

# Standardization of Resuscitation Carts and Medication Trays in a Level III Neonatal Intensive Care Unit: A Quality Improvement Initiative

Charles-Olivier Chiasson, Marie-Anne Pépin, Audrey Larone Juneau, and Ahmed Moussa

**To cite:** Chiasson CO, Pépin MA, Juneau AL, Moussa A. Standardization of resuscitation carts and medication trays in a level III neonatal intensive care unit: a quality improvement initiative. *Can J Hosp Pharm*. Forthcoming 2024. doi: 10.4212/cjhp.3463

## INTRODUCTION

The CHU Sainte-Justine is a level III university-affiliated mother-child hospital located in Montréal, Québec. Approximately 900 babies are admitted to its 65-bed neonatal intensive care unit (NICU) every year. In 2016, a hospital-wide modernization transformed the NICU into a ward of single-patient rooms, which brought new challenges in the organization of neonatal resuscitation. In addition to the increase in surface area complicating access to the resuscitation carts, the organization and contents of the carts were inconsistent at the time, and the medications available were limited to agents needed for intubation. The multidisciplinary Neonatal Resuscitation Committee undertook the task of developing and implementing standardized resuscitation carts, with the goal of allowing complete resuscitation and initial stabilization of patients.

Emergency resuscitations are stressful, and effective and rapid responses are required in these situations. Dangerous medication errors can occur in up to half of the cases involving medication administration in emergency situations.<sup>1</sup> The standardization and systematic organization of resuscitation carts could facilitate the process of resuscitation and might even decrease medication errors, potentially improving patient safety. Literature reporting the benefits of using a standardized cart, in terms of the acquisition time for supplies and ease of use, is scarce.<sup>2-5</sup> The current report describes the implementation of new standardized carts and medication trays in a NICU, the impact of these changes on clinical care, and staff perceptions of this quality improvement initiative.

## DESCRIPTION OF THE PRACTICE

A nationwide survey was sent to the other 12 Canadian university-affiliated NICUs to obtain information about their neonatal resuscitation carts, with 5 providing a response. In addition, local experts were questioned for their

opinions about current practices and their view of the ideal cart. This input pointed to the need for a large, well-equipped resuscitation cart in terms of contents (medications, equipment, and cognitive aids), given the complexity of newborn care and the increasing size of the NICU. The pharmacist on the Neonatal Resuscitation Committee then designed a standardized resuscitation cart, medication tray, and resuscitation binder, for resuscitation and initial stabilization of patients, specifically adapted for our centre and including nationally established practices, as per the survey responses. The standardized resuscitation carts were implemented in May 2017. For a detailed list of the equipment available in each cart and photographs of the drawers, see Supplement, parts A and B (available from <https://www.cjhp-online.ca/index.php/cjhp/article/view/3463/>).

The resuscitation binder contains all essential information for neonatal resuscitation, organized in 5 sections (Table 1). The medication tables are organized by patient weight, with the specific weight options chosen to minimize the number of tables in the binder, to limit dose variation to a maximum of 10%, and to take into consideration the weights of older patients. For some drugs, selected additional information is included regarding dilution or specific indications. Each dosing table (created in Microsoft Excel) is displayed on 2 pages with large font, to allow the content to be easily viewed by multiple people at the same time.

As with any organizational change, training and plans for a transitional period were required. Therefore, starting 2 months before the intervention, a training program and information dissemination by pharmacists facilitated staff members' acceptance of the changes and minimized potential errors during the transition period. A mock cart was available for consultation, and an online (virtual) training program was developed to help nursing staff become acquainted with the location of each medication within the tray. In addition, in situ simulations are presented every 2 weeks, with the participation of small multidisciplinary

groups on a rotating basis, to maintain optimal response during acute critical events.

## EVALUATION OF THE PRACTICE

After implementation, an online survey was distributed to NICU staff ( $n = 289$ ) involved in neonatal resuscitation (for the survey questions, see Supplement, part C, available from <https://www.cjhp-online.ca/index.php/cjhp/article/view/3463/>). In addition, incident/accident reports were collected from the hospital's database. Reports from 2014 to 2016 were compared with those from 2018 to 2020; reports from 2017 were excluded because that was the transition period. Survey responses and incident/accident reports were analyzed using descriptive methods based on frequencies. Data from open-ended questions were analyzed by 2 researchers (M-A.P. and C-O.C.), who used content analysis to identify the predominant themes. A third person (A.M.) was consulted in cases of disagreement.

Staff training was completed 1 month before implementation of the new carts. The transition period went smoothly, thanks to rigorous orchestration of the change and thorough staff training. A period of adaptation was observed, but it lasted only a few weeks, as personnel quickly became comfortable with the changes. Most issues were of

a nonclinical nature, for example, assigning responsibility for returning medication trays to the pharmacy. However, a certain reluctance to open the sealed medication tray was perceived at first. These issues were quickly resolved.

The survey was distributed to all NICU staff in July 2020 (slightly more than 3 years since transition to the new carts); 29 responded, for a 10% response rate (Table 2). Of these respondents, 23 had been familiar with the pre-intervention resuscitation carts and could offer comparisons with the new carts. Overall, 83% and 76% of respondents stated that they were somewhat or very satisfied with the carts' organization and contents, respectively. However, a tendency toward a neutral response was observed in relation to the organization and contents of the medication trays. Satisfaction with the resuscitation binder was also high, with 76% of respondents being somewhat or very satisfied with its various characteristics. Most respondents agreed that the transition itself was simple, and the new cart design reduced stress during resuscitations. No participants stated that they were dissatisfied or completely disagreed with any of the statements. Overall, at least 70% of respondents somewhat or completely agreed that the updated cart and binder improved clinical parameters, by increasing the speed of equipment acquisition, enhancing global patient care, and reducing the risk of error. The improvement in speed of medication acquisition stood out,

**TABLE 1. Description of Sections in Resuscitation Binder**

Section No. and Title	Description of Contents				
1: Endotracheal intubation	Reference table for endotracheal tube size Documentation sheet for the intubation procedure Cardiac instability sheet				
2: Medication dosing tables, organized by patient weight	400 g	500 g	600 g	700 g	800 g
	900 g	1000 g	1200 g	1400 g	1600 g
	1800 g	2000 g	2250 g	2500 g	2750 g
	3000 g	3500 g	4000 g	4500 g	5000 g
	5500 g	6000 g	6500 g	7000 g	7500 g
	8000 g	8500 g	9000 g	9500 g	
3: Preprinted order sheets	Amiodarone IV		Management of acute hyperkalemia		
	Sodium bicarbonate IV drip		Magnesium sulfate IV bolus		
	Calcium gluconate IV		Midazolam IV drip		
	Dobutamine IV drip		Milrinone IV drip		
	Dopamine IV drip		Norepinephrine IV drip		
	Epinephrine IV drip				
4: Additional medication information	The following relevant information for each drug can be found: administration particularities, indication, onset of action, mechanism of action, drug interactions, contraindications and precautions, side effects, antidote, compatibilities, useful references				
5: Resuscitation algorithms from the Pediatric Advanced Life Support Program (PALS)	PALS vital signs in children Pediatric cardiac arrest algorithm Pediatric bradycardia with a pulse and poor perfusion algorithm Pediatric tachycardia with a pulse and poor perfusion algorithm				

**TABLE 2. Responses on a Survey of Neonatal Intensive Care Unit (NICU) Staff Members after Implementation of Standardized Resuscitation Carts**

<i>Survey Section and Options</i>		<i>Survey Responses</i>				
<b>Respondent Characteristics</b>		<b>No. of Respondents (n = 29)</b>				
Profession						
Nurse		15				
Respiratory therapist		8				
Neonatologist		3				
Charge nurse		2				
Neonatal nurse practitioner		1				
NICU experience						
< 2 years		0				
2–3 years		3				
4–10 years		9				
> 10 years		17				
		<b>Response; No. (%) of Respondents</b>				
<b>Likert-Scale Questions</b>		<b>Dissatisfied or completely disagree</b>	<b>Somewhat unsatisfied or disagree</b>	<b>Neutral</b>	<b>Somewhat satisfied or agree</b>	<b>Completely satisfied or agree</b>
Satisfaction: resuscitation cart (n = 29)						
Organization		0 (0)	0 (0)	5 (17)	20 (69)	4 (14)
Contents		0 (0)	3 (10)	4 (14)	15 (52)	7 (24)
Satisfaction: medication tray (n = 29)						
Organization		0 (0)	1 (3)	11 (38)	9 (31)	8 (28)
Contents		0 (0)	0 (0)	10 (34)	10 (34)	9 (31)
Satisfaction: resuscitation binder (n = 29)						
Ease of use		0 (0)	1 (3)	6 (21)	13 (45)	9 (31)
Clarity of information		0 (0)	0 (0)	7 (24)	12 (41)	10 (34)
Contents		0 (0)	1 (3)	6 (21)	13 (45)	9 (31)
Agreement: resuscitation cart (n = 23)						
Increased speed of equipment acquisition		0 (0)	2 (9)	5 (22)	12 (52)	4 (17)
Increased speed of medication acquisition		0 (0)	0 (0)	3 (13)	12 (52)	8 (35)
Improved global patient care		0 (0)	1 (4)	4 (17)	12 (52)	6 (26)
Decreased the risk of errors		0 (0)	1 (4)	6 (26)	10 (43)	6 (26)
Agreement: resuscitation binder (n = 23)						
Increased speed of medication preparation		0 (0)	0 (0)	3 (13)	8 (35)	12 (52)
Improved global patient care		0 (0)	0 (0)	3 (13)	12 (52)	8 (35)
Decreased the risk of errors		0 (0)	1 (4)	2 (9)	13 (57)	7 (30)
Training received during implementation period was adequate (n = 23)						
Transition period was easy (n = 23)		0 (0)	1 (4)	11 (48)	11 (48)	0 (0)
These changes have decreased level of stress during resuscitations (n = 23)		0 (0)	2 (9)	6 (26)	14 (61)	1 (4)
<b>Short-Answer Questions</b>		<b>Respondent Comments</b>				
Elements most appreciated		All resuscitation carts are uniform Ease of access Equipment separators used (plastic boxes, kits for rapid sequence intubation, etc.) Sufficient equipment Contents of the medication trays Resuscitation binder with medication doses according to weight				
Elements to improve		Drawer organization, need to access multiple drawers at once Adding more separators in drawers as some equipment gets mixed Excess equipment in cart, some drawers are unused Clearer item identification				

with 87% of participants either somewhat or completely agreeing with that statement. More than 75% of participants agreed or strongly agreed that the newly implemented resuscitation carts helped improve global patient care.

Eight incident/accident reports involving neonatal resuscitation carts were identified from the period 2014–2016. All of these reports mentioned issues related to equipment missing from the carts. Only 3 reports were filed during the period 2018–2020; the reports mentioned missing equipment ( $n = 1$ ), presence of an unlocked cart in the delivery room ( $n = 1$ ), and non-replacement of an expired medication tray in the NICU ( $n = 1$ ). The annual number of admissions was similar between the 2 evaluation periods.

Written feedback from respondents is presented in Table 2. Ultimately, on a scale from 1 to 100, the average global satisfaction was 85 for this quality improvement intervention.

## IMPLICATIONS AND SIGNIFICANCE FOR PRACTICE

This quality improvement initiative involved updating and standardizing NICU resuscitation carts, which included optimizing equipment availability, creating a new medication tray, and redesigning the resuscitation binder.

The NICU staff appreciated the standardization of the new resuscitation carts and perceived a clinical impact on the quality of resuscitation and patient care. These results, combined with the decrease in incident/accident reports due to missing equipment, are particularly encouraging, demonstrating possible benefits for patient care. Although they do not represent objective measures, our survey results are in line with previously published data showing a decrease in drug acquisition time with use of a standardized resuscitation cart.<sup>2-5</sup>

The NICU staff agreed that the training was appropriate. In addition, continuing education, in the form of in situ simulations, aims to ensure that neonatal resuscitation competencies are maintained. The introduction of standardized carts has been shown to reduce equipment acquisition time, but the effect fades after 1 year, which highlights the importance of continuous training.<sup>3</sup>

The positive effect of the redesigned resuscitation binder on clinical parameters was underlined by the NICU staff who responded to the survey. Given that pharmacists' involvement in resuscitation is a main factor in reducing drug errors,<sup>1</sup> and given that their presence is possible only on weekdays in our NICU, the binder allows for some of the pharmacists' expertise to remain available for consultation even when they are not present in the ward. In addition, after several other centres made requests to access the redesigned binder, it was published as a practical handbook for medication dosing in the NICU,<sup>6</sup> which demonstrates the potential generalizability of this tool.

The survey feedback suggested the need for further re-evaluation to optimize resuscitation in our centre. In particular, the initial objective of preventing missing equipment may have led to overstocking the cart. Current analysis of equipment quantities will help in modifying cart contents without compromising patient safety. We have also improved the organization of cart drawers by adding separators and improving item identification.

The activities described here had some limitations. The intervention was performed in a single centre, where clinical practice may differ from practice in other centres. The survey of NICU staff asked about events and practices from 3 years before implementation of the redesigned carts, which may have introduced recall bias; the survey also had a low response rate relative to other surveys in the literature. In addition, underreporting of incidents/accidents during neonatal resuscitation most likely accounted for the limited data available; however, this situation would have been similar before the intervention.<sup>7</sup> Finally, even though the pre- and post-intervention periods occurred in the same hospital, the settings were quite different following the hospital expansion. More specifically, whereas the pre-intervention period took place within a NICU ward with multiple-bed rooms and proximity to equipment, the post-intervention period occurred in a much larger unit with single-bed rooms. This difference would probably bias the results toward the null effect.

## CONCLUSION

Through careful planning, this quality improvement initiative demonstrated clear progress toward resolving the issue of missing equipment and supported the pursuit of excellence in patient care. Furthermore, this report supports the pivotal role of the pharmacist and the importance of continued quality improvement in neonatal resuscitation to optimize patient care. The need for more descriptive analyses, such as this one, as well as practice guidelines and possibly controlled studies to evaluate the clinical impact of such interventions, could help further improve resuscitation practices and achieve a better standard of care on a more global level.

## References

1. Flannery AH, Parli SE. Medication errors in cardiopulmonary arrest and code-related situations. *Am J Crit Care*. 2016;25(1):12-20.
2. Walker ST, Brett SJ, McKay A, Aggarwal R, Vincent C. The "Resus:Station": the use of clinical simulations in a randomised crossover study to evaluate a novel resuscitation trolley. *Resuscitation*. 2012;83(11):1374-80.
3. Maul E, Latham B, Westgate PM. Saving time under pressure: effectiveness of standardizing pediatric resuscitation carts. *Hosp Pediatr*. 2016; 6(2):67-71.
4. Chitkara R, Rajani AK, Lee HC, Snyder Hansen SF, Halamek LP. Comparing the utility of a novel neonatal resuscitation cart with a generic code cart using simulation: a randomised, controlled, crossover trial. *BMJ Qual Saf*. 2013;22:124-9.

5. Chan J, Chan B, Ho HL, Chan KM, Kan PG, Lam HS. The neonatal resuscitation algorithm organized cart is more efficient than the airway-breathing-circulation organized drawer: a crossover randomized control trial. *Eur J Emerg Med.* 2016;23(4):258-62.
6. Chiasson CO, Lalonde M, Larone Juneau A, Moussa A. *Médicaments d'urgence en néonatalogie: doses précalculées selon le poids.* Éditions du CHU Sainte-Justine; 2020.
7. Wilmer A, Louie K, Dodek P, Wong H, Ayas N. Incidence of medication errors and adverse drug events in the ICU: a systematic review. *Qual Saf Health Care.* 2010;19(5):e7.

**Charles-Olivier Chiasson**, PharmD, MSc, is with the Department of Pharmacy, CHU Sainte-Justine and Université de Montréal, Montréal, Québec.

**Marie-Anne Pépin**, PharmD, MSc, is with the Department of Pharmacy, CHU Sainte-Justine and Université de Montréal, Montréal, Québec.

**Audrey Larone Juneau**, RN, MSc, is with the Division of Neonatology, CHU Sainte-Justine and Université de Montréal, Montréal, Québec.

**Ahmed Moussa**, MD, MMed, is with the Division of Neonatology, Department of Pediatrics, CHU Sainte-Justine and Université de Montréal, and the CHU Sainte-Justine Research Centre, Montréal, Québec.

**Competing interests:** None declared.

**Address correspondence to:**

Dr Ahmed Moussa  
Department of Pediatrics  
CHU Sainte-Justine  
3175, chemin de la Côte-Sainte-Catherine  
Montréal QC H3T 1C5

**email:** ahmed.moussa@umontreal.ca

**Funding:** None received.

**Submitted:** February 15, 2023

**Accepted:** May 11, 2023

**Published:** October 11, 2023