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# Severe illness getting noticed sooner: SIGNS-for-Kids—initial validity assessment of a paediatric illness recognition tool for caregivers

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## INTRODUCTION

Timely identification of severe illness provides opportunity to prevent clinical deterioration and reduce morbidity and mortality.[1–4] An expert panel consisting of parents and multidisciplinary providers created the Severe Illness Getting Noticed Sooner (SIGNS)-for-Kids as a public health tool to help caregivers identify and articulate the manifestations of severe illness in children.[5] The tool was created during a consensus development workshop to incorporate expert opinion and previously published symptom checklists of severe illness.[6 7] The SIGNS tool consists of 5 domains (behaviour, breathing, skin, fluids and response to usually effective treatment) and 13 subdomains. The objective of this study was to review the sensitivity of the SIGNS-for-Kids items in a cohort of children with fatal illnesses as an initial validation step.

## METHODS

A retrospective review of paediatric deaths was performed using records from the local coroner's office. Information available included summative coroner reports and comprehensive medical records. Eligible patients had an index deterioration event described between January 2013 and December 2018, were ≤18 years and ≥36 weeks gestational age at the time of event, had observations or reports for >6 hours prior to the index event and were not in an intensive care unit (ICU) or under anaesthetist supervision at the time of index event. Index deterioration events were defined as cardiac arrest, respiratory arrest, intubation, transfer to ICU, interfacility transfer or urgent surgical procedure. We excluded patients with trauma or sudden unexplained death. The main outcome was the presence of SIGNS items. Secondary measures were the time before index event that SIGNS was present and the time to death from the index event. Analyses were descriptive and were performed using SAS V.9.4 (SAS Institute).

## RESULTS

We screened 200 records and excluded 150 children with either traumatic death (n=77), less than 6 hours of documentation before the index event (n=61), ineligible age (n=7) or a diagnosis of sudden unexplained death (n=5). The 50 studied children had mean (SD) age of 32.0 (50.8) months. The index events were cardiac arrest in 25 (50%), endotracheal intubation in 12 (24%), interfacility transfer in 8 (16%) and respiratory arrest in 5 (10%). The diagnoses associated with the index event included respiratory in

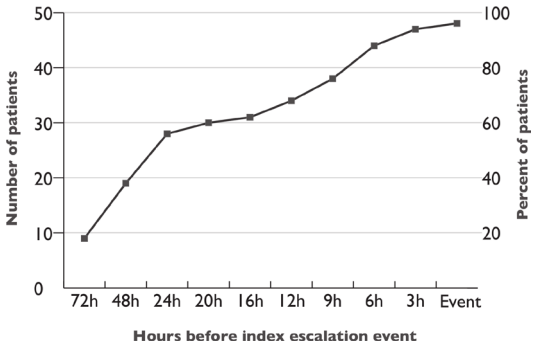


**Figure 1** Data were abstracted from Ontario Coroners records of 50 paediatric (>8 hours of age and <18 years) non-traumatic deaths with escalation events (intubation, transfer to ICU, CPR) that occurred outside an ICU or Anaesthetist supervised area; 48 (96%) had one or more SIGNS criteria documented in the available records. More than half of cases had SIGNS criteria documented for 24 hours before index escalation event and 42 (84%) died within 48 hours after escalation.

Table 1 Proportion of children with SIGNS items present prior to index event

| SIGNS category | SIGNS subcategory | Item N (%) | Category N (%) | Hours prior to index event median (IQR) |
|---|---|---|---|---|
| Behaviour | Reduced interaction | 7 (14) | 22 (44) | 24.0 (8.3–43.8) |
| | Reduced independent actions | 16 (32) | | |
| | Abnormal or lack of movement | 2 (4) | | |
| Breathing | Noticeable breathing | 20 (40) | 26 (52) | 36.0 (8.3–49.5) |
| | Long pauses between breaths | 6 (12) | | |
| Skin | Jaundice in the first month of life | 0 (0) | 10 (20) | 8.5 (6.3–18.0) |
| | Mottled and cold skin (and other) | 10 (20) | | |
| | Blue(ish) skin and tongue | 1 (2) | | |
| | Purple rash | 0 (0) | | |
| Fluids | Persistent vomiting | 7 (14) | 21 (42) | 24.0 (7.0–55.0) |
| | Colourful vomiting | 3 (6) | | |
| | Minimal fluid intake | 13 (26) | | |
| | Not passing urine | 3 (6) | | |
| Treatment | No treatment response | 1 (2) | 1 (2) | |
| Any | | 48 (96) | | 24.0 (9.0–48.5) |

SIGNS, Severe Illness Getting Noticed Sooner.

33 (66%), circulatory in 24 (48%), infectious in 18 (36%) and endocrine/metabolic in 8 (16%).

One or more SIGNS criteria were present prior to index event in 48 (96%) children. Items from two SIGNS categories were present in 14 (28%), of which the most common combinations were behaviour/breathing (n=5) and behaviour/fluids (n=5). Items from three SIGNS categories were present in 6 (12%), with the most common combinations being behaviour/skin/fluids (n=2) and behaviour/breathing/skin (n=2).

SIGNS was present ≥24 hours before initial escalation in 28 (56%) children, and death occurred within 48 hours after index event in 42 (84%) (figure 1). Proportions of children with each SIGNS item present and median duration prior to index deterioration are presented in table 1.

Breathing abnormality was observed in 26 (52%) with median duration of 36.0 (8.3–49.5) hours before index event. The most common breathing abnormality was 'noticeable breathing' in 20 (40%). Behaviour abnormality was observed in 22 (44%) with median duration of 24.0 (8.3–43.8) hours prior to event. The most common behaviour abnormality, reduced independent actions, occurred in 16 (32%). Fluid abnormality was present in 21 (42%) with median duration of 24.0 (7.0–55.0) hours prior to event. The most common fluid abnormality, minimal intake, occurred in 13 (26%). No children had jaundice in the first month of life or a purple rash. Death occurred within 48 hours after index event in 42 (84%).

## DISCUSSION

This retrospective evaluation suggests the potential utility of the SIGNS criteria to identify children with severe illness. Almost all children with fatal illness had one or more SIGNS, and SIGNS items were present long enough to permit timely intervention and care escalation. The four main limitations of this study are: its retrospective design, the selection of children with fatal illnesses who may have progressed to death even if intervention had occurred earlier, the exclusion of children with sudden unexplained death (where SIGNS should be absent), and parental recall and clinician ascertainment biases that may follow recognition of severe illness. Future prospective studies in children with and without critical illness are needed to further evaluate the validity and caregiver usability prior to clinical implementation.

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## REFERENCES

1 Parshuram CS, Dryden-Palmer K, Farrell C, *et al*. Effect of a pediatric early warning system on all-cause mortality in hospitalized pediatric patients: the epoch randomized clinical trial. *JAMA* 2018;319:1002–12.
2 Parshuram CS, Duncan HP, Joffe AR, *et al*. Multicentre validation of the bedside paediatric early warning system score: a severity of illness score to detect evolving critical illness in hospitalised children. *Crit Care* 2011;15:R184.
3 Kotsakis A, Lobos A-T, Parshuram C, *et al*. Implementation of a multicenter rapid response system in pediatric academic hospitals is effective. *Pediatrics* 2011;128:72–8.
4 Sharek PJ, Parast LM, Leong K, *et al*. Effect of a Rapid Response Team on Hospital-wide Mortality and Code Rates Outside the ICU in a Children's Hospital. *JAMA* 2007;298:2267–74.
5 Gilleland J, Bayfield D, Bayliss A, *et al*. Severe illness getting noticed sooner - SIGNS-for-Kids: developing an illness recognition tool to connect home and hospital. *BMJ Open Qual* 2019;8:e000763.
6 Hallisy J. *Empowered patient: ten warnings of a rapidly deteriorating patient*. Canadian Patient Safety Institute, 2011.
7 Gaskin KL, Wray J, Barron DJ. Acceptability of a parental early warning tool for parents of infants with complex congenital heart disease: a qualitative feasibility study. *Arch Dis Child* 2018;103:880–6.