Improving pediatric trauma education by teaching non-technical skills

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To the patients who did not receive all my skill, knowledge, or love at the time they needed me most. I dedicate this journey in their honour, a commitment to relentless growth.

I. List of Abbreviations

AI - Artificial intelligence

ANOVA - Analysis of variance

ANTS - Anaesthetists' Non-Technical Skills

CNT - *Compétences non-techniques*

CRM - Crisis Resources Management

ETAT - Emergency Triage Assessment and Treatment

FRN - Funding reference number

HIC - High-income countries

ICC - Intraclass correlation coefficient

LMIC - Low and middle-income countries

NGT - Nominal group technique

NOTSS - Non-Technical Skills for Surgeons

PEARLS - Promoting Excellence and Reflective Learning in Simulation

NTS - Non-technical skills

RCT - Randomized controlled trial

RM-ANCOVA - Repeated-measures analysis of covariance

T-NOTECHS - Non-Technical Skills for Trauma

TRIK - Trauma Resuscitation in Kids

UFMG - *Universidade Federal de Minas Gerais* (Federal University of Minas Gerais)

VR - Virtual reality

WHO - World Health Organization

II. Disclosure

Fabio Mendes Botelho Filho declares no conflicts of interest. All contributions to this thesis were uncompensated.

III. Style guidelines for the thesis

This thesis follows the style recommendations set by McGill University. Specifically:

- Spelling and grammar align with the Canadian Press Stylebook (J. McCarten, 2021) and the Canadian Oxford Dictionary (K. Barber, 2004).
- Graphs and tables were constructed according to the American Medical Association (2020) standards.
- Citations adhere to the American Psychological Association style (2020).

IV. Abstract

This thesis aims to address the scarcity of educational methods for teaching non-technical skills (NTS) in pediatric trauma education.

Trauma kills one million children and adolescents annually, and part of these deaths are attributed to poor communication and collaboration among trauma care providers. Enhancing the quality of pediatric trauma care requires a robust educational program to optimize these professionals' NTS. However, effective methods for teaching NTS are scarce not only in trauma literature but also in health sciences.

We hypothesized that a structured debriefing focused on NTS could improve these skills in medical students participating in a pediatric trauma simulation workshop. Our objectives were to (1) develop this NTS debriefing tool and (2) assess its effects on students' confidence, behaviour, and performance.

Seven experts, each with expertise in at least one area—pediatric trauma, NTS, or surgical education—were invited to design a debriefing tool for NTS in pediatric trauma simulation using the Nominal Group Technique. A subsequent randomized controlled trial (RCT) was organized to evaluate the tool's impact.

Medical students were invited to participate in pediatric trauma simulation workshops. Twenty students were allocated to the control condition and 25 to the intervention. After the first round of scenarios, the intervention condition received NTS debriefing, whereas the control received standard debriefing. Trauma instructors facilitated all the debriefing sessions, after which the students engaged in a second round of scenarios. Metrics were analyzed before and after the debriefing, and comparisons were made between the conditions (control versus intervention) and within subjects (before and after the debriefing). They included self-assessment surveys to gauge students' confidence and perceived knowledge, the

Non-Technical Skills for Surgeons (NOTSS) score for NTS evaluation, and adherence to the trauma protocol for performance. Statistical analyses involved t-tests, Mann-Whitney, Wilcoxon signed-rank, Kruskal-Wallis, analysis of variance (ANOVA), and repeated-measures analysis of covariance (RM-ANCOVA) tests.

The workshops, irrespective of the condition, bolstered students' knowledge and confidence in managing pediatric trauma. However, only students in the intervention condition showed statistically significant improvement in their overall NOTSS scores and across all NTS categories: situational awareness, decision-making, communication and teamwork, and leadership. Students allocated to the intervention condition also had a statistically significant increase in completed trauma protocol steps.

Introducing a structured NTS-focused debriefing augments these skills and protocol adherence, underscoring the value of formally integrating NTS training into pediatric trauma education.

Keywords: communication, wounds and injuries, child, leadership, health education, simulation training

V. Résumé

Cette thèse vise à pallier le manque de méthodes éducatives pour l'enseignement des compétences non techniques (CNT) dans la formation au trauma pédiatrique.

Le trauma tue un million d'enfants et d'adolescents chaque année, et une partie de ces décès est attribuée à une mauvaise communication et collaboration parmi les professionels de soins de trauma. Pour améliorer la qualité des soins de trauma pédiatrique, un programme éducatif robuste est nécessaire pour optimiser les CNT de ces professionnels. Cependant, les méthodes efficaces pour enseigner les CNT sont rares, tant dans la littérature sur le trauma que dans les sciences de la santé.

Nous avons émis l'hypothèse qu'un débriefing structuré axé sur les CNT pourrait améliorer ces compétences chez les étudiants en médecine participant à un atelier de simulation de trauma pédiatrique. Nos objectifs étaient de (1) développer cet outil de débriefing CNT (2) et d'évaluer ses effets sur la confiance, le comportement et la performance des étudiants.

Sept experts, chacun spécialisé dans au moins un domaine - trauma pédiatrique, CNT ou éducation chirurgicale - ont été invités à concevoir un outil de débriefing pour les CNT dans la simulation de trauma pédiatrique en utilisant la technique de groupe nominal. Un essai contrôlé randomisé (ECR) a ensuite été organisé pour évaluer l'impact de l'outil.

Des étudiants en médecine ont été invités à participer à des ateliers de simulation de trauma pédiatrique. Vingt étudiants ont été affectés à la condition de contrôle et 25 à l'intervention. Après le premier tour de scénarios, la condition d'intervention a reçu un débriefing CNT, tandis que le contrôle a reçu un débriefing standard. Toutes les séances de débriefing ont été animées par des instructeurs en trauma, et après celles-ci, les étudiants ont participé à un second tour de scénarios. Les métriques ont été analysées avant et après le débriefing, et des comparaisons ont été faites entre les conditions (contrôle versus intervention) et au sein des

sujets (avant et après le débriefing). Elles comprenaient des enquêtes d'auto-évaluation pour mesurer la confiance et la connaissance perçue des étudiants, le score des Compétences Non Techniques pour Chirurgiens (NOTSS) pour l'évaluation des CNT, et l'adhésion au protocole de trauma pour la performance. Les analyses statistiques impliquaient des tests t, Mann-Whitney, Wilcoxon à rang signé, Kruskal-Wallis, analyse de variance (ANOVA) et analyse de covariance à mesures répétées (RM-ANCOVA).

Les ateliers, quelle que soit la condition, ont renforcé les connaissances et la confiance des étudiants dans la gestion du trauma pédiatrique. Cependant, seuls les étudiants dans la condition d'intervention ont montré une amélioration statistiquement significative de leurs scores globaux NOTSS et dans toutes les catégories des compétences non techniques (CNT) : conscience situationnelle, prise de décision, communication et travail d'équipe, et leadership. Les étudiants affectés à la condition d'intervention ont également eu une augmentation statistiquement significative dans le nombre d'étapes du protocole de trauma complétées.

Introduire un débriefing axé sur les CNT structuré augmente ces compétences et l'adhésion au protocole, soulignant la valeur d'intégrer formellement la formation aux CNT dans l'éducation au trauma pédiatrique.

Mots-clés: communication, blessures et traumatismes, enfant, leadership, éducation à la santé, formation par simulation.

VI. Acknowledgements

Pursuing a graduate degree in a foreign country and another language is challenging. The thesis alone does not capture the collective effort of countless individuals who supported and stood by me throughout this journey. Their belief in my potential has instilled a deep gratitude within me, not just for my academic achievements but also for rekindling my trust in humanity and a purpose to thrive together.

Firstly, I must acknowledge Dr. Poenaru, my supervisor, who opened doors and welcomed my family wholeheartedly. His faith in me, paralleling the trust he has placed in his Canadian students and fellows, is a testament to the disruptive humility he cultivated from his youth. Following him was Dr. Emil, who accepted Dr. Poenaru's indication and embraced my wife Julia and me as part of the Montreal Children's Hospital family. Under his mentorship, I comprehended my role as a pediatric surgeon and the nurturing environment that allows growth. He restored my passion for pediatric surgery, an undervalued specialty in Brazil. Having role models like Dr. Poenaru and Dr. Emil is akin to navigating known waters, whereas their absence is like sailing uncharted territories.

Dr. Poenaru and Dr. Emil have built upon the legacy established by Dr. Laberge. He exemplifies how one can harness privileges and skills for the greater good instead of isolating oneself in a comfort zone. I bet that if we had only five more "Dr. Laberges," all the world's problems would be solved. Subsequently, my co-supervisor, Dr. Harley, addressed my longstanding question regarding the feasibility of high-quality surgical education amidst the inherent challenges of working in the busy and stressful surgical field. Dr. Harley introduced me to surgical education theories, challenged my conventional thinking, honed my academic and research skills, and, most importantly, instilled the organization's value in achieving outcomes.

The entire Montreal Children's Hospital and McGill University staff, including medical students, coordinators, residents, fellows, nurses, and pediatricians, deserve my gratitude for their trust. A special mention to Ms. Guadagno, our research director, who paved the way for a smooth and joyful journey.

My foundation, which has brought me to this point, was built on the love and sacrifice of my family. My parents and brother have been my pillars of strength, providing the resources and emotional fortitude required when a loved one sets out on a journey to distant lands. I also owe a debt of gratitude to the Brazilian pediatric surgical team. Their encouragement to pursue greater horizons, even if it meant leaving the service, showcased their belief in my potential and desire to contribute more to the world.

Moreover, I thank Dr. Simone Abib and the Federal University of Sao Paulo for introducing me to the academic realm and playing a pivotal role in my trauma research. My gratitude also extends to the Canadian Institutes of Health Research (FRN: MFE - 187862) and the Montreal Children's Hospital Foundation through the Jean-Martin Laberge Global Pediatric Surgery Fellowship for the financial support that allowed me to chase this dream.

A special acknowledgment must be made for Julia and our son, Matteo. Julia is the heartbeat of our household. While many believe that money, pressure, skill, or assertive leadership are the mainstays of success, I have realized that the most potent force is having someone in your corner cheering you unconditionally. Julia has been my rock, offering solace during trials and celebrating our triumphs. Our son Matteo, born from this union of love and partnership, has been a beacon of joy and a daily reminder of the need for balance in life. He instilled in me the importance of laying a foundation for future generations, being my greatest teacher from the day he arrived.

There are countless others—relatives, friends, and colleagues—whose contributions and support have been invaluable. Space constraints prevent me from naming each one, but I carry their kindness.

VII. Contribution to original knowledge

The unique contributions of this research project are to:

1. Uncover the barriers hindering the advancement of pediatric trauma education;

2. Propose and detail a debriefing tool to foster non-technical skills (NTS) applicable in trauma education;

3. Validate the proposed NTS debriefing tool in a randomized controlled trial (RCT);

4. Demonstrate that better NTS is associated with enhanced protocol adherence.

VIII. Contribution of authors.

My supervisor, Dr Dan Poenaru, and I initially conceptualized the presented research. We designed the research protocols, procured ethical board approvals, collected and analyzed the data, composed the manuscripts, and assembled the appropriate teams for each study. Dr. Jason Harley, my co-supervisor, became involved following the reviews which identified the NTS training gap. Given their expertise in surgical education, Dr. Harley proved to be an invaluable collaborator in the study design, analysis, interpretation, discussion, and review of the empirical projects this dissertation is comprised of.

Our research has generated two studies:

1. Botelho, F., Yanchar, N., Abib, S., Bank, I., Harley, J. M., & Poenaru, D. (2022). *A debriefing tool to acquire non-technical skills in trauma courses.* Surgery Open Science, 10, 228–231. https://doi.org/10.1016/j.sopen.2022.10.012

2. Botelho, F., Rangel, AG., Harley, J.M., & Poenaru, D. (2024). Improving *Pediatric Trauma Education by Teaching Non-technical Skills. A Randomized Controlled Trial. Journal of Pediatric Surgery.* https://doi.org/10.1016/j.jpedsurg.2024.01.018

Additional authors had the following contributions:

Drs. Yanchar, Abib, and Bank, pediatric trauma specialists, aided in refining the debriefing tool to emphasize NTS in pediatric trauma. They actively participated in discussions and reviewed the first study's manuscript.

Dr. Rangel played a pivotal role in data collection and technical support during the experimental phase of the second study.

Regarding the thesis, I was responsible for writing it, and Dr. Poenaru and Dr. Harley reviewed it.

IX. List of tables and figures

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Chapter 1. Introduction

1.1 Rationale

Trauma is a major global health problem, leading to approximately one million deaths yearly among children and adolescents (GBD 2019 Diseases and Injuries Collaborators, 2020; Global Burden of Disease Child and Adolescent Health Collaboration, 2017). While mortality is pressing, morbidity is also extensive; for each death, there are 12 hospitalizations and 60 emergency department visits (Blinman TA, Nance M 2014). Moreover, the risk of long-term disability due to injuries makes them the leading cause of disability between 10 and 49 years old worldwide (Global Burden of Disease Child and Adolescent Health Collaboration, 2017).

Optimal pediatric trauma care is vital at two critical moments: right after the injury and during definitive hospital treatment (Gunst et al. 2010; Demetriades et al. 2005). Prevention significantly enhances immediate post-injury survival rates (WHO 2008; Yanchar, Warda, and Fuselli 2012; Upperman 2022). However, outcomes largely depend on a cohesive, prepared trauma team awaiting the patient during the hospital phase (Courtenay, Nancarrow, and Dawson 2013; Acker and Kulungowski 2019). Improved outcomes are more tied to timely and appropriate treatment than injury severity (Callese et al. 2014). Despite advances, hospital errors persist (Acker and Kulungowski 2019). Unprepared trauma teams continue to overlook critical conditions (J. Whitaker et al. 2020; Wong et al. 2015).

Improving pediatric trauma teams and quality of care is challenging (Kiragu et al. 2018). Indeed, children often do not receive optimal care following injuries, primarily when this care is provided by general providers in low-resource settings (Botelho et al. 2020; Botelho-Filho 2020; Kiragu et al. 2018). Several factors contribute to this, such as the busy nature of emergency departments, the emotional stress providers experience when treating children, the complexity of the injuries, and the need for personnel and equipment dedicated to pediatric

trauma care (Botelho et al. 2020; Botelho-Filho 2020; Kiragu et al. 2018). Although the literature suggests simple interventions like checklists, these often fail to produce long-term impact, indicating the need for more comprehensive interventions (Simpson, Rivara, and Pham 2012; John Whitaker et al. 2021).

In a previous project, we implemented strategies from the literature to improve trauma protocol adherence, specifically using a checklist for the initial assessment of an injured child (Kelleher et al. 2014; van Maarseveen et al. 2020). Despite our efforts, we observed no significant improvement in protocol adherence at our hospital (Botelho, Truché, et al. 2021). We questioned why these strategies were ineffective in our context. We considered some reasons for these negative results, such as the volume of trauma cases handled by the hospital and the absence of more robust educational interventions to introduce the checklist, to teach, and to prompt its use. This oversight could have diminished the tool's effectiveness (Botelho, Truché, et al. 2021). Another key takeaway from this research was the risk associated with directly importing interventions without considering the unique challenges and contexts of each setting. Enhancing the quality of pediatric trauma care is, therefore, much more complex than usually anticipated (J. Whitaker et al. 2020; Simpson, Rivara, and Pham 2012). Interestingly, one of the reviewers of our manuscript, typically hesitant to accept studies with 'negative' findings in their words, recognized the importance of our discussion. They considered the manuscript valuable as it highlighted the need for more tailored interventions rather than simply adopting existing ones and how a more comprehensive educational approach to incorporating new tools in daily practice (even checklists) was essential (Botelho, Truché, et al. 2021).

Current trauma training programs, like the Advanced Trauma Life Support (ATLS, Collicott and Hughes 1980), center on adults and insufficiently cover non-technical skills (NTS), such

as situational awareness and leadership (Anderson et al. 2018; Botelho et al. 2020). These programs focus on technical skills, which include a range of hands-on techniques, including rapid assessment and bleeding control, the management of an obstructed airway, and the execution of life-saving procedures like cricothyroidotomy or thoracotomy (Mackenzie et al. 2019).

A Canadian study revealed that NTS training features less than 1% of surgical educational activities across 14 universities in Canada (Lee et al. 2020), and the main challenges of teaching NTS lie in the absence of established training methods (Griffin et al. 2020; Ounounou et al. 2019). Addressing the scarcity of NTS training methods could mitigate frequent pediatric trauma care errors, as it has already proven beneficial in other areas such as aviation, engineering, and different medical specialties (Tannenbaum and Cerasoli 2013; Griffin et al. 2020; Ashcroft, Wilkinson, and Khan 2020; Kim et al. 2022).

We undertook two scoping reviews to gain deeper insight into pediatric trauma education and better understand its barriers. The first review examined pediatric trauma training courses and identified opportunities and priorities to impact outcomes (Pinkham et al. 2022). The second study examined the educational technologies frequently employed for teaching trauma skills and their respective advantages and feasibility (Khan et al. 2023).

These reviews underscored primary hurdles in pediatric trauma education worldwide, ratifying our first concern – a shortage of NTS training – but highlighted a prohibitive cost, limiting access. While cost issues are more pronounced in LMICs, the NTS deficit is a universal challenge (Ngwa, Olver, and Schmeler 2020; Pinkham et al. 2022). NTS comprise approximately 50% of the skill set required for a healthcare provider independent of their country (Pinkham et al. 2022; Khan et al. 2023; Gawande et al. 2003).

Although we considered conducting a systematic review on teaching NTS in trauma care, we found an excellent and recent one by Ounounou et al. addressing the subject, *Non-technical skills in surgery: a systematic review of current training modalities* (Ounounou et al. 2019). This work, which included trauma in its search strategy, presented the crucial gap in the paucity of teaching modalities for NTS. In their own words: "*With the importance of non-technical skills in surgery being recognized, establishing effective training methods have become more pertinent. It is essential for surgeons to be trained in non-technical skills, therefore the most valuable teaching modalities need to be identified and implemented within curricula. It is hoped that non-technical skills training will be standardized and implemented into curricula across surgical specialties. There is a good basis to recommend the use of high fidelity and low fidelity simulation for non-technical skills training. Future studies should focus on developing a validated training method for non-technical skills that can be implemented into surgical training across all surgical specialties*" (Ounounou et al. 2019).

Debriefing is one of the training methods explored to teach NTS but not yet validated for this goal. Studies in surgery and trauma education that incorporate NTS often utilize simulation for analysis, albeit without a structured framework. While other educational strategies, such as readings and lectures, are still viable and should be the focus of future studies, the potential and current literature gap regarding debriefing is highlighted by Garden et al. Their systematic review, 'Debriefing after simulation-based non-technical skills training in healthcare,' suggests that the foundational elements of effective debriefing in healthcare non-technical skills training are still predominantly based on expert opinion. (Garden et al. 2015) Furthermore, Sullivan and collaborators studied the debriefing practices of instructors in trauma courses. (Sullivan et al. 2018) They observed that many instructors were not using debriefing techniques fully. They mainly provided direct information, limiting opportunities for trainees to reflect, which should be the primary objective of debriefing strategies (Eppich

and Cheng 2015). In summary, Sullivan's work suggested researchers and educators have failed to effectively leverage the power of debriefing to-date to best develop trainee skills (Sullivan et al. 2018).

It became clear that an educational tool specifically for NTS training in pediatric trauma was needed after reflecting on these authors' findings. Consequently, we decided to develop our intervention, an NTS debriefing tool, followed by its testing in an RCT.

For clarity, the detailed findings from our lab's two scoping reviews (Khan et al. 2022, Pinkham et al. 2021) regarding pediatric trauma education are summarized in *Chapter 2* under sub-section 2.2, titled *Pediatric Trauma Education*. Following an in-depth analysis in this chapter, the subsequent sections of the thesis will concentrate on developing and assessing the debriefing tool.

1.2 Hypothesis

We hypothesized that a structured NTS debriefing could amplify medical students' NTS during simulated pediatric trauma scenarios.

1.3 Specific objectives

The specific objectives of our research were to:

1. Formalize a debriefing tool to foster NTS for pediatric trauma education.
2. Evaluate the impact of NTS training on trainees' confidence, perceived knowledge, NTS (primary outcome), and protocol adherence during pediatric trauma scenarios.

Chapter 2. Literature review

2.1 Burden of pediatric trauma and improving quality of care

Trauma kills one million children yearly and has been a dominant cause of death and disability across 204 countries for 30 years (GBD 2019 – Diseases and Injuries Collaborators 2020; Global Burden of Disease Child and Adolescent Health Collaboration et al. 2017). Over the past two decades, few advancements in pediatric trauma outcomes have been observed, elevating its status as a pressing public health issue (James et al. 2020; WHO 2008). As emphasized by the World Health Organization (WHO), the escalating burden of disease and mortality from pediatric trauma accentuates the urgency for interventions, especially in LMICs. Nevertheless, pediatric trauma continues to be overlooked on the global health agenda (GBD 2019 – Diseases and Injuries Collaborators, 2020; Global Health Estimates: Life Expectancy and Leading Causes of Death and Disability, 2023). Different barriers impede pediatric trauma care, notably resource constraints and an absence of a cohesive pediatric trauma education agenda (J. Whitaker et al. 2020; Wong et al. 2015; Botelho et al. 2020). Additionally:

- trauma is heavily influenced by social determinants of health (Lam et al. 2023; Breslin et al. 2023). Poverty, unsafe public transportation, and inadequate living conditions increase the risk of trauma in children (Lam et al. 2023; Breslin et al. 2023; Botelho-Filho 2020).
- Lack of specialized care. Inconsistencies in who manages pediatric trauma, ranging from surgeons to pediatricians, indicate an absence of leadership (Botelho et al. 2020; Botelho-Filho 2020). This issue led to the creation of the Pediatric Trauma Society, which aims to centralize efforts and promote guidelines in pediatric trauma. However, its impact remains predominantly in North America (Mora et al., 2020; *Pediatric Trauma Society*, 2023).

- Paucity of dedicated research. Without a clear leadership, it is challenging to promote research and advocate for pediatric trauma care effectively (Kiragu et al. 2017; Ahmad et al. 2021).

This neglect of pediatric trauma mirrors a broader overlook of surgical diseases in global investments, which have predominantly focused on chronic or communicable diseases (Meara and Greenberg 2015). Approximately five billion people lack access to surgical care, half of whom are children (Meara and Greenberg 2015).

Even in countries with robust infrastructure like the United States of America, which boasts an extensive network of pediatric trauma centres, 17.4 million children and adolescents below the age of 15 encounter challenges accessing these facilities (Nance, Carr, and Branas 2009). In LMICs, the situation is exacerbated by limited specialized trauma centres catering to expansive populations, leading to delays in care (Athey et al. 2001; Mitchell et al. 2013). A key recommendation to combat this issue is to ensure that even regional and non-specialized centres can deliver a fundamental level of pediatric trauma care (Kiragu et al. 2017; Upperman 2022). Indeed, enhancing education for healthcare providers emerges as the most influential strategy to improve outcomes in acute diseases, decreasing their mortality and disability (Gausche-Hill et al. 2015).

Trauma care providers at the busiest Latin American trauma hospital execute only 34% of the trauma protocol during primary assessments of injured children (Botelho-Filho 2020; Botelho et al. 2020). The poor performance persisted irrespective of the provider specialty (surgical vs. non-surgical) and despite completing the ATLS course. The providers demanded more education focused on pediatric trauma care. The reasons behind the paucity of pediatric trauma education will be discussed in the following section.

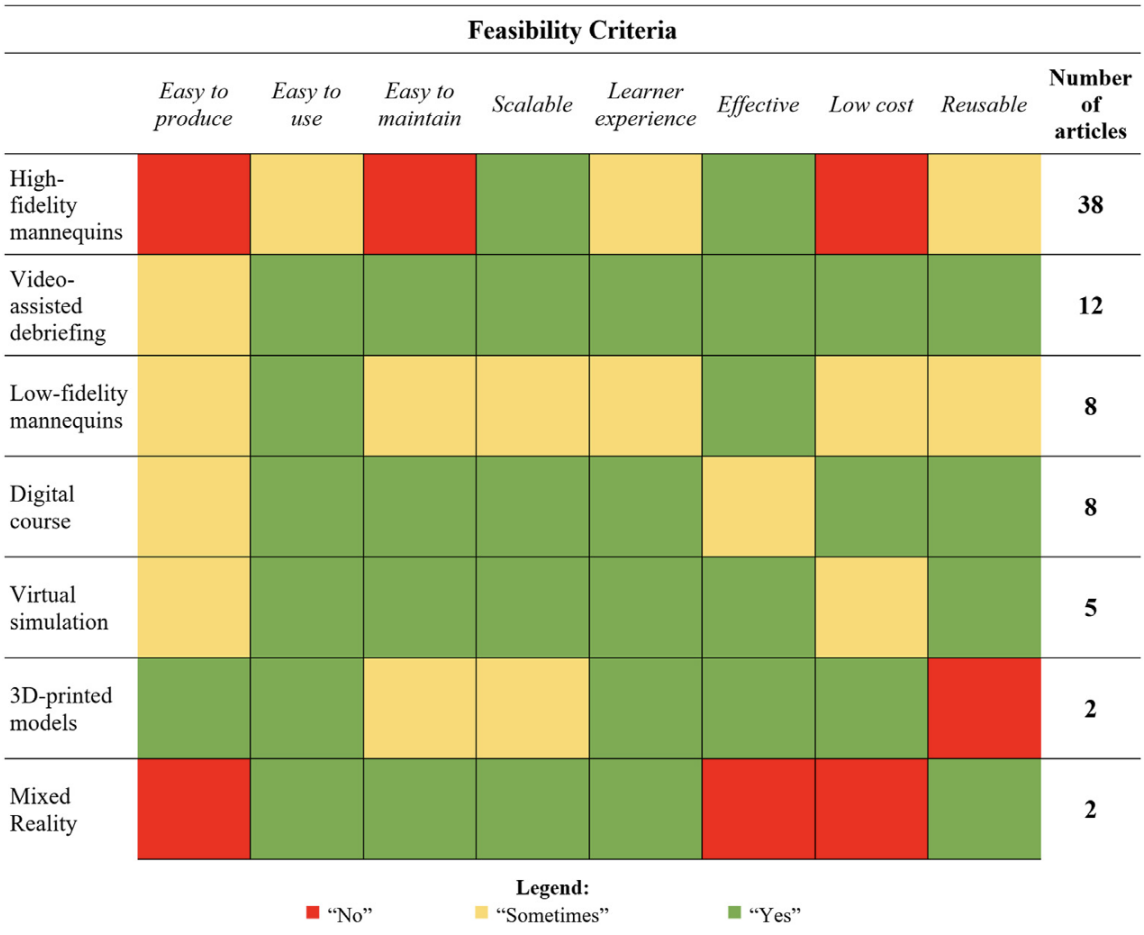
2.2 Pediatric trauma education

Providing pediatric trauma education is challenging, with pronounced disparities worldwide (J. Whitaker et al. 2020). The evolution of trauma training curricula since the inception of the ATLS course in the 1980s showcases ongoing endeavours to elevate trauma care training, although with inconsistent global uptake (Collicott and Hughes 1980; Botelho et al. 2020; Anderson et al. 2018; Jayaraman et al. 2014). There has also been a considerable shift toward innovative training methods (Guze 2015). Modern training harnesses technological advancements, from web and mobile apps (Chandran et al. 2022) to 3D printing and high-fidelity simulation for a more immersive experience (Carey and Rossler 2023).

Although high-fidelity simulation training has become the gold standard in trauma training, its high costs render it inaccessible to many global regions (*Figure 1*, Fritz, Gray, and Flanagan 2008; Platz et al. 2011; Delisle and Hannenberg 2020; Tao 2011). Moreover, pediatric trauma training recommendations seem unattainable beyond the challenges of procuring mannequins and qualified instructors. The American College of Surgeons stipulates at least 16 hours of annual pediatric trauma training for all healthcare providers involved in treating injured children (Committee on Trauma 2014). Nevertheless, even with ATLS, the globally renowned trauma course available in 86 countries, only 6% of the world's physicians have completed it in the last 14 years (WHO, 2019; Kerby & Bulger, 2022). Based on these statistics, training teams to treat the 60 million children who visit hospitals annually would potentially necessitate a billions of dollars investment in pediatric trauma education yearly (Blinman TA, Nance M 2014; Committee on Trauma 2014; Global Burden of Disease Child and Adolescent Health Collaboration et al. 2017; Myers et al. 2019; Kiragu et al. 2018). Such expenses raise concerns about perpetuating inequities in trauma education rather than reducing them. To revolutionize trauma training, a shift towards scalable, cost-effective, and portable simulation techniques is imperative (Gentry et al. 2019; Guze 2015; J. Whitaker

et al. 2020; Wong et al. 2015). Other tools like low-fidelity mannequins, digital courses, and virtual reality (VR) offer varied feasibility outcomes, but it is required better scientific validation before their adoption.

Figure 1. Feasibility evaluation of technologies used in trauma education



From: Khan, M., Botelho, F., Pinkham, L., Guadagno, E., & Poenaru, D. (2023). Technology-enhanced trauma training in low-resource settings: A scoping review and feasibility analysis of educational technologies. *Journal of pediatric surgery*, *58*(5), 955–963. https://doi.org/10.1016/j.jpedsurg.2023.01.039

Unsurprisingly, global examples of dedicated pediatric trauma courses are scarce worldwide. Most courses identified by another review from our lab were based on the *Emergency Triage Assessment and Treatmen*t (ETAT) model from WHO, concentrating on general pediatric emergencies rather than trauma-specific cases (Pinkham et al. 2022). Expertise in general

trauma or pediatric emergency does not inherently equate to proficiency in pediatric trauma. Pediatricians often falter in confidence when faced with pediatric trauma patients despite their proficiency in general pediatric emergencies (Botelho et al. 2020). Additionally, general surgeons familiar with adult trauma are unfamiliar with pediatric patients (Botelho et al., 2020). The absence of a designated specialty for pediatric trauma care in most hospitals to advocate for pediatric trauma education contributes to the ongoing challenges (Botelho et al., 2020).

Pediatric trauma care requires swift decision-making, precise technical execution, and coordinated teamwork amidst the emotional intensity of an injured child's concerned family (Knudson and McGrath 2007; Kiragu et al. 2017). Moreover, an injured child evokes strong emotions in healthcare providers, clouding judgment and decision-making (Tallo et al. 2014). In a qualitative study (Guise et al. BMJ Open, 2017), authors explored the effects of stress and anxiety on pediatric patients' safety. In their words: "caring for paediatric emergencies creates unique stressors on providers that may affect patient safety." These stressors were identified as: (1) identification with the children;], (2) difficulty in seeing an innocent child injured, and (3) professional insufficient exposure to pediatric emergency. The authors also encourage tools that can help these providers foster their NTS. These particularities should be reflected in pediatric trauma courses and are directly linked to non-technical skills - NTS (Pinkham et al. 2022). Even though ATLS provides foundational trauma training globally, its efficacy in mitigating childhood injury fatalities remains unconfirmed (Jayaraman et al. 2014).

A comprehensive pediatric trauma course should provide balanced instruction in technical skills and NTS (Pinkham et al. 2022), given that a significant proportion of errors by healthcare providers stem from NTS deficits (Acker & Kulungowski, 2019; Courtenay et al., 2013). The course should also set clear learning objectives tailored to local resources and

epidemiology, favour an immersive training module, use validated assessment tools, evaluate students' performance in both technical and NTS, establish a well-defined debriefing strategy, and assess the quality of care in clinical activities following the educational intervention (*Table 1*, Pinkham et al. 2022). This framework proposed by our laboratory has since been recognized and cited as the standard guideline for stakeholders planning to implement pediatric trauma education interventions (Muenyi et al. 2023).

Table 1. Core components to implement a successful pediatric trauma training program

1. Focus on pediatric trauma;
2. Set clear learning objectives based on local resources and epidemiology;
3. Preferentially use an immersive module of training;
4. Include training in communication and other non-technical skills;
5. Use validated assessment tools;
6. Evaluate students' performance in both technical and non-technical skills;
7. Establish a clear debriefing strategy;
8. Measure the quality of care in clinical activities following the educational intervention.

From: Pinkham, L., Botelho, F., Khan, M., Guadagno, E., & Poenaru, D. (2023). Teaching Trauma in Resource-Limited Settings: A Scoping Review of Pediatric Trauma Courses. *World journal of surgery*, *46*(5), 1209–1219. https://doi.org/10.1007/s00268-021-06419-3

While initiatives like the Trauma Resuscitation in Kids (TRIK) course (a Canadian pediatric trauma course based on high-fidelity simulation) have clear objectives and robust assessment strategies for technical skills (The Royal College of Physicians and Surgeons of Canada, 2023), NTS are not formally taught. Less than 19% of the trauma courses (for adult and pediatric trauma) mention NTS in their content (Khan et al. 2023). Additionally, when these skills are integrated into training, they often lack a structured educational framework (Khan et al. 2023).

In summary, our analysis of the barriers to pediatric trauma education highlighted two primary challenges:

1. The high costs, which predominantly affect LMICs.
2. The global shortfall in NTS training.

The widespread lack of NTS training underscored the need for deeper investigation with the goal of achieving a far-reaching impact.

2.3 Non-technical skills

2.3.1 The origins of non-technical skills research in health sciences

NTS are equally vital in healthcare as technical skills (Stahel et al. 2022). NTS encompasses different skills, and the most studied are situational awareness, decision-making, leadership, communication, and teamwork (Scott et al. 2019). Situational awareness involves accurately perceiving patient-related information and anticipating complications, which informs decision-making in critical scenarios. Effective communication ensures clear understanding, reducing medical errors, while teamwork emphasizes collaboration for optimal patient outcomes. Finally, leadership guides and coordinates healthcare teams (Jung et al. 2018).

The origins of incorporating NTS into training and daily practices can be traced back to the aviation industry, where the focus on these skills has contributed to the safe operation of thousands of daily flights with minimal errors (Helmreich, Merritt, and Wilhelm 1999). In contrast, an average of 20 errors per surgical case makes the operating room extremely dangerous (Jung et al., 2020).

The introduction of NTS in surgery gained momentum following the influential work at the University of Aberdeen, Scotland (Flin et al. 2012; S. Yule, Flin, Paterson-Brown, and Maran

2006; Steven Yule et al. 2009). These researchers incorporated safety lessons learned from civil aviation and the Scottish oil drilling industry (Zenati, Dias, and Kennedy-Metz 2022), launching the remarkable Anaesthetists' Non-Technical Skills (ANTS) taxonomy for anesthesiology (Fletcher et al. 2003). Furthermore, they expanded the application of NTS to surgeons, developing the Non-Technical Skills for Surgeons (NOTSS) score, a refined framework to assess surgeons' behaviours during procedures and crisis management situations (Steven Yule et al. 2009; S. Yule, Flin, Paterson-Brown, and Maran 2006).

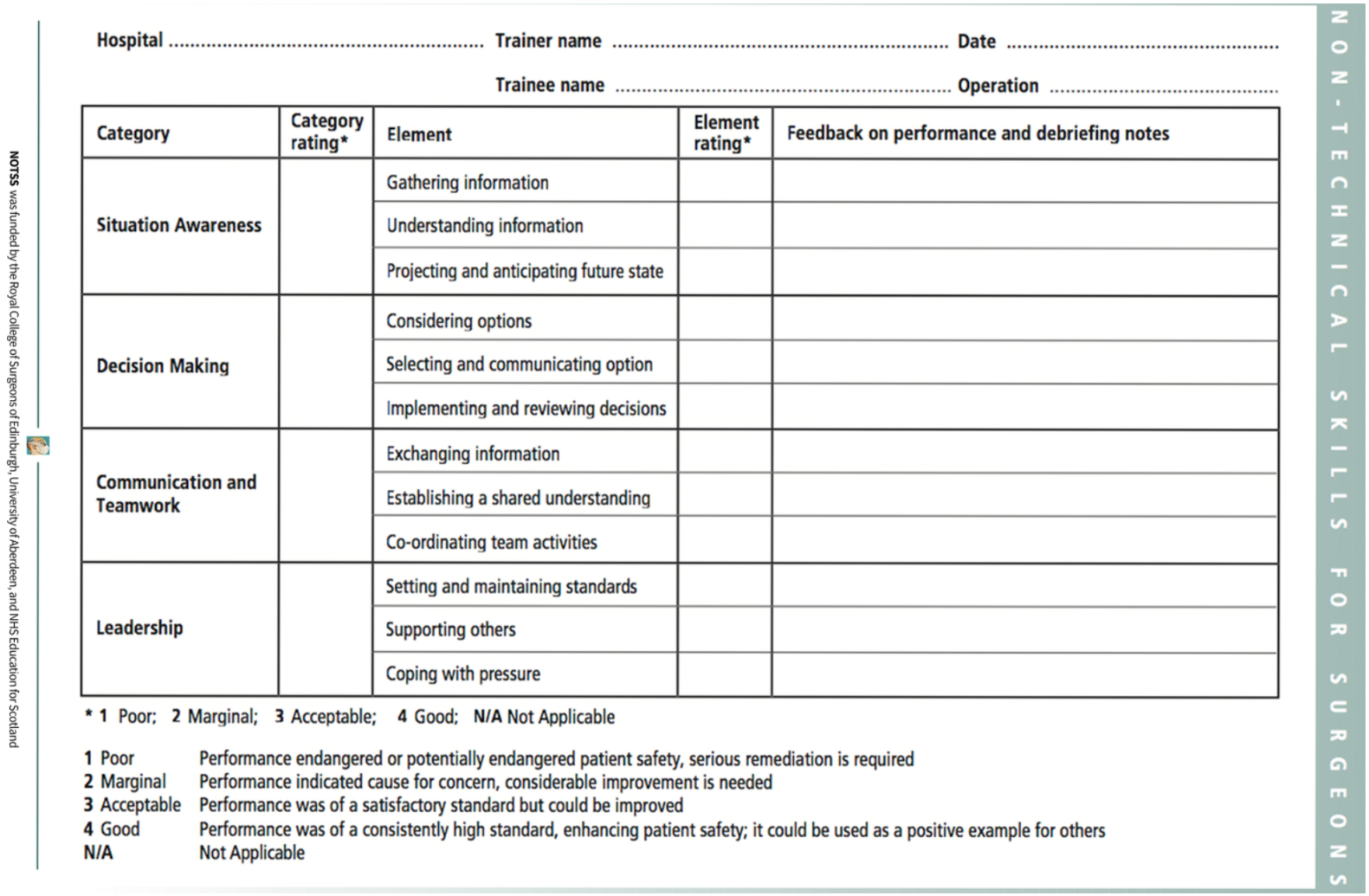
2.3.2 The NOTSS score system

Behavioural marker systems, like NOTSS, allow observers to identify and rate specific behaviours exhibited by professionals. Examples of these systems include ANTS (Anaesthetists' Non-Technical Skills), Non-Technical Skills for Trauma (T-NOTECHS), and Crisis Resource Management (CRM), each with unique attributes and potential limitations (Ounounou et al. 2019; Ashcroft, Wilkinson, and Khan 2020; Fletcher et al. 2003; Helmreich, Merritt, and Wilhelm 1999; Sullivan et al. 2018; Ziesmann et al. 2013; Sevdalis et al. 2008). The ANTS system, designed specifically for anesthesiology, effectively promotes NTS in this specialty. However, its specificity limits its applicability in trauma education and other surgical areas (Fletcher et al. 2003). T-NOTECHS, tailored for trauma scenarios, focuses on the NTS of the entire team's performance. Compared to NOTSS, T-NOTECHS's broader scope may make it less effective in identifying individual performance issues, as NOTSS provides a more structured framework for assessing an individual's NTS (Steinemann et al. 2012; Sullivan et al. 2018). CRM takes a holistic approach, highlighting NTS within the broader context of medical teams; however, like T-NOTECHS, it does not delve as deeply into the nuances of a leader's responsibilities (Helmreich, Merritt, and Wilhelm 1999; Briggs et al. 2015).

Several factors influenced our decision to use NOTSS. It is the most validated scoring system for NTS within the surgical domain (Griffin et al. 2020; Ounounou et al. 2019; Patel et al. 2019). Its specificity to surgical settings, mainly focusing on the leader's role in team direction, offers a distinct advantage. Research indicates that enhancing a leader's NOTSS can indirectly improve team performance (Sullivan et al., 2018). Qualitative feedback from trauma team members consistently emphasizes the significance of the leader's skills as a pivotal factor in team dynamics and enhanced care (Hjortdahl et al. 2009; Scott et al. 2019). This focus on the leader's abilities, rather than on the trauma team, is, therefore, particularly relevant in trauma care. Lastly, NOTSS can serve as a "bellwether" behavioural marker system, suggesting that changes in NOTSS are likely to reflect in other scoring systems like T-NOTECHS or CRM (Sullivan et al., 2018). With these advantages, NOTSS emerged as the most appropriate choice for our study.

The NOTSS system breaks down NTS into four primary categories: situational awareness, decision-making, communication and teamwork, and leadership. Each category contains three elements related to specific observable behaviours. These elements are then scored on a scale ranging from 1 (poor) to 4 (excellent) based on their quality and appropriateness in the observed situation (*Figure 2*, Flin et al. 2012).

Figure 2. The NOTSS scoring system



NOTSS was funded by the Royal College of Surgeons of Edinburgh, University of Aberdeen, and NHS Education for Scotland

NON-TECHNICAL SKILLS FOR SURGEONS

Hospital ..... Trainer name ..... Date .....

Trainee name ..... Operation .....

Category	Category rating*	Element	Element rating*	Feedback on performance and debriefing notes
Situation Awareness		Gathering information		
		Understanding information		
		Projecting and anticipating future state		
Decision Making		Considering options		
		Selecting and communicating option		
		Implementing and reviewing decisions		
Communication and Teamwork		Exchanging information		
		Establishing a shared understanding		
		Co-ordinating team activities		
Leadership		Setting and maintaining standards		
		Supporting others		
		Coping with pressure		

* **1** Poor; **2** Marginal; **3** Acceptable; **4** Good; **N/A** Not Applicable

1 Poor	Performance endangered or potentially endangered patient safety, serious remediation is required
2 Marginal	Performance indicated cause for concern, considerable improvement is needed
3 Acceptable	Performance was of a satisfactory standard but could be improved
4 Good	Performance was of a consistently high standard, enhancing patient safety; it could be used as a positive example for others
N/A	Not Applicable

Available online at https://www.notss.org/research#education

To calculate the NOTSS score, an evaluator observes a surgeon during a procedure or critical situation and rates their performance in each behavioural element. The individual scores for each element are then aggregated to provide scores for each category. Finally, the categories' scores can be combined to give an overall NOTSS score for the surgeon (*Figure 2*). This systematic approach offers information for feedback, enabling the providers to understand providers' or trainees' strengths and areas that require improvement. The primary aim of employing the NOTSS score was to enhance surgical safety and patient outcomes by focusing on the non-technical aspects of surgical practice (The Non-Technical Skills for Surgeons Lab, 2023). However, it has been applied in different contexts, including trauma simulation (Briggs et al. 2015; Ounounou et al. 2019).

2.3.3 Impact of non-technical skills

Studies have shown that NTS training enhances performance in simulated scenarios (Briggs et al., 2015; Dewolf et al., 2020; Griffin et al., 2020; Ounounou et al., 2019). Surgeons who demonstrate better outcomes often possess stronger NTS (Ounounou et al., 2019; Yule, Flin, Paterson-Brown, & Maran, 2006). Recent evidence has also indicated that NTS interventions can impact clinical outcomes, although these studies are still scarce. For example, a study with 473 patients observed reduced operative times and quicker proficiency among trainees in hernia repair following exposure to NTS briefings and postoperative debriefings. (Koike et al., 2023).

Trauma requires team members to make assertive split-second decisions under pressure (Agha, Fowler, and Sevdalis 2015; Ounounou et al. 2019; S. Yule, Flin, Paterson-Brown, and Maran 2006). NTS enhances trauma care by promoting efficient collaboration, swift problem-solving, and optimal resource allocation (Botelho et al., 2022; Fletcher et al., 2003; Hjortdahl et al., 2009; Rosen et al., 2018).

Despite the recognized importance of Non-Technical Skills (NTS), their training is still inadequately implemented in surgical education (Patel et al. 2019). As mentioned before, in Canadian teaching hospitals, less than 1% of faculty mentioned NTS to their students during surgical activities (Lee et al. 2020).

One of the main barriers to training NTS is the absence of validated educational methods to do it, and although NOTSS is a good assessment tool, only scoring healthcare providers or students is insufficient to enhance their NTS (Ounounou et al. 2019). This gap highlights the importance of exploring educational tools for training NTS (Kim et al. 2022).

2.4 Debriefing

Debriefing is the most promising educational resource to enhance NTS (Griffin et al. 2020; Tannenbaum and Cerasoli 2013). During debriefing sessions, participants critically analyze their decisions, actions, and communication strategies experienced in simulated scenarios. This practice offers insights into their performance, highlighting areas needing enhancement (Eppich and Cheng 2015). Beyond individual reflection, debriefing facilitates open dialogue and collaborative learning, fostering an environment of psychological safety and continual growth (Garden et al. 2015; Kolbe et al. 2013; Rosqvist, Lauritsalo, and Paloneva 2019). The simple act of debriefing itself promotes NTS (Garden et al. 2015; Kolbe et al. 2013; Rosqvist, Lauritsalo, and Paloneva 2019).

Despite these powerful benefits, educators' adoption and implementation of debriefing strategies are inconsistent (Briggs et al. 2015). Many strategies remain underutilized, thus diminishing the debriefing's potential impact (Briggs et al. 2015; Sullivan et al. 2018). Educators often take a passive learning approach, providing tons of information, and do not encourage students to self-evaluate and engage in reflective learning (Briggs et al. 2015).

The PEARLS (Promoting Excellence and Reflective Learning in Simulation) Healthcare Debriefing Tool was conceived to enhance the structure and effectiveness of debriefing (Eppich and Cheng 2015). This tool integrates various debriefing techniques, such as learner self-assessment, focused facilitation, and provision of information (Bajaj et al. 2018). While PEARLS is prevalent across several specialties, its application, specifically for NTS, was underexplored (Ounounou et al. 2019; Sullivan et al. 2018; Wieck et al. 2018; Youngson 2016).

We, therefore, chose PEARLS as the potential candidate to enhance NTS in pediatric trauma, aiming to address the discussed gap in teaching NTS. To explore this potential, we assembled a panel of experts to evaluate PEARLS' effectiveness (detailed in *Chapter 3*). After the panel reached a consensus, we evaluated the new educational intervention tool in an RCT (*Chapter 4*), following Kirkpatrick's framework.

2.5 Evaluating pediatric trauma educational interventions

Kirkpatrick's framework provides a systematic approach to evaluate outcomes after an educational intervention (Kirkpatrick and Craig 1970). This model categorizes outcomes into four distinct levels. At "Level 1: Reactions," the emphasis is on the participants' immediate responses to the training, often captured via feedback forms, surveys, or post-course interviews. "Level 2: Learning" focuses on assessing the knowledge participants acquire, and it is usually measured through methods like pre-and post-tests and retention tests administered weeks or months after the course to ascertain sustained knowledge. "Level 3: Behaviours" delves into how participants apply their new knowledge. Evaluations at this level involve skill assessments through simulations or real-world data analysis before and after the course (including protocol adherence). "Level 4: Results" emphasizes the tangible

outcomes, like whether improved skills have reduced patient mortality or morbidity. In trauma education, a systematic review has underscored the importance of these metrics (Mackenzie et al. 2019). The authors suggested that reactions might be gauged by course satisfaction, learning by acquiring new knowledge in trauma management, behaviours by improved skill application, and results by clinical improvements in patient care.

Building on the work of Mackenzie et al., we utilized similar metrics to gauge the impact of the NTS debriefing tool, presented in *Chapter 4*.

Chapter 3

3.1 Manuscript I. *A debriefing tool to acquire non-technical skills in trauma courses*

3.1.1 Citation: Botelho, F., Yanchar, N., Abib, S., Bank, I., Harley, J. M., & Poenaru, D. (2022). A debriefing tool to acquire non-technical skills in trauma courses. Surgery Open Science, 10, 228–231. https://doi.org/10.1016/j.sopen.2022.10.012

3.1.2 Abstract

Objective: The study reports the use of a nominal group technique (NGT) to evaluate the PEARLS Healthcare debriefing tool as a tool to foster non-technical skills in trauma simulation courses. Additionally, it introduces a debriefing card to be used in trauma courses.

Design: A nominal group technique was used to evaluate the main strategies for PEARLS. The experts had the opportunity to share their opinions in an online survey and online meeting.

Results: Seven participants participated in the nominal group. Based on the online survey results, the self-assessment debriefing strategy (from PEARLS) was rated 4.83/5 in relevance, the focused facilitation 5/5, and the provision of information 4.5/5. Participants felt that PEARLS was appropriate and useful for fostering non-technical skills: all the debriefing strategies contained in PEARLS were felt to be valid and worth using; and cue cards for the instructors were suggested to assist them in conducting structured formal debriefings. A specific debriefing tool for trauma scenarios was designed based on these suggestions, which is presented in this article.

Conclusion: A nominal group of experts in education, simulation, and trauma support PEARLS strategies for non-technical skills training in trauma courses.

Keywords: Interprofessional education; Simulation training; Social skills; Surgery; Wounds and injuries.

3.1.3 Introduction

Pediatric trauma is a leading cause of mortality and disability worldwide, responsible for one million child deaths yearly.[1] Most of the errors in trauma can be preventable and are due to a lack of proper communication and collaboration among team members.[2,3] Therefore, better education in non-technical skills such as leadership, communication, decision-making, teamwork, and situation awareness is an efficient intervention to improve team performance and, consequently, the quality of care.[4] Educational programs in trauma require hybrid educational approaches, including formal classroom techniques and simulation in an immersive and realistic environment;[5] training in both technical and non-technical skills;[6] and "hot debriefing," a debriefing intervention followed after all simulated scenarios for knowledge and skills integration.[5–7]

However, surgical services have not taught non-technical skills since the ideal way to teach them is yet to be determined in the literature.[8,9] Even though debriefing has been considered a promising instrument to foster non-technical skills,[8,10] its use among educators is still heterogeneous,[6] and most of the strategies are not used, limiting the efficacy of this powerful tool.[6,11]

The PEARLS (Promoting Excellence and Reflective Learning in Simulation) Healthcare Debriefing Tool is one of the promising frameworks to promote non-technical skills. It

integrates and structures different debriefing strategies such as learner self-assessment, focused facilitation, and provision of information.[12] It has been used widely in different specialties but not specifically for non-technical skills.[9,11,13,14] Therefore, this study reviews PEARLS as a tool to foster non-technical skills in pediatric trauma courses.

3.1.4 Material and Methods

We formed a nominal group technique (NGT). An NGT is a panel of specialists structured to reach a consensus on a specific topic. NGT has some advantages in comparison to the Delphi technique. It is faster and more suitable for reaching a consensus on an instrument already developed instead of designing a new one.[15,16] Usually, the average number of participants in an NGT is between six to eight; hence, eight specialists were invited to compose the nominal group for this work, while the first author of this manuscript moderated the panel.

Along with the invitation, an online survey was sent to the participants. They were asked to rate (using a Likert scale) the relevance of the different strategies used in PEARLS, considering their use for non-technical skills. Additionally, the experts were invited to write their comments regarding other strategies and also to suggest delivery modalities of the instrument to the instructors (for example, by cards, posters, or mobile apps). Two weeks after the survey, the participants participated in an online meeting, where they had the opportunity to share their comments. They also voted on which PEARLS strategies should be included or rejected in a debriefing session aimed at promoting non-technical skills. After the meeting and considering the experts' opinions, a debriefing tool card was drafted and shared by email for the experts' final considerations.

A descriptive analysis of the participants' answers in the survey and the meeting is reported in this manuscript. The conclusive debriefing tool to foster non-technical skills in pediatric trauma scenarios is also presented.

3.1.5 Results

Seven participants (of eight invitations) participated in the nominal group. The participants' profiles are shown in table I.1.

Table I.1. Nominal Group Technique - Participants' Profile

	Gender	Country	Title	Position	Affiliation	Areas of expertise
1	F	Scotland	PhD	Emeritus professor	University of Aberdeen	Non-technical skills, psychology, surgical education.
2	F	Canada	MD	Clinical professor, pediatric surgeon	University of Calgary	Pediatric trauma, pediatric surgery, simulation.
3	F	Brazil	MD PhD	Full professor, pediatric surgeon	Universidade Federal de São Paulo	Pediatric trauma, pediatric surgery, simulation.
4	F	Canada	MD	Associate professor, emergency medicine	McGill University	Pediatric emergency, pediatric trauma, simulation.
5	M	Scotland	MD	Emeritus professor	University of Aberdeen	Non-technical skills, pediatric surgery, surgical education.
6	NB	Canada	PhD	Associate professor	McGill University	Psychology, surgical education, simulation.
7	M	Canada	MD PhD	Full professor, pediatric surgeon	McGill University	Pediatric surgery and trauma, surgical education, simulation.

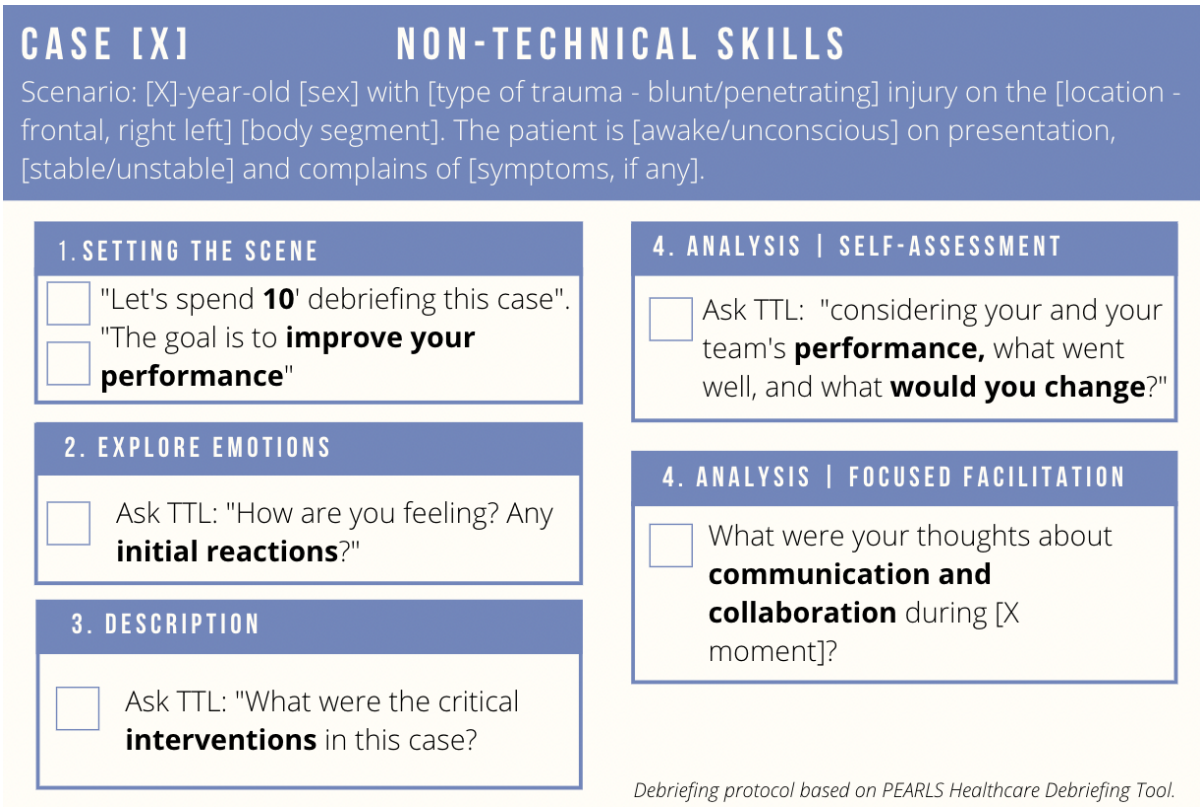
According to the online survey results, the self-assessment debriefing strategy rated 4.83 in terms of relevance (maximum 5). The focused facilitation was rated 5, and the provision of information was rated 4.5. None of the panelists suggested another strategy to be added, and two participants commented that the best way to equip the instructor with the debriefing tool would be by card. The other panelists did not make comments regarding the delivery method in the survey. One member of the NGT could not answer the online survey due to personal problems but participated in the meeting.

During the online meeting, all the survey questions were reviewed, and the diverse feedback strategies were discussed. At the end of the session, the participants concluded that:

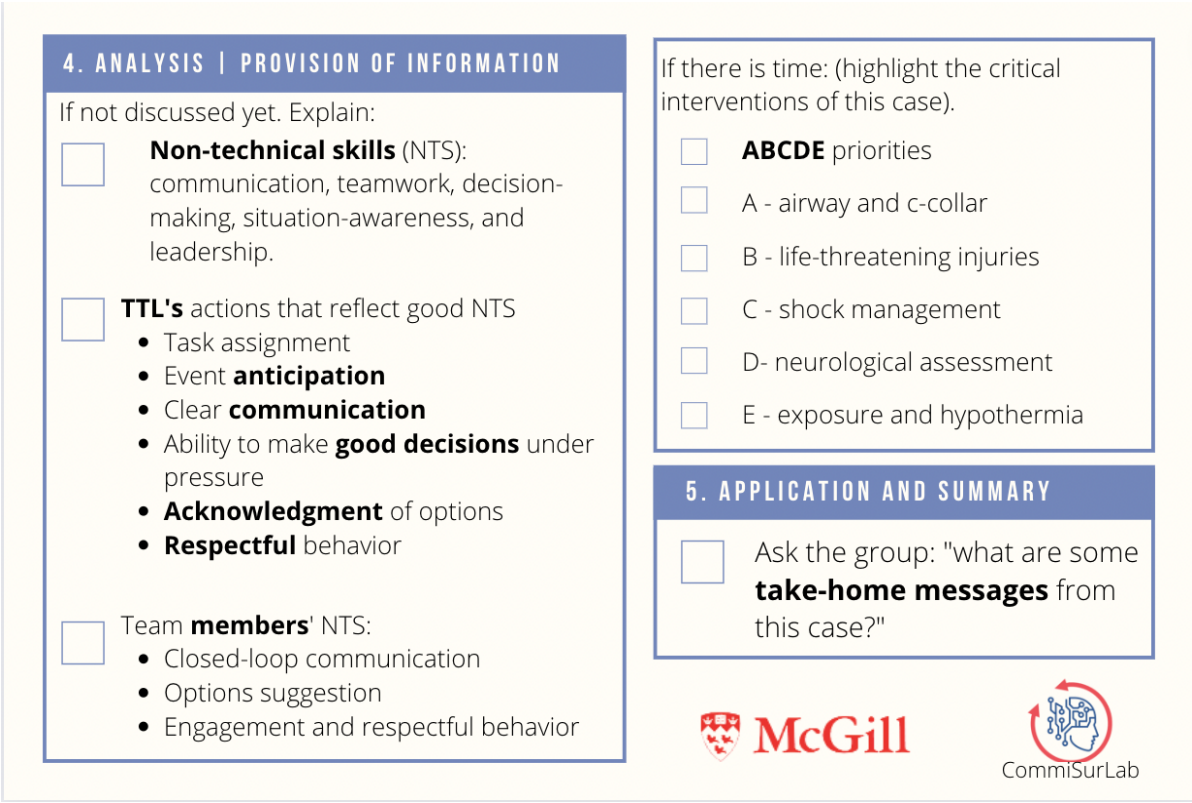
- the PEARLS Healthcare Debriefing Tool would be enough and appropriate for fostering non-technical skills;
- all the strategies contained in PEARLS would be valid and should be used;
- cards should be given to the instructor to help them providing formal feedback;
- other resources such as videos, apps, or websites would be excessive and unneeded for debriefing non-technical skills.

Following the meeting, a debriefing tool for non-technical skills in pediatric trauma scenarios was designed (figure I.1). The instrument was sent to the NGT participants and received their final approval.

Figure I.1. Debriefing Protocol for Non-Technical Skills in Pediatric Trauma Scenarios



Front page of the debriefing tool



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3.1.6 Discussion

Pediatric trauma education is still a novice area in surgical education and needs improvement. It is known that most pediatric trauma courses are inefficient, meaning that their outcomes are not translated into clinical practice.[17] Additionally, the most disseminated general trauma course worldwide, the *Advanced Trauma Life Support* course, proved to be insufficient in increasing the quality of care for injured children.[18,19] Another problem with pediatric trauma education is the shortage of current programs worldwide. They are insufficient to fulfill the *American College of Surgeons Resources for Optimal Care of the Injured Patient*, which recommends at least 16 hours of annual pediatric trauma education for every provider who assists injured children.[5,20]

It is about time to review and invest in pediatric trauma education. Our group believes that a good start would be to increase the efficiency of the current courses by promoting the training of non-technical skills through a structured debriefing tool. Without guidance, most instructors tend to provide only directive feedback, limiting the process of learning.[11] Also, a structured debriefing tool such as PEARLS with multiple debriefing strategies can mitigate the limitations of using a single approach. For example, only the self-assessment technique poorly evaluates non-technical skills compared to technical skills as trainees have more difficulty perceiving their behaviors.[13,21]

Because PEARLS has different steps of intervention and considers multiple areas of the learning process,[12] the nominal group understood that it would be an excellent framework for non-technical skills.

The future direction of this work is to evaluate the drafted debriefing tool (*Figure I.1*) in a randomized controlled trial. We intend to compare it to the standard debriefing method used in trauma courses which is directive and focused on technical skills (such as the provision of

information about procedures to protect the airway or manage shock). The results of that trial could help educators prioritize what trainees' skills they should work on during their debriefing time in advanced life support courses.

We suspect that the teams that will receive debriefing on non-technical skills will perform better than those that receive debriefing only on technical skills. Most technical skills can be learned with educative tools like videos, reading material, and practice models.[22,23] Therefore, we want to verify if the precious debriefing time after the scenarios should be used primarily for non-technical skills which are harder to learn without an instructor and simulation.[24]
In conclusion, the group of experts supports PEARLS for non-technical skills training. Even though we have examined this in the context of pediatric trauma, our conclusion could be generalized to other fields of medical education.

3.1.7 Acknowledgments

The authors are thankful for the contribution of the following experts in this work: Dr. Ilana Bank, Dr. George Youngson, Dr. Natalie Yanchar, Dr. Rhona Flin, and Dr. Simone Abib.

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3.2 The relevance of Manuscript I

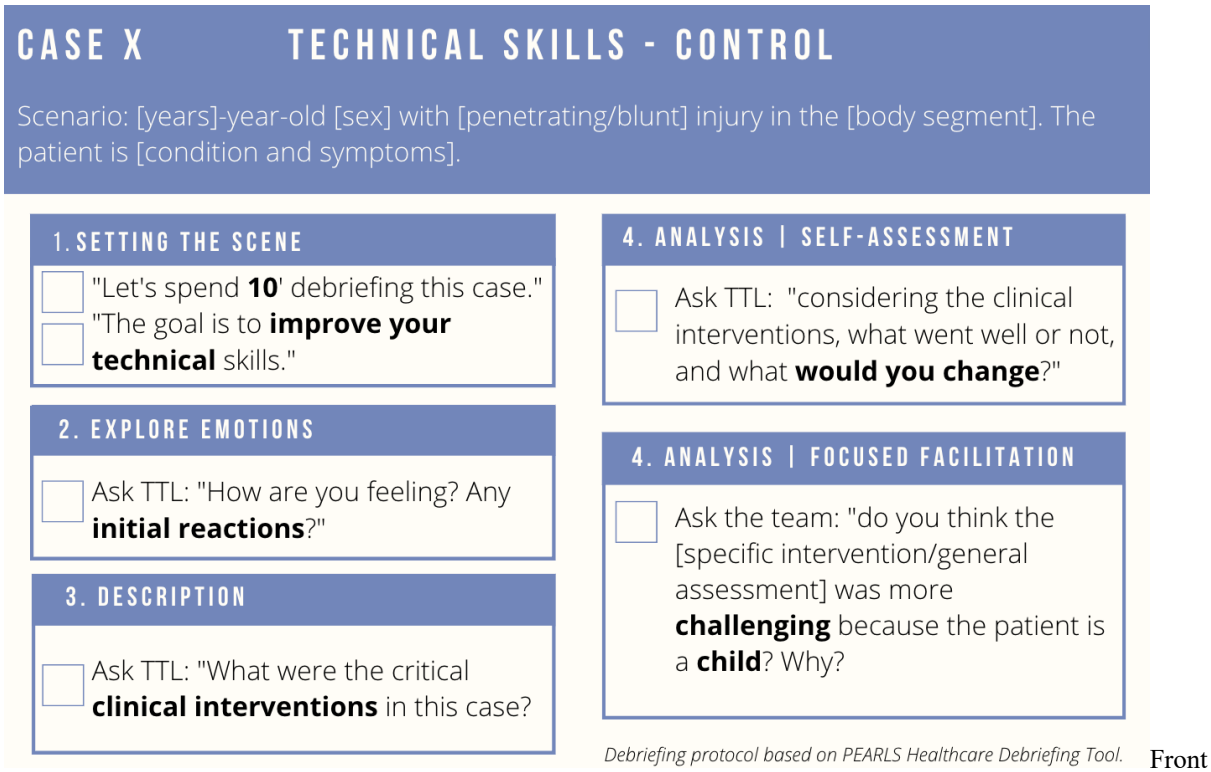
Manuscript I focused on the methods for generating the debriefing tool for our main intervention. Initially, we planned to create an entirely new debriefing tool, but after reviewing the PEARLS framework, we were pleased to find that we could incorporate many of its principles. A formal consultation with the authors of PEARLS was also conducted during this phase, who not only supported our manuscript but also authorized the use of the framework in our work.

We chose to publish the manuscript (and, consequently, the NTS debriefing tool) on an open platform to make it accessible to trauma instructors and team leaders, providing them with a useful guide for their debriefing sessions, regardless of their location. As we acknowledge that trauma education is expensive, providing the tool for free is the right action.

It is important to note that while developing the NTS debriefing tool, we also created a debriefing tool for the control condition (in the subsequent RCT) to minimize potential confounding factors. This is depicted in *Figure 3*. This step ensured that any improvements observed in the intervention condition were attributable to the NTS content, rather than solely to the presence of the card or the structured approach and various techniques used. The card for the control teams – focused on technical skills – was based on standard debriefings used in trauma courses.

In the following chapter, we will present the evaluation of the debriefing cards after a RCT. We hypothesized that structured NTS debriefing could enhance medical students' NTS. Our specific objectives were to evaluate the impact of this debriefing on students' confidence and behaviour in terms of NTS, as well as adherence to protocol.

Figure 3. Debriefing protocol for technical skills in pediatric trauma scenarios



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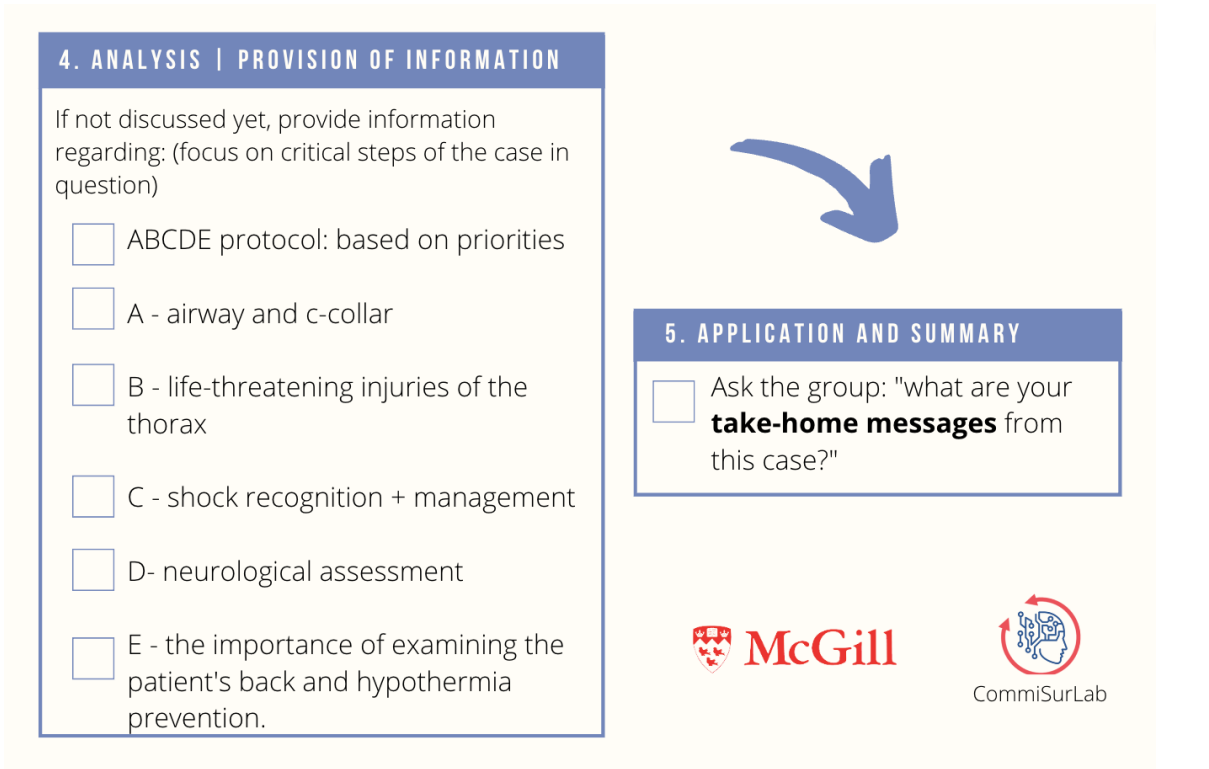

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Chapter 4

4.1 Manuscript II. *Improving pediatric trauma education by teaching non-technical skills. A randomized controlled trial*

4.1.1 Citation: Botelho, F., Rangel, AG., Harley, J.M., & Poenaru, D. (2024). Improving *Pediatric Trauma Education by Teaching Non-technical Skills. A Randomized Controlled Trial. Journal of Pediatric Surgery.* https://doi.org/10.1016/j.jpedsurg.2024.01.018

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4.1.3 Disclosure: The authors do not have conflicts of interest.

4.1.4 Abstract

Background

Pediatric trauma is a significant cause of child mortality, and the absence of non-technical skills (NTS) among health providers is linked with errors in patients' care. In this study, we evaluate the effectiveness of a structured debriefing protocol in enhancing NTS during pediatric trauma simulation.

Methods

A total of 45 medical students were successfully recruited from two medical schools, one in Brazil and one in Canada. Medical students were assigned to a control (N = 20) or intervention group (N = 25) in a randomized control trial. Following simulated scenarios,

participants in the intervention group underwent NTS debriefing, while the control received standard debriefing based on the Advanced Trauma Life Support (ATLS) protocol. Students' confidence, NTS level, and performance were measured through self-assessment surveys, the Non-Technical Skills for Surgeons (NOTSS) score, and adherence to the trauma protocol, respectively. Baseline characteristics and outcomes were compared using t-tests, Mann-Whitney, Wilcoxon signed-rank Kruskal-Wallis, ANOVA, and a repeated-measures ANCOVA. A significance level was set at $p<0.05$.

Results

The workshop increased students' confidence in leading trauma resuscitation regardless of their assignment to condition. While controlling for covariates, students in the intervention group significantly improved their overall NOTSS compared to those in the control and in all categories: situational awareness, decision-making, communication and teamwork, and leadership. The intervention teams also demonstrated a significant increase in completing trauma protocol steps.

Conclusion

Implementing structured debriefing focusing on NTS enhanced these skills and improved adherence to protocol among medical students managing pediatric trauma-simulated scenarios. These findings support integrating NTS training in pediatric trauma education.

Keywords

Communication, wounds and injuries, child, leadership, health education, simulation training

Level of Evidence: I

Abbreviations

NTS - Non-technical skills

ATLS - Advanced Trauma Life Support

NOTSS - Non-Technical Skills for Surgeons

RCT - Randomized controlled trial

RM-ANCOVA - Repeated-measures - Analysis of covariance

ICC - intraclass correlation coefficient

4.1.5 Highlights

- Errors in pediatric trauma care can be addressed by better non-technical skills among healthcare professionals. However, there is still a gap in how we should teach these skills.
- A structured debriefing focused on non-technical skills significantly improved trainees' non-technical skills and improved adherence to the trauma protocol.
- Findings of this trial support the integration of non-technical skills training in pediatric trauma education.

4.1.6 Introduction

Injuries remain a significant global burden for children and adolescents, causing nearly one million deaths annually.[1,2] Mortality represents just a fraction of the problem, as there are approximately 12 hospital admissions and 60 emergency department visits for each reported death.[3] Furthermore, injuries are a leading cause of disability globally, particularly in adolescents.[1]

Optimizing pediatric trauma care is crucial at two pivotal moments: immediately after the injury and during definitive in-hospital care.[4] While prevention plays a significant role in

enhancing immediate survival rates,[5] during the in-hospital phase, outcomes are primarily influenced by a well-coordinated trauma team ready to treat the patient upon their admission.[6] Notably, improved outcomes are more significantly correlated to the time of delivery and appropriate treatment than to the severity of the injury itself.[6]

Significant progress has been made in prevention and pre-hospital care, however, errors at the hospital are still frequent and often due to poorly prepared trauma teams.[7] Common errors include failure to recognize critical conditions such as shock and life-threatening injuries.[8] Although comprehensive educational programs could address these challenges,[8] the current trauma training courses, such as the Advanced Trauma Life Support (ATLS), are focused on adults and lack sufficient emphasis on non-technical skills (NTS), including situational awareness, decision-making, communication, teamwork, and leadership.[9]

Incorporating NTS in training is crucial. It can address the common errors in pediatric trauma care and has improved outcomes across different fields such as civil aviation, engineering, and anesthesiology.[10] Despite its benefits, NTS is rarely mentioned in surgical programs.[11] Indeed, NTS are taught in less than 1% of surgical activities with students and faculty in Canadian medical schools,[12] and the absence of established training methods is considered the main barrier to the proper teaching of these skills.[11]

To address this gap, we developed a debriefing tool for fostering NTS in pediatric trauma simulation workshops,[13] and this manuscript presents the evaluation of this tool after a randomized controlled trial (RCT). We hypothesized that a structured NTS debriefing could enhance medical students' NTS, and our specific objectives were to evaluate the impact of this debriefing on students' confidence, behavior (in terms of NTS), and adherence to protocol.

4.1.7 Methods

Debriefing protocol

The debriefing protocol used in this study was designed by a panel of seven experts in surgical education and pediatric trauma. The tool was published,[13] and is available in *Appendix 1*.

Sample

A sample size of 34 students was estimated for this study, with 17 participants assigned to control teams and 17 to intervention teams. The calculation was based on a two-tailed design, a large effect size, and a power of 0.8, and was supported by a previous study.[14] The study population consisted of medical students in their final two years. To maintain consistency and prevent additional confounders, residents and faculty members were excluded from participation due to their limited availability and prior exposure to trauma education workshops.

Students from McGill University in Canada and *Universidade Federal de Minas Gerais* (UFMG) in Brazil were invited to participate in trauma workshops, which took place in their respective simulation labs. The primary author (FB) was affiliated with both universities during the data collection period, and the study methods were the same for each workshop – except for the language used, which was English for McGill and Portuguese for UFMG.

Ten workshops were conducted by the same research team, following identical protocols between September 2022 and August 2023, eight in Canada and two in Brazil. A total of 53 students participated in the workshops, resulting in 106 recorded scenarios for evaluation. All self-assessment evaluations from the 53 students were analyzed. However, eight students (four from the intervention and four from the control) were excluded from further (non-self-

assessment) analyses due to recording issues, which hindered NTS and adherence to protocol assessment. These students could not be excluded from the self-assessment analysis, as the survey was anonymous. Ultimately, 90 videos from 45 students (20 in the control group and 25 in the intervention) were included in the NOTSS and the adherence to protocol analysis. The difference in the number of participants between the control and intervention groups occurred because not all students who registered for the course attended. Since teams were randomized at registration, we could not evenly distribute these students among the different teams on the workshop days (study).

Pediatric trauma workshops

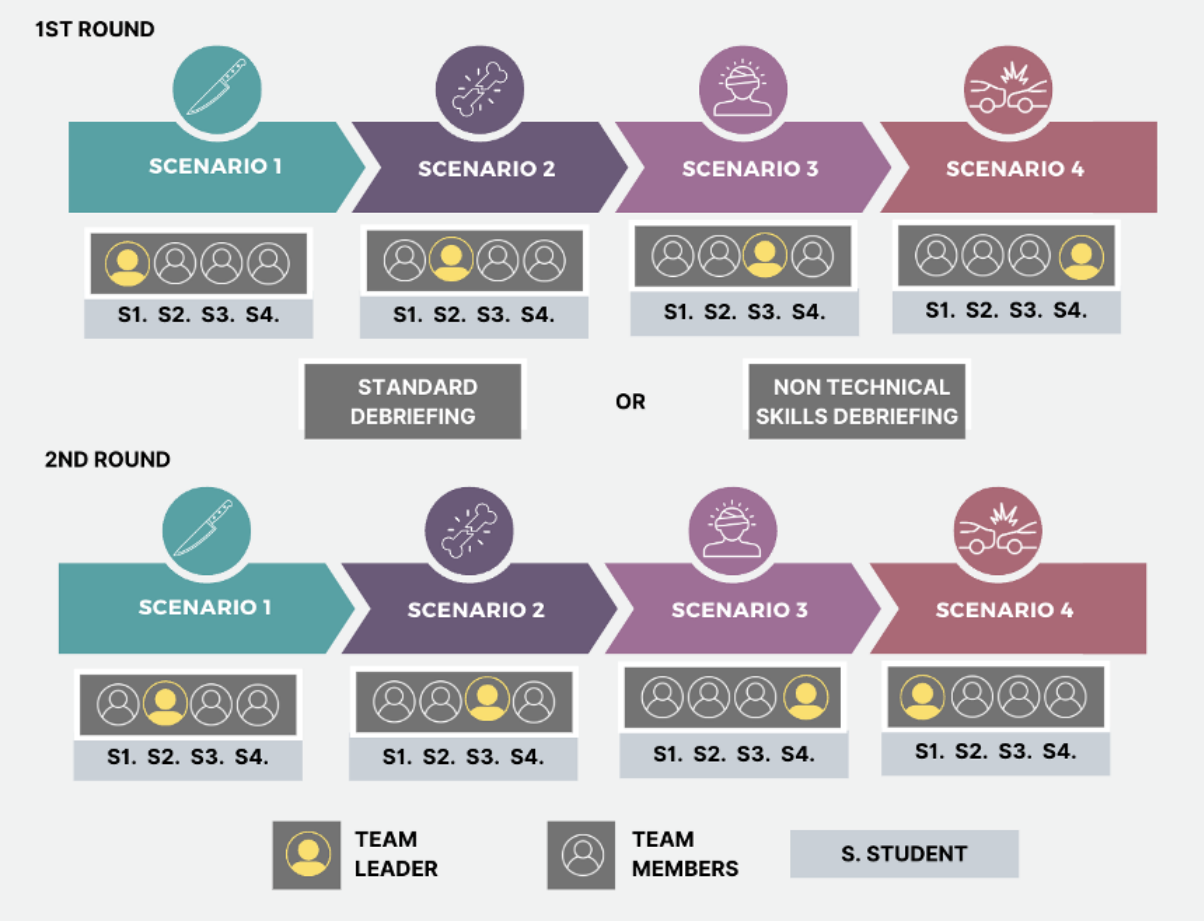
Participants received reading materials on pediatric trauma, watched online lectures on the primary assessment of injured children and engaged in a practical workshop conducted in the simulation labs.

For the randomization process, each student was assigned a unique code. A member of the research lab, who was not directly involved in the research, compiled the codes into a list and randomized it using random.org prior to each workshop.[15] The randomization assigned the first and subsequent odd positions to the control teams, while the even positions were assigned to the intervention teams. Additionally, the same member of the research lab prepared the workshop materials and debriefing cards, which were sealed in an envelope and provided to the instructors (*Appendix 1*). The codes assigned to each group were revealed after collecting all the metrics. While the instructors were not blinded to the group assignments, the students and the evaluators remained unaware of the group allocation, ensuring a blinded assessment of outcomes.

Each team consisted of four members, designated as trauma team leader, nurse, emergency physician, and respiratory therapist. The teams rotated through four pediatric trauma

scenarios, allowing participants to switch roles and experience being trauma team leaders once in each round *(Figure II.1*). The scenarios were basic and designed for low-fidelity mannequins to maintain the participants' focus on the critical decisions of the scenario rather than diverting their attention to the features of high-fidelity mannequins or specific surgical procedures (chest tube insertion, for example). A complete description of the scenarios is available in the *Appendix 2*.

Figure II.1. Workshop design



Teams of four members were formed for both arms (standard debriefing or non-technical skills debriefing), with specific roles assigned to each member: trauma team leader (yellow), nurse, emergency physician, and respiratory therapist. These groups participated in four pediatric trauma scenarios, providing opportunities for participants to rotate roles and experience being the trauma team leader at least once. After the initial rounds of scenarios, the groups received debriefing according to their assigned arm. The participants then rotated in a second round of scenarios, with the condition of being the leader in a different scenario.

An instructor was assigned to each team and accompanied them throughout the scenarios, providing basic information for managing the case, such as vital signs and laboratory exam results. After the first round of scenarios, the control group received a 30-minute standard feedback, in which the instructor discussed the ATLS protocol and how the students could apply it to the scenarios. The intervention group also received a 30-minute structured debriefing session but focused on enhancing participants' NTS, including situational awareness, decision-making, communication, teamwork, and leadership abilities. Instructors used the debriefing cards in both conditions to guide their discussion (*Appendix 1*).[13]

Following the debriefing session, all participants proceeded to a second round of scenarios. While the scenarios remained the same, participants rotated in the team leader role (*Figure II.1*).

Participants' assessment and course evaluation

We selected our metrics based on Kirkpatrick's framework, which explores different outcomes after an educational intervention, such as reaction, behaviour, and performance.[16] Additionally, a systematic review of trauma courses' efficacy guided us in identifying the relevant metrics for trauma education,[17] discussed below.

Self-assessment

After the practical session, participants were asked to complete a self-assessment questionnaire. The questionnaire measured their overall satisfaction with the workshop, perceived increase in learning, confidence in functioning as a trauma team member, and confidence in assuming the role of a trauma team leader. We employed quantitative Likert scales, ranging from 1 to 5, to measure satisfaction and confidence levels (*Appendix 3*).

Non-technical skills scoring system (primary outcome)

We employed the Non-technical Skills for Surgeons (NOTSS) score to assess NTS.[18] The NOTSS score is a quantitative performance rating system that uses a scale of 1 (poor), 2 (marginal), 3 (acceptable), and 4 (good). It evaluates four main categories of NTS: situational awareness, decision-making, communication and teamwork, and leadership. The assessment tool can be accessed online at notss.org.[19] Examples of desired and undesired behaviors in this study are provided in *Appendix 4*. The "acceptable" score was set as > 3.00 by the NOTSS developers.[18]

All scenarios were recorded, and two evaluators (who were not instructors in the course and were blinded to the group allocation) assessed the recorded videos. One of the evaluators is a pediatric trauma surgeon, and the other is a physician and a master's student. Both evaluators are affiliated with the senior investigator's research lab and completed all online NOTSS training modules available on the Royal College of Surgeons of Edinburgh website.[20]

Adherence to protocol

Adherence to protocol was evaluated using a checklist of 12 essential decisions based on the ATLS trauma protocol (*Appendix 5*), by the same evaluators of the NTS score.[7,21] The interested outcome was measured by the percentage of completed steps during each scenario.

Analysis

We ran descriptive analyses on students' demographics, such as age, sex, gender, country, and program year. The self-assessment results, NOTSS scores, and trauma protocol adherence were summarized using means and standard deviations. We tested variable normality with the Shapiro-Wilk test and checked homoscedasticity using Levene's test.

To manage outliers in our data, we employed winsorization as a corrective technique. Subsequent comparisons were made using statistical tests such as the Mann-Whitney test,

Wilcoxon signed rank, student's t-test, Kruskal-Wallis, analysis of variance (ANOVA) and a repeated-measures analysis of covariance (RM-ANCOVA).

Within the RM-ANCOVA model, the dependent variable was defined as the "NOTSS score." The independent variables were set as the "group (condition)," "time," and the interaction "group vs. time." Covariates included "country of residence," "gender," and "program year." The mean difference between the scores (score after minus score before) was computed, and when suitable, differences between groups were compared using t-tests.

Inter-rater reliability among NOTSS evaluators was measured using the intraclass correlation coefficient (ICC). Data storage and management were handled in Microsoft Excel, version 16.73, 2023. Analyses were performed in R Studio, version 2023.03.1+446, and STATA, version 18. A significance level was set at $p<0.05$.

Ethical considerations

The study was approved by the McGill University Health Centre, Research Ethics Board (#2022-7561), the McGill Faculty of Medicine and Health Sciences (IA-FMHS-22-03-061), and by the *Comissão Nacional de Ética em Pesquisa* do Brasil (Brazilian Ethics in Research National Committee, protocol CAAE 60926922.0.0000.5105). All participants signed a consent form.

4.2.8 Results

Demographics

We present the baseline demographic characteristics of the students across our subgroups (*Brazilian control, Brazilian intervention, Canadian control*, *and Canadian intervention*).

These characteristics included sex, gender, program year, and age (*Table II.1*). We examined their baseline scores for the dependent variables, including knowledge of pediatric trauma, confidence, overall NOTSS score and its categories (situational awareness, decision making, communication and teamwork, and leadership), and adherence to protocol, as detailed in *Table II.2*. We conducted a series of ANOVAs to examine whether any statistically significant differences between subgroups existed for each of our dependent variables. We found that no statistically significant differences existed between subgroups for most of these variables, with two exceptions: situational awareness ($F(3,41) = 3.02$, $p = 0.04$) and adherence to the protocol ($F(3,41) = 3.27$, $p = 0.03$). Subsequent pairwise comparisons, indicated that differences between the four groups (compared one-by-one) in the situational awareness category were not statistically significant when a Bonferroni correction to adjust for multiple comparisons was made. For adherence to the protocol, a significant difference was observed specifically between the *Brazilian intervention* and *Canadian control* subgroups (p=0.046, 95% CI, -0.286 to -0.001). However, this variance is thought to be partially attributable to the higher number of Canadian students within the control group nearing the end of their training. As this last comparison was not part of our main analyses, our baseline comparisons supported combining our subgroups to enhance our statistical power. Specifically, the *Brazilian control* and *Canadian control* subgroups were merged into a single control group, while the *Brazilian intervention* and *Canadian intervention* subgroups were combined into one intervention group.

Table II.1. Descriptive statistics of students' demographics in each group and stratified by country

	Standard Debriefing (control)		**NTS Debriefing (intervention)**	
	Canada (n = 8)	**Brazil (n= 12)**	**Canada (n = 10)**	**Brazil (n = 15)**
Female, sex, No (%)	6 (75.0)	5 (41.7)	6 (60.0)	10 (66.7)
Gender, No (%)				
Female	6 (75.0)	5 (41.7)	6 (60.0)	10 (66.7)
Male	2 (25.0)	7 (58.3)	4 (40.0)	5 (33.3)
Non-binary	0	0	0	0
Last year of the program, No (%)	6 (75.0)	5 (41.7)	5 (50.0)	4 (19.0)
Age, mean (SD), y	25.3 (1.9)	24.3 (2.6)	26.7 (1.6)	27.4 (8.7)

Abbreviations: NTS, non-technical skills; NOTSS, Non-Technical Skills for Surgeons.
a. Initial NOTSS score assessed during the first round of scenarios before the debriefing session.

Table II.2. Comparisons between baseline variables in each group and stratified by country

	Standard Debriefing (control)		**NTS Debriefing** (intervention)		***P* value**
	Canada (n = 8)	**Brazil** (n= 12)	**Canada** (n = 10)	**Brazil** (n = 15)	
Self-Assessment, mean (SD)					
Knowledge in pediatric trauma[a]	1.91 (0.70)	2.31 (0.75)	2.31 (0.75)	2.06 (0.57)	0.51[1]
Confidence level to be a team member[b]	1.46 (0.52)	1.69 (1.18)	1.62 (0.65)	1.44 (0.63)	0.91[1]
Confidence level to be a team leader[b]	1.18 (0.41)	1.15 (0.38)	1.15 (0.55)	1.13 (0.64)	0.98[1]
NOTSS score[c], mean (SD)					
Overall	2.35 (0.30)	2.21 (0.37)	2.33 (0.21)	1.99 (0.49)	0.09[2]
Situational Awareness	2.54 (0.29)	2.38 (0.47)	2.50 (0.32)	2.09 (0.47)	**0.04[2]**
Decision Making	2.25 (0.38)	2.02 (0.60)	2.25 (0.30)	1.91 (0.59)	0.30[2]
Communication and Teamwork	2.35 (0.32)	2.40 (0.51)	2.25 (0.32)	1.99 (0.65)	0.17[2]
Leadership	2.25 (0.42)	2.20 (0.39)	2.37 (0.22)	1.98 (0.47)	0.12[2]
Adherence to protocol, mean% (SD)					
Overall	84 (0.08)	70.1 (0.10)	76.6 (0.14)	70.0 (0.13)	**0.03[2]**

Abbreviations: NTS, non-technical skills; NOTSS, Non-Technical Skills for Surgeons.
a. NOTSS score assessed during the first round of scenarios before the debriefing session.
b. Confidence level rated as 1: not at all confident; 2: slightly, 3: moderately, 4: quite a bit, 5: extremely.
c. NOTSS score: 1, poor performance; 2, marginal performance; 3, acceptable performance; 4, good performance.
1. Kruskal-Wallis
2. ANOVA

Self-assessment

The participants' overall satisfaction with the workshops was high, with an average rating of 4.8 out of 5, without statistically significant differences between the intervention and control groups. The students perceived a significant increase in pediatric trauma knowledge after the workshops. They also reported heightened confidence in their ability to function effectively as part of a trauma team, both as team members and trauma leaders. There were no statistically significant differences in the confidence level results between the intervention and control groups after the debriefings (*Table II.3*). Before the workshop, only 13% of students felt somewhat confident in their ability to take on a leadership role within a team. By the conclusion of the workshop, this number had increased, with 94% of students reporting that they felt some level of confidence in their leadership abilities.

Table II.3. Self-assessment survey for knowledge of pediatric trauma and confidence level to be a team member or a team leader before and after the workshop

	Standard debriefing (control) Mean (SD)			**NTS debriefing (intervention)** Mean (SD)			***P* value**[1]
	Before	After	Mean difference	Before	After	Mean difference	
Knowledge in pediatric trauma[a]	2.1 (0.2)	3.6 (0.1)	1.5 (0.1)	2.2 (0.1)	3.7 (0.1)	1.5 (0.1)	0.91
Confidence level to be a team member[b]	1.6 (0.2)	3.2 (0.2)	1.6 (0.2)	1.5 (0.1)	3.4 (0.2)	1.9 (0.1)	0.24
Confidence level to be a team leader[b]	1.2 (0.1)	2.7 (0.3)	1.6 (0.3)	1.1 (0.1)	2.7 (0.1)	1.6 (0.1)	0.77

Abbreviations: IQR, interquartile range; NTS, non-technical skills.

a. Knowledge acquisition rated as 1: no knowledge at all, 2: a little bit, 3: some, 4: quite a bit, 5: expert.

b. Confidence level rated as 1: not at all confident; 2: slightly, 3: moderately, 4: quite a bit, 5: extremely.

1. Mann-Whitney test between the mean difference of both arms.

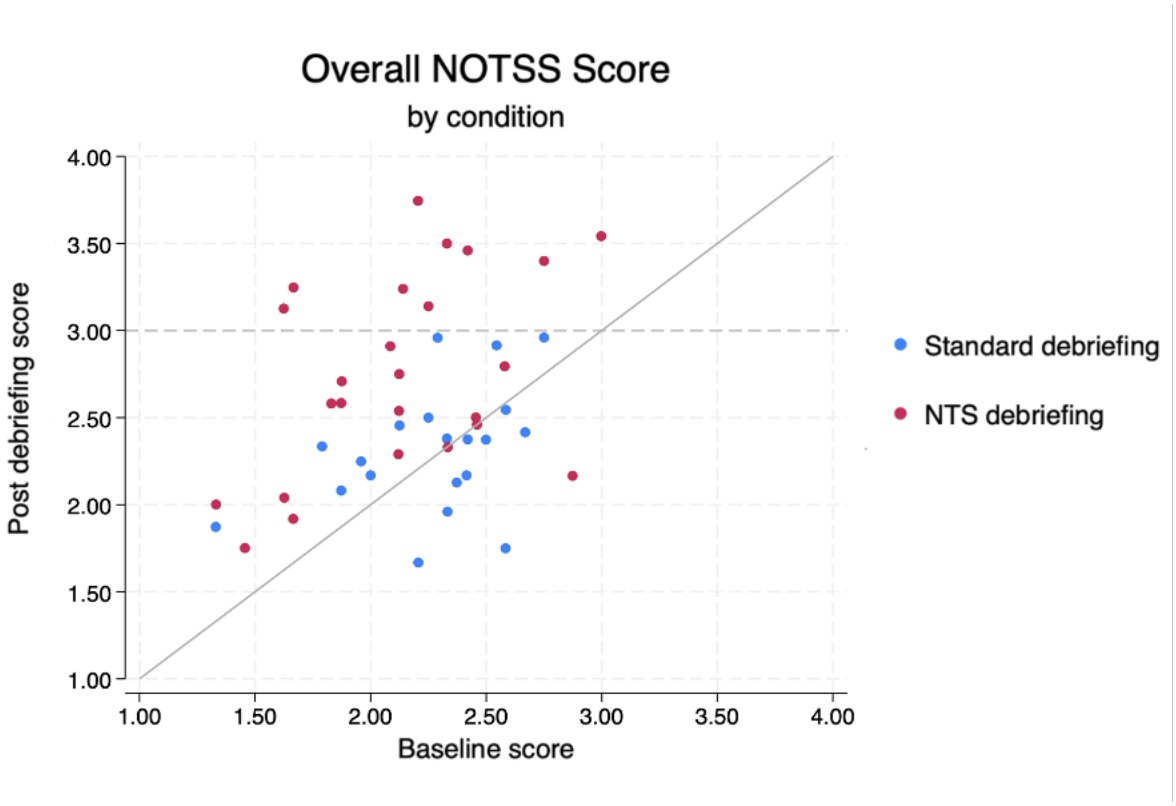
NOTSS score

The inter-rater reliability for evaluating the overall NOTSS scores between the two evaluators was excellent, with a coefficient of 0.79 ($IC_{95\%}$ 0.70-0.86; $p<0.01$).

The RM-ANCOVA demonstrated a significant main effect of time on NOTSS scores ($F(1, 43) = 19.38$, $p < 0.01$), with a large effect size ($\eta^2 = 0.311$), after controlling for the country, program year and gender. No statistically significant main effect was observed for the condition alone ($F(1, 43) = 1.12$, $p = 0.29$). Furthermore, there was a significant interaction effect between condition and time ($F(1, 43) = 17.57$, $p < 0.01$) on the NOTSS score, with a large effect size ($\eta^2 = 0.290$). Pairwise comparisons confirmed that this significance was due to the intervention group alone when comparing their pre- and post-debriefing scores (mean difference = 0.62, 95% CI, 0.35 to 0.86, $p < .001$). In contrast, the control scores did not statistically significantly increase over time (mean difference = 0.01, 95% CI, -0.27 to 0.29, $p = 0.99$).

In summary, participants in the intervention group enhanced their overall NOTSS from a pre-intervention mean of 2.13 to a post-intervention mean of 2.75. Conversely, the control group participants showed a marginal improvement, with their scores increasing from a mean of 2.29 to 2.30. Therefore, the intervention group outperformed the control group by a 0.61 score improvement. These findings are also detailed in *Table II.4* and depicted in *Figure II.2*.

Figure II.2. Overall NOTSS score - comparisons between standard debriefing (control group) and NTS debriefing (intervention)



Abbreviations: NOTSS, Non-Technical Skills for Surgeons.
NOTSS score: 1, poor performance; 2, marginal performance; 3, acceptable performance; 4, good performance.
Dashed line: minimum acceptable post-debriefing score (3.00).
Diagonal line: Represents no change in students' NOTSS scores. Students above the line improved their scores, while those below the line saw a decrease.

The same RM-ANCOVA model was applied to each of the four key subcategories defined by the NOTSS framework: situational awareness, decision-making, communication and teamwork, and leadership. The results indicated a statistically significant interaction effect between condition and time on all NOTSS score categories while controlling for country, gender, and program year. Pairwise comparisons demonstrated that these results were due to the benefits of the NTS debriefing on the intervention group. Detailed results of the categories are presented in *Table II.4* and *Appendix 6*

Table II.4. Overall and stratified NOTSS scores, before and after the debriefing

	Debriefing type	**NOTSS score**, mean (SD)[1]		***P value***[2]	**Difference between groups** (95% CI)[3]	***P value***[3]
		Baseline	**Post debriefing**			
Overall	Standard	2.29 (0.35)	2.30 (0.32)	0.87	0.61 (0.31 to 0.88)	**<0.01**
	NTS	2.13 (0.40)	2.75 (0.55)	**<0.01**		
Categories						
Situational Awareness	Standard	2.45 (0.37)	2.51 (0.37)	0.59	0.53 (0.21 to 0.86)	**<0.01**
	NTS	2.26 (0.45)	2.85 (0.58)	**<0.01**		
Decision-Making	Standard	2.10 (0.46)	2.24 (0.42)	0.27	0.51 (0.12 to 0.89)	**0.01**
	NTS	2.03 (0.49)	2.68 (0.58)	**<0.01**		
Communication and Teamwork	Standard	2.37 (0.42)	2.13 (0.32)	0.06	0.79 (0.43 to 1.15)	**<0.01**
	NTS	2.08 (0.49)	2.63 (0.63)	**<0.01**		
Leadership	Standard	2.22 (0.40)	2.33 (0.36)	0.27	0.54 (0.28 to 0.82)	**<0.01**
	NTS	2.17 (0.36)	2.82 (0.54)	**<0.01**		

Abbreviations: NOTSS, Non-Technical Skills for Surgeons; NTS, non-technical skills.

1. NOTSS score: 1, poor performance; 2, marginal performance; 3, acceptable performance; 4, good performance.

2. T-test

3. The "Difference between groups" column represents the difference between the variation of the NOTSS score in the intervention group and the variation in the control group (mean difference of intervention - mean difference of control). For example, a result of "0.61" means that the intervention group increased their NOTSS score by 0.61 more than the control group. The subsequent p-value is the result of a t-test comparing the mean difference of the intervention group with the mean difference of the control group

Adherence to protocol

Participants in the intervention group demonstrated a higher percentage of completed steps in the trauma protocol after the intervention, with a rate of 83.0% compared to 72.6% before the intervention (p<0.01, *Table II.5*). The control group also showed increased adherence, but without statistical significance, with a rate of 80.8% compared to 75.9% before the debriefing (p=0.12, *Table II.5*). No significant differences were observed between the intervention and control groups regarding final adherence to the trauma protocol (83.0% cf. 80.8%, p=0.17).

Similar results were also captured by the RM-ANCOVA conducted to assess the interaction effect between condition and time on adherence to protocol while controlling for confounding factors (gender, program year and country). This main effect was not statistically significant (F (1, 43) = 1.44, p = 0.23), indicating that the changes in adherence to protocol over time did not differ significantly between groups. There was, however, a significant main effect of time (F (1, 43) = 11.67, p < 0.01), suggesting that adherence to protocol improved over time across all participants.

Table II.5. Adherence to protocol stratified by group (debriefing type), before and after the debriefing

Debriefing type	**Adherence to protocol** mean%, (SD)		***P* value**[1]	**Difference between groups** (95% CI)[2]	***P value***[2]
	Baseline	**Post debriefing**			
Standard	75.9 (11.4)	80.8 (9.7)	0.12	6.1 (-14.8 to 2.7)	0.17
NTS	72.6 (13.5)	83.7 (13.5)	**<0.01**		

1. T-test

2. The "Difference between groups" column represents the difference between the variation of the “adherence to protocol” in the intervention group and the variation in the control group (mean difference of intervention - mean difference of control). A result of "6.1" means that the intervention group increased their adherence by 6.1% more than the control group, although this result was not statistically significant. The subsequent p-value is the result of a t-test comparing the mean difference of the intervention group with the mean difference of the control group.

4.2.9 Discussion

Training NTS is essential and can have a significant effect on surgical outcomes, similar to the effect of learning hands-on technical surgical skills. Gawande et al. highlight that while 53% of surgical errors are attributed to a surgeon's lack of experience or technical skill, 43% are linked to problems with NTS. Notably, errors are reported to be more frequent in emergencies than in non-emergency situations.[22]

NTS training and its daily use can be traced back to the aviation industry, where the focus on these skills has contributed to the safe operation of thousands of flights with minimal errors.[23] In healthcare, particularly in the field of surgery, the introduction of NTS gained momentum following influential work at the University of Aberdeen.[18,24,25] The Aberdeen team developed the NOTSS score, which assesses surgeons' behaviors during operations and crisis management scenarios, as presented in our work.[18,24,25]

The success of the NOTSS scoring system led to its widespread adoption in surgical research,[11,26,27] and it was demonstrated that team members working under leaders with high NOTSS scores perform better. [28–30] Despite the importance of these results, their integration has significantly lagged in medical education,[31] as there is a paucity of studies on effective teaching NTS skills.[11]

Various methods, such as readings, lectures, and simulation debriefing, were suggested,[27] with ongoing research to determine the superiority of one educational tool over the others.[11] In our study, we opted for simulation debriefing, which appeared to be the most promising method, as it promotes reflection, feedback, and learning from experiences in a controlled and supportive environment.[13] Additionally, debriefing encourages open communication, collaboration, and shared learning among team members, promoting safety [32–34] and is itself an opportunity to enhance NTS in our view. We also opted not to

provide NTS reading materials or lectures prior to the workshop to avoid influencing baseline NOTSS scores.

Ten workshops were necessary to recruit participants for our study. Eight workshops occurred in Canada, while two were in Brazil. The inclusion of Brazilian students in our study was driven not only by challenges in recruiting participants in Canada (fewer students per year than in Brazil) but also by the lead investigator's (FB) initiative to promote equal opportunities between the two countries and democratize educational and research opportunities.[35] By adhering strictly to the same study protocols in both countries and employing standard randomization, we ensured that the control and intervention groups of the Brazilian and Canadian arms were similar, enabling meaningful comparisons.

Self-assessment results

Both the intervention and control groups demonstrated improvements in their confidence levels in being part of a trauma team and assuming a leadership role, with no statistical difference between the two groups. These findings suggest that the workshops and simulated practice alone can enhance confidence, which represents the first level of efficacy in Kirkpatrick's framework.[17]

Self-assessment scales have limitations. Previous research has indicated that while participants may find it easier to self-assess their technical skills, evaluating their own non-technical skills is challenging.[36,37] Accounting for these limitations, we decided to investigate other metrics to analyze the efficacy of the NTS debriefing, including the NOTSS score and adherence to the trauma protocol.

Interestingly, only 13% of the students had any confidence at all in assuming a trauma team leadership role before the workshops, which raises concerns about the adequacy of the

current medical school curriculum. Despite graduating with the skills to manage complex technical situations (such as difficult airway management), they were unprepared to lead a primary survey in trauma - one of the most common pediatric emergencies. Moreover, participants stated no prior engagement in simulated team training, reinforcing the need to review the medical curriculum, at least in the institutions where this study was conducted.

The critical importance of NTS in medical education was highlighted by Lee et al. in their investigative work titled "*Nontechnical Skills in the Undergraduate Surgical and Anesthesiology Curricula: Are We Adequately Preparing Medical Students*?"[12] They found a remarkably low representation of NTS in learning goals, with only 0.76% within surgical activities and 4.55% within anesthesiology. The CanMEDS framework, widely adopted by Canadian medical schools as a guiding educational model, defines the key roles of a competent physician in Canada – Communicator, Collaborator, Leader, Health Advocate, Scholar, and Professional. Notably, the majority of these roles encompass NTS.[12]

Integrating NTS teaching within pediatric trauma settings, particularly for medical students, is an invaluable opportunity in our opinion. Firstly, pediatric trauma protocols are relatively straightforward; secondly, the care of pediatric trauma patients typically involves collaboration with a multidisciplinary team; and thirdly, medical students can effectively internalize and hone their NTS in a practical and impactful manner, as presented in our results and discussed in the next section.

NOTSS score results

The implementation of the focused NTS debriefing tool resulted in a significant improvement in the NTS of the students, independently of covariates. On average, the students did not reach the ideal NOTSS score (> 3.00), possibly due to the short duration of the workshops (4 hours) and of the debriefing (30 minutes), as well as the absence of other educational

methods, such as readings and lectures that could have contributed to a higher score. Nonetheless, it is remarkable how the participants in the intervention group showed a 0.61 greater improvement in their scores compared to the control group and almost achieved the desired score even after a short period of training. We speculate that if the intervention included multiple sessions, as is typical in trauma courses, the participants' scores might have exceeded the target threshold. It is also important to recognize that the benchmark of 3.00, regarded as acceptable, stems from qualitative research, and warrants further evaluation. Future research should include multiple workshops conducted at different time points to evaluate retention and introducing additional educational materials such as readings and lectures.

To accommodate scheduling constraints, eleven different instructors were necessary to run all the workshops (six did both control and intervention, three only intervention, and two only control). Their expertise varied, from last-year general surgery residents to pediatric surgeons and emergency physicians. Despite this diversity, the NOTSS score improvement in the intervention group was significant across the different teams. This fact demonstrates the effectiveness of a structured debriefing tool in unifying the quality of debriefing strategies, mitigating variations among instructors, and ensuring robust sessions.

Adherence to protocol results

To assess the impact of improved NTS on adherence to protocol, we utilized the percentage of completed steps of a trauma protocol as a metric, which is widely employed in trauma simulation research.[9,17,21] Our objective was to establish a correlation between the enhancement of NTS and a better understanding of the protocol, leading to increased adherence. Ultimately, better adherence to protocols is associated with reduced decision-making time in managing real-life trauma situations.[38]

We observed a significant improvement in protocol adherence only in the intervention teams, and the final number of completed steps was similar between the intervention and control groups. Still, several factors may contribute to these findings: (1) a power calculation was not made for this outcome, (2) some of the students did not reach the ideal level of NTS proficiency, and (3) the scenarios were designed to emphasize team interaction, potentially being too easy for the students to follow the protocol (less stressful factors).

Study limitations

The study has several limitations. First, the anonymity of the self-assessment survey, prevented the removal of participants later excluded in the video recording analysis from the survey results. Additionally, while the Canadian and Brazilian groups had similar profiles, unexplored factors such as language, simulation lab infrastructure, and culture might have influenced some of the results.

Another limitation is that the NOTSS score is subjective and may be influenced by the personal judgments of evaluators. To counteract this concern, two (one male and one female) independent and blinded investigators assessed the students. The evaluators' inter-rater reliability scores were also determined to gauge the consistency between them. These strategies mitigate but do not fully eliminate the potential impact of subjectivity in NTS research.

Additionally, participants might naturally do better on their second try at scenarios due to increased familiarity with the sessions. The decision to repeat the scenarios made the study more homogenous as different scenarios carry different difficulty levels, potentially impacting the NOTSS score and adherence to protocol. To mitigate the influence of repetition, we decided on a control group (and not doing only a quasi-experimental study, with only pre-post analysis). We also asked the students in the second round not to be the

trauma team leaders in the same scenario that they were in the first round. Although this limitation does not seem to have interfered with the NOTSS score (as the control group score was similar after the debriefing, 2.29 cf. 2.30), it may have interfered with the adherence to protocol analysis (adherence to the trauma protocol). Probably, due to participants' repeated opportunity to use the same trauma protocol.

While we observed positive results of NTS debriefing in medical students, its effectiveness on a more experienced population, such as residents and staff with potentially higher NTS, remains uncertain. Although students with high NTS scores (between 2.50 and 3.00) improved their NTS in our cohort, future studies should analyze the NTS debriefing impact on different populations.

Lastly, our sample size was not calculated to analyze the secondary outcomes, such as the protocol adherence. Any conclusion drawn beyond the primary outcome should be approached with caution.

4.2.10 Conclusion

Our study represents, to the best of our knowledge, the first attempt to teach NTS in pediatric trauma and has demonstrated the efficacy of focused NTS debriefing in enhancing medical students' NTS in this context.

Given that pediatric trauma remains a leading cause of mortality and disability worldwide, our findings strongly support the inclusion of a dedicated NTS section in pediatric trauma courses, encompassing comprehensive debriefing sessions. Balancing technical skills teaching and nurturing NTS during the debriefing process may mitigate errors in clinical care and improve overall outcomes.

Future research should explore more modalities for fostering NTS, quantify their impact on clinical outcomes, evaluate these skills in other populations and their retention over time.

4.2.11 Acknowledgement

We express our gratitude to the Steinberg Centre for Simulation and Interactive Learning at McGill University and the *Labsim – Laboratório de Simulação da Faculdade de Medicina da Universidade Federal de Minas Gerais* for graciously permitting us to conduct our research within their institutions.

4.2.12 References

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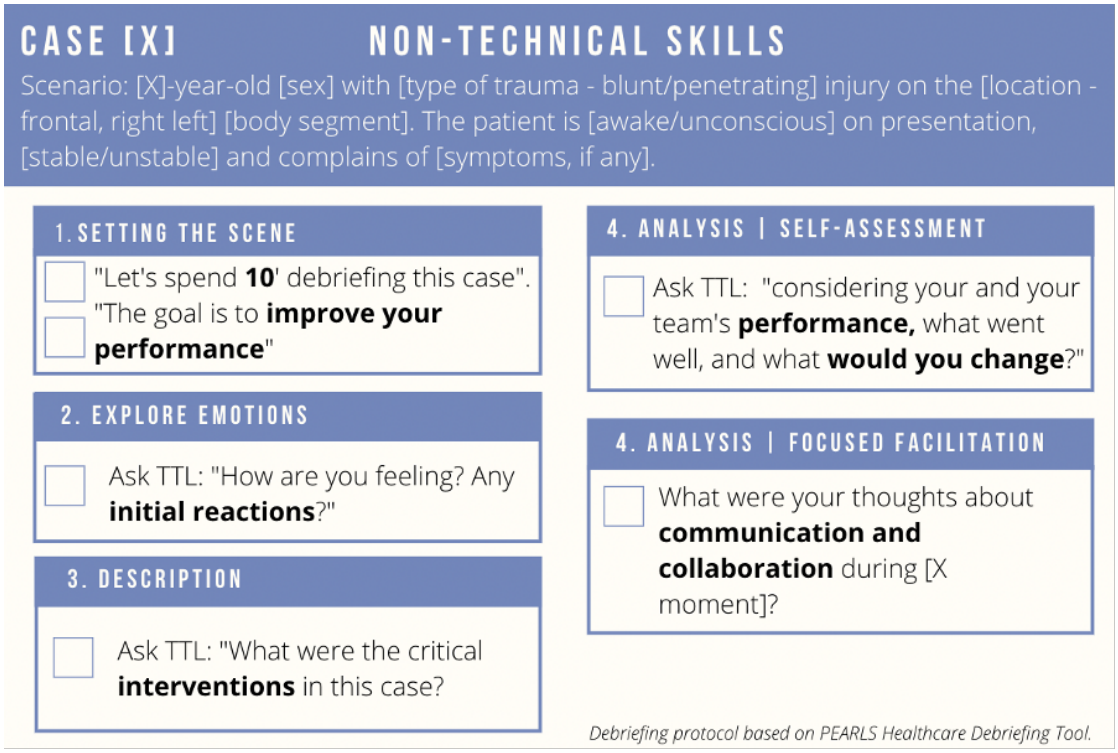
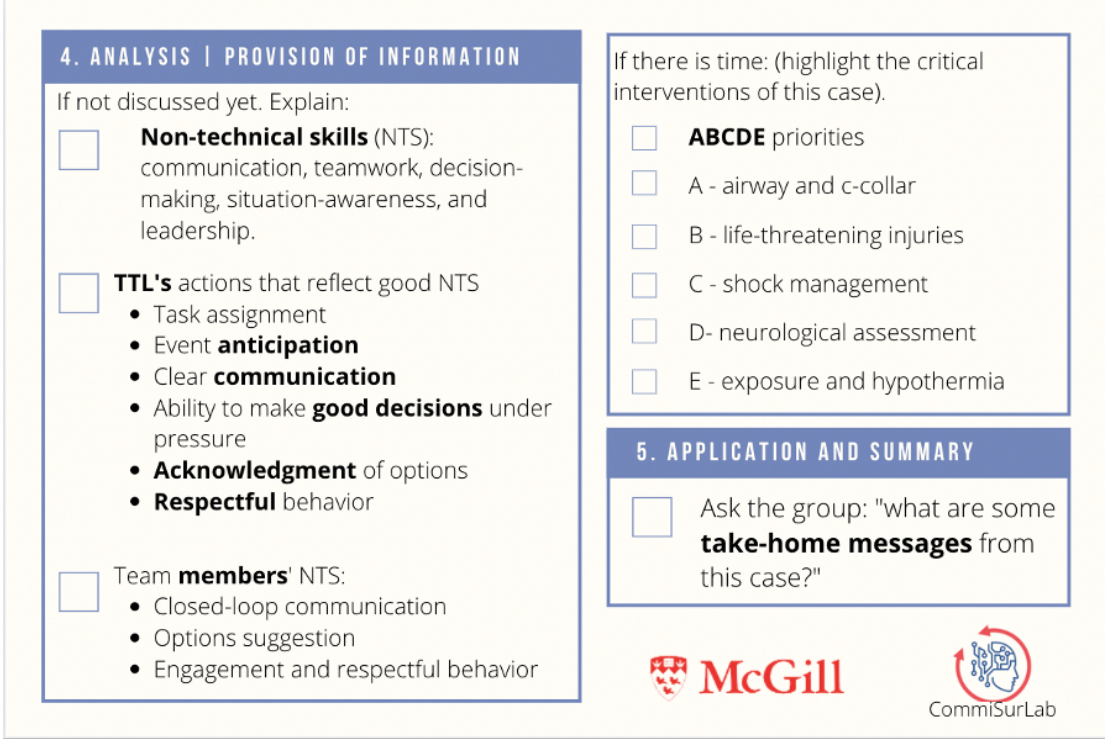
Appendix 1. *Debriefing protocols*

***1.1** Non-technical skills debriefing protocol (intervention)*



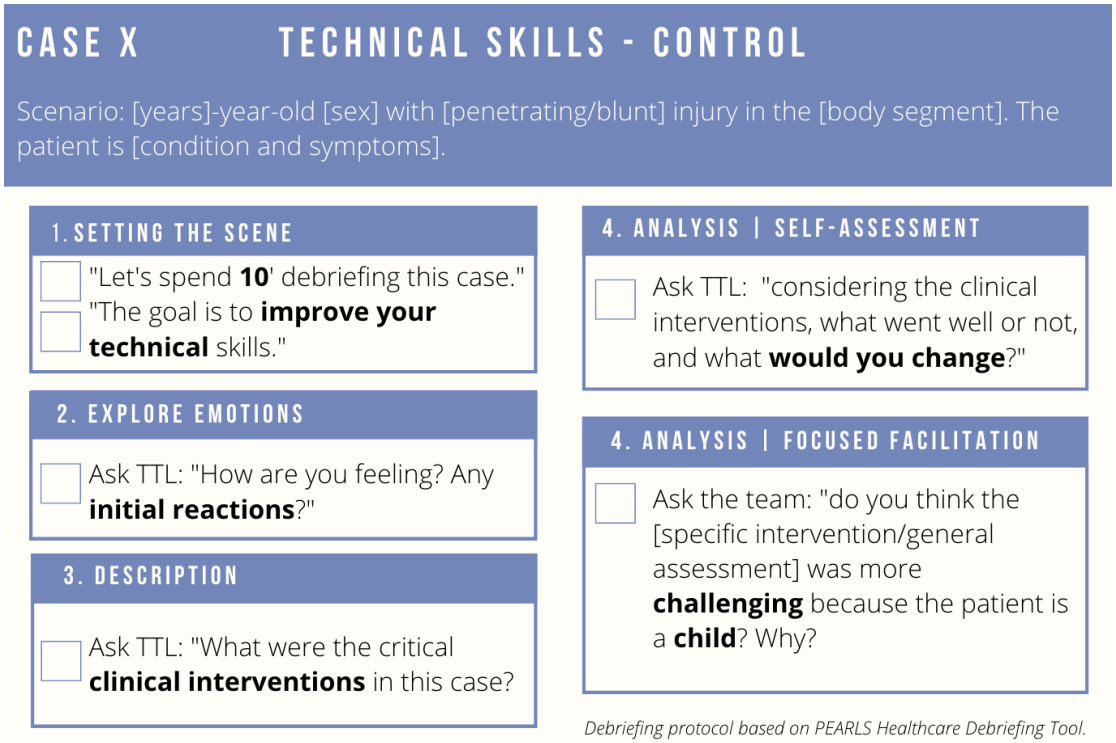
Front page of the debriefing tool



Back page of the debriefing tool

From: Botelho, F., Yanchar, N., Abib, S., Bank, I., Harley, J. M., & Poenaru, D. (2022). A debriefing tool to acquire non-technical skills in trauma courses. *Surgery open science*, *10*, 228–231. https://doi.org/10.1016/j.sopen.2022.10.012

***1.2** Standard debriefing protocol (control)*



CASE X **TECHNICAL SKILLS - CONTROL**

Scenario: [years]-year-old [sex] with [penetrating/blunt] injury in the [body segment]. The patient is [condition and symptoms].

1. SETTING THE SCENE

- ☐ "Let's spend **10**' debriefing this case."
- ☐ "The goal is to **improve your technical** skills."

2. EXPLORE EMOTIONS

- ☐ Ask TTL: "How are you feeling? Any **initial reactions**?"

3. DESCRIPTION

- ☐ Ask TTL: "What were the critical **clinical interventions** in this case?

4. ANALYSIS | SELF-ASSESSMENT

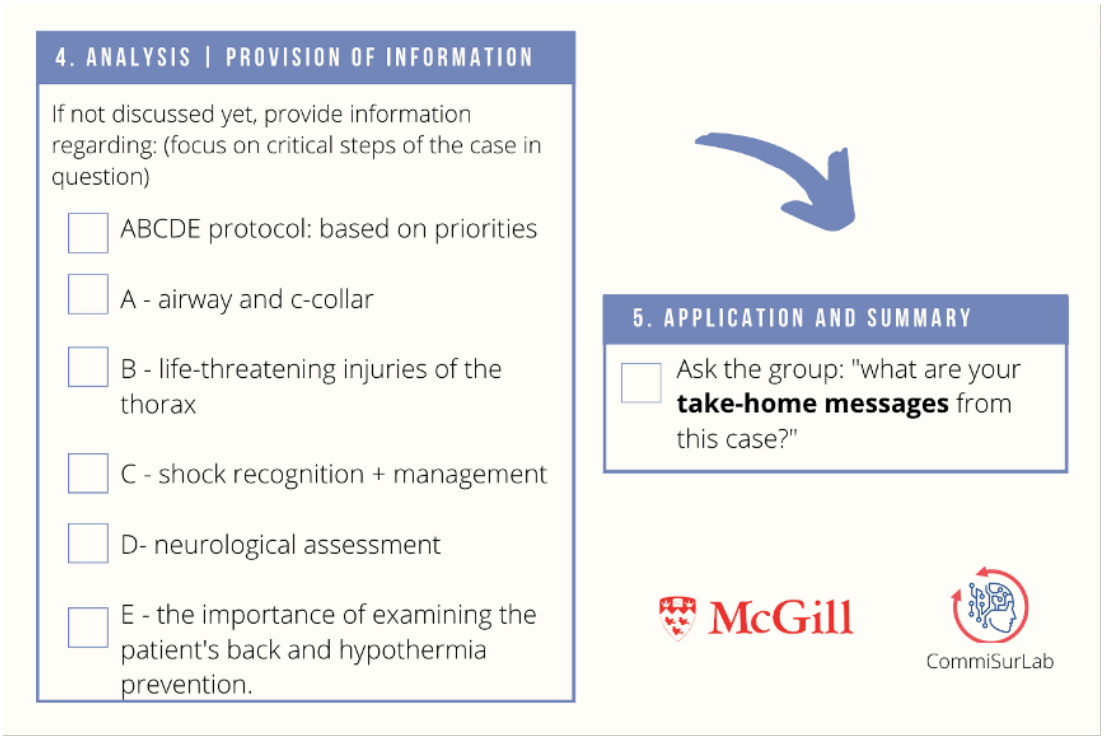
- ☐ Ask TTL: "considering the clinical interventions, what went well or not, and what **would you change**?"

4. ANALYSIS | FOCUSED FACILITATION

- ☐ Ask the team: "do you think the [specific intervention/general assessment] was more **challenging** because the patient is a **child**? Why?

Debriefing protocol based on PEARLS Healthcare Debriefing Tool.

Front page



4. ANALYSIS | PROVISION OF INFORMATION

If not discussed yet, provide information regarding: (focus on critical steps of the case in question)

- ☐ ABCDE protocol: based on priorities
- ☐ A - airway and c-collar
- ☐ B - life-threatening injuries of the thorax
- ☐ C - shock recognition + management
- ☐ D- neurological assessment
- ☐ E - the importance of examining the patient's back and hypothermia prevention.

5. APPLICATION AND SUMMARY

- ☐ Ask the group: "what are your **take-home messages** from this case?"

McGill

CommiSurLab

Back page

Appendix 2. Description of the scenarios (critical events are underlined)

2.1 Case 1*. Penetrating trauma*

Vignette: A 16-year-old male patient is a victim of a penetrating injury to the right chest. The patient was stabbed during a fight. He was brought to the emergency room by his friends. The patient is awake and complaining about respiratory distress.

Before assessment:

- The team leader should define roles and summarize the report. The team should understand their material and roles. They should be prepared for weight assessment using the Broselow tape

Assessment:

A (airway):

- The patient is awake with a clear voice. No c-collar protection. <u>The trainee needs to protect the c-spine.</u>

B (breathing):

- Oxygen saturation: 93%. Respiratory rate: 32. Decreased lung sounds on the right side.
- The team should: <u>Start oxygen. Alternative: Start oxygen from letter A. Insert a chest tube on the right side. Alternative: Start with right needle decompression.</u>

C (circulation):

- Before chest tube insertion, vital signs: Heart rate: 125, Blood pressure: 90x70, cold extremities, capillary refill: 4 sec.
- After chest tube insertion, vital signs: Heart rate: 100, Blood pressure: 100x70, capillary refill: 2 sec, warm extremities. The patient is not in shock after the chest tube insertion.

D (disability):

- Glasgow Coma Scale: 15. Symmetric pupils, and the patient moves all limbs.

E (exposure):

- Perform the log-roll maneuver. Recognize the stab wound on the back.

Secondary survey:

- No other major findings.

Other comments for the instructor:

- The patient deteriorates if the team "jumps" to letter C

***2.2 Case 2**. Extremity trauma*

Vignette: A 10-year-old male patient fell while skiing. The pre-hospital care team brings him to the emergency room. The patient is awake and complains of pain in the right leg.

Before assessment:

- The team leader should define roles and summarize the report.
- The team should understand their material and roles.
- They should be prepared for weight assessment using the Broselow tape

Assessment:

A (airway):

- The patient is awake with a clear voice.
- The c-collar is on.

B (breathing):

- Oxygen saturation: 97%
- Respiratory rate: 24, normal lung sounds.

C (circulation):

- Heart rate: 130, blood pressure: 90x70.
- Cold extremities, capillary refill: 4 seconds.
- The right leg is bleeding.
- The team should decide to stop the bleeding from the leg wound.
- Initiate fluids (20ml/kg).

D (disability):

- Glasgow Coma Scale (GCS): 15.
- Pupils are symmetric, and the patient moves all four limbs.

E (exposure):

- Perform the log-roll maneuver.
- Protect the patient from hypothermia.

Secondary survey:

- No other major findings.

Other comments for the instructor:

- Ensure that the team does not skip to letter C without addressing the leg bleeding or initiating fluids.
- Call for the orthopedic surgeon's assessment.

***2.3 Case 3**. Head trauma*

Vignette: A 15-month-old girl fell down the stairs at her house. The parents brought her to the emergency room, reporting that she is lethargic. The triage nurse laid the baby down on the hospital stretcher and placed a C-collar on her neck

Before assessment:

- The team leader should define roles and summarize the report.
- The team should understand their material and roles.
- They should be prepared for weight assessment using the Broselow tape

Assessment:

A (airway):

- The baby starts crying after a stimulus (verbal, pain). C-collar is in place.

B (breathing):

- Oxygen saturation: 92%
- Respiratory rate: 42, normal lung sounds on both sides.
    - The team should decide to start oxygen. Alternative: start oxygen from the letter A.

C (circulation):

- Vitals (after oxygen): Heart rate: 120, blood pressure: 85x60.
- Warm extremities, capillary refill: 2 seconds.

D (disability):

- Calculate Glasgow Coma Scale (GCS) using the table on the wall.
- GCS: 11 (eye-opening: 3 - to verbal; motor: 5 - localize pain; verbal: 3 - inappropriate crying).
- Pupils are symmetric, and the baby moves all four limbs.
- Ask for the neurosurgeon's help.

E (exposure):

- Protect the baby from hypothermia. Assess the back.

Secondary survey:

- No other major findings.

Other comments for the instructor:

- Ensure that the team does not skip to letter D without addressing the baby's lethargy and initiating appropriate measures.

***2.4 Case 4**. Road traffic trauma*

Vignette: a 6-year-old boy is a victim of a road traffic accident. The patient was brought to the emergency room by the pre-hospital team. The patient is immobilized with C-collar on. The patient is awake and complaining about abdominal pain.

Before assessment:

- The team leader should define roles and summarize the report.
- The team should understand their material and roles.
- They should be prepared for weight assessment using the Broselow tape

Assessment:

A (airway):

- The patient is awake with a clear voice. C-collar present

B (breathing):

- Oxygen saturation: 98%. Respiratory rate: 24, normal lung sounds

C (circulation):

- Heart rate: 140. Blood pressure: 90x65
- Cold extremities, capillary refill: 4 sec

The team should:

- Recognize that the patient has hemorrhagic shock
- Find bleeding source in abdomen
- Start IV fluids
- Ask for surgical evaluation (can be done at the end of the primary survey)

D (disability):

- Glasgow coma scale: 15
- The pupils are symmetric and reactive; the patient moves their four limbs

E (exposure):

- Perform log-roll maneuver
- Protect from hypothermia

Secondary survey:

- No other major findings.

Other comments for the instructor:

- The students should not progress to letter D if the patient is unstable.
- The patient stabilizes after a bolus of 20ml/kg of normal saline or ringer lactate.

Appendix 3. Self-assessment survey and course evaluation

1.Pediatric Trauma Knowledge

Question: How do you classify your pediatric trauma knowledge before and after today's session?

	No knowledge at all	A little bit of knowledge	Some knowledge	Quite a bit of knowledge	Expert knowledge
Before	o	o	o	o	o
After	o	o	o	o	o

2. Confidence

Question 1: Additionally, let us know your level of confidence to be part of a pediatric trauma team before and after the session:

	Not at all confident	Slightly confident	Moderately confident	Quite confident	Extremely confident
Before	o	o	o	o	o
After	o	o	o	o	o

Question 2: What about your confidence to be a pediatric trauma leader?

	Not at all confident	Slightly confident	Moderately confident	Quite confident	Extremely confident
Before	o	o	o	o	o
After	o	o	o	o	o

3. Course evaluation

Question 1: Please, rate your experience today (one to five stars):

o o o o o

Question 2: Please, share your ideas for improvement:

Appendix 4. *Examples of behaviors to guide instructors' scoring*

NOTSS category	Elements	Score	Examples
Situational awareness	*Gathering information*	1	Failure to gather information caused a problem or led to a missed injury, such as not calculating the GCS in the patient with traumatic brain injury.
		2	Gathered information from the instructor but did not use the information in the room (e.g., GCS scale, Broselow) and did not ask for information from colleagues. Only used basic information from the mannequin. Acted as a passive leader. Delayed in recognizing important findings for critical decisions
		3	Gathered information from the instructor and either: - Utilized the information from the room (e.g., GCS scale, Broselow). - Sought information from colleagues. - Conducted a thorough physical examination.
		4	Gathered information from the instructor and incorporated information obtained from the patient (through a complete physical exam), the room (whenever available), and colleagues.

Understanding information	1	Misunderstood information and made an incorrect diagnosis or took the wrong action (e.g., removing the chest tube; calculated the Glasgow Coma Scale incorrectly). Experienced delays in performing necessary tasks. Became lost in the scenario and failed to ask for oxygen if saturation was low. Points should be deducted in the "gathered information" category if the participant failed to seek necessary information or misinterpreted it.
	2	Experienced delays or had numerous questions for the instructor, which may not be feasible in real-life situations. Example: Inquiring about the normal range of vital signs or appropriate medication dosage. Did not fully understand the information but engaged in discussions with colleagues. Acted passively by solely listening to the emergency doctor without active participation.
	3	Understood the information well but did not reflect on it or engage in discussions with colleagues to further explore its implications.
	4	Understood the information well and actively discussed or reviewed it with colleagues.
Projecting and anticipating	1	Did not mention any future steps; however, if they called a specialist for consultation, it can be considered as a future step and award 2 points.

		2	Called a specialist or mentioned any future events or plans.
		3	Clearly anticipated a future event and prepared a plan B
		4	Clearly anticipated a future event, prepared a plan B, and cited relevant literature or guidelines.
Decision-making	*Considering options*	1	Failed to recognize, treat, or experienced significant delay in addressing a critical problem and did not consider options for resolving it. For example, considered chest drainage when it was unnecessary.
		2	Pointed out an option for treatment or action but did not ask for colleagues' opinions or demonstrated passive leadership.
		3	Clearly asked for opinions from colleagues or actively engaged in discussions and considered various options using conditional statements (e.g., "If I do this, that will happen").
		4	Asked for opinions from colleagues and remembered relevant guidelines or literature, or actively discussed pros and cons.
		1	Made a diagnosis but did not treat it or experienced a significant delay, such as not dressing a wound on the leg or failing to initiate oxygen for a patient with low saturation. Any action that caused harm, such as removing a chest tube, falls into this category.

Selecting and communicating orders	2	Asked the team to take action but did not specify who should do it (unless specifically asking by name or role, which still earns 2 points), or displayed passive behavior without causing harm.
	3	Prompted action directly and organized most of the time.
	4	Prompted action, discussed alternatives if the initial plan failed. For example, instructing to perform dressing, but if bleeding does not stop, apply manual compression.
Implementing and reviewing	1	Asked for the wrong order or failed to review the case when things were not going well or lacked leadership.
	2	Implemented orders only.
	3	Implemented orders and reviewed the cases or orders at any point. Ensured the orders worked or not (using the instructor's feedback only).
	4	Implemented orders, reviewed the case with active feedback from the team, such as asking if the actions worked or if everyone agreed.

Communication and teamwork	*Exchanging info*	1	Performed tasks independently without involving the team, such as a leader conducting a physical assessment without reporting findings.
		2	If the leader asked for orders, it indicated information exchange, earning 2 points, or displayed passive leadership.
		3	If the leader asked for the team's opinion at any time or led a discussion.
		4	Solicited the team's opinion, reviewed the case, and invited other inputs. For example, summarizing the actions taken and asking for further suggestions.
	Establishing a shared understanding	1	Leader did not share understanding, and the patient suffered harm, experienced a significant delay, or exhibited a clear lack of leadership.
		2	Only assigned orders without actively involving the team.
		3	Reviewed the case with the team at least once or asked if the team agreed with interventions or the overall case.
		4	Actively reviewed the case with the team, ensured understanding of their actions and comfort with the case so far. (If the student asked for specific procedures or interventions but not the overall case or if it was sporadic, consider awarding 3 points).

	Coordinating team activities	1	Worked independently or lacked leadership, allowing someone else to take control.
		2	Only gave orders.
		3	Asked for actions, assigned or clarified roles at the beginning.
		4	Assigned roles, politely asked for actions, and checked if everyone was ready or comfortable with the assigned tasks.
Leadership	*Setting and maintaining standards*	1	Showed disrespect to any team members or clearly lost leadership (e.g., not knowing what to do, allowing the emergency room to take control).
		2	Led the scenario neutrally or allowed the emergency doctor to perform most of the tasks, but still maintained clear leadership identification.
		3	Politely led the scenario, maintained the standard throughout, and gave 2 points if the focus was lost occasionally.
		4	Set standards at the beginning, maintained them throughout, and ensured the team followed the desired behavior.

Supporting others	1	Displayed disrespect or hostility.
	2	Remained neutral.
	3	Maintained politeness most of the time and acknowledged the team's actions (e.g., "Thank you for doing that").
	4	Acknowledged the team's actions, actively invited their participation (e.g., asking for their opinions), and fostered an engaged team.
Coping with pressure	1	Could not complete the scenario due to anxiety or lack of leadership or required significant help from the instructor to solve critical decisions.
	2	Remained neutral in a way that the team was not engaged or excited (boring) or remained silent without causing harm.
	3	Maintained a calm demeanor, engaged the team.
	4	Calm and occasionally requested their increased attention or focus. Avoided making jokes.

Abbreviation: GCS, Glasgow coma scale.

Appendix 5. Adherence to protocol checklist

	Protocol steps	**Successfully performed if the students:**
A (Airway) and c-spine protection	1. C-spine immobilization	Check or position a c-collar
	2. Airway assessment	Talk to the mannequin or OR observe they have a strong cry. If there is no response, a definitive airway should be considered
B (Breathing)	3. Evaluation of the respiratory rate	Inquire about the respiratory rate
	4. Breath sounds auscultation	Auscultate the thorax
C (Circulation)	5. Evaluation of the heart rate	Evaluate the heart rate
	6. Evaluation of the blood pressure	Evaluate the blood pressure
D (Disability)	7. Pupil Evaluation	Observe pupil status
	8. Glasgow coma score (GCS) calculation	Calculate the GCS.
E (Exposure)	9. Examination of the patient's back	Perform the log-roll maneuver.
	10. Hypothermia prophylaxis	Cover the patient with a blanket.
Weight	11. Weight assessment	Use a Broselow tape OR ask for the weight patient's weight from a family member
Secondary survey	12. Secondary survey assessment	Initiate the secondary survey assessment.

Appendix 6. Detailed results of the NOTSS categories

Situational Awareness

The RM-ANCOVA demonstrated a significant main effect of time on the situational awareness scores ($F(1, 43) = 16.73$, $p < 0.01$), after controlling for the country, program year and gender. No statistically significant main effect was observed for the condition alone ($F(1, 43) = 0.45$, $p = 0.50$). Furthermore, there was a significant interaction effect between condition and time ($F(1, 43) = 11.28$, $p < 0.01$).

Pairwise comparisons confirmed that this significance was due to the intervention group alone when comparing their pre- and post-debriefing scores (mean difference = 0.59, 95% CI, 0.30 to 0.88, $p < .001$)). In contrast, the control scores did not statistically significantly increase over time (mean difference = 0.06, 95% CI, -0.26 to 0.38, $p = 0.96$).

Decision Making

The RM-ANCOVA demonstrated a significant main effect of time on the decision making scores ($F(1, 43) = 16.94$, $p < 0.01$), after controlling for the same confounding factors. No statistically significant main effect was observed for the condition alone ($F(1, 43) = 0.03$, $p = 0.85$). Furthermore, there was a significant interaction effect between condition and time ($F(1, 43) = 6.99$, $p = 0.01$).

Pairwise comparisons confirmed that this significance was due to the intervention group alone when comparing their pre- and post-debriefing scores (mean difference = 0.65, 95% CI, 0.29 to 1.00, $p < .001$)). In contrast, the control scores did not statistically significantly increase over time (mean difference = 0.14, 95% CI, -0.25 to 0.54, $p = 1.00$).

Communication and Teamwork

The model did not demonstrate a significant main effect of time on communication and teamwork scores ($F(1, 43) = 2.99$, $p = 0.09$) after controlling for the same confounders. No statistically significant main effect was observed for the condition alone ($F(1, 43) = 0.62$, $p = 0.43$). However, there was a significant interaction effect between condition and time ($F(1, 43) = 19.70$, $p < 0.01$).

Pairwise comparisons confirmed that this significance was due to the intervention group alone when comparing their pre- and post-debriefing scores (mean difference = 0.55, 95% CI, 0.22 to 0.88, $p < .001$)). In contrast, the control scores did not statistically change over time (mean difference = -0.24, 95% CI, -0.60 to 0.12, $p = 0.46$).

Leadership

The model demonstrated a significant main effect of time on the leadership scores ($F(1, 43) = 33.00$, $p < 0.01$), after controlling for the cofounders. A statistically significant main effect was also observed for the condition alone ($F(1, 43) = 5.92$, $p = 0.01$). Furthermore, there was a significant interaction effect between condition and time ($F(1, 43) = 17.69$, $p < 0.01$).

Pairwise comparisons confirmed that this significance was due to the intervention group alone when comparing their pre- and post-debriefing scores (mean difference = 0.65, 95% CI, 0.41 to 0.90, $p < .001$)). In contrast, the control scores did not significantly increase over time (mean difference = 0.10, 95% CI, -0.16 to 0.37, $p = 1.00$).

3.2. The relevance of Manuscript II

Manuscript II represents the cornerstone of my doctoral research, offering level I evidence in a pioneering study. It examines, for the first time in literature, how an educational tool – specifically, the NTS debriefing tool – effectively enhances trainees' NTS and protocol adherence.

This research has profoundly influenced my approach as a trauma instructor and academic clinician approach. I have realized the importance of prioritizing NTS during debriefings, whether in training courses or following real-life situations. While there are numerous opportunities to acquire technical skills, debriefing emerges as crucial for NTS development.

Manuscript II calls for a paradigm shift in teaching trauma, which entails incorporating a dedicated chapter on NTS in trauma textbooks, adding relevant NTS lectures during courses, and employing a structured and focused NTS debriefing framework.

The findings of this manuscript also paved the way for further research. A significant need has emerged to refine the NTS scoring system (NOTSS, as an example), which currently demands extensive resources, such as trained personnel and video recording capabilities. Recognizing these limitations and the benefits of personalized debriefing scores, we embarked on a project to develop a large-language model to score participants in simulation.

Furthermore, we are exploring cost-effective alternatives to high-fidelity simulations to democratize NTS training access. VR has emerged as a promising platform, as highlighted in our literature review (Khan et al. 2022), and we have been developing a VR platform to enhance trainees' NTS in pediatric trauma.

Chapter 5. Overall discussion

5.1. Additional comments on the non-technical skills debriefing tool

Traditional medical education has often favoured passive learning techniques, which are limited in retention (Barsness 2020). Similarly, exclusive reliance on a single debriefing strategy such as self-assessment is ineffective, as trainees need help to assess their NTS accurately (Boet et al. 2011; Wieck et al. 2018).

The PEARLS Healthcare debriefing tool was identified as a suitable candidate for adaptation to teaching NTS due to its structured nature and combination of multiple feedback strategies such as self-assessment, focused facilitation, and provision of information (Eppich and Cheng 2015).

The PEARLS tool also influenced our choice to use the Nominal Group Technique (NGT) instead of the extensive Delphi technique, typically used for designing new frameworks (Harb et al. 2021; McMillan, King, and Tully 2016).

We carefully selected participants for the NGT, aiming for a gender-balanced panel due to the potential influence of gender on feedback in surgical education and skills acquisition (Ali et al. 2015; Minter et al. 2005). For example, male learners have a propensity for repeated practice, whereas female learners prefer one-on-one instruction (Ali et al. 2015; Minter et al. 2005).

To design our NTS debriefing tool, the invitees included four women, three men, and one non-binary panellist, with only one man unable to participate. Additionally, our selection ensured expertise in three key areas: NTS, pediatric trauma, and simulation. The group also included two creators of the NOTSS scoring system and a representative from a low-resource setting to broaden the tool's applicability.

The NGT team agreed that the strategies within PEARLS were sufficient to foster NTS without needing additional methods. The card was designed to be adaptable to various scenarios and user-friendly. Instructors can easily input case-specific information, such as age, sex, and specific injury, into designated areas on the card. Interestingly, the debriefing card's utility extended beyond pediatric trauma. It is also suitable for adult trauma education and even applicable to real-life events, opening new avenues for broader validation in future research.

5.2 Additional comments on the RCT study

Sample

The reviewers of our main manuscript (*Chapter 4*) raised concerns about our study population – medical students – suggesting they might not be adequately prepared to manage pediatric trauma scenarios, even in simulation. However, our findings do not support this assertion. Even though the students had not participated in trauma or team simulations before, our final results showed that they completed over than 80% of the trauma protocol, independently of the condition. The scenarios, while not overly complex, reflected everyday situations at the trauma bay, including (1) a baby with head trauma, (2) a leg fracture with shock, (3) a stabbed wound in a teenager, and (4) a child with abdominal trauma after a car accident (Faria et al. 2022).

The decision to involve medical students as participants was driven by their limited knowledge of NTS and to underscore the feasibility of early NTS training in healthcare education, in alignment with the CanMEDS framework (Lee et al. 2020).

Self-assessment

While not detailed in the main manuscript, measuring students' overall satisfaction with the pediatric trauma workshops was an essential step in our research, achieving a 4.8 score out of 5 on the satisfaction scale. This measurement aimed to ensure that the workshop met their expectations and did not provide a negative experience, which could potentially impair their NTS acquisition. A recent study, for example, has shown that an intentional simulated patient death can result in increased short-term anxiety, stress, and negative emotions among learners without necessarily leading to improved skill retention or knowledge acquisition (Khanduja et al. 2023). The authors concluded that negative experiences during simulation should be avoided.

Regarding the confidence evaluation, while studies in trauma education often use it as an indicator of positive outcomes, reliance solely on this metric can be misleading (Ounounou et al. 2019; Fuglsang, Bloch, and Selberg 2022; Coggins et al. 2017). A systematic review done by Davis and colleagues highlighted the limitations of self-assessing overall skills compared to external evaluation (Davis et al. 2006). The authors found that physicians often have limited ability to accurately self-assess, suggesting that professional development and competence evaluation should incorporate instructors. Notably, the least skilled individuals and those most confident prior to intervention exhibited the poorest self-assessment accuracy. Furthermore, accuracy in self-assessing NTS was found to be even lower in comparison to the technical skills (Boet et al. 2011).

An additional observation emerged from our study regarding the students assigned to the control condition. Twenty-five percent of these students reported being quite or extremely confident in their leadership roles post-workshop. In contrast, no student in the intervention condition reported this confidence level even after the NTS debriefing. These results raise the

question of whether exposure to the NTS materials would have influenced students' self-assessment, as they would have more accurate information to assess themselves.

In summary, self-assessment in simulation studies should be approached with caution. We advocate for including different levels of Kirkpatrick's framework in trauma education research to better understand the effectiveness of educational intervention (Kirkpatrick and Craig 1970; Mackenzie et al. 2019).

NOTSS categories limitations

The NOTSS developers conducted cognitive task interviews with 27 consultant surgeons across 11 hospitals in Scotland, discussing critical incidents in operating rooms to generate and refine the NOTSS score system (S. Yule, Flin, Paterson-Brown, and Maran 2006; S. Yule, Flin, Paterson-Brown, Maran, et al. 2006; Jung et al. 2018). Although their approach was robust, combining extensive literature review and expert interviews, the correlation of each NOTSS category – situational awareness, decision making, communication and teamwork, and leadership – with outcomes has yet to be independently tested (Jung et al. 2018). The categories act as a guide, indicating the focus areas for debriefing and personalizing feedback. However, the significance of these categories' impact on outcomes has yet to be fully understood.

Projecting an ideal number of debriefing sessions

We conducted all four scenarios before any debriefing session to prevent the potential cross-contamination of NTS knowledge among scenarios. This method deviates from the standard trauma education practice, where a debriefing usually follows each scenario. Adopting the traditional approach might have yielded higher post-workshop scores due to more debriefing sessions.

Participants assigned to the intervention condition showed consistent improvement in their NOTSS scores (0.62 on average), irrespective of their initial scores (*Table 2)*. Based on these findings and since the ideal number of debriefing sessions for NTS training is still under investigation (Kim et al. 2022), we hypothesize that approximately four NTS debriefing sessions could elevate any student to an acceptable score (≥ 3.00). Although this projection should be considered cautiously, as the cumulative effects of multiple debriefing sessions have not yet been fully explored, this number can be a reference for future research about NTS training retention.

Table 2. Comparative mean differences in NOTSS score by baseline ranges

Baseline NOTSS score	Mean difference	
	Standard debriefing	NTS debriefing
1.0 to 1.5	0.50	0.50
1.5 to 2.0	0.29	0.78
2.1 to 2.5	-0.02	0.64
2.6 to 3.0	-0.20	0.22

Abbreviations: NOTSS, Non-Technical Skills for Surgeons; NTS, Non-Technical Skills

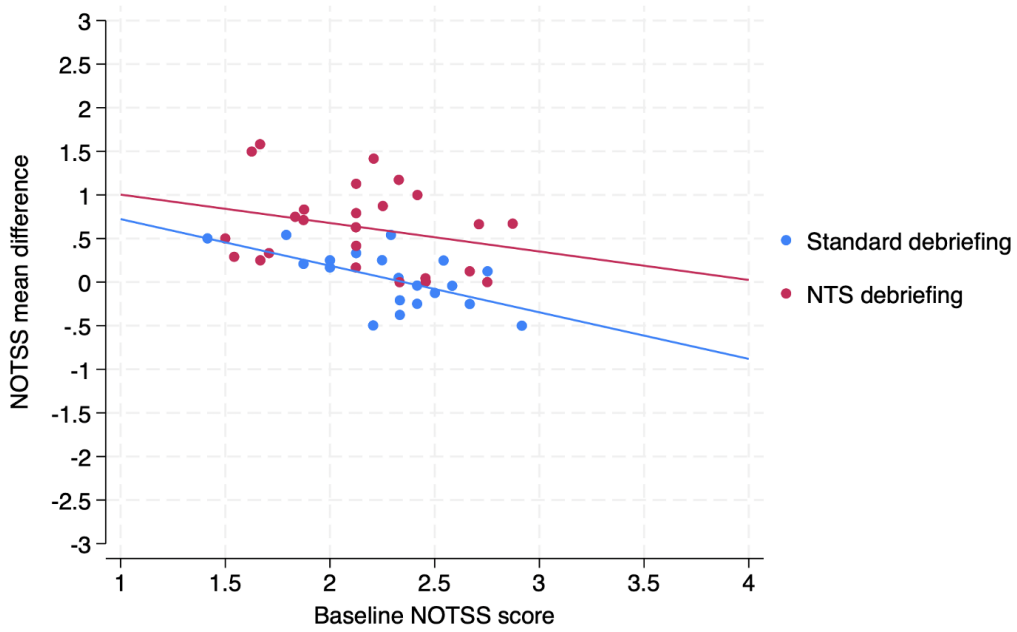
It is noteworthy mentioning that NTS tends to improve, rather than decline over time, as physicians practice continuously. Sanguanwit and colleagues, in their 16-week study with emergency residents, observed that NTS improved with consistent work in the emergency department, irrespective of specific interventions (Sanguanwit et al. 2023). Remarkably, a single two-hour NTS mini-course, consisting of a one-hour lecture followed by a one-hour simulation, increased the weekly improvement by 60% compared to what was predicted

without intervention. This finding highlights the potential cost-effectiveness of NTS interventions, as the need for repeated courses to maintain skills may be less frequent for NTS compared to technical skills.

NTS deterioration in the control condition

Table 2 also reveals a downward trend in NOTSS scores after debriefing for students in the control group. Contrary to expectations of a plateau (towards zero, when the baseline score is closer to its maximum), with every unit increase in the baseline NOTSS scores, we observed a 0.62 drop in NOTSS mean difference, t(18) = -2.68, p = 0.01, 95% CI (-1.11 to -0.13). Further analysis revealed that a baseline NOTSS score of 2.29 served as a critical threshold. Beyond this point, participants began to experience a decline in their NOTSS scores, indicating a deterioration in their NTS (*Figure 4*). These results highlight a critical need to further explore this impact, ensuring that current trauma courses are not undermining NTS.

Figure 4. Mean differences in NOTSS score by baseline scores



Abbreviations: NOTSS, Non-Technical Skills for Surgeons

Given the constraints on debriefing time and based on this thesis's findings, we advocate prioritizing NTS in debriefing sessions over technical skills, which can be acquired through other validated training methods (Colonna et al. 2022; Haubruck et al. 2018). While technical skills can be improved using digital tools like digital box trainers, immersive VR trainers, robotic surgery trainers, and serious games, these tools are still being studied for NTS training (Feenstra et al. 2023).

Finally, two last comments on our NOTSS analysis to better clarify the study and that was not included in the main paper: (1) we defined a successful outcome as the ability of the NTS debriefing tool to enhance students' NTS. Any statistically significant improvement in NOTSS scores when comparing the groups before and after the intervention was considered indicative of a successful outcome. (2) “Time” in the RM-ANCOVA means the analysis performed in the two different rounds.

Additional rationale in choosing protocol adherence as a measure

The effectiveness of trauma educational interventions in adult and pediatric care has yet to achieve Level 4 of Kirkpatrick's framework, which signifies clear clinical benefits (Mackenzie et al. 2019; Jayaraman et al. 2014). This shortfall is attributed to various factors, including the multitude of confounding elements in trauma assessments – diverse team compositions; the range of injury severities; the inherent nature of emergencies complicating experimental studies (Botelho et al. 2020; Botelho-Filho 2020; Mackenzie et al. 2019); and the scarcity of validated measures for gauging impact (Simpson, Rivara, and Pham 2012).

Most trauma education studies concentrate on outcomes at Levels 1 or 2 of Kirkpatrick's model, typically measuring increased provider confidence or enhanced knowledge acquisition (Mackenzie et al. 2019). Our study aimed to go beyond this by examining NTS acquisition

and investigating whether improved NTS leads to better protocol adherence (Level 3 of Kirkpatrick). While our intervention did result in a notable increase in adherence, we recognize the limitations inherent in this analysis, questioning if we should have used different parameters. Adherence to protocol still stands as an intermediary step between skill acquisition and patient outcomes (van Maarseveen et al. 2020; Botelho et al. 2020; Ahmed et al. 2019; Briggs et al. 2015). It is a proxy for quality care but not a direct measure of patient outcomes (Botelho et al. 2020).

The American College of Surgeons suggested parameters like hypo/hypercapnia, resuscitation volume issues, and hypothermia to evaluate pediatric trauma quality of care in real-life situations (Committee on Trauma 2014). Current high-fidelity mannequin technology requires expert technicians and instructors to replicate these physiological parameters accurately, posing challenges to using them as outcome measures in simulation. Consequently, this limitation hinders understanding the full impact of new educational interventions.

Emerging technologies such as VR and AI may help bridge this gap, offering more immersive and realistic experiences that reproduce the patient's physiological status. They hold, therefore, the potential to unlock more effective metrics for trauma education research.

5.3 Additional future directions

As the field of NTS in surgical practice continues to evolve, several areas warrant further investigation to improve our understanding and application of these skills, as proposed in the following sections.

5.3.1. Relate NTS implementation to improved clinical outcomes

Although studies have demonstrated the association between implementing an NTS curriculum with better scores, establishing a direct link between NTS training and patient outcomes is still necessary (Griffin et al. 2020; Kim et al. 2022). New studies should explore how integrating NTS training into surgical education programs translates into measurable improvements in patient outcomes, such as reduced errors, complications, and patient-reported experience.

5.3.2 Explore long-term retention of the NTS curriculum.

Building upon the existing evidence of short-term effectiveness, future studies should investigate the long-term retention of NTS skills acquired through specific training interventions (Ounounou et al. 2019; Kim et al. 2022). Assessing the durability and transferability of these skills over time will help determine the need and optimal frequency required to maintain proficiency in NTS among trauma providers.

5.3.3 Utilize objective methods for NTS scoring

Future endeavours should also explore using objective methods to mitigate subjectivity and enhance the reliability of participant evaluation. Applying AI algorithms and machine learning techniques may solve this challenge, reducing bias and scoring variability.

5.3.4 Analyze the impact of the debriefing in a different sample

As discussed in our main manuscript, the impact of NTS debriefing on a more experienced population has yet to be discovered. As residents and staff may already possess better NTS, it is essential to understand if the debriefing tool would benefit them or if they would require different or a combination of strategies.

5.3.5 Evaluate other educational methods

To optimize NTS training, further investigation is needed to determine the effectiveness of other educational methods. Research should aim to discern the relative impact of reading materials, recorded lectures, VR platforms, and other educational approaches. By elucidating the strengths and limitations of each method, future studies can guide the development of efficient NTS training programs using debriefing and combining other educational strategies.

We have built a VR platform to increase the accessibility of pediatric trauma education, including teaching NTS. VR can democratize NTS training, allowing trainees to connect with colleagues and experts worldwide (Pinkham et al. 2022; Khan et al. 2023). Nevertheless, further research should establish its safety and compare its efficacy with high-fidelity mannequins.

Lastly, we are also engaged in a project to automate direct feedback on NTS using AI. Automated feedback can contribute to a better quality of education in settings with a shortage of instructors. A recent study demonstrated that AI instructors can provide feedback comparable to or even superior to that of experienced neurosurgeon instructors in simulated oncologic neurosurgery scenarios (Fazlollahi et al. 2022).

5.4 Additional limitations

An additional limitation of our study, reflecting a broader limitation inherent to simulations using mannequins, pertains to the influence of instructors in the simulation room. A comprehensive study in France, which assessed 344 scenarios, observed that instructors acting as participants in the trauma room affect NTS in almost all instances (Koca et al. 2023). This effect occurs as instructors may prompt students to utilize previously overlooked resources or to foster communication. Given that our study involved multiple instructors, this variation could have contributed to the differing scores observed. Immersive VR platforms

may overcome this limitation as they will require minimal instructor intervention or participation over time (Fazlollahi et al. 2022; Colonna et al. 2022; Abulfaraj et al. 2021).

5.5 Final comment – interventions in pediatric trauma education, a global surgery research agenda

Better education for healthcare providers and students improves patient care but also fosters a cultural environment conducive to advancements in prevention and public awareness campaigns (Botelho, Truché, et al. 2021; Anderson et al. 2018; Rajbhandari et al. 2020; WHO 2008; Blinman TA, Nance M 2014). In our opinion, the most relevant intervention for pediatric trauma education in the last years was the *Trauma and Resuscitation in Kids* (TRIK) course, a 16-hour pediatric trauma course for healthcare providers in North America (Trauma Resuscitation in Kids – TRIK), The Royal College of Physicians and Surgeons of Canada, 2022). However, TRIK lacks a formal debriefing for NTS, and our efforts to globalize this course, including hosting the first course outside North America in Brazil (October 2022), encountered financial barriers.

As diversity leads to more efficient interventions (Garas et al. 2020), adopting an equitable international collaboration is paramount. Research in *Global Surgery* often follows a unidirectional pathway, from high-resource settings to intervening in low-resource environments, imposing an agenda that may not benefit the local settings and the global agenda (Garba et al. 2021; Botelho, López, et al. 2021). Alternatively, it is vital to consider welcoming professionals from low-resource settings to well-resourced academic institutions. These professionals bring valuable experiences and insights into the challenges faced by most of the world's population (Botelho, López, et al. 2021). Equipping these professionals with the right tools can foster an environment of 'brain circulation' (Dente 2007). This approach

enriches the knowledge pool worldwide and addresses major global health problems overlooked in the past, including trauma (Chen et al. 2022; Wiesel 2014). It should be incorporated by global surgery departments primarily based in high-income countries (Garas et al. 2020; Garba et al. 2021).

Ninety-five percent of the deaths in pediatric trauma still happen in LMICs (GBD 2019 Diseases and Injuries Collaborators 2020). Addressing this challenge requires someone from the field to interpret the results better and suggest the following steps (Ahmad et al. 2021; Botelho, López, et al. 2021).

This thesis was only possible after I was welcomed by Canada, McGill and its resources. I hope that this example of collaboration may serve as a model for other institutions and that our results can increase the quality of care at trauma bays worldwide.

Chapter 6. Conclusion

In the study's first objective, experts agreed that a comprehensive and structured debriefing tool incorporating multiple debriefing strategies is the ideal pathway for fostering NTS training in pediatric trauma. From this consensus, an NTS debriefing card was generated, including self-assessment, focused facilitation, and provision of information as debriefing strategies.

In the second objective, we showcase the effectiveness of the focused NTS debriefing tool in augmenting medical students' NTS and increasing adherence to the trauma protocol. To our knowledge, this research is the first one to present an efficient method to teach NTS in pediatric trauma. The study also showed that failing to debrief NTS does not merely hinder improvement; it can actively diminish the NTS participants bring to the simulation lab.

Given that pediatric trauma remains a foremost cause of death and disability globally, our findings advocate for the integration of a dedicated NTS component in pediatric trauma courses. Prioritizing NTS training and balancing it with technical skills during debriefing sessions should be the new approach to teaching pediatric trauma. Such an approach has the potential to reduce errors in clinical care and enhance overall outcomes, saving children's lives.

Subsequent research should delve into diverse educational resources for fostering NTS, assess the long-term retention of these skills, and measure their effect on clinical results.

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XI. Appendix

Research Ethics Board approvals and consent forms

Research Institute of the McGill Health Centre approval

Centre universitaire de santé McGill — McGill University Health Centre

2021-05-26

Dr. Dan Poenaru

c/o: Fabio Mendes Botelho Filho

email: fabio.botelho@mail.mcgill.ca

Re: MUHC Authorization (Pediatric Trauma / 2022-7561)

"Improving Performance in Pediatric Trauma by Teaching Nontechnical Skills"

Dear Dr Poenaru,

We are writing to confirm that the study mentioned above has received research ethics board approval and all required institutional approvals, namely:

- Use of adult resources

You are hereby authorized to conduct your research at the McGill University Health Centre (MUHC) as well as to initiate recruitment.

Please refer to the MUHC Study number in all future correspondence relating to this study.

In accordance with applicable policies it is the investigator's responsibility to ensure that staff involved in the study is competent and qualified and, when required, has received certification to conduct clinical research.

Should you have any questions, please do not hesitate to contact the support for the Personne mandatée at personne.mandatee@muhc.mcgill.ca.

We wish you every success with the conduct of the research.

Sincerely,

Sheldon Levy

Mandatée (SL) Personne
Sheldon Levy
for:
Marie Hirtle, LL.B. LL.M.
Personne Mandatée
Centre Universitaire de Santé McGill

Authorization from the Faculty of Medicine and Health Sciences

McGill | Faculty of Medicine and Health Sciences | Faculté de médecine et des sciences de la santé

3655 Promenade Sir William Osler #633 Montreal, QC H3G 1Y6
3655, Promenade Sir William Osler #633 Montréal, QC H3G 1Y6
T: (514) 398-3124

Letter of Institutional Authorization

Ethics File Number : **(MUHC 2022-7561)**

Project Title : ***Improving Performance in Pediatric Trauma by Teaching Non-Technical Skills***

McGill PI: **Dan Poenaru, MD**

McGill Student PI: **Fabio Botelho, MD (PhD candidate)**

Primary REB of Record : **(MUHC)**

Approval Date (dd/mm/yyyy) : 26-05-2021

This letter authorizes the REB named above to serve as Board of Record for the review and oversight of this research project for the portion of the research undertaken at McGill University.

This authorization is granted in accordance with an agreement, compliant with current TCPS guidelines and any other applicable guidelines or legislation regarding multisite review, allowing for the above REB to serve as the REB of Record for human participant research undertaken at both the institution and at McGill University.

This is not an REB approval.

This authorization is granted under the following conditions:

- All requirements of the REB of Record are adhered to;
- Submission of approved amendments or any other changes submitted to and approved by the REB of Record, that pertain to the research portion conducted at McGill ;
- Submission of study annual renewal reviewed by the REB of Record;
- Submission of study termination.

Special conditions or comments: N/A

Institutional authorization is valid for the term of the project and is subject to the conditions listed above.

Authorized Signatory: Ilde Lepore *Date: March 11, 2022*

Ethics Officer,
Faculty of Medicine and Health Sciences

McGill reference #: **IA-FMHS-22-03-061**

Brazilian ethics approval

Note: When initiating the process for ethics approval to conduct my study in Brazil, I faced uncertainty regarding my ability to recruit students exclusively from one university. This led me to seek ethical approval from the national research ethics committee for a study design involving participants from various institutions. I clarified in my application that the necessity to extend recruitment beyond a single institution was the rationale for not limiting the application to one proponent institution. This approach received ethical approval (details of the approval are presented in the subsequent pages). Fortuitously, our initial recruitment phase in one city yielded a sufficient number of students from one institution. Consequently, while the article primarily concentrates on a single institution, it is important to note that the study received authorization for a more expansive participant base.

FACULDADE DE MINAS - FAMINAS/MURIAÉ

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Promoção de Habilidades Cognitivas em Estudantes e Profissionais da Saúde
Pesquisador: FABIO MENDES BOTELHO FILHO
Área Temática:
Versão: 1
CAAE: 60926922.0.0000.5105
Instituição Proponente:
Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 5.572.894

Apresentação do Projeto:
Trata-se de um estudo controlado randomizado para verificar o poder de eficácia de um debriefing estruturado para habilidades cognitivas em profissionais e estudantes da saúde. Atualmente, há diversos cursos de reanimação de pacientes e para situações emergenciais que focam apenas em habilidades técnicas. Infelizmente, a maior parte dos erros médicos vem da falta de habilidades não-técnicas ou cognitivas como falta de uma boa comunicação, liderança, poder de decisão. Assim queremos melhorar o aprendizado dessas habilidades em cursos de suporte à vida, sobretudo, de capacitação no atendimento à criança vítima de acidente ou violência. Para realizar o estudo utilizaremos a Escala de Avaliação de Habilidades Cognitivas chamada NOTSS (Non-technical Skills for Surgeons) para avaliar o nível de habilidades cognitivas de estudantes e profissionais de saúde. Os participantes da pesquisa serão filmados durante um curso de trauma pediátrico e a partir das gravações poderemos avaliar e dar notas às suas habilidades cognitivas através do NOTSS. O grupo intervenção receberá feedback sobre sua performance durante o atendimento do trauma pediátrico, por instrutores qualificados que usarão um protocolo de debriefing, cujo objetivo é aumentar exatamente essas habilidades cognitivas e não só técnicas. Esse protocolo foi desenvolvido pelo pesquisador principal. O grupo controle receberá debriefing, mas apenas sobre as habilidades técnicas (como proteção das vias aéreas do paciente, acesso venoso), mas não sobre as habilidades cognitivas descritas. Os grupos realizarão um novo round de cenários simulados após o debriefing e espera-se que o grupo que

recebeu o debriefing de habilidades cognitiva conseguirá terminar os casos cenários de uma for mais rápida e eficaz. Esse trabalho está sendo conduzido com a mesma metodologia no Canadá, sendo originária da McGill University. Está aprovado pelo Comitê de Ética da McGill University Health Centre (número: 2022 - 7561). Como no Brasil, faremos o curso de trauma pediátrico com inscrições abertas para qualquer profissional de saúde ou estudante da área de
saúde, vinculado a diferentes instituições, preferimos submeter o processo via CONEP.

Objetivo da Pesquisa:
Objetivo Primário:
Aumentar a performance de estudantes e profissionais de saúde a partir da utilização de um debriefing focado para melhorar as habilidades cognitivas dessa população.

Objetivo Secundário:
1. Avaliar as habilidades cognitivas de estudantes e profissionais de saúde com o uso do NOTSS;
2. Examinar a influência das diferenças individuais nas pontuações do NOTSS, como experiência, idade e gênero.

Avaliação dos Riscos e Benefícios:
Riscos:
Essa pesquisa não envolve riscos aos participantes. Os dados coletados não levarão à qualquer tipo de identificação pessoal.

Benefícios:
Caso os resultados sejam positivos teremos mais dados para defender o ensino de habilidades cognitivas tão pouco ensinadas nas escolas de saúde. Iremos também fornecer o nosso debriefing estruturado para todas instituições que quiserem utilizar essa ferramenta em seus cursos práticos e de suporte à vida.

Comentários e Considerações sobre a Pesquisa:
Pesquisa muito importante para a consolidação do aprendizado, pois o debriefing é um instrumento de aprendizagem que mostra, com clareza, os pontos que devem ser melhorados pelos participantes.

Considerações sobre os Termos de apresentação obrigatória:
- Folha de rosto - o pesquisador não apresenta instituição proponente

- Debriefing - aprovado pelo aprovado pelo Comitê de Ética da McGill University Health Centre (número: 2022-7561)
- Brochura do projeto de pesquisa - versão português e inglês
- Termo de Consentimento Livre e Esclarecido

Conclusões ou Pendências e Lista de Inadequações:

Não existem inadequações.

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1985014.pdf	25/07/2022 12:48:18		Aceito
Folha de Rosto	folhaDeRosto1.pdf	25/07/2022 12:47:44	FABIO MENDES BOTELHO FILHO	Aceito
Projeto Detalhado / Brochura Investigador	brochura_portuges.docx	15/07/2022 21:30:09	FABIO MENDES BOTELHO FILHO	Aceito
TCLE / Termos de Assentimento / Justificativa de Ausência	notss_portugues_tcle.docx	15/07/2022 21:29:31	FABIO MENDES BOTELHO FILHO	Aceito
Outros	propoesaREBauthorized.docx	15/07/2022 21:29:08	FABIO MENDES BOTELHO FILHO	Aceito
Outros	final_authorization_reb.pdf	15/07/2022 21:14:47	FABIO MENDES BOTELHO FILHO	Aceito

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

MURIAE, 09 de Agosto de 2022

Assinado por:
Alexandre Horacio Couto Bittencourt
(Coordenador(a))

Consent form (English version)

CONSENT FORM

Research Study Title:	Improving Performance in Pediatric Trauma by Teaching Nontechnical Skills
Researcher responsible for the research study:	Dr. Dan Poenaru Harvey E. Beardmore Division of Pediatric Surgery, Montreal Children's Hospital, MUHC
Co-Investigator(s)/sites:	Dr. Fabio Botelho / McGill University Health Centre Dr. Jason Harley, Ph.D. McGill University
Research Coordinator:	Ms. Elena Guadagno, MLIS. McGill University Health Centre

INTRODUCTION

We invite you to participate in this research study because you are a McGill medical student (3rd or 4th year) or a McGill general surgery resident. As we believe that non-technical skills (such as leadership, communication, and decision-making) are essential for adequate training, we want to test a new tool for assessing and teaching these skills in a simulated pediatric trauma course.

Before you accept to take part in this study and sign this information and consent form, please take the time to read, understand, and carefully examine the following information. You may also want to discuss this study with other health professionals, family members, or close friends.

BACKGROUND

Although pediatric trauma is an epidemic and severe disease worldwide, few research projects have proposed feasible solutions to combat this problem. One of these suggested solutions is improving professional education. Education through simulation, typically using mannequins, has been demonstrated to be a well-suited environment to develop technical skills (such as chest tube insertion, and intravenous lines) and nontechnical skills (team communication, leadership, decision-making, situational awareness). However, no studies have formally explored non-technical skills education in pediatric trauma.

PURPOSE OF THE RESEARCH STUDY

This study aims to demonstrate the successful acquisition of non-technical skills through a simulation-based program and its translation to better clinical outcomes for injured children.

DESCRIPTION OF THE RESEARCH PROCEDURES

This research study will take place at the Steinberg Simulation Centre.

1. Duration and number of visits

Your participation in this research project will last one month. It will include one optional online meeting (lasting 1 hour for questions and answers about the study) and one on-site visit. The on-site visit can last up to 6 hours.

2. Study Design

When participating in this research project, you will be assigned to either an intervention or a control group.

Using the Non-technical Skills for Surgeons (NOTSS) - an assessment tool designed to score surgeons' non-communication skills - and systematic debriefing strategies, we plan to formally evaluate non-technical skills through two different rounds of pediatric trauma simulation scenarios.

Furthermore, this study is randomized, meaning you will be assigned to one of the two groups. You may not choose the group you will be assigned; this process is done randomly (like flipping a coin). One group will receive technical and non-technical skills debriefing, and one will receive only technical skills debriefing. This study is single-blind, meaning you may not

know which study group you were allocated to.

3. Tests and procedures

During your participation in this research study, a research team member will conduct the following tests and procedures:

DESCRIPTION OF STUDY PROCEDURES	
Procedure	**Description**
Self-Assessment Questionnaires	Questionnaires that will evaluate your confidence in treating pediatric trauma, and your satisfaction with the course.
Quizzes	Quizzes to evaluate knowledge about pediatric trauma.

The schedule of procedures for each visit is listed below:

Procedure	**Visit 1 (online meeting)**	**Visit 2 (simulation centre)**
Questions and answers session about the project.	X	
Self-Assessment Questionnaires		X
Quizzes		X

PARTICIPANT'S RESPONSIBILITIES

- Attend the online meeting to understand more about the project.
- Participate in the simulated pediatric trauma course.

BENEFITS ASSOCIATED WITH THE RESEARCH STUDY

You may or may not personally benefit from participating in this research project. However, we hope that the study results will contribute to advancing scientific knowledge in this field and help us find better educational strategies to facilitate students' learning processes.

RISKS ASSOCIATED WITH THE RESEARCH STUDY

Risk: lack of data confidentiality.

Mitigation plan: we will store the data only in McGill-secured data clouds to mitigate this risk.

VOLUNTARY PARTICIPATION AND THE RIGHT TO WITHDRAW

Your participation in this research project is voluntary. Therefore, you may refuse to participate. You may also withdraw from the project at any time, without giving any reason, by informing the study doctor or a research team member.

Your decision not to participate in the study, or to withdraw from it, will have no impact on the quality of education and services to which you are otherwise entitled or on your relationship with the faculty.

The leading researcher or the Research Ethics Board may end your participation without your consent. This may happen if new findings or information indicate that participation is no longer in your interest, if you do not follow study instructions, or if there are administrative reasons to terminate the project.

If you withdraw or are withdrawn from the study, the information collected for the study will be stored, analyzed, and used to ensure the integrity of the study.

Any new findings that could influence your decision to stay in the research project will be shared with you as soon as possible.

CONFIDENTIALITY

During your participation in this study, the study team will collect and record information about you in a study file. They will only collect information required to meet the scientific goals of the study. We would also like to register the scenarios using the cameras of the simulation centre. The videos will be safely stored at the McGill OneDrive accounts of the researchers. They will be used to determine how many steps of the simulation scenario you performed, the time to perform them, and the NOTSS score.

The study file may include information from your profile (such as age, gender, and program department).

All the data collected during the research project (including personal information and videos) will remain strictly confidential to the extent provided by law. You will only be identified by a code number. The key to the code linking your name to your study file will be kept by the research team. No papers will be used for data collection. All data will be collected through Outlook Apps (Excel, Word, Forms), protected by personal passwords, and the files generated (data analyses) will be stored at McGill storage electronic data system (OneDrive), also covered by passwords.

To ensure your safety, a copy of this information and consent form will be given to you or sent to your email.

The study data will be stored for seven years by the study researcher.

The data may be published or shared during scientific meetings; however, it will not be possible to identify you.

You have the right to consult your study file to verify the information gathered and correct it if necessary.

However, to protect the scientific integrity of the research project, accessing certain information before the project ends may require you to withdraw from the study.

MARKETING POSSIBILITIES

The research results, including those following your participation in this study, could lead to the creation of commercial products. However, you will not receive any financial benefits.

FUNDING OF THE RESEARCH PROJECT

The only funds for this study are research funds received by the study researcher.

COMPENSATION

You will receive an amount of CAD 80$ for one in-person study visit for costs and inconveniences incurred during this research study. If you withdraw from the study or are withdrawn before it is completed, you will only receive compensation if you have attended the in-person meeting. A gift card may be offered as an alternative to the direct deposit of

CAD 80$. Direct deposit takes up to eight weeks, and you may choose the best option for you.

SHOULD YOU SUFFER ANY HARM

Should you suffer harm of any kind following any other procedure related to the research study, you will receive the appropriate care from the research team.

By agreeing to participate in this research project, you are not waiving any of your legal rights nor discharging the study researcher, the sponsor, or the institution, of their civil and professional responsibilities.

CONTACT INFORMATION

If you have questions or if you have a problem you think may be related to your participation in this research study, or if you would like to withdraw, you may communicate with the study researcher or with someone on the research team at the following numbers:

Dr. Fabio Botelho - 514-820-8667

Dr. Dan Poenaru - 514-929-2654

For any question concerning your rights as a research participant taking part in this study, or if you have comments, or wish to file a complaint, you may communicate with:

The McGill Ombudsman at the following phone number: +514 398 7056.

OVERVIEW OF ETHICAL ASPECTS OF THE RESEARCH

The McGill University Health Centre Research Ethics Board reviewed this research and is responsible for monitoring the study.

Research Study Title: Improving Performance in Pediatric Trauma by Teaching Nontechnical Skills.

SIGNATURES

Signature of the participant

I have reviewed the information and consent form. Both the research study and the information and consent form were explained to me. My questions were answered, and I was given sufficient time to make a decision. After reflection, I consent to participate in this research study in accordance with the conditions stated above, including the use of all personal data and videos collected.

- I authorize the researcher in charge of this study to communicate with me directly to ask if I am interested in participating in another research:

Yes ☐

No ☐

- I wish to receive a copy of the study results by email.

Yes ☐ No ☐ If yes, please provide contact information: _____

Name of participant Signature Date

Signature of the person obtaining consent

I have explained the research study and the terms of this information and consent form to the research participant, and I answered all his/her questions.

Name of the person obtaining consent Signature

Date

Consent form (French version)

FORMULAIRE DE CONSENTEMENT

Titre de l'étude de recherche:	Amélioration de la performance en traumatologie pédiatrique en enseignant les compétences non techniques
Chercheur responsable:	Dr. Dan Poenaru Harvey E. Beardmore Division of Pediatric Surgery, Montreal Children's Hospital, MUHC
Co-Investigateur(s)/sites:	Dr. Fabio Botelho / McGill University Health Centre Dr. Jason Harley, Ph.D. McGill University
Coordinateur de la recherche:	Ms. Elena Guadagno, MLIS. McGill University Health Centre

INTRODUCTION

Nous vous invitons à participer à cette étude de recherche car vous êtes étudiant en médecine à McGill (3ème ou 4ème année) ou résident en chirurgie générale à McGill. Comme nous croyons que les compétences non techniques (telles que le leadership, la communication et la prise de décision) sont essentielles à une formation adéquate, nous voulons tester un nouvel outil pour évaluer et enseigner ces compétences dans un cours de traumatologie pédiatrique simulé.

Avant d'accepter de participer à cette étude et de signer ce formulaire d'information et de consentement, veuillez prendre le temps de lire, comprendre et examiner attentivement les informations suivantes. Vous pouvez également discuter de cette étude avec d'autres professionnels de la santé, des membres de la famille ou des amis proches.

CONTEXT

Bien que la traumatologie pédiatrique soit une épidémie et une maladie grave dans le monde, peu de projets de recherche ont proposé des solutions viables pour combattre ce problème. Une de ces solutions suggérées est d'améliorer l'éducation professionnelle. L'éducation par simulation, généralement à l'aide de mannequins, a été démontrée être un environnement bien adapté pour développer les compétences techniques (telles que l'insertion de tubes thoraciques et les lignes intraveineuses) et les compétences non techniques (communication en équipe, leadership, prise de décision, conscience de la situation). Cependant, aucune étude n'a exploré formellement l'éducation en compétences non techniques en traumatologie pédiatrique.

RAISON DE L'ÉTUDE DE RECHERCHE

Cette étude vise à démontrer l'acquisition réussie de compétences non techniques grâce à un programme basé sur la simulation et sa traduction en de meilleurs résultats cliniques pour les enfants blessés.

DESCRIPTION DU PROCÉDÉ DE RECHERCHE

Cette étude de recherche aura lieu au Centre de Simulation Steinberg.

1. **Durée et nombre de visites**

   Votre participation à ce projet de recherche durera un mois. Il comprendra une réunion en ligne facultative (d'une durée d'une heure pour des questions et des réponses sur l'étude) et une visite sur place. La visite sur place peut durer jusqu'à 6 heures.

2. **Conception de l'étude**

   Lors de votre participation à ce projet de recherche, vous serez affecté à un groupe d'intervention ou de contrôle. En utilisant les compétences non techniques pour les chirurgiens (NOTSS) - un outil d'évaluation conçu pour noter les compétences non techniques des chirurgiens - et des stratégies de débriefing systématiques, nous prévoyons d'évaluer formellement les compétences non techniques à travers deux rounds différents de scénarios de simulation de traumatisme pédiatrique.

   De plus, cette étude est randomisée, ce qui signifie que vous serez affecté à l'un des

deux groupes. Vous ne pouvez pas choisir le groupe auquel vous serez affecté; ce processus est effectué aléatoirement. Un groupe recevra un débriefing sur les compétences techniques et non techniques, et l'autre ne recevra qu'un débriefing sur les compétences techniques. Cette étude est à simple insu, ce qui signifie que vous ne savez pas dans quel groupe d'étude vous avez été affecté.

3. **Tests et procédures**

Au cours de votre participation à cette étude de recherche, un membre de l'équipe de recherche effectuera les tests et procédures suivants :

DESCRIPTION DES PROCÉDURES D'ÉTUDE	
Procédure	**Description**
Questionnaires d'auto-évaluation	Questionnaires qui évalueront votre confiance dans le traitement des traumatismes pédiatriques et votre satisfaction avec le cours.
Quiz	Quiz pour évaluer les connaissances sur les traumatismes pédiatriques.

L'horaire des procédures pour chaque visite est indiqué ci-dessous:

Procédure	**Visite 1 (réunion en ligne)**	**Visite 2 (centre de simulation)**
Session de questions et réponses sur le projet.	X	
Questionnaires d'auto-évaluation		X
Quiz		X

RESPONSABILITÉS DU PARTICIPANT

- Assister à la réunion en ligne pour comprendre davantage le projet.

Participer au cours simulé de traumatisme pédiatrique.

AVANTAGES LIÉS À L'ÉTUDE DE RECHERCHE

Vous pouvez ou non bénéficier personnellement de votre participation à ce projet de recherche. Cependant, nous espérons que les résultats de l'étude contribueront à l'avancement des connaissances scientifiques dans ce domaine et nous aideront à trouver de meilleures stratégies pédagogiques pour faciliter les processus d'apprentissage des étudiants.

RISQUES LIÉS À L'ÉTUDE DE RECHERCHE

Risque: manque de confidentialité des données.

Plan de mitigation : nous stockerons les données uniquement dans les nuages de données sécurisés de McGill pour atténuer ce risque.

PARTICIPATION VOLONTAIRE ET DROIT DE SE RETIRER

Votre participation à ce projet de recherche est volontaire. Par conséquent, vous pouvez refuser de participer. Vous pouvez également vous retirer du projet à tout moment, sans donner de raison, en informant un membre de l'équipe de recherche.

Votre décision de ne pas participer à l'étude ou de vous en retirer n'aura aucun impact sur la qualité de l'éducation et des services auxquels vous avez droit ou sur votre relation avec la faculté.

Le chercheur principal ou le Conseil d'éthique de la recherche peut mettre fin à votre participation sans votre consentement. Cela peut se produire si de nouvelles découvertes ou informations indiquent que la participation n'est plus dans votre intérêt, si vous ne suivez pas les instructions de l'étude ou s'il y a des raisons administratives pour mettre fin au projet.

Si vous vous retirez ou êtes retiré de l'étude, les informations collectées pour l'étude seront stockées, analysées et utilisées pour garantir l'intégrité de l'étude.

Toute nouvelle découverte qui pourrait influencer votre décision de rester dans le projet de recherche vous sera partagée dès que possible.

CONFIDENTIALITÉ

Pendant votre participation à cette étude, l'équipe de recherche collectera et enregistrera des informations sur vous dans un fichier d'étude. Ils ne collectent que les informations nécessaires pour atteindre les objectifs scientifiques de l'étude. Nous aimerions également enregistrer les

scénarios à l'aide des caméras du centre de simulation. Les vidéos seront stockées en toute sécurité sur les comptes OneDrive de McGill des chercheurs. Ils seront utilisés pour déterminer le nombre d'étapes du scénario de simulation que vous avez effectuées, le temps nécessaire pour les effectuer et le score NOTSS.

Le fichier d'étude peut inclure des informations de votre profil (telles que l'âge, le genre et le département du programme).

Toutes les données collectées lors du projet resteront strictement confidentielles dans la mesure permise par la loi. Vous ne serez identifié que par un numéro de code. La clé du code reliant votre nom à votre fichier d'étude sera conservée par l'équipe de recherche. Aucun papier ne sera utilisé pour la collecte de données. Toutes les données seront collectées via les applications Outlook (Excel, Word, Forms), protégées par des mots de passe personnels, et les fichiers générés (analyses de données) seront stockés sur le système de stockage électronique de données de McGill (OneDrive), également protégé par des mots de passe.

Pour garantir votre sécurité, une copie de ces informations et du formulaire de consentement vous sera remise ou envoyée à votre courriel.

Cependant, tout partenaire en dehors du Québec est tenu de respecter les règles de confidentialité équivalentes à celles en vigueur au Québec et au Canada.

Les données d'étude seront conservées pendant sept ans par le chercheur d'étude.

Les données peuvent être publiées ou partagées lors de réunions scientifiques; cependant, il ne sera pas possible de vous identifier.

Vous avez le droit de consulter votre fichier d'étude pour vérifier les informations recueillies et les corriger si nécessaire.

Cependant, pour protéger l'intégrité scientifique du projet de recherche, accéder à certaines informations avant la fin du projet peut vous obliger à vous retirer de l'étude.

POSSIBILITÉS DE COMMERCIALISATION

Les résultats de la recherche, y compris ceux obtenus à la suite de votre participation à cette étude, pourraient mener à la création de produits commerciaux. Cependant, vous ne recevrez aucun avantage financier.

FINANCEMENT DU PROJET DE RECHERCHE

Les seuls fonds pour cette étude proviennent des fonds de recherche reçus par le chercheur chargé de l'étude.

COMPENSATION

Vous recevrez un montant de 80 $ CAD pour une visite en personne dans le cadre de l'étude pour couvrir les coûts et les désagréments encourus au cours de cette étude de recherche. Si vous vous retirez de l'étude ou si vous êtes retiré avant son achèvement, vous ne recevrez une compensation que si vous avez participé à la réunion en personne. Une carte-cadeau peut être offerte en alternative au dépôt direct de 80 $ CAD. Le dépôt direct prend jusqu'à huit semaines et vous pouvez choisir l'option qui vous convient le mieux.

EN CAS DE DOMMAGE

Si vous subissez un quelconque dommage à la suite d'une autre procédure liée à l'étude de recherche, vous recevrez les soins appropriés de l'équipe de recherche.

En acceptant de participer à ce projet de recherche, vous n'abandonnez aucun de vos droits légaux ni ne libérez le chercheur en charge de l'étude, le sponsor ou l'institution de leurs responsabilités civiles et professionnelles

INFORMATIONS DE CONTACT

Si vous avez des questions ou si vous avez un problème que vous pensez être lié à votre participation à cette étude de recherche, ou si vous souhaitez vous retirer, vous pouvez communiquer avec le chercheur en charge de l'étude ou avec un membre de l'équipe de recherche aux numéros suivants :

Dr Fabio Botelho - 514-820-8667

Dr Dan Poenaru - 514-929-2654

Pour toute question concernant vos droits en tant que participant à la recherche participant à cette étude, ou si vous avez des commentaires ou souhaitez déposer une plainte, vous pouvez communiquer avec : L'Ombudsman de McGill au numéro de téléphone suivant : +514 398 7056.

VISION D'ENSEMBLE DES ASPECTS ÉTHIQUES DE LA RECHERCHE

Le Conseil d'éthique en recherche du Centre universitaire de santé McGill a examiné cette recherche et est responsable de surveiller l'étude.

SIGNATURES

Signature du participant

J'ai examiné les informations et le formulaire de consentement. L'étude de recherche et le formulaire d'information et de consentement m'ont été expliqués. Mes questions ont été répondues et j'ai eu suffisamment de temps pour prendre une décision. Après réflexion, je consens à participer à cette étude de recherche conformément aux conditions décrites ci-dessus, y compris l'utilisation de toutes les données personnelles et vidéos collectées.

- J'autorise le chercheur en charge de cette étude à me contacter directement pour me demander si je suis intéressé par une participation à une autre recherche :

Oui ☐

Non ☐

- Je souhaite recevoir une copie des résultats de l'étude par courrier électronique.

Oui ☐ Non ☐ Si oui, veuillez fournir les informations de contact:

_____

Nom du participant Signature Date

Signature de la personne obtenant du consentement

J'ai expliqué l'étude de recherche et les termes de ce formulaire d'information et de consentement au participant à la recherche, et j'ai répondu à toutes les questions.

Nom de la personne obtenant du consentement Signature Date

Consent form (Portuguese version)

FORMULÁRIO DE INFORMAÇÃO E CONSENTIMENTO

Pesquisador responsável pelo estudo de pesquisa: Dr. Fabio Mendes Botelho Filho

Título do Estudo de Pesquisa: Promoção de Habilidades Cognitivas em Estudantes e Profissionais de Saúde através de um Debriefing Estruturado

INTRODUÇÃO

Estamos convidando você a participar deste estudo de pesquisa porque você é um estudante ou profissional de saúde. Como acreditamos que habilidades cognitivas (como liderança, comunicação e tomada de decisão) são essenciais para um treinamento adequado, queremos testar uma nova ferramenta para avaliação e ensino dessas habilidades em um curso simulado de trauma pediátrico. Para entender se as ferramentas de nossa avaliação auxiliam no ensino de habilidades cognitivas, precisaremos de participantes como você na nossa pesquisa.

Antes de aceitar participar deste estudo e assinar este formulário de consentimento, por favor, leia e examine cuidadosamente as seguintes informações. Você também pode discutir este estudo com outros profissionais de saúde, familiares ou amigos próximos.

JUSTIFICATIVA DO ESTUDO

Embora o trauma pediátrico seja uma doença epidêmica e grave em todo o mundo, poucos projetos de pesquisa têm proposto soluções viáveis para combater esse problema. Uma dessas soluções sugeridas é melhorar a formação profissional. A educação por meio de simulação, geralmente usando manequins, demonstrou ser um ambiente adequado para desenvolver habilidades técnicas (como inserção de dreno torácico, linhas intravenosas) e habilidades cognitivas (comunicação em equipe, liderança, tomada de decisões, consciência situacional). No entanto, não há estudos que tenham explorado formalmente o ensino de habilidades não técnicas em trauma pediátrico.

OBJETIVO DO ESTUDO DE PESQUISA

O objetivo deste estudo é demonstrar a aquisição bem-sucedida de habilidades cognitivas por meio de um programa baseado em simulação e sua tradução para melhores resultados clínicos para crianças feridas.

DESCRIÇÃO DOS PROCEDIMENTOS DE PESQUISA

Ao participar deste projeto de pesquisa, você será designado para um grupo intervenção ou um grupo controle.

Usando as habilidades não técnicas para cirurgiões (NOTSS) - uma ferramenta de avaliação projetada para pontuar as habilidades de comunicação dos cirurgiões - e estratégias sistemáticas de debriefing, planejamos avaliar formalmente as habilidades cognitivas por meio de duas rodadas diferentes de cenários de simulação de trauma pediátrico. Após a primeira rodada, os participantes serão divididos em dois grupos: um grupo intervenção e um grupo controle. O grupo de intervenção receberá um debriefing formal sobre seu desempenho cognitivo e técnico, enquanto o grupo de controle receberá apenas feedback sobre habilidades técnicas. Nossa expectativa é que os alunos que receberam o debriefing de habilidades cognitivas e técnicas tenham (1) uma pontuação NOTSS melhor e (2) um melhor desempenho ao final do segundo cenário.

Os cenários serão gravados, assim os pesquisadores poderão analisar os vídeos depois para o cálculo do NOTSS e informações sobre performance e os vídeos serão armazenados de forma segura conforme descrito no tópico Confidencialidade.

BENEFÍCIOS ASSOCIADOS AO ESTUDO DE PESQUISA

Você pode ou não se beneficiar pessoalmente de sua participação neste projeto de pesquisa. No entanto, esperamos que os resultados do estudo contribuam para o avanço do conhecimento científico neste campo e nos ajudem a encontrar melhores estratégias educacionais para facilitar os processos de aprendizagem dos alunos.

RISCOS ASSOCIADOS AO ESTUDO DE PESQUISA

Não há riscos associados.

PARTICIPAÇÃO VOLUNTÁRIA E DIREITO DE RETIRADA

Sua participação neste projeto de pesquisa é voluntária. Portanto, você pode se recusar a participar. Você também pode desistir do projeto a qualquer momento, sem dar qualquer motivo, informando o médico do estudo ou um membro da equipe de pesquisa.

Se você desistir ou for retirado do estudo, as informações coletadas para o estudo serão armazenadas, analisadas e usadas para garantir a integridade do estudo.

Quaisquer novas descobertas que possam influenciar sua decisão de permanecer no projeto de pesquisa serão compartilhadas com você o mais rápido possível.

CONFIDENCIALIDADE

Durante sua participação neste estudo, a equipe do estudo gravará todo o curso, além de coletar e registrar informações sobre sua performance em um arquivo do estudo. Os pesquisadores apenas coletarão informações necessárias para atender aos objetivos científicos do estudo.

O arquivo do estudo pode incluir informações do seu perfil pessoal (como idade, sexo, sexo e departamento do programa).

Todas as informações coletadas durante o projeto de pesquisa permanecerão estritamente confidenciais na medida prevista em lei. Você só será identificado por um número de código. Não serão utilizados papéis para coleta de dados. Todos os dados serão coletados por meio do RedCap ou arquivos da Microsoft (ie Word, Excel), protegidos por senhas pessoais e os arquivos gerados (análises de dados) serão armazenados no sistema de armazenamento eletrônico de dados protegido por senhas, no sistema eletrônico da McGill University.

Para garantir sua segurança, uma cópia dessas informações e formulário de consentimento serão fornecidos a você.

Os dados do estudo serão armazenados por 7 anos pelo pesquisador do estudo.

Os dados podem ser publicados ou compartilhados durante reuniões científicas; porém não será possível identificá-lo.

FINANCIAMENTO DO PROJETO DE PESQUISA

Os únicos fundos para este estudo são fundos de pesquisa recebidos pelo pesquisador do estudo.

INFORMAÇÕES DE CONTATO

Se você tiver dúvidas ou se tiver algum problema que acredite estar relacionado à sua participação neste estudo de pesquisa, ou se desejar desistir, você pode se comunicar com o pesquisador do estudo ou com alguém da equipe de pesquisa nos seguintes números de telefone e email:

Dr. Fabio Botelho – WhatsApp +1 514-820-8667 | mendesbotelho@hotmail.com

ASSINATURAS

Assinatura do participante

Eu revi as informações e o formulário de consentimento. Tanto o estudo de pesquisa quanto o formulário de informação e consentimento foram explicados a mim. Minhas perguntas foram respondidas e tive tempo suficiente para tomar uma decisão. Após reflexão, concordo em participar deste estudo de pesquisa de acordo com as condições indicadas acima, além de autorizar a gravação da minha participação.

Desejo receber uma cópia dos resultados do estudo por e-mail.

Sim ☐ Não ☐ Se sim, forneça informações de contato: _____

Nome do participante Assinatura Data

Assinatura da pessoa que obtém o consentimento

Expliquei o estudo de pesquisa e os termos dessas informações e formulário de consentimento ao participante da pesquisa e respondi a todas as suas perguntas.

Nome da pessoa que obtém o consentimento

Assinatura Data