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Pediatric ED Saves: Analyzing the ED Screen of Direct Admissions

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ABSTRACT

Introduction: Direct admissions (DAs) are a routine hospital entry portal with few guidelines to assess patient safety during this process. This study assessed the effectiveness of an institutional screen for patients presenting as DA. It investigated patient variables that may predict appropriateness for DA and those at high risk for deterioration. **Methods:** The study includes patients who received the institutional screen between June 1, 2019, and May 31, 2020. We placed charts into three groups: group 1 (stable), group 2 (unstable), and group 3 (stable then transferred to pediatric intensive care unit within 6 hours). We assessed effectiveness by calculating sensitivity, specificity, and predictive values. We used comparative analysis between groups to identify patients safe for DA and those at high risk for deterioration, **Results:** The screen was 80% sensitive and 100% specific, predicting 97.7% of stable patients. Of the 652 charts reviewed, 384 met the inclusion criteria. Group 1 (31.60, 26.45%, 5.23%) had lower respiratory rate, respiratory diagnosis, and oxygen requirement compared to group 2 (45.00, 78.13%, 15.63%) and group 3 (44.50, 75.00%, 50.00%). For SpO_2, group 1 (98.70) was higher than group 2 (96.03). For the Pediatric Early Warning Score, group 2 (1.72) was higher than group 1 (0.31) and group 3 (0.63). **Conclusions:** The institutional screen is an effective tool to identify patients presenting as DA needing immediate emergency department intervention and/or pediatric intensive care unit care. The screen benefits patients with a respiratory diagnosis, oxygen requirement, high respiratory rate or low SpO_2. *(Pediatr Qual Saf 2023;8:e678; doi: 10.1097/pq9.0000000000000678; Published online August 7, 2023.)*

INTRODUCTION

The emergency department (ED) is the gateway for admission to the hospital Planned admissions, also known as direct admissions (DAs), comprise one out of four hospitalizations.[1] These types include patients from outpatient clinics, urgent cares, outlying EDs, and inpatient units deemed stable for care on the inpatient floor by a hospitalist. Occasionally, patients planned as DAs may be more ill on arrival than the inpatient floor can manage, requiring immediate intervention and even intensive care unit (ICU) admission.[1–3] Despite this, few guidelines exist to mitigate adverse events for these patients.[1,2]

Although various scoring systems have assessed patients arriving at an ED, there is a lack of guidelines to help physicians assess pediatric patients that do not enter the hospital through the ED yet may be too ill for DA.[2,4–9]

To maximize the safety of patients presenting as DAs, our institution developed a process to screen patients in the ED to prevent critically ill patients from arriving on the inpatient floor. Upon arrival at our institution, a pediatric emergency medicine (PEM) attending/fellow and ED nurse evaluate patients using the screening process. This process includes RN documentation of date, time of arrival, heart rate, RR, temperature, pulse oximetry, supplemental oxygen (if any), time sent to the floor, pediatric early warning score (PEWS), clinical asthma score (CAS), in addition to physician (PEM attending/fellow) evaluation of stability for inpatient floor care. For stable patients, the PEM attending/fellow and ED nurse document the ED screening process in the electronic medical record (EMR, Oracle Cerner, Austin, Tex.) using a standard template for DA before accompanying the patient to the inpatient floor. If the patient is more ill on arrival than the inpatient floor can manage, such

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Supplemental digital content is available for this article. Clickable URL citations appear in the text.

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To cite: Ramirez-Cueva F, Grinberg GP, Kuchinski AM, Gibson R, Xu H, Zhang LF, Seeyave D. Pediatric ED Saves: Analyzing the ED Screen of Direct Admissions. Pediatr Qual Saf 2023;8:e678.

Received for publication June 16, 2022; Accepted July 7, 2023.

Published online August 7, 2023

DOI: 10.1097/pq9.0000000000000678

as needing immediate resuscitation or intervention, the patient becomes a standard ED patient.

The primary objective of this study is to analyze the ED screening process for pediatric DA in our institution. To our knowledge, no prior studies evaluate variables that predict appropriateness for DA. Hence, our secondary objective is to identify patients safe for DA and those at high risk of deterioration, specifically patients that may be more ill than the inpatient floor can manage to require ED or ICU care on arrival.

METHODS

The setting was the Children's Hospital of Georgia, an academic, tertiary-care, free-standing children's hospital. The ED provides care to over 30,000 children per year. This project was a retrospective chart review of the EMR of patients who received our institutional screen before admission between June 2019 and May 2020. The institutional review board of Augusta University determined this study as exempt.

We obtained data from two sources. First, we obtained monthly direct admission reports from the emergency communications center. Then, we cross-referenced the pediatric intensive care unit (PICU) rapid response call reports from the direct admission reports capturing all DA patients who required a rapid response call or ICU transfer within 6 hours. We limited data to 6 hours before the deterioration event to capture data close to the event. Rapid response teams are interdisciplinary groups that evaluate and manage patients at risk of clinical deterioration, ultimately deciding if patients require ICU care.[10] A study by Kuehn et al identified that ICU transfers close to DA had significant mortality.[11] We identified patient charts from the EMR using the medical record number, financial encounter number, date of birth, age, and date of DA.

Of the 652 charts reviewed, 384 met the inclusion criteria. We included patients accepted as DA by the pediatric hospitalist service and screened through the ED. Exclusion criteria included patients who (1) are an ED to ED transfer; (2) have no ED screen performed; (3) are DAs to the PICU or NICU; (4) present as a DA but ultimately discharged home from the ED; (5) are held in the ED due to change in the protocol (needing COVID swab before direct admission); and (6) are held in the ED due to limited inpatient bed availability. We also excluded patients due to an inability to find the encounter or an inability to find the patient in the EMR (Fig. 1).

We used a master code sheet to protect patient data and included a participant identification number uniquely associated with patient data collected from the EMR. We stored all data on the institution's secure research drive. We list all data collected from the EMR in Table 1.

Our institution developed the ED screen to determine the appropriateness of patients presenting as DA to the hospital. To clarify the terminology used, we categorized patients as stable or unstable in the following manner. If evaluation by the PEM attending/fellow or ED nurse resulted in routine DA to the inpatient floor, then we categorized the ED screen result as stable. If evaluation resulted in a patient being held in the ED for immediate resuscitation or intervention due to the patient being

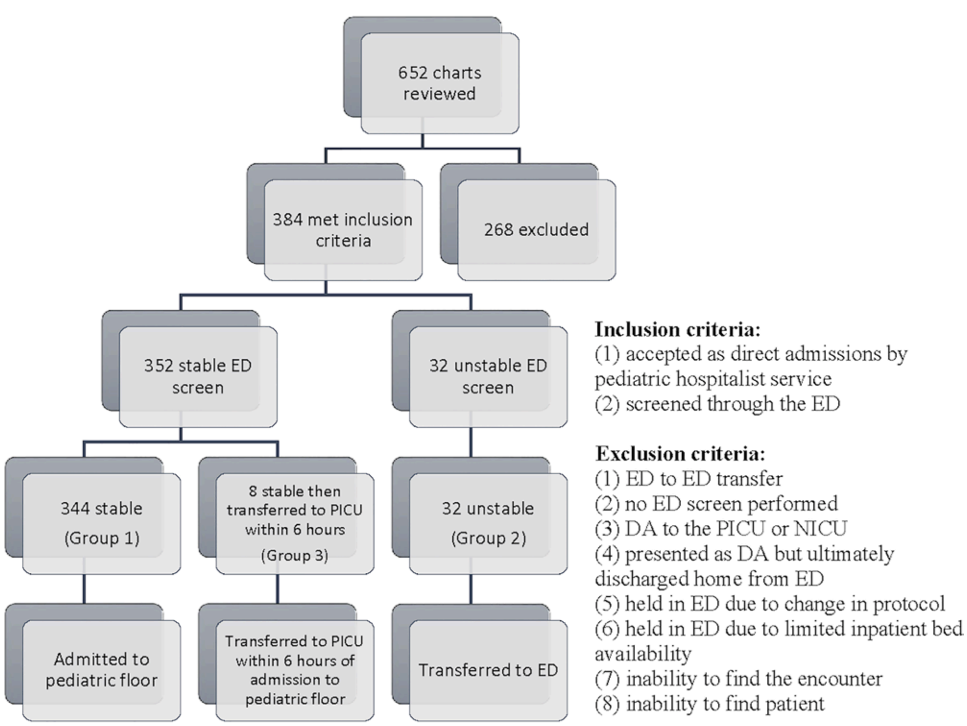

Fig. 1. Flowchart of patient disposition.

Table 1. Data Collected from ECC DA and PICU Rapid Response Reports

Variable	Description
Date and time of ED Screen	Year, month, time
ED screen performed	Yes, no RN, physician or both
ED screen result	Stable, unstable
Age	
Sex	Male, female
ED diagnosis	Respiratory Sepsis Other (cardiac, surgical, neurologic, other)
Vital signs	HR, temperature, RR, SpO_2, O_2 requirements, SBP, DBP
PEWS	PEWS total, behavior, cardiovascular, respiratory, asthma with continuous nebulization
Destination	ED, admit, home
ED work up	Intervention, observation, labs, imaging, additional study (ie, EEG), consult [6]
Disposition	Floor, PICU, surgery, transfer
Hospital course	Intervention, observation, labs, imaging, additional study (ie, EEG), consult, PICU transfer within 6 h
PICU reasoning	Change in respiratory status, other (change in neurologic status, decompensated shock, frequent monitoring)
PICU intervention	Respiratory support (HFNC, CPAP, BiPAP, Intubation), drips (vasopressors, insulin), every hour checks, other
Final disposition	Home, rehab, psych, mortality

BiPAP, bilevel positive airway pressure; CPAP, continuous positive airway pressure, EEG, electroencephalogram; HFNC, high-flow nasal cannula.

more ill on arrival than the inpatient floor could manage, we categorized the ED screen result as unstable. Patient disposition was used as a "gold standard" to accurately identify the best possible assessment of these patients' stability. We categorized patients as truly unstable if they were held in the ED or transferred to the PICU within six hours of admission to the inpatient floor. We categorized patients as truly stable if they had an unremarkable hospitalization on the inpatient floor.

To investigate patient variables predicting ED intervention and PICU transfer within six hours of direct admission, we collected the data listed in Table 1. We categorized ED diagnosis by disease process such as respiratory, sepsis, or other. "Other" included disease processes such as cardiac, surgical, and neurologic. In addition, we categorized oxygen requirements as room air or other. Oxygen requirements in the "other" category included 0.5 L up to 6 L/min given via nasal cannula, blow-by or tracheostomy. The PEWS used the Brighton scoring system.[12] System components included behavior, cardiovascular, respiratory, and asthma with continuous nebulization. Each abnormal parameter scored 1 point with a maximum score possible of 11 for the PEWS total (Fig. 2).[13]

Additionally, we categorized PICU reasoning based on transfer indication, including change in respiratory status or other. Reason for PICU transfer in the "Other" category included change in neurologic status, decompensated shock, or frequent monitoring. Finally, we categorized PICU interventions based on clinical need, including respiratory support, continuous infusions, frequency of clinical examinations, and other. PICU interventions in the "Other" category included patients with a tenuous clinical status that required a higher level of care.

STATISTICAL ANALYSIS

We placed charts into three groups according to screening results. Group 1 (true negative) included patients screened as stable who had an unremarkable hospital course. Group 2 (true positive) included patients screened as unstable and required ED intervention and/or PICU admission. Group 3 (false negative) included patients screened as stable and transferred to the PICU within 6 hours. No patients were screened as unstable that did not require ED intervention and/or PICU transfer within 6 hours (false positive) (Fig. 1).

To determine the accuracy of the ED screen, we calculated sensitivity, specificity, and predictive values (Table 2). We used one-way ANOVA to test the means differences of age, respiratory rate (RR), pulse oximetry (SpO_2), systolic blood pressure (SBP), and PEWS total in the three groups.

We used Tukey's multiple comparisons to explore the differences between the mean of each group (Table 2); and Fisher's exact test to find differences in proportions of diagnosis, O_2 requirement, PICU reason, and sex in the three groups. The frequencies, percentages, and Fisher's test *P* values are presented in Table 3. The *P* value is set at a significance level 0.05 using SAS 9.4 (SAS Institute, Cary, N.C.).

RESULTS

Of the 652 charts reviewed, 384 patients were accepted for inpatient care by the hospitalist and screened in the ED on arrival. We excluded 268 charts where the breakdown was (1) ED to ED transfer (23 patients); (2) no ED screen performed (15 patients); (3) admission to PICU or NICU (162 patients); (4) planned admission but ultimately discharged from the ED (two patients); (5) held in ED due to protocol change (ie, needing COVID swab) or unavailable floor bed; (five patients), or (6) erroneous entry (duplicate or no patient encounter) (61 patients). Of the 15 patients who presented as direct admission and did not have an ED screen performed, there was no PICU transfer or escalation of care within 6 hours of admission to the inpatient floor. Due to the study's retrospective nature, we could not determine why the ED staff did not perform a screening.

The screen was 80% sensitive and 100% specific. The screen predicted 97.7% of stable patients (Table 2). Eight cases initially screened stable but eventually transferred to the PICU within 6 hours. Of these eight cases, six were due to respiratory diseases such as asthma or bronchiolitis. The other two cases were neonates with signs of sepsis that became evident after obtaining blood pressure or temperature.

Pediatric Early Warning Score (PEWS)

	0	1	2	3	Score
Behavior	Playing/ Appropriate	Sleeping	Irritable	• Lethargic/confused **OR** • Reduced response to pain	
Cardiovascular	Pink **OR** capillary refill 1-2 seconds	Pale **or** dusky **OR** capillary refill 3 seconds	• Grey **or** cyanotic **OR** • Capillary refill 4 seconds **OR** • Tachycardia of 20 above normal rate	• Grey **or** cyanotic **AND** mottled **OR** • Capillary refill 5 seconds **or** above **OR** • Tachycardia of 30 above normal rate **OR** • Bradycardia	
Respiratory	Within normal parameters, no retractions	• >10 above normal parameters **OR** • using accessory muscles **OR** • 30+%Fi02 **or** 3+liters/min.	• >20 above normal parameters **OR** • Retractions **OR** • 40+%Fi02 **or** 6+liters/min.	• ≥5 below normal parameters with retractions **or** grunting **OR** • 50+%Fi02 **or** 8+liters/min.	

***Score by starting with the most severe parameters first.**
***Score 2 extra for every 15-minute nebs (includes continuous nebs) or persistent post-op vomiting.**
***Use "liters/minute" to score regular nasal cannula.**
***Use "Fi02" to score a high flow nasal cannula.**

Monaghan, A. (2005) Detecting and managing deterioration in children. *Paediatric Nursing, 17, 32-35.* Adapted for use at Children's of Minnesota.

	Heart Rate at rest	Respiratory Rate at rest
Newborn (birth – 1 month)	100-180	40-60
Infant (1 – 12 months)	100-180	35-40
Toddler (13 months – 3 years)	70-110	25-30
Preschool (4 – 6 years)	70-110	21-23
School Age (7 – 12 years)	70-110	19-21
Adolescent (13 – 19 years)	55-90	16-18

Fig. 2. Guide to PEWS.[13]

Additionally, we present the common diagnoses of patients who were DAs screened stable and had an unremarkable hospital course in **Table 1, Supplemental Digital Content 1,** ***http://links.lww.com/PQ9/A514***. There were 344 patients in the stable with unremarkable hospitalization course group. Of the 32 screened as unstable, 9 needed PICU level of care, and the rest (23) were deemed stable for the floor after receiving ED intervention. ED interventions included medications (breathing treatments) and an observation period for all 23 patients. In addition, six patients had laboratory tests, and four patients had imaging performed. Since this is a retrospective study, we cannot determine how the 23 patients would fare on the floor if they did not receive ED intervention. Anecdotally, these patients would receive a rapid response call on the floor if they bypassed the ED screen.

The three groups have statistical differences in RR, SpO_2, and PEWS. Group 1 (31.60) had a significantly lower mean RR than group 2 (45.00) and group 3 (44.50). Group 1 (98.70) had significantly higher SpO_2 than group 2 (96.03). For PEWS total, group 2 (1.72) had a significantly higher PEWS total than group 1 (0.31) and group 3 (0.63) (Table 3).

The proportion of patients with Respiratory diagnosis is significantly lower in group 1 (26.45%) than in group 2 (78.13%) and group 3 (75.00%). The proportion of oxygen requirement in group 1 (5.23%) is significantly lower than in group 3 (50.00%). Group 2 (15.63%) is in

Table 2. Analysis of CHOG PED Screen

	Estimate	Standard Error	95% Confidence Limits	
Sensitivity	0.8000	0.0632	0.6760	0.9240
Specificity	1.0000	0.0000	1.0000	1.0000
Positive predictive value	1.0000	0.0000	1.0000	1.0000
Negative predictive value	0.9773	0.0079	0.9617	0.9928

Table 3. Tukey Pair Wise Comparison for Age, RR, SpO_2, SBP, PEWS in Three Groups

					Tukey Paired *P* values	
					Group	
Variable	Group	N	Mean	Std	2	3
Age (mo)	1	344	57.65	64.45	0.6218	0.2388
	2	32	68.75	71.31		0.1402
	3	8	20.25	32.08		
RR (breaths per minute)	1	341	31.60	12.21	<0.0001	0.0166
	2	32	45.00	19.78		0.9948
	3	8	44.50	15.37		
SpO_2 (% saturation)	1	342	98.70	1.67	<0.0001	0.4837
	2	32	96.03	4.18		0.0552
	3	8	97.88	2.70		
SBP (mmHg)	1	192	110.86	16.20	0.5275	0.2249
	2	19	115.05	16.22		0.1225
	3	3	95.33	2.08		
PEWS total	1	304	0.31	0.54	<0.0001	0.4018
	2	32	1.72	1.46		0.0002
	3	8	0.63	0.74		

Table 4. Fisher's Exact test for Diagnosis, O_2 Requirement, PICU Reason, and Sex by Three Groups

Variable	Description	Group 1, N (%)	Group 2, N (%)	Group 3, N (%)	Fisher's *P*
Diagnosis	Other	209 (60.76%)	3 (9.38%)	1 (12.50%)	<0.0001
	Respiratory	91 (26.45%)	25 (78.13%)	6 (75.00%)	
	Sepsis	44 (12.79%)	4 (12.50%)	1 (12.50%)	
O_2 requirement	Other	18 (5.23%)	5 (15.63%)	4 (50.00%)	<0.0001
	RA	326 (94.77%)	27 (84.38%)	4 (50.00%)	
PICU reasoning	Other	3 (50.00%)	5 (38.46%)	2 (25.00%)	0.6879
	Respiratory	3 (50.00%)	8 (61.54%)	6 (75.00%)	
Sex	F	154 (44.77%)	13 (40.63%)	3 (37.50%)	0.8136
	M	190 (55.23%)	19 (59.38%)	5 (62.50%)	

between these two groups. There are no differences in sex and PICU reasons between groups (Table 4).

DISCUSSION

DAs are a routine portal of entry to the hospital. However, few guidelines exist to assess patient safety during this process. An inherent risk of DA includes rapid emergency transfer from the floor to ICU.[11] This study assessed the effectiveness of an institutional screen to determine the appropriateness of patients presenting as DA to the hospital. It also investigated patient variables that would be appropriate for DA, specifically looking at patients that may be more ill than the inpatient floor can manage, requiring ED or ICU care on arrival.

The institution designed the ED screen to include all patients presenting to the hospital as DAs. The screen identified patients requiring emergent ED intervention or PICU admission initially deemed stable for the inpatient floor. The screen combines objective patient variables (ie, vital signs) and clinician judgment of appropriateness for the floor. We believe the ED screen is simple, quick, and reproducible in other pediatric institutions. Although studies have shown that the clinical judgment of ED physicians upon ED triage has been effective in recognizing unstable patients who present as DA, variation in the perception of patient stability between two or more clinicians is a limitation in this study.[9] Also, other institutions' inpatient floor capability may differ from ours.

Approximately 10% of patients presenting as DA in our study were unstable. Early recognition of these patients was key to developing our institutional screen. Considering the diagnosis and focusing on clinical and objective parameter markers of disease severity may help determine which patients are unstable for DA. Our study found that respiratory conditions were more likely to fall within this group. The screen was useful but not perfect for this subset of patients. The screen missed six respiratory patients, which could be attributed to disease progression or delay in care, as seen in another study.[14] This finding highlights the need for prompt evaluation once DA patients arrive on the inpatient floor. It was also unsurprising that a higher RR, higher O_2 requirement, higher PEWS, and lower oxygen saturation were predictive of needing additional intervention either in the ED or once transferred to the PICU, as found in several other studies.[5,7,12,13,15] In contrast, a study by Gorham et al did not find RR predictive of deterioration.[16]

Two of the eight cases initially screened as stable but transferred to the PICU within 6 hours were neonates with sepsis symptoms but with a presumptive diagnosis of dehydration or hypothermia. Although this was a small proportion of the patient population (0.5%), physicians must be vigilant when evaluating these DA patients. Neonatal sepsis may manifest with nonspecific symptoms that may not be evident on clinical examination. We suspect that obtaining blood pressure and temperature as part of the screening process, particularly in neonates presenting a concern for sepsis, could have provided a more objective evaluation and may have changed the disposition of these patients. Gorham et al[16] developed a tool, the Vitals Risk Index, that included SBP for identifying patients at risk of deterioration. However, this study did not find temperature to be predictive of deterioration. A future study looking at a larger population of unplanned ICU transfers, their ED screen results and vital signs would better capture data on these at-risk patients.

Another element to capture truly unstable patients presenting as DA may be documented communication between referring and accepting healthcare providers. Standard of care practice should be to obtain and document a patient's chief complaint, vital signs, physical examination, and given interventions when accepting and evaluating a patient.[10,11,17] Although this was not part of this study's aim, comparing this documentation to a patient's evaluation upon ED arrival would be a helpful assessment of clinical deterioration before admission and the need for immediate intervention or PICU care.

Most (90%) patients directly admitted had an unremarkable hospitalization on the inpatient floor. Of these patients, we found that certain diagnoses may benefit from not going through the ED, which would offload a busy ED. For example, neonates with hyperbilirubinemia that need inpatient phototherapy risk delay in care and contracting infection when going through the ED.[1] We recommend further research to determine the risks and benefits of bypassing ED screening for these patient populations. It would also be helpful to have a guideline of limitations of the inpatient floor to delineate appropriateness for DA.

There were several limitations to this study. Due to the study's retrospective nature, we have limited control over the population sampled, and the quality of data collected from the EMR depended on the accuracy of patient charting by physicians and nurses. There is a variation in the perception of patient stability between physicians, which ultimately affects the outcome of the ED screen. Information bias may have affected the classification of patients as stable or unstable by researchers. We could not identify why the screens were not done at times, which may have introduced sampling bias. Additionally, we analyzed data from a single institution; thus, findings may not be generalizable to other hospitals in the country.

Our future research aims include improving the DA process by educating and implementing a standardized handover tool that focuses on the early identification of high-risk patients that are directly admitted, using ED resources efficiently, and decreasing hospital costs and length of stay. We have created a Key Driver Diagram

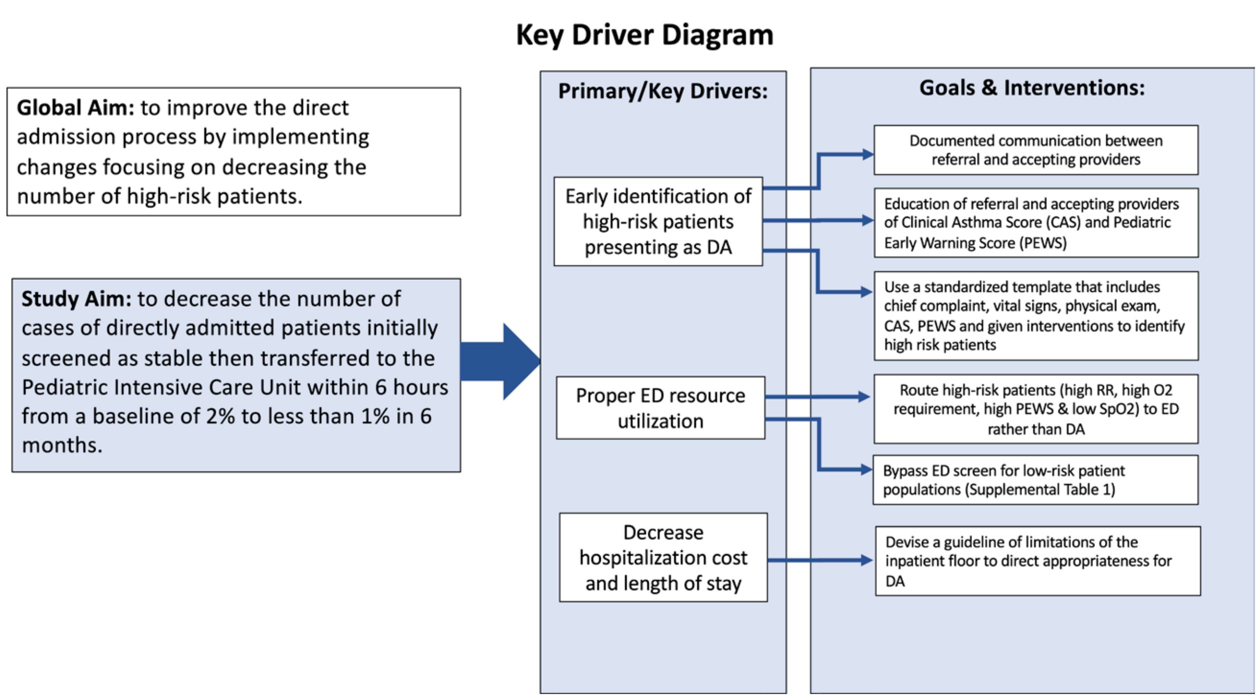

Fig. 3. Key driver diagram.

highlighting our future goals in Figure 3. Once this handover tool has been created and validated at our institution, we hope to disseminate it to children's hospitals nationwide, allowing for a safer DA process. We believe that the information reported in this study can ultimately help improve safety issues associated with DAs.

CONCLUSIONS

In our study, the ED screen had excellent but not perfect effectiveness in determining patients inappropriate for DA. There is room for improvement to avoid missing these at-risk patients, particularly neonates and patients with respiratory diagnoses. Transitions in care should have a standardized template to include relevant patient information to avoid adverse events and improve patient safety. We recommend the ED screen for patients with a respiratory diagnosis, oxygen requirement, high RR, low SpO2 or high PEWS before DA. We identified patient diagnoses safe for DA and those at risk of deterioration. Further research is needed to determine if misses are due to inefficient patient handoffs, clinical deterioration of the patient, or delays in care.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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