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EDITORIAL

Incidence and Outcomes of In-Hospital Cardiac Arrests in Children Undergoing Cardiac Surgery: An Opportunity to Learn More from Success

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In this issue of *Heart, Lung and Circulation*, Dagan et al. report the trends in incidence and outcomes of in-hospital cardiac arrest (IHCA) in children undergoing cardiac surgery at a single specialist paediatric cardiac surgical centre [1]. The main findings of this retrospective observational study are the dramatic decrease in cardiac arrest rate, which was seen mainly in low to moderate risk category surgeries, and the decreased overall hospital mortality for children suffering IHCA between January 2007 and December 2016. The observed fall in mortality post-IHCA mirrors an overall fall in hospital mortality in cardiac surgery patients.

The authors speculate that a number of potential contributing factors may help to explain these impressive results. These include: the effect of incremental experience resulting in iterative improvements in surgical performance and perioperative management protocols; the potential impact of immunomodulating therapies on the post cardiopulmonary bypass inflammatory response; and, the earlier use of extracorporeal life support (ECLS) in unstable postoperative patients.

In reality, and as the authors themselves point out, none of these factors can be inferred from data presented in the study. The severity of the post cardio-pulmonary bypass inflammatory response, the frequency of low cardiac output state, the exact timing of cardiac arrest, first arrest rhythm, or time to ECLS for children in the cohort with IHCA are just a handful of potentially relevant data that remain unknown.

So, what are the important factors that relate to the improved hospital outcomes observed in these children? And what of the relative impact of potentially numerous changes in interacting systems of care implemented over the last decade, and acquisition and fine-tuning of individual and team skills, all intended to improve patient outcomes? What should we learn from this single site program that could transfer to other centres undertaking this risky work, in order to lift performance and positively impact the lives of similar children?

Care of children undergoing surgery for congenital heart disease is complex and risky, with numerous elements, interdependencies and interconnections. In-hospital cardiac arrest may be viewed as the tip of an iceberg of adverse patient outcomes and, as such, a reasonable barometer of a wider range of important patient outcomes. In the study by Dagan et al., this is borne out by the demonstrated relationship between mortality post IHCA and hospital mortality in cardiac surgery patients [1]. The authors have not attempted to describe the relationship between hospital mortality and patient complications or morbidity in this study; however, a recent evaluation of postoperative morbidity in a paediatric cardiac centre in the United Kingdom has described key events and important patient outcomes over and above short-term survival [2].

There is danger in extrapolating improvement in any hospital outcome to improved long-term mortality post hospital discharge, or, similarly, to other long-term

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outcomes valued as the most meaningful by patients and families themselves [3]. Data is emerging on new and long-term morbidity following paediatric cardiac surgery, with evidence of long-term increased risk of death, including in children that survive to hospital discharge following surgery on the lowest risk congenital heart lesions [4,5]. Neurodevelopmental disability is common in neonates surviving complex surgery for congenital heart disease and gaps in our knowledge remain on how this is impacted by key events including IHCA [6]. As the cohort of survivors of paediatric cardiac surgery grows, there is increased understanding of the importance of planning care to meet the needs of families and children as these needs manifest across a person's life span [7].

Dagan et al. note there has been no change over the last decade in IHCA rates in children undergoing high risk surgeries, with rates 13.6 times higher than children undergoing low risk surgeries and lower likelihood of survival to hospital discharge. As the authors point out, this is in keeping with reports from other centres [8,9]. The reason for this is postulated to be failure to effectively ‘‘rescue’’ in these high-risk cases. A more detailed understanding of the persistently high IHCA rates and, in particular, the high hospital mortality in this group is essential. Failure to rescue (FTR) rate, defined as number of deaths in those with a complication, has been utilised as a quality measure in adult cardiac surgery for more than two decades. Evaluation of FTR as a quality metric in paediatric cardiac surgery suggests that improved mortality in patients with complications is a valid marker of program quality [10].

In order to gain maximum value from this single site experience, however, the study by Dagan et al. would need to be reframed as a refreshing opportunity to learn from success. This would necessitate a determined and deliberate effort to move away from the ‘‘try again, fail again, fail better’’ paradigm that has characterised the last two decades of patient safety [11]. The factors nominated by the authors as potential contributors to the results observed are an example of ‘‘work-as-imagined’’ and, notwithstanding the plausibility that these factors may improve outcomes, they cannot be considered to have done so with any level of confidence. Given the retrospective nature of this study, it may not be possible to accurately determine the ‘‘work-as-done’’ elements of care actually undertaken by clinicians on the front line that result in children previously expected to suffer IHCA no longer doing so in the most recent past. Without this important and additional information, it is not possible to craft national or international consensus guidelines with any expectation of successful transfer of key elements of care to other institutions that undertake these surgeries.

The study by Dagan et al. is useful mainly in identifying a positive trend in a key event which is worthy of further study. Improved understanding of success in key moments or events remains a laudable and worthy aim. In keeping with the wider shift in safety culture from Safety-I, where adverse events such as IHCA are seen as aberrations in the system of care, to a Safety-II approach which moves the focus to understanding the complex work-arounds and bottom-up adaptiveness of systems that enables success against the odds [11], this study should be viewed as an opportunity to learn from success. Implicit in this shift in thinking is the understanding that we cannot fully appreciate a system and its performance by looking predominantly at harm. Future studies should start by utilising a Safety-II approaches to focus on aspects of work as actually accomplished that determine how things typically go right more than 97% of the time in children that survive IHCA following cardiac surgery. Dagan et al. have set us on the first step to understanding and achieving this.

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