Title: Moving anesthesiology educational resources to the point of care: experience with a pediatric anesthesia mobile app

Authors: Katherine S. Monroe, Michael A. Evans, Shivani G. Mukkamala, Julie L. Williamson, Craig S. Jabaley, Edward R. Mariano, Vikas N. O’Reilly-Shah

Corresponding Author:
Vikas N. O’Reilly-Shah, M.D., Ph.D.
Assistant Professor of Anesthesiology, Emory University School of Medicine and Children’s Healthcare of Atlanta
voreill@emory.edu

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### Table S1. Survey for Collection of Pre-Rotation Information

| Question                                                                 | Responses                                                                 |
|--------------------------------------------------------------------------|---------------------------------------------------------------------------|
| How would you identify your gender?                                      | Female                                                                    |
|                                                                           | Prefer not to answer                                                       |
|                                                                           | Male                                                                      |
| What is your age?                                                        | 18–58                                                                     |
| What is your stage of training?                                          | AA Student                                                                |
|                                                                           | CA3                                                                       |
|                                                                           | CA1                                                                       |
|                                                                           | Fellow                                                                    |
|                                                                           | CA2                                                                       |
| Which pediatric anesthesia rotation is this for you?                     | First rotation                                                            |
|                                                                           | Second rotation                                                           |
|                                                                           | Fellow                                                                    |
|                                                                           | Third rotation                                                            |
| I own the following technical devices or technologies:                   | Smartphone                                                                |
|                                                                           | Tablet computer                                                           |
| Do you use anesthesiology-specific applications in the operating room?  | Yes / No                                                                  |
| While providing clinical care, I use the following to guide management  | Paper textbook or journal article                                          |
|                                                                           | Internet via desktop                                                      |
|                                                                           | Internet via smartphone                                                   |
|                                                                           | Tablet app                                                                |
| Have you done any reading, questions, or targeted studying related to    | Extensive targeted studying in preparation for this rotation             |
| pediatric anesthesia prior to this rotation?                             | Read a chapter in a basic text, or a summary chapter in a review text     |
|                                                                           | Limited to studying for the ITE, review questions, or a pediatric lecture |
|                                                                           | Minimal or no pediatric specific studying                                 |
| Have you had any exposure or involvement in the medical care of children | No                                                                        |
|                                                                           | 2 months                                                                  |
|                                                                           | Greater than 2 months                                                     |
|                                                                           | 1 month                                                                   |
|                                                                           | Pediatrics residency                                                       |
| Do you currently have children living in your household?                 | Yes / No                                                                  |
| How much time during the work day do you spend on a tablet or cell phone| < 1 hour                                                                  |
|                                                                           | 1–2 hours                                                                 |
|                                                                           | > 4 hours                                                                 |
| I’m an early adopter of new technology.                                  | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Medical apps are currently useful to me in the clinical care of patients. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I use medical apps less frequently as my expertise and experience base  | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| grows.                                                                  | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Perioperative staff feel that my use of electronic devices and apps in  | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| the OR are distracting.                                                  | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Surgeons feel that my use of electronic devices and apps in the OR are   | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| distracting.                                                             | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Medical apps are used frequently among my fellow learners.               | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I plan to pursue additional subspecialty training in pediatric anesthesia.| 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I plan to work primarily with children in my anesthesia practice.        | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I am not confident when handling smartphones/tablets and mobile          | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| applications.                                                            | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| On clinical rotations, I find that web searches and internet resources   | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| provide the following educational value:                                 | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| On clinical rotations, I find that tablets and apps provide the          | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| following educational value:                                             | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| On clinical rotations, I find that intraoperative didactics provide the | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| following educational value:                                             | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| On clinical rotations, I find that lectures provide the following        | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| educational value:                                                       | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| On clinical rotations, I find that textbooks provide the following       | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| educational value:                                                       | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| On clinical rotations, I find that journal articles provide the          | 10 point Likert: 0 = No Value, 10 = Most Value                            |
| Question                                                                 | Responses                                                                 |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Did you read all of the assigned reading materials provided at the beginning of the rotation? | Yes/No                                                                   |
| How many times per week would you estimate your tablet use?              | 0–20                                                                     |
| Did the assignment of a tablet affect the amount of time you spent using an electronic device in the OR? | Increased the amount of time using electronic devices                    |
|                                                                          | Did not change the amount of time using electronic devices                |
|                                                                          | Decreased the amount of time using electronic devices                    |
| How much did the “Emory Anesthesiologist” app enhance your education?   | 10 point Likert: 0 = No Benefit, 10 = Large Benefit                      |
| How do you judge the benefit of the “Emory Anesthesiologist” App for yourself? | 10 point Likert: 0 = No Benefit, 10 = Large Benefit                      |
| How much do you feel that the tablets affected your vigilance in the operating room? | 7 point Likert: 1 = Large decrease in vigilance                           |
|                                                                          | 4 = No effect on vigilance                                               |
|                                                                          | 7 = Large increase in vigilance                                           |
| I would appreciate having this app or a version of this app for use on other rotations (OB, cardiac, general adult). | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Medical apps are currently useful to me in the clinical care of patients. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I use medical apps less frequently as my expertise and experience base grows. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Perioperative staff feel that my use of electronic devices and apps in the OR are distracting. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| Surgeons feel that my use of electronic devices and apps in the OR are distracting. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I plan to pursue additional subspecialty training in pediatric anesthesia. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I plan to work primarily with children in my anesthesia practice.        | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| I am not confident when handling smartphones/tablets and mobile applications. | 5 point Likert: 1 = Strongly Disagree, 3 = Neutral, 5 = Strongly Agree    |
| On clinical rotations, I find that web searches and internet resources provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| On clinical rotations, I find that tablets and apps provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| On clinical rotations, I find that intraoperative didactics provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| On clinical rotations, I find that lectures provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| On clinical rotations, I find that textbooks provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| On clinical rotations, I find that journal articles provide the following educational value: | 10 point Likert: 0 = No Value, 10 = Most Value                           |
| Question                                                                                                                                                                                                 | Responses                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Which of the following is LEAST LIKELY to reduce the risk of emergence delirium and/or postoperative maladaptive behavioral changes?                                                                      | Parental presence on induction                                                                                                                                                                      |
|                                                                                                                                                                                                          | Oral midazolam                                                                                                                                                                                      |
|                                                                                                                                                                                                          | IV dexmedetomidine                                                                                                                                                                                   |
|                                                                                                                                                                                                          | Emergence propofol                                                                                                                                                                                   |
|                                                                                                                                                                                                          | IV fentanyl                                                                                                                                                                                          |
| An infant presents for elective inguinal hernia repair. He is breastfeeding. His last PO breast milk was at 0600h. When can anesthesia be induced?                                                       | 800                                                                                                                                                                                                |
|                                                                                                                                                                                                          | 900                                                                                                                                                                                                |
|                                                                                                                                                                                                          | 1000                                                                                                                                                                                               |
|                                                                                                                                                                                                          | 1200                                                                                                                                                                                               |
|                                                                                                                                                                                                          | 1400                                                                                                                                                                                               |
| A 3 year old 15 kg child presents for elective uterethromeatoplasty. Mom reports that he had a "pretty bad cold" about 10 days ago with fevers and runny nose but no productive cough. Which of the following is MOST likely to indicate that it is safe to proceed? | Lungs clear to auscultation bilaterally                                                                                                                                                              |
|                                                                                                                                                                                                          | Activity level normal                                                                                                                                                                                |
|                                                                                                                                                                                                          | Absence of an elevated WBC count                                                                                                                                                                   |
|                                                                                                                                                                                                          | Mom affirms that the child is back to baseline                                                                                                                                                      |
| What is the largest component of heat loss and subsequent hypothermia in an anesthetized pediatric patient?                                                                                              | History of reactive airway disease                                                                                                                                                                 |
|                                                                                                                                                                                                          | Radiation                                                                                                                                                                                           |
|                                                                                                                                                                                                          | Convection                                                                                                                                                                                          |
|                                                                                                                                                                                                          | Evaporation                                                                                                                                                                                         |
|                                                                                                                                                                                                          | Conduction                                                                                                                                                                                          |
|                                                                                                                                                                                                          | Room temperature IV fluids                                                                                                                                                                          |
| A child laryngospasms on inhalational induction. He desaturates despite positive pressure, and cannot be ventilated. Sublingual IM succinylcholine is administered. The SpO2 is 40%, and the heart rate decreases to 45 bpm. Systolic BP is 66. Which is the MOST important next step in this patient? | Epinephrine                                                                                                                                                                                         |
|                                                                                                                                                                                                          | Atropine                                                                                                                                                                                            |
|                                                                                                                                                                                                          | Intubate the patient                                                                                                                                                                                 |
|                                                                                                                                                                                                          | Propofol                                                                                                                                                                                            |
|                                                                                                                                                                                                          | Begin chest compressions                                                                                                                                                                              |
| What is the appropriate maintenance fluid administration rate (cc/hr) for a 14 kg child undergoing strabismus repair excluding NPO deficit and insensible losses?                                           | 0–100                                                                                                                                                                                              |
| Which of the following is the BEST estimate of blood volume in a full term 6 month old infant?                                                                                                                 | 60 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 70 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 80 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 90 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 100 ml/kg                                                                                                                                                                                           |
| A child presenting for elective inguinal hernia repair. He is breastfeeding. His last PO breast milk was at 0600h. When can anesthesia be induced?                                                       | 800                                                                                                                                                                                                |
|                                                                                                                                                                                                          | 900                                                                                                                                                                                                |
|                                                                                                                                                                                                          | 1000                                                                                                                                                                                               |
|                                                                                                                                                                                                          | 1200                                                                                                                                                                                               |
|                                                                                                                                                                                                          | 1400                                                                                                                                                                                               |
| What is the largest component of heat loss and subsequent hypothermia in an anesthetized pediatric patient?                                                                                              | Lungs clear to auscultation bilaterally                                                                                                                                                              |
|                                                                                                                                                                                                          | Activity level normal                                                                                                                                                                                |
|                                                                                                                                                                                                          | Absence of an elevated WBC count                                                                                                                                                                   |
|                                                                                                                                                                                                          | Mom affirms that the child is back to baseline                                                                                                                                                      |
| History of reactive airway disease                                                                                                                                                                       | History of reactive airway disease                                                                                                                                                                 |
| What is the largest component of heat loss and subsequent hypothermia in an anesthetized pediatric patient?                                                                                              | Radiation                                                                                                                                                                                            |
|                                                                                                                                                                                                          | Convection                                                                                                                                                                                          |
|                                                                                                                                                                                                          | Evaporation                                                                                                                                                                                          |
|                                                                                                                                                                                                          | Conduction                                                                                                                                                                                          |
|                                                                                                                                                                                                          | Room temperature IV fluids                                                                                                                                                                          |
| A child laryngospasms on inhalational induction. He desaturates despite positive pressure, and cannot be ventilated. Sublingual IM succinylcholine is administered. The SpO2 is 40%, and the heart rate decreases to 45 bpm. Systolic BP is 66. Which is the MOST important next step in this patient? | Epinephrine                                                                                                                                                                                         |
|                                                                                                                                                                                                          | Atropine                                                                                                                                                                                            |
|                                                                                                                                                                                                          | Intubate the patient                                                                                                                                                                                 |
|                                                                                                                                                                                                          | Propofol                                                                                                                                                                                            |
|                                                                                                                                                                                                          | Begin chest compressions                                                                                                                                                                              |
| What is the appropriate maintenance fluid administration rate (cc/hr) for a 14 kg child undergoing strabismus repair excluding NPO deficit and insensible losses?                                           | 0–100                                                                                                                                                                                              |
| Which of the following is the BEST estimate of blood volume in a full term 6 month old infant?                                                                                                                 | 60 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 70 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 80 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 90 ml/kg                                                                                                                                                                                            |
|                                                                                                                                                                                                          | 100 ml/kg                                                                                                                                                                                           |
| 27 week neonate is now 15 days old and weighs 2 kg. She is scheduled for thoracotomy and left lower lobectomy. Appropriate pain control methods are the following EXCEPT:                                         | Caudal epidural placed at T5–T7 with bupivacaine solution                                                                                                                                            |
|                                                                                                                                                                                                          | Morphine 0.1 mg/kg bolus                                                                                                                                                                             |
|                                                                                                                                                                                                          | Local skin infiltration of 2 cc 0.25% bupivacaine by surgeon                                                                                                                                         |
|                                                                                                                                                                                                          | Ketorolac 0.5 mg/kg IV q8h×3 days                                                                                                                                                                   |
|                                                                                                                                                                                                          | Hydromorphone 5 mcg/kg bolus                                                                                                                                                                         |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Higher hemoglobin                                                                                                                                                                                   |
|                                                                                                                                                                                                          | Lower per kg tidal volumes                                                                                                                                                                           |
|                                                                                                                                                                                                          | Lower per kg closing volume                                                                                                                                                                          |
|                                                                                                                                                                                                          | Higher per kg oxygen consumption                                                                                                                                                                   |
|                                                                                                                                                                                                          | Lower per kg functional residual capacity                                                                                                                                                          |
|                                                                                                                                                                                                          | Bleeding secondary to platelet dysfunction                                                                                                                                                         |
|                                                                                                                                                                                                          | Retinopathy of prematurity                                                                                                                                                                          |
|                                                                                                                                                                                                          | Laryngospasm                                                                                                                                                                                        |
|                                                                                                                                                                                                          | Tracheomalacia                                                                                                                                                                                       |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Postoperative apnea of prematurity                                                                                                                                                                  |
|                                                                                                                                                                                                          | 0–500                                                                                                                                                                                              |
| A 15-week-old ex-30-week preterm infant presents for hernia repair. The neonate must be admitted for 24h postsurgically because he is at an INCREASED risk of:                                      | Caudal epidural placed at T5–7 with bupivacaine solution                                                                                                                                            |
|                                                                                                                                                                                                          | Morphine 0.1 mg/kg bolus                                                                                                                                                                             |
|                                                                                                                                                                                                          | Local skin infiltration of 2 cc 0.25% bupivacaine by surgeon                                                                                                                                         |
|                                                                                                                                                                                                          | Ketorolac 0.5 mg/kg IV q8h×3 days                                                                                                                                                                   |
|                                                                                                                                                                                                          | Hydromorphone 5 mcg/kg bolus                                                                                                                                                                         |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Higher hemoglobin                                                                                                                                                                                   |
|                                                                                                                                                                                                          | Lower per kg tidal volumes                                                                                                                                                                           |
|                                                                                                                                                                                                          | Lower per kg closing volume                                                                                                                                                                          |
|                                                                                                                                                                                                          | Higher per kg oxygen consumption                                                                                                                                                                   |
|                                                                                                                                                                                                          | Lower per kg functional residual capacity                                                                                                                                                          |
|                                                                                                                                                                                                          | Bleeding secondary to platelet dysfunction                                                                                                                                                         |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Retinopathy of prematurity                                                                                                                                                                          |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Laryngospasm                                                                                                                                                                                        |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Tracheomalacia                                                                                                                                                                                       |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | Postoperative apnea of prematurity                                                                                                                                                                  |
| What is the BEST explanation for more rapid arterial desaturation in neonatal patients as compared to adults?                                                                                             | 0–500                                                                                                                                                                                              |
| Question                                                                 | Responses |
|------------------------------------------------------------------------|-----------|
| **The SmartTots consensus guidelines:**                                | Recommend against elective anesthesia for children under age 1 |
| Emphasizes regional over general anesthesia for risk reduction         |           |
| Emphasizes the importance of care team and family communication        |           |
| Makes definitive recommendations regarding safe timing for elective    |           |
| pediatric anesthesia                                                   |           |
| Emphasizes the use of neuroprotective agents such as dexmedetomidine    |           |
| **Which is the following does NOT characterize obstructive sleep apnea** | Females are as commonly affected as males |
| (OS) in the pediatric population?                                       | May present with hyperactivity |
|                                                                        | Snoring is sensitive but not specific for diagnosing OSA |
|                                                                        | Most commonly affects children age 2–6 |
|                                                                        | Surgical tonsillectomy is infrequently the definitive treatment |
| **A 5 year old with Downs syndrome is scheduled for tonsillectomy and** | Obtain stat cervical neck films for preoperative clearance |
| adenoidectomy for obstructive sleep apnea. He has no cervical neck    | Obtain stat cervical CT for preoperative clearance |
| films. On history and exam, he has full upper extremity strength and   | Cancel the case until cervical neck is cleared |
| no cervical symptoms. How do you proceed?                              | Proceed with the case with direct laryngoscopy minimizing neck |
|                                                                        | extension. |
|                                                                        | Asleep fiberoptic intubation |
| Pierre Robin sequence is associated with all of the following except    | Micrognathia |
|                                                                        | Macroglossia |
|                                                                        | Cervical spine instability |
|                                                                        | Potential life threatening extrathoracic airway obstruction |
|                                                                        | Cleft palate |
| **Which of the following is NOT a treatment for intraoperative**        | IV sodium bicarbonate |
| hyperkalemia?                                                           | IV magnesium |
|                                                                        | INH albuterol |
|                                                                        | IV calcium chloride |
|                                                                        | IV insulin and glucose |
| **A 6 year old boy presents to the emergency room after sustaining an** | Treat bp with antihypertensives |
| unrestrained motor vehicle accident an hour after dinner. His GCS is 5,| Ventilate with a target of end-tidal CO2 of 20 |
| his BP is 145/76, HR 42, RR 15, Saturation is 96% via 100% face mask. | Use succinylcholine to secure the airway |
| Decision is made to intubate him in the trauma room. The MOST          | Avoid volume resuscitation |
| appropriate management is to:                                            | Await cervical imaging prior to intubation |
| **A 6 week old 3.2 kg male infant is scheduled for laparoscopy for**    | Go to the OR for definitive management |
| history of projectile emesis. On exam, the child has a HR 190, bp 65/45,| Fluid bolus of 20 cc/kg of normal saline |
| temperature of 37.2, and respiratory rate of 32 and appears lethargic. | Fluid bolus of 20 cc/kg of D5W |
| Ultrasound demonstrates ‘olive’ consistent with pyloric stenosis. The   | Administration of maintenance IV fluids at 12.8 cc/hr |
| MOST appropriate next step in management is:                           | Oral electrolyte solution |
| **A boy with acute epiglottitis is brought to the emergency room. You** | Propofol, succinylcholine |
| are consulted to intubate the patient for airway protection. He has    | Propofol, rocuronium |
| preexisting IV access. The patient is brought to the operating room    | Ketamine, rocuronium |
| and a pediatric otolaryngologist is ready to perform tracheostomy if  | Sevoflurane inhalational induction |
| necessary. Which of the following is the most appropriate induction    | Ketamine, succinylcholine |
| technique?                                                              | <60 bpm |
| You are paged to the delivery room to resuscitate a newborn. The      | <80 bpm |
| neonate is full term, has poor motor tone, and there is no meconium    | <100 bpm |
| staining of the amniotic fluid. What heart rate is considered          | <120 bpm |
| bradycardia in this instance?                                          | <140 bpm |
|                                                                        | 10 mg/kg |
|                                                                        | 5 mg/kg |
|                                                                        | 2 mg/kg |
|                                                                        | 0.5 mg/kg |
|                                                                        | 0.1 mg/kg |
| Question                                                                 | Responses                                           |
|-------------------------------------------------------------------------|-----------------------------------------------------|
| A 1 month old boy presents with 12 hours of persistent non-bilious     | Respiratory acidosis                                |
| vomiting, newly diagnosed with pyloric stenosis. Which acid-base        | Metabolic alkalosis                                 |
| disturbance is MOST likely in this infant?                              | Respiratory alkalosis                               |
|                                                                         | Metabolic acidosis                                  |
|                                                                         | No acid-base disturbance is likely                   |
| A 5 year old with Duchenne's muscular dystrophy presents for surgery.  | Malignant hyperthermia                              |
| Which of the following is MOST associated with DMD?                     | Neuroleptic malignant syndrome                       |
|                                                                         | Hypokalemic periodic paralysis                       |
|                                                                         | Rhabdomyolysis                                      |
| Which is the MOST appropriate size blade and tube for an otherwise     | Miller 2, 4.5 cuffed ETT                             |
| healthy 3.5kg neonate?                                                  | Miller 1, 4.5 uncuffed ETT                           |
|                                                                         | Miller 1, 4.0 cuffed ETT                             |
|                                                                         | Miller 1, 3.5 cuffed ETT                             |
|                                                                         | Miller 0, 3.0 uncuffed ETT                           |
| Which of the following does NOT cause a right-to-left shunt in a        | Hyperthermia                                        |
| neonate?                                                                | Hypoxemia                                           |
|                                                                         | Hypercarbia                                         |
|                                                                         | Acidosis                                            |
Table S4. Participants’ views of: (a) the educational value of various didactic modalities, (b) whether use of the app was viewed as distracting to patient care by staff or surgeons

(a) On clinical rotations, I find that X provide the following educational value: 0 = No value 10 = Most value

| Educational Modality                        | Low (0–4) | Medium (4–7) | High (8–10) |
|---------------------------------------------|-----------|--------------|-------------|
| ...web searches and internet resources      | 0         | 19 (63%)     | 11 (37%)    |
| ...tablets and apps                        | 0         | 21 (70%)     | 9 (30%)     |
| ...intraoperative didactics                | 0         | 16 (53%)     | 14 (47%)    |
| ...lectures                                | 1 (3%)    | 18 (60%)     | 11 (37%)    |
| ...textbooks                               | 1 (3%)    | 23 (77%)     | 6 (20%)     |
| ...journal articles                        | 3 (10%)   | 24 (80%)     | 3 (10%)     |

(b) Please rate the following:
(1 = Strongly Disagree 5 = Strongly Agree)

| Rating          | Disagree (1–2) | Neutral (3) | Agree (4–5) |
|-----------------|----------------|-------------|-------------|
| Pre: Staff View App Use As Distracting | 6 (20%)       | 14 (47%)    | 10 (33%)    |
| Post: Staff View App Use As Distracting | 5 (33%)       | 6 (40%)     | 4 (27%)     |
| Pre: Surgeons View App Use As Distracting | 11 (37%)      | 9 (30%)     | 10 (33%)    |
| Post: Surgeons View App Use As Distracting | 8 (53%)       | 3 (27%)     | 4 (20%)     |
**Survalytics Detailed Description**

The Survalytics platform is designed to send survey questions to the app and to retrieve survey responses and other analytic metadata from the app. These surveying capabilities are not one-time or static. New survey questions can be delivered via the Internet to the installed base of mobile devices at any time, with the questions being presented to the app users the next time that the app is opened. Survey data and app usage information are transmitted to and from the app utilizing services provided “in the cloud” by Amazon Web Services (Amazon Seattle, WA).

A detailed schema for the survey and analytic data collection was developed. The Survalytics platform allows for the surveys to have a branched structure. Such a branched survey was used to collect basic demographic information from the user after initial installation and agreement by the user to participate in the study. The survey questions are summarized in Table S1. Users had the ability to opt in or opt out of the study at any time.

Location of the device was determined using three different approaches, as described below. For all of the approaches, only the country and “administrative region” were determined and stored, even when more precise determination of location was possible. Here “administrative region” refers to the largest geographical subdivision within the country such as the state in the U.S. or province in India. The precision of the location determination was limited to granularity no more defined than administrative region in order to provide Health Insurance Portability and Accountability Act (HIPAA) compliant de-identification of data. Healthcare providers were entering into the app a patient age and weight. If the location information stored were more precise, patient age and weight information entered into the app might be combined with the specific location and date in a manner that could potentially comprise protected health information (PHI) as defined by HIPAA.

The first of the three approaches to determining the country and administrative region data was based on GPS coordinates which were reverse geocoded using Google’s Geocoding API [1]. “Reverse geocoding” refers to the process of converting longitude and latitude coordinates, such as those provided by GPS, into human-interpretable geographic descriptions such as country, state/province, or address. The second approach was based on using the mobile device’s Internet Protocol (IP) address. The IP address was reverse geocoded using a web-based service provided by ip-api.com [2]. The last approach was based on the country code stored in the memory chip used to uniquely identify the device (the Subscriber Identity Module or SIM card). Only country information is available via this last approach.

During analysis, the country and administrative region from GPS reverse geocoding was preferentially used. However, GPS coordinates were not always available for a variety of reasons including GPS reception problems, GPS sensor failure, or the device user not consenting to sharing GPS location information. If GPS data were not available, the country and administrative region from IP address was used. Sometimes, this information was not available due to lack of Internet connectivity at the time of data collection. If not, the country from the SIM card (felt to be the least accurate) was used.

The Survalytics platform stores each “event” (e.g. consent, a survey response, an in-app click, or closure of the app) in a local database on the device. When Internet connectivity is detected, one data packet is transmitted from the app at a time, with each packet representing a single “event”. Each packet contains relevant details of the event (e.g. what was clicked), as well as a generic set of information including an anonymous globally unique identifier (generated when the app is first opened on the device), time information (specifically, timestamp, time zone, and local time), location information (from the three sources outlined above), and device language. Transmitted packets are stored as records in an Amazon Web Services DynamoDB database. See the publication describing Survalytics [3] for even further additional technical details.

The anonymous user identifier allows for all of the data from one device to be tied together. Together with the time stamps, this allows the sequence of app usage events and survey responses for each mobile device to be reconstructed from the database.
Mobile Healthcare App Study JSON Document Schema

I. Survey/demographics central database tables

The overall architecture is designed to simplify the codebase by using JSON primarily as a transport vehicle and limiting the number of database fields to those that need to be known by the database in question. For example, the AWS source database for downloading questions only needs to know questionguid (for a hash key) and the json_str containing the meat of the question. Telling it ordinal position simplifies other areas of the Android code and so that was included. Otherwise, the content remains unparsed until downloaded by the Android app.

On device, the database is again limited to guid, ordinal position, and jsonstr. The additional fields are flags for internal tracking use. Parsed JSON supplies fields for the generation of the question on-device and for the uploaded response.

http://www.jsoneditoronline.org/
https://www.guidgenerator.com/online-guid-generator.aspx

On AWS: Question Table:

| Field              | Type             |
|--------------------|------------------|
| questionguid_str   | STRING, PRIMARY HASH KEY |
| ordinalposition_int| INT, RANGE KEY   |
| json_str           | STRING           |

json_str JSON Schema: Question

```
{
    surveyname_str : STRING
    surveyguid_str : STRING
    ordinalposition_int : INT
    questionguid_str : STRING
    questionprompt_str : STRING
    questiontype_str : STRING
    responses_arr : ARRAY
        [
            {
                responseid_int : INTEGER
                response_str : STRING
            },
            {
                responseid_int : INTEGER
                response_str : STRING
            },
            ....
        ]
OPTIONALLY
    conditional_upon_questionguid_str : STRING // questionguid to check*
    conditional_upon_responseid_int : INTEGER // responseid to check*
    // *-above two work together and both required to be specified
    conditional_upon_datemsid_int : INTEGER
    // date (in UTC Unix epoch ms) after which to administer this question
    conditionalbycountry_str : STRING // use ISO 3166 alpha-2 codes
```
delaybydays_int : INTEGER
// wait this many days after the question is first downloaded to ask this question

ongoingquestion_arr : ARRAY // array of day of week+time as follows
[
  {
    notificationtime_str : STRING
  },
  {
    notificationtime_str : STRING
  },
  ...
  // notificationtime formatted as follows: EEEHHmm
  // EEE = three letter day of week (Mon, Tue, Wed, Thu, Fri, Sat, Sun, Dly)
  // Dly = daily
  // HH = military time hours 00-23
  // mm = minutes 00-59
  // Examples: Tue0900, Thu1400, Dly1200
]

deletequestion_str : STRING // questionguid of ongoing question to
// delete from local SQLite db

Local DB on Android

Table questions
questionguid_str
json_str
ordinalposition_int // Primary key
final_responseid_int
final_response_str
answered_bool
uploaded_bool // unused

Table responses
_id
json
uploaded


II. Responses: Generic schema

The generic schema serves as the basic information passed with all types of uploaded data. The additional overhead is minimal and the presence of this information in each of uploaded packet simplifies future analysis against unnecessary complexity in terms of crossreferences and joins.

```json

{
    "userguid_str" : STRING PRIMARY RANGE INDEX
    "localtime_ms_int" : INTEGER PRIMARY HASH INDEX
    "localtime_hrs_military_int" : INTEGER
    "localtime_dayofweek_str" : STRING
    "localtimezone_str" : STRING
    "country_tm_str" : STRING
    "lo_lang_str" : STRING // locale lang
    "app_lang_str" : STRING
    "region_ipapi_str" : STRING // www.ip-api.com/json
    "regionname_ipapi_str" : STRING
    "country_ipapi_str" : STRING
    "region_gc_str" : STRING // geocoding
    "country_gc_str" : STRING
    "entrytype_str" : STRING LSI // included in all section III items
    "...
```
III. Responses: Specific added fields to generic document schema

Survey/demographics data

```json
... entrytype_str : "survey",
  surveyguid_str : STRING
  questionguid_str : STRING
  questionprompt_str : STRING
  response_str : STRING
  responseid_str : STRING //questionguid & "." Integer.toString(respid)
  responses_arr : ARRAY [if type is multiple response eg checkbox)
[    
     responseid_str :STRING
       //questionguid & "." Integer.toString(respid)
     response_str :STRING
    ,
    
     responseid_str :STRING
       //questionguid & "." Integer.toString(respid)
     response_str :STRING
    ],
  ...]
```

Consent/Consent Change

```json
... entrytype_str : "consentcode_int/consentchange_int"
  "consentcode_int" : INTEGER
  "consentchange_int" : INTEGER
    1 - do not consent
    2 - consent
    3 - exit study
    4 - re-enter study
```

On Start

```json
... entrytype_str : "onstart"
  "age_yrs_fra" : FRACTION
  "weight_kg_fra" : FRACTION
```

Age/weight entered by app user (age over 89 to be reported as 89+)

```json
... entrytype_str : "ageweight",
  "age_yrs_fra" : FRACTION
  "weight_kg_fra" : FRACTION
```
Total time using the app

... 
entrytype_str : "totaltimeofuse",
"timeinapp_ms_int" : INTEGER,
"ageweightmodified_int" : INTEGER //0=no 1=yes

Drugs favorited and changes to favorites

...
entrytype_str : "favoriteslist",
"favoriteslist_arr" : ARRAY
 [ 
  {  
   "drugid_int" : drug.get_id(), INTEGER  
   "name_str" : drug.getDrugName(), STRING  
   "position_int" : favepos INTEGER
  },
  {  
   "drugid_int" : drug.get_id(), INTEGER  
   "name_str" : drug.getDrugName(), STRING  
   "position_int" : favepos INTEGER
  },
  ....
]

In-app clicks (drugs, Epocrates, airway setup guide, critical events checklist, externally linked nerve blocks)

...
entrytype_str : See the click types below

Entrytype_str click types:
"drugclick",
"epocrates",
"linkline_str",
"airwaysetupguide",
"pdfline_str"

Extra JSON for drug/epocrates
   "drugid_int" : drug.get_id()  
   "name_str" : drug.getDrugName()

Extra JSON for linkline:
   "linkline_str" : STRING == name  //nerveblock and spachecklist
   "linklineurl_str" : STRING == link  //nerveblock and spachecklist

Extra JSON for pdfline_str:
   "pdfline_str" : STRING == click
Methodology for Calculation of App Use Frequency

Under circumstances with no “complications,” the frequency of app use for a fixed time interval would be estimated in a straightforward and intuitive manner by counting the number of app uses in the time interval and dividing by the length of the interval. The situation encountered in estimating the app use frequency based on the data obtained from the Survalytics platform is more complicated. This is because the app can be unloaded or otherwise abandoned (e.g., lost phone), and the Android operating system does not allow app unload events to be detected and reported by in-app analytics.

Because of this, estimating the app use rate as the number of uses between the time of consent and the time of conclusion of the study divided by the length of that interval would underestimate, potentially by a large amount, the rate of app use (while the app was available) for any user that unloaded the app or otherwise abandoned it. Similarly, estimating the rate of app use based on a time interval determined by the last time the app was used causes overestimation of the usage rate because the time after the last use until the end of the study (or until the app is unloaded) is truncated from the interval used to calculate the rate.

The approach used here to estimate the usage rates is designed to help correct for these biases in a reasonable way. The method is based on the assumption that, for any user $i$, the use of the app while installed (or otherwise not abandoned) follows a Poisson distribution with a constant usage rate $\lambda_i$. In this case, it can be shown that the expected value of the latest usage time $t_n$ in an interval $[0, T]$ where there have been $n$ uses in that interval is $E(t_n) = Tn/(n+1)$. This last equation is derived from the fact that, for a Poisson process with $n$ events occurring in the time interval $[0, T]$, the times of those events will have the same distribution as the order statistics of $n$ uniform random variables on the same interval (see, for example, Doob, page. 400) [4]. The formula above for $E(t_n)$ can be used to estimate $T$, the end of the time interval. Specifically, the estimated unload time is $\hat{T} = t_n(n+1)/n$, where $t_n$ is the latest usage time and $n$ is the number of observed uses.

Using this idea, the usage rate $\lambda_i$ for user $i$ is estimated as follows. First the app unload time predicted from the time of the last use is estimated by

$$\hat{T}_{U,i} = \frac{n_i+1}{n_i} (t_n - T_{C,i}) + T_{C,i}$$

where $n_i$ is the number of app uses by user $i$, $t_n$ is the time of the last use, and $T_{C,i}$ is the time of consent for user $i$.

The time which is then used as the end of the time interval in the estimation of the usage rate is the minimum of the estimated unloading time $\hat{T}_{U,i}$ and $T_i$, the time of the conclusion of the study. The estimate of the rate $\hat{\lambda}_i$ for user $i$ is then given by:

$$\hat{\lambda}_i = \frac{n_i}{\min(\hat{T}_{U,i}, T_i) - T_{C,i}}.$$  

These estimated usage rates will be smaller than ones based on using the last observed time of use, and larger that those based on the end time of the study (unless the estimated unload time is later than the end of the study).

George Easton, PhD

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