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RESEARCH ARTICLE

How organisational factors and clinical decision support system affect nurses' knowledge for decisions in triage

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ABSTRACT
This paper delves into heuristic decision-making by nurses during the triage process, aiming to elucidate how organisational factors influence nurses' decision-making regarding the assignment of priority codes to patients, and to assess the effectiveness of Clinical Decision Support Systems (CDSS) in this context. Drawing on an experimental dataset of 25 triage cases evaluated by 35 nurses via interviews, the study was conducted in two Spanish Emergency Departments using CDSS. Findings indicate that organisational factors predominantly influence decisions in cases with complete and coherent information. However, in cases where information is incoherent or missing, individual nurse characteristics guide decision-making. Furthermore, it suggests that CDSS should be tailored to nurses' clinical reasoning to serve as effective support for individual decision-making processes.

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1. Introduction

Managers in organisational settings engage in cognitive processes to interpret their perceived reality; however, decision-making does not solely rely on an expansive knowledge base, but rather on a finite subset that supports heuristic approaches. Heuristics serve as efficient decision-making tools that align with the cognitive strategies developed within organisational frameworks, enabling swift decisions based on limited knowledge, but are effective due to their strong ties to the organisational context and structured knowledge, as emphasised by research (Artinger et al., 2015; Gigerenzer et al., 1999; Katsikopoulos, 2011).

Heuristics play an increasingly strategic role in scenarios marked by ambiguity and uncertainty (Bettis, 2017; Grandori, 2010), where knowledge is scarce and decision-making time is limited (MacGillivray, 2014; Nikolaeva, 2014). The urgency coding of patients in emergency rooms, known as triage, is a prime example of an environment where heuristics are applied. Triage involves a swift assessment of a patient's need for immediate care, prioritising treatment based on urgency rather than the order of arrival. During the triage process, a nurse typically performs the initial evaluation, interpreting a patient's clinical condition from limited cues within a brief time frame, drawing on experience amidst the daily uncertainties of emergency care (Benner & Tanner, 1987). Cone and Murray (2002) affirmed the complexity of the decision-making process that nurses carry out in triage, because this requires responding to the patient's needs beyond the available information, using "both rational or linear decision-making processes and intuitive processes" (p. 402).

The development of these decision-making processes among nurses has been widely studied, yet many of these studies, while focusing on intuitive decision-making, seldom address the concept of heuristics explicitly. Benner et al. (1992) and Watson (1994) observed that while novice nurses often rely on strict guidelines and protocols, seasoned nurses tend to make decisions based on a synthesis of the patient's health issues and fundamental principles gained from extensive experience. This aligns with the perspectives of Gilbert-Saad et al. (2021) and Ehrig et al. (2021), who discuss how expert decision-makers employ heuristics when faced with uncertainty and the need for rapid decisions. Cranley et al. (2009), in their exploration of strategies nurses use to tackle clinical uncertainty, underscore the importance of a rationalistic approach founded on sequential cognitive processes, as well as a phenomenological approach that is characteristic of experts' performance. Others, like Alba (2018) and Anton et al. (2021), have delineated clinical decision-making in nursing as involving either rational/analytical cognitive models or those based on intuition that are closely linked to experience – a concept referred to as Naturalistic Decision Making by Nibbelink and Brewer (2018). A review of the literature reveals that the decision-making processes of adept nurses, rooted in their experience, essentially align with heuristic cognitive

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processes, a view supported by Bettis (2017) and Atanasiu (2021), who propose that learning through experience is a key mechanism for the emergence of heuristics. Nonetheless, the literature has not thoroughly examined whether intuition-based clinical decision-making, while being influenced by experience, is also shaped by other factors such as the context in which decisions are made.

From a managerial perspective, understanding how individual decision-making is impacted by organisational factors can empower managers to discern and leverage elements of the organisational environment to enhance the quality of decisions (Hauser, 2014). In the Triage process, the improvement of the quality decision-making is a very critical topic as the assignment of the priority code to patients impacts on the waiting time of the more urgent patients and, consequently, on the patients' safety.

In the context of triage, optimising the quality of decision-making is paramount, as the allocation of priority codes to patients directly affects the waiting times for urgent care and, consequently, patient safety. Seminal works by Simon (1997) and Cyert and March (1992) have underscored the pivotal influence of the organisational context on individual decision-making, shaped by elements like corporate ethos and logic – termed decision premises (Levinthal & Newark, 2023) – as well as by established operating procedures and rules. While the role of organisational influence on decision-making is recognised within management literature (Faraj & Xiao, 2006), the dynamic between individual and organisational factors and how they interact during the decision-making process is not well understood, especially in terms of which aspects take precedence and what information is prioritised by decision-makers when organisational factors dominate over individual judgements.

Triage provides an apt context for examining how organisational factors interact with individual decision-making. Literature suggests that the dominance of either organisational or individual influences may hinge on the ambiguity of circumstances. In the triage process, patients present with a range of symptoms that can be clear-cut, inconsistent, or even enigmatic. This study aims to offer insights on enhancing triage decision-making – a critical factor in Emergency Departments for minimising the wait times of patients in urgent need. It categorises patient information into three levels of complexity for triage case structuring: simple cases with coherent and complete information; intermediate cases with complete but inconsistent information; and complex cases, where information is ambiguous and key cues are missing. These levels reflect the different types of scenarios nurses must evaluate to assign priority codes.

This leads us to the first research question posed in the paper:

RQ1: In what ways do organisational factors and the complexity level of patient presentations impact nurses' decisions in assigning priority codes during triage?

To bolster the efficacy of clinical decision-making in triage, the implementation of computerised Clinical Decision Support Systems (CDSS) has been initiated. These systems are designed to assist nurses in decision-making by managing patient classifications and monitoring. However, research examining the actual efficacy of CDSS in supporting nurses during triage is insufficient. This observation gives rise to the second research question:

RQ2: What is the effectiveness of Clinical Decision Support Systems (CDSS) in aiding nurses with triage assessment priority codes, and how are these systems utilized?

Informed by a theoretical analysis that explores the triage process, and how individual and organisational factors influence heuristic effectiveness in triage evaluations, as well as the role of CDSS in supporting decision-making, this paper presents research conducted in two Spanish Emergency Departments. The study utilised an experimental set consisting of 25 triage cases evaluated by 35 nurses through interviews. The paper culminates in a discussion of the findings and their broader implications.

2. Theoretical framework

2.1. The triage process

The triage process is an essential preliminary clinical evaluation for managing patients according to the level of urgency (Tanner, 2006). It establishes waiting times based on the urgency codes assigned, which may either underestimate or overestimate the severity of patients' conditions, thus impacting their wait times and potentially the wait times of others with more severe, life-threatening conditions (Considine et al., 2007). This initial assessment is crucial, as it directly affects patient safety (Croskerry, 2002; FitzGerald et al., 2010; Göransson et al., 2008). The triage process typically consists of two stages: the initial evaluation and subsequent re-evaluation. Our research focuses on the initial evaluation phase, where an individual nurse determines the priority code for the patient being examined.

Triage, a critical function of emergency care, is typically evaluated in terms of over-triage or under-triage – comparing the priority code assigned to patients against predetermined outcomes. In emergency departments, the key challenge lies in swiftly identifying and prioritising patients who require urgent care. Under-triage refers to the allocation of a less urgent priority code to critically injured patients, risking severe consequences or even death due to treatment delays. Over-triage, on the other hand, involves assigning immediate care to patients who are not critically injured, leading to organisational issues such as hospital overcrowding and strained personnel and resources (Christian, 2019; Frykberg, 2005). Often, nurses must make these critical decisions without access to complete clinical documentation, operating with incomplete or sometimes inconsistent information. Moreover, triage decisions are frequently made under significant time pressure, with an acute awareness of the risks associated with incorrect assessments, which have been linked to numerous hospital fatalities (Harris et al., 2004). Many scholars have underscored the high risk of diagnostic errors in the triage process due to various factors, including intense decision pressure, stress, high levels of diagnostic uncertainty, and organisational constraints. Croskerry (2002, 2013) has been prominent in highlighting the cognitive biases and decision-making errors that contribute to misdiagnosis, advocating for cognitive debiasing strategies. These strategies encompass specific educational and workplace interventions such as training in reasoning and medical decision-making, cognitive tutoring systems, simulation training, enhanced information gathering, and structured data acquisition methods. Additionally, Ely et al. (2011) have recommended the use of various checklists to minimise diagnostic errors, while Hitchcock (2014) emphasises solving issues like hospital overcrowding and ineffective team communication and coordination, which further contribute to diagnostic inaccuracies. Alternatively, Graber et al. (2002) suggest adopting decision-support systems akin to those discussed in this paper. To the best of our knowledge, existing studies on triage have not sufficiently explored how the complexity of patient presentations – that is, the patients' characteristics – might influence nurses' allocation of priority codes, nor the extent to which organisational frameworks and guidelines could direct such decision-making. This paper seeks to explore the cognitive heuristics employed by nurses when deciding on priority codes, taking into account the varying complexities of the situations they encounter.

2.2. Individual and organizational issue affecting heuristics effectiveness in triage evaluation

In decision-making, the concept of heuristic was introduced by Herbert Simon (1957) as a manifestation of a decision-maker's bounded rationality. Simon conceptualised heuristics as adaptive tools allowing individuals to draw inferences within uncertain environments where not all knowledge is available. Consequently, these heuristics lead to "satisficing" – finding solutions that are good enough for the situation at hand – through the utilisation of social evolutionary mechanisms (Cavarretta, 2021). Although these simplified decision-making processes may achieve satisfactory outcomes (Basel & Brühl, 2013), they are inherently constrained by the potential for incorrect choices and biases (Leemann & Kanbach, 2023). In contrast, Gigerenzer's research group (1999) recognised that heuristics are particularly effective under conditions of ambiguous information and time constraints, providing an adaptive response tailored to the uncertainties of the decision-making environment (Artinger et al., 2015; Baum & Wally, 2003; Khatri & Ng, 2000). Galavotti et al. (2021) have further emphasised the beneficial role of heuristics in both individual and organisational decision-making contexts, mirroring Guercini and Milanesi (2020)'s observation that the adoption of simple rules is often more efficient than more complex cognitive approaches in situations fraught with uncertainty. The concept of "ecological rationality" underpins the value of heuristics, referring to their ability to leverage knowledge structures effectively within uncertain social and physical environments (Basel & Brühl, 2013; Bertel & Kirlik, 2010; Brighton & Gigerenzer, 2012; Chater et al., 2003; Mousavi & Kheirandish, 2014). This should be distinguished from the concept of risk, as uncertainty encompasses a broader range of unknowns (Guercini & Lechner, 2021; Kozyreva & Hertwig, 2021; Mousavi & Gigerenzer, 2014). Adopting Gigerenzer's perspective on heuristics, organisational and management research has explored how cognitive processes and the surrounding environment interact (Hertwig et al., 2022; Loock & Hinnen, 2015). In the application of heuristics, a decision-maker's bounded cognition only considers a portion of the available knowledge, thus minimising the effort needed to process all potential cues, simplifying the weighting of cues, integrating less information, and evaluating fewer alternatives. Individual traits, organisational dynamics, and the particulars of the decision-making problem all influence which elements of knowledge are deemed salient in reaching a decision.

Individual characteristics such as education, socio-economic background, age, and work experiences significantly shape the decision-making process (Hambrick & Mason, 1984). Within organisations, the organisational factors encompass both formal and informal rules, shared by organisational members (Bingham et al., 2007), that propagate through a social process of imitation and influence (MacGillivray, 2014). The nature of the decision problem itself is defined by the structure of the available knowledge, including how it is presented, its complexity, time constraints, response demands, and other relevant factors (Maule & Edland, 1997; Payne et al., 1993). Management studies have hence placed a significant emphasis on heuristics in decision-making, advocating for organisations to guide decision-making with simple, memorable rules that can be algorithmically encoded (Guercini & Lechner, 2021; Marti & Reinelt, 2022), thereby enhancing the quality of individual decision-making. Nevertheless, adherence to organisational rules does not immunise against erroneous decisions made during the knowledge selection and interpretation process by individuals (Vuori & Vuori, 2014). In this regard, Newell et al. (2003) study "provide an insight into the conditions under which different heuristics are used, and question the predictive power of the fast-and-frugal approach" (p. 82).

The triage process is particularly suited to the application of cognitive heuristics. For one, priority code assignments are based on only the most pertinent subset of available information, often assessed under time pressure and uncertainty, yet the decisions reached can still be remarkably accurate (Gigerenzer & Kurzenhäuser, 2005). Nurses determine a patient's priority code by interpreting clinical conditions using limited cues within a constrained timeframe (Benner & Tanner, 1987). Furthermore, the structure and coherence of patient information, or lack thereof, significantly impact nurses' judgement accuracy (Cioffi, 1998). Triage guidelines and training are intended to standardise decision-making, leading nurses towards consensus with their colleagues and reducing the scope of subjective judgement (Zachariasse et al., 2019).

The wide range of factors influencing decision-making results in substantial variability among nurses when assessing patient urgency – particularly when faced with limited or complex information about patient conditions (Chung, 2005). The competencies and risk aversion of individual nurses, organisational work structure, rules, and the environment where triage occurs contribute to this inconsistency (Andersson et al., 2006). Despite established protocols for patient prioritisation based on urgency, decision-making in triage is ultimately influenced by the nurse's individual abilities, the organisation's structure, and the specifics of the patient's condition (Benner & Tanner, 1987). The triage process is pivotal, both for its operational impact within hospitals and for its inherent cognitive demands, where potential biases or errors may arise from factors like intuition or individual experience, as outlined in the introductory studies. Variations in experience among individuals can therefore lead to differing decisions. Decisions shaped within an organisational framework tend to exhibit less variability and reduce individual decision-maker accountability (Levinthal & Newark, 2023). This study aims to provide empirical evidence regarding decision problems where organisational factors predominate over individual considerations in the decision-making process.

2.3. CDSS sustaining decision-making in triage process

In recent years, economic organisations focused on expeditious and effective decision-making have developed knowledge systems that significantly influence cognitive behaviours (Montibeller et al., 2006), aiming to bolster the decision-making process. However, the outcomes of these systems have been mixed and occasionally underwhelming (Arnott, 2006). Within the healthcare industry, the proliferation of Clinical Decision Support Systems (CDSS) aligns with research in cognitive ergonomics – the branch concerned with optimising the interaction between users and systems to enhance cognitive functioning in decision-making (Patel et al., 2013). Despite their potential, the widespread adoption of CDSS remains limited due to challenges in accurately representing the nuanced cognitive processes underpinning clinical reasoning, including heuristic-based decision-making (Islam et al., 2014).

CDSSs have direct effects on patients' healthcare and therefore must be correctly validated before their adoption in an emergency department to ensure patient safety (Varshney, 2014). In addition, validation aims at guaranteeing the correctness of triage recommendations. The literature shows the various methods used to evaluate CDSSs. Generally, the two main elements subjected to validation are a system's knowledge and correctness. Traditionally, this process also includes the assessment of costs, the quality of information, and the effects on practitioners' actions.

The development of CDSSs, however, assumes a very important role in the healthcare field given the increasing volume of information related to the management of patient care that clinicians are challenged to manage. In Triage process, the CDSS continually supports the nurse in all four phases. In fact, during the first two phases, nurse submits all available information about the patient and the software gives the emergency code. The software also allows redefining emergency code through the triage revaluation.

Indeed, the growing volume of knowledge has a great influence on patient safety (Patel et al., 2013) but also on the economic conditions of healthcare organisations and on cognitive reasoning, both positively (in terms of efficiency and effectiveness) and negatively (in terms of errors). Islam et al. (2014) point out that studies relating to CDSSs argue that those systems are designed without considering clinical reasoning methods, including heuristic processes, even if this limitation may in some situations be useful for promoting impartial decision-making processes and for standardising assistance procedures as pointed out by Ganju et al. (2020). Indeed, clinicians generally have no great inclination to use such systems (Islam et al., 2014; Johnson et al., 2014; Shah & Oppenheimer, 2008), because often they are not able to integrate human cognitive processes into complex situations. It emerges that the available CDSSs cannot be adequate to support decision-making based on cognitive heuristics such as Triage process to make the correct decision.

3. Rationale and research propositions

This study aims to discern whether organisational factors outweigh individual factors (or vice versa) in nurses' decision-making processes when they assign priority codes to patients upon arrival at the Emergency Department (ED). Each patient presents a distinct decision-making challenge with their own set of information. We hypothesise that when nurses make identical decisions, they are likely drawing from a shared heuristic framework influenced by organisational norms, which diminishes individual variance. Conversely, when nurses' decisions diverge, this points to reliance on individual judgement, shaped by personal interpretation of the information and unique heuristic applications. Our goal is to identify when organisational policies can direct individual decision-making and to explore whether the inclination to over or under assess is shaped by the structure of the decision problem and/or organisational influences. In the context of the study, where Clinical Decision Support Systems (CDSS) are used to aid the triage process, we seek to understand the systems' effectiveness and the nursing staff's response to these tools.

According to this premise and coherently with the research questions, we will refer to the assessments by nurses as Human Assessment (HA), those by CDSS as Software Assessment (SA), and the evaluation of the expert, considered as the right evaluation, as Expert Assessment (EA).

Focusing on the HA assessments and EA evaluations, we can infer the following research propositions connected to the R1 (Figure 1).

The comparison of HAs is employed to comprehend the prevalence of organisational factors in nurses' decision-making considering the complexity of the Triage cases:

Proposition 1.R1: In which level of complexity do organisational factors prevail over individual ones?

The comparisons between HA-EA enable us to deduce insights on accuracy of nurses' decisions and potential over or under assessments:

Proposition 2.R1: "How accurately do nurses assign priority codes, and what is their tendency to overestimate or underestimate these codes based on the level of complexity?"

Focusing on the HA assessments, SA assessments and EA evaluations, we can infer the following research propositions connected to the R2 (Figure 1).

The comparisons between SA-EA shed light on the software's efficacy in assigning the correct priority code and potential over or under assessments.

Proposition 3.R2: "Is the assignment of the priority code provided by CDSS accurate?"

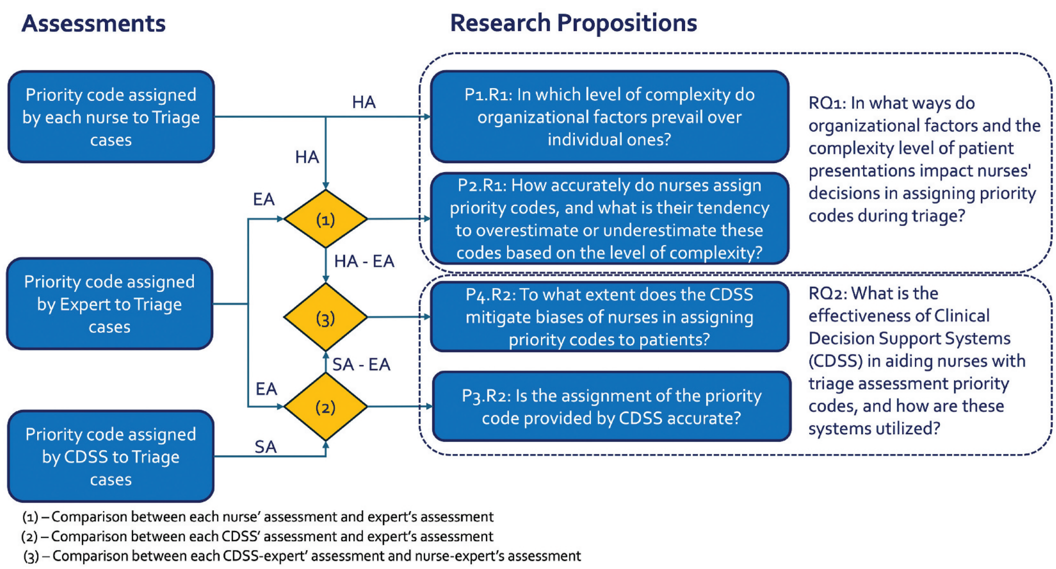

Figure 1. Combination of assessments in relation to the research propositions.

The comparison between HA and SA aims to understand if human reasoning is in line with software and if the CDSS can mitigate the nurses' bias.

Proposition 4.R2: To what extent does the CDSS mitigate biases of nurses in assigning priority codes to patients?

Additionally, interviews with nurses regarding the utilisation of CDSS in their work augment the analysis with the nurses' perceptions of its utility.

4. Methodology

4.1. Research method

The research is based on multiple case studies involving nurses working in emergency departments. The exploratory nature of the research and the need to have case studies that are comparable led us to select emergency departments with similar organisational structure. The two selected emergency departments are in Spain, and they are similar in organisation and provision of services, e.g., the numbers of physicians, nurses, and auxiliaries have the same dimension in both emergency departments. Both EDs adopt CDSS to support nurses in triage decision-making. The methodology framework is structured as follows:

(a) Design of an experimental set, simulating patients arriving to Emergency Department
(b) Submission of experimental set to the nurses through questionnaire and interviews
(c) Analysis of the questionnaire and triangulation with qualitative interviews data.

4.2. Design of the experimental set

Our inquiry into nurses' cognitive decision-making processes is based on a collection of 25 simulated triage cases reflecting the varied conditions of patients arriving at the ED – a common simulation approach in triage research (Gerdtz & Bucknall, 2007). The scenarios were crafted by the research team and a triage trainer to ensure a diverse representation of patient information complexities and accurate patient condition interpretations per established guidelines and protocols. The triage trainer, acting as an expert, provided the appropriate priority codes for each scenario, with the assumption that their judgements are accurate.

The triage cases encompass three types of information:

- Type 1 (IC1): Qualitative cues, which include the patient's reported symptoms upon arrival and observed pain.
- Type 2 (IC2): Quantitative cues, comprising vital signs and other objective patient data.
- Type 3 (IC3): Historical and background patient data.

An example of a triage case (Figure 2) demonstrates the application of these data types.

The 25 Triage cases keep in account the complexity of the decision problem, introducing the following three levels of complexity based on the structure of knowledge (Chung, 2005; Cioffi, 1998, 2001): simple, intermediate, and complex. In the simple Triage cases, IC1, IC2, and IC3 are consistent and lead to the clear and simple definition of the Triage code. The key cue to make decision and the additional cues lead to the same decision. In the intermediate Triage cases, IC1, IC2, and IC3 are at odds with each other, and only if the nurse chooses the right cue, he/she makes the correct decision. For the intermediate level, the qualitative cues (IC1) lead to the correct assignment of priority codes, whereas the quantitative cues (IC2) lead to under-assess the priority codes. In the complex Triage cases, knowledge is ambiguous, and it lacks some relevant information. In this case, the nurse must decide the triage code based on his/her expertise and experience.

The three levels of complexity in which the 25 cases are grouped refer to the greater or lesser information that these cases provide, regardless the Triage urgent code. For example, a complex case can correspond to an urgent code and another one corresponds to a not urgent code.

4.3. Data collection and analysis

We developed a structured questionnaire based on the 25 designated triage cases to collect data, with the process unfolding in two distinct phases: conducting interviews with nurses and assessing the priority codes assigned during the triage cases using the CDSS. Nurses from two emergency departments-one public and one semi-public, with 20 and 15 nurses, respectively, – participated in the study. Initially, the research team engaged with each nurse individually, presenting the triage

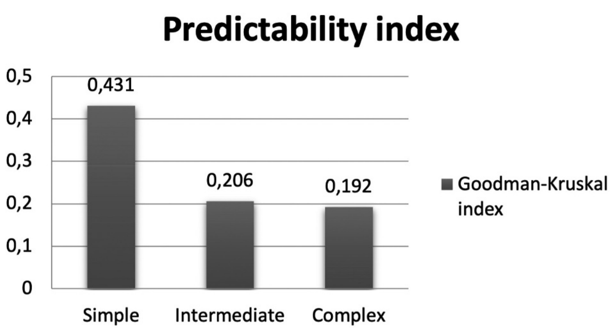

Figure 2. Example of triage case.

cases and requiring them to determine and justify a priority code within a two-minute timeframe. Subsequently, the information and clinical data from each case were inputted into the CDSS by both the nurses and the research team to generate the corresponding software-derived triage codes. Additionally, the nurses were asked to describe their utilisation of the CDSS in the process of assigning priority codes. Overall, the study yielded three datasets comprising a total of 925 responses: 25 expert assessments (EA), 25 CDSS assessments (SA), and 875 nurses' assessments (HA).

5. Results

5.1. Nurses' assessment according to the complexity of cases

In alignment with Proposition 1.R1, we analysed nurses' assessments (HAs) to determine whether organisational influences are more pronounced than individual factors in the assignment of priority codes. To evaluate this, we employed the Goodman-Kruskal index, which measures the level of agreement among nurses when assigning priority codes to the 25 triage cases, independent of their accuracy. The Goodman-Kruskal index is a statistical measure used to assess the concordance or agreement between three or more judges when classifying the same set of items into ordered categories. This index quantifies the degree of agreement among raters, taking into account both the observed and expected discordances in their classifications. The index ranges from 0 to 1, with higher values indicating a higher level of agreement among the judges. In our case, nurses act as judges, the sets of items to be evaluated are triage cases, and the ordered categories represent the five levels of priority codes.

Analysing the relative frequency distribution of the nurses' responses for each case, we found that a homogenous distribution – where responses align to a single priority code – suggests the influence of organisational guidelines, leading to consistent heuristic application and decisions. Conversely, a heterogeneous distribution indicates a stronger presence of individual discernment influencing priority code assignment. Upon applying the Goodman-Kruskal index to the cases, sorted by their complexity levels, we observed an increasing trend of heterogeneity in assessments from simple to more complex cases, as depicted in Figure 3.

The data indicated that responses to simple cases were generally more uniform than those for intermediate or complex cases, confirming that case complexity influences the heuristic decision-making process.

5.2. Correctness of nurses' assessments compared to the expert cases assessment

Coherently with Proposition 2.R1, the nurses' correctness in assignment the priority code turns up pairs to 50% of the total 875 answers is characterised. The percentage of 15% of answers is characterised by under-assessment (HA < EA) and the percentage of 35% by over-assessment (HA > EA).

Figure 4 shows the nurses' correctness according to the level of complexity of the triage cases, we can observe that nurses' behaviours are significantly different in simple, intermediate, and complex cases ($\chi 2$ test with $p < .05$).

The percentage of correctness of nurses' answers (HA = EA) decreases from simple to complex cases and nurses tend to over-assess in simple and complex cases, while they tend to under-assess in intermediate cases.

5.3. Effectiveness of CDSS through an analysis of the difference in assessment both between the CDSS and the expert and between CDSS and nurses

In line with Proposition 3.R2, we initially assessed the accuracy of the CDSS by comparing its decisions with those made by the expert. The findings indicate that in 52% of cases, the CDSS accurately matched the expert's decision. However, in the remaining cases, there were discrepancies, with the CDSS occasionally assigning urgency levels that were either too high or too low, leading to over-assessment in 24% of cases and under-assesment in another 24%. Further analysis involved comparing the decisions made by the CDSS with those of the nurses to understand the alignment in decision-making and to explore the CDSS's role in bias mitigation.

According to Proposition 4.R2, we observed that nurses also made correct decisions in 50% of cases, yet their assessments differed from the CDSS in terms of over- and under-assessments, at rates of 16% and 35%, respectively. Notably, concordance between nurses

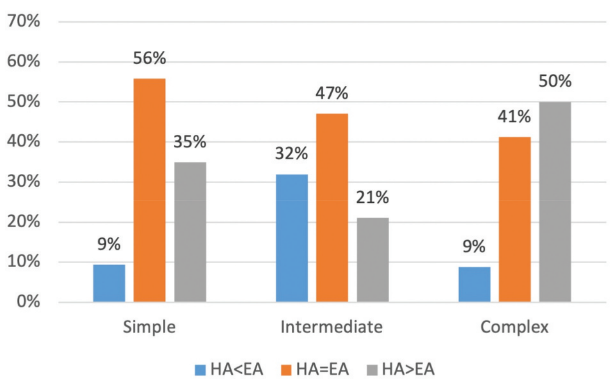

Figure 3. Goodman-Kruskal index from simple to complex cases.

Type 1 (IC1) qualitative cues				
Man, about 50 years, asymptomatic even if slightly rough. He claims that the day before felt a retro-sternal chest pain radiating to the arms with a sense of dizziness, sweating, and oppression.				
Type 2 (IC2) quantitative cues				
Vital signs: FC 80/min; T 36° C, PA 150/80 mm/Hg: SpO2 98%; FC 80/min				
Type 3 (IC3) Antecedents				
Smoker; the symptoms, the day before, were now spontaneuosly reversible; duration of pain about 20 min; 2 attacks of palpitation an dizziness occurred later.				
Priority code				
1	2	3	4	5
Justification:				

Figure 4. Comparison between expert's and nurses' assessments according to the complexity of cases.

and the CDSS dropped from 62.2% in simple cases to 39.7% in complex cases. We have then analysed the over- and under-assessments regarding the complexity of the cases comparing the under-assessments (UA) and over-assessments (OA) made by nurses and by the CDSS. We have considered as reference line the expert assessments. This comparison is shown in Figure 5 where the bar width is the sum of the percentages for over-assessment and under-assessment, respectively, above and below the expert assessment line.

We notice that in simple cases both software and nurses tend to have a tendency to over assess. In the simple cases, the qualitative and quantitative information are coherent and beyond the errors the behaviour in over assess is similar. Instead, in the intermediate cases, the three types of information (I1, I2, and I3) are in competition, and giving attention to a cue rather than another can lead to different decision. This situation can happen even in complex cases where the information is not consistent, and some information may be missing. Our results corroborate that in incoherent or ambiguous knowledge, nurses tend to have a different behaviour with respect to CDSS. In intermediate nurses tend to over-assess (21%) and under-assess (31,9%), while the over-assessment of CDSS is

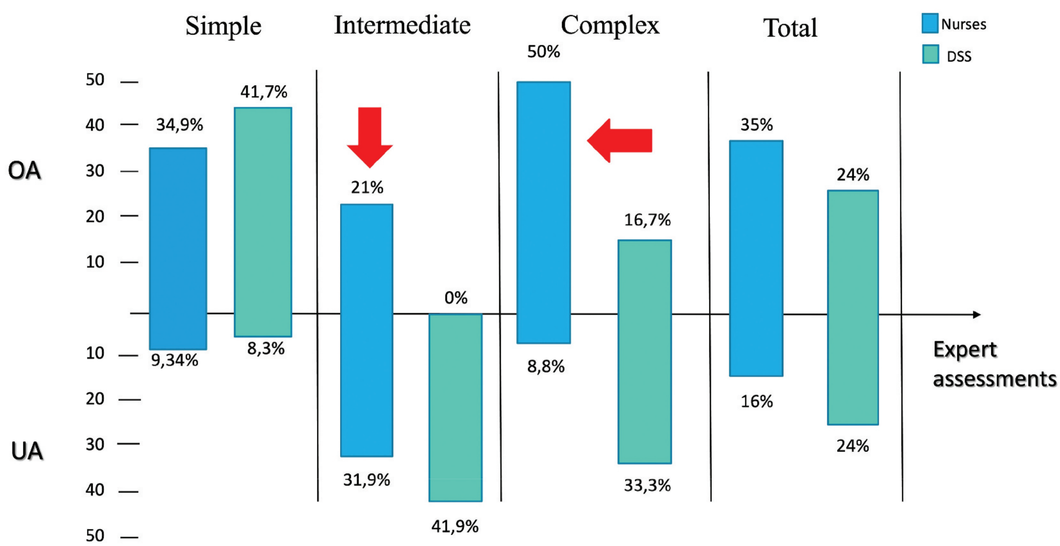

Figure 5. Errors (OA and UA) made by nurses and by CDSSs according to the complexity of cases.

equal to zero and under-assess is equal to 41,9%. In complex cases, the highest percentage of nurses' errors is characterised by over-assessment (50%), with under-assessment at 8.8%. Instead, the CDSS tends to under-assess (33.3%), with over-assessment of complex cases at 16.7%. This analysis put in evidence that the software can be a support for nurses only in simple cases. In this case, the decisions of nurses and CDSS are similar. Conversely, in situations characterised by incoherent knowledge or ambiguity, the software gives a different outcome with respect to nurse's decision.

In conclusion, in complex cases, where information provided is ambiguous, nurses have the lowest percentage of agreement with the CDSS. This result, in short, highlights how the nurse gives an assessment of the patient moving towards over-assessment with the increase in the complexity of cases.

6. Discussion

The triage context has provided a lens through which to explore the intricate process of individual decision-making underpinned by cognitive heuristics, shedding light on how organisational influences intersect with individual decision-making under conditions of time pressure and uncertainty.

6.1. The interaction between organizational and individual factors on nurses' decisions according to the complexity level of the triage case

Our research reveals that individual and organisational factors are interwoven, and the structure of information of the decision problem can affect the prevailing of individual factors on organisational ones and *vice versa*.

The organisation studies give relevance to the coordination mechanisms and guidelines for activities coordination and for giving a direction to individual in their decision-making (Bingham et al., 2007; Eisenhardt & Martin, 2000; Eisenhardt & Sull, 2001; Vuori & Vuori, 2014). Our results underline that this organisational role depends on the structure of information of the decision problem. Indeed, the Goodman-Kruskal index confirms that the degree of complexity of the triage cases affects the heterogeneity of the nurses' responses, and this occurs especially in complex cases, where the information is missing. In such case, the individual factors prevail on the organisational ones in the assignment of the priority code. The interpretation of ambiguous information is usually based on the recalling to memory of known organisational procedures and can be applied for routine rather than for novel tasks (Rudolph et al., 2009). The complex Triage case studies can be assimilated to novel tasks, and the heterogeneity of the nurses' responses in these case studies allows us to deduce the following proposition:

In ambiguous decision problems, cognitive decision-making leverages on individual characteristics to supply the missing knowledge and make decision. Conversely, in routine task the organisation rules are recalled to make decision.

6.2. Nurses' over and under assessment according to the complexity level of the triage case

The examination of the accuracy of nurses' assessments (comparing HA to EA) unveils a compelling pattern. In both simple and complex triage case scenarios, there is a proclivity for nurses to overestimate urgency compared to expert evaluations.

During the interview, a nurse claimed: "*In case of older patients with low priority, we usually make sure to give them a high priority code so they don't have to wait too long and get too tired*". Another nurse highlighted: "*In case we are unsure, we usually give a higher priority code than the protocols suggest because we don't want to take any chances with the patient's safety*".

Thus, in scenarios with clear or ambiguous information, nurses may err on the side of caution, choosing a more urgent triage level than warranted to preclude adverse outcomes. Conversely, intermediate scenarios reveal a tendency among nurses to underestimate urgency. This variance is attributable to the case design; intermediate scenarios present conflicting information where objective data may suggest normalcy, potentially overshadowing subjective indicators of serious conditions. Thus, objective stability can become a pitfall, leading to misjudgements. According to this, a nurse stressed: '*in situations with unclear clinical information, we prefer to base our decisions on objective cues because they are indisputable*".

These findings imply that nurses may exhibit risk-averse behaviour, placing undue emphasis on objective data when presented with contradictory information, which consequently leads to underestimation.

Such behaviour aligns with Ellebrecht's (2019) observation that deliberate over-triage by nurses is a common practice.

Drawing from Beach and Mitchell's (1978) decision-making theory, we can infer that nurses select their decision strategy based on several factors: the observable impact of their decision, its future significance, and their personal accountability for that decision. In triage, the reversibility of priority codes may inadvertently encourage less vigilance. However, the stakes associated with patient outcomes intensify the nurses' accountability, fostering risk aversion. Organisational constraints (Saghafian et al., 2018) may inadvertently encourage nurses to assign priority codes conservatively to shield themselves from potential repercussions.

These observations let us deduce the following proposition:

(1) These observations let us to deduce the following proposition:
(1) *The organisation should give attention to the accountability of the nurses and define rules or leverages to reduce the risk aversion behaviours.*
(2) Against this backdrop, the organisation could redesign the Triage process in order to transform it in a collective decision-making, reducing the perception of the accountability of a single nurse, giving more emphasis to the reassessment phase of the Triage process.
(3) These findings sound with the statement of Zachariasse et al. (2019) that recites "there are more potential factors that could affect triage systems' validity, such as the local infrastructure, the experience and training of the triage nurse, the presence of a computerized triage application or variations in disease epidemiology" (p. 7). The minimisation of errors in decision-making can guarantee the right balance between organisational rules (Ramanujam & Rousseau, 2006) and personal knowledge and experience (Considine et al., 2007).

6.3. The interaction between the CDSS and nurses in assigning priority codes to patients

Our study has revealed that there is a divergence between CDSS and nurses when it comes to assigning priority codes to patients. The accuracy of the software is lower (52%), and this can depend on the characteristics of the CDSS. In Spain, the CDSS in use is "web_e-PAT", which enables nurses to input both qualitative and quantitative patient data (see Figure 1). Web_e-PAT uses a technology that belongs to the artificial intelligence domain based on decision trees, that is, it employs a "tool used to support decision making through computing expected values of all decision alternatives in order to identify the best solution" (Mărginean et al., 2010, p. 631), easy to interpret (Manolopoulou et al., 2015). Hence, the decision trees technology is based on a function that receives, as input, a vector of attribute-value pairs and returns the decision, but as Albu (2017) states, "one advantage of such a system is that the knowledge is represented in a language that is very close to the natural one and this makes it a reliable model. Unfortunately, sometimes this feature is not enough to create a fully functional medical decisional system" (p. 66).

Comparing the outcomes of CDDS with the nurses' assessments, it emerges a difference in the under- and over-assessments. In the intermediate cases, the percentage of over-assessment of nurses is 21%, whereas the percentage of over-assessment of the CDSS is 0%, the conclusion is that nurses assign different weights to the conditions and symptoms of the patient (subjective information) and make more urgent triage decisions (each symptomatic category incorporated into the programme is characterised by a fixed weight). Also, in complex Triage case studies, we observe a difference in over and under assessment between nurses and CDSS.

The perception of nurses about the usefulness of CDSS is emerged during the interviews. A nurse stated: "*the CDSS can be a support, but the software cannot observe the patient and does not know how much he/she appears to suffer. For this reason, in same case, we assign a different priority code respect to the CDSS'assessment".*

This evidence is confirmed by the majority of nurses that recognise the support of CDSS in known and routine patient's conditions (simple and intermediate Triage cases) even if, in some cases, they manipulate the information entered in the system to change the priority code. As example, a nurse told us that in the interaction with patients affected by particular diseases (Alzheimer's, etc.), he/she prefers to assign them a higher triage level to shorten long waiting times and avoid creating discomfort or chaos in the waiting room. Consistent with the earlier findings, it can be inferred that nurses manipulate the CDSS, as they remain responsible for the decision rather than the CDSS.

This suggests that the CDSS is not a tool used by the organisation to influence nurses' interpretation processes, but rather a support that nurses can use if needed. In its current version, the CDSS does not effectively assist nurses. Instead, in the emergency department, a well-designed CDSS could be a complementary tool integrated into the workflow and aimed at supporting the first phase of Triage process, allowing the nurses to dedicate more time to the reassessment phase. The CDSS could also be an effective tool to train nurses to be assigned to triage in the emergency room. The adoption of the CDSS could be more useful if it evolved into an innovative system of machine learning (Gunning et al., 2019), capable of evolving and learning, and able to imitate the capabilities of human intelligence.

7. Conclusions

This study explores the individual decision-making in triage process that leverages on cognitive heuristics to make sound decisions with very little knowledge and acting quickly in the proper environment (Islam et al., 2014; Marewski & Gigerenzer, 2012); specifically, the paper investigated the prevalence of organisational factors over the individual ones in a nurse's decision-making process when assigning a priority code to a patient upon their arrival at the Emergency Department.

The research is framed in the debate on how the effectiveness exploitation of information structures in the social and physical environment characterised by uncertainty is influenced by different elements: individual characteristics related to the experience and ability of individuals (Ehrig et al., 2021; Galavotti et al., 2021; Gilbert-Saad et al., 2021; Guercini & Milanesi, 2020; Rudolph et al., 2009); the organisational factors (Bingham et al., 2007; Cyert & March, 1992; Levinthal & Newark, 2023; Simon, 1997); the features of the decision problem, such as the structure of information, the time pressure (Stevenson et al., 2000), the available alternatives (Payne et al., 1993).

The field of study of the triage process developed by nurses, on the other hand, is a ground rich in research that has highlighted the complexity of the decision-making process that nurses carry out in triage and how the reasoning process underlying is influenced not only by rational and individual factors but also guided by organisation (Cone & Murray, 2002).

The prevalence of organisational factors over the individual ones in this research was achieved through an experimental set formed by 25 triage cases, submitted to 35 nurses through interviews; the research is carried out in two Spanish Emergency Departments where the triage process is supported by a CDSS. Our findings highlight how as the level of complexity of the situation increases, linked to the ambiguity of the information available, the organisational context and its factors are less able to support the reasoning process since the organisational context is not able to provide useful information or provide conflicting information. Consequently, the nurse decision-maker must appeal to another decision-making factor, the experience. The use of experience, being closely linked to the working experience of the individual nurse, gives rise to a variability in reasoning processes.

Our results therefore underline how organisational factors interact with individual factors, an interaction that constitutes a key element in the triage decision-making process. The organisational factors can affect the decision in routine decision problem (Cyert & March, 1992; Levinthal & Newark, 2023; Simon, 1997), whereas the individual mainly leverages on own experience and knowledge to solve novel decision problem, in line with the decision-making processes developed by many managers in organisations (Ehrig et al., 2021; Galavotti et al., 2021; Gilbert-Saad et al., 2021; Guercini & Milanesi, 2020).

An interesting aspect of our study is the role of organisation as constrain that prompt individuals to take risk-aversion behaviour. Nevertheless, this study underscores the necessity for further research on human reasoning, particularly in characterising triage decision-making and medical decision-making overall (Elwyn et al., 2001). It calls for an exploration into which organisational aspects exert the most significant influence on decision-making processes and how healthcare organisations can leverage these organisational factors to standardise reasoning processes. Decision-making processes formulated within the framework of organisational rules not only diminish decision-making variability but also alleviate the burden of responsibility on decision-makers (Levinthal & Newark, 2023). Indeed, deciding on one's own experience without the support of organisational factors can be considered dangerous by individuals because it increases the level of responsibility for the possibility of cognitive biases occurring. Therefore, in such situations, nurses tend to assign a higher priority code due to heightened complexity in determining triage levels, driven by risk aversion. This finding is reinforced by the different assessments made by CDSS whose reasoning is based exclusively on organisational rules without the influence of the risk aversion phenomenon.

Although the CDSS is not influenced by risk aversion, the characteristics of the CDSS used in Triage are not adequate to work effectively in the situations, yet. In this perspective, this study could give useful insights also on the design of a CDSS able to integrate an accurate knowledge of the human reasoning used by nurses in triage and actively support decision-making (Islam et al., 2014). Our findings show that the current characteristics of CDSS are not able to make the correct decisions. On the one hand, this study highlights the importance of recognizing the organizational rules and constraints that impact decision-making processes, even when individuals rely on heuristics. Our study prompts the organisation to give more attention to the characteristics that a CDSS must have to be an effective support to human decision-making processes in a society increasingly driven by technology (de Carvalho Botega & da Silva, 2020). The design of DSS should be tailored to the decision problem and be carried out through continuous evolutionary processes, in order to minimise possible biases related to problems, organisation, and environments (Arnott, 2006). Consequently, future studies could monitor the effectiveness of CDSSs over time in relation to developments and progress in the field of artificial intelligence, in order to verify whether the evolution of the latter, over time, makes these CDSSs more in tune with the reasoning processes of individuals.

The main limitation of this work resides in the explorative nature of the research being strongly dependent on the context and therefore the Triage case studies cannot be applied to other clinical contexts and the results are not generalised.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

Data are stored at the Department of Industrial Engineering, University of Naples Federico II. Data will be made available on request.

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