The Telephone Game: Signal Degradation of Automated Vital Sign Recording in Anesthesia Information Management Systems

Presenting Author: Jorge A. Gálvez, MD, MBI
Co-authors: Diane Dao, MD**;** Olivia Nelson, MD; Allan F. Simpao; Jonathan M. Tan, MD, MBI, MPH; Jack O. Wasey, BMBCH, MA, Msci; Aaron Masino, PhD; Richard Tsui, PhD; James Scott; Mohammed Saeed; Larry Sloberman; Michael Hamid; Mary B. Bartko

Background: Anesthesia information management systems (AIMS) enable automated vital sign documentation.(1) Automated recording of vital signs has been shown to be superior to manual recording.(2, 3) However, artifacts can be recorded inadvertently through automated systems.(4-6) AIMS are becoming increasingly complex, and many rely on medical-device interface (MDI) systems to incorporate data streams from physiological monitors to the electronic health record. This experiment was designed to evaluate the fidelity of data transfer from the patient to the electronic health record (EHR).

Methods: Experiments were run at CHOP in a biomedical engineering testing environment that included a vital sign simulator (Index 2 SpO2 Simulator, Fluke Biomedical, Solon, OH), Solar B monitor (GE, Chicago, IL), MDI integration system (Capsule Tech, Andover, MA), and EHR (Epic Systems, Verona, WI). The vital sign simulator generated pulse oximetry data that was recorded by the Solar B Monitor. The Solar B monitor data are transferred to the MDI at a rate of one measurement every 6 seconds, which is then recorded by the EHR every 1 minute. We simulated scenarios by alternating the SpO2 simulator between 100% and 40% as follows (Figure 1, top row): Simulation #1: SpO2 100% for 1 minute; SpO2 40% from +01:00 to +01:40; repeated once; Simulation #2: SpO2 100% for 1 minute; SpO2 40% from +01:20 to +02:00; repeated once. Data were exported from MDI server and EHR. The experimental sessions were recorded with a video camera (Go Pro, San Mateo, CA).

Results: Figure 1 shows the data measurements from the Pulse Ox Simulator, GE Monitor, MDI, and AIMS (top to bottom) for Simulations #1 and #2. Vital sign variations were seen in the MDI and AIMS records compared to the value displayed on the clinical monitor. In Simulation #1, the SpO2 values recorded in the AIMS record reflected the peaks (100% SpO2) without the troughs (40% SpO2) (Figure 1, left column). Shifting the 40-second long hypoxemia episodes by 20 seconds in Simulation #2 resulted in recording of the trough (40% SpO2) without the peaks (100% SpO2), notably without reflecting the interval improvement between the episodes of hypoxemia (Figure 1, right column).

Conclusion: This experimental model demonstrates the impact of data granularity and the MDI and AIMS sampling rates on automated vital sign recording. Clinical events such as laryngospasm with hypoxemia can unfold rapidly in the operating room yet may not be documented accurately by the AIMS or EHR if the measurements are recorded at 60 second intervals.(6) Furthermore, the AIMS and EHR data sampling parameters are often unclear. MDI systems can allow recording of higher frequency vital signs. It is imperative that documentation systems that rely on automated data capture can record high-frequency vital signs to accurately

record each patient's status and any clinical interventions to address transient perturbations in the patient's state.

Figure 1

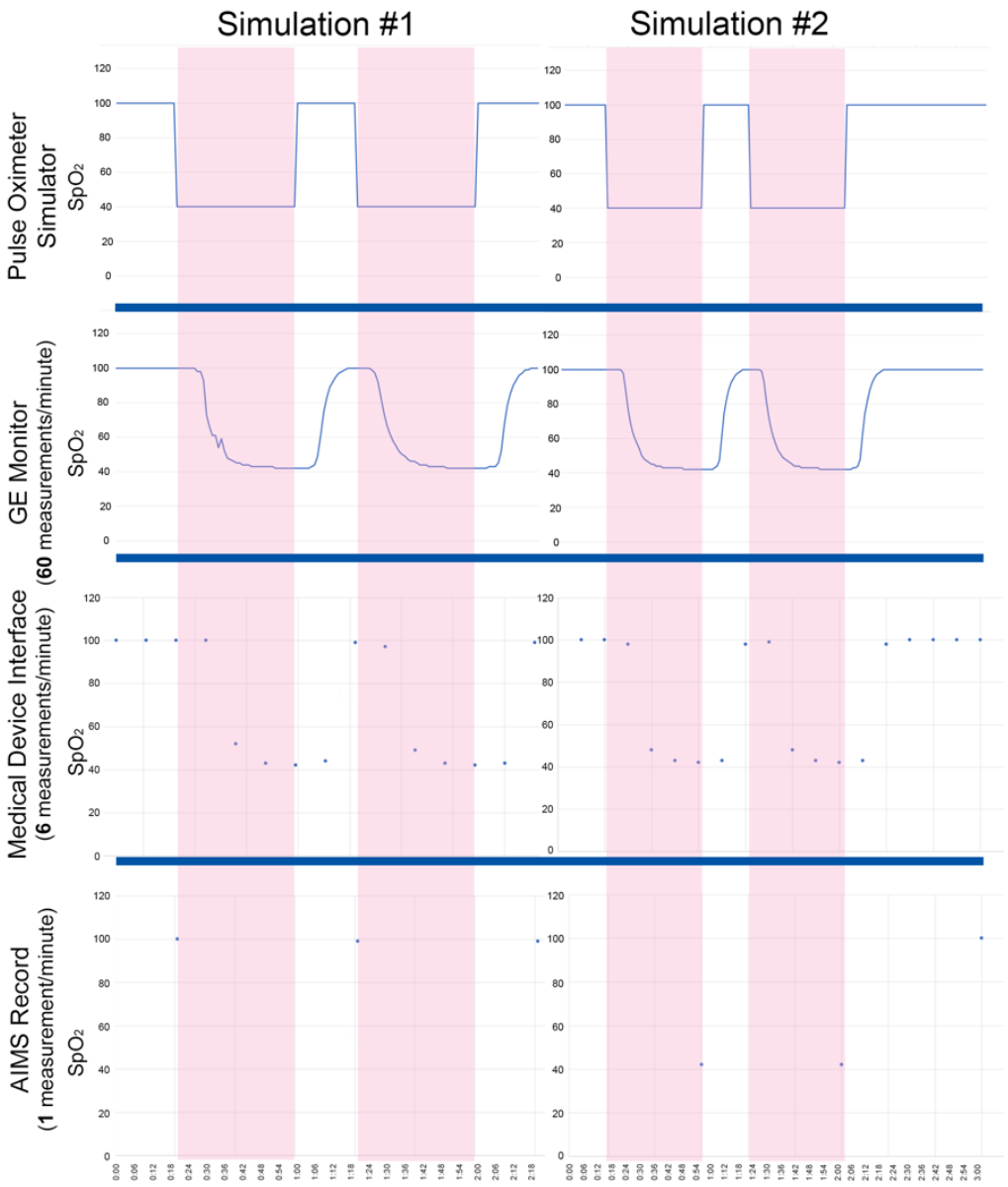

Figure 1: Pulse oximetry (SpO2) data generated by simulator (top row) and recorded by GE Solar Monitor (second row), medical-device interface (third row) and anesthesia information management system (AIMS) (fourth row) for simulation #1 and simulation #2. Hypoxemia episodes for simulation #1 and #2 highlighted in red.

References

1. Tanoubi I. The electronic medical record in anesthesiology: a standard of quality healthcare and patient safety. Can J Anaesth. 2017.

2. Reich DL, et al. Arterial blood pressure and heart rate discrepancies between handwritten and computerized anesthesia records. Anesthesia & Analgesia. 2000;91:612-6.

3. Simpao AF, et al. The reliability of manual reporting of clinical events in an anesthesia information management system (AIMS). Journal of Clinical Monitoring and Computing. 2012;26:437-9.
4. Kool NP, et al. Artifacts in research data obtained from an anesthesia information and management system. Can J Anaesth. 2012;59(9):833-41.
5. Hoorweg AJ, et al. Incidence of Artifacts and Deviating Values in Research Data Obtained from an Anesthesia Information Management System in Children. Anesthesiology. 2018;128(2):293-304.
6. Simpao AF, et al. One Laryngospasm, 2 Realities: A Case Report Highlighting the Impact of Data Granularity on Post Hoc Analysis of Perioperative Events. A&A Practice. 2018;11(11):315-7.