Scoring Systems in Paediatric Emergency Care:

Panacea or Paper Exercise?

Review Article

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Abstract

Scoring systems to recognise the most ill patients, or those at risk of deterioration, are increasingly utilised in hospitals which look after paediatric in-patients. There have been efforts to implement these systems in emergency and urgent care settings but they have yet unproven value. This is because the child or young person presenting acutely is a different cohort than the 'treated' ward based group. The majority of children presenting to emergency and urgent care settings are discharged home and so scoring systems need to recognise the most unwell but also assist in safe and appropriate discharge as well as highlighting those patients in need of more senior review. This article explores this conundrum, suggesting how cognitive factors have a role to play, and how scoring systems can have wider effects than just individual patient care.

Keywords: Emergency Care, Paediatrics, Scoring Systems, Human Factors

Key Points:

1. There is a double-ended challenge to identify the most ill children while simultaneously determining who is safe to discharge when considering scoring systems in Paediatric Emergency Departments.
2. There needs to be recognition that urgent and emergency care represents a different cohort of patient than those on the ward.
3. Utilising cognitive factors in scoring systems may improve the safety culture within Paediatric Emergency Departments
4. Scoring systems do not only benefit individual patients but have wider system effects.

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Introduction

Mechanisms which identify a change in a patient's clinical condition have been widely adopted in medical practice in the developed world, as a risk management tool to reduce serious adverse events through patient deterioration or caregiver error. Adverse events or injuries caused by medical management are estimated to account for as many as 98 000 *deaths per year* in the United States alone [1]. As well as being detrimental to patients, they affect morale (and sometimes employment) of medical and nursing staff. This can have a huge financial burden on healthcare (estimated at \$40 billion per year in the US [2]) affecting a country's litigation costs and government spending on health.

These mechanisms are often put under the umbrella term "EWS" but the terminology may be used by different health care organisations in different ways. Some use the term as an Early Warning 'Score', generally the numerical value or response generated when one parameter, or combination of parameters, from an observation chart fall outside a specified normal range. This is also termed a track and trigger system. Unlike routine adult practice, commonly measured 'vital signs' vary with age in Paediatric practice, and when added to the high level of physiological compensation most children are capable of then an age-appropriate visual charting system for selected physiological observations is cognitively attractive. An EWS may also refer to an Early Warning 'System' which may include the 'score' but also a clearly defined response to it. For example many hospitals use an EWS to trigger critical care outreach team attention, and to assist in placing patients in the right area of the hospital [3, 4]. While Emergency Departments (EDs) may benefit from similar scores and systems, the optimal design to meet the specific needs and operating characteristics of this clinical environment has yet to be established.

The place of the early warning scores and systems in the Emergency Department

In the ED the first defence against failing to recognise the deteriorating patient has traditionally been a triage system. Here children are categorised by time needed for medical review based on appearance, a few initial clinical features and history of presenting complaint (Figure 1). For example, the Manchester Triage System flowchart uses individual presenting features (such as stridor or drooling) from a presenting complaint (such a shortness of breath) to determine which category the patient would belong to [5]. This approach assumes the concept of a queue of patients waiting to be seen, and relies heavily upon symptoms and signs, which may be less obvious in children, and may not correlate with likelihood of deterioration. The two main aims of triage are to state a priority sequence for medical attention and to identify sick patients, rather than enable discharge of patients not needing hospitalisation (an equally fundamental role of the ED in the developed world).

Figure 1: Manchester Triage System flowchart Shortness of breath in children (Second edition). Reprinted from Mackway-Jones K et al. Emergency Triage, Manchester Triage Group. Second edition. Oxford: Blackwell Publishing Ltd; 2006, p 134.[5]

Although there is a relationship between triage category, hospital length of stay and ultimate outcome for the child [6,7,8] technically the category itself does not quantify the severity of illness or injury in an individual child only

perceived need for medical treatment. Within triage scores themselves there are differential admission rates indicating a more precise measure of acuity may be needed [9]. The increasing use of Early Warning Systems and associated Early Warning Score charts in hospitals has prompted experimentation with their use on Emergency Departments [10]. The utility of this approach has yet to be proven with poor specificity resulting in potentially inappropriate use of resources [11]. A recent review of Early Warning Scores demonstrated effectiveness in recognising the very sick child [12] but much poorer performance on identifying need for admission. The challenge is visually demonstrated by comparing the sensitivity and specificity of six Children's Early Warning Scores as recognising children admitted for over 24 hours (Figure 2). This is based on prospective data from 580 sets of observations in a non-tertiary Emergency Department. While the specificity of the tools at predicting admission was good so that children with high scores were often admitted (i.e. there were few false positives); the sensitivity was poor meaning that children with low scores were also admitted relatively frequently (i.e. there were many false negatives).

Figure 2 – Comparison of 6 different scoring systems in an Emergency Department at recognising needing admission for greater than 24 hours (Dr. E. Watson 2013, unpublished)

POPS – Paediatric Observation Priority Score[13]
 PAWS – The Paediatric Advances Warning Score[14]
 C&V - The Cardiff and Vale PEWS[15]
 Brighton – The Brighton PEWS[16]
 Poole – The Poole COAST PEWS[17]
 NHSI – The NHS Institute for Innovation and Improvement PEWS[18]

Much of the controversy around Early Warning Score or System use in the Emergency Department probably stems from inappropriate expectations or incomplete understanding of their strengths and limitations. The majority of current tools are designed to identify critically abnormal physiology or identify deterioration over time. Few have yet been specifically designed and validated to identify patients who are safe to discharge from ED. The biggest impact on clinical care in the Emergency Department may be in the minimisation of cognitive bias and error, well-recognised factors in the genesis of severe adverse events in healthcare. Many cognitive biases have been described [19] and some examples are included in table one.

Table 1 - Cognitive biases as described by Croskerry[19]	
Confirmation bias	Looking for evidence to support a pre-conceived opinion, rather than looking for information to prove one-self wrong.
Diagnosis momentum	Accepting a previous diagnosis without sufficient skepticism.
Framing Effect	Making a decision based on the positive (or negative) way in which situation presented.
Overconfidence bias	Over-reliance on one's own ability, intuition, and judgment.
Premature closure	Similar to "confirmation bias" but more "jumping to a conclusion"
Self-satisfying bias	The "eureka" moment that stops all further thought

Emergency Medicine (EM) has been described as a 'natural laboratory of error' [20], in large part due to a constellation of operating characteristics

commonplace to busy Emergency Departments and described in table two. These characteristics include, but are not limited to:

- (i) High patient loads, which vary dependant on season and time of day.
- (ii) Diverse skill sets due the large number of staff employed and high turnover rates.
- (iii) The need for multiple handovers due to the relatively rapid throughput of patients.
- (iv) Intense time pressures due to enforced target times or need to clear cubicle space to see new patients.
- (v) Diagnostic uncertainty due to the acute nature of the presentation.

These characteristics challenge decision making, of which there are many explanatory theories. One of the most well-known cognitive models explaining human decision-making, which includes medical diagnosis and management decisions, has been derived from the dual process model [21,22]. This proposes two independent thought mechanisms (designated *system 1* and *system 2*) which are able to work cooperatively in decision-making. System 1 utilises heuristics or 'pattern recognition' to make rapid and near-effortless judgements with a reasonable degree of accuracy. This system accounts for the majority of day-to-day decisions for which the stakes are low. System 2 on the other hand is an analytical or hypothetico-deductive process with the ability to refine or modify System 1 judgements or to reach decisions in the absence of pre-existing heuristics. While less prone to cognitive biases, it is an energy-intensive process which is heavily dependent on working memory and is thus susceptible to fatigue or pressure from competing tasks.

While the utility of Early Warning Scoring Systems as tools for cognitive debiasing remains largely untested at this time, their design characteristics would predict that they should ameliorate:

- **Diagnostic failure:** Failure to establish the correct diagnosis *sufficiently early to permit effective treatment*

- **Failure to recognise illness severity:** The correct diagnosis is established but illness severity is underestimated, leading to delayed *escalation of support*
- **Failure of communication:** Communication between staff may be absent or ineffective. This includes inaccurate medical information as well as human factors

Table 2: Emergency Department operating characteristics predisposing to medical error

Characteristic	Caused by	Leading to	Potential error types
Intermittent high patient load	Clinical need at time	High cognitive load Fatigue Stress Interruptions/distractions High decision density	System 1 errors Impaired System 2
Inexperience in some staff	Wide breadth of presenting pathology Need to roster 24/7	Information deficits	Inadequate knowledge
Multiple handovers	Triage → ED clinical area Shift → Shift	Communication failure Failure to establish baseline	Impaired System 2: Information deficit
	ED → destination ward	Cognitive biases	Diagnostic momentum Premature closure
Time pressure	High workload ED waiting time targets	↑ reliance on System 1	Impaired system 2 Tendency to premature closure*
Diagnostic uncertainty	Unknown patients	Potential information deficits	Impaired System 2:

	Wide breadth of presenting pathology Time pressure Nonspecific presentations eg ' <i>Chest pain</i> '	↑ reliance on System 1	Framing effect Confirmation bias Self-satisfying bias Premature closure
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Designing an Early Warning scores and systems for the Emergency department

As with ward based tools, an optimal ED tool should possess the following characteristics:

Reducing Knowledge Deficit: Most tools define an acceptable reference range for each physiological variable commonly measured. This assists junior staff, particularly if inexperienced with children

Decreasing cognitive load: Graphical or numerical display of physiological observations, whether at the triage stage or repeatedly over time, allows clear identification of sick children.

Escalating seniority of review: Specific scores activate senior clinician involvement

Identifying both tails of the distribution curve: Ability to identify potentially critically unwell children as well as those fit for discharge without hospital admission, is the fundamental purpose of an ED

Improving Communication: Many tools are now integral to the process of patient handover and triage. Handover is well known to be a high-risk transition for patients, and objectivity and alerts are possible using scoring systems.

A child focused score in an Emergency Department has shown great value in the detection of those requiring intensive care but it is not clear on how many

children who were sent home activated the system [23] or were “over-triaged”, to use an old-fashioned term. The inability to identify children on both tails of the distribution curve make ward based EWS scores likely to be less suitable for the ED, as their purpose is only to identify sick children. Paediatric practice in emergency medicine aims to identify sick children and avoid unnecessary admission. It is clearly not a reasonable proposition to admit every child who may be unwell as this would overload services and create further errors later in the system. Safely identifying the child suitable for discharge after a small period of observation is core skill of emergency care practitioners who deal with children.

There are few ED derived scoring systems. The Paediatric Observation Priority Score, developed at the authors’ institution, has shown early promise in identifying both ends of the distribution curve accurately [13] and has undergone external validation [24]. It incorporates heart rate, respiratory rate, saturations, temperature, work of breathing, AVPU (is the child Alert, responsive to voice, responsive to pain or unresponsive), key features of past medical history and an ordinal scale of nursing concern of a child’s first assessment on presentation to our Emergency Department. Physiological values within Advance Paediatric Life Support criteria for age, without evidence of breathing difficulty or significant past medical history and an alert child with no nursing concerns would have a POPS of 0 (Figure 3). Variation outside of normality scores 1 or 2 points in each domain leading to maximum of 16. It is currently in active use in three children’s Emergency Departments in the UK and its impact is being formally evaluated in 5 others. Recently data from over 24000 patients indicated that only 11 children discharged with POPS 0 returned to be admitted and required further definitive management [25]. Furthermore in relation to predicting admission the receiver operating characteristic (ROC) curve was 0.802 for POPS values sectioned into categories {0, 1–2, 3–4, 5–7 and 8+} with a sensitivity of 97.7% at POPS>4 [25].

Figure 3 – The Paediatric Observation Priority Score

Paediatric Observation Priority Score (POPS) Chart
This chart is not a substitute for good clinical judgement and any concerns about the condition of a child should be brought to the attention of a senior nurse or doctor

Age	Score	2	1	0	1	2	Total Score	Priority
Any	Sats	<90%	90-94%	>95%	90-94%	<90%		
Any	Breathing	Stridor	Audible grunt or wheeze	No distress	Mild or Moderate Recession	Severe Recession	0-1	
Any	AVPU	Pain	Voice	Alert	Voice	Pain	2-3	
Any	Gut Feeling	High level concern	Low level concern	Well	Low level concern	Child looks unwell	4-7	
Any	Other	Oncology Patient	Significant PMH*		Significant PMH*	Congenital heart disease	8+	Immediate review
0-1	Pulse	<90	90 - 109	110 - 160	161 - 180	180+		Any child scoring above 8 should be considered for transfer to resus
	RR	<25	25 - 29	30 - 40	41 - 50	50+		
	Temp	<35°	35 - 35.9°	36 - 37.5°	37.6 - 39°	39°+		
1-2	Pulse	<90	90 - 99	100 - 150	151 - 170	170+		
	RR	<20	20 - 24	25 - 35	36 - 50	50+		
	Temp	<35°	35 - 35.9°	36 - 38.4°	38.5 - 40°	40°+		
2-5	Pulse	<80	80 - 94	95 - 140	141 - 160	160+		
	RR	<20	20 - 24	25 - 30	31 - 40	40+		
	Temp	<35°	35 - 35.9°	36 - 38.4°	38.5 - 40°	40°+		
5-12	Pulse	<70	70 - 79	80 - 120	121 - 150	150+		
	RR	<15	15 - 19	20 - 25	26 - 40	40+		
	Temp	<35°	35 - 35.9°	36 - 38.4°	38.5 - 40°	40°+		
13-16	Pulse	<50	50 - 60	60 - 100	100 - 110	110+		
	RR	<12	12 - 14	15 - 20	20 - 25	25+		
	Temp	<35°	35 - 35.9°	36 - 38.4°	38.5 - 40°	40°+		

***Significant PMH includes:**

- Ex-premature
- Syndromic conditions
- Cardiac problems
- Asthma
- Diabetes
- Long term steroids
- All other chronic conditions

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Developing a safer culture

Are scoring systems a tokenistic response to an ever present ‘safety first’ campaign or do they have value in changing cultures? Moving from an assumption that ‘scoring systems’ do no harm and therefore are an inevitable implementation process to a mindset that examines how scoring systems may operate in a particular clinical environment is an important first step. Given the acquisition of basic observations may be poor [26] the first step might be worth considering how do observations, both physiological and subjective, assist in a safety agenda to begin with.

Recently the ‘*normalcy*’ of normal observations has been challenged [27] so it is important the validity of the observation process is established and updated if necessary. Research has identified the need to pay special attention to heart rate, respiratory rate and temperature in the evaluation of infants (National Institute for Health and Care Excellence 2013). What is not certain is how these physiological variables interact [28]. More subjective criteria such as work of breathing and overall ‘gut feeling’ have yet to establish themselves

as clear independent risk factors [29,30,31]. There is little work on the outcome of children presenting to emergency or urgent care with normal observations. Certain high risk groups have been identified (such as the neonate or infant less than 3 months) but global criteria for safe discharge has yet to be established. Delivery of post consultation discharge advice on when to return or seek further medical help (i.e. providing a safety net) is an important tool used by healthcare professionals [32]. However, its delivery follows the decision to discharge so is not an integral part of the discharge decision making process itself. How safe would a score need to be to allow it to assist in the discharge making process? Obviously for recognition of serious illness or injury a certain degree of false negatives are necessary to ensure disease isn't missed. What is the acceptable risk in discharging patients? Does any such system need to be 100% accurate in this regard?

Beyond the individual

Once an individual patient has their Early Warning Score calculated, there are several potential knock-on effects:

- The clinician calculating the score learns to be more thorough, and omits fewer data fields
- The same clinician learns the normal physiological values in children
- In handover, staff can be objective about a child they are “worried about”: the handover of responsibilities and prioritisation of that child is now objective, not subjective, and changes in their condition are monitored objectively, whoever cares for that child

Secondly, in any ED there are likely to be many patients who are “a priority”. In most ED's there is usually a senior doctor and senior nurse with global responsibility for all the patients. Looking at the spread and numbers of patients by scores, helps manage the whole ED safely. This is rarely the focus of publications on EWS scores, but is very important in maintaining a safe ED. It is important though that analysis of this use of scoring systems is robust and

tested pragmatically. It is possible that a usage of scores in this way may have unintended consequences in relation to perceived human resource need.

Discussion

There has been a universal increase in presentations to emergency and urgent care setting in the developed world [33,34,35] with a generally static, or reduced, incidence of serious illness [36]. This combination of events has resulted in it becoming increasingly difficult to recognise those children at most need of intervention or observation and may explain the increasing trend of admissions to hospital [37].

In the ED, risk reduction in managing children is likely to need a paediatric-specific score and system, and probably one different from use in the ward, since it will be calculated quickly, less sequentially, and often by paediatric inexperienced staff. There needs to be recognition that urgent and emergency care represents a different cohort of patient than those on the ward. By their nature, all early-warning tools currently in existence represent a compromise between sensitivity and specificity and individual institutions should consider where the appropriate balance lies and select the most suitable tool accordingly. The tool then needs to be used appropriately and proactively. There is no point in simply recording a score in the medical records and taking no action.

Finally, routine usage of validated PEWS specific scores in the ED may have benefit beyond the individual patient. It teaches staff the normal physiological parameters, emphasises the importance of physiological measurements and acting on them if they are abnormal, provides a common parlance of objective evidence of “how sick”, helps justify discharge at that time, and by looking at the overview of all the patient scores in the department at the time may provide a tool to help staff maintain a better overview of the department to ensure that all patients are safe.

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