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The Cardiac Children's Hospital Early Warning Score (C-CHEWS)[1,2]

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Inpatient pediatric cardiovascular patients have higher rates of cardiopulmonary arrests than other hospitalized children. Pediatric early warning scoring tools have helped to provide early identification and treatment to hospitalized children experiencing deterioration thus preventing arrests from occurring. However, the tools have rarely been used and have not been validated in the pediatric cardiac population. This paper describes the modification of a pediatric early warning scoring system for cardiovascular patients, the implementation of the tool, and its companion Escalation of Care Algorithm on an inpatient pediatric cardiovascular unit.

Background

Arrest Prevention

PEDIATRIC CARDIOPULMONARY ARRESTS have been reported in 0.7–2% of all pediatric inpatient admissions (Reis, Nadkarni, Perondi, Grisi, & Berg, 2002; Slonim, Patel, Ruttimann, & Pollack, 1997; Suominen, Olkkola, Voipio, Korpela, Palo, & Rasanen, 2000) and 5.5–14% of intensive care unit (ICU) admissions (Reis et al., 2002; Rhodes et al., 1999; Suominen et al., 2000) despite diligent monitoring (Akre, Finkelstein, Erickson, Liu, Vanderbilt, & Billman, 2010; Nadkarni et al., 2006; Reis et al., 2002; Suominen et al., 2000) and advances in medicine and technology. Survival to discharge outcomes are poor (11–37%) for children that experience an in-hospital cardiopulmonary arrest (Brilli et al., 2007; Lopez-Herce et al., 2004; Meaney et al., 2006; Nadkarni et al., 2006; Parra et al., 2000; Reis et al., 2002; Samson, Berg, & Berg, 2006; Samson, Nadkarni, et al., 2006; Slonim et al., 1997; Suominen et al., 2000; Tibballs & Kinney, 2009; Young & Seidel, 1999). Symptoms of deterioration may be present 6–12 hours prior to arrest events, had these symptoms been recognized and treated sooner, almost two-thirds of in-hospital pediatric cardiopulmonary arrests may have been prevented (Pearson, Ward-Platt, Harnden, & Kelly, 2010; Akre et al., 2010; Parshuram, Hutchinson, & Middaugh, 2009; Schein, Hazday, Pena, Ruben, & Sprung, 1990; Tibballs & Kinney, 2009; Tume, 2007). "Given the dismal survival rate of in-hospital cardiac arrest, it is critical to develop systems that recognize predictable clinical warning signs and intervene before patients reach the point of arrest" (VanVoorhis & Willis, 2009, p. 919).

To improve outcomes for patients at risk for clinical deterioration and cardiopulmonary arrest, hospitals have been charged by several international committees to implement systems that identify significantly abnormal values and then trigger an immediate treatment response (Berwick, Calkins, McCannon, & Hackbarth, 2005; DeVita et al., 2006; Peberdy et al., 2007). Hospitals initiated rapid response teams (RRTs), also known as patient at risk teams

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(PART), critical care outreach (CCO), or medical emergency teams (MET), as an adjunct to their code blue teams to provide this immediate treatment for patients that are identified as being at risk for deterioration and possible arrest (Brilli et al., 2007; Hanson et al., 2009; Hillman, Parr, Flabouris, Bishop, & Stewart, 2001; Hunt et al., 2008; Salamonson, Kariyawasam, van Heere, & O'Connor, 2001; Sharek et al., 2007; Tibballs & Kinney, 2009; Tibballs, Kinney, Duke, Oakley, & Hennessy, 2005; ul-Haque, Saleem, Zaidi, & Haider, 2010; VandenBerg, Hutchison, & Parshuram, 2007; VanVoorhis & Willis, 2009; Zenker et al., 2007). The RRTs are defined as an interdisciplinary group that "resemble Code teams in that they are staffed by health care professionals…Unlike a Code team, a RRT is summoned before a code occurs…to initiate changes in care that prevent the arrest, or by facilitating transfer to an intensive care unit" (Berwick et al., 2005, p. 324). Pediatric RRTs have been composed of PICU physicians, ICU RNs, respiratory therapists, ED physicians and/or a supervisor for patient placement (Brilli et al., 2007; Hanson et al., 2009; Sharek et al., 2007; Tibballs & Kinney, 2009; Tibballs et al., 2005; ul-Haque et al., 2010; VanVoorhis & Willis, 2009; VandenBerg et al., 2007; Zenker et al., 2007). Pediatric RRTs typically respond to the bedside within 5–15 minutes of activation to assess patients, write orders for any diagnostic studies or interventions, discuss management with the primary team, and determine optimal location for the patient (Brilli et al., 2007; Hanson et al., 2009; Sharek et al., 2007; Tibballs & Kinney, 2009; Tibballs et al., 2005; ul-Haque et al., 2010; Zenker et al., 2007). Studies have reported reduction in pediatric inpatient cardiopulmonary arrests, reduction in mortality rates, and improved survival outcomes post-arrest following the implementation of RRTs (Chan, Jain, Nallmothu, Berg, & Sasson, 2010; Chapman, Grocott, & Franck, 2010; Hunt et al., 2008; Tibballs & Kinney, 2009).

Activation criteria for when to call RRTs have been developed by hospitals based upon retrospective reviews and/or clinician consensus (Brilli et al., 2007). Activation criteria may be a combination of physiological parameters and/or subjective assessments. Early warning scoring tools are tools that may be used as activation triggers for hospitals' RRTs. There are three types of early warning tools: (1) single and multiple parameter systems which trigger a response when one or more parameters achieve a defined threshold; (2) aggregate systems which weigh observations based upon abnormality and a summary of the scores are achieved; and (3) combination systems which have single or multiple parameter systems with aggregate weighted scoring systems (Gao et al., 2007).

Pediatric Early Warning Scores

Pediatric early warning scores (PEWS) tools have been created based on previously developed adult early warning scoring tools. Pediatrics create a unique challenge in the development of early warning scoring tools in that vital sign norms are aged-based whereas in adults these norms are more finite (Brilli et al., 2007). The PEWS published by Monaghan (2005) (Figure 1) is an aggregate tool based on three assessment domains: behavior, cardiovascular and respiratory with each domains' score ranging from 0 to 3, with 3 being the highest severity of illness (Monaghan, 2005). Components of the PEWS' domains are based on bedside physical assessments and do not require familiarity with the patient or patient's history or clinical values (i.e. recent laboratory values), which contributes to the ease of bedside use compared to other pediatric early warning scoring tools which do require additional patient information (Duncan, 2006; Duncan, Hutchison, & Parshuram, 2006; Edwards, Powell, Mason, & Oliver, 2009; Haines, Perrott, & Weir, 2006; Tibballs, 2006). Nurses complete the assessment, total the score, and are guided to follow a four-tiered escalation of actions guide based upon the PEWS score (Monaghan, 2005; Tucker, Brewer, Baker, Demeritt,

Pediatric Early Warning Score (PEWS)

	0	1	2	3	Score
Behavior / Neuro	Playing / appropriate	Sleeping	Irritable	▪ Lethargic / confused **OR** ▪ reduced response to pain	
Cardiovascular	▪ Pink **OR** ▪ capillary refill 1-2 seconds	▪ Pale **OR** ▪ capillary refill 3 seconds	▪ Grey **OR** ▪ capillary refill 4 seconds **OR** ▪ heart rate > 20 above normal rate	▪ Grey **OR** ▪ Mottled **OR** ▪ capillary refill ≥ 5 seconds **OR** ▪ heart rate > 30 above normal rate **OR** ▪ bradycardia	
Respiratory	Within normal parameters, no retractions	▪ >10 above normal parameters, using accessory muscles **OR** ▪ 30 % FiO2 or ≥3 L/min	▪ > 20 above normal parameters ▪ Retractions **OR** ▪ 40 % FiO2 or ≥6+ L/min	▪ 5 < normal parameters with retractions ▪ Grunting **OR** ▪ 50 % FiO2 or ≥8 L/min	
					Total:

Figure 1 The Pediatric Early Warning Score (PEWS) tool (Monaghan, 2005).