Nurses' Decisions, Irreducible Uncertainty and Maximizing Nurses' Contribution to Patient Safety

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Abstract

Nurses, like all healthcare professionals, use reasoning and judgment to make decisions. In doing so, they must grapple with irreducible clinical uncertainty. But, in managing uncertainty, the modes of reasoning used should encourage more good than harm. However, the nursing profession considers intuitive reasoning as a mark of the expert. Consequently, nurses are predominantly taught to handle uncertainty intuitively. Information-seeking behaviour is rare. This is problematic for two reasons: (1) intuitive decision-making is prone to reasoning biases and (2) mechanisms to judge nurses' decision-making rarely use intuitive responses themselves as the basis for scrutiny. In addition, when we evaluate nurses' decision-making in the context of problems such as time pressure, a less-than-optimistic picture emerges. However, this type of examination is a necessary first step in maximizing the contribution of nurses to patient safety.

Before We Start: Two Questions

Before beginning this exploration of the contribution of nurses' decision-making to patient safety, we pose two simple scenarios and ask you, the reader, to decide if either is a "good" or a "bad" idea. We will return to these scenarios later in the paper.

Scenario one: You are a hospital chief nurse, concerned about the decreasing fitness levels and increasing numbers of musculoskeletal problems in your nursing workforce. One of your senior nurses suggests that a weekly exercise programme for staff might help because "it works with Japanese car makers."

Scenario two: You are a public health nurse, and a mother asks you, "Is it OK to place my baby to sleep on her front [i.e., prone]?"

Irreducible Uncertainty in Nursing

What is uncertainty? In nursing, as in life itself, some decisions must be made without all the relevant information or the knowledge of whether the results of the decisions will make the situation better or worse. Central to professional decision-making in healthcare is choosing management strategies in the context of uncertainty. In healthcare, uncertainty is pervasive,

appears at each point in a patient journey and is inescapable (Hammond 1996).

The management of uncertainty can lead to unreasonable and unacceptable variations in healthcare (Eddy 1994). Nurses are not immune to these uncertainties and, as with physicians, their management of uncertainty can also contribute to variations in care. One clinical area for observing variability in nurses' decisions is wound care. Vermulen et al. (2006) examined the agreement between an "expert panel" and a sample of doctors and nurses who chose between gauze or occlusive dressings for a selection of wounds. For wounds that warranted gauze dressings, the mean level of agreement among nurses was poor (kappa [κ] 0.23, 95% confidence interval [CI] 0.15–0.31). Agreement was even worse for occlusive dressings (κ 0.12, 95% CI 0.07–0.16). Experience with more wounds did not lead to a greater consensus about what to do; the lack of agreement did not diminish in line with nurses' increasing clinical experience.

Nurses and Their Decisions

Decision-making is a regular part of modern nursing. In the United Kingdom, survey data showed that 64% (range 33–93%) of senior nurses make medical diagnoses, 71% (range 58–89%) order and interpret diagnostic tests and 94% (range 87–100%) make "professionally autonomous decisions" (Royal College of Nursing 2005). (*Senior nurse* is a term used to describe a variety of posts, such as clinical nurse specialist, nurse practitioner, advanced nurse practitioner and nurse consultant.) Canadian nurse practitioners are extending their roles to carrying out assessments, form differential diagnoses, make diagnoses and plan interventions (Canadian Nurses Association 2005). In cognitive psychological terms, the processes underlying these decisions are no different from those of doctors' decision-making and are just as vulnerable to bias and variation.

Types of Decisions

In a seven-year program of work examining the information-related behaviour of nurses, 240 nurses were observed and interviewed to determine and categorize the kinds of decisions they face and the *core uncertainties* in nursing (McCaughan et al. 2005; Thompson et al. 2001) Here, we use the term *decision* to include all the different types (Table 1), including judgments.

Volume of Decisions

The volume of decisions faced by nurses in clinical practice is substantial and an important aspect of the perceived complexity of clinical practice (Cader et al. 2005; Hamm 1998; Thompson 1999). Thompson et al. (2004) estimated that an acute care nurse would make an average of one decision every 10 minutes. Some estimates are even higher, with Bucknall (2000) observing one decision being made every 30 seconds in critical care. In primary care, a health visitor (public health nurse) faces at least five decisions per mother-baby consultation (McCaughan et al. 2005). Feeling pressured to make clinical decisions quickly (i.e., being subject to time constraints) is often cited as a reason why intuitive reasoning ("gut feeling") is considered the modus operandi of many nurse decision-makers (Thompson et al. 2004).

Nurses, Decision-Making and Responding to Uncertainty

When people are uncertain, their response is to seek ways to minimize uncertainty. In healthcare, professionals are expected to seek the best available knowledge to reduce their uncertainty and, in doing so, promote improvement rather than harm. In the United Kingdom, the code of the Nursing and Midwifery Council (2009) states that practitioners should "use the best available evidence." They must "deliver care based on the best available evidence of practice," ensure that any advice given about "healthcare products or services" is "evidence based" and ensure that the "use of complementary of alternative therapies is safe and in the best interests" of those in the care of the practitioner. These are professionally binding "standards of conduct, performance and ethics." However, enshrining the expectations in a professional code of conduct is no guarantee that individuals will actually engage in evidence-based practice.

In healthcare, uncertainty is pervasive, appears at each point in a patient journey and is inescapable.

Indeed, our examination (Thompson et al. 2004) of decision-related "information behaviour" (Case 2002) has shown this not to be so. Two studies of 240 acute and primary care nurses (McCaughan et al. 2005; Thompson et al. 2004) reveal that real-time engagement with written or electronic information (i.e., information that was *external* to one's own memories and experiences) constituted a tiny fraction of the time spent dealing with decision challenges and uncertainties. In 90 hours of primary care, the extent of information-seeking behaviour amounted to a single telephone call (to a colleague). In 180 hours of acute care, representing about 1,080 decisions, local protocols were examined four times and a drug manual used 50 times. Similar results have been found with nurses in Canada they favour experiential over scientific knowledge (Estabrooks et al. 2005).

It does appear, then, that certain kinds of decisions induce nurses to search for certain kinds of information. For most nurses, however, in most situations, intuitive reasoning – the use of knowledge from their own experience or the experiences of others – dominates.

For some theorists in nursing, this reliance on intuition is something to be promoted (Rew and Barrow 2007). Patricia

Benner and others have long argued that intuition in the hands of experts leads to better choices (Benner 1984; Benner and Tanner 1987). Unfortunately, the problem in nursing is that intuition is often deployed by non-experts, leading to less-than-optimal choices and exposure to reasoning biases. As Tversky stated, "Whenever there is a simple error that most laymen fall for there is always a slightly more sophisticated version of the same problem that experts fall for" (1983: 6).

With those results in mind, let us now return to the two scenarios posed at the beginning of the paper. Regarding scenario one, most readers would have been unsure if an exercise program for nurses would be a good thing. Despite not knowing, most readers would have relied on an intuitive sense of what they think – perhaps with reference to their own experiences or a sense of "right" and "wrong." Almost no readers are likely to have consulted the Cochrane Library (http://www.thecochranelibrary.com) or PubMed (http://www.ncbi.nlm.nih.gov/pubmed/) to seek an answer. If they had, they would have found that a randomized clinical trial of an exercise program for nurses showed no impact on fitness or injuries and merely interfered with nurses' ability to plan work (Skargren and Oberg 1999).

With respect to scenario two, most people now realize that having babies lie in the prone position – what "intuitively" sounds like a good idea based on babies' well-recognized propensity to

Table 1. Decision types and clinical choices expressed by acute and primary care nurses

Decision type	Examples of clinical choices
Intervention/effectiveness: decisions that involve choosing among interventions	Choosing a mattress for a frail elderly man who has been admitted with an acute bowel obstruction
Targeting: a subcategory of intervention/effectiveness decisions outlined above, of the form "choosing which patient will benefit most from the intervention"	Deciding which patient should get anti-embolic stockings
Prevention: deciding which intervention is most likely to prevent the occurrence of a particular health state or outcome	Choosing which management strategy is most likely to prevent the recurrence of a healed leg ulcer
Timing: choosing the best time to deploy the intervention	Choosing a time to begin asthma education for newly diagnosed patients with asthma
Referral: choosing to whom a patient's diagnosis or management should be referred	Deciding that a patient's leg ulcer is arterial rather than venous and merits medical rather than nursing management in the community
Communication: choosing ways of delivering information to and receiving information from patients, families or colleagues; sometimes these decisions are specifically related to the communication of risks and benefits of different interventions or prognostic categories	Choosing how to approach cardiac rehabilitation with an elderly patient who has had an acute myocardial infarction and lives alone with her family nearby
Service organization, delivery and management: decisions concerning the configuration or processes of service delivery	Choosing how to organize handover so that communication is most effective
Assessment: deciding that an assessment is required and what mode of assessment to use	Deciding to use the Edinburgh Postnatal Depression screening tool
Diagnosis: classifying signs and symptoms as a basis for a management or treatment strategy	Deciding whether thrush or another cause is the reason for a woman's sore and cracked nipples
Information seeking: the choice to seek (or not to seek) further information before making a clinical decision	Deciding that a guideline for monitoring patients who have had their dosage of angiotensin-converting enzyme inhibitor adjusted may be of use, but choosing not to use it before asking a colleague
Experiential, understanding or hermeneutic: relates to the interpretation of cues in the process of care	Choosing how to reassure a patient who is worried about cardiac arrest after witnessing another patient arresting

"spit up" (and on biological "first principles") – is actually not recommended. This increase in knowledge is due to good-quality and well-disseminated research (Mitchell 1993). Thus, a simple and "intuitively correct" idea, when rigorously and systematically evaluated, turns out to be not so correct after all.

The absence of behaviour to seek information from external sources and the promotion of professional (nursing) autonomy (even with commensurate accountability) means that intuitive reasoning is often the sole barrier or defence against errors (Reason 2000) and patient harm. Yet, as described by Croskerry (see "Context Is Everything," at http://www.longwoods.com/product.php?productid=20945), humans are prone to systematic errors when relying on intuition. Thus, when faced with a profession that values intuition in decision-making, is it possible to explore intuitive reasoning in ways that highlight the clinical implications? Is it also possible to provide suggestions for corrective interventions and quality improvement?

Methods for Unpacking the "Black Box" of Nurses' Decision-Making Errors

An important area of decision-making in nursing is the prediction of critical events. Nurses are a key link in the chain of contributory factors that lies behind "failure to rescue." For example, Hodgetts (2002) found that half of in-patients who suffered a cardiac arrest had had documented signs of deterioration in the 24 hours before the event – signs that had not been acted on. The data not acted on are those basic to nursing knowledge: heart rate, respiratory rate and oxygenation (Goldhill 2001). Medical emergency teams (METs) and critical care outreach teams bring expertise to the bedside, but their presence at the bedside still depends on a nurse's judgment. In a study by Cioffi (2000), 98% of calls to METs originated from nurses. However, when nurses' responses to abnormal vital signs were reviewed, up to 26% were associated with delays of between one and three hours (Crispin and Daffurn 1998), and changes in clinical signs resulted in a MET call in just 2.8% of cases (Daffurn et al. 1994). Nurses appear to be both misinterpreting and mismanaging valuable clinical information (McQuillan et al. 1998). Further information about the contribution of nurses' decision-making to patient safety comes from three related research projects (Thompson et al. 2007, 2008; Yang 2009), each of which used real data from *real* patients in *real* hospitals. The study questions included the following: Can nurses in clinical environments separate "signals" from "noise" (which is an issue at the heart of clinical uncertainty)? And Do nurses recognize their limitations in decision-making and adjust their reasoning and confidence accordingly?

Signal Detection

Signal detection analysis (Stainslaw and Todorov 1999; Swets et al. 2000) allows us to measure an individual's ability to identify correctly the presence or absence of a signal in an environment in which that signal is masked by the presence of noise. There are four possible outcomes of judging the probability of a critical event during a hospital admission: true positive (TP), false positive (FP), false negative (FN) and true negative (TN).

By exposing individuals to repeated sets or "trials" of decision challenges in the form of clinical scenarios and using signal detection analysis, one can calculate a person's ability to separate the signal (TP and TN) from the noise (FP and FN). The result is a statistic known as "d-prime" (d'). It is also possible to examine the decision "threshold" that a person sets for himself or herself in an effort to minimize the FP and FN and maximize the TN and TP. This latter result is known as beta statistic (β).

We are good at training nurses for certainty but not for the uncertainty that dominates clinical practice.

We asked 245 nurses in Canada, Australia, the United Kingdom and Holland if they would intervene in response to each of 50 clinical scenarios. For 26 of the 50 scenarios, we simulated time pressure by giving them less than 10 seconds to make a decision. As shown in Table 2, intuitive but more experienced nurses were twice as likely to intervene appropriately (β of –.10 as opposed to –.05) and were less likely to "miss" and so "fail to rescue" (23% versus 27%). Interestingly, whilst nurses with only 1 or 2 years experience have an increased tendency toward intervening, this is at the expense of the numbers of 'false alarms' in their judgements. Such false alarms are not trivial; they cost time (the nurse's and other healthcare professionals)

Table 2. Tendency toward intervening, misses and false alarms (*N* = 237)

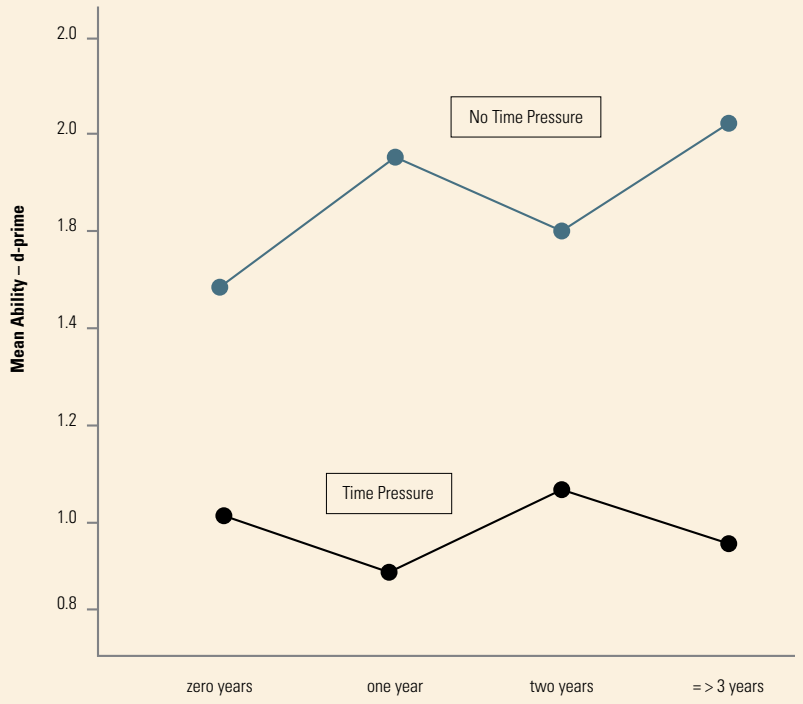
Experience in Critical Care in Years (*n*)	Decision Tendency: Mean β (SD)	Mean Proportion of Misses	Mean Proportion of False Alarms
0 (70)	–.05 (.54)	0.27	0.30
1 (84)	–.18 (.51)	0.21	0.34
2 (33)	–.47 (.52)	0.16	0.38
≥ 3 (50)	–.10 (.58)	0.23	0.30

SD = standard deviation.

and hence money in health systems, experience seems to offer the optimal blend of tendency toward action and ability to discriminate.

However, once time pressure was controlled for, it was clear that the benefits that accrued from extensive clinical experience were negated. This is shown by the flat trajectory of the bottom line in Figure 1.

Figure 1. Nurses' judgmental ability in the context of time pressure (*N* = 245)

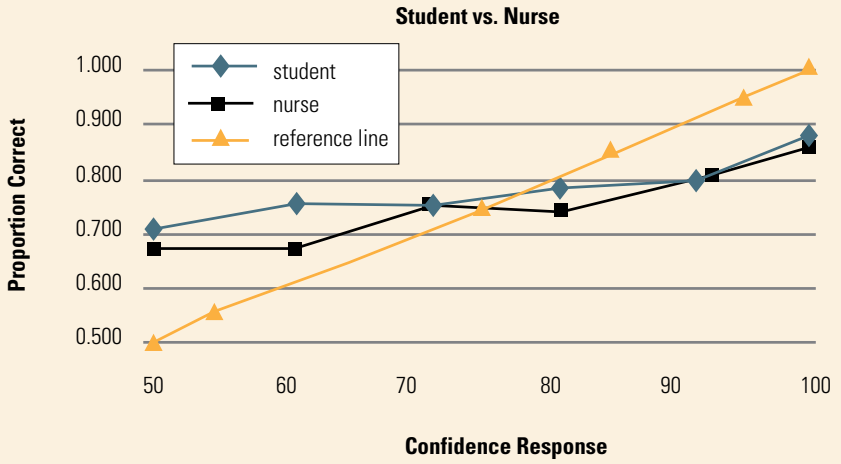


Calibration

Seeking information (if only a second opinion) depends on feeling uncertain. Do nurses recognize the impact of time and other contexts on their decision-making and adjust their personal confidence in "correctness" accordingly? In other words, are they well calibrated?

Yang (2009) used a high-fidelity clinical simulator to explore this question. She exposed novice and experienced nurses to a mix of written description clinical scenarios and more realistically simulated patient scenarios (using a SIM-MAN dummy and associated audio and visual cues). On average, experienced nurses were more confident but no more accurate than novices (Figure 2). Of more concern is the general trend seen in experienced nurses (as well as novices) toward over- and under-confidence (poor calibration). Thus, there is a lack of benefit associated with clinical experience when calibrating confidence with performance.

Figure 2. Confidence and accuracy of judgment in students and experienced nursing staff



Judgment Analysis

Judgment analysis (Cooksey 1996) offers an approach to illustrating not just the performance of nurses but the ways in which they weight, synthesize and employ appropriate information when making judgments. Judgment analysis is based on the concept of cognition as a "lens" through which information is focused and a judgment reached. Consider, for example, a nurse who is judging whether a patient in the emergency room, who has crushing, left-sided, radiating chest pain and a "normal" blood pressure, is worthy of medical attention on the basis that this is probably a cardiac event of some kind. The nurse *should* assign a higher weight to the chest pain than to the patient's blood pressure. When the nurse's judged

relationship matches the true (but unknown) relationship in the clinical environment, then the nurse is considered to have made an accurate judgment.

An analysis by Thompson et al. (2007) revealed that nurses varied significantly in their assessments of both the probability of a critical event and whether or not they would intervene (according to local protocols). The range for the probability of intervening varied from 6% in some nurses to 96% in others. These varying results were found despite that fact that each nurse had received identical information. The study revealed the following findings. First, in general, nurses had, at best, only modest performance. Second, they were remarkably consistent in applying this modest performance to each patient scenario. Third, a lack of linear reasoning explained why performance was suboptimal. Finally, the non-linear reasoning score (alongside the "modest" achievement) revealed no added value from the use of intuition and information beyond that presented.

Nurses failed to match the required reasoning for the task to the judgment task itself. This is troubling as making judgments is common in acute care nursing practice. Nurses did not seem to have "learned" by experience that a simple rule for helping judge when a patient is at risk of a critical event can, and should, suffice. If this judgment exemplar – scrutinized from three different angles: the ability to separate signal from noise, weight clinical cues appropriately, and calibrate personal confidence and performance – typifies other judgments in nursing, then what actions do we need to take to encourage better decision-making by nurses and thus contribute further to patient safety?

Bucknall observed one decision being made every 30 seconds in critical care.

Training Nurses for Uncertainty versus Certainty

One action we can take to encourage better decision-making involves education. As educators, we are good at training nurses for certainty but not for the uncertainty that dominates clinical practice. There are three areas in which this training should focus: (1) uncertainty recognition, (2) making use of evidence that might help reduce uncertainty in valid and reliable ways and (3) professional socialization.

We need to equip nurses with the skills, tools and confidence to recognize uncertainty. There is considerable professional reward in being recognized as the all-knowing, confident professional decision-maker striving toward a certain outcome. Unfortunately, such confidence is often unfounded, as is illustrated by the prevalence of errors (which are themselves often mistakes at the level of professional planning and cognition) (Reason 1998). Nurses are often exhorted to be reflective practitioners, but simple reflection is prone to the same biases as intuition itself, such as hindsight bias (Jones 1995). One remedy is to design feedback about decisions into daily work patterns. The use of routinely and automatically collected data may reveal trends in the unintended consequences of professional overconfidence in decision-making, trends not otherwise accessible to simple reflection.

One simple technique for recognizing uncertainty and converting it into a format suitable for the application of research evidence is use of the focused clinical question. Whereas the scrutiny of clinical questions asked by clinicians has long been a feature of examinations of medical uncertainty (Ely et al. 1999, 2002), research into nurses' clinical questions is comparatively rare. The technique of decomposing uncertainty into constituent parts, representing it as a clinical question and using this as the basis for search behaviour is well established (Flemming 1998) but not routinely taught in many nursing schools.

The well-focused clinical question is a firm foundation for search behaviour (Haynes 2006). However, nurses need to be given the means to search, appraise and apply research evidence to practice. Traditional methods of teaching critical appraisal are not universally effective (Taylor et al. 2000); therefore, innovative and practice-relevant means of teaching the use of research evidence in clinical decision-making should be developed and evaluated.

Perhaps the biggest change required of nurses is a social one: nurses need a process of professional socialization that encourages them to see themselves as active clinical decision-makers. The recognition of the power of clinical decision-making brings with it greater accountability and the need for a visible rationale for one's reasoning. This visibility itself encourages less reliance on unjustified intuition and increases the likelihood of more (appropriate) analytical approaches (Hammond et al. 1987). From a socio-professional context, the nursing profession needs to more closely align its dominant discourse – which stresses the advantages of holism, intuition and expertise borne of experience – with an empirical picture that, while less optimistic, may better represent many patients' and carers' experiences.

A recent critical review of the concept of "expertise" in nursing has debunked the myth of universal expertise in nursing arising solely from clinical experience, from being nominated as an expert by your peers or from just telling people that you are an expert (Ericsson et al. 2007). In a classic study, Highriter (1969) observed (rather than relying on self-reported data) and found no reliable difference between college- and hospital-trained nurses in their ability to manage patients and families in acute care. She did, however, comment that this could be due to the fact that nurses work under such time constraints that any difference would be difficult to see. Crucially, as the face validity of the methods used to represent clinical judgment and decision-making tasks increases, any difference between experts and non-experts largely evaporates. Corcoran-Perry et al. (1999)

found (as we did) that aside from few differences in the decision outcomes of expert and non-expert nurses, there was no difference in the reasoning processes of experts and non-experts. The differences that are seen (in performance of a task such as intravenous cannulation) are attributable to the quality of domain-specific training and experience, coupled with supervision and feedback pertaining to tasks, rather than to generic ideas of "development" or "reflection" by the nurse.

Conclusion

There are safety benefits at the societal level in having a workforce in nursing that is better trained in decision-making (as evidenced by the work of Aiken et al. [2003] and Needleman and Buerhaus [2003]). However, at the individual level of decision-making, it may be difficult routinely to identify these benefits.

Nurses, as the largest part of the healthcare workforce, have a huge, and hitherto underexploited, potential to contribute to the reduction of harm. One of the ways this contribution can be maximized is by recognizing that nurses do indeed make clinical decisions. This recognition must involve nurses as well as other professionals and policy makers. We all need to know more about the decisions that nurses make and the defences against weaknesses that can contribute to errors in decision-making. This knowledge must come from ways of exploring decision-making that do not rely on self-reported and post hoc descriptions of feelings, perceptions and actions.

When nurses' decision-making as a context for the implementation of evidence is better understood, then the idea of nurses as truly "knowledgeable doers" (Department of Health 1999), playing as full a part as possible in the patient safety agenda, will be closer to becoming a reality. HQ

References

Aiken, L.H., S.P. Clarke, R.B. Cheung, D.M. Sloane and J.H. Silber. 2003. "Educational Levels of Hospital Nurses and Surgical Patient Mortality." *Journal of the American Medical Association* 290(12): 1617–23.

Benner, P. 1984. *From Novice to Expert: Excellence and Power in Clinical Nursing Practice.* Reading, MA: Addison-Wesley.

Benner, P and C.A. Tanner. 1987. "Clinical Judgement: How Expert Nurses Use Intuition." *American Journal of Nursing* 87(1): 23–31.

Bucknall, T.K. 2000. "Critical Care Nurses' Decision Making Activities in the Natural Clinical Setting." *Journal of Clinical Nursing* 9(1): 25–35.

Cader, R., S. Campbell and D. Watson. 2005. "Cognitive Continuum Theory in Nursing Decision-Making." *Journal of Advanced Nursing* 49(4): 397–405.

Canadian Nurses Association. 2005. *Core Competency framework.* Canadian Nurses Assocation. Accessed June 27, 2009. http://www.cno.org/for/rnec/pdf/CompetencyFramework_en.pdf

Case, D. 2002. *Looking for Information: A Survey of Research on Information Seeking, Needs and Behaviour.* London: Academic Press.

Cioffi, J. 2000. "Nurses' Experiences of Making Decisions to Call Emergency Assistance to their Patients." *Journal of Advanced Nursing* 32: 108–114.

Cooksey, R.W. 1996. *Judgement Analysis: Theory, Method and Applications.* New York: Academic Press.

Corcoran-Perry, S.A., S.M. Narayan and S. Cochrane. 1999. "Coronary Care Nurses' Clinical Decision Making." *Nursing Health and Sciences* 1(1): 49–61.

Crispin C. and K. Daffurn. 1998. "Nurses' Responses to Acute Severe Illness." *Australian Critical Care* 11: 131–33.

K. Daffurn, G.F. Bishop, K.M. Hillman and A. Bauman. 1994. "Problems Following Discharge after Intensive Care." *Intensive Critical Care Nursing* 10: 244–251.

Department of Health. 1999. *Making a Difference: Strengthening the Nursing, Midwifery and Health Visiting Contribution to Health and Healthcare.* London: Her Majesty's Stationery Office.

Eddy, D. 1994. "Variations in Physician Practice: The Role of Uncertainty." *Health Affairs* 3: 74–89.

Ely, J.W., J.A. Osheroff, M.H. Ebell, G.R. Bergus, B.T. Levy, M.L. Chambliss and E.R. Evans. 1999. "Analysis of Questions Asked by Family Doctors Regarding Patient Care." *BMJ* 319: 358–61.

Ely, J.W., J.A. Osheroff, P.N. Gorman, M.H. Ebell, E.A. Pifer and P.Z. Stavri. 2002. "A Taxonomy of Generic Clinical Questions: Classification Study." *BMJ* 321(429): 432.

Ericsson, K.A., J. Whyte and P. Ward. 2007. "Expert Performance in Nursing: Reviewing Research on Expertise in Nursing within the Framework of the Expert Performance Approach." *Advances in Nursing Science* 30(1): E58–71.

Estabrooks, C.A., W. Rutakumwa, K.A. O'Leary, J. Profetto-McGrath, M. Milner, M.J. Levers and S. Scott-Findlay. 2005. "Sources of Practice Knowledge among Nurses." *Qualitative Health Research* 15(4): 460–76.

Flemming, K. 1998. "Asking Answerable Questions." *Evidence-Based Nursing* 1(2): 36–37.

Goldhill, D.R. 2001. "The Critically Ill: Following your MEWS." *QJM* 94: 507–10

Hamm, R.M. 1998. "Clinical Intuition and Clinical Analysis: Expertise and the Cognitive Continuum." In J. Dowie and A. Elstein, eds., *Professional Judgement: A Reader in Clinical Decision Making.* Cambridge, England: Cambridge University Press.

Hammond, K.R. 1996. *Human Judgement and Social Policy: Irreducible Uncertainty, Inevitable Error and Unavoidable Injustice.* Oxford, England: Oxford University Press.

Hammond, K.R., R.M. Hamm, J. Grassia and T. Pearson. 1987. "Direct Comparison of the Efficacy of Intuitive and Analytic Cognition in Expert Judgement." *IEEE Transactions on Systems, Man and Cybernetics* 17: 753–70.

Haynes, B.R. 2006. "Of Studies, Syntheses, Synopses, Summaries, and Systems: The '5S' Evolution of Information Services for Evidence-Based Healthcare Decisions." *Evidence-Based Medicine* 11(6): 162–64.

Highriter, M.E. 1969. "Nurse Characteristics and Patient Progress." *Nursing Research* 18(6): 484–501.

Hodgetts, T.J. 2002. "Incidence, Location and Reasons for Avoidable In-hospital Cardiac Arrest in a District General Hospital. *Resuscitation* 54(2): 115–23

Jones, P.R. 1995. "Hindsight Bias in Reflective Practice: an Empirical Investigation." *Journal of Advanced Nursing* 21: 783–88.

McCaughan, D., C. Thompson, N. Cullum, T. Sheldon and P. Raynor. 2005. "Nurse Practitioner and Practice Nurses' Use of Research Information in Clinical Decision Making: Findings from an Exploratory Study." *Family Practice* 22(5): 490–97.

McQuillan, P., S. Pilkington, A. Allan, B. Taylor, A. Short, G. Morgan, et al. 1998. "Confidential Inquiry into Quality of Care before Admission to Intensive Care." *BMJ* 316: 1853–58.

Mitchell, E.A. 1993. "Sleeping Position of Infants and the Sudden Infant Death Syndrome." *Acta Paediatrica* 82(Suppl. 389): 26–30.

Needleman, J. and P. Buerhaus. 2003. "Nurse Staffing and Patient Safety: Current Knowledge and Implications for Action." *International Journal for Quality in Health Care* 15(4): 275–77.

Nursing and Midwifery Council. 2009. *The Code in Full.* London: Author. Accessed June 27, 2009. <http://www.nmc-uk.org/aArticle.aspx?ArticleID=3056>.

Reason, J. 1998. *Human Error.* Cambridge, England: Cambridge University Press.

Reason, J. 2000. "Human Error: Models and Management." *BMJ* 320(7237): 768–70.

Rew, L. and E.M. Barrow Jr. 2007. "State of the Science: Intuition in Nursing, a Generation of Studying the Phenomenon." *ANS Advances in Nursing Science* 30(1): E15–25.

Royal College of Nursing. 2005. *Maxi Nurses. Advanced and Specialist Nursing Roles.* London: Jane Ball Employment Research Limited. Accessed May 1, 2009. <http://rcn.org.uk/_data/assets/pdf_file/0006/78657/002756.pdf>.

Skargren E and B. Oberg. 1996. " Effects of an Exercise Program on Musculosketetal Symptoms and Physical Capacity among Nursing Staff." *Scandinavian Journal of Medicine & Science in Sports* 6(2):122-30.

Stainslaw, H. and N. Todorov. 1999. "Calculation of Signal Detection Theory Measures." *Behaviour Research Methods, Instruments, and Computers* 31: 137–49.

Swets, J.A., R.M. Dawes and J. Monahan. 2000. "Psychological Science Can Improve Diagnostic Decisions." *Psychological Science in the Public Interest* 1: 1–25.

Taylor, R., B. Reeves, P. Ewings, S. Binns, J. Keast and R. Mears. 2000. "A Systematic Review of the Effectiveness of Critical Appraisal Skills Training for Clinicians." *Medical Education* 34: 120–25.

Thompson, C. 1999. "A Conceptual Treadmill: The Need for 'Middle Ground' in Clinical Decision Making Theory in Nursing." *Journal of Advanced Nursing* 30(5): 1222–29.

Thompson, C., D. McCaughan, N. Cullum, T.A. Sheldon, A. Mulhall and D.R. Thompson. 2001. Research Information in Nurses' Clinical Decision-Making: What Is Useful?" *Journal of Advanced Nursing* 36(3): 376–88.

Thompson, C., L. Dalgleish, T. Bucknall, C. Estabrooks, A.M. Hutchinson, K. Fraser, R. de Vos, J. Binnekade, G. Barrett and J. Saunders. 2008. "The Effects of Time Pressure and Experience on Nurses' Risk Assessment Decisions: A Signal Detection." *Nursing* Research 57(5): 302–11.

Thompson, C., N. Cullum, D. McCaughan, T. Sheldon and P. Raynor. 2004. "Nurses, Information Use, and Clinical Decision Making – The Real World Potential for Evidence-Based Decisions in Nursing." *Evidence Based Nursing* 7(3): 68–72.

Thompson, C., T. Bucknall, C.A. Estabrookes, A. Huthinson, K. Fraser, R. de Vos, J. Binnecade, G. Barrat and J. Saunders. 2007. "Nurses' Critical Event Risk Assessments: A Judgement Analysis." *Journal of Clinical Nursing* 18: 601–12.

Tversky, A. 1983. The New York Times. 6–12. Accessed June 27, 2009. <http://www.nytimes.com/1983/12/06/science/rational-decisions-prove-not-to-be.html?&pagewanted=all>.

Vermeulen, H., D. Ubbink, S. Schreuder and M. Lubbers. 2006. "Inter- and Intra-observer (Dis)agreement among Physicians and Nurses as to the Choice of Dressings in Surgical Patients with Open Wounds." *Wounds* 18: 10.

Yang, H. 2009. *The Effects of Improving Representative Design on Nurses' Risks Assessments: A Comparison of Written Case Simulations and Physicals Simulations.* PhD Thesis, University of York, York, UK

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