The Development and Evaluation of a Tablet-Based Application for Massive Transfusion Protocol

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Abstract

Introduction: The purpose of this project was to evaluate a tablet-based documentation application for massive transfusion protocols (MTPs).

Methods: 13 trauma nurses at a level-one pediatric trauma center were randomly assigned to use paper documentation (n=5) or the tablet-based application (n=8) during simulated MTPs. Documentation completeness was compared using an independent t-test. Tablet users completed a system usability survey (SUS).

Results: Documentation of blood product volumes and times significantly improved with the tablet (p=<0.001 and p=0.001 respectively). The tablet received a mean SUS score of 89%.

Discussion: A tablet-based application has potential to improve real-time documentation of MTPs.

Keywords: Massive Transfusion Protocol, Tablet-based Application, Documentation, and Usability

Introduction

Hemorrhage is a leading cause of preventable mortality for pediatric trauma patients (Karam & Tucci, 2016). It is estimated that one-half of the deaths related to hemorrhagic shock occur within the first six hours of initial trauma (Noland et al., 2019). Massive transfusions are a life-saving resuscitation method for patients experiencing hemorrhagic shock. Massive transfusion protocols (MTPs) require a systematic and protocol-based approach to reverse coagulopathy and prevent mortality from exsanguination. It is essential to diligently monitor each blood product administered to achieve appropriate product ratios. Massive transfusion protocols lack a standardized documentation tool and rely on paper documentation, commonly referred to as "the paper towel method," to keep track of products given and guide the process. A key limitation to evaluating MTPs is the inconsistency in documentation (Broxton et al., 2017). Paper documentation during resuscitation measures is often inaccurate (Peace et al., 2014). Tablet-based applications improve documentation and process efficiency during resuscitations and medical emergencies (Grundgeiger et al., 2016). This is the first tablet-application developed and evaluated to guide and document massive transfusion protocol.

Background and Significance

A detailed literature review was conducted regarding massive transfusion protocols and the use of tablet-based applications during emergencies. Massive transfusions are a low volume high-intensity and life-saving resuscitation intervention. In pediatric trauma patients experiencing massive hemorrhage, blood component therapy in a 1:1 ratio of packed red blood cells and fresh frozen plasma has a higher survivability (Noland et al., 2019). Accurately tracking blood product volumes during massive transfusions is essential in order to achieve a target ratio. In a pilot study focusing on documentation during cardiac arrests, tablet-based

documentation significantly improved the quality of documentation (Peace et al., 2014).

Additionally, mobile technology has the ability to improve real-time healthcare decision-making

(Dekoneko et al., 2019).

Aims of the Project

The purpose of this project was to develop a tablet-based application to guide and

document massive transfusion protocol, to compare documentation completeness between

conventional paper documentation and the tablet documentation, and to evaluate the usability of

the application during massive transfusion simulations.

Conceptual Framework

The Reach Effectiveness-Adoption Implementation Measurement (RE-AIM) framework

guided the development and implementation of this project. The RE-AIM framework is an

effective planning and evaluation framework for developing and evaluating interventions and

producing policies (Glasgow & Estabrooks, 2018). The RE-AIM framework encourages the

development of planning strategies to increase the population reach and achieve positive and

sustainable outcomes. The RE-AIM framework has been used in a variety of clinical settings,

including in the context of implementing the use of interactive technology in the clinical

environment (Glasgow & Estabrooks, 2018). The framework addresses how to reach the

population for the intervention, determine if the intervention is effective, design and disseminate

the intervention, determine if the intervention is achievable, and ensure that the intervention can

be maintained long-term (Harden et al., 2018).

Methods

Application Development

An interprofessional team of mentored engineering students and clinical experts developed the tablet-based application for massive transfusion protocol. The team held recurring sprint meetings over a 6-month period to review mockups and provide feedback. In addition to documenting blood products and volumes, the application has several key features. The application facilitates weight-based transfusion goals, provides a real-time product ratio calculator, provides prompting to check labs and replace calcium, notifies the user when the total blood volume has been replaced, and provides a printable full report of all documentation entered into the tablet. The ratio meter and blood product meters turn green, yellow and red to signify which blood product component is needed to maintain the designated ratio. After the application was fully developed, the evaluation period began.

Study Design

As a quality improvement project, this project was provided exempt approval by the Institutional Review Board (IRB). Tablet-based documentation applications for cardiac arrest have been evaluated during simulated resuscitations (Peace et al., 2014). For the purpose of this project, randomized simulated massive transfusions were conducted in the emergency department of a level one pediatric trauma center to compare real-time documentation using conventional paper documentation or the newly developed tablet.

Participants

In the emergency department, 13 nurses (n=13) volunteered to participate in the simulations. Participants were randomly assigned to complete the simulations using paper documentation or the tablet by drawing from a hat upon entrance to the simulation. Eight nurses

completed the simulation using the tablet (n =8) and five nurses completed the simulation using paper documentation (n=5).

Setting and Equipment

The massive transfusion simulations took place in the trauma bay in the emergency department of a local level-one pediatric trauma center. The trauma department provided the simulation equipment; a pediatric mannequin with two large-bore peripheral intravenous lines and a cooler of artificial packed red blood cells, whole blood, platelets, fresh frozen plasma, and cryoprecipitate.

Simulation Scenario

Participants were provided a case scenario and were required to complete three rounds of massive transfusion while completing real-time documentation. Each simulation received the same number and ratio of blood products to resemble the massive transfusion policy at the institution. Participants using paper documentation were asked to document as they would in a real situation; each participant in the paper documentation group chose to document using a paper towel. Tablet users were provided with a brief introduction to the application prior to starting the simulation.

Measurement

Participants completed a demographic survey prior to starting the simulations. The survey was anonymous and collected information regarding the participants level of experience as a nurse and whether or not they had performed a massive transfusion in the past year. Documentation was assessed regarding completeness of blood product type, time of transfusion, and volume of transfusion. 27 blood products were transfused in each scenario. The "gold standard" documentation included 27 blood products with a corresponding time stamp and

volume. Documentation was collected from each participant either in paper form or from the tablet report. Documentation totals for each category were calculated. A two-tailed independent sample t-test was used to compare documentation completeness between both groups regarding blood product type, transfusion times, and product volumes documented. Tablet users completed the system usability scale (SUS) survey upon completion of the simulation. The system usability scale is a reliable 10-item questionnaire to assess the usability of a new technology (Press et al., 2015). The average usability score was calculated to determine the overall rating of the application. Tablet-users were asked to anonymously submit any additional comments or concerns regarding the applications usability.

Results

Demographics

In the emergency department, 13 nurses (n=13) participated in the massive transfusion simulation. Of the participants, one (7%) had 0-2 years of nursing experience, two (15%) had 3-5 years of experience, four (30%) had 6-8 years of experience, and six (46%) had >8 years of experience. Just five (38%) of the participants had experience running a massive transfusion in the past year.

Documentation Comparison

A two-tailed independent sample *t*-test was conducted to compare the average documented number of blood product types, transfusion times, and blood product volumes. The total possible documented in each category was 27. An average of 20 (74%) of the blood products were documented using the paper documentation method compared to an average of 26 (96%) in the tablet documentation. This was not significantly different between the paper and tablet methods (p = 0.197). Blood product volumes were not documented on any of the collected

paper documentation. An average of 26 (96%) of the blood product volumes were documented in the tablet- application. Documentation of blood product volumes was significantly higher in the tablet group (p<0.001). The average number of documented transfusion times in the paper documentation was five (18%); the average number of documented transfusion times in the tablet group was 26 (96%). The average number of documented transfusion times in the tablet group was significantly higher than the paper group (p = 0.001).

Usability Results

A total of eight System Usability Scale (SUS) surveys were completed to assess the usability of the tablet-application. The average SUS score was 89%. This is considered an excellent usability rating for a new technology.

Discussion

Massive transfusion protocols are a life-saving resuscitation method for massive hemorrhage. Ratio-based blood product administration that closely resembles whole blood during massive transfusions is associated with decreased mortality. Massive transfusion protocols require accurate real-time documentation and clinical expertise to achieve ratio goals. This is the first tablet-based application developed to guide and document massive transfusion protocol in real-time. Nurses that used the tablet-based application during massive transfusion simulations completed significantly more essential charting elements than those who completed the simulations using paper documentation. The system usability scale results demonstrated that the application is "user-friendly," however due to the small sample size, it is unclear if this result is significant.

Limitations

The simulations for this project were conducted during the COVID-19 pandemic. Although the institution allowed this project to be conducted in-person, the timeframe was limited resulting in a small sample size of participants. One of the major limitations to the evaluation process was the small sample size and the authenticity of the simulation environment. For the purpose of the simulations, each participant was required to document and manage the transfusions. In a real life scenario, there may be a separate documentation nurse. Additionally, there were an unequal number of nurses in the paper documentation group versus the tablet-application group. To implement and maintain the tablet-application long term in an emergency department setting, it may be beneficial to have on-site Information Technology (IT) personnel who are familiar with the application to update and edit the application as needed.

Conclusion

Tablet-based documentation and smartphone applications improve documentation and clinician performance during simulated emergencies. Massive transfusion protocols are considered a life-saving resuscitation method. Paper documentation during resuscitations and medical emergencies are inadequate. The tablet-based application for massive transfusion protocol is "user friendly" and has the potential to improve the documentation of essential charting elements of massive transfusion protocol. Further evaluation is needed to determine if the application improves clinical performance and helps achieve transfusion ratios that more closely resemble the final target. However, if the technology improves clinical performance and blood product ratios it could reduce hemorrhage related mortality for pediatric patients.

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Appendix A

Tables and Figures

Figure A1

Tablet-Based Application Interface