AUSTRALASIAN JOURNAL OF PARAMEDICINE

PARAMEDICS AUSTRALASIA

Review

Paramedic judgement, decision-making and cognitive processing: a review of the literature

Meriem Perona BSc, BHSc(Paramedic), PGDipForensSc is PhD candidate[1]; Muhammad Aziz Rahman MBBS, MPH, CertGTC, GCHE, PhD is a Senior Lecturer and Public Health Physician[1]; Peter O'Meara BHA, MPP, PhD, FPA is Adjunct Professor[2]

Affiliations:
[1]Austin Health Clinical School of Nursing, La Trobe University, Victoria
[2]Department of Community Emergency Health and Paramedic Practice, Monash University, Melbourne, Victoria

https://doi.org/10.33151/ajp.16.586

Abstract

Background
Paramedics routinely perform multiple time-sensitive decisions in dynamic environments, often with limited information and equipment. Paramount to patient safety, how paramedics make judgements and decisions within their uncertain environment is important. The primary aim of this review was to identify, examine and synthesise the published literature on how paramedics working in the out-of-hospital environment use judgement and make decisions.

Methods
Databases CINAHL, Embase, Medline and PubMed were searched and common themes pertaining to paramedic decision-making were identified. Full text original research articles that focussed on how paramedics perform decision-making in the out-of-hospital environment were included. Papers excluded were non-English; those examining emergency medical technicians, nurse- or physician-led ambulances; paramedics operating in hospital or clinic-based environments; and studies of purely paramedic student populations. Data were managed using the 'preview, question, read, summarise' approach.

Results
A total of 362 abstracts and titles were reviewed; six were found to address the research aim. Of those six, four were qualitative in approach, one quantitative and one was mixed-methods. Overall, paramedics displayed the application of subconscious (intuitive) and conscious (analytical) thought processes – consistent with dual-process theory – with experience and formal education influencing factors. Paramedics gathered cues, problem solved, critically analysed, reasoned and displayed aptitude at rapid clinical impressions in critically ill patients with minimal information. Expert paramedics collected, processed and utilised information differently to novices portraying an interconnectedness of conscious and sub-conscious processing.

Conclusion
Paramedic judgement and decision-making is complex and multifaceted with multiple layers of knowledge interwoven. Implications for practice include better cognitive performance; educational course structure guidance; encouraging implementation of routine reflection and feedback, thus promoting continued improvement and better patient outcomes. Despite its importance, research was lacking.

Keywords:
emergency medical services, paramedic, ambulance, decision-making, critical thinking

Corresponding Author: Meriem Perona, M.Perona@latrobe.edu.au

Introduction

Paramedics form an integral part of the healthcare system providing out-of-hospital care with an ever evolving and expanding scope of practice (1). Although there is currently no single definition of 'paramedic' (2), Australasia's professional organisation for paramedics, Paramedics Australasia, define a paramedic as 'a health professional who provides rapid response, emergency medical assessment, treatment and care in the out-of-hospital environment'; and the United Kingdom College of Paramedicine states that 'paramedics are autonomous first contact practitioners who undertake a wide range of diagnostic and treatment activities as well as directing and signposting care' (3). As such, paramedics are required to assess and treat patients presenting with health and social-related emergencies of any nature and acuity (medical, traumatic, behavioural, psychological), and are routinely called on to make multiple time-sensitive clinical and non-clinical decisions. These are often performed in stressful and unpredictable situations within variable environments where lack of resources is an inherent factor (4,5). Moreover, these challenging operational circumstances yield conditions that are intrinsically uncertain and high risk (6), and are therefore prone to errors in judgement (7). Some argue that the decision density and time constraints encountered by paramedics in the out-of-hospital environment (8-10) are greater than those found in an emergency department (11). However, despite the varied and stressful conditions under which paramedics operate, only recently researchers have directed their attention towards clinical judgement and decision-making within paramedicine (12). Leading clinical decision-making theories from cognitive psychology support a dual processing approach in higher cognition (including processes such as reasoning, thinking, judgement, decision-making and social cognition) (13), which follows two differing modes of processing: one that occurs at a subconscious level, and one that occurs on a conscious level. The field of medicine has long acknowledged the importance of critical thinking, clinical judgement and decision-making abilities of the clinicians to patient safety heralding it as the physicians' most critical skill (14), however the field of paramedicine has only recently followed suit (11,15).

With humble beginnings as a trade where ambulance personnel were armed with a first aid certificate and a large stretcher vehicle, to formally trained paramedics capable of complex procedures such as pre-hospital thrombolysis in myocardial infarction (16-18), enhanced airway procedures including rapid sequence intubation (19) and pre-hospital ultrasound (20,21) to mention a few, the field of paramedicine has undergone both an extension as well as expansion in its scope of practice in the past 40 years (4,18). Many paramedics are now university trained (22), with an increasing number of countries acknowledging them as registered health professionals (23,24), and their skill set is ever growing to meet the needs and the demands of the communities they serve (25). Furthermore, the field of paramedicine has commenced developing its own body of knowledge steered by few academic paramedic experts (26,27), with the acknowledgement that what is applicable in hospital may not be 'in the field' (5). Pushing the bounds of paramedicine, the concept of mobile integrated healthcare and community paramedicine programs (involving community or extended care paramedics) has been implemented in some areas of the world with great success (28-31) and recent legislative changes in England have resulted in the possibility of independent prescribing of certain medications carried out by select paramedics being more realistic than ever (32).

Collectively, this growth in paramedic practice has been seen to harbour positive implications to patient outcomes (1,33). However, the phenomena of 'scope creep', ie. the supposed educational gap that ensues rapid increase in scope of practice (11), suggests that patient safety may also be impacted with clinical judgement and education seen as two key issues influencing patient safety in paramedic care (11,15). Given this, paramedics are met with increased demands for precise critical thinking, clinical judgement and subsequent decision-making, with their capacity to undertake such mental tasks under scrutiny; no longer is merely 'memorising' lists acceptable, but critical thought and analysis expected (1).

Arguably, understanding how paramedics perform clinical judgement and decision-making may assist in identifying and minimising negative influencing factors thereby reducing clinical errors and adverse events (14,34,35), translating into improved patient safety and outcomes as well as services provided to the community. Moreover, this knowledge has the potential to foster and inform the pedagogical approach of judgement and decision-making in novice paramedics and paramedic students (36). The primary aim of this narrative review was to identify, examine and synthesise the published literature on how paramedics working in the out-of-hospital environment make clinical decisions and use judgement.

Methods

A narrative approach was chosen due to the anticipated limited research specific to the paramedic field and predicted methodology heterogeneity, but also it sought to discuss theory evaluation and survey the 'state of knowledge' in this area (37). A search of the literature was conducted using the electronic databases: CINAHL, Embase, Medline and PubMed. A manual search of the references was conducted to account for any articles that may have been missed in the electronic search. In order to meet the inclusion criteria, articles were required to: have been written in English, original research, published in academic peer-reviewed journals with full text available, and contain a focus on cognitive processes utilised by paramedics during decision-making in the out-of-hospital environment. No date limiters were applied.

Articles were excluded if they focussed specifically on nursing or physician decision-making in the out-of-hospital environment (38), incorporated emergency medical technicians (EMT) (39) or EMS fire response participants (40) and did not allow for extrapolation of paramedic-specific findings, and did not examine or discuss the cognitive processes performed by working paramedics. Study protocols were also excluded (41), and the relevant paper outlining the findings sourced. In light of current understanding of the importance of experience and exposure on decision-making, articles that focussed on student paramedics only (34,42) were also excluded, and those that investigated both students and experienced paramedics were required to report on them separately to meet inclusion (43).

Database searches were conducted in March 2018 with titles, abstracts and full text articles reviewed by one author (MP). The analysis and synthesis of articles for this review adopted the 'preview, question, read, summarise' ('PQRST') approach to data management, as proposed by Cohen (cited in Cronin) (44). In summary, following de-duplication, the abstracts and titles of articles were overviewed and general classification of themes allowed to emerge then manually organised into files accordingly (45). This approach facilitated the emergence of the most commonly reported themes throughout the literature derived from the search terms allowing for identification of articles potentially exploring paramedic cognitive features to be identified for deeper evaluation. Thereafter, each article requiring further analysis for inclusion was carefully read, summarised and appraised using the critical appraisal skills program qualitative studies checklist (46).

Table 1. Search strategy

Electronic database search strategy*
1. Clinical decision-making 2. Diagnostic reasoning 3. Critical thinking 4. Clinical judgement 5. #1 or #2 or #3 or #4 6. Emergency medical services 7. Pre-hospital care 8. Paramedic personnel 9. Paramedic 10. Out-of-hospital 11. Pre-hospital 12. Ambulance 13. #6 or #7 or #8 or #9 or #10 or #11 or #12 14. #5 and #13
*Limits applied: full text, peer-reviewed, English language

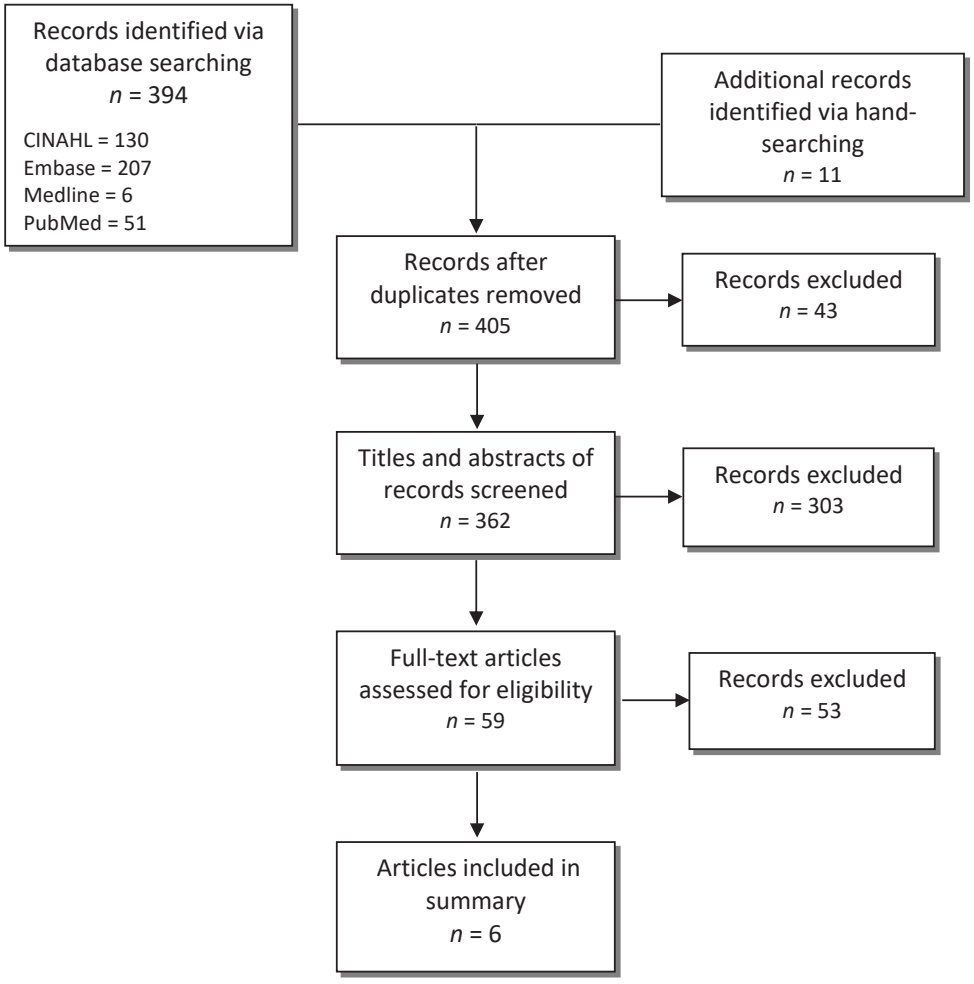

Figure 1. Flow chart diagram of the review process

Table 2. Summary of articles examining cognitive processing during paramedic decision-making

Author	Location	Sample	Research design	Findings
Jensen et al (47)	Nova Scotia, Canada	Participants: primary, intermediate and advanced care paramedics (n=904) Students registered in primary care paramedic programs (n=268)	Quantitative: Rational Experiential Inventory-40 (REI-40) Likert survey – a psychometric tool used to identify thinking style preferences centred around dual processing cognition – examining thinking styles (preferred and perceived) of working paramedics and paramedic students	Both cohorts had a perceived ability to use experiential and rational thinking with both groups scoring higher for rational thinking than experiential thinking. This inferred a preference for the former thinking style
Jones et al (48)	New York, USA	Participants: paid and voluntary BLS (n=20) and ALS (n=30) EMS providers from nine different EMS services (n=50)	Qualitative: focus group interviews using purposive sampling of basic and advanced life support paramedics exploring how paramedics undergo trauma triage and hospital destination decision. Data were collected using a standardised questioning guide to assess EMS provider trauma triage decision making	Eight themes were identified: rapid evaluation, use of estimation, provider intuition, provider education/training, thought process, protocol application, patient factors, and system factors Initial intuition enabled judgement used to govern treatment priorities and assessment order. First patient assessments yield dichotomous normal/abnormal inferences, later verified with a slower more thorough assessment
Smith et al (49)	Ohio, USA	Participants: – registered paramedics (n=10) – novice paramedics: 6–12 months' experience (n=6) – expert paramedics: supervisor recommend and >3 years' experience (n=4)	Qualitative: 'staged world' cognitive task analysis utilising mixed fidelity simulation of two clinical scenarios (one medical, one trauma) followed by post-scenario interviews	Expert paramedics generated more hypotheses, engaged in greater cue gathering including the alteration of treatment and questioning where required, and applied more inferential and strategic reasoning than their novice counterparts
Wyatt (50)	Victoria, Australia	Participants: ICP ≥4 years' experience acting as clinical educators (n=3)	Qualitative: ethnographic case study using participant observation and interview to gather data – purposive sampling Tacit knowledge made explicit through interviews by encouraging deep reflection on judgements made	Knowledge forms in a particular context which impacted behaviour and is altered with changes to context Experience seen to impact clinical judgement, as did observing colleagues operate. Reflection was highlighted as important Difference in thinking processes and information storage between expert and novice paramedics
Shaban (51)	Queensland, Australia	Participants: (n=3) – one male paramedic, vocational training, 30+ years' experience – one male paramedic, advanced diploma, 10 years' experience – one female ICP, advanced and associate diploma, 10 years' experience	Qualitative: case study designs that incorporated semi-structured interviews around previous cases attended by those specific paramedics. Examined paramedic clinical judgement and decision-making during care of patients with mental illness	Knowledge, experience and intuition came together to assist the paramedic in judgement and decision-making of mental illness. Patient and paramedic safety was at the forefront of decisions
Ryan and Halliwell (52)	United Kingdom	Participants: (n=108) – ICHD vocationally trained employing managers (n=30) – ICHD vocationally trained tutors (n=8) – foundation degree students (n=30) – BSc honours degree students (n=50)	Mixed methods: case study approach with phenomenology and hermeneutics employing interviews, focus groups and questionnaire surveys. Investigating whether students are 'road practice ready' by graduation	Vocationally trained paramedics relied heavily on intuition and experiential knowledge. Conversely, university graduate paramedics lacked experiential knowledge, though adopted hypotheticodeductive reasoning incorporated with templates used to gather data (eg. primary survey)

Results

After removal of duplicates, a total of 362 abstracts and titles were reviewed and from that, the full text of 59 articles were further assessed resulting in six articles included in the final summary. One article (47) was quantitative using a Likert scale survey, while four articles utilised a qualitative approach (48-51) with the remaining article mixed-methods (52). Of the qualitative articles a mixture of data collection was used including interviews (48-50,52), clinical scenarios (18,49), case study (51), questionnaire survey (47,52) and real-life observation (50). Common themes pertaining to paramedic cognitive processing and decision-making were identified among the articles screened. Five themes emerged: i) sub-conscious versus conscious cognitive actions, ii) specific decision-making processes, iii) effect of experience on judgement and decision-making, iv) how increasing expertise results in different decision-making processes, and v) the effect of education on judgement and decision-making.

i) Sub-conscious versus conscious cognitive actions

Common threads throughout the included studies incorporated the concept of a rapid subconscious information base and thinking process as well as a rational conscious and methodical one. The thought processes derived from the former cognitive elements were portrayed by participants using various terms and were frequently described as difficult to surmise and measure; somewhat intangible in nature and not arising from 'a verifiable or objective source' (51). Terms used throughout the articles to describe this included: 'intuition' (48,49,51,52), 'gut feeling' (48,49,51,52), 'insight' (51), and 'informal knowledge' (51). This theme appeared across studies examining various types of settings seen in paramedic practice including mental illness (51), trauma triage and hospital destination choices (49), as well as during general paramedic practice (52). For example, Shaban (51) reported sub-conscious processes were a significant driving theme encompassing safety (patient and paramedic) in mental illness attendances, whereas Jones et al (48) reported its use where speed over accuracy was warranted in the setting of trauma amidst abundant time-sensitive pressures. Paramedics in Ryan and Halliwell (52) also reported making intuitive-driven decisions overall based on pattern recognition pulling from previous experience.

At the crux of this phenomenon, Wyatt's (50) seminal paper explicated the elusive cognitive entity 'tacit knowledge'. Wyatt describes tacit knowledge as the non-formal knowledge acquired within the milieu of the workplace obtained during the action of doing and further enhanced by broader social and cultural associations. However, as this knowledge form was seen to be contextual so too is it altered with changes to that context, ie. when transitioning from Advanced Life Support (ALS) paramedic to Intensive Care Paramedic (ICP), or nursing practice to paramedic practice.

Although sub-conscious cognition was heavily implicated in judgement and decision-making throughout these articles, not all actions were seen to be based on this cognitive enigma, with slower conscious thought processes used to form judgements and decisions also appearing throughout the literature. These were based on theoretical knowledge, ie. explicit knowledge that is evidence-based and sourced from articles and books (50,51). Participants in Jones et al (48) impressed performing slower more thorough assessments including acquiring more accurate measurements, when time permitted and once initial interventions had been undertaken and was reportedly used to verify what had already subjectively and intuitively been determined. Similarly, the verification of sub-consciously process driven decisions with consciously analysed theoretical information was expressed by a participant featured in Shaban's (51) work, whereupon they stated their 'formal knowledge' was searched for information to substantiate decisions made via 'informal knowledge' as this would allow decisions to withstand scrutiny on the basis of evidence-based knowledge.

ii) Specific decision-making processes

The decision-making processes exhibited in the literature were far more extensive than a simple sub-conscious/conscious binomial modality. Instead, it was infinitely complex and interwoven. Paramedics repeatedly reported gleaning information from various sources, or 'gathering cues', in an attempt to understand the circumstances, and then situating themselves such that they could understand the intricacies of the problem (both medical and social), affording them an opportunity to make sound decisions within the sphere of the patients' needs (49,51,52). They hypothesised of potential clinical manifestations (49,52), engaged in verbal discourse with other paramedics in collaboration particularly during challenging cases and uncertainty, anticipated outcomes of their management and interventions, and performed critical reflection thereafter (49,50). Paramedics considered the needs of the patient, both systemically and individually (48) as well as exhibited forward-thinking via contemplation of what the patient would encounter – consequences that may occur – after the paramedic's aspect of care was concluded, whether at hospital or at home (51).

Wyatt's participants also responded to unfamiliar problems with problem solving heuristics (mental shortcuts) (50), and Ryan and Halliwell (52) emphasised the application of tools such as mnemonics and checklists to gather clinical data to aid in a systematic approach. Clinical guidelines (or protocols) were also implemented (algorithmic thinking), however, were not seen to be blindly followed in word-for-word fashion, but rather interpreted via the lens of prior experiences, particularly among more senior paramedics (48,50). Jones et al (48) argued that decision-making is not linear, patient assessments, interactions and their needs are not linear, and so guidelines, which are fashioned in a linear step-by-step fashion, were not often used in the setting of trauma triage.

iii) Effects of experience on judgement and decision-making

Rigid uncompromising judgement was reported among novice paramedics, with interventions initiated in a step-wise fashion after all information is thoroughly gathered, and decisions

strongly governed by guidelines (50). However, with gained experience, the paramedic's approach to problem solving, judgement and decision-making is seen to transition; decisions are made faster and main presenting problems are identified and addressed earlier, presumably as they develop and enhance their tacit knowledge repertoire. Many participants throughout the included studies highlighted the importance of experience on augmenting their sub-conscious processing and described these experiences as stored experiential knowledge (49,51,52) which was instrumental in the formation of pattern recognition (52). All paramedics in Shaban's (51) study impressed their use and reliance on intuition based on previous experiences, with one referring to it as 'field knowledge', stating he combined this with what he had learnt from his formal education to make judgements and reach decisions. Shaban (51) concluded the different combinations and permutations of knowledge, experience, and intuition enabled judgement during the course of paramedic work.

iv) How increasing expertise results in different decision-making processes

Experiential knowledge was evident among expert paramedics and is instrumental to the transitional development from paramedic novice to expert. However, while experts drew on their previous experiences as stored knowledge, Wyatt (50) cautioned that experience alone did not make an expert and experiential knowledge does not act in isolation. Experts in Wyatt's study espoused the importance of theoretical knowledge, but also the invaluable process of routine reflection and feedback (experience as a reflective tool), as well as the observation of colleagues operating. Both Wyatt (50) and Smith et al (49) proclaimed a distinction in thinking processes and information storage between expert and novice clinicians with experts possessing a greater effectiveness of information interpretation. Furthermore, experts displayed greater flexibility and openness to a patient's clinical presentation via a reluctance to label patients with a specific diagnosis, thereby circumventing a reduction in their professional capacity to consider multiple options (50). As such, unlike novices who were established to be rigid and uncompromising in their approach, experts were able to alter the course of management or make amended judgements based on new evidence or information derived from patient assessments, incorporating new findings into hypotheses revisions accordingly (49,50). Experts were able to act anticipatorily employing greater inferential and strategic thinking (49,50), with judgement and decision-making ability enhanced by their self-confidence and willingness to try (50).

Interestingly, experts were seen to vocalise in the setting of multiple patients and divided competing priorities (49), and when confronted with unique and non-routine cases where pattern recognition fails, outwardly discussing issues and sharing experiences with other present paramedics, thus facilitating open collaboration and consensus obtainment on the most suitable course of action (50).

Ultimately, experts in both studies were seen to gather, process and utilise information differently to non-experts portraying an interconnectedness of conscious and sub-conscious processing drawing on information from multiple sources, including: observation of colleagues operating, other health professionals, patients and their families.

v) Effects of education on judgement and decision-making

The presence of formal education was seen to alter how paramedics approached problems, made judgements and undertook decisions (52). When judgement and decision-making were examined among experienced paramedics, those that had completed formal education stated their educational foundation assisted in the process, facilitating the combination of informal and formal knowledge to foster reasoning and govern decisions. Hence, decisions were formed based on the needs of the individual patient. Interestingly, a paramedic participant from Shaban's research with extensive experience (over 30 years), with no formal tertiary education, felt his education was lacking in the area of mental illness and purported to rely heavily upon intuition, experience and algorithmic thinking with decisions based on risk-aversion behaviour entrenched in fear of ramifications (51).

Similar correlations between formal education, theoretical knowledge and decision-making were reported by Ryan and Halliwell (52). Paramedics with extensive experience, although trained under the Institute of Health Care Development based vocational education program, reported confidence in decision-making due to experience-primed pattern recognition, and therefore reliance on intuition. Conversely, university graduates, even though they appositely lacked experiential knowledge, reported confidence in decision-making due to training involving a pedagogical method enforcing a structured patient approach via the use of templates (eg. primary survey: DRABCDE) to gather information with treatment options based on findings using a hypotheticodeductive reasoning model (the formulation of hypotheses followed by sourcing data to disprove hypotheses generated). Furthermore, they possessed a deeper understanding of principles and displayed relational threads between different subject areas. Similarly, Jensen et al (47) revealed a preference for, and perceived ability to use, analytical styled thinking as reported by university students (as well as working paramedics) when administered a validated psychometric tool used to identify thinking strategy and preferences centred around dual processing cognition. Such findings potentially challenge our current understanding on how paramedic novices, experienced paramedics and paramedic experts all approach their decision-making, and the pedagogy influencing variables behind them.

Discussion

The findings of this review have displayed judgement and decision-making processes performed by paramedics to be complex and multifaceted. Experience is seen to enhance

one's sub-conscious, or intuitive, capacity, while depth and breadth of knowledge coupled with reflection steeped in experience is seen to encourage expertise, however contextual. The implementation of formal education augments one's capacity for hypothesis generation and problem solving, enhancing conscious analytical thinking. Each of the included articles emphasised a sub-conscious fast cognitive approach as well as a slower conscious analytical one. These findings all offer support for the dual-process theory of cognition to judgement and decision-making among paramedics.

Theories addressing dual cognitive processing have become the most dominant and widely accepted approach among cognitive and social psychologists, as well as neuroscientists, as the model that best describes the human judgement and decision-making process (13) including those of physicians (53) and, more recently, paramedics (54). The fundamental theme postulated within these theories encompasses two distinct modes of cognitive processing styles with each possessing differing characteristics. Type 1 processing is hypothesised to occur on the subconscious level, is efficient, instinctual, non-analytical, implicit and utilises heuristics, colloquially referred to as 'gut feeling' (14). Conversely, Type 2 processing is conscious, slow, abstract, analytical and deliberate. Type 2 processing is called on when a more complex problem requiring in-depth reasoning arises and consequently carries a higher cognitive load (55,56). It is enhanced with maturity, socialisation, undertaking formal education, and can be refined by training in critical thinking and logical reasoning (57). It should be noted, however, that one processing type does not occur independently of the other with the decision-maker oscillating between the two cognitive processing modes on a continuum (known as the cognitive continuum theory) (57-59) whereby the outcome involves a synthesis of both processing modes. Another processing type, 'Type 2-by proxy', utilises tools developed using evidence-based knowledge such as guidelines/protocols, mnemonics, algorithms and are known to be frequently used by paramedics (54). All of these elements were seen throughout the analysed articles, supporting this theory within paramedic practice.

Applying this philosophy in a clinical capacity, on first patient encounter, the clinician subconsciously initialises his or her Type 1 processing by searching for prominent features or combinations of salient symptoms resulting in pattern recognition triggers (gestalt effect) garnered from past experiences (57,60), thus allowing the clinician to rapidly form hypotheses or differential diagnoses (61). As this is recognition-primed, this method is effective only if the patient is presenting in a manner that provides the clinician with the particular contextual and clinical clues necessary for the pattern recognition triggers available in their Type 1 processing repertoire (14). Given this, it is argued that Type 1 processing leaves the clinician susceptible to misdiagnosis and clinical errors, particularly when the patient presents with atypical symptoms (57,62) – intuition is not infallible.

Unrecognised patient presentations initiate the engagement of Type 2 processing (14), and attempts to make logical sense and rationalise the presentations via a systematic examination of the presenting data to determine the diagnosis (57). Evidently, the depository of knowledge within one's non-analytical processing ability is influenced by the experience level of the decision maker (60,61). With repetition, practice and experience, processes that once required Type 2 processing transfer into a Type 1 processing event, ie. Type 1 is enriched due to prior learning through Type 2 (13,63). Accordingly, experienced clinicians recognise significantly more patterns using Type 1 cognition, spending greater time in Type 1 processing, while novices spend most of their time in Type 2 processing (14). Such a transition of knowledge represents 'intuition', tacit knowledge or experiential knowledge and explains why novices who have yet had opportunities to develop this, are routinely reported to act in a slow deliberate fashion, ie. utilising Type 2 thinking. The findings of Wyatt (50) eloquently portray this phenomenon in depth whereupon novices and experts are seen to approach cases differently, with the expert drawing on multiple forms of knowledge. However, it is prudent to acknowledge that, even though experience entrenches a robust Type 1 processing capacity, experience does not automatically imply expertise; the two are not synonymous.

Where experience is often correlated with time, expertise reflects depth of knowledge – knowledge that is specific and extensive to the specified field (or domain) – requiring accumulation of skill based on time, experience and practice to develop. As Hoffman (64) explains, the development of expertise involves the progression form a superficial and literal understanding of problems (as structured in the novice) to an articulated, conceptual and principled understanding. Their problem representation is more abstract (as opposed to concrete) and draws from deep knowledge (64). Therefore, experts possess a different organisation and interpretation of knowledge in comparison to their non-expert counterparts (64), as reported by Smith et al (49) and Wyatt (50). Another notable quality witnessed in experts was the verbalisation, or explicit reasoning, when in a group and confronted with an ambiguous or challenging patient presentation (49,50). Such verbal discourse is seen to invite other group members to participate in reciprocated problem solving (cognitive load sharing), and facilitates mutual performance monitoring (65). Agreement will be noticed, however so will dissent and any inconsistencies in reasoning become apparent, resulting in greater efficiency of the team and better patient outcomes (66). During such situations shrouded in uncertainty, experts display a shift from their tacit-rich knowledge processing to a return to algorithmic and analytical thinking (50).

Vital to the development and maintenance of expertise is reflection and feedback (including outcomes) (67,68). This cognitive activity facilitates the restructuring of knowledge as

experiences are reviewed and outcomes appraised and measured against actions; expertise is dynamic and constantly evolving. Nevertheless, unless an action produces an immediate response, paramedics do not routinely receive formal feedback, such as physician confirmed diagnosis or patient outcomes; what Croskerry (69) refers to as 'specialty follow-up deficiency'. This hampers the paramedic's opportunity to reflect on their prior thoughts (such as hypotheses generated) and resultant actions, thus impeding the reconstruction of said knowledge (67,68,70).

As established earlier, Type 2 processing is heavily influenced and enhanced by education and refined by training in critical thinking and reasoning. The acquisition of rich theoretical knowledge and development of cognitive skills during higher education undoubtedly impacts one's confidence in decisions made (71) and ability to engage in their Type 2 processes (72). Given that globally the paramedic field is in a period of rapid metamorphosis with increased demand on its constituents, the inception of university degrees into the training of paramedics is still relatively recent for some countries, such as Australia and the UK (22,52,73), with many countries still not requiring tertiary-based training as a prerequisite for employment (74). Therefore, the paramedic workforce consists of a coalescence of vocationally trained paramedics (many of whom, with the inception of ALS practice, undertook bridging courses), vocationally trained paramedics who have upskilled to ICP and completed formal training during that process, baccalaureate-holding paramedics, and baccalaureate-holding paramedics who have upskilled to ICP with post-graduate qualifications (52). Where experienced vocationally trained paramedics reported relying on intuition and experience, novice paramedics reported a propensity for hypotheticodeductive thinking (75), presumably owing to their deep learning facilitated during university-based training; they possess an ability to think and reason critically without heavily relying on intuition, with the capacity to form relational threads between different subject areas allowing for reordering or reinterpretation of information (52).

The use of guidelines (Type 2-by proxy) facilitate a standard of care ensuring safe practice and are often heavily reinforced to students and novices. Some paramedics employ such tools as a 'proforma' to follow verbatim (51), while others as a platform by which to gather information to engage in informed choices amongst considered options, as opposed to merely a tick-box algorithmic styled approach (52). Guidelines, by their namesake, offer a guide by which treatment and decisions may be governed, and also act as an educational tool, however they are not always preferred over human judgement by users (39). Although guidelines offer decision-making support, they cannot replace clinical judgement as this may imply that a dichotomous answer exists where a complex dynamic patient presents (11). This point was emphasised by Jones et al (48), in that decision-making, unlike guidelines, is not a linear process. Nonetheless, Jensen et al (54) caution against dismissing them, particularly where there is chaos and time pressures, as using Type 1 processing in this setting may result in errors and have detrimental effects for the patient; guidelines are in place to ensure vital elements are not missed. Moreover, extended deliberation over various hypotheses and making a decision may also prolong care – paralysis by analysis. That is not to say that guidelines cannot be structured in such a way to facilitate different thinking and decision styles under various circumstances. To highlight this, Jensen et al (54) discovered that different thinking strategies were employed by paramedics during different scenarios. For example, participants frequently engaged in event-driven and algorithmic thinking during the trauma scenario, while 'rule out worse scenario' and algorithmic thinking were used in the medical scenario. Such knowledge may assist in producing 'user friendly' guidelines, that are not linear, and at times allow for flexibility while supporting the paramedic in their individual style and approach and thereby circumventing barriers to guideline application, as seen by Jones et al (48).

This review has emphasised that paramedics engage in complex processes that are yet to be fully appreciated. Much of what we understand about paramedic decision-making has been borrowed from medicine. However, where physician development and training has been heavily steeped in formal tertiary education for an extended period of time, the development of paramedics has not. Given the inherent importance of formal education has on Type 2 processing (eg. complex reasoning and analytical processing), and the relatively new introduction of tertiary education to paramedicine, it would be remiss to assume that what applies to physicians applies to all paramedics with regards to judgement and decision-making actions. That is not to imply that paramedics are inept at critical thinking, but rather the need to paramedic-specific research in this area is paramount, however lacking. Throughout the search of the literature, only six articles were found exploring paramedic decision-making processes, with no research discovered investigating paramedic decision-making processes in atypically presenting patients where uncertainty is fraught. Such limited research does not support generalisability of findings due to lack of replication of studies, nor examination of variables that may impact judgement and decision-making. Given its importance in patient safety and outcomes, research into this area is needed as a matter of urgency.

Implications for practice

Elucidation of how paramedics perform judgement and decision-making is vitally important. Although it aids in best patient outcomes, it also supports the enhancement of the paramedic profession at all levels. Teaching judgement and decision-making theory to students will assist them in understanding their own processes and limitations (76); while understanding the impact the introduction to tertiary education has and the way paramedic graduates approach problems, how that may differ to the predecessors, has the potential to inform mentorship programs as they transition into practice. A crucial

time, graduates (and therefore novices) require additional support while they obtain their practical knowledge and imbed it into their sound theoretical knowledge, with the understanding that their cognitive load is heightened due to extensive Type 2 thinking, potentially fatiguing faster than their more experienced colleagues. This leaves the novice more likely prone to errors, particularly during a night shift. Undoubtedly, this phase of a paramedic's career is fraught with extraneous cognitive loading which need not be. Further reaching, a greater understanding of the cognitive actions may also assist experienced paramedics in their practice by promoting self-awareness, encouraged reflection, feedback and continued professional engagement in scientific knowledge. Deductively, in understanding how paramedics think, and in what context, guidelines and other adjuncts may be fashioned to reflect this.

Revealing the importance of feedback to paramedics to support reflection and restructuring of knowledge may encourage the field to implement formal processes enabling paramedics to follow up, thus improving diagnostic reasoning and clinical judgement. This would then facilitate regulation of knowledge and learning opportunities by identifying areas for improvement and gaps in knowledge. This perpetuates a profession filled with competent, continually improving and evolving paramedics providing the best evidence-based care striving for best patient outcomes.

Limitations

Although this review adds valuable information to the paramedic body of knowledge and raises an opportunity for discussion and further question generation in the vital skill of paramedic judgement and decision-making, limitations within this review were encountered. Unlike nurses and midwives (77), presently there is no global standardisation, or scope of practice, for the role of a 'paramedic', and this needs to occur; certain countries utilise nurses or physicians in ambulances, others have dedicated 'paramedic' role with and without tailored higher education. This yields difficulty for researchers to draw general inferences given such variables within sampled populations and, as such, interpreting international research is met with challenges and should be done with caution. Moreover, the significant heterogeneity of methodologies including participant cohorts and endpoints adds further complexity in applying generalisability to the findings (78,79). This review was limited to 'paramedics'. However, clear definitions and outlining of skillsets is not always reported in papers; nonetheless, every attempt was made to control for this. English language was also an inclusion criterion. This may have resulted in papers not published in English being excluded.

Conclusion

Paramedics apply sub-conscious (intuitive) and conscious (analytical) thought processes – consistent with the dual-process theory. Experience and formal education were influencing factors on how situations were approached, and how decisions were made.

Paramedics displayed the ability to problem solve, critically analyse, perform complex reasoning and work cohesively with the patient as well as in a group. They were adept at rapidly forming clinical impressions in the critically ill with minimal information, and were able to modulate their interventions accordingly, while simultaneously continuing to gather data as they performed life-saving measures. Moreover, expert paramedics were seen to gather, process and utilise information differently to novices portraying an interconnectedness of conscious and sub-conscious processing drawing on information from multiple sources culminating from both professional and personal experiences. The findings of this review offer an important contribution towards understanding and encouraging research in this area. Implications to paramedic practice include: better paramedic cognitive performance in judgement and decision-making; course structure guidance; and encouragement in the implementation of routine reflection and feedback, thus supporting continued improvement in practice translating to better patient outcomes.

Acknowledgements

The authors wish to thank the reviewers for their invaluable time, input, feedback and guidance.

Conflict of interest

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement. Peter O'Meara is an Associate Editor of AJP.

References

1. Ball L. Setting the scene for the paramedic in primary care: a review of the literature. Emerg Med J 2005;22:896-900.
2. Bowles RR, van Beek C, Andersen GS. Four dimensions of paramedic practice in Canada: defining and describing the profession. Australasian Journal of Paramedicine 2017;14(3).
3. Paramedic – Scope of Practice Policy. Bridgwater, England: College of Paramedics, 2015.
4. Bigham B, Welsford M. Applying hospital evidence to paramedicine: issues of indirectness, validity and knowledge translation. CJEM 2015;17:281-5.
5. Carter H, Thompson J. Defining the paramedic process. Australian Journal of Primary Health 2015;21:22-6.
6. Harenčárová H. Managing uncertainty in paramedics' decision making. J Cogn Eng Decis Mak 2016;11:42-62.
7. LeBlanc VR, MacDonald RD, McArthur B, King K, Lepine T. Paramedic performance in calculating drug dosages following stressful scenarios in a human patient simulator. Prehosp Emerg Care 2005;9(4):439-44.

References (continued)

8. Patterson PD, Weaver MD, Frank RC, et al. Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers. ibid. 2012;16:86-97.
9. Williamson A, Feyer A. Moderate sleep deprivation produces impairments in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication. Occup Environ Med 2000;57:649-55.
10. Jensen JL, Croskerry P, Travers AH. Consensus on paramedic clinical decisions during high-acuity emergency calls: results of a Canadian Delphi study. Can J Emerg Med 2011;13:310-8.
11. Atack L, Maher J. Emergency medical and health providers' perceptions of key issues in prehospital patient safety. Prehosp Emerg Care 2010;14:95-102.
12. Shaban R. Mental health and mental illness in paramedic practice: A warrant for research and inquiry into accounts of paramedic clinical judgment and decision-making. Journal of Emergency Primary Health Care 2004;2(3-4).
13. Evans JS. Dual-processing accounts of reasoning, judgment, and social cognition. Annu Rev Psychol 2008;59:255-78.
14. Croskerry P, Nimmo GR. Better clinical decision making and reducing diagnostic error. J R Coll Physicians Edinb 2011;41:155-62.
15. Price R, Bendall JC, Patterson JA, Middleton PM. What causes adverse events in prehospital care? A human-factors approach. Emerg Med J 2013;30:583-8.
16. Terkelsen CJ, Lassen JF, Norgaard BL, et al. Reduction of treatment delay in patients with ST-elevation myocardial infarction: impact of pre-hospital diagnosis and direct referral to primary percutanous coronary intervention. Eur Heart J 2005;26:770-7.
17. Johnston S, Brightwell R, Ziman M. Paramedics and pre-hospital management of acute myocardial infarction: diagnosis and reperfusion. Emerg Med J 2006;23:331-4.
18. Jensen JL. Paramedic clinical decision making [Masters]. Dalehousie University, Halifax, Nova Scotia; 2010.
19. Masci K, Fitzgerald M, Cooper DJ, et al. Prehospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury: a randomized controlled trial. Ann Surg 2010;252:959-65.
20. Heegaard W, Hildebrandt D, Spear D, Chason K, Nelson B, Ho J. Prehospital ultrasound by paramedics: results of field trial. Acad Emerg Med 2010;17:624-30.
21. Walcher F, Weinlich M, Conrad G, et al. Prehospital ultrasound imaging improves management of abdominal trauma. Br J Surg 2006;93:238-42.
22. O'Brien K, Moore A, Dawson D, Hartley P. An Australian story: paramedic education and practice in transition. Australasian Journal of Paramedicine 2014;11(3).
23. Williams B, Brown T, Onsman A. Is the Australian paramedic discipline a full profession? ibid. 2012;(1):3.
24. O'Meara P. Paramedics marching toward professionalism. ibid. 2009;7(1).
25. Evans R, McGovern R, Birch J, Newbury-Birch D. Which extended paramedic skills are making an impact in emergency care and can be related to the UK paramedic system? A systematic review of the literature. Emerg Med J 2013.
26. Munro G, O'Meara P, Kenny A. Paramedic transition into an academic role in universities: a demographic and qualification survey of paramedic academics in Australia and New Zealand. Irish Journal of Paramedicine 2016;1(2).
27. O'Meara P, Tourle V, Stirling C, Walker J, Pedler D. Extending the paramedic role in rural Australia: a story of flexibility and innovation. Rural Remote Health 2012;12:1-13.
28. Abrashkin KA, Washko J, Zhang J, Poku A, Kim H, Smith KL. Providing acute care at home: Community Paramedics Enhance an Advanced Illness Management Program-Preliminary Data. J Am Geriatr Soc 2016;64:2572-6.
29. O'Meara P, Stirling C, Ruest M, Martin A. Community paramedicine model of care: an observational, ethnographic case study. BMC Health Serv Res 2016;16:39.
30. Pearson KB, Gale J, Shaler G. Community paramedicine in rural areas: state and local findings and the role of the State Flex Program. Portland: Maine Rural Health Research Center, Team FM; February 2014.
31. O'Meara P. Community paramedics: a scoping review of their emergence and potential impact. International Paramedic Practice 2014;4:5-12.
32. Christie G. Independent non-medical prescribing for paramedics. Nurs Stand 2015;29:36-9.
33. Savage ML, Poon KK, Johnston EM, et al. Pre-hospital ambulance notification and initiation of treatment of ST elevation myocardial infarction is associated with significant reduction in door-to-balloon time for primary PCI. Heart Lung Circ 2014;23:435-43.
34. Jensen JL, Calder LA, Walker M, et al. Experiential and rational clinical decision making: a survey to determine decision-making styles of paramedics. Can J Emerg Med 2013;15:S41.
35. Bigham BL, Bull E, Morrison M, et al. Patient safety in emergency medical services: Executive Summary and Recommendations from the Niagara Summit. ibid. 2011;13:13-8.
36. Mellifont D, Barr N, Dunn P. A systems approach to learning, practice and reflection in emergency primary health care: student perspectives. Australasian Journal of Paramedicine 2014;11(3):1-8.
37. Baumeister RF, Leary MR. Writing narrative literature reviews. Rev Gen Psychol 1997;1:311-20.
38. Gunnarsson BM, Warrén Stomberg M. Factors influencing decision making among ambulance nurses in emergency care situations. International Emerg Nurs 2009;17:83-9.
39. Halter M, Vernon S, Snooks H, et al. Complexity of the decision-making process of ambulance staff for assessment and referral of older people who have fallen: a qualitative study. Emerg Med J 2011;28:44-50.

References (continued)

40. Newgard CD, Nelson MJ, Kampp M, et al. Out-of-hospital decision making and factors influencing the regional distribution of injured patients in a trauma system. J Trauma 2011;70:1345-53.
41. Jensen JL, Croskerry P, Travers AH. Paramedic clinical decision making during high acuity emergency calls: design and methodology of a Delphi study. BMC Emerg Med 2009;9:17.
42. Nilsson T, Lindstrom V. Clinical decision-making described by Swedish prehospital emergency care nurse students – an exploratory study. Int Emerg Nurs 2016;27:46-50.
43. Jensen JL, Bienkowski A, Travers AH, et al. A survey to determine decision-making styles of working paramedics and student paramedics. CJEM 2016;18:213-22.
44. Cronin P, Ryan F, Coughlan M. Undertaking a literature review: a step-by-step approach. Br J Nurs 2008;17:38-43.
45. Patrick LJ, Munro S. The literature review: demystifying the literature search. Diabetes Educ 2004;30:30-8.
46. Programme CAS. CASP Qualitative Checklist 2018. Available at: https://casp-uk.net/casp-tools-checklists/
47. Jensen JL, Tavares W, Calder LA, et al. A survey to determine decision-making styles of working paramedics and student paramedics. Can J Emerg Med 2016;18:213-22.
48. Jones CMC, Cushman JT, Lerner EB, et al. Prehospital trauma triage decision-making: a model of what happens between the 9-1-1 call and the hospital. Prehosp Emerg Care 2016;20:6-14.
49. Smith MW, Bentley MA, Fernandez AR, Gibson G, Schweikhart SB, Woods DD. Performance of experienced versus less experienced paramedics in managing challenging scenarios: a cognitive task analysis study. Ann Emerg Med 2013;62:367-79.
50. Wyatt A. Paramedic practice – knowledge invested in action. Australasian Journal of Paramedicine 2003;1(3).
51. Shaban RZ. Paramedic clinical judgement and decision-making of mental illness in the pre-hospital emergency care setting: a case study of accounts of practice: Griffith University; 2011.
52. Ryan L, Halliwell D. Paramedic decision-making: how is it done? Journal of Paramedic Practice 2012;4:343.
53. Croskerry P. Clinical cognition and diagnostic error: applications of a dual process model of reasoning. Adv Health Sci Educ Theory Pract 2009;14(Suppl 1):27-35.
54. Jensen JL. Paramedic clinical decision-making: result of two Canadian studies. International Paramedic Practice 2011;1:63-71.
55. Kahneman D. A perspective on judgment and choice: mapping bounded rationality. Am Psychol 2003;58:697-720.
56. Gauffroy C, Barrouillet P. Heuristic and analytic processes in mental models for conditionals: an integrative developmental theory. Dev Rev 2009;29:249-82.
57. Croskerry P. A universal model of diagnostic reasoning. Acad Med 2009;84:1022-8.
58. Hammond KR, Hamm RM, Grassia J, Pearson T. The relative efficacy of intuitive and analytical cognition: a second direct comparison. Boulder, Colorado: Centre for Research on Judgement and Policy, Institute of Cognitive Science, Colorado Uo; 1984. Report No.: CRJP 252.
59. Stanovich KE. The robot's rebellion: finding meaning in the age of Darwin. Chicago, IL: University of Chicago Press; 2004.
60. Graber ML. Educational strategies to reduce diagnostic error: can you teach this stuff? Adv Health Sci Educ Theory Pract 2009;14(Suppl 1):63-9.
61. Marcum JA. An integrated model of clinical reasoning: dual-process theory of cognition and metacognition. J Eval Clin Pract 2012;18:954-61.
62. Croskerry P. ED cognition: any decision by anyone at any time. Can J Emerg Med 2014;16:13-9.
63. Kahneman D, Frederick S. Representativeness revisited: attribute substitution in intuitive judgment. New York: Cambridge University Press; 2002 September, 2001.
64. Hoffman R. How Can Expertise be Defined? Implications of research from cognitive psychology. Exploring expertise. London: Palgrave Macmillan; 1996.
65. Waller MJ, Gupta N, Giambatista RC. Effects of adaptive behaviors and shared mental models on control crew performance. Manage Sci 2004;50:1534-44.
66. Tschan F, Semmer NK, Gurtner A, et al. Explicit reasoning, confirmation bias, and illusory transactive memory: a simulation study of group medical decision making. Small Group Res 2009;40:271-300.
67. Schmidt HG, Rikers RM. How expertise develops in medicine: knowledge encapsulation and illness script formation. Med Educ 2007;41:1133-9.
68. Sandars J. The use of reflection in medical education: AMEE Guide No. 44. Med Teach 2009;31:685-95.
69. Croskerry P. The feedback sanction. Acad Emerg Med 2000;7:1232-8.
70. Katajavuori N, Lindblom-Ylänne S, Hirvonen J. The significance of practical training in linking theoretical studies with practice. High Educ 2006;51:439-64.
71. Burrell L, Noble A, Ridsdale L. Decision-making by ambulance clinicians in London when managing patients with epilepsy: a qualitative study. Emerg Med J 2013;30:236-40.
72. Athari ZS, Sharif SM, Nasr AR, Nematbakhsh M. Assessing critical thinking in medical sciences students in two sequential semesters: does it improve? J Educ Health Promot 2013;2:5.
73. Hou XY, Rego J, Service M. Review article: paramedic education opportunities and challenges in Australia. Emerg Med Australas 2013;25:114-9.
74. O'Meara P, Furness S, Gleeson R. Educating paramedics for the future: a holistic approach. J Health Human Serv Adm 2017;40:219-51.

References (continued)

75. Woodford P. The decision is yours. Journal of Paramedic Practice 2015;7:90-4.
76. Pelaccia T, Tardif J, Triby E, Charlin B. An analysis of clinical reasoning through a recent and comprehensive approach: the dual-process theory. Med Educ Online 2011;16.
77. WHO nursing and midwifery progress report 2008-2017. Geneva, Switzerland: World Health Organisation; 2013.
78. Snooks HA. On-scene alternatives for emergency ambulance crews attending patients who do not need to travel to the accident and emergency department: a review of the literature. Emerg Med J 2004;21:212-5.
79. Mulholland SA, Gabbe BJ, Cameron P. Is paramedic judgement useful in prehospital trauma triage? Injury 2005;36:1298-305.
80. Karthikeyan G, Pais P. Clinical judgement & evidence-based medicine: time for reconciliation. Indian J Med Res 2010;132:623-6.
81. Krch D. Cognitive processing. In: Kreutzer JS, DeLuca J, Caplan B, editors. Encyclopedia of Clinical Neuropsychology. New York, NY: Springer New York; 2011. p. 627.
82. Scriven M, Paul R, editors. Defining critical thinking. 8th Annual International Conference on Critical Thinking and Education Reform; Summer 1987: The Foundation for Critical Thinking.
83. Wang Y, Liu D, Ruhe G, editors. Formal description of the cognitive process of decision making. Proceedings of the Third IEEE International Conference on Cognitive Informatics; 2004; Victoria, Canada.