

More than just training: rethinking the paediatric code cart design for better emergency care outcomes

¹Dr. Katherine Innis, ²Dr. Jillian Lewis, ¹Professor Russell B. Pierre, ³Dr. Simone Dundas Byles, ²Dr. Oluwayomi Olugbuyi

¹ Department of Child and Adolescent Health, University of the West Indies, Kingston, Jamaica

² Department of Child and Adolescent Health, University Hospital of the West Indies, Kingston, Jamaica

³ Department of Surgery, Radiology, Anaesthesia and Intensive Care, University of the West Indies, Kingston, Jamaica

Corresponding Author:

Dr. Katherine Innis

Email: katherine.innis@uwimona.edu.jm

DOAJ: [ef941e344fa54911aca2d4390ed7e560](https://doaj.org/ef941e344fa54911aca2d4390ed7e560)

DOI: <https://doi.org/10.48107/CMJ.2025.03.003>

Copyright: This is an open-access article under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/) which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.

©2025 The Authors. Caribbean Medical Journal published by Trinidad & Tobago Medical Association

ABSTRACT

The importance of a well-equipped and efficiently organised code cart cannot be overstated in the context of providing optimised emergency care for children. In addition to quality improvement initiatives addressing appropriate maintenance of code cart supplies, there is the global need to focus on efficient and intuitive paediatric code cart design to manage this unique population separately from adults.

A Critical Gap in Paediatric Emergency Care

The code cart, also known as a crash cart, resuscitation cart, or emergency trolley, is a mobile storage device equipped with medications and equipment essential to manage patients with life-threatening conditions ¹. The efficiency of these carts, especially in critical and timely interventions, significantly influences patient outcomes. Literature is limited regarding the maintenance and optimisation of resuscitation equipment in a paediatric setting.

Challenges in Paediatric Code Cart Readiness

Issues with paediatric code carts often include the unavailability of essential equipment and medications, alongside disorganisation and mismanagement of supplies, which may lead to critical delays in the resuscitation response. A 2001 survey across emergency departments in Canada highlighted that 15.9% of centres lacked intraosseous needles and 3.5% did not have infant bag valve mask devices or infant laryngoscope blades ². In South Africa, a 2020 cross-sectional audit found that the paediatric emergency units had only 43% of the necessary resuscitation equipment available, with 42% of the equipment being deemed functional ³. Research in Rwanda reported a 50% availability of infant bag-valve mask devices but a complete absence of intraosseous needles across district hospitals ⁴. A review in Buenos Aires showed that only 43.9% of emergency drugs in the inpatient wards at a children's hospital were adequate (that is, not expired, insufficient or absent) ⁵.

Quality Improvement Efforts to Address Cart Readiness

Many healthcare institutions have launched quality improvement initiatives aimed at enhancing the readiness of paediatric code or resuscitation carts. Adopting systematic checks and organising storage within the carts have been promoted to mitigate issues related to expired or improperly stocked medications ¹. At a tertiary children's hospital in Buenos Aires, the implementation of an educational program to improve staff competency in managing resuscitation cart supplies led to an increase in drug availability from 43.9% to 70.3% ($p < 0.001$)⁵. While these organizational measures are a step in the right direction, one must consider the unique challenges of paediatric resuscitation.

Paediatric Code Cart Design

Traditionally, paediatric code carts, similarly to adult resuscitation carts, have been organized according to anticipated emergency interventions (e.g., medication drawer, intravenous drawer) ⁶. However, this design

presents a number of problems for the paediatric population, including multiple drawers being opened during a resuscitation event and the chaotic arrangement of equipment for children of different sizes, ranging from newborns to adolescents ⁶. The paediatric population presents unique challenges in emergency care that are not mere extensions of adult medical practices. Paediatric code carts require specific organizational strategies to accommodate the diverse needs of different age groups and sizes, from infants to adolescents. Moreover, the complexity and high-stress nature of paediatric emergencies necessitate a design that reduces cognitive load and enhances efficiency ⁷. Recognizing the need for a strategy separate from adult practice, many healthcare groups have sought more efficient systems or innovative layouts of the paediatric code cart. During paediatric emergencies, the Broselow Pediatric Emergency Tape is used to estimate a child's weight based on body length. The measured length corresponds with a colour-coded zone, which provides guidance on weight-based medication dosing, resuscitation equipment sizes, and other critical interventions. The Broselow Pediatric Emergency Tape-based design tested at Lucile Packard Children's Hospital enabled quicker and more accurate retrieval of equipment, demonstrating the benefits of using colour-coded drawers for different patient sizes.⁶ Despite minimal prior experience with the Broselow cart, health care personnel provided the correct items significantly more often with this design compared to the standard code cart (99% vs. 83%, $p < 0.001$) ⁶. At a 62-bed non-freestanding children's hospital in Kentucky, Maul et al created a new standardised paediatric code cart design using the Lean 5S system (Sort, Set, Shine, Standardize, Sustain), and subsequently demonstrated a 46% reduction in time to access necessary equipment when compared with the old version of the carts ⁸. To optimise the code cart's intuitiveness, a multidisciplinary team at Cincinnati Children's Hospital employed the Lean Management and Human Factors principles to redesign their carts, which not only demonstrated significantly decreased time and errors in obtaining the correct items, but also decreased operational costs by over US \$800 per full cart restock ⁹. Lean Management focuses on efficiency, including organisation and establishing flow, such as grouping items for a specific task in one location. Human Factors focuses on the human performance and their interaction with the environment, including how persons locate items alongside mitigating errors e.g., laying medications flat to increase visibility ⁹.

Continuing Challenges and Future Directions

The design and functionality of paediatric code carts continue to be an area needing further research, particularly to separate and refine the standards to distinguish from adult resuscitation practices. Each year, the United States of America records approximately 15,200 paediatric in-hospital resuscitation events, mostly due to respiratory failure or shock^{10,11}, with presumably higher rates in lower- and middle-income countries. Optimising the design of paediatric code carts is crucial for improving clinical outcomes by ensuring quick and reliable access to necessary tools and medications during emergencies for children of all sizes. The current state of paediatric code cart readiness is not just a reflection of medical practice, but a benchmark for our commitment to the youngest and most vulnerable.

Acknowledgements: Not applicable.

Ethical approval statement: Not applicable.

Financial disclosure or funding: None

Conflict of interest: None

Informed consent: Not applicable.

Author contributions: Every author has made a significant contribution to design of the final manuscript. K. Innis, the first author, conceptualized and drafted the manuscript. J Lewis, RB Pierre, S Dundas Byles and O Olugbuyi revised the manuscript.

REFERENCES

1. Aljuaid J, Al-Moteri M. Periodic Resuscitation Cart Checks and Nurse Situational Awareness: An Observational Study. *J Emerg Nurs.* 2022;48(2):189-201. doi:10.1016/j.jen.2021.12.002
2. McGillivray D, Nijssen-Jordan C, Kramer MS, Yang H, Platt R. Critical pediatric equipment availability in Canadian hospital emergency departments. *Ann Emerg Med.* 2001;37(4):371-376. doi:10.1067/mem.2001.112253
3. Lai King L, Cheema B, van Hoving DJ. A cross sectional study of the availability of paediatric emergency equipment in South African emergency units. *Afr J Emerg Med.* 2020;10(4):197-202. doi:10.1016/j.afjem.2020.06.008
4. Hategeka C, Shoveller J, Tuyisenge L, Kenyon C, Cechetto DF, Lynd LD. Pediatric emergency care capacity in a low-resource setting: An assessment of district hospitals in Rwanda. *PLoS One.* 2017;12(3):e0173233. doi:10.1371/journal.pone.0173233
5. Fernández Achával MI, Mammi LF, Fortini Cabarcos N, et al. Assessment of emergency trolley drugs in a children's hospital. Before and after study on an educational intervention. *Arch Argent Pediatr.* 2020;118(4):234-239. doi:10.5546/aap.2020.eng.234
6. Agarwal S, Swanson S, Murphy A, Yaeger K, Sharek P, Halamek LP. Comparing the utility of a standard pediatric resuscitation cart with a pediatric resuscitation cart based on the Broselow tape: a randomized, controlled, crossover trial involving simulated resuscitation scenarios. *Pediatrics.* 2005;116(3):e326-33. doi:10.1542/peds.2005-0320
7. Luten R, Wears RL, Broselow J, Croskerry P, Joseph MM, Frush K. Managing the unique size-related issues of pediatric resuscitation: reducing cognitive load with resuscitation aids. *Acad Emerg Med.* 2002;9(8):840-847. doi:10.1111/j.1553-2712.2002.tb02175.x
8. Maul E, Latham B, Westgate PM. Saving Time Under Pressure: Effectiveness of Standardizing Pediatric Resuscitation Carts. *Hosp Pediatr.* 2016;6(2):67-71. doi:10.1542/hpeds.2015-0161
9. Frazier M, Webster K, Dewan M, et al. Improving Usability of the Pediatric Code Cart by Combining Lean and Human Factors Principles. *Pediatr Qual Saf.* 2023;8(4):e676. doi:10.1097/pq9.0000000000000676
10. Morgan RW, Kirschen MP, Kilbaugh TJ, Sutton RM, Topjian AA. Pediatric In-Hospital Cardiac Arrest and Cardiopulmonary Resuscitation in the United States: A Review. *JAMA Pediatr.* 2021;175(3):293-302. doi:10.1001/jamapediatrics.2020.5039
11. Holmberg MJ, Ross CE, Fitzmaurice GM, et al. Annual Incidence of Adult and Pediatric In-Hospital Cardiac Arrest in the United States. *Circ Cardiovasc Qual Outcomes.* 2019;12(7):e005580.