

## Understanding triage assessment of acuity by emergency nurses at initial adult patient presentation: A qualitative systematic review

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### ABSTRACT

**Background:** Nurses make complex triage decisions within emergency departments, which significantly affect patient outcomes. Understanding how nurses make these decisions and why they deviate from triage algorithms facilitates interventions that work with their decision-making processes, increasing acceptability and effectiveness.

**Aims:** This qualitative systematic review aimed to understand decision-making processes emergency nurses use to make acuity decisions during triage assessment at initial patient presentation.

**Methodology:** Medline, CINAHL and Academic Search Complete were systematically searched to 15th December 2022. Data were analysed using thematic synthesis. Established themes were reviewed with GRADE-CERQual to evaluate certainty of evidence.

**Results:** 28 studies were included in the review. Data analysis uncovered three superordinate themes of holistic reasoning, situational awareness, and informed decision-making. The findings show nurses value holistic assessments over algorithms and rely on knowledge and experience. They also assess the wider situation in the emergency department.

**Conclusions:** This review presents new perspectives on nurses' decision-making processes about patient's acuity. Nurses holistically gather information about patients before translating that information into acuity scores. These actions are informed by their knowledge and experience; however, the wider situation also impacts their decisions. In turn, the nurses use interpretations of patients' acuity to control the wider situation.

### 1. Background

Understanding how nurses make acuity assessments on initial presentation to emergency departments is important. It affects how rapidly patients are seen by doctors and subsequent time to receive treatment. Studies have reported associations between accuracy in triage to waiting times and patient mortality outcomes [1,2], with accurate and timely triage needed to ensure patient safety and avoid adverse events [3]. Currently, evidence-based decision-making algorithms have been developed to provide guidance and ensure safe practice [2]. However, significant differences can occur between decision-making algorithms and practice. Studies have noted that nurses will make acuity decisions that differ from recommendations of algorithms [4,5]. These deviations from algorithms may represent nurses acting on their own clinical

judgment, with recent studies identifying that nurses have equal or higher accuracy than triage algorithms at predicting both mortality [6] and chance of admission [7].

Understanding how nurses make acuity decisions and why they deviate from algorithms would offer insights to know what practices are taking place, why acuity scores are assigned and whether they are accurate. Whilst quantitative perspectives present numerical outcomes of acuity decision-making, to understand thought-processes and reasoning behind nurses' actions, a qualitative perspective is required [8]. Through this we can gain insights into what factors drive nurse decision-making processes.

Although several literature reviews have previously explored this area, no qualitative systematic review has robustly explored nurses' reasoning around the use of acuity assessments. Qualitative systematic

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reviews aim to draw together and summarise research in a systematic manner, with high quality and rigour, whilst beginning to develop new theory that allows understanding of behaviours and reasoning behind actions [9].

The purpose of this review was to draw together qualitative findings about triage decision-processes of nurses, whilst illuminating decision-making processes from the perspectives of nurses themselves.

## 2. Aims

This qualitative systematic review aimed to understand the processes emergency nurses use to make acuity decisions during triage assessment at initial patient presentation. Areas for exploration include what influences decision-making processes, and why nurses may deviate from available algorithms.

## 3. Methods

A review protocol was submitted to PROSPERO and registered (ID: CRD42022289244). The review followed an established framework for conducting systematic reviews [10].

### 3.1. Search strategy

Search terms were developed using keywords taken from the research question to ensure searches were targeted towards suitable literature. Boolean operators were used. Search strings are presented in [Supplementary File I](#). Searches were undertaken from 7th March 2022 to 7th June 2022 and updated 15th of December 2022.

MEDLINE OVID, CINAHL and Academic Search Complete were searched. [Clinicaltrials.gov](https://clinicaltrials.gov) was searched for relevant registered trials to ensure no studies were missed.

Bielefeld Academy Search Engine, NTLTD, EThOS, King’s Fund, Nuffield Trust and NICE were all searched for relevant grey literature. Reference lists of included studies had their citation lists checked for relevant studies. This continued through a snowballing approach until no further relevant studies were identified.

### 3.2. Eligibility Criteria

Eligibility criteria are presented in [Table 1](#). Only adult patients, whose primary presentation was not maternity or mental health were included, due to differences in approaches to assessment and staff required. Papers featuring mixes of patients meeting inclusion and exclusion criteria were considered at full-text review. If the population consisted of greater than 80% of participants without any exclusion criterion, the paper was considered eligible.

Papers were screened using Rayyan (<https://www.rayyan.ai>). Each paper was double screened by at least two reviewers (HG, WA, JP, SS, EW, GW, AZ and LDB), blinded to each other’s decisions. Title and abstracts were initially screened, with disagreements in inclusion/exclusion transitioned to full-text review. Full-texts were also blind screened by at least two reviewers (HG, WA, JP, SS, EW, GW, AZ and LDB). Disagreements on inclusion were discussed with the entire review team

**Table 1**  
Inclusion/exclusion criteria.

Inclusion criteria	Exclusion criteria
Nurses in emergency departments	Study focussed on triage of specific illness or presentation.
Patients triaged aged 16 + years.	Patients’ main presentation is maternity or mental health problem.
Paper focusses on process of assessment of acuity.	Paper published in language other than English.
Paper is qualitative primary research.	

until consensus was made. Overall agreement between reviewers was assessed using Cohen’s kappa.

### 3.3. Data extraction

Data extracted included: bibliographic information, study design, participants and main findings, using standardised data extraction forms. The included papers were divided between members of the review team (WA, JP, SS, EW, GW, AZ and LDB) for data extraction, whilst one reviewer (HG) extracted from all included papers. The results were then compared, discussed and merged to form the final data extraction. Results are presented in [Supplementary File II](#).

### 3.4. Methodological appraisal

Study methods were assessed by members of the review team, examining the same papers they were assigned during data extraction to ensure continuation between stages and maximise familiarity with the data. One reviewer (HG) assessed all included papers whilst blinded to the decisions of the other reviewers. Assessment was performed using the CASP qualitative checklist [11].

### 3.5. Data synthesis

We adopted a data synthesis approach using thematic synthesis based on the framework by Thomas and Harden [12]. Synthesis was performed by inductive line-by-line coding of texts of primary included studies, allowing extraction and synthesis of findings via translation between different studies. Codes were inductively developed as analysis was undertaken, being added to a centralised list. Coding individual papers was undertaken independently by two reviewers per paper. One reviewer (HG) coded every paper and the review team (WA, JP, SS, EW, GW, AZ and LDB) continued with the papers they assessed at previous stages to maintain continuity. Codes were organised into descriptive themes via grouping of similar concepts using hierarchical tree structures [12]. Descriptive themes were created using a nominal group technique approach [13] and required consensus between all members of the review team before inclusion.

Once descriptive themes were established, one reviewer (HG) supported by two academic supervisors (TS and MMG) developed analytic themes, grouping descriptive themes into a model for discussion, which was presented to the full review team for agreement. GRADE-CERQual was used to evaluate the certainty of evidence in the analytic findings of the review. GRADE-CERQual identifies the strengths and weaknesses of presented findings and demonstrates the quality of evidence underpinning these findings [14].

## 4. Results

The results of the search strategy are summarised in [Fig. 1](#). Database searches produced 12,151 papers. In total, 28 papers were eligible and included.

Agreement for title/abstract screening was 99.2% (k = 0.80, 95% CI 0.76–0.83) between the eight reviewers. Agreement for full-text screening was 90.8% (k = 0.77, 95% CI 0.64–0.89).

Demographics of the participants of included studies are presented in [Supplementary File III](#).

### 4.1. Methodology assessment of included papers

Results of methodological assessments are presented in [Fig. 2](#). Issues around recruitment were noted in six studies (21%), with lack of discussion of recruitment strategies or sampling techniques. Researcher relationships with participants was an area with severe concerns, with many studies (n = 21, 75%) stating no or unclear reporting.

Two studies did not explicitly list ethical permissions, and two did

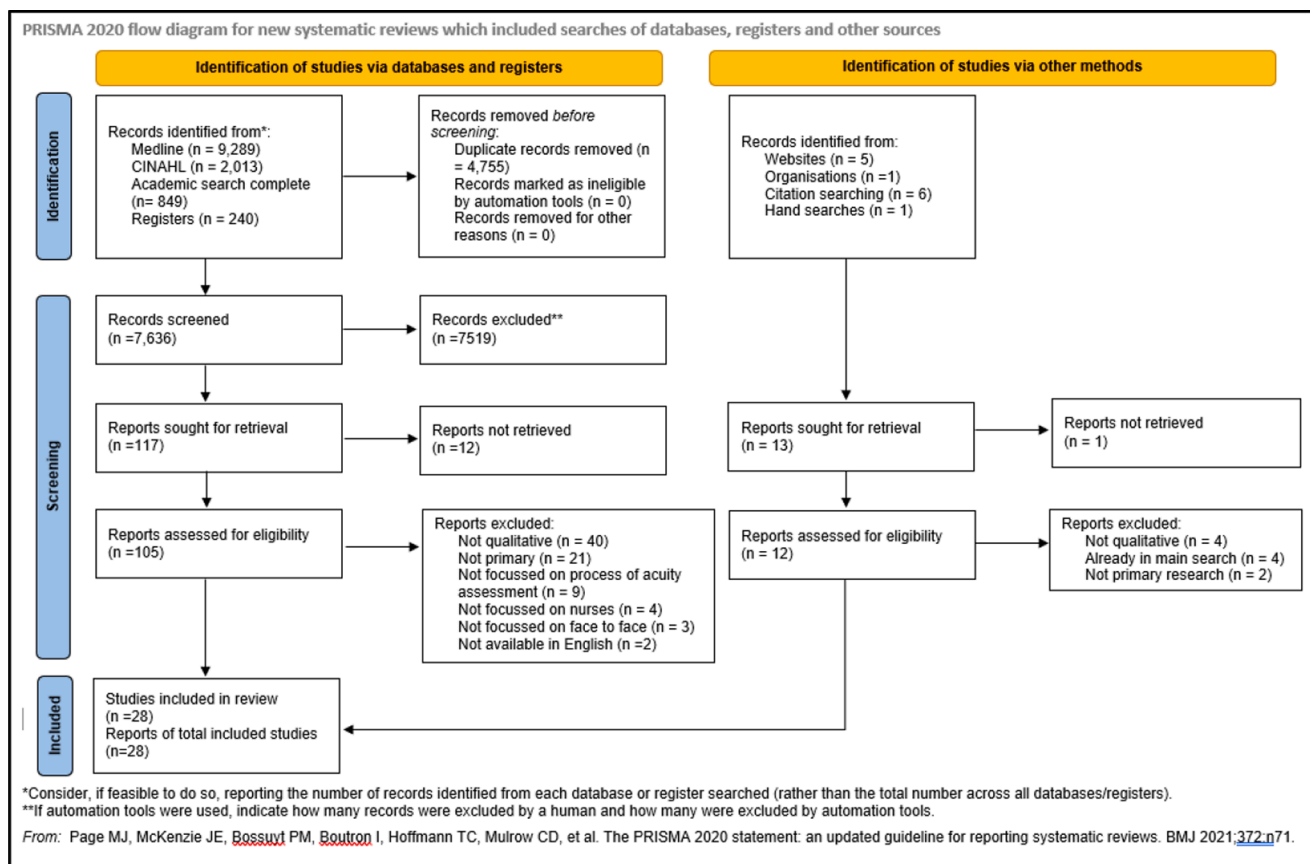


Fig. 1. PRISMA flow diagram.

not discuss informed consent. Six studies (21%) lacked depth to discussions of analysis processes, leading to difficulties in distinguishing how findings were created, with possibilities of researcher bias and misinterpretations of results [15].

One study failed to discuss credibility of findings through triangulation and verification, raising questions surrounding accuracy of their interpretations [15]. Seven studies (25%) did not discuss either further research or implications for policy or practice, resulting in lack of direction to how the authors view the research as fitting into the larger narrative of triage practice [16].

#### 4.2. Results of analysis

Initial analysis resulted in creation of 31 codes. These were analysed to reveal 16 descriptive themes. These were further analysed in the context of the research question to produce analytic themes. These analytic themes were then grouped into categories, producing three superordinate themes and seven subordinate themes, one of which had two further subordinate themes (Fig. 3).

#### 4.3. GRADE-CERQual results

GRADE-CERQual was used to evaluate certainty of evidence in the findings. Overall, certainty was good, with nine papers rated as high-certainty, and one as moderate.

A summary of the GRADE-CERQUAL assessment is shown in Table 2. The full details of the assessment, with quotes supporting the themes are in Supplementary File IV.

Overall, the appraisal of methodology revealed concerns with the included papers. No issues were considered enough to result in the methodological concern being rated as severe. However, all findings were rated as moderate concerns for methodology due to the previously

identified issues.

The finding rated as moderate-certainty had very minor concerns relating to coherence, and minor concerns relating to relevance. However, due to a lower number of supporting studies than other findings the adequacy was rated as moderate concerns. This does not necessarily suggest inaccuracy to the finding, but rather that the area requires further research [17]. Despite this, the overall finding was still rated as moderate-certainty to reflect this need for further research, combined with the moderate concerns for methodology.

### 5. Findings

#### 5.1. Theme 1: Holistic reasoning

*“On that basis, she gave him a yellow triage code, later explaining that she preferred to consider him ‘as a whole’ rather than prioritising on the basis of single symptoms.” Participant [18].*

The first theme reflects nurse’s assessment processes, exploring how nurses create acuity scores. The theme distinguishes that they go beyond triage algorithms to explore all aspects they consider influence patient’s acuity. Nurses assess patients using holistic reasoning [18–24], gathering data through visual, vital and verbal signs [20,21,23,25–28], which is interpreted through a mix of clinical reasoning and intuition to translate into acuity scores [18,19,29–31]. The decision-making process is influenced by nurses’ personal beliefs and assumptions [21,28,30,32,33], perceptions of risk [22,26,29,34–37], and awareness of environmental pressures in the department [18,24,25,31,36,38]. Nurses deviate from available triage algorithms because they feel they do not reflect the individualism of patients and the situational aspects of the assessment process [18,21,22,36,39,40].

Paper	Was there a clear statement of the aims of the research?	Is a qualitative methodology appropriate?	Was the research design appropriate to address the aims of the research?	Was the recruitment strategy appropriate to the aims of the research?	Was the data collected in a way that addressed the research issue?	Has the relationship between researcher and participants been adequately considered?	Have ethical issues been taken into consideration?	Was the data analysis sufficiently rigorous?	Is there a clear statement of findings?	How valuable is the research?
Alves (2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Unclear	Unclear	Yes
Andersson (2006)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Unclear
Bijani (2018)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Bijani (2019)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Buriola (2020)	Yes	Yes	Yes	Unclear	Yes	No	Unclear	Unclear	Yes	Unclear
Chang (2016)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Chung (2005)	Yes	Yes	Yes	Yes	Yes	No	Yes	Unclear	Yes	Unclear
Cone (2002)	Yes	Yes	Yes	Yes	Yes	No	Unclear	Yes	Yes	Unclear
De Souza (2013)	Yes	Yes	Yes	Yes	Yes	No	Yes	Unclear	Unclear	Unclear
Edwards (2007)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Unclear
Edwards (2008)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Forde (2014)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fry (2005)	Yes	Yes	Yes	Yes	Unclear	No	Yes	Unclear	Yes	Unclear
Goranssen (2008)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Hitchcock (2013)	Yes	Unclear	Yes	Unclear	Yes	Unclear	Yes	Yes	Yes	Yes
Johannessen (2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Johannessen (2018)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Johansen (2011)	Yes	Yes	Yes	Unclear	Yes	No	Unclear	Unclear	Yes	Unclear
Johnson (2021)	Yes	Unclear	Yes	Yes	Yes	No	Unclear	Yes	Yes	Yes
Jones (2015)	Yes	Unclear	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Mirhaghi (2016)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes
Moon (2021)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reay (2015)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Reay (2019)	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes
Roscoe (2016)	Yes	Yes	Yes	No	Yes	No	Yes	Unclear	Yes	Yes
Stritto (2005)	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Yes
Wolf (2010)	Yes	Yes	Yes	Unclear	Yes	Yes	Yes	Unclear	Yes	Yes
Wolf (2017)	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes

Fig. 2. CASP appraisal of included papers.

5.2. Theme 2: Situational awareness

“I just try to figure out who the sickest person is based on all the others who are waiting, and then I sort them by that so I know what order the patients go back.” Participant [36].

The second theme represents situational perspectives of the assessment process, and how the environmental pressures impact on nurses’ abilities to make accurate decisions. Our findings explored perceptions of environmental pressures, with high numbers of patients [28,30,31,34,36], poor staffing [24,38,41,42], absence of suitable assessment space [41–43] and lack of flow from the triage area [24,25,30,31,33,36,42,44,45] all perceived to negatively affect nurses’ decision-making processes. These are further affected by interprofessional dynamics, with interactions with other nurses [36,37], medics [24,28,34,35,40], paramedics [23,24,36] and managers [18,22,24,26] seen to impact assessment processes. In response to these environmental pressures, nurses will alter decision-making processes to moderate the impact, through timekeeping [19,25,30,34,39], gatekeeping [21,26,30,32,35,37] and manipulation of triage tools [18,24,31,38].

5.3. Theme 3: Informed Decision-Making

“I believe he needs experience or be a very developed person when graduating because you do need a clinical perspective, you need experience in the emergency sector in order to be able to do the classification” Participant

[36].

The third theme represents information that nurses use to make triage decisions, whether gained through formal teaching or through their work. The findings highlight how nurses’ decision-making processes are informed by their knowledge [29,33,35,42,44] and experience [19,21,25,27,30,33,39], which provide context to assessments [27,33], and aids in developing clinical reasoning and intuition [27,33,39–44]. Knowledge and experience were also seen to contribute to development of personal attributes that supported nurses in practice, such as autonomy, adaptability and emotional stability [28–30,36,44]. Nurses describe the importance of training in triage to being able to accurately assess patients [34,38,39,41,42,44], however, many nurses identified feelings that present training was lacking both in quantity and quality [23,28,38,39,42,44].

6. Discussion

This review aimed to understand triage assessment of acuity by emergency nurses at initial patient presentation, and identified three superordinate themes: holistic reasoning, situational awareness and informed decision-making (Fig. 3).

The first theme highlights the nurses’ assessment process and their preference for holistic assessment beyond triage algorithms to create acuity scores. Whilst nurses’ use of holistic assessment has been previously described in general literature, its use in triage is often overlooked

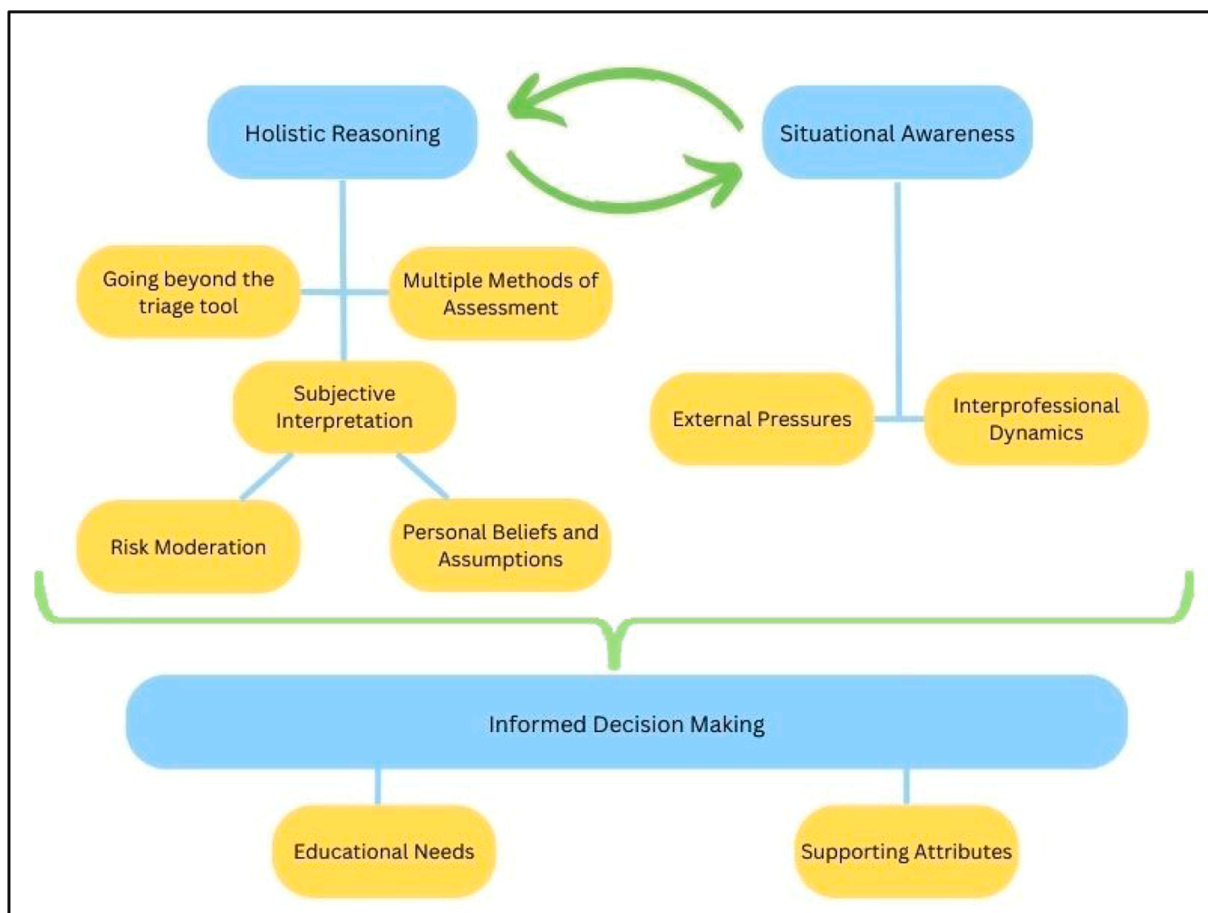


Fig. 3. Superordinate and subordinate themes.

in favour of discussion of triage algorithms.

An important finding from this review is that nurses prefer holistic assessments because they feel they allow them to assess acuity more accurately, describing triage algorithms as too generalised and unable to react to individual circumstances of patients' presentations. This leads to nurses' gathering as much data as possible, utilising wide mixes of assessment methods as described in Roscoe et al. [27], in an attempt to gain holistic perspectives of patients acuity.

This theme also discusses how nurses interpret gathered information, utilising clinical reasoning and intuition with influences from personal beliefs and risk assessments, reflecting findings from Tanner [46]. Yet, our findings show that clinical reasoning and intuition are not two separate routes of assessment, but instead moved between and combined as information is assessed and transformed to interpret appropriate acuity categories (Fig. 4), something described by Yoon et al. [47] in paediatric triage, but not yet described in adults.

The second theme explores external influences on assessment processes, and how they impact nurses' abilities to make accurate decisions. This review expanded on Tanner's [46] description of the importance of the context of situational awareness, finding nurses compare the acuity of patients they assess against the acuity of other patients in the department, resulting in a situational triage.

The influence of factors outside nurse-patient interactions also agrees with findings from Fekonja's recent systematic review [48], who noted that the environment reflects important pressures on acuity decisions. Our findings explored how these pressures increase nurses' stress, impacting assessments. They also cause changes in nurses' processes, with shortened assessments and more reliance on intuition. As a result, nurses cannot perform the holistic assessments they value, potentially resulting in missed symptoms.

To reduce these pressures, nurses often take actions that aim to control the situation. Our research shows this can give rise to a dynamic cycle where nurses assess both acuity and situation, attempting to balance decisions to simultaneously meet the best interests of patients and the wider department.

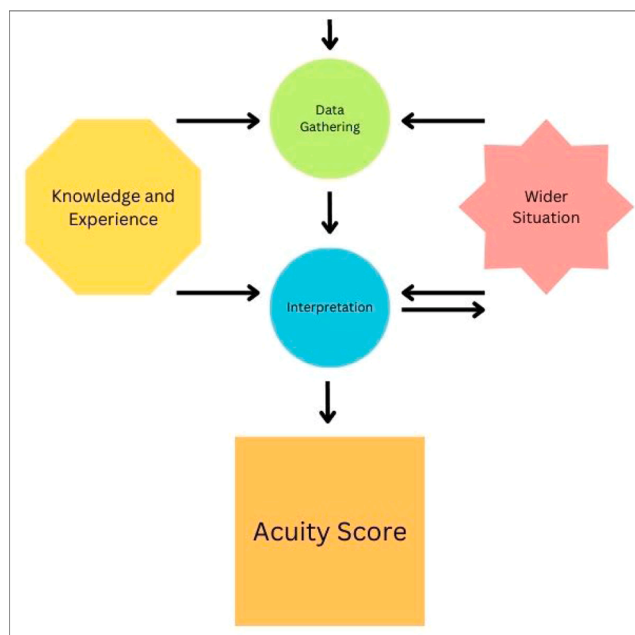
The third theme emphasises how nurses utilise tacit knowledge and experience, gained through formal learning and working practices, to make informed decisions, reflecting findings from Yoon et al. [47]. Our findings further show neither knowledge nor experience alone are considered sufficient to ensure accurate triage decisions. Rather they are elements that work together and inform one-another to provide the understanding necessary to perform triage.

This knowledge and experience are gained through formal learning and working practices, which constantly evolve and develop. Supporting attributes, such as emotional stability, also develop through training and experience, strengthening nurses' abilities to make accurate triage decisions. However, this review identified strong perceptions of needs for training in triage with current available options considered severely lacking.

Together, the three themes provide a new interpretation of how nurses make acuity assessments (Fig. 5.) by using holistic reasoning to gather data, combining clinical reasoning and intuition to interpret that data into an acuity score, utilizing personal beliefs and assumptions, perceptions of risk, and situational awareness to make informed decisions, and drawing on their knowledge and experience to provide context to assessments. However, external factors, such as the acuity of other patients and environmental pressures, also influence assessment processes, leading nurses to control the situation by taking actions to balance patient acuity against situational pressure.

**Table 2**  
GRADE-CERQUAL results.

Finding	Methods	Coherence	Adequacy	Relevance	Overall Certainty
Holistic Reasoning	Moderate	Minor	Minor	Minor	High
Going Beyond the Triage Tool	Moderate	Minor	Minor	Minor	High
Multiple Methods of Assessment	Moderate	No/Very minor	Minor	Minor	High
Subjective Interpretation	Moderate	Minor	No/Very minor	Minor	High
Informed Decision Making	Moderate	Minor	Minor	Minor	High
Educational Needs	Moderate	No/Very minor	Moderate	Minor	Moderate
Supporting Attributes	Moderate	Minor	Minor	Minor	High
Situational Awareness	Moderate	Minor	Minor	Minor	High
External Pressure	Moderate	No/Very minor	No/Very minor	Minor	High
Interprofessional Dynamics	Moderate	No/Very minor	No/Very Minor	Minor	High



**Fig. 5.** Nurses' decision-making processes for assigning acuity.

**7. Strengths and limitations**

This study presents with an important strength. To the best knowledge of the authors, this is the first qualitative systematic review of nurses' processes for assessing acuity in emergency departments. The work benefits from a rigorous process using validated methodologies and tools to develop its findings, and use of GRADE-CERQual to assess these findings adds further rigour.

The study presents with important limitations to consider. Firstly, 12 studies were excluded due to inability to access full-text publications, and two due to not being published in English. These reports may have contained information that was pertinent to the review process, however the lack of access means that this information may have been missed.

Secondly, the review team all worked in acute medicine and have experience of emergency triage. This potentially may have influenced perspectives of what processes were used in triage, especially during the study selection and data analysis sections. However, due to the high rigour used in the methodologies, this effect is controlled as far as possible.

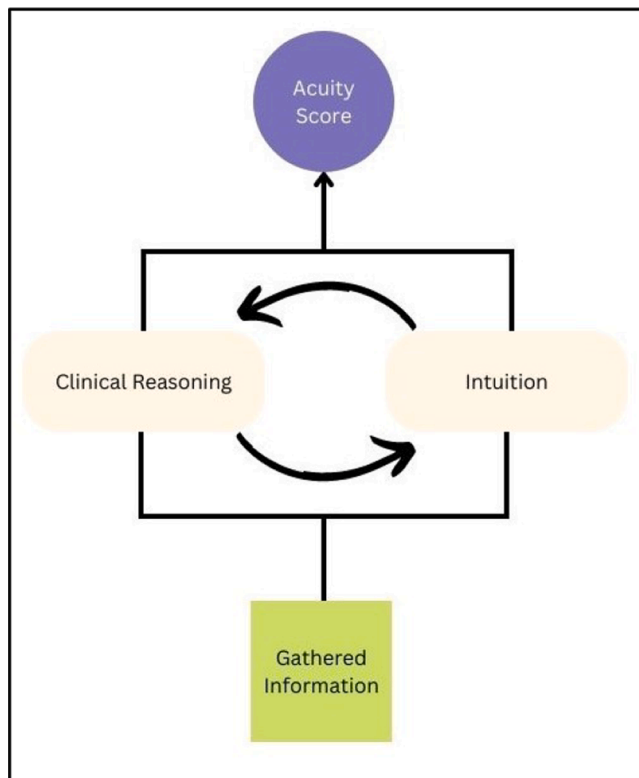
**8. Implications for policy and practice**

**8.1. Policy**

Nurses feel going beyond triage algorithms is important to their decision-making processes. Whilst using triage algorithms is helpful for less experienced nurses and when nurses are unsure, understanding that they may make decisions outside of these algorithms, and evaluating their accuracy in terms of patient outcomes rather than algorithm adherence is necessary.

Triage requires suitable environments, with adequate time, space, flow and staff. Ensuring these are available will positively effect nurses' abilities to accurately triage patients. Further, managers should ensure they prioritise accurate triage over emergency department metrics.

Ensuring nurses have the proper knowledge and experience to be able to make triage decisions is vital to safe and effective triage. This review highlighted nurses' perceptions that the training they receive is inadequate and infrequent. Introducing regular training courses will have significant benefits to the triage process.



**Fig. 4.** Clinical reasoning and intuition.

## 8.2. Practice

Nurses go beyond the triage algorithms to gather extra information they feel is necessary to be able to make accurate triage decisions, utilising holistic reasoning. Nurses must ensure these are safe decisions, made with clinical evidence and demonstrable processes, and not impacted by their own beliefs and biases.

Adequate knowledge and experience for triage nurses is key to ensuring they can accurately make decisions. Nurses should access training opportunities where available and engage in personal learning and reflection to ensure their practice is safe and effective.

## 8.3. Future research

Further research into the nurse's use of holistic reasoning, with considerations of the specific information they consider important and unimportant would allow for greater understanding, as well as potential development of tools that meets the nurses' needs.

Exploration of methods of reducing environmental impacts upon triage processes would be efficient for supporting nurses to make their decisions accurately. To do so, we need to understand what nurses feel is required to improve their environments.

Understanding how best to train nurses for triage would allow targeted improvements to the triage processes. As such a review of available research on interventions for training in triage would be beneficial, especially combined with knowledge of what nurses feel they need training in.

## 9. Conclusions

This review offers important understanding on the processes emergency nurses use to make acuity decisions during triage assessment at initial patient presentation.

A key finding from this review is that nurses prefer holistic assessment over triage algorithms, feeling they provide complete and individualised perspectives of patients' acuity. This important finding not only sheds light on why nurses go beyond triage algorithms but also highlights potential areas of focus for future research.

Our findings discuss how assessing the acuity of patients only makes up part of the assessment process. They explored how nurses compare their patient against other patients and the wider situation in the emergency department as part of their assessments, whilst also considering environmental pressures. A major finding of this review is that nurses modify their assessments to mitigate negative influences of the environment, potentially at the expense of accurate triage.

We also considered what informs nurses' assessments, finding nurses rely on a combination of knowledge and experience supported by personal characteristics. Findings also highlighted nurses feeling their currently available training for triage is insufficient, a significant finding with implications for educators and researchers.

By exploring these processes, we better understand how nurses make acuity decisions. This means we can make improvements to triage systems that work with nurses' processes, increasing acceptability and effectiveness, and resulting in improved patient outcomes.

### Reporting Guidelines

This study was registered on PROSPERO (ID: CRD42022289244). Both PRISMA and ENTREQ checklists were used ([Supplementary Files V. and VI.](#)).

### Author's Contributions

HG lead on the study as part of their PhD, writing the protocol under the supervision of TS and MMG. The review was led by HG, with a review team consisting of WA, JP, SS, EW, GW and AZ, joined by LDB from

full text screening onwards. HG led the write-up, with contributions and editing from all other authors. All authors approved the final manuscript.

### Ethical Statement

This review was carried out following ethical guidelines.

Funding Source

No funding was received for this study.

Reporting Guidelines

This study was registered on PROSPERO (ID: CRD42022289244). Both PRISMA and ENTREQ checklists were used ([Supplementary Files IV. and V.](#)).

### CRediT authorship contribution statement

**Hugh Gorick:** Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing – original draft, Writing – review & editing, Supervision, Project administration. **Marie McGee:** Formal analysis, Methodology, Supervision, Writing - review & editing. **Gemma Wilson:** Investigation, Formal analysis, Writing – review & editing. **Emma Williams:** Investigation, Formal analysis, Writing – review & editing. **Jaimik Patel:** Investigation, Formal analysis, Writing – review & editing. **Anna Zonato:** Investigation, Formal analysis, Writing – review & editing. **Wilfred Ayodele:** Investigation, Formal analysis, Writing – review & editing. **Sabina Shams:** Investigation, Formal analysis, Writing – review & editing. **Luca Di Battista:** Investigation, Formal analysis, Writing – review & editing. **Toby O. Smith:** Methodology, Formal analysis, Writing – review & editing, Supervision.

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ienj.2023.101334>.

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