eCriticalcare.org
Resident Education using a Cloud-based Mobile App in a Flipped Classroom

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Preamble

Resident education is one of the pivotal functions of academic teaching hospitals. With the advent of the World-Wide Web and mobile computing platforms accessibility, availability, and discourse (*via* social media) of medical education has changed in substantial ways. Much like shifts in content delivery in the consumer world (e.g. from newsprint to online), the consumption of information in medical education now centres around the use of mobile devices such as smartphones & tablets and includes use of Podcasts, websites and blogs [5]. Also public content repositories such as Youtube have become a means of disseminating medical education. Moreover, trainees are increasingly using smartphones and other mobile platforms as the main means by which they consume information and interact with data both locally on their devices but also 'socially' with others including trainees & instructors in their program.

Teaching during residency occurs by didactic lectures (e.g. academic half-days), bed-side clinical teaching, and direct patient responsibility. In addition to these, other forums such as morbidity and mortality rounds bring together didactic teaching and clinical experiential learning for the purposes of higher medical education. This, in part, is what defines the post-graduate medical education (PGME) experience. The resident experience is however complex and has several challenges that are different from undergraduate medical education (UME). As clinical clerks, trainees have lesser clinical responsibility, do not participate in routine overnight call, and generally have more didactic teaching that remains part of their day-to-day routine. In contrast, residency is typically a rotation-based learning process that accompanies increasing amounts of clinical responsibility, longer work hours, frequent call requirements, and the complexities intrinsic to changing environments and supervisors that are particular to each rotation. These factor can dilute the time and attention residents are capable of devoting to their learning during clinical rotations.

Thus, at present there are unique opportunities at the intersection of mobile technologies and medical education in order to enhance learning and performance - this is the impetus behind *ecriticalcare.org*.

Introduction

A rotation in an intensive care unit (ICU) comes with unique challenges that amplify some of the aforementioned considerations. For example, ICU rotations come with a steep learning curve, clinical responsibility along with heightened acuity, and frequent overnight call requirements. Moreover, given that an ICU ro-

tation is central to most residency programs (medical and surgical), a diversity of residents with different backgrounds come together to work in a complex team environment to both learn and care for critically-ill patients. Therefore, timely introduction of key education material, such as fundamentals of resuscitation, serve a key purpose. Therefore, the challenge is to provide an engaging manner by which such information can be consumed asynchronously to enhance learning - this setting is fertile ground for deployment of App-based mobile platform learning.

Apps on mobile devices differ from traditional websites in a number of ways. In Apps, information is self-contained, the interaction and user-interface is rich and can utilize advanced device capabilities such as location/geo-based features, activity tracking, and more. Moreover, the interaction is action-oriented rather than information oriented and data can be available as well on device for working off-line.

The notion of using Apps for learning is supported by the recent explosion of medical apps and medical content online and on social media. This expansion of technology and online information also comes with challenges in providing quality (control) information, ensuring effective self-learning strategies. There are also barriers to accessibility such as owning a device, internet access, and technologic know-how. Some of these challenges are shared with more traditional forms of learning as well. Nonetheless, the current framework of resident education also has other unique challenges, especially in an ICU setting, which may be ameliorated by using a combination of mobile technology and online content delivery.

Current challenges facing resident education in the ICU include: diverse training backgrounds, preparedness for acute clinical situations and their accompanying anxiety, time commitments of a busy rotation, and call requirements that cause dyssynchrony between attendance of traditional classroom-based didactic lectures. The current state of education delivery includes bed-side clinical teaching, teaching during rounds, didactic sessions, and recently added simulation sessions. One specific aspect of education, at the start of the rotation, traditionally relies on an "orientation email" with handouts. The effectiveness of this modality has not been well studied in PGME trainees and not specifically in residents who start a critical care rotation. There are also concerns regarding compliance in reading this material pre-rotation.

We introduce a novel application of an App-based, internet hosted (i.e. cloud-hosted) classroom solution for distribution of medical education content on a platform that engages trainees for the purposes of preparing them for their intensive care rotation. This app-based solution addresses some of the challenges of delivering medical education during residency with specific relevance to providing information about key topics at the start of a complex and demanding rotation such as an ICU rotation. The concept of using mobile and cloud-based technology to

deliver medical education for trainees before and during their critical care rotation provides a unique and timely innovation that hopefully will enhance learning and clinical preparation [6, 1, 7]. The concept of delivering an online curriculum before the start of a rotation is inline with an approach termed "flipped classroom" [4, 3, 2].

The aim of this project was to utilize an app-based, online, education platform that residents could utilize before, during, and after their ICU rotation. The prime purpose was to prepare residents for their ICU rotation focusing on key topics but also to deliver content using a novel approach that allows for modern consumption of the material on mobile devices using Apps - this facilitates asynchronous bidirectional communication using social media built-in to the platform. The content was developed based on a survey of needs and the impact of such an intervention was measured in order to assess the effectiveness of this modality in delivering educational content in the ICU setting.

Methods

In this project we utilized Google's Classroom platform to develop an ICU orientation educational curriculum called "ICU Boot Camp", focusing on basics of airway, breathing, and circulation, in addition to vascular access, sedation, and a general orientation video.

Google Classroom
The *ecriticalcare.org* domain was purchased and an application was placed into Google's educational division for Google Apps for Education support for this domain with affiliation with Western University's Division of Critical Care. This process equates to a restricted educational grant from Google. Upon acceptance, the structure of the organization was put in place and training occurred via the author to both clinical administrators in order to effectively use the portal and be able to register students pre-rotation. The setup of the educational portal required a significant time investment and several conversations with Google support services in order to get the platform fully functioning and applicable to Western's trainees. It is important to note that a significant amount of time was used vetting other online educational platforms (e.g. Moodle, www.moodle.com). Google's Classroom was selected due to it's innate ability to be cross platform, app-based, and given its utilization in several other academic institution's course delivery.

Survey of Needs for curriculum development

Prior to development of a basic curriculum for "ICU Boot Camp" a survey of needs took place for educational purposes. This was conducted across two blocks at both sites (CCTC and MSICU). In addition, ad-hoc discussions took place between the author and faculty & residents in order to assess their view points in improving both the educational curriculum and content delivery. Emphasis was placed on content development and delivery during the pre-rotation epoch as an education curriculum existed at both sites for in-rotation learning. The existing curriculum covers key topics and is didactic in nature attended by the residents most mornings prior to the start of ICU rounds and clinical duties. Thus, the flipped-classroom content was targeting the pre-rotation epoch in preparing residents for their ICU rotation. Ideally this content would be utilized prior to the start of the rotation. Thus this survey assessed the perspective and views towards a flipped classroom environment. Moreover, a listing of teaching topics covering ICU practice (n=27) was composed based on discussions with faculty and fellows. Respondents to the survey of needs could then rank among these topics - this ranking was then used to select the first series of podcasts to be recorded. In addition, the Survey of Needs was used to gauge interest in developing a podcast-based flipped classroom.

Curriculum Development and Post-Rotation Survey

Based on the survey of needs, and the concept of an "ICU Boot Camp" focusing on pre-rotation competency, a subset of topics from the survey of needs selected for content development. Video Podcast were developed by the author on: airway management, sepsis and septic shock, orientation to the ICU, and getting things done. In addition, two previously existing video Podcasts covering ultrasound-guided vascular access and ICU sedation by Dr. Arntfield were included. The new content was peer-reviewed by Drs. Khosravani, Fuller, and Arntfield. The content was the posted to Google Apps for use within the mobile app service. In addition, a curated PDF library encompassing key topics in intensive care medicine was composed by the author and made available on the app.

An accompanying website for ecriticalcare.org was developed by the author highlighting the content, and overall educational intent of the program.

A Post-rotation survey was performed in order to assess and gain feedback regarding the efficacy of the flipped classroom model in addition to assess utilization of the online (App-based) resource and also solicit feedback and comments about the overall initiative.

Results

Survey of Needs

Participants across the two ICUs responded to the survey of needs (40% of those surveyed responded, n=14). From a selection of 27 topics, the mean number of requests per listed topic was 9. Of the 27 topics, 8 topics reached this threshold. From these series of topics, 4 were selected to start the development process for the podcasts: 1) Introduction to Airway Management, 2) Sepsis and Vasoactive agents, 3) Vascular Access, 4) Sedation and Analgesia. In addition, podcasts regarding "Orientation to the ICU and Getting Things Done in the ICU" were recorded. In addition, 93% of respondents stated that they would find the podcasts beneficial and 100% of respondents stated that they would utilize them for educational purposes.

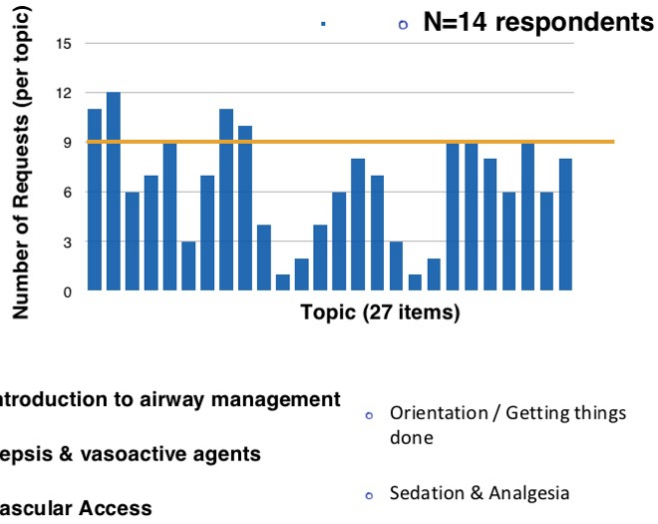

Figure 1: Survey of needs results used to determine the initial podcast topics to be developed for ICU Boot Camp. 8 topics were requested by 9 or more (representing the mean, denoted by a line) respondents.

Post-rotation Survey

Junior residents rotating through the ICU were surveyed across 4 blocks and 2 ICU sites with a response rate of 65% (39/60 individuals surveyed). Results were obtained only after an individual had completed their ICU rotation during the phase when the ICU Boot Camp program was rolled out.

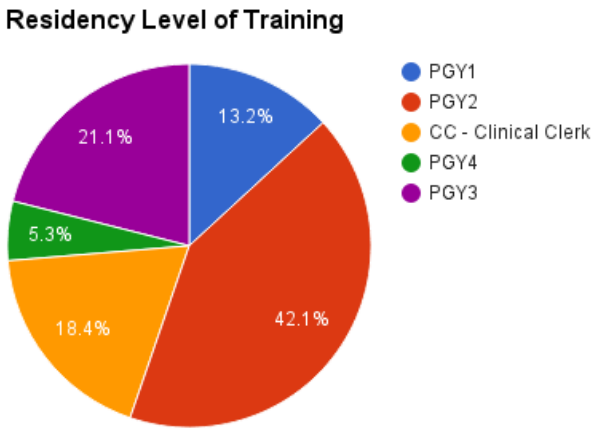

Figure 2: Distribution of post-graduate years among ICU Boot Camp users who responded to the post-rotation survey.

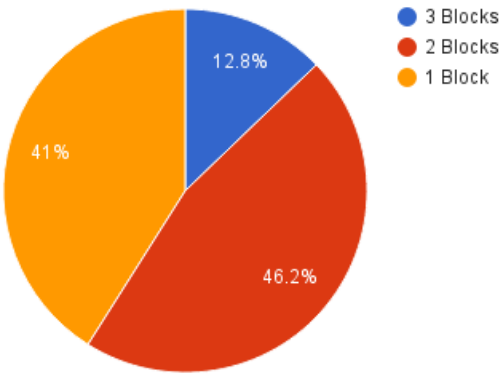

Figure 3: The distribution of respondents based on number of blocks completed in the ICU.

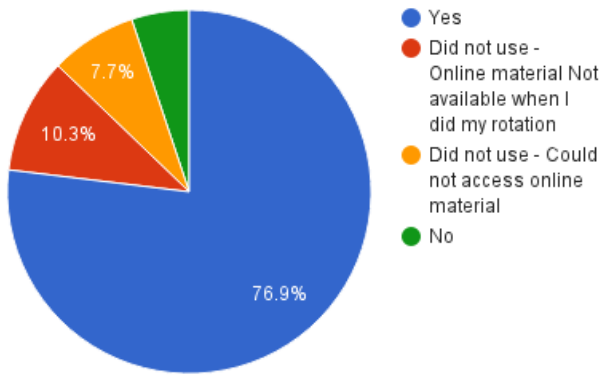

Figure 4: Proportion of users that accessed the online portal in relation to those that had difficulty accessing the content.

The majority of respondents were PGY2 residents (42%) (Fig 2.), and home specialties primarily comprised of Internal Medicine (26%), Medical Students (23%), and Anesthesia residents (15%). The remainder of trainees were from surgical specialties, family medicine, and obstetrics and gynaecology. Most rotators completed 1 or 2 blocks of ICU (Fig. 3)

Approximately 77% of respondents utilized the online resources and approximately 10% of users had difficulty using the portal (Fig. 4). The majority of respondents (31%) used the portal for approximately 3 hours, followed by 23% of respondents who utilized 23%; intriguingly 18% of respondents did not use the online material (some of whom were able to access the online content). With regards to the content consumed, Airway Management was the most popular podcast (54%) followed by Sepsis and Septic Shock (51%), and Vascular Access (49%). Of the respondents that both accessed and viewed podcasts, almost 1/3 consumed all of the podcasts in the series. Approximately 95% of respondents stated that they enjoyed their ICU rotation.

With regards to additional content and modalities of delivery, approximately half (49%) of respondents request more teaching from ICU fellows and most than half (56%) expressed the need for more teaching by the staff/faculty. Approx-

imately 20% of respondents expressed interest in more combined didactic and flipped-classroom content. Interestingly, the lowest amount of interest expressed was for more education around "family meetings and ethics" (10%), followed by "more patient encounters" (13%).

Discussion and Future Directions

We developed and deployed an online cloud-based/App-based educational portal using Google's Classroom for ICU education of Junior residents who rotate through our ICUs. The largest target audience captured was junior learners at the transition points between clerkship and residency (clinical clerks) and junior residency and Sr. residency (PGY2s). During the survey of needs, all of the respondents stated that they would use the App-based/online resource - post implementation 77% of learners used the platform but 10% encountered technical difficulty accessing the material, which highlights issues surrounding access and utility with the technology. For those that used the resource, a significant proportion spent 2-3 hours consuming the podcast material. Most learners requested additional didactic lectures by fellows and consultants thereby emphasizing the continued need and role for traditional classroom-based in-person teaching. Moreover, our survey was able to provide a glimpse into the educational needs and perspectives that junior learners have in an ICU setting - almost 95% of learners enjoyed their ICU rotation and comments provided by learners suggest that there is both a role and continued desire to have a flipped classroom approach alongside traditional didactic learning.

There are several benefits to the platform as developed in that it is expandable and scalable. One such benefit is that podcasts can be created and also curated (from existing sources on the web made available within the App). Thus, 'courses' can be created for various trainee levels and roles including expansion of the platform for educational initiatives within the ICU including to allied health and non-trainee staff. Use of Google's platform offers a robust platform that is enhanced based on a development and maintenance cycle, as per Google, allowing for long-term sustainability. In addition, Google can provide administrator and trouble-shooting support as needed.

Another key aspect of our App-based platform is the social media aspect that was not explored in our project but one that is being added in the future. This allows for intra-rotation feedback by trainees in order to improve their learning experience. There is also room for continued growth and development of additional lectures as identified by the initial survey of needs. Learners were able to provide feedback on additional topics of interest along with their rotation (see Appendix for full survey data including end of rotation comments), which in future application of

this platform can be used to make changes during a rotation to maximize learning and satisfaction from an educational perspective.

Our findings are limited by the fact that data herein is self reported and not fully tracked directly by the classroom Application - this specifically applies to the amount of time users spent on the site. In addition, the relatively small sample size and proportion of respondents limits the conclusions drawn from the data presented. Nonetheless, the positive user comments coupled with the adoption rate of 77% suggests that flipped classroom in an ICU setting is an effective teaching modality. In addition there was no pre- and post- tests of the knowledge content and hence information about the efficacy of knowledge transfer was not assessed in this study.

This project is the start of an online portal dedicated to learning and disseminating knowledge among the critical care group (including trainees) at Western. The mobile App aspect of the platform allows for modern and asynchronous learning environment using the modern and engaging interface of Apps which goes beyond traditional websites. The content is delivered in a safe and private forum and discussion around learning topics can occur within a closed social media-type space within the App. This represents an additional future direction within the App. Moreover, other adjunct projects such as procedure logging or other tasks such as resident activity level can be added on using a mobile phone's advanced features with appropriate consent and approval.

To our knowledge, this is the first application of an App-based educational platform for learning ICU basics for junior trainees and our study starts to build the foundation for using this technology to advance medical education within Western's Critical Care program and beyond. This App-based tool has utility alongside the valued traditions of classroom & bedside-based clinical teaching.

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