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A review of clinical decision-making: models and current research

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Abstract

Aims and objectives: The aim of this paper was to review the current literature with respect to clinical decision-making models and the educational application of models to clinical practice. This was achieved by exploring the function and related research of the three available models of clinical decision making: information processing model, the intuitive-humanist model and the clinical decision making model.

Background: Clinical decision-making is a unique process that involves the interplay between knowledge of pre-existing pathological conditions, explicit patient information, nursing care and experiential learning. Historically, two models of clinical decision making are recognised from the literature; the information processing model and the intuitive-humanist model. The usefulness and application of both models has been examined in relation the provision of nursing care and care related outcomes. More recently a third model of clinical decision making has been proposed. This new multidimensional model contains elements of the information processing model but also examines patient specific elements that are necessary for cue and pattern recognition.

Design: Literature review

Methods: Evaluation of the literature generated from MEDLINE, CINAHL, OVID, PUBMED and EBESCO systems and the Internet from 1980 – November 2005.

Results: The characteristics of the three models of decision making were identified and the related research discussed.

Conclusions: Three approaches to clinical decision-making were identified, each having its own attributes and uses. The most recent addition to the clinical decision making is a theoretical, multidimensional model which was developed through an evaluation of current literature and the assessment of a limited number of research studies that focused on the clinical decision-making skills of inexperienced nurses in

pseudoclinical settings. The components of this model are discussed and the relative merits to clinical practice.

Relevance to clinical practice: It is proposed that clinical decision-making improves as the nurse gains experience of nursing patients within a specific speciality and with experience, nurses gain a sense of saliency in relation to decision making. Experienced nurses may use all three forms of clinical decision making both independently and concurrently to solve nursing-related problems. It is suggested that O'Neill's clinical decision making model could be tested by educators and experienced nurses to assess the efficacy of this hybrid approach to decision-making.

Key Words: Clinical decision-making, decision-making models, nursing practice, nursing experience, nurses, nursing.

Introduction

Clinical decision making may be defined as choosing between alternatives (Thompson & Dowding, 2002). Clinical decision-making is a process that nurses undertake on a daily basis when they make judgements about the care that they provide to patients and management issues. As nurses become more experienced as care providers, the process of clinical decision-making becomes easier and more manageable and the forms of decision-making become increasingly intricate. Clinical decision-making is a complex activity that requires practitioners to be knowledgeable in relevant aspects of nursing, To have access to reliable sources of information and appropriate patient care networks and to work in a supportive environment (O'Neill, Dluhy & Chin, 2005). To develop nurses as autonomous clinical decision makers, pre-registration education and training programmes need to incorporate an educational framework that supports the development of the prerequisite intellectual and cognitive skills that are needed in order to manage complex information and to make judgements (Smith et al., 2004, Thompson et al., 2004).

Historically, two models of clinical decision-making have been discussed in the nursing literature (Thompson, 1999). These two models have been illustrated in nurse research publications (Luker et al., 1998, Offredy, 1998, Hedberg & Larson., 2003). More recently, O'Neill et al., (2004) and O'Neill et al (2005) developed a theoretical model developed which primarily focuses on the decision making processes that may be used by inexperienced nurses. This paper aims to review the current literature with respect to clinical decision-making models and the educational application of models to clinical practice.

In undertaking this review of the literature, the search used MEDLINE, CINAHL, OVID, PUBMED and EBESCO systems and the Internet to identify unpublished work. 1317 publications were identified, of these 779 were research papers and 123 were UK based research papers. Limits on searches included:

- English language publications.
- British, American and Australian literature
- The search was limited to 1980 – November 2005.

- Papers that explored the process and methodology of clinical decision making.

Due to the vast quantity of literature and the word limitations of this brief review, papers were preferentially selected that added to current comprehension of the complexities of this multifaceted subject. This meant that many of the initial clinical decision making studies were briefly introduced as the predominant focus was on recent studies that explored the concept and provided new dimensions to the existing body of knowledge on clinical decision making. The advantage of this approach is that the reader is provided with current information that adds to the corpus of evidence that supports arguments for the different approaches that may be employed during decision-making.

The Information Processing Model

The information processing model is rooted in medical decision making (Joseph & Patel, 1990). This model uses a scientific or hypothetico-deductive approach to assist metacognitive reasoning that is essential to medical diagnosis (Graber, 2003, Gordon & Franklin, 2003). Nurses adopted this hypothetico-deductive approach to assist clinical decision-making using decision trees to numerically assess potential outcomes. For each decision tree, possible outcomes are assigned a numerical value and the probability of reaching an outcome is assessed. Wu et al. (2005) used a decision tree model to assess how women decide on whether to have a hysterectomy. The study assisted nurses working in gynaecological settings to comprehend the decisions that women faced and the need for proper counselling following surgery.

Analytical decision making models have been used to help describe nurse's ability to diagnostically reason (Carnevali, 1984, Radwin, 1989). Analytical models assume that the clinical decision maker's thought processes follow rational logic that can be studied until a decision has been made. During the process of making the decision, the experience of the clinical decision maker and the ability to recognise situations that

impinge on the decision making process are also key components of this analytical model (Klein, 1989, Klein & Calderwood, 1991).

The hypothetico-deductive approach to clinical decision-making involves several stages: cue recognition or cue acquisition, hypothesis generation, cue interpretation and hypothesis evaluation (Tanner et al., 1987). The initial encounter with the patient occurs during the cue recognition stage. During this time, the nurse will collate clinical information about the patient. This is followed by hypothesis generation, when the nurse will develop a tentative hypothesis specific to the information that has been generated. This may be undertaken shortly after the initial encounter and may be case specific and developed in relation to previous experience and education (O'Neill et al., 2005). Hypothesis generation is preceded by cue interpretation. This stage involves the interpretation of cues generated from the initial encounter and will focus on the confirmation of cues that significantly contribute to the original hypothesis or alternatively, the rejection of cues unrelated to the original hypothesis. In the final stage, the evidence collated will be evaluated in relation to its relative merits, advantages and disadvantages and possible contribution to the confirmation or rejection of the original hypothesis. Carnevali (1984) identified additional stages of the hypothetico-deductive process that may be used by nurses during diagnostic reasoning, these include: entry to the data search field and shaping the direction of data gathering, hypothesis and data directed search of data field and diagnosis.

Hammond (1996) examined the use of hypothetico-deductive model by nurses during clinical decision making. The findings highlighted the difficulties nurses encountered due to caution when producing hypotheses. Aspinall (1979) found that the incorporation of decision trees improved the decision-making ability of nurses and increased the likelihood of nurses reaching a correct diagnosis. The complexity of the structural decision aids such as decision tree algorithms can be viewed as beneficial to the success of the clinical decision-making process (O'Neill et al., 2005).

Manias et al., (2004) in their review of decision-making models used by graduate nurses to manage patients' medications, found that hypothetico-deductive reasoning was the most prevalent model used. This assessment was based on the quantitative assessment of observations of nurse-client interactions and qualitative assessment of nurse interviews and description of decisions undertaken. Hypothetico-deductive

reasoning was identified in 25 out of 37 observations of patient-client interactions. Graduate nurses were recruited from a wide range of nursing practice settings; this approach increased the reliability of the data. In this study, intuition was marginally used. This may be a reflection of the inexperience of the nurses involved in the study.

In contrast, Hedberg and Larsson, (2003) explored the clinical decision making strategies used by experienced nurses. The key findings suggest that nurses regularly corroborated with colleagues, particularly those with specific competence to validate their own knowledge and interpret events which act as cues for clinical decision making specific to patient care. The need for collegial verification is often related to indecision and uncertainty about the clinical decision-making process and can act as a prompt to enhance the process (Thompson et al., 2001). An additional predominant feature of Hedberg and Larsson's (2003) study was the ability of nurses to think ahead of situations and adopt preventative strategies to anticipated circumstances. This process is related to the use of intervention decisions and the recognition of similar scenarios and possible adverse events (Klein, 1989) but also encouraged nurses to act independently. These activities are commensurate with the rationalistic analytical or hypothetico-deductive model of clinical decision making (Easen & Wilcockson, 1996, Hammond, 1996, Lauri et al., 2001). Although this study was informative and helped to confirm and highlight the characteristics of analytical approach to decision-making, the study was small scale involving only six nurses and the production of nineteen scenarios. Although the findings were useful about how nurses make clinical decisions, the verisimilitude and the veridicality of the data is open to question as nurses often have difficulty explaining how they did things (Nisbett & Wilson, 1977). This study highlights the need for additional large scale studies that examine the rationalistic analytical decision-making strategies used by experienced nurses.

The hypothetico-deductive model of decision-making has its drawbacks. There may be flaws in the use of decision trees whereby the tree may have an inaccurate structure or decision points may have incorrect probabilities attached which invalidates the outcomes. Hypotheses may be incorrect which leads to the generation of propositions that are essentially inaccurate (Buckingham & Adams, 2000). This quantitative approach to decision-making assumes that existing knowledge is available and

accurate at the time of making the decision (Miers, 1990, Harbison, 1991). However, in real life events, decisions that are often made possess an element of uncertainty (Kuipers et al., 1988, Orme & Maggs, 1993), therefore consideration has to be given to the perceived benefits of any decision and also its possible consequences (Wooley, 1990).

The Intuitive-Humanist Model

The focus of this model is intuition and the relationship between nursing experience, the knowledge gained from it and how it enriches the clinical decision making process as the nurse progresses along the professional trajectory (Benner, 1982, Benner, 1984, Young, 1987). In this model, hypothesis testing is not used as a marker of accurate or inaccurate propositions and reasoning. This has led to scepticism due to the lack of scientific reasoning and reasoning that is based on hunches (McCain, 1965, Smoyak, 1982). This scepticism may be unrelated to the uncertainty of clinical practice and the fact that nurses develop ways of coping with the milieu of clinical practice where the homeostasis of the patient may constantly change (Kelly, 1964) and where textbook cues are inappropriate (Hammond et al., 1967). Attempts to define and characterise the components of intuition have added to current comprehension of this detailed attribute (Benner & Tanner, 1987, Pyles & Stern, 1983, Rew, 1988, Schraeder & Fisher, 1986, Young, 1987).

Benner (1984) succinctly illustrates how the inexperienced or novice nurse will use procedures and guidelines to make decisions but as the nurse gains a wealth of experience, decision making becomes intuitive. Intuition has been defined in several ways. According to Benner and Tanner, (1987) intuition is ‘understanding without a rationale’ (p.23). It is also defined as ‘the deliberate application of knowledge, or understanding that is gained immediately as a whole and that is independently distinct from the usual, linear and analytical reasoning process’ (Rew, 2000, pg. 95). Gerrity (1987) suggests that intuition is ‘a perception of possibilities, meanings and relationships by way of insight’ (p. 63). Intuition has also been described as ‘immediate knowing of something without the conscious use of reason’ (Schraeder & Fischer, 1987, p.45). According to Rew, (2000), intuition is ‘a component of complex judgement, the act of deciding what to do in a perplexing, often ambiguous and

uncertain situation. It is the act of synthesizing empirical, ethical, aesthetic and personal knowledge. Intuitive judgement is the decision to act on a sudden awareness of knowledge, that is related to previous experience, perceived as a whole and difficult to articulate' (p. 95).

Intuition has also been described as the making of connections or sensing of a physical or spiritual relationship (Leners, 1992, Davis-Floyd & Davis, 1996). Physical connections involve two people and focus on body language and non-verbal communication patterns whereas spiritual connections tend to be abstract and involve the exchange of energy fields (Leners, 1992).

Intuition has been correlated with experience. King and McLeod Clark (2002) found that the quality of analysis of decision-making improved as nurses gained experience of patient management. Moreover, Watson, (1994) reported that previous experiential learning enhanced the ease by which nurses made decisions. Nurse prescribers also used experiential learning and knowledge of the patient to underpin clinically based decisions (Luker et al., 1998). This finding concurs with previous studies on the decision-making strategies used by practice nurses (Luker & Kenrick, 1992, Maynard, 1994). Inferences drawn from these findings imply that there is a need for greater insight into the use of evidence and knowledge to support nursing practice and nurse prescribing decisions.

Attempts have been made to investigate the characteristics of intuition using psychometric testing and factor analysis. Smith et al., (2004) found that nursing students experienced intuition in an equivalent way to experienced nurses. The key findings identified seven factors that characterised the concept of intuition. Factors included physical sensations such as gut feelings, emotional awareness that embodies premonitions, apprehension and reassuring feelings which were supported by feelings of unease, anxiety, or fear. Making connections was associated with factors such as spiritual connections, reading of cues and sensing energy. The seven factors identified were consistent with previous studies (Leners, 1992, Kelly, 1994, Davis-Floyd & Davis, 1996, Buckingham & Adams, 2000, Ling & Luker, 2000, Hansten & Washburn, 2000, Khatri & Ng, 2000, King & Macleod Clark, 2002). Although Smith et al., (2004) only achieved a 35% response rate to their student nurse questionnaire,

they suggest that the findings presented were representative of the student population with regard to age, gender, ethnicity and education. Moreover, the characteristics presented reflect previous studies and demonstrate a need for refinement of the psychometric tool and the development of teaching and learning strategies that foster intuitive ability.

The characteristics related to intuition have also been researched by Rew, (2000). In her study she examined the concept of intuition from a panel of experts, psychiatric-mental health nurses and a convenience sample of nurses studying on continuing educational courses. Data were analysed using factor analysis and findings revealed a six factor model which represented 60% of the variance in scores. The items identified revealed the following; acknowledges intuition in clinical practice, willing to take risks, takes risks, takes action based on intuition, cautiousness and rigidity, self awareness and being creative. These characteristics concur with previous results (Rew, 1990; 1991). This study demonstrates that the unidimensional acknowledges using intuition in nursing scale (AUINS) is a reliable and valid tool that can be used to measure nurses' acknowledgement of intuition as an aspect of clinical decision making. It is suggested that AUINS is a valuable empirical indicator that can be used to test and develop theory pertinent to clinical decision making.

One issue relevant to this model is the role of learning from experienced nurses. Inexperienced nurses value the contribution that can be gained from learning from experienced colleagues (O'Neill, 1997, Cioffi, 2000) As Nurius et al., (1999) point out, in order for inexperienced nurses to develop their skills in clinical decision making they require supportive networks that focus on the clarity of roles and responsibilities and that promote sensitive leadership. Holl 1996 removed

Hedberg and Larsson, (2003) in their small scale exploratory study of the clinical decision making strategies used by experienced nurses found that nurses identified cues as part of the decision making process. The identification of cues was assisted by knowledge of the patient and by nurses' knowledge, both of which helped them to recognise and compare cues with cues they had previously encountered in the same patient or in a similar patient they had previously nursed. This process of recognition of cues is commonly referred to as pattern recognition or similarity recognition (Cioffi

& Markham, 1997, Davies & Fox-Young, 2002). Pattern recognition is often associated with intuitive judgement (Benner & Tanner, 1987) and perception (Effken, 2001). Pattern recognition occurs when the nurse compares the signs and presenting symptoms of a patient problem with patterns recognised from memory in order to match the presenting trend (Gordon, 1987). This ability of nurses to undertake pattern recognition will develop as knowledge increases (Cioffi & Markham, 1997, Aitken, 2003) and as nurses gain experience in a sub-speciality or specific area of nursing (Reichman & Yarandi, 2002). With time, pattern recognition will be replaced by more refined recognition patterns (Hoffman, et al., 2004). This replacement is often related to competence, the reduction of anxiety (Papa et al., 1990), the development of a sense of saliency and the ability to recognise the defining characteristics of a given clinical situation (Jacavone & Dostal., 1992). These characteristics are commensurate with nurses using an intuitive approach to clinical decision-making.

Cioffi and Markham, (1997) associate intuition with three forms of heuristics or subjective probability judgements that form the basis of intuitive reasoning based on the Tversky and Kaheman model (1983). These include; availability heuristics, representational heuristics and anchoring and adjustment heuristics. Representational heuristics focuses on the frequency of events that can be recognised and triggered from memory. Buckingham and Adams, (2000) correlate this form of intuition with the prototype model of classification based on how representative and similar the nursing example is from the prototype form. The second form of classification is the exemplar model which correlates with the availability heuristics model in which clinical decision making is judged on the basis of recollection of experiences with patients presenting with the same condition (Buckingham & Adams, 2000). Both prototype and exemplar models are thought to involve pattern recognition and the complexity of this form of decision-making should not be underestimated. No attempts have been made to elucidate whether the prototype and exemplar models involve conscious or unconscious behaviour unlike other models which suggest that pattern recognition occurs at a conscious level and intuition at an unconscious level (Jenkins, 1985). The approach used by Buckingham and Adams, (2000) attempts to clarify the processes underpinning clinical decision making and demystify intuition rather propose that intuition and pattern recognition are individual models (Offredy, 1998, Stroud et al., 1999, Manias et al., 2004).

A drawback of using pattern recognition as a decision-making tool is the possibility that cues maybe associated with wrong decisions and that the decision maker is relying on memory to recognise cues that may be inaccurate.

O'Neill's Clinical Decision-Making Model

O'Neill et al.s(2005) clinical decision-making model is a multi-dimensional model that was developed from the synthesis of findings from research studies in graduate students (O'Neill, 1999, O'Neill et al., 2004), qualified nurses (O'Neill, 1997) and from the novice to expert clinical reasoning model (O'Neill & Dluhy, 1997). The model is based on a computerised decision support system that utilises both hypothetico-deduction and pattern recognition as a basis of decision making. The benefits of each model is absorbed and used to develop a decision support model. The central features of the model include investigating pre-encounter data, anticipating and controlling risk, the provision of standard nursing care, situational and client modification and triggers to hypothesis generation followed by nursing action. An adaptation of the O'Neill et al. (2005) model illustrates the key components of the model. The key components of the model are explored.

Patient-specific pre-encounter data are used as a tool to help the nurse to anticipate risks to patients. The degree of risk of each potential problem is ranked and then the nursing action is instituted to reduce the likelihood of the most threatening risks (Thompson et al., 2002).

Pre-counter data is the information that the nurse has before meeting the patient. The information may include written information in the records and flow sheets or data generated from communication with health personnel. Textbook knowledge, beliefs, assumptions, interests and experiences that influence nurse behaviour are noted. The role of the pre-encounter data is to help to predict the likelihood that a client will develop a particular health problem. Often this may be performed using a 'think aloud' or open discussion technique (Chase, 1995).

Anticipating and controlling risk essentially involves the nurse considering the degree of risk of each potential health problem and ranking them accordingly. This is then

followed by the implementation of appropriate nursing care in order to reduce the possibility of health care related problems and the most threatening risk (Thompson et al., 2002).

The standard nursing care that is offered is assessed in accordance with the institutional nursing care procedures, protocols and practice habits prescribed by particular hospitals. Standard nursing care will be selected based on pre-encounter data. This knowledge may be tentative as the condition of the patient may be subject to alteration (Charlin et al., 2000).

Situational and client modifications are the next component of the clinical decision-making. This takes place in the midst of patient focused crises that often involve more than one patient, repeated and constant interruptions time management directives (Street, 1992, McCaughan et al., 2002). Features that influence both situational and client modifications and the quality of clinical decisions that are made include the interactions that occur between staff often in a rapidly changing environment, the quantity and skill mix of nurses involved in the provision of care, knowing the patient and the physiological and psychological processes central to the management of the patient's condition.

The final aspect of the clinical decision-making model involves hypothesis generation. During clinical decision-making, the nurse will test a hypothesis in relation to potential changes in the status of a patient, the availability of pre-encounter information or important cues to the patient's current status. Assessment of the clinical situation of patient cues can increase effectiveness of information processing (Carnevali & Thomas, 1993). Additional features that the nurse should also consider include the professional and social context of the problem encountered and its potential impact on the process of clinical decision-making (Lauri & Salanterä, 1995). During hypothesis generation and testing, the nurse should review the patient's condition for substantial improvement or deterioration of an existing symptom or the development of new symptoms (James, 2001). During this time, the nurse will start to develop a sense of saliency as he/ she gain experience in the assessment of the homeostasis of patients they care for (Benner & Tanner, 1987). In particular as nurses become more experienced care givers, they will develop the ability to recognise

whether a patient's condition is deteriorating (Jacavone & Dostal, 1992). According to Taylor, (1997) with experience nurses develop the acuity to trigger several hypotheses concurrently. Depending on the level of clinical experience, the nurse may then select patient-specific information and use pattern recognition to either support or reject a definitive hypothesis (Elstein & Schwarz, 2002). Fig. 2^[RW1]. Illustrates an exemplar of how the model can be used to manage a problem of increased breathlessness in a patient with asthma.

O'Neill's theoretical model is limited by the fact that it was developed through evaluation of current literature and from findings of a small scale research study that tested the clinical decision-making skills of inexperienced nurses in a pseudoclinical setting. O'Neill et al., (2005) recognise that the model needs to be challenged in the realities of clinical practice to assess its maturity. The model could be used by educators as a simulation exercise to develop the clinical decision making skills of student nurses in particular the rationale that underpins decision-making in relation to common nursing problems (O'Neill et al, 2004). The model may also be viewed as a useful teaching tool for newly qualified nurses who need to be 'nurtured' and who have not been exposed to the intricacies of the job as previous generations of nurses (Bucknall, 2000).

In the clinical setting, the model could be used by lecturer practitioners in a think aloud technique to assess the clinical decision-making skills of experienced nurses to determine the sense of saliency of nurses working in a variety of clinical settings.

Conclusions

Current models of clinical decision-making are presented and discussed. The characteristics of the hybrid model developed by O'Neill et al., (2004) are presented and potential uses are discussed. The efficacy of this new approach to decision-making needs to be tested in applied research studies involving student and qualified nurses, particularly experienced nurses as they may incorporate both hypothetico-deduction and intuition during decision-making which will test the usefulness of this hybrid approach.

In terms of education, the model could be used as a teaching tool, or as part of a think aloud seminar using patient focused scenarios to assess its efficacy as a decision making approach. This will allow an evaluation and justification of the model's tenacity, applicability and usefulness to nursing practice and development of nursing theory.

References

- Aitken, L.M. (2003). Critical care nurses' use of decision-making strategies. *J. Clinical Nursing*, 12, 4: 476-483.
- Aspinall, M.J. (1979). Use of a decision tree to improve accuracy of nursing diagnosis. *Nursing Research*, 28: 182-185.
- Benner, P. (1982). From novice to expert. *Amer.J.Nursing*, 82,1: 402-407.
- Benner, P. (1984). *From Novice to Expert: Excellence and Power in Clinical Nursing Practice*. Addison-Wesley: Massachusetts.
- Benner, P. & Tanner, C. (1987). Clinical judgement: how expert nurses use intuition. *Am.J.Nursing*, 87, 1: 23-31.
- Bucknall, T.K. (2000). Critical care nurses' decision-making activities in the natural setting. *J. Clinical Nursing*, 9: 25-36.
- Buckingham, C.D. & Adams, A. (2000). Classifying clinical decision making: a unifying approach. *J.Advanced Nursing*, 32, 4: 981-989.
- Carnevali, D. (1984). The diagnostic reasoning process. In *Diagnostic Reasoning in Nursing*. Carnevali, D., Mitchell, P., Woods, N. & Tanner, C. (eds). J.B. Lippincott Company: Philadelphia.
- Carnevali, D. & Thomas, M. (1993). *Diagnostic Reasoning and Treatment Decision Making in Nursing*. Lippincott, Philadelphia, PA.
- Charlin, B., Tardiff, J. & Boshuizen, H. (2000). Scripts and medical diagnostic knowledge. *Academic Medicine*, 75: 182-190.
- Chase, S. (1995). The social context of critical care. *Heart and Lung*, 24: 154-162.
- Cioffi, J. (2000). Nurses experiences of making decisions to call emergency assistance to their patients. *J.Advanced Nursing*, 32: 108-114.
- Cioffi, J. & Markham, R. (1997). Clinical decision-making by midwives: managing case complexity. *J. Advanced Nursing*, 25: 265-272.
- Davies, E. & Fox-Young, S. (2002). Validating a scope of nursing practice decision-making framework. *Intern.J.Nursing Studies*, 39, 1: 85-93.
- Davis-Floyd, R.& Davis, E. (1996). Intuition as authoritative knowledge in midwifery and home birth. *Medical Anthropology Quarterly*, 10, 237-269.
- Easen, P. & Wilcockson, J. (1996).Intuition and rational decision-making in professional thinking: a false dichotomy? *J.Advanced Nursing*, 24: 667-673.
- Effken, J. (2001). Informational basis for expert intuition . *J.Advanced Nursing*, 34, 2: 246-255.

- Elstein, A.S. & Schwarz, A. (2002). Clinical problem solving and diagnostic decision-making: selective review of the cognitive literature. *British Medical Journal*, 324: 729-732.
- Gerrity, P. (1987). Perception in nursing: the value of intuition. *Holistic Nursing Practice*, 1, 3: 63-71.
- Gordon, M. (1987). *Nursing Diagnosis, Process and Application*. McGraw Hill, New York.
- Gordon, R. & Franklin, N. (2003). Cognitive underpinnings of diagnostic error. *Academic Medicine*, 78: 8: 782.
- Graber, M. (2003). Metacognitive training to reduce diagnostic errors: Ready for prime time. *Academic Medicine*, 78, 8: 781.
- Hammond, K. (1996). How convergence of research paradigms can improve research on diagnostic judgement. *Medical Decision Making*, 16: 281-287.
- Hammond, K.R., Kelly, K.J., Schneider, R.J. & Vancini, M. (1967). Clinical inference in nursing: Revising judgements. *Nursing Research*, 16, 1: 38-45.
- Hansten, R. & Washburn, M. (2000). Intuition in professional practice: executive and staff perceptions. *J. Nursing Administration*, 30, 4: 185-189.
- Harbison, J. (1991). Clinical decision making in nursing. *J. Advanced Nursing*, 16: 404 -407.
- Hedberg, B. & Larsson, U.S. (2003). Observations, confirmations and strategies-useful tools in decision-making process for nurses in practice? *J. Clinical Nursing*, 12, 2: 215-222.
- Hoffman, K., Donoghue, J. & Duffield, C. (2004). Decision-making in clinical nursing: investigating contributing factors. *J. Advanced Nursing*, 45, 1: 53-62.
- Jacavone, J. & Dostal, M. (1992). A descriptive study of nursing judgement in the assessment and management of cardiac pain. *Advances in Nursing Science*, 15: 54-63.
- James, G. (2001). Clinical reasoning in novices: Refining the research question. *British Journal of Therapy and Rehabilitation*, 8: 286-293.
- Jenkins, H.M. (1985). A research tool for measuring perceptions of clinical decision-making. *J. Prof. Nursing*, 1, 4: 221-229.
- Joseph, G.M. & Patel, V.L. (1990). Domain knowledge and hypothesis generation in diagnostic reasoning. *Med. Decis Making*, 10:31-46.

- Kelly, K.J. (1964). An approach to the study of clinical inference in nursing. Part 1: Introduction to the study of clinical inference in nursing. *Nursing Research*, 13: 314-315.
- Kelly, K.J. (1994). The nature of intuition among nursing staff development experts: A Heideggerian hermenutical analysis. Doctoral Dissertation. George Washington University, Fairfax, VA.
- Khatri, N. & Ng, A. (2000). The role of intuition in strategic decision making. *Human Relations*, 53, 1: 57-86.
- King, L. & Macleod Clark, J.M. (2002). The role of intuition and the development of expertise in surgical ward and intensive care nurses. *J.Advanced Nursing*, 37, 4: 322-329.
- Klein, G. (1989). Recognition-primed decisions. In *Advances in Man-Machine-Systems Research* . Rouse, W. (ed). JAI, Greenwich.
- Klein, G. & Calderwood, R. (1991). Decision models: lessons from the field. *IEEE Transactions on Systems. Man and Cybernetics*, 21, 5: 1018-1026.
- Kuipers, B., Moskowitz, A.J. & Kassirer, J.P. (1988). Critical decisions under uncertainty: representation and structure. *Cognitive Science*, 12: 177-210.
- Lauri, S., Salanterä, S., Chalmers, K., Ekman, S.L., kin, H., Kappeli, S. & MacLeod, M. (2001). An exploratory study of clinical decision-making in five countries. *J. Nursing Scholarship*, 33, 1: 83-90.
- Lauri, S. & Salanterä, S. (1995). Decision-making models of Finnish nurses and public health nurses. *J.Advanced Nursing*, 21: 520-527.
- Leners, D.W. (1992). Intuition in nursing practice. *J.Holistic Nursing*, 10, 2: 137-153.
- Ling, M.S. & Luker, , K.A. (2000). Protecting children: intuition and awareness in the world of health visitors. *J.Advanced Nursing*, 32, 3: 572-579.
- Luker, K.A., Hogg, C., Austin, L., Ferguson, B., & Smith, K. (1998). Decision making: the context of nurse prescribing. *J.Advanced Nursing*, 27: 657-665.
- Luker, K.A. & Kenrick, M. (1992). An exploratory study of the sources of influence on the clinical decisions of community nurses. *J.Advanced Nursing*, 17: 957-966.
- Manias, E., Aitken, R. & Dunning, T. (2004). Decision-making models used by 'graduate nurses' managing patients' medications. *J. Advanced Nursing*, 47, 3: 270-278.
- Maynard, A. (1994). Managing nurses. *Health Service Journal*, 19, 104: 5411.

- McCain, R.F. (1965). Nursing by assessment-not intuition. *American J. Nursing*, 65: 82-84.
- McCaughan, D., Thompson, C., Cullum, N., Sheldon, T.A. & Thompson, D.R. (2002). Acute care nurses' perceptions of barriers to using research information in clinical decision-making. *J.Advanced Nursing*, 39,1: 46-60.
- Miers, M. (1990). Developing skills in decision making. *Nursing Times*, 86, 30: 32-33.
- Nisbett, R.E. & Wilson, DeCamp, T. (1977). Telling more than we can know: verbal reports on mental processes. *Psychological Review*, 84, 3: 231-257.
- Offredy, M. (1998). The application of decision making concepts by nurse practitioners in general practice. *J.Advanced Nursing*, 28: 988-1000.
- Nisbett, R. & Wilson, T. (1977). Telling more than we can know: verbal reports on mental processes. *Psychological Review*, 84: 231-259.
- Nurius, P., Kemp, S. & Gibson, J. (1999). Practitioner's perspectives on sound reasoning: adding a worker-in-context component. *Administration in Social Work*, 23: 1-22.
- O'Neill, E.S. (1997). Home care nurses inferences and decisions. *Applied Nursing Research*, 10: 33-38.
- O'Neill, E.S. (1999). Strengthening graduate students' clinical reasoning. *Nurse Educator*, 24: 11-16.
- O'Neill, E.S., Dluhy, N.C, Fortier, P.J. & Howard, M.E. (2004). Knowledge acquisition, synthesis and validation: a model for decision support systems. *J.Advanced Nursing*, 47, 2: 134-142.
- O'Neill, E.S., Dluhy, N.C. & Chun, E. (2005). Modelling novice clinical reasoning for a computerised decision support system. *J. Advanced Nursing*, 49, 1: 68-77.
- O'Neill, E.S. & Dluhy, N.C. (1997). A longitudinal framework for fostering critical thinking and diagnostic reasoning. *J. Advanced Nursing*, 26: 825-832.
- Orme, L. & Maggs, C. (1993). Decision making in clinical practice: how do expert nurses, midwives and health visitors make decisions? *Nurse Education Today*, 13: 270-276.
- Papa, F., Shores, J. & Meyer, S. (1990). Effects of pattern matching and experience in the development of diagnostic expertise. *Academic Medicine*, 65: S21-S22.
- Pyles, S.H. & Stern, P.N. (1983). Discovery of nursing gestalt in critical care nursing: The importance of the gray gorilla syndrome. *Image: Journal of Nursing Scholarship*, 15, 2: 51-58.

- Radwin, L. (1989). Cues and strategies used in the diagnosis of pain conditions. In *Classification of Nursing Diagnosis: Proceedings of the Eight National Conference*. J.B.Lippincott: Philadelphia.
- Reichman, R. & Yarandi, H. (2002). Critical care cardiovascular nurse expert and novice diagnostic cue utilisation. *J.Advanced Nursing*, 39: 24-34.
- Rew, L. (1988). Intuition in decision making. *Image: J. Nursing Scholarship*, 20, 150-154.
- Rew, L. (1990). Intuition in critical care nursing practice. *Dimensions of Critical Care Nursing*, 9, 1: 30-37.
- Rew, L. (1991). Intuition in psychiatric-mental health nursing. *J. Child and Adolescent Psychiatric and Mental Health Nursing*, 4: 110-115.
- Rew, L. (2000). Acknowledging intuition in clinical decision making. *J. Holistic Nursing*, 18, 94-108.
- Schrader, B. & Fischer, D. (1987). Using intuitive knowledge in the neonatal intensive care nursery. *Holistic Nursing Practice*, 1, 3: 45-51.
- Smith, A.J., Thurkettle, M.A. & Dela Cruz, F. (2004). Use of intuition by nursing students: instrument development and testing. *J.Advanced Nursing*, 47, 6: 614-625.
- Smoyak, S.A. (1982). Clinical practice: Intuition or based on research? *J.Psychosocial Nursing and Mental Health Services*, 20: 9-13.
- Street, A. (1992). *Inside Nursing*. State University of New York. Albany, NY.
- Stroud, S.D., Smith, C.A., Edlund, B.J. & Erkel, E.A. (1999). Evaluating clinical decision-making skills of nurse practitioner students. *Clinical Excellence for Nurse Practitioners*, 3, 4: 230-237.
- Tanner, C., Padrick, K., Westfall, U. & Putzier, D. (1987). Diagnostic reasoning strategies for nurses and nursing students. *Nursing Research*, 36: 358-363.
- Taylor, C. (1997). Problem solving in clinical nursing practice. *J.Advanced Nursing*, 26: 273-280.
- Thompson, C. (1999). A conceptual treadmill: the need for 'middle ground' in clinical decision making theory in nursing. *J. Advanced Nursing*, 30, 5: 1222-1229.
- Thompson, C. & Dowding, (2002). *Clinical Decision Making and Judgement in Nursing*. Churchill Livingstone: London.
- Thompson, C., McCaughan, D., Cullum, N., Sheldon, T., Mulhall, A. & Thompson, D. (2001). Research information in nurses' clinical decision-making: what is useful? *J.Advanced Nursing*, 36, 3: 376-388.

- Thompson, C., Dowding, D. & McCaughan, D. (2004). Strategies for avoiding pitfalls in clinical decision-making. *Nursing Times*, 100, 20: 40-42.
- Tversky, A. & Kaheman, D. (1983). Judgement under uncertainty: heuristics and biases. *Science*, 185: 329-336.
- Watson, S. (1994). An exploratory study into a methodology for examination of decision making by nurses in the clinical area. *J.Advanced Nursing*, 20: 351-360.
- Wittman-Price, R.A. (2004). Emancipation in decision-making in women's health care. *J.Advanced Nursing*, 47, 4: 437-445.
- Wooley, N. (1990). Nursing diagnosis: exploring the factors which may influence the reasoning process. *J.Advanced Nursing*, 15: 110-117.
- Wu, S.M., Chao Yu, Y.M., Yang, C.F. & Che, H.L. (2005). Decision-making tree for women considering hysterectomy. *J.Advanced Nursing*, 51, 4: 361-368.
- Young, C. (1987). Intuition and nursing process. *Holistic Nursing Practice*, 1, 3: 52-62.

Figure 1. Clinical Decision-Making Model

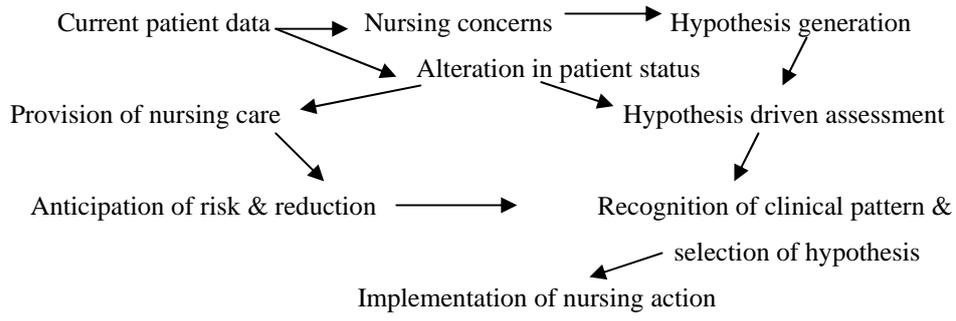


Figure 2. Decision support system for an asthmatic patient with a history of breathlessness

