A Novel Smartphone Application to Support Learning and Maintaining Competency with Bier Blocks for Pediatric Forearm Fracture Reductions

Adam Bretholz MD., Brett Burstein, MD CM., Ph.D.

Affiliations: Division of Pediatric Emergency Medicine, The Montreal Children’s Hospital, McGill University Health Center (BB, AB), and T.H. Chan School of Public Health, Harvard University (BB)

Correspondence: Dr. Brett Burstein, The Montreal Children’s Hospital, 1001 Decarie Boulevard, Montreal, Quebec H4A 3J1, Quebec, Canada. Fax: 514-412-4397; Tel.: 514-412-4400; E-mail: brett.burstein@mail.mcgill.ca

Keywords: intravenous regional anesthesia, lidocaine, procedural sedation

Word Count: 1000 (Excluding abstract, figure legend, disclosures, acknowledgments and references)

Running Header: Mobile App for Bier Block

Acknowledgments: The authors wish to thank Kevin Birch from Silverbirch Mobile for software development assistance, Jean-Pierre Cordeau and Elena Guadagno for technical support, and Drs. Harley Eisman, Michelin Ste-Marie and Robert Barnes for institutional support.

Funding Sources/Disclosures: No funding or conflicts of interest to disclose
Abstract

Distal forearm fractures are among the most common injuries presenting to the Pediatric Emergency Department (PED). Bier block (BB), or intravenous regional anesthesia, is a safe and effective alternative to procedural sedation for closed reduction of forearm fractures, and is associated with fewer adverse events, a shorter length of stay and reduced costs. BB has long remained relatively underutilized, however with an increasing emphasis on efficient resource use and patient-centered care, there is renewed interest in this technique. Our tertiary PED recently became the first in Canada to successfully implement an active BB program. Subsequently, we developed a mobile BB smartphone application (App) designed to support the safe, sustained departmental use of BB. The App can be used for training and maintenance of competency, and incorporates instructional material, as well as our institutional BB protocol, printable medication order sheets and monitoring forms. The present report describes the development and functionality of the BB smartphone App. Additionally, we highlight how the App serves as a paradigm of an educational tool designed for individual users, but also to support the department-wide implementation and dissemination of a new technique.
**Background**

Bier block (BB), or intravenous regional anesthesia, is a safe and effective alternative to procedural sedation for forearm fracture reduction.\(^1\)\(^-\)\(^3\) Using a pneumatic tourniquet, the isolated injured extremity is injected with local anesthetic to provide complete limb analgesia for reduction. The patient remains conscious throughout the procedure, which therefore requires no fasting or post-procedure observation period, and avoids the potential risks of procedural sedation. Consequently, this technique is associated with reduced length of stay and resource utilization,\(^4\) and can be used for children as young as \(2\)\(^-\)\(4\) years old.\(^1\),\(^2\),\(^4\)

Despite BB’s apparent benefits, it remains infrequently employed for forearm fracture reductions. A survey of \(44\) North American pediatric emergency departments (PED) reported that the most common reason cited for not using local anesthesia techniques was the efficacy of procedural sedation. The authors further suggested that limited physician comfort and perceived longer preparation time were important barriers to BB use.\(^5\) These factors, coupled with sporadic clinical opportunity, departmental logistics and personnel turnover are all important challenges to the successful implementation of a sustained BB program.

Recently, our center became the first Canadian PED to successfully introduce a BB program for forearm fracture reductions. PED personnel were trained at the time of BB implementation using a multimodal training course. Training increased comfort and utilization of BB among participants, however, we observed a modest but significant decrease in comfort at 6-months post-training, and the majority of participants expressed interest in refresher training.\(^6\)
Rationale

Smartphones are widely used and medical smartphone applications (Apps) have been shown to support the acquisition of technical skills. We have developed a novel point-of-care smartphone App designed to facilitate learning and maintenance of BB competency. Here we report on the App development process and functionality, with an emphasis on both its utility for individuals interested in using BB, but also as a model for the development of an educational tool to support the implementation of any new technique in the ED.

Description of the Innovation

Mobile App Content and Functionality

The App functions as a self-contained tool to support the safe utilization of BB by both physicians and nurses, and may be used by either novice or experienced users. Additionally, the App contains all supporting resources necessary to establish a departmental BB program.

The BB App (shown in Figure 1) contains a brief description of BB and a full demonstration video. From the main screen, users can find complete step-by-step instructions. A dose-calculator determines weight-based lidocaine dosing, in metric or imperial units with maximal dosages, and a timer directly integrates a stopwatch function. A user-friendly memory aid is provided for the signs, symptoms and management of lidocaine toxicity. A tab from the main menu links to evidence-based BB references including our institutional protocols for BB and local anesthetic toxicity management, a medication order sheet with integrated dosage calculator, and a safety monitoring record. All reference materials can be saved, printed or emailed from within the App directly. All content was adapted from our evidence-based institutional BB training course.
Technical Requirements

Total App storage requirement is 30MB, and once installed on a mobile device, all content is available without Internet connection. The current version is compatible with Apple iOS devices, and is available for free through the Apple App store.

App Development and Associated Costs

The App was developed and released in 2015, following institutional approval for release of all content and protocols. Beta testing was performed using Apple’s proprietary Testflight software. Development costs were under $1250 CAD in addition to a mandatory fixed recurring cost of $100 CAD per year to maintain an Apple developer account.
Discussion

The BB App was developed to improve and maintain comfort of individuals performing BB, and to enhance the safe, sustainable functioning of a departmental BB program. The App was designed for interdisciplinary use by both nurses and physicians. This point-of-care reference supports maintenance of competency that is often limited by sporadic clinical opportunities, patient preferences and departmental logistics. To our knowledge, this is the only App for BB and it is unique in its range of functionality.

Despite the rapid proliferation of medical smartphone Apps, there is a paucity of literature on the use of Apps to learn or support ED procedures, and very few such Apps. The majority of currently available medical Apps contain basic demonstration videos, instructional texts, clinical decision rules, or calculators. More recently, Apps with greater functionality and sophistication have been described for point-of-care use in acute care settings. Hawkes et al have described an App for neonatal intubation which increased physician knowledge and improved procedural performance.

The BB App is also exemplary of how a smartphone tool can compliment and augment the introduction of a new technique throughout a department or institution. Procedure preparation time is shortened by convenient access to printable medical order sheets, monitoring forms and dose calculators. Use of such an App may reduce the time and resources required for frequent departmental refresher training, and can help bridge the gap between courses for infrequent users or new personnel. Moreover, full evidence-based protocols within the App facilitate knowledge translation to other departments and institutions wishing to implement a similar program.

Importantly, the BB App has not undergone external peer-review, however this limitation
is not unique to our App. Moreover, we have not quantified the effect of the App to prevent the attrition of comfort among BB users, nor how the App compares to refresher courses. Understanding how to best integrate this and other Apps into current educational models of procedural learning remains to be studied, but is beyond the scope of this report.

**Summary**

BB is safe and effective for pediatric forearm fracture reductions but remains under-utilized. We have developed a novel BB smartphone App to overcome the barriers to more widespread use of this technique. The App is a resource for individual BB users, but also provides a case study for how an institution can develop an educational tool to support a new program and enhance knowledge translation with other centers.

**Figure Legend**

Figure 1. Main menu and selected screenshots of the BB smartphone App.
References


