



Educational strategies for deployment of resuscitative endovascular balloon occlusion of the aorta in a tertiary Canadian emergency department

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Abstract

Resuscitative endovascular balloon occlusion of the aorta (REBOA) is not a novel intervention in the trauma literature. However, the incorporation of this intervention into the Canadian emergency department setting is recent in onset. This healthcare setting is dynamic and the nurses who practise in the emergency setting must be efficient care providers for an infinitely diverse set of potential patient presentations. The introduction of this complex procedure was accompanied by a variety of educational strategies to enhance the uptake of this new knowledge. The usage of small groups, didactic teaching, hands-on practice, establishing unit champions, coordinating in-situ simulations, and creating workflow documents were strategies used by the education team at this academic center for this particular knowledge dissemination exercise.

Key words: REBOA, hemorrhage, education, emergency, nurse

The introduction of new procedures, equipment, policies and practice changes are a regular occurrence for a registered nurse (RN) who works in an emergency department. Efforts of educators in this environment to incorporate novel initiatives must be flexible and reflective of the learning needs and styles of the team. Resuscitative endovascular balloon occlusion of the aorta (REBOA) is a complex intervention that has been introduced across several Canadian trauma centres. The purpose of this article is to provide a brief overview of REBOA from an emergency nursing perspective, highlighting knowledge translation strategies, both routine and creative, which were employed at one centre to educate emergency nurses on this topic and the attempts to mitigate subsequent knowledge attrition.

Background

What is REBOA?

Despite advances in practice protocols and early recognition strategies, uncontrolled hemorrhage and hemorrhagic shock

continue to be the leading causes of potentially preventable death after a traumatic injury (Moore et al., 2015). Hemorrhagic shock is a condition produced by a rapid and significant loss of intravascular volume, which leads to hemodynamic instability and decreases in oxygen delivery, which then impacts tissue perfusion causing cellular hypoxia, organ damage, and potentially death (Moore et al., 2015). In the trauma patient scenario, noncompressible torso hemorrhage (NCTH) is one potential cause of this significant intravascular blood loss (Sambor, 2018). NCTH is the vascular disruption of the vascular activity of the axial torso vessels, solid organs, the pulmonary parenchyma and/or the bony pelvis (Adamski, 2016). NCTH is not treatable with local hemostatic interventions such as pressure dressings or tourniquets due to anatomical location of the source of bleeding and the definitive treatment for it is surgical (Qasim et al., 2015).

REBOA is an intervention that can potentially be used for hemorrhage control for these patients in the interim between injury and definitive treatment (Adamski, 2016). REBOA involves placing a catheter designed with a compliant balloon into the aorta via the common femoral artery and inflating this balloon until the aorta is occluded allowing for temporary hemorrhage control, and maintenance of cerebral and coronary perfusion (Sambor, 2018).

Historical review

Despite only recently being introduced into trauma centres in Canada, REBOA is not a novel concept. It has been documented as an intervention since the 1950s where a field military physician used this approach on soldiers who were injured in the Korean War (Glaser & Brenner, 2017; Qasim et al., 2015). Over the next few decades, literature on REBOA was limited to select case studies and animal trials (Qasim et al., 2015). Since the turn of the century, medical professionals in Japan and the United Kingdom began utilizing this intervention with higher frequency and began generating an increased repository of data and subsequent scientific literature (Glaser & Brenner, 2017).

Current literature

Within the past decade, increasing research and effort has been put into optimizing the design of available catheters to ensure

an increased ease of use for practitioners and patient safety (Ordoñez et al., 2017). There has been an increasing number of case studies and other emerging literature from the United States in this timeframe, as well (Glaser & Brenner, 2017). Literature is focused on the impact on mortality and morbidity rates associated with the usage of the intervention and may or may not also include comparison data on the use of a different and far more invasive method for hemorrhage control; the thoracotomy (Glaser & Brenner, 2017; Qasim et al., 2015).

As the literature develops, there is an increased focus on favourable patient outcomes from the use of this hemorrhage control strategy, as patients who undergo REBOA experience slightly higher overall survival rates than those who underwent a thoracotomy or were not treated with some measure of hemorrhage control (Glaser & Brenner, 2017; Ordoñez et al., 2017). Authors who write on REBOA indicate that as familiarity and exposure to this intervention develops among trauma teams, there may be an increase in these optimal patient outcomes (Glaser & Brenner, 2017; Sambor 2018).

This intervention was featured in Canadian mainstream media in 2018 following the addition of the ER-REBOA™ catheter to Health Canada's (2017) approved registered medical devices list in 2017 (Global News, 2018; St. Michael's Hospital, 2018). There was also an article that made national news from Montreal in the form of a REBOA success story. A patient was interviewed while recovering from traumatic injuries where REBOA had been used to successfully control hemorrhage while in the emergency department until the patient transferred to the operating room (Canadian Broadcasting Corporation, 2018). Following the lead of other Canadian centres, the Ottawa Hospital also considered the potential implementation of this intervention.

REBOA initiative at The Ottawa Hospital

Setting

The Ottawa Hospital (TOH) is a tertiary level academic health-care centre serving the population of eastern Ontario. The facility is made up of three sub-sites, which provide a range of services including sub-acute, chronic, and acute care. The site where this initiative was rolled out is the designated site for the following subspecialties: trauma, neurosciences, cardiovascular and vascular services. This site receives patients who require these specialized services from throughout the region. In the annual report released by the Ottawa Regional Trauma Program for 2017-2018, it was noted that 856 patients were admitted to TOH for trauma care (Ottawa Regional Trauma Program, 2018). The leading mechanisms of injuries were motor vehicle collisions and falls, which comprised 40.7% and 40.2% of these visits respectively, while penetrating trauma accounted for an additional 10% of these trauma-related visits (Ottawa Regional Trauma Program, 2018).

Process initiate REBOA as a patient care intervention

This intervention was initially proposed for usage at TOH by members of the trauma program, which includes both RNs and MDs. This proposal followed both the approval of usage of the ER-REBOA™ catheter by Health Canada and the release of a joint statement from trauma and emergency medicine leaders in the United States on the suggested clinical use of REBOA (Brenner et al., 2018). Of data reviewed by members of the

trauma program from the 2015-2016 trauma registry, 12 patients were identified that would have been potential candidates for the procedure (Ottawa Regional Trauma Program, 2016). These numbers were presented as part of the initial discussion with the corporate operations committee for the hospital to determine impact on overall operations. After the product was approved for use at TOH by senior leadership teams, including the product evaluation committee and corporate operations committee, the implementation planning phase was brought back to key stakeholders. These primary stakeholders included: emergency nurses and educators, trauma physicians, emergency physicians, and emergency administration. Input was also sought from clinical representatives from the operating room, vascular, anaesthesia, interventional radiology and the intensive care unit.

Work was completed by members of the trauma program, emergency administration and emergency educators to complete a TOH specific Standard Operating Procedures to delineate the appropriate use of this tool (Appendix A). Part of the procedure notes that the only physicians at TOH who can currently use this equipment in patient care are trauma team leaders who have undertaken private specialty training in its use. Supply and procurement are currently monitored by the trauma coordinator.

Educational dissemination strategies

While the physicians were trained offsite in a private two-day program, there also needed to be a comprehensive plan to complete an educational roll-out with members of the emergency nursing team at this site who practise in the resuscitation area or critical care section of the department. At the time of roll-out, there were approximately 125 RNs in the department with 85 of them fully trained to practise in the resuscitation area. However, to support universal professional development, no nurses were excluded from the training plan. This was a complex roll-out, as this is an intervention that demands expertise despite the limited exposure to both the procedure and, thus, the components used. Educational strategies were planned and implemented by an education team comprised of emergency nurse educators, emergency nurses and the trauma coordinator for the trauma program. A combination of activities was planned to try to increase visual and tactile exposure to this complex intervention (Trauma System News, 2018). Based on previous feedback from nurses in this department, it was important that both formal and informal teaching methodologies were incorporated into this education plan. It was also important to consider different learning styles that would need to be accommodated in this knowledge translation process (Saunders et al., 2017).

Formal approaches

Small group sessions. The initial approach to the formalized education was to bring in an expert from Prytime Medical. This representative held small focus groups over the course of three days, which offered a combination of didactic and hands-on approach to learning. These focus groups lasted from 45 minutes to one hour in duration. Each session ran through an overview of the equipment, relevant historical use, theory and rationale for usage, inclusion criteria to initiate the intervention, insertion techniques, and nursing interventions before, during, and after the procedure. It also included teaching on the company mnemonic—MEFIIS™—used to guide insertion. This dedicated

time allowed staff to manipulate the device and necessary additional equipment with the guidance of an expert, as a realistic mannequin was present and featured a cardiovascular simulator to allow the user to experience the circulatory impact of the REBOA. This also allowed visual, auditory and tactile learners a way to interact with the teaching that meets their needs (Melrose et al., 2015). The small group approach allowed for 35 RNs to receive training, or, approximately 40% of eligible staff. The invitation was extended to operating room, anesthesiologist and ICU staff in an effort to promote an interdisciplinary approach, reflective of the inherent nature of trauma care.

Establishing unit champions. The initial selection of who would be covered to attend the small group session was driven by a desire to create a group of unit champions who would also contribute to the dissemination process. Unit champions are individuals who are viewed from an 'implementation science' perspective as persons who are able to positively influence uptake and action of a new process (Miech et al., 2018). Individuals who best suit this role are described in the literature as those who are respected, positive about change, advocates and skilled team members (Mount & Anderson, 2015). Nurses who possess these traits and had expressed an interest in teaching, or who had previously demonstrated skill as a mentor were initially approached to become a unit champion for this initiative.

The creation of such a group of individuals is meant to foster a collegial learning environment that other staff can benefit from. This is a methodology that has been used for previous successful educational implementations at this facility and has the necessary 'buy-in' from staff. Working with the pre-existing staffing rotations allowed for the targeting of a diverse group of RNs to help ensure coverage across different staffing cohorts. Initially it was hoped that approximately 20 RNs could be targeted to fit this group. However, an increased number of nurses were able to attend the small group sessions, which increased the size of this group.

In-situ simulation. In-situ simulation is a methodology for teaching that has recently been featured heavily in nursing education literature (Swift & Wannamaker, 2018). TOH has used this method of teaching in different areas, including the emergency department. This method has been used internally to study communication, test different protocols and to collect quality assurance data on how the team functions and on how process or product changes impact the flow of patient care. In-situ simulation has been used to test the capacity of various response systems at TOH, including the disaster response for a mass casualty event. Being able to complete patient interventions as a team, in a high-fidelity setting yields high value for both learners and educators (Barleycorn & Lee, 2018). The small group sessions with the representative at the onset of this educational dissemination allowed for low-fidelity simulation, as the attending nurses were able to guide each other through the intervention with realistic equipment and simulator-generated patient outcomes.

Six months after the intervention was introduced to the team, a high-fidelity simulation exercise was planned. The team this time was much more inclusive to different specialties and roles were played by those who would be completing the tasks in an actual patient scenario. That is, the trauma team leaders who have received the training for insertion of REBOA were active players in this simulation design with one participating. Planning for this simulation

required curriculum design for the session, the development of educational objectives, and the preparation of a structured debrief. Using in-situ simulation allowed the education team to monitor the ongoing ability of the team to be able to support this patient intervention. There are additional simulation sessions planned for future dates at the time of this article creation and, thus, there is no final number of nurses impacted by this methodology.

Unit tool boxes. Various formalized worksheets were created for usage by both the primary and secondary trauma nurse for the patient who requires REBOA (Appendix B). These are housed with the ER-REBOA™ catheters to ensure that they are always easily accessible, as a tool to guide the various elements of the intervention. Having these worksheets is meant to ease the cognitive burden of being able to execute this complex task. It is helpful for the RN who is documenting the intervention, but also for the bedside RN who is assisting the trauma team leader.

Informal approaches

In addition to the formal approaches described, other, more informal and less-structured methods were used to aid in knowledge translation. These approaches augmented the formal training aids to allow avenues for open discourse in a supportive space about the intervention and associated concerns to be addressed.

Off-site education night. The education team hosted an off-site informal gathering in the setting of an education night. The nurses who work in this setting hold these education nights on a semi-regular basis and invite different physicians to present on a variety of emergency medicine content. Previous feedback had indicated that staff find these nights to be immensely valuable and highly applicable for practice. At this event, a trauma surgeon presented on the importance of properly resuscitating the trauma patient. REBOA was discussed as an adjunct to treatment only. The education was augmented with a mannequin with exposed vasculature so that the insertion of the ER-REBOA™ catheter could be emulated with a visual representation of the circulatory effects. This was key as experts note the importance of repeated exposure and hands-on experience to the overall success in training nursing staff in this modality (Trauma Systems News, 2018). Staff were able to manipulate the device and ask questions of the education team and trauma surgeon present. The documents that make up the toolbox were also present for staff to use. Sixteen nurses were present for this informal event.

Unit newsletter. Educational newsletters are distributed to the unit on a biweekly to monthly basis. They cover practice changes and reminders, give cues to what new processes are coming or are being implemented and always include a focused section which highlights a particular topic and how to find additional resources. Just prior to the official implementation date to initiate the REBOA intervention in this facility, the newsletter focused on this subject. It included relevant links to provider videos and teaching information. Newsletters are circulated to all staff via intranet email within the hospital, but there is no official tracking of readership completed, so it is difficult to evaluate the reach of this methodology.

Challenges

Environmental

In this site there are constant fluctuations in staffing levels and in staff movement out of the department. There are also high, but fluctuating volumes and patient acuity that challenge staffing

needs as well. In this type of an environment, it can be difficult to arrange dedicated worked hours towards education. The chaotic care environment also contributes to a difficult teaching environment. Attempts to mitigate the impact of the environment were taken by moving an educational activity off-site and work will be done with new hires to the department to complete the necessary training as part of orientation processes.

Exposure and knowledge attrition

Initial training at TOH was completed six months prior to the writing of this article. At this time, REBOA has not been used at this site. With the initial retrospective review predicting low potential patient candidates for this procedure, this is not necessarily surprising. As this life-saving intervention is complex, both in theoretical content and in skill mastery, the usage of in-situ simulation has been helpful for staff to work at remaining current with this skillset.

Future plans

As has been stated, at the time of this submission, REBOA has yet to be initiated as a patient care intervention at TOH. The education team will provide follow-up education and assess for areas of optimization as they are identified for the staff nurses. The unit newsletter will include a reminder in regards to the REBOA resources within the 'practice reminders' session periodically. When staff who are advancing to work within this specialized area, they undergo a training day where orientation to REBOA is included. As this education day happens within the unit, it is and has been an opportunity for current staff to have a refresher training session with the modified mannequin and the unit toolbox. Additionally, as has been mentioned, further in-situ simulation days have been planned for the unit to enhance team collaboration in preparing to use this complex patient intervention.

Conclusion

Resuscitative endovascular balloon occlusion of the aorta is a hemorrhage control intervention that has the potential to optimize select patient care. Emergency nurses at the Ottawa Hospital have been provided with various educational strategies, both formal and informal, to assist in the uptake of this

procedure. Ongoing efforts to reduce knowledge attrition rates will focus on succinct reminders and on locally available resources both for self-directed learning and for usage if the intervention is to be implemented.

Take aways

- REBOA is a potentially life-saving strategy for life-threatening hemorrhage.
- Emergency nurses have an important role in the implementation of a REBOA program.
- Simulation and multi-method education strategies are essential components of an implementation plan for a complex intervention such as REBOA.

About the authors

Sarah Gaudet, MN, RN, ENC(C), is a current Clinical Emergency Nursing Educator in Ottawa, transplanted in from the East Coast. She is currently serving as a board member for the Emergency Nurses Association of Ontario and has a passion for trauma care, simulation and digital learning.

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Mathieu LeBreton, RN, BScN, CNCC(C), has a diverse nursing background in critical care, emergency, and flight nursing and was the Trauma Coordinator for The Ottawa Hospital from 2015-2020. He is currently the Clinical Care Leader in the Intensive Care Unit of The Ottawa Hospital's Civic Campus. His interests are quality improvement and system efficiency, and he is currently completing his Master's in Healthcare Quality at Queens University.

Cari Poulin, MN, RN, is an Emergency Nurse Educator in Ottawa who has completed a Master of Nursing. Her interests include anything trauma or resuscitation related, and she is a champion within the organization for using in-situ sim as a tool to 'stress-test' the Resus room.

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Appendix A: Standard Operating Procedure (SOP)

	ISSUE DATE:	SOP#:
	LAST REVIEWED:	APPROVED BY:
	NEXT REVIEW DATE:	ISSUED BY:
STANDARD OPERATING PROCEDURE (SOP) FOR: Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA)	PAGE NUMBER: 18 of 4	
	TRAINING OR CERTIFICATION REQUIRED? <input type="checkbox"/> YES <input type="checkbox"/> NO	

Purpose Statement:

REBOA is a balloon catheter introduced through a 7Fr sheath in the common femoral artery (CFA) and advanced above the aortic bifurcation (Zone III) or in the thoracic aorta (Zone I). The compliant balloon is inflated to achieve aortic occlusion to stop hemorrhage downstream. The catheter is impregnated with a radiopaque band. This is intended to be a bridge therapy for definitive & immediate surgical hemorrhage control

Indications:

- Life threatening torso hemorrhage below the diaphragm due to traumatic mechanism of injury

Scope:

- This procedure is exclusively done by REBOA-trained Trauma Team Leaders (TTL).
- This will be performed exclusively at the Civic Campus of The Ottawa Hospital (Lead Trauma Hospital)

Alerts:

In the event REBOA is not available, an Emergency Department Thoracotomy could be warranted with the goal to cross clamp the aorta at the discretion of the TTL.

Definition(s)

- REBOA: Resuscitative Endovascular Balloon Occlusion of the Aorta
- CFA: Common Femoral Artery
- TTL: Trauma Team Leader
- ME-FIIS: Measure, Empty-Flush, Insert, Inflate, Secure

Equipment:

- Sterile Drape
- Central Line Kit
- Introducer Sheath 7F x1 (Prelude Pro 11cm 7F TOH order # 789273)
- 18G 7cm Echogenic Needle
- Syringe 20ml x1
- Syringe 10ml pre-filled/sterile x 3
- Scalpel #11 x 1
- Suture, nylon 2-0 reverse cutting x 1

Procedure

Insertion of catheter

- Ensure that Trauma Surgeon covering the Trauma Unit is on route
- Book operating room as Priority A case as soon as possible
- Obtain CFA access as per standard technique and use introducer sheath.
- Measure from sternal notch to CFA access point
 - Zone III; Approximately 28cm
 - Zone I: Approximately 46cm
- Ensure Balloon is fully deflated by holding vacuum for 5 seconds and close stopcock
- Advance & twist peel-away to cover P-tip by using a "Corkscrew method". Ensure the balloon and P-tip are covered.
- Attach & flush the arterial line set up
- Insert peel-away into valve of sheath approximately 5mm
- Advance catheter to desired depth by holding orange peel-away, advancing blue catheter and pull peel-away back after balloon passes valve.

- Position catheter using x-ray to confirm position using radiopaque markers
- Inflate balloon, starting with 2cc of saline. Do not overinflate
- Monitor arterial waveform and watch for increase in blood pressure
 - Feel for loss of contralateral pulse
 - Note time of inflation
- Secure catheter close to the introducer sheath

Removal of catheter

- Fully deflate balloon slowly and hold vacuum for 5 seconds and close stopcock.
- Twist the catheter in "Corkscrew method" while removing
 - If necessary, remove the catheter and sheath as a unit
 - Prepare healthcare team for rebound hypotension
- Apply manual pressure over access point for 15 minutes (longer if patient is anticoagulated or Trauma Induced Coagulopathy).
- Check for full and equal pulse in each leg.

REBOA Nurse 2 Cheat-sheet

To be used concurrently with 6 REBOA Steps (ME-FIIS)

Ensure Patient is on a Trauma Stretcher for X ray

Ensure Two Arterial Line Set-ups are Ready and Fully Flushed

1. Measure

- Is the Art line set-up ready and fully flushed?
- Do you have all necessary nursing supplies?
- Is portable x-ray present? Is the film in place with table?

2. Empty

- Ensure that vacuum pressure has been applied to balloon for full 5 seconds

3. Flush

- Ensure tubing ends are cleansed with green swab prior to handover to physician
- Aid physician in attaching and flushing REBOA catheter to arterial line
- Ensure all air is purged from the line and that stop-cocks are correctly closed.
- Ensure Vital signs are being completed prior to insertion

4. Insert

- Ensure Nurse 1 has time of insertion, insertion length, zone of insertion data
- Ensure chest x-ray completed
- Ensure arterial line is zero'ed/ready to transduce
- Ensure the REBOA catheter doesn't migrate during x-ray
- Assist with lead jacket for x-ray

5. Inflate

- Vital signs pre and post inflation
- Ensure REBOA Art line is transducing Prior to inflation
- Ensure Nurse 1 has balloon inflation time
- Assist physician as needed with balloon inflation
- Maintain pressure bag on original Art line

6. Secure

- Aid physician as needed with securing the catheter while sutures and dressing are placed
- V/S q5 min
- Flush Arterial line and call out inflation time q 10 min
- Ongoing lower limb assessments q15 min