University of Technology, Sydney  
Christine.duffield@uts.edu.au

***Title; A comparison of novice and expert nurses' cue collection during clinical decision-making: verbal protocol analysis.***

## **Abstract**

***Background.*** The type of cues used during clinical decision-making contexts is not well understood. Further, there are conflicting findings in relation to how novice and expert nurses use cues.

***Objective.*** The aim of this study was to determine if there were differences between novice and expert nurses in the range and type of cues selected as well as how cues were clustered together when making clinical decisions while caring for post-operative patients in an Intensive Care Unit.

***Method.*** The sample consisted of four novice and four expert nurses caring for patients post Abdominal Aortic Aneurysm surgery in an Intensive Care Unit. Data were collected using a Think Aloud process while participants cared for patients, followed by retrospective interviewing, to generate verbal protocols. The verbal protocols were analysed using content analysis to examine various aspects of decision-making, including number and type of cues used and cue clustering. The decision tasks attended in the real world of practice were described in detail to illuminate the use of cues in context.

***Results.*** Expert nurses collected a wider range of cues than novice nurses, almost twice as many different cues. The expert nurses also clustered more cues together to identify patient status when making decisions. Expert nurses were more proactive in collecting relevant cues and anticipating problems that may help identify patient problems.

***Conclusions.*** In the real world of practice expert nurses collect a broader range of cues to assess patient status than novice nurses. This differs to expert nurses cue collection in simulations where expert nurses may select only those cues that are necessary for the identified problem. This difference, if identified in other studies, may have important implications for nursing research and education.

***What is already known;***

- There is contradictory information regarding the number of cues that are collected and used by novice and expert nurses
- The way nurses use cues during decision making may vary with experienced nurses being more accurate and selecting the most relevant cues in simulations, and novice nurses over selecting cues and being less accurate.

***What this article adds;***

- In clinical practice expert nurses use a wide range of cues
- Expert nurses collect cues that may help to identify impending patient problems, hence preventing problems and “rescuing patients”, this appears to be in contrast to the small number of relevant cues that are collected in simulated settings
- Expert nurses use more complex cue clusters than novice nurses.

**Key words**

**Cue usage, decision-making, expert, novice, verbal protocol analysis**

**Introduction:**

Care of critically ill patients often involves complicated decisions undertaken rapidly in complex environments and requires nurses who are well equipped with decision-making skills to deliver safe, effective care and prevent patient complications (Currey and Botti, 2003). The prevention of patient complications has been termed “rescuing” patients and depends on the nurses ability to detect complications early and to intervene appropriately (Aiken, Clarke, Cheung, Sloane, and Silber, 2003). The accurate detection by nurses of cues and cue clusters indicating possible patient deterioration is an important aspect of clinical decision-making. However, there appears to be an incomplete understanding of how nurses perceive and process cues while making decisions with some conflicting findings in the literature.

**Background**

The information processing theory describes cognitive processing during decision-making and posits that cues or patient information are received as input data from both motor and sensory sources and processed in the short term memory (STM) with pre-existing knowledge stored in the long term memory (LTM) to lead to an outcome such as a decision (Newell and Simon, 1972; Anderson, 2004). The STM has a small working capacity, is very fast and has a limited capacity to handle incoming information (Newell and Simon, 1972; Ericsson and Simon, 1984; Thompson, 1999). Data are collected serially in the STM to represent a problem and are combined into four to seven chunks to overcome the small working capacity (Elstein and Bordage; 1991). The chunks are replaced in the attention as new incoming stimuli are perceived (Newell and Simon, 1972). In contrast, the LTM has a very large capacity to handle information and a relatively permanent storage ability, but is slower than the STM. Knowledge stored in the LTM can be unlocked by stimuli such as patient cues coming into the STM and is used to aid the STM processing (Thompson, 1999). The perception of incoming information, including the collection and clustering of cues, is an important step in the processing of information during clinical decision-making. The collection of cues can be influenced by a number of factors and this is important to consider when examining cue collection and usage. Differences in the way expert and novice nurses collect and use cues have been

examined with some differences being reported.

The accuracy of judgement during decision-making has been examined by comparing decisions made by nurses to patient outcomes or to expert consensus (Dowding and Thompson, 2003). Expert nurses have previously been found to be both more accurate in making nursing diagnoses and better able to rapidly select the most relevant cues in studies employing nursing simulations and narratives (Thiele, Holloway, Murphy, Pendarvis and Stucky; 1991, Lamond and Farrell, 1998; Reischman and Yarandi; 2002). The rapid focusing on the most relevant cues is possibly due to the expert's domain specific knowledge (Lamond and Farrell, 1998). This ability may be reflective of what Tanner (2006) describes as "noticing" whereby nurses' anticipation or expectation of a situation is dependant on either their knowledge of particular patients or their theoretical knowledge. In contrast novice nurses in studies employing simulated studies were found to be less accurate in deciding on nursing diagnoses as they over selected cues and could not discriminate between cues (Reischman and Yarandi, 2002).

Diagnostic accuracy has been examined by comparing nurses' diagnosis after cue collection to patient diagnosis established. Methods employed include comparing the nurses' diagnoses to laboratory results or expert consensus with some inconsistencies in diagnosing being apparent. The inconsistencies are due to variable use of information and over or under estimation of the importance of some cues (Dowding and Thompson, 2003). The accuracy of a judgement also depends on how cues are used. Considerable variation in the usage of cues by heart failure nurses was found by Thompson et al (2007) in a study employing judgement analysis. Decisions were made by heart failure nurses on two different patient situations, one easy and one hard, in both decision situations a single cue accounted for 30% of the decision, with the nurses attaching varying levels of importance to the information presented, demonstrating only moderate "correspondence" between the nurses' judgements. Thompson et al (2008) also investigated the use of cues resulting in decision outcomes in critical event situations and found that under time pressure nurses were less accurate in identifying the need for intervention in simulated patients at risk.

Benner (2001) found that expert nurses used fewer cues than novice nurses, while Elstein et al (1978) reported that expert medical practitioners use a greater number of cues than novice medical practitioners. Novice nurses were described as noting minimal cues and using single cues to trigger a hypothesis, while ignoring cues which do not fit their generated hypotheses (Tanner, Padrick, Westfall and Putzier, 1987; Taylor, 1997). In contrast the study conducted by Greenwood and King (1995) found that novice nurses collected a greater number of cues than expert nurses, and proposed this was due to an inability to discriminate between salient and non-salient cues.

As well as a difference in the number of cues that expert and novice nurses are aware of and collect during decision-making there appears to be differences in the range of cues collected. Expert nurses were seen to collect information on a wide range of aspects in addition to the patients' presenting symptoms and illness when collecting cues for a particular problem, while novice nurses tended to concentrate on the presenting symptoms only (White, Nativio, Kobert and Engberg, 1992). In contrast, a study by Hanneman (1996) and a study by Nojima, Tomikawa, Makabe and Synder (2003) found that expert nurses' assessment was found to be more focused than that of novice nurses, concentrating on a smaller range of cues.

The way nurses cluster cues during decision-making may also vary. Gastro-intestinal surgical nurses and critical care nurses were seen to cluster cues differently while making decisions on simulated patients, with critical care nurses listing and clustering cues more accurately during hypothesis generation about patients' fluid status (Redden and Wotton, 2001).

The nature and way nurses notice cues can affect their decision-making (McCarthy, 2003) and a number of factors have been identified as affecting the noticing of cues, including personal beliefs and assumptions (McCarthy, 2003), the nature of the decision task (Newell and Simon, 1972) and experience (Benner, 2001). Prowse and Lyne (2000) and Hardy, Garbett, Titchen and Manley (2002), described expert nurses as possessing

effective observational skills which allow them to detect early changes in clinical parameters, and prevent patient complications. Inexperienced nurses on the other hand spend more time evaluating patients and defer treatment or communicating a problem until they are sure a trend is occurring (Bucknall, 2000). The effective observational skills of the expert nurses were probably gained from experience. These results suggest that there may be differences in the way novice and expert nurses approach decision-making in nursing, with expert nurses taking a proactive approach and collecting information and anticipating problems.

Studies examining cue collection and usage have found differences during decision-making by novice and expert nurses, including the accuracy and selectivity of cue usage, the number of cues selected, the range of cues collected, and less often the way in which cues are clustered. Very few studies have investigated the types of cues used by expert nurses as compared to novice nurses. Studies in decision-making examining the quality of the decisions have most often employed scenarios and compared decisions made for accuracy to a criterion decision, however the process of decision-making has not been extensively explored in relation to quality decision-making (Dowding and Thompson, 2003).

Understanding how nurses collect and use cues during decision-making can enable educators to better develop skills such as decision-making and clinical reasoning and may help to improve new graduate nurses' performance on this important aspect of nursing practice. Consequently, this study was designed to answer the following questions:

- Are there differences in cue usage for novice and expert nurses when making decisions about the management of a patient's haemodynamic status post Abdominal Aortic Aneurysm (AAA) surgery?
- What cues are clustered together by novice and expert nurses while making decisions about the management of a patient's haemodynamic status post AAA surgery?
- Are there differences in the approach to decision tasks by expert and novice nurses while managing a patient's haemodynamic status post AAA surgery?

The study represents one part of a larger study that examined decision-making processes used by novice and expert nurses in the real world of practice while caring for patients post AAA in the intensive care setting. The study was designed to examine real world decision-making processes and cues collected. There was no attempt made to measure the overall quality of the decisions made.

## **Method**

The study was an empirical, descriptive study that compared cue usage and clustering during the decision-making of novice and expert nurses while caring for patients post AAA repair. The study examined in depth the decision-making of a small group of participants to elicit rich data from individual nurses. The study employed methods from the information processing theory, both think aloud (TA) and verbal protocol analysis to trace decision-making. The decision-making examined in the study centered on haemodynamic status and included reasoning around interlinked concepts that have a direct or indirect impact on haemodynamic status. This involved a range of concepts which could possibly impacting on cardiovascular and haemodynamic status including monitoring vital signs, respiratory function and peripheral perfusion, oxygen saturation, arterial blood gases, pain, fever and medications which can effect heart rate and monitoring for fluid status (Currey and Aiken, 2005). Cue usage and clustering was contextualised by examining in detail the decision tasks attended to by both the novice and expert nurses. A detailed description of each decision task was developed and each task described as proactive or reactive 1. Proactive tasks were those where participants were thinking ahead to a possible problem and collecting cues beforehand that could help identify such problems, whereas reactive tasks were those where a participant reasoned backwards to determine why a problem had occurred and collecting cues after the problem had occurred.

## **Setting and Participants**

The study was conducted in an Intensive Care Unit (ICU) of a regional Australian hospital. The participants consisted of eight ICU nurses who were recruited in two categories, novice and expert, with four nurses in each category. Sampling was

purposive, as the nurses were selected according to a criterion modeled on that developed by Benner (2001), to identify expert and novice nurses (see Table 2 for selection criteria). Benner's (2001) definition of an expert includes experience in an area, as well as recognition by others for expert performance and identification of self as an expert nurse (Benner, 2001).

### **Data collection**

Think aloud (TA) was used to collect data as verbal protocols. The verbal protocols collected in the study were both concurrent and retrospective as suggested by Ericsson and Simon (1993). Concurrent TA sessions access short term memory (STM) whereas retrospective interviews access long term memory (LTM) (Ericsson and Simon, 1993; Johnson, 1993). The concurrent verbal reports were collected by having nurses think aloud as they carried out care and were audio-taped and later transcribed. The retrospective verbal protocols were collected in a 45 – 60 minute interview after the tape of the concurrent session had been transcribed and examined by the researcher. The follow-up interview provided an opportunity to explore decision-making and rationales for decisions further (Aitken, Marshall, Elliot, McKinley, 2007)

To maximise the likelihood of similar decision-making tasks, the decision-making of nurses while planning and managing care of patients within the first 24 hours post AAA surgery was investigated. The TA sessions also all occurred during the first two hours of each participant's shift to further increase similarity of decision-making tasks.

Prior to data collection, participants practised TA with a simple exercise that was tested in the pilot study. The exercise has been used by other researchers such as Aitken (2000), and consisted of asking participants to TA while working out how many windows there are in her/his house.

### **Ethical considerations**

Ethical approval was obtained from the Area Health Service and the University. Written informed consent to participate was formally given before research began and all

participants were able to withdraw from the research at any time without giving a reason. Access to the information collected was restricted to the researcher and study supervisors only. Data were stored in a locked file.

For the proposed study the following guidelines were used to limit the exposure of patients to potentially detrimental information in TA:

- Data collection was terminated if patients or families so requested.
- The nurses were instructed not to verbalise any information they considered could be detrimental to patients and family during TA sessions and asked to discuss such information in the retrospective interview session.
- Coding was used to de-identify participants and patients.

### **Data analysis**

The data collected by TA were analysed using protocol analysis based on the principles explicated by Newell and Simon (1972), and content analysis. Cues used by each participant were identified, tabulated and enumerated to compare cue collection by novice and expert participants. Cues were also examined for how they were clustered by both groups. The decision tasks of the participants were identified and then classified as either proactive or reactive and the frequency of each type of decision task compared for the novice and expert groups.

### **Reliability and validity**

Data were collected using both concurrent and retrospective verbal protocols to increase reliability and validity. The use of different data collection techniques in this way allows cross-checking during data analysis (Newell and Simon, 1966; Coderre et al, 2003).

All data were collected by the one researcher and primary analysis was also conducted by the same researcher to increase reliability and consistency (Aitken and Mardegan, 2000; Taylor and Dionne, 2000). Data transcription was attended by the researcher who is familiar with both the tasks and language used in the study setting to increase the reliability and consistency of data collection and analysis (Fonteyn et al, 1993; Aitken

and Mardegan, 2000). Inter-rater reliability of cue collection was ascertained by having another researcher familiar with the area of speciality and the research methodology analyse sections of the verbal protocols and calculating Kappa. A Kappa of 0.774, 95% confidence interval of 0.5215–0.887 was obtained for the coding of data including cues.

Questions used during the retrospective interviews were designed to stimulate recall of specific instances. For example, participants were asked “Tell me what cues you were noticing when ...”.

## **Results**

### **Characteristics of the sample**

The sample consisted of four novice and four expert nurses, two were male and six were female. The participants ranged in age from 20-50 years, the four expert nurses were over 30 and the novice nurses were aged between 20 and 35. Expert nurse participants had between 10 and 25 years experience in the ICU, while the novice participants had between eight months and one year. All four novice nurses had a degree as their entry to nursing, with one novice having another tertiary qualification. Three expert nurses held a degree, with one having only a hospital based certificate.

### **Cue collection**

During the two hour period of care expert participants collected 89 different cues, while novice participants collected 49 different cues, indicating that expert participants collected a wider range of cues than did novice participants. Novice and expert participants collected almost the same number and type of cues to assess haemodynamic status (Table 3); however use of rhythm strips was unique to the expert participants.

In contrast, the cues used to assess for respiration and ventilation differed between the two groups of participants, with expert participants using the additional cues of chest movement, air entry, muscle strength, tidal volume and history of smoking (Table 3). The only difference in the use of cues for assessing limb status was that expert participants ascertained whether patients had peripheral vascular disease (PVD) in their history (Table

3).

Expert participants used a greater number and broader range of cues to assess patients for pain than novice participants, including restlessness, gesturing and grimacing, distress, withdrawing when touched, sleeping or not sleeping, tensing muscles, holding the stomach and pointing to where the pain was occurring (Table 3). A similar pattern was observed in relation to expert participants' broad assessment of fluid balance including output of drains, dry mouth, urine colour, urine specific gravity, patients' age, central venous pressure (CVP) and blood pressure (BP) (Table 3). Expert participants also used more cues to assess a patient's mental state, including following commands, eye opening and response to vocal stimuli (Table 3), and to assess haemodynamic status using additional cues such as the weight of patient, exercise patterns and patient appearance (Table 3).

### **Cue clustering**

Examination of how participants related cues together when assessing and deciding on concepts such as circulation and fluid depletion showed that expert participants related more cues together than novice participants. While each participant worked through different processes and detail, some common principles were observed. In general novice decision-making incorporated few cues and progressed in a linear manner, for example:

- novice participant noted a patient's low BP
- then assessed the patient's CVP
- then assessed fluid lost intra-operatively
- no further actions were taken.

Importantly, in this specific instance no other cues were considered to determine the possible diagnosis of fluid depletion, although other novice nurses did consider the effect of epidural rate on BP and the effect of a high BP on the graft.

In contrast, an expert nurse clustered a greater number of cues to assess and manage the patient's haemodynamic status. For example:

- expert participant noted a patient's low BP

- reviewed the theatre chart to determine amount of fluid lost during theatre
- rechecked the BP by doing a manual measurement as she stated that the arterial line can sometimes be inaccurate
- reviewed the administration of epidural pain relief as the participant stated that epidural infusions can affect BP
- consulted the patient's previous health record to determine patient history and see if an explanation for the patient's slow heart rate (e.g. prior treatment with beta blockers) could be determined
- the patient's general appearance and fitness level were also considered
- further assessment of the patient's pain was undertaken, as the participant considered that epidural infusions can affect BP and if the patient's pain management was under control the epidural administration rate could be reduced
- the patient's temperature was assessed, with the participant stating that temperature could also affect BP and as his BP was now low it could drop even further as he "warmed up"
- urine output and CVP were both assessed, and as they were both low the participant considered the patient was probably fluid depleted
- a fluid bolus was then administered (after obtaining an order from the medical officer) and assessment that this led to a rise in BP was noted.

Cues that other participants incorporated into the assessment and management of the patient's haemodynamic assessment included the effect of lidocaine boluses into the epidural on BP, as well as the affect of anxiety and stress on patient's BP and the possibility that a low BP could indicate post operative bleeding or that high BP could affect the graft.

The four novice nurses considered low BP in relation to one to four cues in total to determine possible fluid depletion whereas the four expert nurses considered low BP in relation to eleven to fifteen cues in total. These differences were repeated in relation to other areas of patient care such as fluid status, pain management and respiratory care. In general the cue clusters used by expert participants were more complex than those used by novice participants.

## **Decision tasks**

Examination of decision tasks helped to contextualise cue usage in the study. The decision tasks involved such aspects of care as:

- assessing fluid status, cardiac output, respiratory status and pain level
- implementing interventions ordered to correct fluid imbalances
- titrating medications to maintain BP and pain relief within predetermined parameters
- implementing deep breathing and coughing exercises
- supplying oxygen or changing ventilator settings.

The type of approach to tasks was classified into two main categories, either proactive or reactive. Proactive tasks involved planning ahead and anticipating what would happen and collecting cues in anticipation of problems. For example, an expert participant turned the intravenous glycerol trinitrate (IV GTN), down even though there was no change in the patient's BP, as the participant believed that "as patients warm up their BP falls" and the patient was starting to "warm up". The patient's BP did begin to fall and the expert nurse then considered other cues such as urine output and CVP, stating the patient was probably fluid depleted and after consultation with the medical officer administered a fluid bolus. On further assessment the patient's BP had risen. Reactive tasks involved responding to a problem once it had occurred and collecting cues to in response to the problem. For example, a novice participant was alerted to a high BP by an alarm while carrying out an ECG then assessed the patient to determine why this was occurring. Expert participants had a higher frequency of proactive tasks (81%) compared to novice participants (55%) (Table 4).

## **Discussion**

This study examined the decision making processes of both novice and expert participants while they were caring for post-operative patients. Specifically, the number of cues collected, the way in which these cues were clustered together and the nature of these cues was examined.

The first step in the processing of information is the recognition of cues from a situation. Cues are perceived in the STM and processed with knowledge from the LTM to produce an outcome such as a decision. In this study participants used a very wide range of cues when monitoring patients post AAA repair. Expert participants in this study used a greater variety of cues, 89 different cues in total compared to 49 different cues for novice participants. This finding is consistent with other work where novice nurses were observed to be collecting few cues compared to expert nurses who accessed an extensive range of cues, including such things as facial expressions, age, weight-bearing capacity, seriousness of illness and degree of dependence (Taylor, 1997). The expert nurses in this study incorporated these cues with test results and other information to obtain a total picture of the patient. They also were noted to judge single anomalies in vital signs, such as a low blood pressure, in relation to the whole picture of the patient that they had established. In the current study expert participants often employed many cues to explain such things as low or high BP, whereas novice participants did not.

Importantly, both the current study and Taylor's (1997) study were conducted in the real world of practice. In contrast to some studies that employed simulation and determined that expert nurses select only the most relevant cues this study found that expert nurses are collecting a very wide range of cues. It appears that, in the real world of practice where the patient situation may change quickly, expert nurses are collecting many cues that enable them to assess for potential problems. It is possible that in simulated studies experts perceive that they quickly recognise the most likely problems and limit their selection of cues to confirm or disconfirm this. In contrast, novices may over select cues in simulations as they attempt to collect as much information as possible to increase accuracy while lacking the ability to discriminate between important and non-important information. In simulated studies where all cues were given, novice nurses who over selected cues were less accurate in decision-making indicating that they were probably selecting more cues to improve accuracy and were unable to determine between relevant and irrelevant cues (Thiele et al, 1991). Conversely expert nurses in simulated studies could often focus on relevant information to make an accurate decision (Reischman and

Yarandi, 2002).

Cue collection and subsequent clinical judgements should not only be more accurate in themselves but they should also lead to accurate clinical interventions (Thompson et al, 2007, and Thompson et al, 2008). Employing judgement analysis Thompson et al (2007) found that nurses assessments of risk was largely inaccurate despite receiving the same information and that the inaccurate judgement policy that a nurse held was remarkably consistent across patients. Thompson et al (2008) also found that nurses are less accurate in deciding to intervene when under time pressure, in simulated scenarios of critical events. In Thompson et al's studies (2007; 2008) the nurses had a limited number of essential, predictive cues to chose from, and the cues were based in previous datasets. The current study was carried out in the real world of practice and consisted of "global" judgement tasks with no objective criterion with which to measure the quality of the judgements (Thompson at al, 2007). The decision tasks also covered a wide range of interrelated concepts that impact on cardiovascular status. However in common with Aitken et al (2008) who reported that critical care nurses identify many concepts and attributes when assessing sedation levels of critical care patients in the real world of practice, the nurses in this study probably also had common guiding principles guiding their assessments, but they also recognised and considered many individual patient differences which resulted in them collecting a wide range of information. The accuracy of the judgements made or correctness of interventions instigated was not studied here but represents an important aspect of quality decision making that requires further investigation in the real world of practice.

Detection of the extensive cues presenting in clinical practice is important as is the detection of the correct cue. Focusing on too few cues or the wrong cues may lead to inaccuracies in detecting patient problems and if novice nurses are noting fewer, important and correct cues this has implications for nursing practice and education (Currey and Botti, 2003). Novice nurses may need more guidance and education to understand the wide range of cues used by expert nurses in the care of patients and also which cues are the correct ones for particular decision situations.

Perception of cues can be affected by the approach to a decision task a person takes; consequently this was investigated to further explain cue usage in this study. Given the

nature of the critical care nurse's role in meeting current care needs as well as preventing future adverse events, a combination of proactive and reactive tasks is considered ideal. The approach to decision tasks differed for novice and expert participants and this is reflected in the way both groups collected and used cues. Expert participants' tasks appeared to use more "proactive" planning which could prevent problems, whereas novice participants were more often "reactive", making decisions after a problem had occurred. This concurs with literature that describes expert nurses as being able to anticipate and predict possible adverse outcomes due to greater experience in a speciality area and domain-specific knowledge. The anticipation of possible problems is believed to be possible due to greater experience with similar cases as well as greater knowledge of assessment and understanding of physiology and pathology and may occur by pattern-matching (Radwin, 1998; Redden and Wotton, 2001). This anticipation and prevention of problems was described by Prowse and Lyne (2000) as informed vigilance, which could allow rapid detection of problems and "rescuing" of patients postoperatively. The collection of a wider range of cues helps in the better detection of impending problems as it allows consideration of many different aspects and the expert may then be able to determine which information is the most important. Novice nurses have been described as having an unfocused approach to care that is dependent on policy and procedures (Hanneman, 1996), and structured by routines such as care plans (Benner et al, 1996). This may restrict the range of cues that novices are aware of and collect.

The way nurses cluster or chunk cues together is also important in clinical decision-making. Expert participants in the study related more cues together when considering haemodynamic monitoring of patients. A similar result was obtained in an Australian study that examined orthopaedic nurses' clinical reasoning; expert nurses were found to relate items of information together more frequently than did novice nurses (Greenwood and King, 1995). The greater linkages or clustering of cues by an expert in a domain has been explained by Ericsson (1996) as being due to the ability to build meaningful patterns that are easier to recall. In a study of the reasoning processes of medical students and medical experts, it was found that students could often recall more facts given, but that medical experts were better at recalling the important pieces of information and how they

fitted together (Ericsson and Charness, 1994). During cognitive processing, experts in a discipline appear to be capable of generating a complex representation of encountered situations, which aids in recall and is often demonstrated in their relating of information together. Novices in a discipline often have a simpler representation of situations which may lead to the reliance on fewer cues (Ericsson, 1996).

Expert participants collect a wider range of cues and have greater linkages between cues and concepts due to the holding of chunks of domain-specific knowledge in the LTM which allows recognition of a wide range of cues and patterns of cues (Ericsson and Simon, 1993; Ericsson and Kintsch, 1995). The LTM can be seen as being made up of an enormous collection of interrelated nodes which are accessed by either recognition or by way of links that associate nodes to others already accessed (Ericsson and Simon, 1984; Ericsson and Simon, 1993; Ericsson and Charness, 1994). As expertise is developed in a domain, the nodes in the LTM are capable of storing more meaningful chunks that are accessed more readily by linkages from one node to the next. Hence it is probably more important to understand how expert nurses relate information together than how much and what kind of information they have. The key to expertise may be the efficient linking of cues to outcomes and concepts and the internalisation and automaticity of this process (Ericsson and Simon, 1993).

Understanding the more complex cue clustering of expert nurses and the identification of both critical and pivotal cues being used in practice may help in developing educational materials for undergraduate and novice nurses. There is also a need to understand how expert nurses link cue clusters together to build highly complex systems of relationships between cue categories (Jones, 1988; Redden and Wotton, 2001). Detailed examination of decision tasks used in other areas of nursing practice would enable determination of whether cue usage in decision-making in other areas is similar to or different from the area of the current study.

### **Study limitations and strengths**

This study involved a small number of participants and examined decision-making

around one type of nursing task in ICU. Thus generalising to other types of nursing tasks may be inappropriate. The study was also carried out in one unit only, and may only represent the decision-making practices of nurses in that unit. However, the study examined many decision instances for each participant and gives an in-depth account of individual decision-making. The similarities and differences uncovered in the study may be representative of nursing decision-making across monitoring tasks.

The study was implemented in the real world of practice and this introduced more variability in decision situations than would be apparent in studies using simulations. However, the use of the real world of practice did allow examination of decision-making as it actually occurs and the identification of cue usage by novice and expert participants. The study did not examine the quality of the decisions made or the decision outcomes. Examining the correspondence between the decisions made and the outcomes could show whether the decisions being made were of high quality but such studies would usually require scenarios to ensure decision situations are the same for all participants.

Strengths of the study included two phases of data collection, concurrent and retrospective TA, which increased the depth and completeness of information collected, enhancing validity and reliability. The concurrent TA sessions provided one strategy to enhance data collection by reducing bias in recall. The retrospective interviews enhanced the data collection process by allowing the researcher to fill in gaps in the concurrent TA protocol.

### **Further research**

More research is needed to determine such important aspects of clinical decision-making, as the common knowledge held by expert nurses about aspects of care, such as the interpretation of monitoring parameters, and how these are linked to give a picture of the patient status. There is also a need to carry out more comprehensive analysis of cue clusters to be able to identify both critical and pivotal cues being used in practice. Improved understanding of how expert nurses link cue clusters together to build highly complex systems of relationships between cue categories would allow identification of

strategies to enable nurses to develop decision making processes. Detailed examination of decision tasks used in other areas of nursing practice would enable determination of whether cue usage in decision-making in other areas is similar to or different from the area of the current study. Studies examining the quality of decisions made in the real world of practice by comparison of judgements made to decision outcome are needed to determine if the greater use of cues by expert nurses results in higher quality decisions.

### **Conclusion**

The current study was conducted in the real world of practice and it was found that novice participants focused on a much narrower range of cues than the expert participants. Further, expert nurses appeared to be more aware of which cues were important, as well as being cognisant of more indicators of patient status than the novice nurses. This is in contrast to studies using simulations, in which it has been stated that experts select fewer cues but are more selective in cue usage. In the real world of practice the expert nurses had a much greater range of cues that they considered important, and collected these. The expert nurses also collected cues together into meaningful clusters of patterns more often and this, combined with their knowledge of patterns of illness, allowed them to predict what may happen and plan care to prevent problems. The expert participants in the study attended to tasks more proactively and novice nurses more reactively. Identification of the strategies that characterise expert decision making may be important in assisting novices to develop similar processes to optimise patient care.

**Author contributions**

**Dr. Kerry Hoffman** – PhD project, study development, data collection and analysis, data interpretation, writing of manuscript.

**Professor Leanne M Aitken** – supervision of project, data interpretation, revision of manuscript

**Professor Christine Duffield** – supervision of project, revision of manuscript

## References

- Aiken, L.H., Clarke, S.P., Cheung, R.B., Sloane, D.M. and Silber, J.H. 2003. Educational levels of hospital nurses and surgical patient mortality. *JAMA*. 290 (12), 1617–1620.
- Aitken, L. 2000. Expert critical care nurses' use of pulmonary artery pressure monitoring. *Intensive and Critical Care Nursing*. 16 (4), 209–220.
- Aitken, L. and Mardegan, K.J. 2000. "Thinking Aloud": data collection in the natural setting. *Western Journal of Research*. 22 (7), 841–853.
- Aitken, L., Marshall, A.P., Elliot, R. and McKinley, S. 2009. Critical care nurses' decision making: sedation assessment and management in intensive care. *Journal of Clinical Nursing*. 18, 36-45.
- Benner, P. 2001. *From novice to expert: Excellence and power in clinical nursing practice*. Upper Saddle River, N.J.: Prentice Hall.
- Benner, P., Tanner, C.A. and Chesla, C.A. 1996. *Expertise in nursing practice. Caring, clinical judgment and ethics*. New York: Springer Publishing.
- Bucknall, T. 2000. Critical care nurses' decision-making activities in the natural setting. *Journal of Clinical Nursing*. 43 (3), 310-319.
- Currey, J. and Botti, M. 2003. Naturalistic decision-making: a model to overcome methodological challenges in the study of critical care nurses' decision-making about patients' hemodynamic status. *American Journal of Critical Care*. 12 (3), 206–212.
- Currey, J. and Aiken, L. (2005) *Assessing cardiovascular status : a guide for acute care*

nurses. *Collegian*. 12 (1), 34-40.

Dowding, D. and Thompson, C. (2003) Measuring the quality of judgement and decision-making in nursing. *Journal of Advanced Nursing*. 44 (1), 49-57.  
Elstein, S.E., Schulman, L.S. and Sprafka, S.A. 1978. *Medical Problem Solving. An analysis of clinical reasoning*. London: Harvard University Press.

Ericsson, K.A. and Kintsch, W. 1995. Long-term working memory. *Psychological Review*. 102 (2), 211-245.

Ericsson, K.A. and Simon, H.A. 1984. *Protocol Analysis: Verbal reports as data*. Cambridge, Massachusetts: The MIT Press.

Ericsson, K.A. (Ed.) 1996. *The road to excellence: the acquisition of expert performance in the arts, sciences, sports and games*. N.J.: Lawrence Erlbaum.

Ericsson, K.A. and Simon, H.A. 1993. *Protocol Analysis: Verbal reports as data. Revised Edition*. Cambridge, Massachusetts: The MIT Press.

Ericsson, K.A. and Charness, N. 1994. Expert performance: its structure and acquisition. *American Psychologist*. 49 (8), 725–747.

Elstein, A. and Bordage, J. 1991. Psychology of clinical reasoning. In Dowie, J. and Elstein, A. Eds. (1991) *Professional judgment: a reader in clinical decision-making*. New York: Cambridge University Press.

Greenwood, J. and King, M. 1995. Some surprising similarities in the clinical reasoning of “expert” and “novice” orthopedic nurses: report of a study using verbal protocols and protocol analyses. *Journal of Advanced Nursing*. 22 (5), 907–913.

Hanneman, S.K. 1996. Advancing nursing practice with a unit-based clinical expert. *Image—the Journal of Nursing Scholarship*. 28 (4), 331–337.

Hardy, S., Garbett., R., Titchen., A. and Manley, K. 2002. Exploring nursing expertise: nurses talk nursing. *Nursing Inquiry*. 9 (3), 196-202.

Jones, J.A. 1988. Clinical reasoning in nursing. *Journal of Advanced Nursing*. 13, 185–192.

Lamond, D. and Farrell, S. 1998. The treatment of pressure sores: a comparison of novice and expert nurses' knowledge, information and decision accuracy. *Journal of Advanced Nursing*. 27 (2), 280–286.

McCarthy, M. C. (2003) Detecting Acute Confusion in Older Adults: Comparing clinical reasoning of nurses working in acute, long-term, and community health care environments. *Research in Nursing and Health*. 26, 203-212.

Newell, A. and Simon, H. 1972. *Human Problem Solving*. New Jersey: Englewood Cliff.

Nojima, Y., Tomikawa, T., Makabe, S. and Synder, M. 2003. Defining characteristics of expertise in Japanese clinical nursing using the Delphi technique. *Nursing and Health Sciences*. 5, 3–11.

Prowse, M.A. and Lyne, P.A. 2000. Clinical effectiveness in post-anesthesia care unit: how nursing knowledge contributes to achieving intended patient outcomes. *Journal of Advanced Nursing*. 31 (5), 1115–1124.

Radwin, L.E. 1998. Empirically generated attributes of experience in nursing. *Journal of Advanced Nursing*. 27 (3), 590-595.

Redden, M. and Wotton, K. 2001. Clinical decision-making by nurses when faced with third space fluid shift: how well do they fare? *Gastroenterology Nursing*. 24 (4), 182–

191.

Reischman, R.R. and Yarandi, H.N. 2002. Critical care cardiovascular nurse expert and novice diagnostic cue utilisation. *Journal of Advanced Nursing*. 39 (1), 24–34.

Tanner, C.A., Padrick, K.P., Westfall, U.E. and Putzier, J. 1987. Diagnostic reasoning strategies of nurses and nursing students. *Nursing Research*. 36 (6), 358–363.

Tanner, C. A. 2006. Thinking like a nurse: A research based model of clinical judgment. *Journal of Nursing Education*. 45 (6), 204-212.

Taylor, C. 1997. Problem-solving in clinical nursing practice. *Journal of Advanced Nursing*. 26 (2), 329–336.

Taylor, K.L. and Dionne, J. 2000. Accessing problem-solving strategy knowledge: the complementary use of concurrent verbal protocols and retrospective debriefing. *Journal of Educational Psychology*. 92 (3), 313-425.

Thiele, J.E., Holloway, J., Murphy, D., Pendarvis, J., and Stucky, M. 1991. Perceived and actual decision-making by novice baccalaureate students. *Western Journal of Nursing Research*. 13 (5), 616–626.

Thompson, C. 1999. A conceptual treadmill; the need for middle ground in clinical decision-making theory in nursing. *Journal of Advanced Nursing*. 30 (5), 1222–1229.

Thompson, C., Bucknall, B., Estabrookes, C.A., Hutchinson, A., Fraser, K., de Vos, R., Binneke, J., Barrat, G. and Saunders, J. 2007 Nurses' critical event risk assessments: a judgement analysis. *Journal of Clinical Nursing*. 18, 601-612.

Thompson, C., Dalglish, L., Bucknall, T., Estabrookes, C., Hutchinson, A., Fraser, F., de Vos, R., Binneke, J., Barrett, G., Saunders, J. 2008 The effects of time pressure and

experience on nurses' risk assessment decisions; a signal detection analysis. *Nursing Research*. 57 (5), 302-311.

White, J.E., Nativio, D.G., Kobert, S.N. and Engberg, S.J. 1992. Content and process in clinical decision-making by nurse practitioners. *Image-Journal of Nursing Scholarship*. 24 (2), 153-157

Table 1 Frequency and range of approach to tasks for novice and expert participants

<b>Novice/expert</b>	<b>Reactive tasks</b>	<b>Proactive tasks</b>
	<b>Average frequency (range)</b>	<b>Average frequency (range)</b>
Novice	45% (23–63%)	55% (43–77%)
Expert	19% (14–36%)	81% (69–86%)

**Table 2 Selection criteria for participants (adapted from Benner, 1984)**

<b>Expert</b>	<b>Novice</b>
Registered Nurse (RN) Critical Care Certificate/Diploma,	RN
More than three years' Critical Care experience	No more than two years' experience in nursing
More than six months' experience in current unit	New graduate on rotation or direct entry critical care staff or recently commenced in critical care
Currently working at least 30 hours/fortnight	Currently working at least 30 hours/fortnight
Recognised as "senior" in unit with team leader responsibility	Recognised as "junior" in unit
Consider themselves to be experts in monitoring patient haemodynamic status in critical care areas	Consider themselves to be novices in monitoring patient haemodynamic status in critical care areas

**Table 3 Cues used by novice and expert participants;**

<b>Concept</b>	<b>Cues used by both novice and expert participants</b>	<b>Cues used by novice participants only</b>	<b>Cues used by expert participants only</b>
Haemodynamic status	Heart rate, blood pressure arterial line, mean arterial pressure (MAP), central venous pressure (CVP), temperature, pulse, oxygen saturations, ABG, blood cell count		Cardiac rhythm, blood pressure manual, electrolyte measures, BSL
Respiration	Depth, rate		Air entry, chest movement, muscle strength, tidal volumes, smoker/ex-smoker
Ventilation	Apnea, rate, patient size, spontaneous breathing, coughing, breathing up, tidal volume, mode, minute volume, alertness, position of ET tube, respiratory rate		Peak airway pressure, PEEP, oxygen percentage, sedation
Pain	Blood pressure, patient report, pain scale	Heart rate	Restlessness, gesturing, grimacing, feeling “crummy”, distress, withdrawing when touched, sleeping or not, tensing muscles, holding abdomen, pointing to an area of the body
Dermatome	Level, epidural rate, temperature, patient position,		Site leakage, oxygen saturations
Limb status	Pulses, movement, warmth, swelling, capillary return, skin colour		History of PVD
Fluid balance	IV rate, blood transfusion, balance in and out, total urinary output, nasogastric output, urine concentration,		Output of drains, dry mouth, urine colour, age, total fluids in theatre,
Mental status	Pupil size, pupil reaction, sternal rub, orientation to time person place,		Following commands, eye opening, response to vocal stimuli
Other	Nausea, bowel sounds		Weight, exercise patterns, patient appearance, abdominal assessment

**Table 4 Example of discrete tasks undertaken by participants**

Novice			Expert		
Decision task-description	Cues collected	Decision task outcome	Decision task-description	Cues collected	Decision task outcome
Monitor alarm altered novice to patient's low BP  <b>Reactive</b>	BP, GTN rate, Fluid lost intra-operatively	Changed GTN rate (rate was changed up or down each time BP dropped or increased and monitor alarm sounded), no further actions taken	Expert turned the rate of GTN infusion down, even though there was no change in the patient's BP  <b>Proactive</b>	Temperature, fluid lost intra-operatively, BP manual and arterial, HR, CVP, MAP, output and input, epidural medication rate, pain	Decided to monitor the patient closely as the nurse predicted that the patient's BP could drop as the patient warmed up after theatre and as a number of factors could impact on BP such as the medications for pain, the patient's anxiety and pain and the patient's current fluid status, a fluid bolus was then administered after consultation with medical officer and on further assessment the patient's blood pressure had risen