How emergency physicians use biomarkers: insights from a qualitative assessment of script concordance tests

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ABSTRACT

Objectives Biomarkers have been developed in emergency medicine to improve decision at bedside using Bayesian approach. We intend to determine the cognitive process actually utilised by emergency physicians to incorporate biomarkers in clinical reasoning.

Design We invited eight emergency physicians to answer eight script concordance tests. Interviews were tape-recorded and qualitatively analysed using predetermined categories until saturation.

Results Emergency physicians mainly mobilised intuition and non-Bayesian reasoning to incorporate biomarkers for diagnosis or treatment strategies.

Conclusions Although biomarkers have been developed to be used in a Bayesian approach, emergency physicians mainly use other analytical and non-analytical cognitive processes to introduce these tools in their clinical reasoning.

INTRODUCTION

Caring for patients at the emergency department requires specific skills to efficiently act in a very constrained environment. In a very short time span, emergency physicians have to simultaneously care for numerous new patients with various levels of complexity.[1]

In the healthcare setting, clinical reasoning is a major determinant for efficacy of medical services.[2] Research in medical education has suggested that analytical and non-analytical (also called 'intuitive') approaches are main models for medical reasoning.[3] Analytical reasoning is a controlled process that mobilises conscious resources to build diagnosis and treatment strategies, and usually set against gut feeling. Among analytical process, the Bayesian approach proposes to convert subjective perception into a quantified level of evidence. On the other hand, intuition is a process that occurs automatically and uses readily available knowledge.[4] To improve decision making, composite strategies have been developed that include prescription and interpretation of biomarkers for stereotyped clinical conditions.[5 6] Based on the use of Bayes' theory, these algorithms are believed to fit physicians' needs and to optimally apply at bedside.[7] As a theoretical paradigm, the use of biomarkers requires specific knowledge and dedicated cognition process. However, it is unclear whether emergency physicians actually use biomarkers according to validated algorithms and the core of knowledge actually mobilised remains uncertain. In addition, a number of patients merely correspond to fields where strategies including biomarkers strictly apply. Nevertheless, temptation is high to use biomarkers, as these may help rule in and rule out diagnosis, assess severity and change physicians' decisions. Therefore, it is conceivable that emergency physicians adapt clinical reasoning to patients' condition and specific environment. This prompted us to determine what cognition process and knowledge were utilised by emergency physicians to use biomarkers.

METHODS

We used script concordance tests (SCTs) to assess clinical reasoning, as this method allows exploring reasoning in a context of uncertainty, and therefore, is more adapted than questions with multiple answers. Construction of SCT corresponded to standards.[8] Briefly, a series of eight short case-based scenarios were generated corresponding to various clinical conditions in emergency medicine. Scenarios incorporated uncertainty for diagnosis and prognosis. Scenarios were followed by a sequence of questions built as follows: a first part adding information to the initial case; a second part containing new information; a third part corresponding to answers to be quoted on a 5-point Likert scale, traducing direction and intensity of the option. More precisely, participants were asked to evaluate the impact of a clinical, biological or imaging result (different independent combinations) based on the probability of a diagnosis or utility of a biomarker. To note, questions systematically referred to biomarkers (see online supplementary appendix).

Participants were physicians from two emergency departments (Cochin Hospital and Hotel-Dieu, APHP, Paris). Physicians were randomly assigned for the order of interview with a 1:1 ratio for each participating site. Each physician was subject to eight SCTs. After each SCT, a face-to-face individual interview was conducted and tape-recorded by two investigators (SG and MG). During this interview, physicians were asked to explain how they reached their answers in order to determine what cognitive processes and knowledge had been mobilised. Tape-recordings were transcripted by professional assistance. *A posteriori* analysis was conducted from transcripted tape-recordings by two other investigators (SW and YEC). For each participant, these investigators independently proceeded to classification of processes and knowledge that were distributed as follows: intuition ('gut feelings' driven by experience and emotion); specific knowledge (stored in long-term memory); problem

Table 1 Definition of cognitive mechanisms and quotations from verbatim recorded during emergency physicians' interviews

Cognitive mechanism (ref.)	Definition	Quotations from verbatim (case, physician)
Intuition[4]	Reflex reaction; trigger and operating systems are below the threshold of physician's consciousness; functioning relies on the use of immediately accessible information and is based on recognition of similar conditions previously met or pathognomonic conditions	'I do not identify specific signs and symptoms in this case. This suggests several diagnoses to me: aortic dissection, intra- abdominal disorder, sciatic nerve pain, acute pyelonephritis. Yes, I believe it could rather be an acute pyelonephritis. However, I acknowledge this is not based on clinical experience, this is rather a subjective feeling.' (case no. 1 physician no. 6)
Specific knowledge	Medical and scientific knowledge stored in long term memory; it is organised to easily resolve clinical problems	'I believe that I would not order a dosage of brain natriuretic peptide as, in this 56-year-old female patient with suspected aortic dissection, there is no evidence for congestive heart failure. I mean that this biomarker is not indicated to make the diagnosis of aortic dissection. Whatever the result, it has no value in this situation'. (case no. 1 physician no. 3)
Problem representation[9]	Connecting information from the patient, the condition he/she experienced, and physician's knowledge	'This 54-year-old man suffering of high blood pressure is referred to the emergency department because of a 2 weeks dyspnoea with acute worsening. SpO2 is 88% and respiratory rate 22/min, the patient presents peripheral oedema.' (case no. 4, physician no. 7)
Hypothetico-deductive reasoning[9]	Process to control hypothesis—diagnosis, for instance—generated by medical history, physical examination, results of imaging and biological analyses, etc	'To summarise, ECG is abnormal, with diffuse underscored ST segment and microvoltage; this does not argue for cardiac ischaemia, there are more evidences acute pericarditis. Troponin levels may elevate in case of pericarditis, but cardiac ultrasounds will help. However, obtaining a blood sample to assess troponin level will help in the management of this patient.' (case no. 3 physician no. 7)
Metacognition[9]	Consciousness by the physician of his/her own cognitive process	'In my opinion, it is difficult to reason upon NT-proBNP when you do not have gender and glomerular filtration. Even more important is age of the patient, I cannot use NT-proBNP without this information.' (case no. 4 physician no. 1)
Bayesian[3]	Rationalistic approach relying on probability of a diagnosis and conditional probabilities that associate this diagnosis to clinical and paraclinical evidences	'For this patient with suspected pulmonary embolism, my reasoning relies on a decisional algorithm. If pre-test probability is high for this patient, a dosage of D-dimers at 350 ng/ml would have no utility to me, I would just ignore this result. If pre-test probability would have been low or intermediate, D-dimers level would have a different signification and diagnosis of venous thromboembolism would have been excluded.' (case no. 2 physician no. 1)

representation (defining the shape and limits of the situation)[9]; hypothetico-deductive reasoning (unconscious link between a situation and patterns stored in the long-term memory); metacognition (reasoning upon own reasoning); Bayesian. Definition for each cognitive mechanism is shown in table 1. Codification rules were predetermined. Interobserver agreement was observed in more than 90%. Differences in interpretation were subject to discussion until consensus. We proceeded to the analysis of cognitive processes for each participant, for each SCT, and for biomarkers and cardiovascular disorders and infection. To illustrate results, quotations of verbatim recorded from emergency physicians' interviews are shown in table 1.

As this is usually practiced for qualitative studies, number of participants could not be calculated a priori and interviews were stopped when no new information was recorded (saturation effect).

RESULTS

Saturation was obtained after interviews of eight senior emergency physicians (four from each participating centre). They were four men and four women; median age was 34 years (range 31–58). Median interview duration was 46 min (range 40–90).

Characteristics of cognitive process and knowledge used to answer SCTs looked very alike among participants, whatever their experience in the field of emergency medicine. We observed that only one participant used different mechanisms to answer the questions raised about the cases.

Globally, a majority of SCTs were subjected to intuitive cognitive processes (table 2). We recorded that seven physicians analysed six to seven cases using intuition. A single physician (physician no. 6, quoted in table 1) used this process in half the cases.

Besides intuitive mechanisms, answers to SCTs mainly relied on physicians' specific knowledge. Almost each case was resolved by each physician based upon current medical and scientific knowledge. As an example, we quote an answer given by participant no. 3 to SCT no. 1 in table 1.

It appeared that use of problem representation was heterogeneous among participants. This process was used in one to four cases by half of the physicians. On the other hand, participant no. 7 utilised problem representation to analyse each SCT (table 1).

Participants infrequently utilised processes based upon organisation into a hierarchy, like hypothetico-deductive reasoning. We observed that five physicians used these processes to analyse 1–4 SCTs.

Metacognition, a process that makes physician think about their own reasoning, was often recognised in our series. It was observed in almost all the SCTs for five physicians. Conversely, physician no. 5 utilised this mechanism in only two out of eight cases.

As our interest focused on biomarkers' use by emergency physicians, we particularly depicted whether Bayesian reasoning contributed to cognitive mechanisms to answer SCTs. We observed that physicians seldom used Bayesian approach to utilise biomarkers. We recorded that five physicians used this cognitive mechanism for none, one or two cases.

Table 2 Cognitive mechanisms utilised by physicians to resolve script concordance tests

Physician no.	Intuition	Specific knowledge	Problem representation	Organisation of information	Metacognition	Bayesian
1	4	7	6	3	6	4
2	6	8	1	1	5	5
3	7	8	2	4	7	3
4	7	7	4	3	6	0
5	7	6	1	2	2	1
6	6	7	5	2	6	1
7	6	8	8	2	8	2
8	7	8	1	0	4	1

Results correspond to number of times each emergency physician utilised the different cognitive process to answer script concordance tests. These results were obtained by consensus between two independent observers.
Results are expressed as the use of each cognitive mechanism at least once in each concordance script test.

Interestingly, analysis by SCTs showed similar results (table 3). To note, most of our cases mixed cardiovascular and infectious disorders, as well as clinical and biochemical data. Case no. 3 specifically addressed cardiovascular disorders and case no. 7 addressed infectious disorders (see online supplementary appendix). Even in these cases, specific knowledge and intuition were mostly used, while a single physician utilised Bayesian approach in case no. 3.

DISCUSSION

Here we report that emergency physicians mobilise intuition and specific knowledge for the use of biomarkers. Therefore intuitive process is privileged in this context.

Translating evidence into clinical practice is subject to barriers including difficulties to use knowledge at bedside.[10] It has long been established that high-quality studies were insufficient to convert evidence into practice. To become operational, procedures have to get through real-life experience. In daily practice, physicians test concepts in actual conditions of medical exercise. However, it is usually observed that practices at bedside do not strictly rely on scientifically established knowledge. It rather depends on a multistep analysis that begins by perception of information and intuition, collection of new data to propose hypotheses. Then physicians elaborate a final diagnosis and plan specific measures.[11–13] Physicians' judgement is more influenced by changes and progression than initial medical history.[14] Moreover, physicians' mindset is subject to plasticity and flexibility in case of uncertainty. These findings reported from other settings than emergency medicine were observed in our study. In addition, experienced physicians more often use intuition than their younger counterparts that are more likely to use hypothetico-deductive reasoning. This observation was confirmed in our panel of senior emergency physicians. In fact, the use of biomarkers should not solely rest upon intuition but should also be guided by algorithms to improve level of care.[15 16] Several impact studies have developed strategies based on a Bayesian approach to improve the use of biomarkers in the setting of emergency medicine. Unfortunately, even when algorithms are supported by high levels of evidence, their application at bedside remains sparse.[17] Whereas number and quality of decisional algorithms constantly increase, they remain poorly used in daily practice. More precisely, experts constantly favour other cognitive process and have preference for intuition.

Intuition is developed upon previous experiences, observation of patients' outcome and feedback. Actually, emergency physicians may obtain information about patients later, partially and sometimes no information is provided. Therefore, emergency physicians have fewer opportunities to properly develop the intuitive pathway. In this specific environment, using algorithms may add value as physicians can immediately integrate information available at bedside in a modelised decision-making process.[18]

Several impact studies have developed strategies based on a Bayesian approach to improve the use of biomarkers in the setting of emergency medicine. This process is consistent with decision-making process in medicine in a 'respectable, orthodox' and 'rational' approach.[19] Unfortunately, even when algorithms are supported by high levels of evidence, their application at bedside remains sparse.[17] Whereas number and quality of decisional algorithms constantly increase, their use remains poor in daily practice. More precisely, experts constantly favour other

Table 3 Cognitive mechanisms utilised for each concordance script tests to be analysed by physicians

SCT no.	Intuition	Specific knowledge	Problem representation	Organisation of information	Metacognition	Bayesian
1	8	8	6	5	5	1
2	7	8	4	1	5	4
3	7	8	2	5	6	1
4	6	8	3	3	7	1
5	3	8	4	0	5	3
6	8	8	6	3	6	1
7	7	6	2	1	7	0
8	5	5	4	1	4	4

Results are expressed as the use of each cognitive mechanism at least once in each concordance script test.
Results correspond to number of times each cognitive process was used to answer each script concordance tests. These results were obtained by consensus between two independent observers.
SCT, script concordance test.

cognitive process and have preference for intuition. This is consistent with recent development from cognitive psychology. More specifically, it refers to dual processes of thinking, suggesting that intuition is the more frequent reasoning process.[19] Hereby, senior physicians would take faster and better decisions using intuitive model of reasoning[19] whereas their use of Bayesian approach is infrequent.[20]

LIMITATIONS

Using SCT to draw conclusions about the use of biomarkers may appear artificial, especially in the setting of emergency medicine. Physicians who answered the test had only one case to treat at a time, which significantly differs from real life. In addition, environmental constraints to emergency physicians include organisational parameters and predominantly permanent threat to obtain hospital beds to admit patients. This may alter emergency physicians' prescription of biomarkers to supposedly straighten initial evaluation. By essence, the use of qualitative methodology does not allow and does not aim to draw generalisable conclusions. However, we believe that our results could be transposed in other settings. We chose to diversify participants' characteristics in terms of demographics, professional setting and practices. Cases submitted to physicians also presented a large variety of emergent clinical conditions. Another interesting limitation refers to clinical research. It is obvious that Bayesian approach cannot be strictly applied when procedure to use biomarkers have not been strictly developed this way. For instance, pretest value may be sometimes intuitive. However, we merely observed that Bayes' theory was used even when very precise algorithms existed. Finally, some answers of the interviews may correspond to *a posteriori* constructions of the problem representation whereas this specific point is difficult to determine.

CONCLUSION

In 1909, Sir Stephen Paget stated in his 'Confessio medici' that 'practice is science touched with emotion'.[21] In spite of one century of scientific progress, this axiom remains valid. As an example, we demonstrated that the use of biomarkers in emergency medicine rather depends on intuition and specific knowledge than Bayesian analysis. In an environment that favours intuitive reasoning, comparing results from practices to algorithms and guidelines could be relevant. Conversely, building algorithms and developing guidelines in emergency medicine should take into account the burden of intuition and its clinical results to increase the emergency physicians' agreement to use these tools. These observations interrogate whether we should accept that complementary approaches are possible for emergency physicians to use biomarkers. However, this should prompt teachers as well as scientific and professional communities to promote a better use of biomarkers by improving and sustaining analytical approach of clinical problems as a complement to the intuitive approach.

Contributors YEC and TP designed the study, recorded TCS and analysed data and produced the manuscript. MG and SG contributed to production of TCS. SW conducted interviews, recorded answers to TCS, and participated to analysis of the data. BC, XM and EF contributed to critical revision of the manuscript.

Competing interests None.

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Data sharing statement We added TCS as an appendix available online for information to readers.

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Notes