



The implementation of an emergency nursing framework (HIRAID) reduces patient deterioration: A multi-centre quasi-experimental study

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ABSTRACT

Introduction: Timely recognition and treatment of acutely ill patients at appropriate levels of the health system are fundamental to the quality and safety of healthcare. This study determines if the implementation of an emergency nursing framework HIRAID (History, Identify Red flags, Assessment, Interventions, Diagnostics, communication and reassessment) improves patient safety.

Methods: A quasi-experimental cohort study was conducted in two emergency departments in [Anonymised], Australia. HIRAID was implemented using a multi-pronged behaviour change intervention. Data of 920 patients (374 pre and 546 post) who deteriorated within 72-hours of ED departure were collected. Statistical tests were conducted as two-sided, with a 95% confidence interval to determine pre/post cohort association.

Results: Patients in the post group had more comorbidities, but experienced less deterioration associated with care delivered in the ED (27% to 13%). There was a reduction in treatment delays [28.3% to 15.1%, $p = 0.041$, 95% CI (1.1%–25.3%)], and delay or failure to escalate care when abnormal vital signs were identified [20.2% to 6.9%, $p = 0.014$, 95% CI (3.5%–23.1%)]. Isolated nursing-related causal factors decreased from 20 (21%) to 6 (8%).

Conclusions: Implementing a standardised emergency nursing framework is associated with a reduction in clinical deterioration related to emergency care.

1. Introduction

Timely recognition and management of acutely ill and injured patients is fundamental to the quality and safety of healthcare [1]. This is particularly so in the emergency care environment where delivering care is uniquely challenging, especially for emergency nurses whose practice is starkly different to nurses in other specialties [2].

Traditionally taught and commonly used approaches to patient assessment such as vital signs and body systems are not evidence-based nor framed in patient safety [3]. A primary survey approach (assessment of airway, breathing and circulation) is evidence-based and promotes a focused assessment commensurate with the reliability of specific data to enable recognition of actual or risk of deterioration [3]. In the Australian [4,5] and many other healthcare systems [6–9], when a patient first presents to the emergency department, the triage nurse performs a rapid primary survey and focused physical assessment to determine the presenting problem and how long the patient can wait to be seen by a medical officer. However, a more comprehensive and standardised patient assessment during emergency care inclusive of the primary survey and vital signs is required [3].

In addition to a comprehensive assessment, emergency nurses must

escalate care to meet the clinical needs of patients. This may include ordering and interpreting investigations (e.g. pathology tests) and performing interventions (e.g. analgesia) as clinically indicated. The quality and timeliness of emergency nurses' assessment and intervention is crucial as patients seeking emergency care often have extended wait times for medical review. We propose a nursing solution for emergency care delivery for any patient presentation called **HIRAID** (History, Identify Red flags, Assessment, Interventions, Diagnostics, communication and reassessment) [10]. This comprehensive framework was originally developed to provide novice emergency nurses with a systematic approach to patient assessment as part of a university post graduate curricula [11] and was revised and re-developed in 2015 to reflect current research evidence [10]. HIRAID is the only validated framework designed to enable emergency nurses to systematically assess and manage emergency patients [12] (Fig. 1).

In the simulated environment, the use of HIRAID improved emergency nurse's detection of clinical indicators of urgency, prioritisation and initiation of treatment, and quality of clinical handover [13]. Nursing and medical staff report HIRAID to be a useful tool to improve consistency of patient assessment, quality of documentation and clinical handover [14]. This study determines the effectiveness of HIRAID in

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improving patient safety under normal emergency operating conditions.

The aim of this study was to determine if the implementation of HIRAID in the emergency care setting improves patient safety. We hypothesised that after the implementation of HIRAID the proportion of patient deterioration calls related to emergency nursing care within 72 h of ward admission would decrease.

2. Background

Emergency nurses are responsible for the initial and ongoing assessment, management and safety of patients in their care. They provide care for patients of all ages, with varying degrees of clinical urgency and severity, most of whom have pain, and undiagnosed conditions [2]. In Australia and many other health care systems [4–9], emergency nurses are the first clinicians patients see when attending an emergency department, so patient safety is contingent on their accurate assessment, interpretation of clinical data, intervention and escalation of care [15]. Australia’s 287 emergency departments treated more than 8.4 million patients in 2018–19, or 23,000 patients per day [16]. Yet, emergency nurses’ approach to patient assessment across Australia’s emergency departments is inconsistent and results in significant unwarranted variation in nursing care, avoidable patient deterioration, poor pain management, poor nursing documentation, human suffering and patient dissatisfaction [17,18].

In 2019, the New South Wales (NSW) Clinical Excellence Commission reported a 29% increase in hospital adverse events (AEs) with poor observations and monitoring as a causal factor [19]. Undetected clinical deterioration in Australian emergency departments occurs in up to one in seven patients causing high-mortality adverse events [20–23]. Early recognition and response to deteriorating emergency department patients is primarily an emergency nursing responsibility [24]. Failure to

recognise and respond to clinical deterioration during emergency care increases the incidence of high-mortality adverse events both during emergency care but also following the emergency care episode, irrespective of whether the patient is admitted to hospital or discharged [17,18]. Evaluating interventions to improve clinical care is an Australian emergency research priority [25,26].

3. Methods

This quasi-experimental pre-post study was conducted between November 2017 and February 2019 in two referral hospitals in regional New South Wales, Australia. There are two small emergency departments in the health district that transfer patients requiring higher level care to the two larger sites. All emergency departments received the intervention. The larger site (site 1) has a total 110 nurses and 46 medical staff (65,000 + presentations per year). The smallest site (site 2) treats 13,000 + patients per year and has two nurses and one general practitioner working per shift. Research conducted as part of this study adhered to the National Statement on the Conduct of Human Research by the Australian National Health and Medical Research Council and was approved by the site Health and Medical Human Research Ethics Committee (LNR/16/WGONG/249).

3.1. The intervention

HIRAID was introduced within all four emergency departments using a detailed implementation strategy reported elsewhere [14]. The strategy was designed following a survey of the facilitators and barriers to implementation [27]. The barriers were mapped to behaviour change techniques using the behaviour change wheel, and assessed using the APEASE criteria (Affordability, Practicability, Effectiveness and cost-

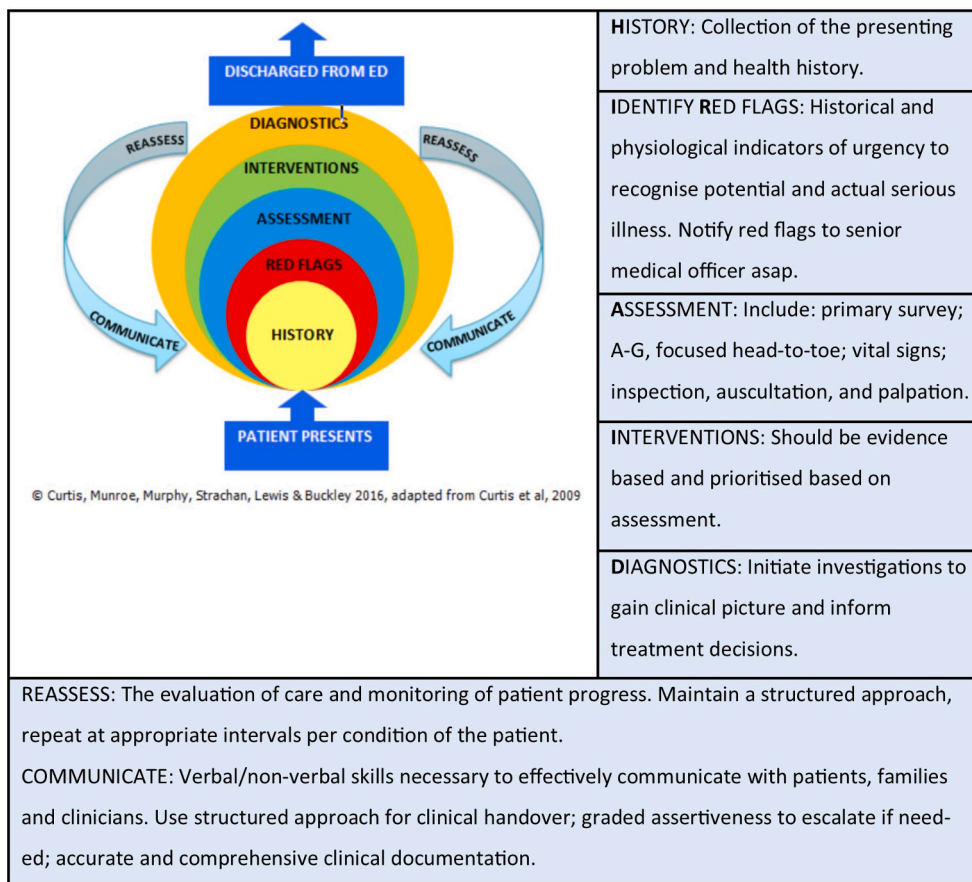


Fig. 1. HIRAID Emergency Nursing Framework.

effectiveness, Acceptability, Side-effects/safety and Equity) by the site senior emergency nursing teams to select strategies most likely be most successful at each site [28]. Modes of delivery selected to implement HIRAID included; the development and compulsory completion of an eLearning module; attendance at a half day HIRAID workshop; integration of HIRAID into emergency department orientation programs and specialty training programs; mandated quarterly random audits of 10 episodes of initial nursing documentation at all sites; introduction of cues within the workplace such as posters and reference cards; development of a brief video outlining what HIRAID is and that it has executive support; development and mandated use of a documentation template based on the assessment structure [14].

3.2. Patient identification

Patients eligible for inclusion were admitted to one of the study sites via the emergency department and received a rapid response call, cardiac arrest call or unplanned intensive care unit admission within 72 h of admission. To identify these patients, data were obtained from the site rapid response team database. Both sites employ a nurse to identify and audit all patients who receive a rapid response call, cardiac arrest calls or an unplanned admission to the intensive care unit. Staff can activate a rapid response call when they are concerned patient deterioration needs immediate medical review by the critical care team. The criteria for activation of a rapid response call are standardised across the NSW State health system [29].

3.3. Data collection

Data were collected from two time periods. The pre period (March 2016-February 2017), which was followed by a 12-month implementation consolidation period, then the post period (March 2018-February 2019). Three clinical nurse consultants independent to the research team collected the data. The nurse consultants had expertise in clinical peer review, rapid response team leadership as well as current critical care, emergency and coronary care experience. The nurses reviewed each patient medical record to extract the required data. Where the patient medical record was not available electronically, the hard copy records were obtained from the medical records department. These data included over 100 event details in eight sections. The sections included patient factors (such as pre-existing conditions calculated using the Charlson co-morbidity index [30], vital signs at the time of deterioration call, specific services involved in the care delivery, factors contributing to the care delivery problem and patient outcomes. A data dictionary was developed in consultation with the nurse consultants and to ensure consistency, where a definition was not already available, a group decision was made and recorded.

3.4. Causal factors classification

To identify influencing or causal factors for clinical deterioration, human factors thought to play a role in leading to the patient deterioration event were collected per the Human Factors Classification Framework for patient safety [31]. These included information that may have influenced clinical practice including equipment, work environment, staff action, patient, organizational, individual and other factors [32] (Table 1).

This framework was selected as previous inter-rater reliability has been demonstrated to be high [31] and it is based on James Reason's model of organisational incidents [33]. Error was classified using Rasmussen's [34] skill, rule or knowledge-based error classifications, or a violation classification [33]. Skill-based errors referred to unintentional failures in the execution of a well-rehearsed action or routine task that required little conscious attention. Rule-based errors referred to unintentional failures during activities conducted in familiar situations controlled by stored rules. Knowledge-based errors referred to

Table 1

Classification of factors contributing to the care delivery problem using the Human Factors Classification Framework for patient safety.

Domain	Description
1 Equipment	Events that involved subcategories of equipment or device failures, breakages or malfunctions, lack of medical equipment and medical supplies.
2 Work Environment	Events resulting from the location of the incident that could not have been changed by personnel at the time, including lighting, temperature, noise and physical layout.
3 Staff Action/Communication	Referred to as staff action events. These resulted from direct involvement by a staff member, including subcategories of communication failures and documentation issues, medical task failures, problems monitoring a patient's status, delays in patient treatment, misdiagnosis of a patient's health condition, and medication-related issues.
4 Patient	Events resulting from direct involvement by a patient that influenced the events.
5 Organisational Factors	Organisational aspects that directly or indirectly influenced safety and quality of medical and nursing activities and their management, including work practices, policies or guidelines, supervision, available resources (including staffing and equipment), work pressure and other organisational factors.
6 Individual Factors	Characteristics of staff members, including knowledge and skills, experience, stress, fatigue and other individual factors.
7 Other	Additional events not elsewhere classified.

unintentional failures during a novel situation that required conscious analytic processing and stored knowledge. A violation is an intentional failure to follow accepted work practices, guidelines or procedures during the execution of a task, a violation does not indicate the intent to cause harm.

For a deterioration event to be labelled as related to care received in the emergency department, the causal factors and/or errors identified must have a clear relationship with or contribution to the deterioration event. Examples included "Staff Action"; delay to intravenous antibiotics in a septic patient, missed diagnostic information like an arterial blood gas in a deteriorating respiratory patient, progressive deterioration in emergency with no identification or escalation. In contrast, if on day two of admission the patient suddenly had an unexpected cardiac arrest, or a rapid response call for a post-op complication, if these events had no indication to treatment and care provided within emergency department it would not be considered as a failure in emergency department.

3.5. Data management and analysis

The majority (86%) of cases were reviewed by the one auditor. To ensure consistency in allocation of causal factors, one of the auditors performed a screen of every case. Where there was any uncertainty, a group discussion was held until consensus was reached. Data were cleaned (validations and definitions) and integrated for an initial descriptive analysis. Data were analysed using Stata Version 14.2 (StataCorp, College Station, USA) to test if the groups were equal in characteristics. T-tests or Mann Whitney U tests were used for the comparison of continuous variables. Chi-square tests were used for categorical variables. Two-sample test of proportions used to assess the change of proportions pre and post and were also used to determine whether there a statistical difference in the numbers of cases included in the final pre and post cohorts. All statistical tests were conducted as two-tailed, and a confidence level of 95% was used to determine if there was a significant association between the pre/post cohorts and study variables of interest. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist was used in reporting this study [35].

4. Results

4.1. Intervention outcomes

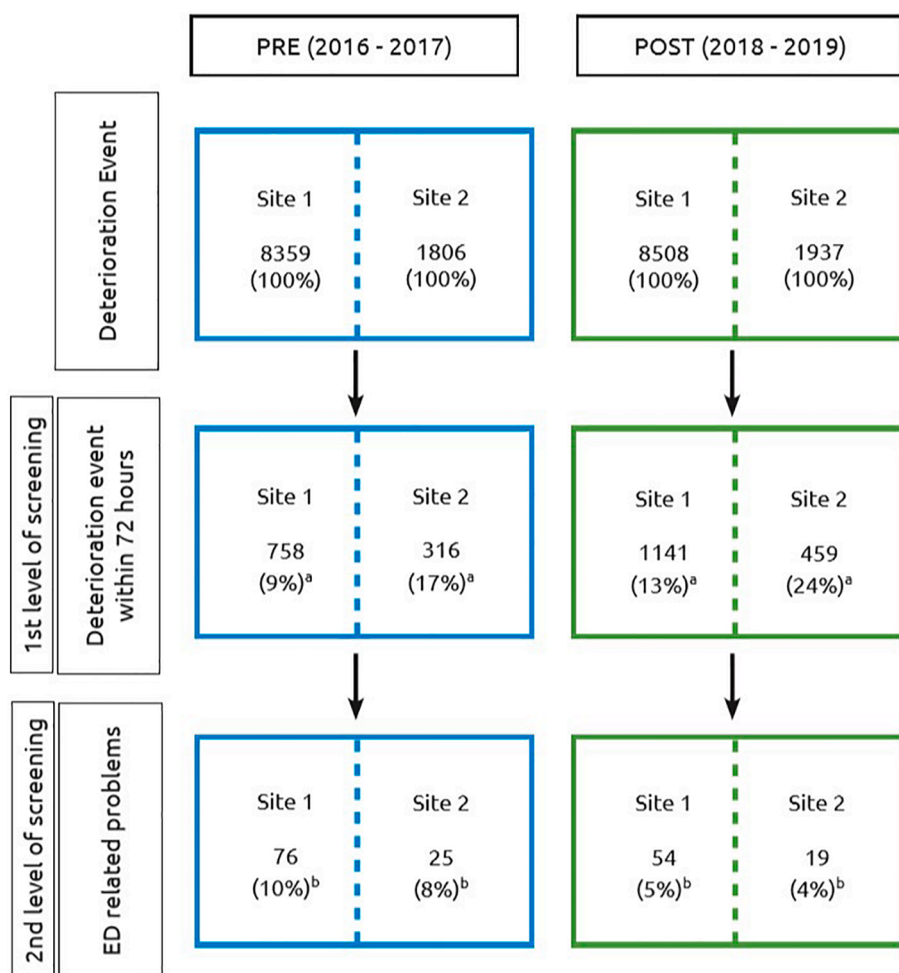
There were 374 patients in the pre-intervention cohort and 546 in the post-intervention cohort eligible for inclusion as they deteriorated on the ward within 72 h of admission via one of the study site emergency departments (Fig. 2). In the pre period there were 100,501 presentations to and 32,048 admissions via the emergency department. In the post period, emergency department presentations increased by 11.49% to 112,048 and admissions via the emergency department increased by 6.33% to 34,078. Hospital bed occupancy was 84% pre and 83% post.

Patients in the post group were older (75 yrs vs 81 yrs, $p = 0.014$) with more comorbidities (4.32 vs 5.79, $p < 0.001$) and higher incidence of polypharmacy (49% vs 77%, $p < 0.001$). In the post group there was a higher proportion of patients from culturally and linguistically diverse backgrounds (2% vs 8%, $p = 0.019$) and patients who had re-presented for the same condition (2% vs 12%, $p < 0.001$). There was a low incidence and no difference between groups identified for the following characteristics: aggression ($p = 1.000$), substance misuse ($p = 1.000$), mental illness ($p = 0.184$), and delirium ($p = 0.136$). There was no significant difference in gender ($p = 0.346$), emergency department length of stay (LOS) ($p = 0.477$) or at which emergency department the patient was treated ($p = 0.908$) (Table 2).

Although there were more episodes of clinical deterioration within 72 h of emergency admission for the post group, there were fewer in-hospital cardiac arrests (pre $n = 9$, 9% vs post $n = 0$) and unplanned ICU admissions (pre $n = 19$, 18.2% vs post $n = 8$, 10.8%). There was an increase in the proportion of rapid response calls (pre $n = 71$, 71.7% vs post $n = 65$, 89.0% $p = 0.007$). There was no difference in rapid response call triggers however the median (IQR) time from emergency department discharge to the deterioration event decreased from 19.5 h (7.20–36.17) to 11 h (4.62–20.03), $p = 0.005$. More patients died following their deterioration event in the post period (7% vs 22%, $p = 0.005$) (Table 3).

4.2. Causal factors for clinical deterioration

The proportion of deterioration episodes related to emergency department care decreased by half [pre $n = 101$ (27.0%) to post $n = 73$ (13.4%), $p < 0.001$, 95% CI (8.5%–18.8%)]. There was a reduction in treatment delays [pre $n = 28$ (28.3%) vs post $n = 11$ (15.1%), $p = 0.041$, 95% CI (1.1%–25.3%)], delay in diagnoses [pre $n = 15$ (15.2%) vs post $n = 3$ (4.1%), $p = 0.019$, 95% CI (2.6%–19.4%)], delay or failure to escalate care when abnormal vital signs were identified [pre $n = 20$ (20.2%) vs post $n = 5$ (6.9%), $p = 0.014$, 95% CI (3.5%–23.1%)]. There was a reduction in the number of organisational factors from 99 to 73 [pre $n = 64$ (64.6%) post $n = 19$ (26.0%), $p < 0.001$, 95% CI



^a Percentages calculated by the numbers in the 1st level of screening divided by total deterioration event numbers

^b Percentages calculated by the numbers in the 2nd level of screening by the numbers in the 1st level of screening

Fig. 2. HIRAID pre and post cohort case selection and screening.

Table 2

Comparison of patient characteristics (pre/post) with clinical deterioration with 72 h of emergency department departure relating to emergency care.

Variable	Pre n=(1 01) *	Post (n = 73)	Statistic**
Age - Median (IQR)	75 (58–85)	81 (69–87)	0.014
Gender – n (%)			
Female	43 (43.4)	37 (50.7)	0.346
Male	56 (56.6)	36 (49.3)	
ED LOS (h) - Median (IQR)	9.75 (5.4–17.0)	8.70 (5.4–15.2)	0.477
Site – n (%)			
Site 1	74 (75.8)	54 (74.0)	0.908
Site 2	25 (25.3)	19 (26.0)	
CCI – mean (SD)	4.32 (2.6)	5.79 (3.0)	< 0.001
Polypharmacy – n (%)	49 (50.0)	56 (76.7)	< 0.001
Time of presentation – n (%)			
Morning (07:00–15:00)	46 (46.5)	28 (38.4)	0.563
Afternoon (15:01–22:00)	31 (31.3)	27 (37.0)	
Night (22:01 – 06:59)	22 (22.2)	18 (24.7)	
Time of admission – n (%)			
Morning (07:00–15:00)	31 (31.3)	21 (28.8)	0.007
Afternoon (15:01–22:00)	38 (38.4)	43 (58.9)	
Night (22:01 – 06:59)	30 (30.3) 30 (30.3)	9 (12.3)	

* Total number were 101 with some variables containing missing values.

** Non parametric tests (Mann-Whitney *U*) or Chi-Squared

IQR: Interquartile Range, CCI: Charlson Comorbidity Index, ED LOS: Emergency Department Length of Stay, h: Hours, SD: Standard Deviation.

Table 3

Number and patient physiologic parameter characteristics of deterioration episode.

Variable	Pre n=(101) *	Post (n = 73)	Statistic**
<i>Call type – n (%)</i>			
Cardiac arrest	9 (9.09)	0 (0.00)	0.007
PACE 2	71 (71.72)	65 (89.04)	
Unplanned ICU admit	19 (18.19)	8 (10.96)	
<i>Vital signs</i>			
RR – Median (IQR)	21.50 (17.00–32.50)	21.5 (17.0–30.0)	0.863
SpO ₂ – Median (IQR)	95.0 (86.0–97.0)	94.0 (90.0–96.0)	0.505
HR – Median (IQR)	104.0 (70.0–128.0)	93.5 (78.5–112.5)	0.234
SBP – Median (IQR)	130.0 (90.0–161.0)	117.0 (87.0–144.0)	0.239
DBP – Median (IQR)	71.5 (48.0–86.0)	68.0 (52.0–80.0)	0.732
<i>AVPU – n (%)</i>			
A	41 (59.4)	44 (67.7)	0.254
P	3 (4.2)	6 (9.2)	
U	18 (26.1)	9 (13.9)	
V	7 (10.1)	6 (9.2)	
GCS – Median (IQR)	14.0 (8.0–15.0)	14.5 (11.0–15.0)	0.349
Pain Score (/10) – Median (IQR)	3.5 (0.0–7.5)	0.0 (0.0–5.0)	0.266
BGL – Median (IQR)	7.4 (6.2–9.8)	7.2 (5.7–9.9)	0.750
Time from ED discharge to call – Median (IQR)	19.5 (7.2–36.2)	10.6 (4.6–20.0)	0.005

* Total number were 101 with some variables containing missing values.

** Non parametric tests (Mann-Whitney *U*) or Chi Square

PACE 2: Patient with Acute Condition for Escalation (PACE) tier 2, RR: Respiratory Rate, SpO₂: Oxygen saturation, HR: Heart Rate, SBP: Systolic Blood Pressure, DBP: Diastolic Blood Pressure, AVPU: Alert, Visual, Pain, Unresponsive, GCS: Glasgow Coma Score, BGL: Blood Glucose Level, ED: Emergency Department, IQR: Interquartile Range, SD: Standard Deviation.

(24.8–52.4)]. When determining if the causal factor was primarily nursing, medical or nursing and medical related, the number and proportion of isolated nursing related causal factors decreased from 20 (21%) to 6 (8%). The number and proportion of isolated nursing related causal factors decreased from 20 (21%) to 6(8%) (Table 4).

5. Discussion

In this study implementation of HIRAID in the emergency care setting improved patient safety as evidenced by a reduction in patient deterioration related to emergency care within 72 h of admission via the emergency department. This is likely due to the demonstrated increased escalation of patient deterioration and time to treatment, which are key components of the HIRAID framework.

HIRAID has a focus on obtaining relevant and important information to guide assessment, clinical intervention, decision making and clinical handover [10]. Effective clinical handover is fundamental to clinical practice and is recognised as a global quality and safety priority [36]. Ineffective clinical handover increases risk of patient-related errors as a result of poor communication and the lack of appropriate and timely transfer of critical information at time of reporting [37]. A structured communication process, increased self-efficacy [38] and skills in graded assertiveness [13] may have contributed to the reduction in failure of escalation as a casual factor to patient deterioration in this study. Further, the reduction in deterioration attributed to overall emergency department care suggests that the improved assessment and management of nurses may have a flow on effect to other emergency staff. The emergency department is a fast paced, highly stressful environment, where interprofessional interdependence and collaboration are vital. HIRAID is viewed by medical officers as an improvement from previous clinical handover tools¹³. It is essential that emergency nurses and doctors exchange information in a coherent, comprehensive way for patient safety, and to maintain collaborative relationships [39].

The robustness of the implementation strategy design and development contributed to the high uptake and application of HIRAID. The strategy addressed the complexity of the emergency care environment and had strong organisational support [40]. There are multiple models available on which to develop and plan an implementation strategy [42]. However, human behaviour, which is central to the sustainable success of any change, must also be incorporated. Although all emergency nurses at the study sites were required to use HIRAID, they were also empowered with the capability, opportunity and motivation to do so. Most respondents in a multicentre survey believed their fundamental responsibility as an emergency nurse is to ensure patient safety and that HIRAID provided a mechanism to enable this [14].

HIRAID provides a structured approach to application of expert knowledge and skills in the emergency care environment. It does not replicate existing courses or rely on upskilling. HIRAID as an assessment process can be readily adapted for implementation in other international jurisdictions [1]. However, HIRAID has only been tested in Australia and requires formal consultation and evaluation with emergency nurses elsewhere. A cost-benefit analysis would also be of value. Global intervention in our emergency departments and other emergency care settings will improve emergency nursing assessment, reduce unwarranted variation in care, facilitate timely recognition and response to clinical deterioration, reduce time to treatment, and enable escalation of care as needed. All of which improves the quality and safety of health care for patients.

There were some limitations to this study. This was a pre post study with a 12-month implementation period between data collection periods so there is a possibility that processes of care changed over time. This risk was managed by monitoring and confirmation with key stakeholders (nurse managers and educators) that there was no other formal intervention or assessment methods implemented during the study period. The study data were obtained from organisational databases and medical records, thus there was potential for data error and missing data. Further, organisational and record data do not enable a detailed understanding of clinician characteristics that may influence application of the HIRAID framework and therefore processes of assessment and management. This risk was actively managed by a detailed analysis of barriers and facilitators to implementation of HIRAID and tailored implementation at each site. It is possible there was a Hawthorne effect

Table 4
Causal factors of deterioration episode.

ED problems	Pre	Post	p-value	Confidence interval of the difference in proportions (%)
Site 1 ED problems (number of deterioration < 72hrs)	76 (758)	54 (1141)	< 0.001	3.0–7.6
Proportion	10.0%	4.7%		
Site 2 ED problems (number of deterioration < 72hrs)	25 (316)	19 (459)	0.026	0.5–7.1
Proportion	7.9%	4.1%		
Overall ED problems (number of deterioration < 72hrs)	101 (374)	73 (546)	< 0.001	8.5–18.8
Proportion	27.0%	13.4%		
<i>Equipment (n1 = 100, n2 = 73) – n (%)</i>				
Equipment	9 (8.1)	8 (11.0)	0.521	–11.8–6.1
Medical Equipment	4 (4.0)	0 (0.0)	0.082	0.16–7.9
Medical Supply	1 (1.0)	0 (0.0)	0.389	–1.0–3.0
<i>Staff action overall (n1 = 99 n2 = 73) – n (%)</i>				
Staff action overall	95 (96.0)	68 (95.8)	0.952	–5.9–6.3
Recognition of red flags	20 (20.2)	16 (21.9)	0.785	–14.1–10.6
Delay in treatment	28 (28.3)	11 (15.1)	0.041	1.1–25.3
delay recognition of resuscitation plan	19 (19.2)	24 (32.9)	0.041	–27.0 to –0.4
Delay recognition to sepsis	12 (12.1)	10 (13.7)	0.759	–11.8–8.6
Communication - staff to patient	7 (7.1)	8 (11.0)	0.372	–12.7–4.9
Medical Management error	29 (29.3)	31 (42.5)	0.073	–27.6–1.3
Senior medical input	5 (5.1)	5 (6.9)	0.618	–9.0–5.4
Consultation requests	9 (8.2)	6 (8.2)	0.841	–7.6–9.3
Conflicting patient care	11 (11.1)	13 (17.8)	0.210	–17.4–4.0
Delay in diagnosis	15 (15.2)	3 (4.1)	0.019	2.6–19.4
Nursing Management error	23 (23.2)	23 (31.5)	0.226	–21.8–5.2
Misdiagnosis	8 (8.1)	1 (1.4)	0.051	0.7–12.7
Communication staff to staff	36 (36.4)	29 (39.7)	0.653	–18.1–11.3
Documentation–medical	26 (26.3)	24 (32.9)	0.345	–20.4–7.2
Documentation–nursing	20 (20.2)	10 (13.7)	0.267	–4.7–17.7
Monitoring of observations	7 (7.1)	2 (2.7)	0.207	–2.0–10.6
Delay or failure to escalate	20 (20.2)	5 (6.9)	0.014	3.5–23.1
Monitoring blood results	9 (9.1)	10 (13.7)	0.341	–14.3–5.1
Alternate chart commenced	4 (4.0)	1 (1.4)	0.303	–2.0–7.4
Which chart?	7 (7.1)	2 (2.7)	0.207	–2.0–10.6
Delays to transfer	8 (8.1)	4 (5.5)	0.508	–4.9–10.1
Safety/Security check	2 (2.0)	0 (0.0)	0.222	–0.8–4.8
Other human factors	0 (0.0)	1 (1.4)	0.243	–4.0–1.3
Consumer involvement	4 (4.0)	6 (8.2)	0.247	–11.6–3.2
<i>Organisational factors (n1 = 99, n2 = 73) – n (%)</i>				
Supervision	0 (0.0)	1 (1.4)	0.243	–4.0–1.3
Work Practice related	4 (4.0)	4 (5.5)	0.658	–7.9–5.1
Policy/guideline not followed	6 (6.1)	10 (13.7)	0.088	–16.8–1.5
Policy/guideline unclear	22 (22.2)	25 (34.3)	0.080	–25.6–1.6
Staffing issues	4 (4.0)	1 (1.4)	0.303	–2.0–7.4
Delay in transfer	13 (13.1)	3 (4.1)	0.044	1.0–17.1
<i>Individual factors (n1 = 99, n2 = 73) – n (%)</i>				
Staff training	0 (0.0)	5 (6.8)	0.008	–12.6 to –1.1
Staff experience	6 (6.1)	3 (4.1)	0.570	–4.6–8.5
Staff stress	2 (2.0)	0 (0.0)	0.222	–0.8–4.8
<i>Error (n1 = 99, n2 = 73)–n (%)</i>				
Rule based error	55 (55.6)	51 (69.9)	0.057	–28.7–0.0
Knowledge based error	32 (32.3)	20 (27.4)	0.487	–8.8–18.7
Skill based error	6 (6.1)	1 (1.4)	0.124	–0.7–10.1
Violation error	64 (64.6)	19 (26.0)	< 0.001	24.8–52.4
Nil error	8 (8.1)	4 (5.5)	0.508	–4.9–10.1

in the post intervention arm, although as this change to clinical practice was mandated, this is not likely. This study was conducted in regional Australia, so the generalisability of the study findings to other jurisdictions may be limited. Finally, an inherent limitation associated with the quasi-experimental design of this study was that the investigators could not control for the effect of potential confounders such as the changes to staff number and their skill mix. A cluster randomised control study that incorporates consumers and an economic evaluation would address this issue and could provide the necessary evidence for embedding HIRAID into policy and practice for system-wide change.

6. Conclusions

Initial and ongoing patient assessment, symptom control and management are core emergency nursing responsibilities and directly linked to patient safety. Failures in recognising and responding to deteriorating

ED patients is associated with high-mortality adverse events such as cardiac arrest and unplanned ICU admission.

HIRAID is a validated framework designed to provide emergency nurses with a structured and systematic approach to patient assessment and management. The use of HIRAID is associated with a reduction in clinical deterioration related to emergency care by enhancing nursing practice through increased escalation of patient deterioration. The reasons for this reduction can be explained by a reduction in the proportion of causal factors relating to nurse action, violation related errors (intentional failure to follow accepted work practices, guidelines, for example, where it has become routine to practice in a certain way), treatment delays and failures in escalation of clinical deterioration. The evidence-based nature of the HIRAID framework and implementation strategy means HIRAID is readily adaptable for implementation in other jurisdictions or contexts of practice.

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.

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