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Uncertainty, Error and Risk in Human Clinical Judgment: Introductory Theoretical Frameworks in Paramedic Practice.

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ABSTRACT

Paramedic judgment and decision-making, not unlike much of ambulance practice, have not been the subject of systematic, sustained research. There exists a paucity of research or inquiry that examines the mechanics of human error in paramedic practice, ambulance or pre-hospital settings. Little is known of how paramedics make judgments and decisions, and how paramedics deal with risk and uncertainty they commonly face in their tasks and the environment in which they work in. The literature and theories on judgment and decision-making are as extensive as they are controversial and the scientific community is yet to obtain a comprehensive understanding of the risk and uncertainty in judgment and decision-making.

The following paper provides an introduction to the concepts of error, risk, and uncertainty in the context of paramedic judgment and decision-making, discussion of two analytic frameworks that examine such error, risk, and uncertainty, and commentary on their application to the paramedic setting.

Introduction

Human judgment and error therein are critical elements of human activity and professional practice. Risk management strategies are methods that aim to limit the occurrence and impact of errors in human judgment. However, human judgment by its very nature always presents with the risk of error. Hammond,[**2**] in a meta-analysis of research into human judgment, refers to this as 'irreducible uncertainty, inevitable error and unavoidable injustice'. Institutions and organisations regulate human judgment using policies, procedures, standards and guidelines. Such instruments are however far from fallible. According to Hammond[**2**, p. 35], "uncertainty in the creation of social policy makes error inevitable, and error makes the injustice unavoidable".

Hammond[**2**] suggests that physicians and health care workers have always lived and will continue to live with irreducible uncertainty in diagnosis, prognosis, therapy, and indeed

virtually all phases of their professional activities. Some specialties within medicine and health carry with them additional risk, and have been identified and referred to as 'high-risk practices'.[**5**] Health care professionals in the emergency care, obstetrics, surgical, anaesthetic, general practice, oncology, paediatric intensive care, and psychiatric settings are faced with levels of risk that far exceed those of most other areas of medicine. The reasons for this are many and varied, but a common theme across all relates to the notion of risk and uncertainty.

Accidents in medicine cost human lives, create widespread environmental damage, and generate much public and political concern.[**4**] Individuals, organisations and institutions are today being called to account for their judgments and decisions more than ever before. Societal concern is growing for greater transparency in the decisions taken on its behalf by policy-makers and the professionals charged with interpreting and delivering the policies of central governments.[**7**] Health care workers, particularly paramedics, are taking on new roles— promoting health, giving diagnostic advice and prognostic information to patients, performing complicated and invasive medical procedures, assessing health risks and screening for early signs of treatable disease— in many cases with decreasing direct supervision. The freedom of health care professionals like doctors, nurses, psychologists and others to practise more autonomously has been accompanied by increased professional accountability for individual decision-making. Accountability for decision-making is the cornerstone of a largely self-regulated profession.[**7**] The relationship between knowledge and decision-making has been a crucial element of many health professions' attempts to increase their professional status—which many, such as medicine and dentistry, have achieved—spearheaded largely by the birth of evidence-based medicine. However, health 'professions' such as nursing and ambulance are yet to develop this relationship between knowledge, judgment, and decision-making, particularly in the paramedic ecology, that is the total contexts in which paramedics are engaged in decision-making. Clinical guidelines, protocols and procedures govern much of paramedic practice, designed to assist the paramedic in their decisions about patient care. Clinical guidelines and procedures are forms of social policy—that is, they propose regulatory principles of action for adoption by individuals, groups and organisations. As such they are results of social construction, accounts and representations of people. The effect of the use of clinical guidelines and protocols (as social policy within ambulance services) on the accountability of paramedic for the quality of care, and indeed management error, warrants investigation as does the relationships between knowledge, judgment and decision-making in light of the introduction of such guidelines.

Research into human clinical judgment in medicine and health is largely restricted to the medical and nursing professions. Although the 'medical practitioner' is central to Western models of medical practice, the practice and activity of other health-care professionals have an equally critical role in patient care outcome. Shaban[**6**] regards paramedics as important health-care professionals with a critical and unrecognised role in the continuum of health care. "Judgment under uncertainty is one of the most pervasive and difficult aspects of life" [**2**, p. 35], and paramedics are routinely required to work in environments of extreme and constant uncertainty, extending from multiple sources with multiple, synergistic effects. Paramedics, for example, are routinely called to attend to an unknown incident where the communications centre has been unable to obtain any case related information. Ambulances are routinely sent to locations on request from third party callers (callers not present at the scene with little or no information). Often emergencies calls are made to the telecommunications carrier (e.g. 000 in Australia) but where the caller hang-ups or their connection is lost (eg. mobile phones fall out of range) before any information is obtained. On arrival paramedics are often faced with difficult and complex situations that require

immediate and emergency intervention. Yet ambulance or paramedic clinical judgment has not been the subject of systematic sustained research**.** A thorough investigation of the literature located few studies that clinical judgment and decision-making practices of paramedics. We argue that research into judgment practices of paramedics is warranted in order to minimise irreducible uncertainty, inevitable error, and unavoidable injustice [2] in the delivery of quality and appropriate health care. To this end, we explore theoretical conceptualisations about decision-making, addressing their relevance to the study of decision-making in field of paramedic practice.

This paper introduces two distinct conceptual frameworks—the 'mechanics of error'[**4,5**] and the 'lens-model'.[**1,2**] In relation to the first of these, Reason[**4,5**] examines the fundamental concepts of error in adverse events, and the 'mechanics of error', referring to this as the 'human condition'. The framework proposed by Reason[**5**] gives researchers insight into the mechanics of error in human judgment and useful risk management strategies by systematic identification of the nature of the error in qualitative ways. However judgment analysis outlined by Reason[**5**] does not acknowledge, or places little or no emphasis on, risk and uncertainty in judgment processes. The second conceptual framework proposed by Cooksey [**1**] and Hammond[**2**] does allow for some characterisation of or insight into risk and uncertainty, and is useful in describing judgment processes in instances where the 'task' of an individual is not known, particularly in paramedic settings where individuals are often required to respond to 'unknown incidents'. This model is particularly relevant in the context of risk analysis and management strategies associated with unknown 'tasks' inside ill-defined, dynamic, uncertain environments with shifting and competing high-stakes goals.

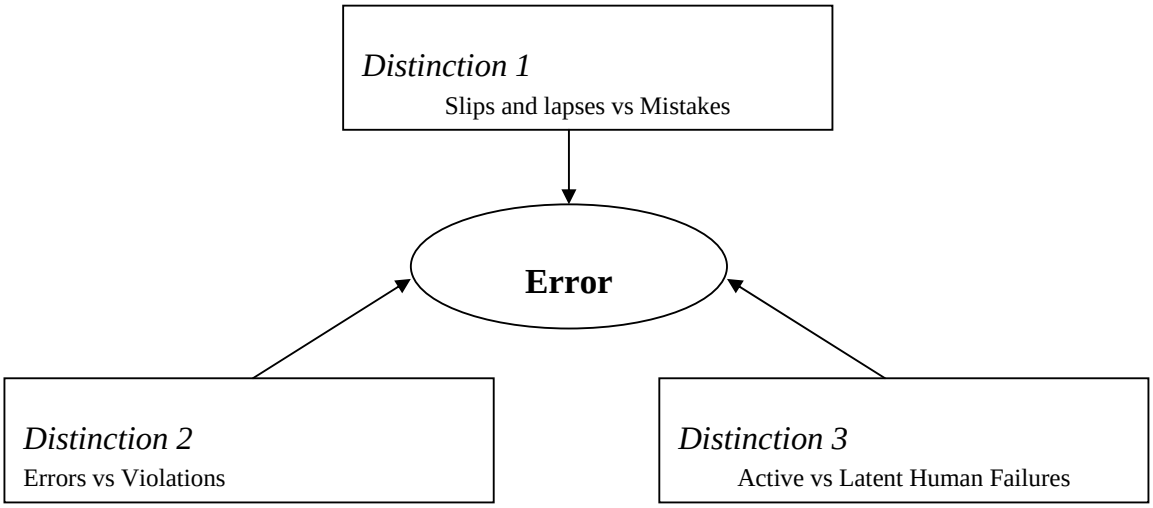
The 'Human Condition', adverse events and error

Human contribution is arguably the central element of error in human clinical judgment. Initial research into human clinical judgment in medicine focused heavily on the work of intensivists and anaesthetists. A survey of published work on human factors estimated that while the absolute numbered accidents decreased the contribution of human error to accidents in hazardous technologies increased fourfold between the 1960s and 1990s from minima of around 20% to maxima of beyond 90%.[**3**] This is due largely to improvement in the accuracy, efficacy, and quality of technology and equipment, which in effect shifts the aetiology of error away from 'equipment' and towards 'the operator'. Fundamentally, equipment is designed, built, operated, organised, and maintained by people. Regardless of the true figure of attributable error, human behaviour clearly dominates the risks to modern technological systems and practice in medicine.[**5**]

Error and the Human Condition

The human contribution to error in clinical judgment may be analysed a number of ways depending on the nature of the enquiry. Reason[**5**] provides an analytic framework for the examination of errors in a mechanical context. Rather than classify all errors in human clinical judgment as 'human error', Reason[**5**] argues that constructivist analysis of error is critical to psychological, sociological, and contextual understanding. Error has three defining levels of distinction pertinent to any analysis and interpretation, as outlined in Figure 1.1 below:

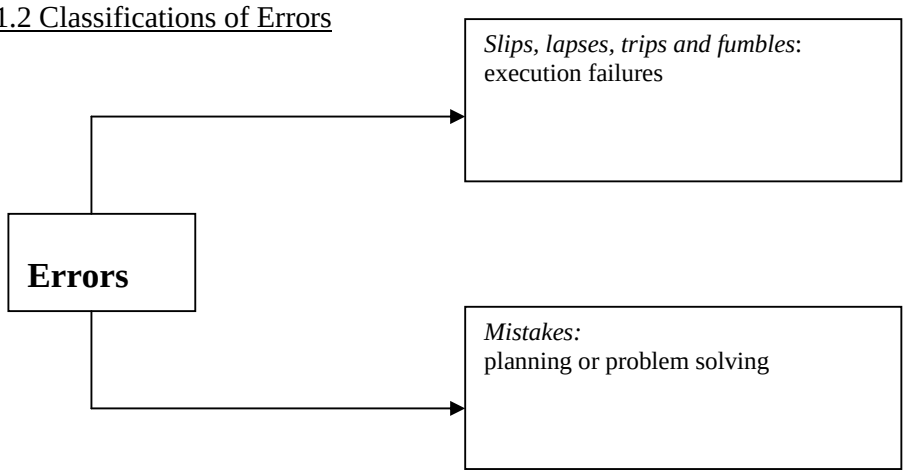
Figure 1.1 Distinctions within 'Error'



Distinction 1 – Slips and Lapses vs Mistakes

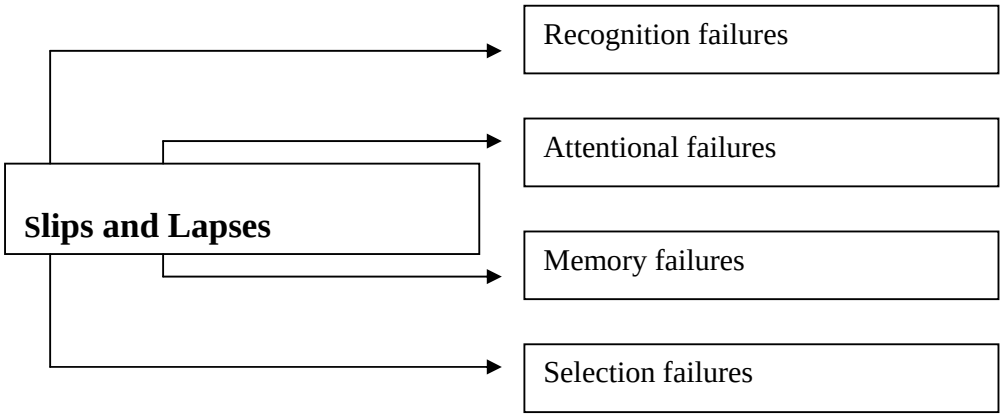
All errors represent some kind of deviation in preferred action or outcome. Defining error as a 'failure of planned actions to achieve their desired goal', Reason[**5**] argued that error could generally be classified in two ways. These are outlined in the Figure1.2 below:

Figure 1.2 Classifications of Errors



At the primary level, errors may be attributed to matters relating to 'execution failures', where the 'plan' is adequate and remains 'on-track' but the actions associated with it do not work out as intended. Typically, these may be caused by 'slips' that are related to attentional failures and 'lapses' where failure in memory may occur. They may be further classified as outlined by Reason[**5**] in Figure 1.3 below:

Figure 1.3 Classifications of 'Slips and Lapses'

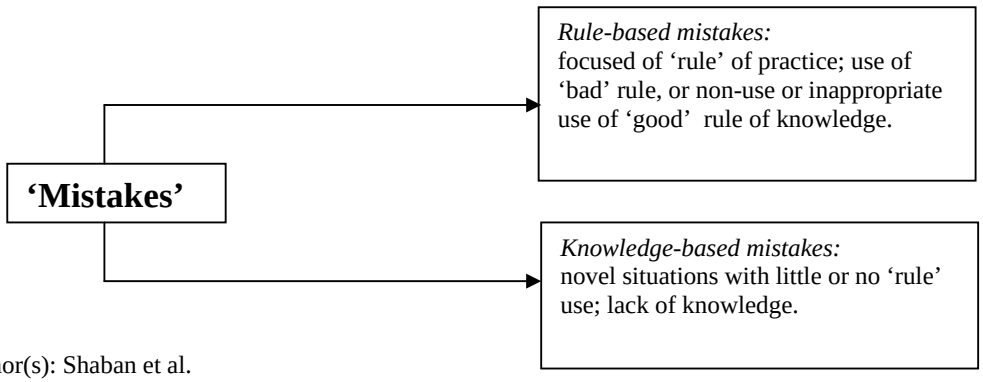


According to Reason[**4,5**] slips and lapses occur within the context of largely automated function in routine tasking, and are largely concerned with attentional failure of the subject. As an example, the incorrect identification of chest pain as symptomatic of indigestion rather than an acute myocardial infarction (AMI) may be classified as a 'recognition failure'. If a paramedic, in administering salicylic acid as anti-thrombolytic therapy in instances of cardiac chest pain, forgets to check if the patient has an allergy to the medication, or forgets a contraindication of the drug and administers it, that may be viewed as a 'memory failure'. These are however illustrative examples only. Research evidence, using this framework, is needed.

In contrast, 'mistakes' are said to occur when actions go entirely as planned, but the plan itself deviates from an adequate path. In this circumstance, "'mistakes' involve higher order cognition such as planning, formulating intentions, judging, and problem solving".[**5**, p. 12] A problem—defined as anything that requires a change or alteration of the current plan—.occurs in 'mistakes'. Typically, 'mistakes' can be classified in two ways, as outlined in Figure 1.4.

Mistakes may be rule-based or knowledge-based. In cases where a mistake is rule-based, the focus of the error revolves around a 'rule' of practice representing knowledge. More specifically, it pertains to the use of a 'bad' rule or the non-use or inappropriate use of a 'good' rule. Reason[**5**] suggests that knowledge-based mistakes are characterised by the use of slow, resource-limited but computationally powerful conscious reasoning carried out in relation to what is often an inaccurate and incomplete 'mental model' of the problem and its causes.

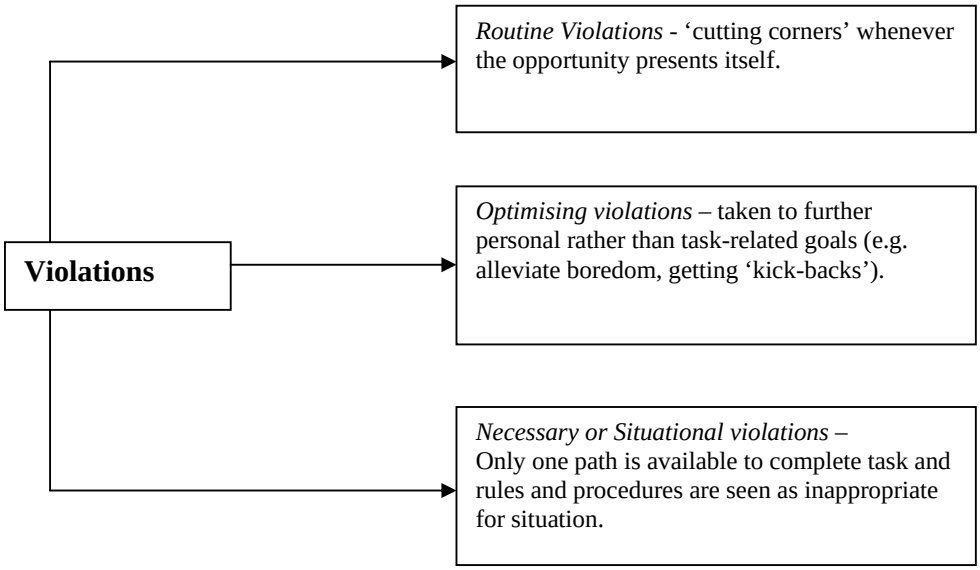
Figure 1.4 Classifications of 'Mistakes'



Distinction 2 – Errors vs Violations

According to Reason,[**5**] the second major distinction when analysing error involves the notions of errors and violations. Violations are deviations from safe operating practice, procedures, standards, or rules, and may be classified as routine, optimising, or necessary (situational), and are illustrated in Figure 1.5. Reason[**5**] pointed out that error and violations differ in a number of important ways. Errors are born largely from informational problems where the information is forgotten, incomplete, incorrect, or unknown, whereas violations are extensions with motivational dimensions. In preventing errors in the workplace, improvements in information-sharing and disseminating systems are required, including education, training, and professional development. Violations require organisational and motivational solutions that may build on errors in management systems.

Figure 1.5 Violations in Error



Distinction 3 – Active vs Latent Human Failure

The third and final element to the fundamental analysis of error as described by Reason[**5**] relates to the difference in the active or latent nature of error. Within this framework, active human error is such that the result of the error is negative and immediately, or almost immediately, known involving unsafe acts (errors or violations). For example, in psychiatry the failure to undertake a comprehensive mental health assessment of a patient may result in the inaccurate diagnosis of a patient condition wherein a condition is missed. This is typical of conditions such as suicidal ideations, violence, schizophrenia, and the affective psychoses. Many case studies have been reported where this has occurred, resulting in an almost immediate and significant consequence with the patient suiciding or committing a violent act such as rape or murder[**3**]. Examples here in paramedic practice could include the failure to invoke an involuntary treatment order and transport patients with an acute psychotic illness with suicidal ideations. Should the patient self-harm after being 'seen' by paramedics, this could be viewed as an 'active error'. Similarly the withholding of medication such as glyceryl trinitrate from a patient experiencing angina or chest pain, without justifiable cause or reason such as contraindication, resulting in deterioration of patient condition such as AMI

or cardiac arrest may be characterised as an 'active error'.

Conversely, latent failures are the result of decisions made or by positions taken by organisations as a whole, where the damaging consequence may lie dormant for some time only becoming evident when local triggering factors overcome the organisations defence mechanisms.[**5**]

The following section presents what is referred to by Cooksey[**1**] as the 'Lens Model' as an alterative means of exploring the ecology and judgment and the nature of decision-making.

The 'Lens' Model of Judgment Analysis – An Introduction

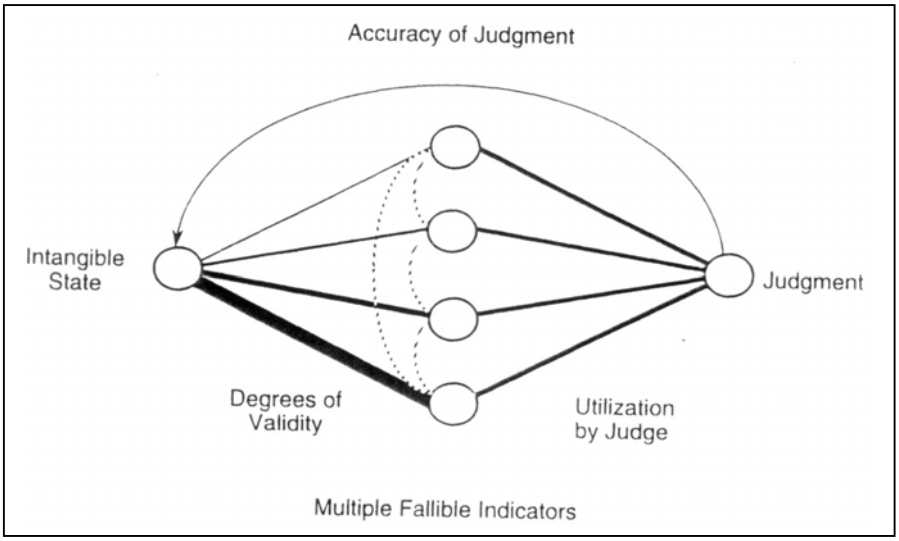
The 'Lens Model' is an alternative approach for the study of human judgment, proposing scope and theoretical framework constructs for judgment analysis. According to Hammond [**2**, p.167] "an organism is depicted as a lens; that is, it 'collects' the information from the many cues that emanate from an object and refocuses them within the cognitive system of the organism in the form of a judgment about the object". Cooksey[**1**] presents a number of variations in 'lens-model' analytic assessment systems, each placing different emphasis on the different aspects, types, and contexts of judgment. Two types are described briefly herein.

The 'single-system' is an analytic method that focuses on the judgment process itself, with minimal or no reference to information about the variables of criteria under study, the nature of the task environment, the social dimension, or the nature of interrelatedness of the judgment process and task environment.[**1**] Hammond[**2**] illustrates this in the Figure 1.6. The 'ecology' or 'criteria' of the task environment are characteristically unknown. "The 'single-system' lens model is a pictorial representation of the presence of:

(1) multiple fallible indicators or lenses (centre);
(2) their differential degrees of validity (thickness of lines indicates degree of validity);
(3) their interrelationships (dashed lines);
(4) degrees of utilisation (or weight by judge); and,
(5) accuracy of judgment"

(Hammond [**2**, p. 168])

Figure 1.6 'Single-System' Lens Model (Hammond [2], 1996, p. 168)

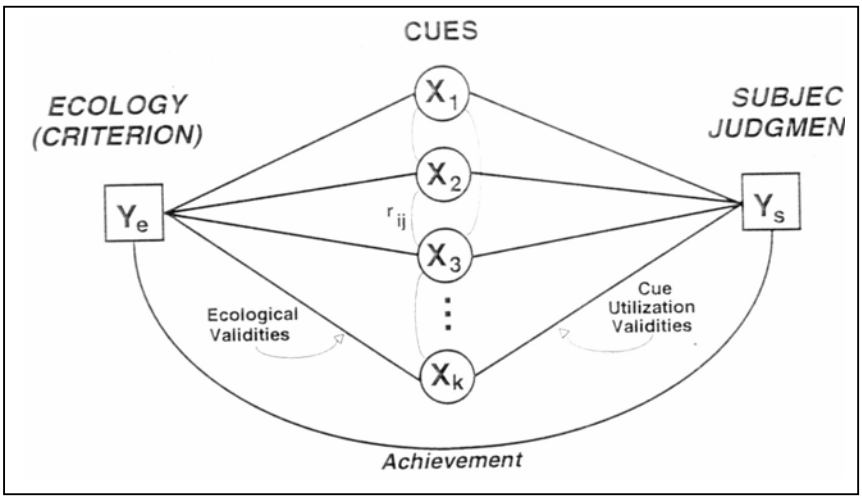


In this characterisation of judgment, the accuracy of information can be described in terms of its ecological reliability and the accuracy of a cue or indicator is described in terms of its ecological validity.[**1**] Both, along with time, have impacts on judgment. However, the central tenet of this system is that the judgment is based on the premise that the ecology of the task is unknown. An intangible event has occurred and, from that event through multiple fallible 'cues' with varying degrees of validity each interrelated with different weighting, judgment is made about the event.

This particular system is useful when considering the environment or ecology of paramedic practice. Paramedics are routinely faced with managing an 'event' where the characteristics of the event itself and the surrounding environment or ecology are unknown. Paramedics are often required to work in high stakes, time critical, uncertain and dynamic environments with ill defined, shifting, and competing goals. The quality and accuracy of the judgment is dependent on, among other things, intangible events that occur within the ecology or context of actual practice. This process would allow some insight into the judgment of the individual, focusing on the judgment itself regardless of the other factors such as information about the variables of criteria under study, the nature of the task environment, the social dimension, or the nature of interrelatedness of the judgment process and task environment. This then allows the description of such factors without emphasis on the relativity of such factors. Such a technique would be useful in the primary analysis of the judgments of paramedics when attending patients with conditions of unknown aetiology, typically by case audit or review. In doing so, this analytic technique allows researchers to 'build' pictures of judgment of intangible events. In comparison, the 'double-system' lens model differs from its single counterpart in that in this analytic framework the judgment cognitive system is compared explicitly with a known task or ecology. This is illustrated in Figure 1.7 below from Cooksey.[**1**]

The strength of this analytic method is in its ability to give insight into judgments about known tasks or events. Cooksey[**1**, p. 61] outlined that " in this system one needs to have available not only a sample of cue profiles (X_i)—representing cases or situations (real or simulated)—for judgment (Y_s), but also a distal criterion measure or outcome (Y_e) that is explicitly tied to each profile". The inclusion of explicit task outcomes provides insight into functional interactions between the person and the ecology being examined. Cues and their correlation in the ecological context are critical here, as found in the 'single-system'. Additionally, the ecological validity of each cue with respect to the criterion measure can be addressed and one can assess how well the ecology can be modelled on the basis of the cues.

Figure 1.7 'Double-System' Lens Model (Cooksey [1], 1996, p61)



The strength of the 'double-system' lens model is that it not only considers the judgment process but also gives consideration to the task conditions and implies comparison of the judgment with an objective assessment task outcome to gauge judgmental accuracy. This analytic method is useful in examining the characteristics of acknowledged experts' judgments in comparison with an available or known task. Therefore, it is assumed that participants have the requisite knowledge needed to exercise judgment, and that the 'double-system' lens model is used to demonstrate how the 'expert' uses knowledge in the context of varying ecology. Regression techniques are used to derive a statistical equation or algorithm, revealing how much weight is attached to each item of information related to the ecological situation or used in the judgment.[**1**]

Discussion

The approaches advocated by Reason[**4**], and Cooksey[**1**] and Hammond[**2**], are two of many competing theories that attempt to account for and investigate human judgment. Both frameworks provide insight of a type into judgment processes of individuals.

The error analytic framework provided by Reason[**5**] allows researchers to gain limited insight into the mechanics of error in human judgment. At present, little systematic and sustained examination of the investigation of error in ambulance and paramedic practice has been reported in the published literature. While traditional investigative case study techniques used satisfy organisational, institutional and legislative requirements, their application and importance with respect to development of professional 'bodies of knowledge', future risk management, education, training and research are not known. The systematic analysis of errors in paramedic practice using models proposed by Reason[**5**] may allow for greater success of risk management strategies by systematic identification of the nature of the error in more qualitative ways. For example, whether an error in paramedic practice is due to 'slips, lapses, trips or fumbles' as opposed to 'mistakes', as well as considerations relating to frequency, and consequence across a population, aid in developing risk management strategies in more productive, time efficient appropriate ways. The systematic monitoring and reporting of the types, nature, context, consequences and characteristics of error can serve to inform, for example, new needs of education and training programs, problems with policies, procedures and work instructions, or other factors otherwise unknown within the professional setting.

Importantly however, judgment analysis outlined by Reason[**5**] does not acknowledge, or places little or no emphasis on, risk and uncertainty in judgment processes. The framework proposed by Cooksey[**1**] and Hammond[**2**] does however allow for some characterisation of or insight into risk and uncertainty. The 'Single-System Lens Model' is useful in describing judgment processes in instances where the 'task' of an individual is not known, particularly in paramedic settings where individuals are often required to respond to 'unknown incidents'. This model is particularly relevant in the context of risk analysis and management strategies associated with unknown tasks inside ill-defined, dynamic, uncertain environments with shifting, high-stake and competing goals. Conversely the 'Double-System Lens Model' may be useful to describe the individual judgment relating to known tasks. Both systems seek to characterise the cues from which, or the 'lenses' through which, the individual associates his or her judgment. Neither framework however seems to be interested in describing actual judgment processes. The use of individual paradigms that over-simplify, rationalise, or fail to take into account or acknowledge the full complexity of judgment processes have been heavily criticised in the literature.[**7**]

Conclusion

Risk and uncertainty exist in human clinical judgment in all forms, disciplines, and faces of medicine. Medicine, although built upon pillars of beneficence and non-maleficence, arguably is not an exact science, if ever such an entity existed. Hammond[**2**] has argued that uncertainty in medicine is treated roughly the same today as it was a half a century ago. Despite the formation of multiple theories and paradigms of judgment and decision-making, medicine has only recently begun to take steps to cope with the consequences of uncertainty. Referring to evidence about advances in how medical knowledge is used, Hammond[**2**, p.35] asserts that:

> *There is little evidence that we are any more proficient today at making use of the hard-won medical knowledge that is available to us than we were a half a century ago, and much evidence that we are not. Irreducible uncertainty and its inevitable consequences remain formidable barriers to an effective distribution of knowledge.*
>
> *Judgment under uncertainty is one of the most pervasive and difficult aspects of life. Uncertainty in the creation of social policy makes error inevitable, and error makes the injustice unavoidable.*

The literature and theories on judgment and decision-making are as extensive as they are controversial. The fragmented nature of theories and studies to date within the general health disciplines addressing aspects of clinical judgment process has not yet resulted in a comprehensive understanding of the phenomena [**7**] or a suitable universal model or theoretical framework. In this paper, just two theories to explore judgment have been examined. The human judgment and error analytic techniques described by Reason[**4**], Cooksey[**1**] and Hammond[**2**] provide different methods to gain some insight into human judgment with mechanical, psychological and/or sociological emphasis. More research in this area is needed. The use of such methods to investigate judgment may mitigate irreducible uncertainty, inevitable error, and unavoidable injustice in the provision of pre-hospital emergency care.

References

1. Cooksey, R. W. Judgment analysis: Theory, methods and applications. Sydney: Academic Press; 1996.

2. Hammond, K. R. Human judgment and social policy: Irreducible uncertainty, inevitable error and unavoidable injustice. New York: Oxford University Press. 1996.

3. Green, G. Emergency psychiatric assessments: Do outcomes match priorities? International Journal of Health Quality Assurance. 1999: 12(7): 309-313.

4. Reason. J. Human Error. New York: Cambridge University Press. 1990.

5. Reason, J. Understanding adverse events: the human factor. In: Vincent. C. Clinical Risk Management. London: British Medical Journal Books. 2001.

6. Shaban, R. Z. Mental health assessments in paramedic practice: An investigation into the constructs and ecology and judgment and decision-making. Proceedings of the Annual Queensland Health Scientific Meeting; 2003 Dec 3-6: Brisbane, QLD, Australia: Queensland Health.

7. Thompson, C. & Dowding, D. Clinical decision-making and judgement in nursing. London: Churchill Livingstone. 2002.

Author Disclosure

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