



Assessing Emergency Department Crowding: A Structured Literature Review of the National Emergency Department Overcrowding Score

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Access this article online
Quick Response Code :



DOI : 10.22487/hj.v12i4.2272

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Page : 752-762

Article History:

Received: 2026-05-03

Revised: 2026-09-28

Accepted: 2026-10-06

Published by:

Tadulako University,
Managed by Faculty of
Medicine.

Website :

<https://jurnal.fk.untad.ac.id/index.php/hj/index>



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Abstract

Background: Emergency department crowding requires reliable measurement to distinguish operational pressure from patient severity and clinical outcomes. **Objectives:** This review evaluated evidence regarding the National Emergency Department Overcrowding Score (NEDOCS) and its potential application in emergency service evaluation. **Methods:** A structured narrative review examined eight previously selected studies within the reported 2021–2026 eligibility period. Searches reportedly covered PubMed, ScienceDirect, Taylor & Francis, and ProQuest, identifying 126 records. Search dates and several selection procedures remained unverified. Findings were synthesized across crowding perceptions, workload, waiting and boarding, and leaving without being seen. **Results:** NEDOCS demonstrated agreement with staff perceptions in some settings, while associations with alternative crowding indices and waiting times varied. Workload findings relied on repeated questionnaires, and pediatric leaving without being seen was associated with crowding in adjusted observational analysis. Simulated boarding removal reduced calculated scores without demonstrating clinical benefits. Methodological heterogeneity and incomplete review documentation limited interpretation. **Conclusions:** NEDOCS may complement existing emergency department performance indicators, but evidence does not establish its effectiveness at Dr. Soeradji Tirtonegoro General Hospital. Local validation, standardized outcome measurement, and transparent review documentation are necessary before implementation.

Keywords: Boarding; Emergency department; Literature review; Overcrowding; Workload.

Introduction

Emergency department (ED) crowding occurs when demand exceeds the resources available for timely assessment and treatment. An input throughput output framework distinguishes arrivals and case mix, processes within the ED, and delays in transfer to inpatient care. These interacting processes explain why patient counts alone cannot characterize operational pressure^{1,2,3}. The National Emergency Department Overcrowding Score (NEDOCS), developed in academic emergency departments, combines capacity, patient load,

ventilation, and time related variables into a department level measure⁴.

Crowding, waiting for initial assessment, total ED length of stay, and boarding are related but distinct. Waiting for assessment starts at registration and ends at the first clinical assessment; total ED stay ends at departure; boarding is the interval after the admission decision until transfer to an inpatient bed. Access block describes impeded transfer to definitive inpatient care. A four hour departure target belongs to particular service policies and cannot be treated as a universal definition of crowding^{5,6}. No dated operational audit was supplied for Dr. Soeradji Tirtonegoro General

Hospital, Klaten; therefore, local claims of bed capacity exceedance or waits longer than four hours cannot be established from this review.

Published reviews describe substantial variation in crowding measures and their reference standards^{7,6}. Associations between crowding and outcomes in admitted patients support the importance of monitoring, but do not demonstrate that introducing a particular score improves care⁸. The contribution of this review is an endpoint specific reading of eight studies, including discordant findings, rather than a claim that NEDOCS is newly validated or universally accurate. Translation and cultural adaptation, such as the Brazilian adaptation, also require distinction from validation of operational thresholds⁹.

The review asks what the selected studies show about NEDOCS in relation to staff rated crowding, perceived workload, waiting or boarding, and leaving without being seen (LWBS). It also asks which design and measurement limitations affect transferability. The objectives are to correct the evidence extraction, compare findings without pooling incompatible endpoints, and identify requirements for a future local service evaluation pilot. No patient level analysis or hospital evaluation was undertaken for this manuscript.

An operational score is valuable when its inputs are consistently collected and alerts reflect independently verified service problems. In Klaten, evaluation should determine whether score based monitoring provides additional information beyond occupancy, time to assessment, boarding, and staff workload indicators. Existing literature can guide pilot development and implementation strategies, but cannot replace local data collection, measurement validation, or systematic evaluation of operational responses and their effectiveness in improving

emergency department performance and service delivery outcomes.

Materials and Methods

Study Design

This manuscript is a structured narrative review of eight studies previously selected in the source manuscript. It is not a primary investigation at the proposed hospital. The revision clarifies the search account and selection flow using PRISMA 2020 and PRISMA-S reporting principles; this does not establish full compliance with systematic review standards^{10,11}. Narrative review quality principles emphasize a clear question, a transparent search description, and appropriate scientific reasoning¹². A registered protocol or registration identifier was not reported.

Sample

The review sample comprised eight empirical studies of hospital emergency departments published within the reported 2021–2026 window. The earlier phrase “past ten years” was inconsistent with this window and was removed. The reported language eligibility was English or Indonesian and required an available full text. Outpatient or prehospital studies, reviews, letters, and abstracts without full reports were outside the intended scope. The publication window does not describe the observation dates of the underlying studies.

For interpreting this corpus, an eligible study needed objective NEDOCS measurements and an operational outcome, another crowding measure, or a matched staff rating. A separate numerical crowding score was not mandatory. Surveys with matched objective scores were distinguishable from opinion-only surveys, which could not assess score performance. This clarification makes the inclusion of the staff workload study conceptually coherent, but its application to all

excluded records cannot be audited from the material supplied.

Data Collection Technique

The reported search platforms were PubMed, ScienceDirect, Taylor & Francis, and ProQuest. Their record counts were 25, 51, 8, and 42, respectively (Table 1). The source recorded the search date only as “02/05/2026”; whether this means 2 May 2026 or 5 February 2026 remains unconfirmed. The executed search fields, platform-specific limits, exact ProQuest collection, and export logs were not supplied. The queries below reproduce the strings reported in the source, rather than independently verified search histories.

PubMed: ("National Emergency Department Overcrowding Score" OR "NEDOCS") AND ("Crowding"[Mesh] OR "Overcrowding") AND ("Emergency Service, Hospital"[Mesh] OR "Emergency Department" OR "Emergency Room").

ScienceDirect, Taylor & Francis, and ProQuest: ("National Emergency Department Overcrowding Score" OR "NEDOCS") AND

("Crowding" OR "Overcrowding") AND ("Emergency Department" OR "Emergency Room" OR "Emergency Service").

The reported pathway was reconstructed as 126 records, 26 duplicates removed, 100 records screened, 70 screening exclusions, 30 reports sought, five unavailable reports, 25 reports assessed, 17 full text exclusions, and eight included studies. The deduplication software and matching rule, screening and extraction reviewers, independence of decisions, and disagreement-resolution procedure were not documented. The count of additional records from reference checking was also not reported; it was not assumed to be zero.

For the revised evidence table, the reported units, observation periods, outcomes, estimates, and bibliographic metadata were checked against retrievable primary-paper descriptions. Background and methodological references were distinguished from the eight included studies. Confidence intervals were retained when verified; missing intervals were not estimated from aggregate descriptions. No new pooled dataset or independent patient records were available.

Table 1. Search platforms and record counts reported in the source manuscript

Platform	Reported records, n	Search specification requiring confirmation
PubMed	25	Executed fields, MeSH translation, limits, export date
ScienceDirect	51	Fields, limits, export date
Taylor & Francis	8	Fields, limits, export date
ProQuest	42	Exact collection, fields, limits, export date
Total	126	Original date notation: 02/05/2026

Data Analysis Technique

A structured narrative synthesis grouped evidence by four endpoints: staff-rated crowding, perceived workload, waiting or boarding, and LWBS. Comparisons with other indices were reported separately. Differences in populations, score definitions, time resolution, comparators, and effect measures precluded a

defensible pooled estimate. The synthesis uses transparent grouping and reporting principles rather than vote counting of statistically significant findings¹³.

A preliminary editorial assessment recorded study level concerns about selection, score implementation, outcome ascertainment, and statistical dependence or confounding

(Table 4). It did not generate a numerical quality score. Design specific JBI checklists provide a basis for completing formal appraisal; selection, index test, reference standard, and flow concerns are particularly relevant to diagnostic style comparisons^{14,15}. Completed item level checklists and independent appraisal procedures for the original review were not available, so this matrix cannot be represented as a completed dual reviewer JBI assessment.

Ethical Consideration

Ethical approval was not required for this study because it was conducted as a structured narrative review exclusively using previously published and publicly accessible scientific literature. The review did not involve direct recruitment of human participants, clinical interventions, collection of primary data, or access to identifiable patient or healthcare personnel information. All findings were derived from secondary analysis and synthesis of published research without accessing confidential institutional records. Therefore, formal approval from an institutional research ethics committee was not considered necessary

under the generally applicable ethical principles governing literature reviews. The study maintained academic integrity through appropriate citation, transparent reporting, and accurate representation of the original research findings. Any subsequent hospital based investigation involving human participants or identifiable clinical data will be subject to applicable institutional ethical review and data protection requirements before implementation.

Result

Characteristic Responden

The template's respondent-characteristics subsection refers here to the included study corpus, not newly recruited patients. Eight studies published between 2021 and 2025 were included within the reported 2021–2026 eligibility window. They represented Ethiopia, Italy, Pakistan, Türkiye, and the United States. Units ranged from encounters and patient records to repeated ED snapshots and staff questionnaires. These heterogeneous units were not summed into a total sample size. Table 2 reports the study-specific units and observation periods.

Table 2. Endpoint specific evidence from the eight included studies

Study, setting, unit and period	Comparator or endpoint	Verified reported finding	Interpretive limitation
Getachew et al. (2024), Ethiopia ¹⁶ Cross-sectional; 899 patients across 120 intervals; November 2022.	Resident and nurse crowding ratings; interval-level comparison.	AUC 0.81 (residents) and 0.79 (nurses). Resident-rated crowding: 65.8% of intervals. AUC CIs not verified.	Subjective reference; one center. Patient count differs from the score's observation unit.
Signorini et al. (2024), Italy ¹⁷ 91 EDs; 2,754,968 retained 2022 encounters; temporal validation January–June 2023.	Registration-to-first-clinical-assessment waiting time; regional five-level NEDOCs adaptation.	Waiting time was not monotonically greater across all higher score categories. A center-specific waiting-time indicator was developed.	Regional categories differ from the standard six. Multi center coverage does not establish applicability in Indonesia.
Zafar et al. (2023), Pakistan ¹⁸ Prospective; 30 observation sets on 14 days, December 2021–January 2022.	Staff visual analog crowding ratings; International Crowding Measure in EDs (ICMED).	NEDOCs–staff rating $r = 0.593$. Reported score mean (SD): 577.94 (251.57); CI not verified.	Thirty sets are not 30 patients. Very high reported scores require scrutiny of

Study, setting, unit and period	Comparator or endpoint	Verified reported finding	Interpretive limitation
Colella et al. (2022), Italy ¹⁹ Hourly snapshots, 9 February–9 March and 10 March–9 April 2020.	Emergency Department Work Index (EDWIN); pre-/post lockdown activity.	Pearson $r = 0.317$ between indices; CI not verified. Index trends were discordant.	input units and implementation. Same year COVID era periods. Correlation between indices does not demonstrate clinical validity or reliability.
Improta et al. (2022), Italy ²⁰ 1,678 clinical records; 15-minute snapshots, 14–20 March 2016.	EDWIN compared with NEDOCS.	Kendall $\tau = 0.36$; CI not verified. EDWIN was described as less sensitive in the busy-to-overcrowded range.	Historical observations despite 2022 publication; repeated snapshots; no independent clinical-outcome criterion.
Gorski et al. (2021), United States ²¹ Pediatric ED; 54,890 encounters over 14 months; 15-minute crowding measures.	LWBS; adjusted logistic models containing either NEDOCS or occupancy.	Adjusted OR 1.30 per 10 score points (95% CI, 1.27–1.33). Model AUC: 0.869 with NEDOCS vs 0.867 with occupancy; $P = 0.27$.	Odds, not risk; AUC describes the multivariable model, not the score alone. Residual confounding and transportability remain concerns.
Altun et al. (2024), Türkiye ²² Adult ED; 216 snapshots on 36 sampled days within a 39-day span, April–June 2021.	Observed score components and counterfactual transfer scenarios.	Results report median NEDOCS 146.47. Hypothetical earlier inpatient transfer lowered recalculated scores.	No implemented intervention or independent outcome improvement. The paper uses inconsistent mean/median labels in places.
McKinley et al. (2025), United States ²³ Pediatric ED; 401 questionnaires, June 2018 and November 2018–January 2019.	Raw NASA Task Load Index (TLX); matched objective NEDOCS.	Individual-response $R^2 = 0.096$ (95% CI, 0.048–0.16). TLX predicting NEDOCS >140: AUC 0.731; AUC CI not verified.	Convenience, anonymous responses; unique staff count unknown. ROC direction is workload → score-defined severe crowding.

AUC = area under the receiver operating characteristic curve; CI = confidence interval; ED = emergency department; LWBS = left without being seen; OR = odds ratio; SD = standard deviation.

The score combines seven operational inputs, including two bed capacity denominators. For reference, the commonly reported equation is $NEDOCS = -20 + 85.8(P/B_ED) + 600(A/B_H) + 13.4V + 0.93L + 5.64W$. Table 3 specifies the inputs and original time definitions. Implementations must document whether counts include waiting-room patients, which beds are operational, and how missing or extreme values are handled^{4,19,22}.

The customary six categories are: 0–20, not busy; >20–60, busy; >60–100, extremely busy but not overcrowded; >100–140, overcrowded; >140–180, severely overcrowded; and >180, dangerously overcrowded. These continuous boundaries avoid gaps when a score is not an integer. Regional adaptations should be identified explicitly. Scores can exceed 200 in published implementations; any truncation or handling of negative values must be declared, rather than silently imposed^{4,22}.

Table 3. Inputs and units for the reference NEDOCS equation

Input	Unit	Definition and implementation note
P	Count	Patients occupying ED treatment spaces, including hallway/doubled spaces in the original definition; distinguish from all registered arrivals.
B_ED	Beds	ED treatment bed capacity; document the capacity definition and any local adaptation.
A	Count	Admitted patients still in the ED awaiting inpatient placement.
B_H	Beds	Hospital inpatient-bed capacity; document operational versus licensed-bed definitions.
V	Count	Ventilated/intubated ED patients awaiting intensive-care placement.
L	Hours	Longest ED stay among admitted patients, measured from registration; this is not time since the admission decision.
W	Hours	Registration-to-being-called time for the last patient called from the waiting room.

B_ED and B_H denote emergency department and hospital bed capacities. L and W must be in hours; convert minutes before calculation. Definitions are anchored to the original development report and later published implementations.

The preliminary appraisal in Table 4 identifies concerns that affect interpretation. Subjective references do not independently verify treatment timeliness; another crowding index measures a related construct rather than an external clinical criterion. Serial snapshots may be autocorrelated, and staff may contribute

repeated responses. Adjustment for selected patient covariates does not remove every source of confounding or establish an intervention effect. Unclear judgments reflect limited verification, not evidence that a method was absent.

Table 4. Preliminary study level assessment of methodological concerns

Study	Selection	Score implementation	Outcome/reference	Dependence/confounding
Getachew	U	U	H: subjective ratings	U: serial intervals
Signorini	U: exclusions	H: regional categories	L: recorded waiting time	U: center/time dependence
Zafar	H: short sampling	U: extreme scores	H: staff ratings	U: repeated snapshots
Colella	H: lockdown periods	U	H: index comparator only	U: temporal confounding
Improta	H: one sampled week	U	H: index comparator only	U: serial snapshots
Gorski	U	U	L: recorded LWBS	U: adjustment reported; clustering unclear
Altun	H: missing sampling days	U	H: score recomputation	U: serial observations
McKinley	H: convenience surveys	U	H: subjective workload	H: repeated anonymous responses

H = identified concern in the domain; L = lower concern for the stated measurement aspect only; U = insufficiently verified.

The Ethiopian and Pakistani comparisons provide evidence of discrimination or association against staff perceptions. Their reference standards and observation units differ, so the estimates should not be interpreted as interchangeable measures of clinical accuracy. Agreement with a subjective rating does not establish agreement with an independent time or safety endpoint^{16,18}.

The pediatric questionnaire study showed a limited proportion of explained variation at the individual response level. Its nonlinear hourly analysis above NEDOCS 60 and its ROC model with workload as predictor answer different questions. Neither analysis validates a universal staff overload threshold or shows that score-based staffing changes improve workload²³.

The regional waiting time study and the Turkish boarding scenarios concern different time constructs. The former challenges monotonic interpretation of score categories; the latter changes inputs that already contribute to the score. Consequently, a recalculated score reduction is partly mechanical and cannot be treated as an observed improvement in waiting time, mortality, or care quality^{17,22}.

The pediatric study associated higher scores with higher adjusted odds of LWBS. Its models containing NEDOCs and occupancy had similar discrimination. This finding concerns an observational patient flow endpoint; it does not establish that introducing the score reduces LWBS or that its thresholds transfer to an adult Indonesian ED²¹.

The Italian studies reported discordance between NEDOCs and EDWIN. Pearson r and

Kendall τ describe different forms of association, not instrument reliability or causal service effects. No new hypothesis tests were calculated for this review, and no pooled effect, recalculated CI, or combined P value was produced^{19,20}.

Figure 1 presents the reconstructed reported selection pathway. The counts reconcile arithmetically, but the source exclusion categories cannot be fully verified. The original reasons total 17: insufficient information on crowding level (15), a healthcare worker survey (1), and a non English report (1). The latter conflicts with the stated English or Indonesian eligibility; the survey exclusion also requires checking against the clarified matched-score criterion. Study identifiers for all 17 exclusions were not supplied.

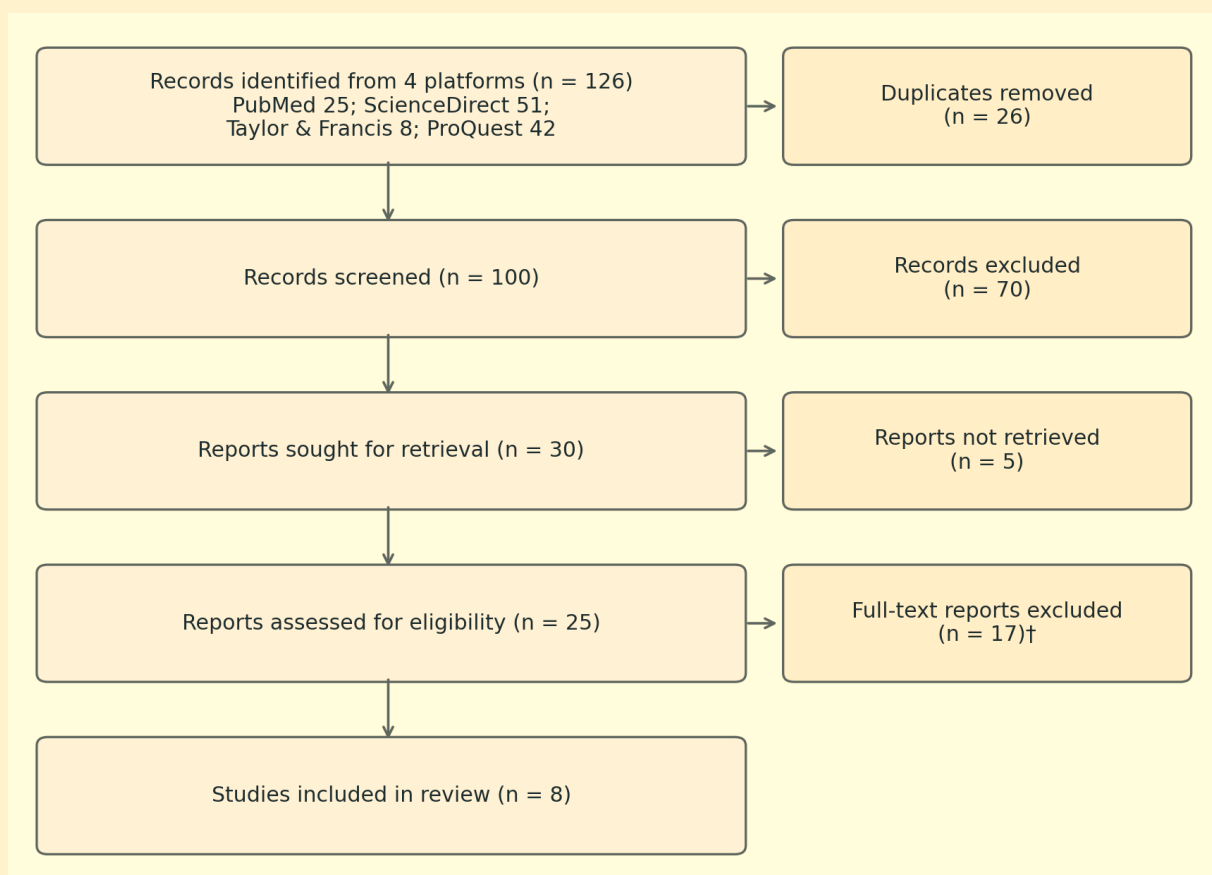


Figure 1. Reconstructed reported study selection flow.

The selected studies provide heterogeneous evidence about different operational constructs. Some support association with staff rated crowding or workload; others show limitations in cross index correspondence or category based waiting time interpretation. The pediatric LWBS evidence concerns adjusted odds and model discrimination, while boarding scenarios concern score recalculation. No study in this corpus demonstrated that implementing NEDOCS improved care at the proposed hospital.

Discussion

The evidence supports selected associations between NEDOCS and operational pressure, but does not identify a universal measure of accuracy. A staff rating is a perception-based reference, workload is a human-factors construct, waiting is a process time, and LWBS is a patient flow outcome. AUC summarizes discrimination for a specified endpoint; it does not demonstrate calibration or prove that acting on an alert improves service. Calibration concerns agreement between predicted probabilities and observed event frequencies and requires explicit evaluation when a prediction model is used²⁴. Neither cross index correlation nor mechanical score reduction establishes clinical benefit.

The variable relationships in this corpus are consistent with broader reviews describing heterogeneous definitions and measurement practices^{7,3,6}. Differences between pediatric and general emergency departments, hospital admission pathways, regional bed definitions, sampling frequency, and COVID related changes can alter score behavior. Multi center waiting-time findings challenge a simple assumption that each score category corresponds to a universally increasing delay. The original perception based development and subsequent cultural adaptation should be

treated as parts of a measurement history, rather than evidence of identical performance across health systems^{4,9}. These differences explain why a single pooled “accuracy” estimate would conceal clinically important distinctions.

At Dr. Soeradji Tirtonegoro General Hospital, a proposed pilot should capture time-stamped score inputs from the clinical information system and bed-management census, with a trained nurse verifying ventilation and transfer status. The ED shift leader and bed management team could review scheduled scores and independently recorded time-to-assessment, post-decision boarding, ED length of stay, LWBS, and workload. Definitions and an escalation response should be agreed before implementation; this workflow has not been evaluated locally. Indonesian operational context includes a registration queue study using quick response codes, which concerns registration workload rather than ED score validation²⁵. HTJ publications on the Revised Trauma Score and stroke severity address patient level clinical constructs; they illustrate why severity assessment should accompany department-level monitoring, without establishing a crowding effect on trauma or stroke outcomes^{26,27}.

The revision distinguishes observation units, endpoints, score adaptations, and contextual references, and makes the reported selection arithmetic explicit. Its principal limitation is the incomplete original review audit trail: the exact search date, platform limits, duplicate-removal method, reviewer procedures, exclusion identifiers, and completed formal appraisals remain unavailable. Platform coverage and English/Indonesian full text restrictions can omit relevant work, and five unavailable reports may introduce selection bias. Most included studies were from individual institutions; several used subjective references,

short observation windows, or serial data. Residual confounding, inconsistent reporting, and unaddressed dependence can limit precision. None of the eight studies provides direct validation at the proposed Indonesian hospital. This manuscript therefore cannot support a definitive claim of local effectiveness.

First, complete the search and selection documentation and apply design appropriate appraisal consistently to all eight studies, with study identifiers and page based support for each judgment. Any search update should be reported as a new update with its own date and counts. A local pilot should prespecify score definitions, acceptable missingness, independently measured endpoints, and alert thresholds; sample consecutive operating periods across shifts and weekdays; and account for patient, staff, and time clustering. Threshold performance should be assessed with confidence intervals and compared with simpler occupancy and process time measures. A later controlled or interrupted time series evaluation could examine whether a predefined response to alerts improves outcomes. Such causal evaluation is a separate research question from validating the score.

Conclusion

NEDOCS may help monitor ED operational pressure alongside independent process and workload indicators. The selected evidence is heterogeneous and does not demonstrate improved care from score use at the proposed hospital. Local validation, explicit input definitions, and evaluation of an implemented response are needed. The original review's search, selection, and formal-appraisal documentation must also be completed before publication.

Acknowledgment

The authors thank their academic supervisors, families, and colleagues for their support during preparation of the review.

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Conflict of Interest Statement

The author(s) declare no commercial, financial, or personal conflicts of interest related to this research. All authors approved the final manuscript and consented to its publication in *Healthy Tadulako Journal*.

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