



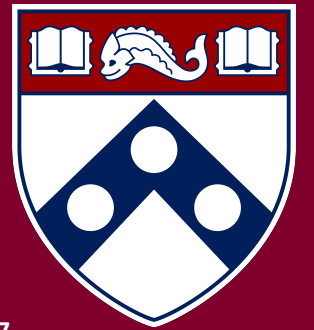
Simulation study to evaluate fidelity of continuous pulse oximetry recording in the electronic health record

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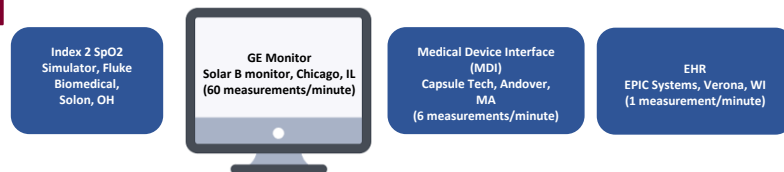
Introduction

Patients undergoing general anesthesia are prone to rapid physiologic changes. Electronic health records (EHR) capture measurements from physiologic monitors at regular intervals, but pulse oximetry data is dynamic. The EHR data sampling rate can fail to capture transient hypoxemic events. Our study aims to examine the impact of a 1-minute EHR data sampling rate. Our hypothesis is that the EHR does not always record transient hypoxemic events.

Methods

Vital sign simulator (VSS) tests were conducted in a biomedical engineering laboratory at the Children's Hospital of Philadelphia

Figure 1



- The VSS generated a continuous pulse oximetry waveform recorded across the AIMS continuum (see figure 1)
- Transient hypoxemia was simulated by alternating oxygen saturation (SpO₂) between 100% and 40% every 30 seconds.
- A digital timer was synchronized with the EHR to guide the simulation scenarios.
- Scenarios were video recorded with an analog timer shown next to the monitor display.

Simulation protocol:

- SpO₂ was set to 100% for 30 seconds, then 40% for 30 seconds.
- The sequence was repeated over 4 minutes.
- Four sequences were completed with a 10-second frame shift for each subsequent sequence.
- Continuous pulse oximetry data from the monitor were transcribed from the video recording in 1-second intervals by a data collection researcher.
- Data was then linked to collated MDI data (10-second intervals) and EHR data at 1-minute intervals (see Table 1)

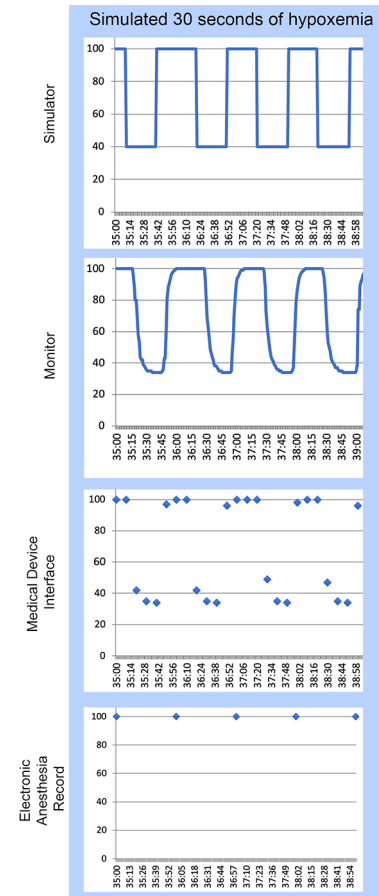
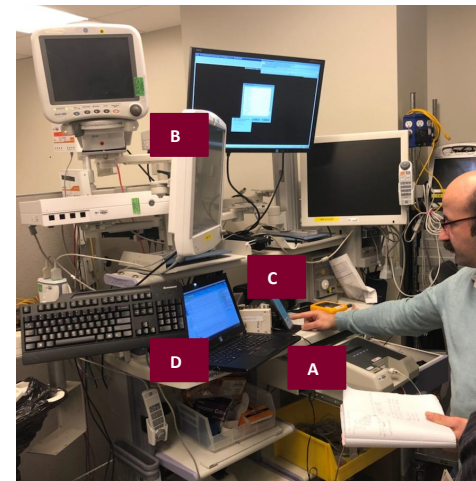


Table 1

Sample of simulated 30 seconds of hypoxemia over 4 minute increment. X-axis represents time (in seconds); y-axis represents oxygen saturation (SpO₂) from 0-100%. Data was compared across 4 devices (simulator, GE monitor, MDI, EHR/EPIC)



Picture 1

Simulation testing environment with Jorge Galvez, MD, MBI and fellow data research scientists.

- A. Index 2 SpO₂ Simulator
- B. GE monitor
- C. Medical Device Interface
- D. EPIC systems

Results

- Table 1 demonstrates data granularity and fidelity across the AIMS continuum.
- An approximately 8- to 10-second delay occurred between simulated hypoxemia and monitor-recorded hypoxemia.
- Transient hypoxemia episodes lasting up to 30 seconds can be missed when recording EHR data at 1 minute intervals.
- MDI-recorded hypoxemia episodes were shorter than simulated hypoxemia episodes.

Discussion

- Patients under anesthesia may have abrupt alterations in vital signs, such as hypoxemia.
- Acute changes in vital signs may not be accurately captured with 1-minute recording intervals seen in the AIMS record.
- The MDI data reflects greater data granularity in the pulse oximeter simulator than the AIMS record.
 - MDI: frequency of 1 measurement per every 10 seconds.
 - AIMS: frequency of 1 measurement per minute.
- High frequency data can improve the identification of acute events.
- AIMS data is useful for research, machine learning, safety event analysis, and quality improvement initiatives.
- This simulation demonstrates the importance of data granularity to capture a patient's vital signs with high fidelity and frequency.
- Accurate automated documentation systems are paramount to capture clinical interventions performed during patient care².

Summary

This experimental simulation testing for hypoxemia demonstrates the importance of physiologic data granularity and fidelity across the AIMS.

Citations

- Hoorweg. Incidence of Artifacts and Deviating Values in Research Data obtained from an Anesthesia Information Management System in Children. Anesthesiology. 2018.
- Simpao. One laryngospasm, 2 realities: a case report highlighting the impact of data granularity on post hoc analysis of perioperative events. A&A Practice. 2018.

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