

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: Simulation experiments were conducted in a biomedical engineering laboratory using a vital sign simulator (VSS) (Index 2 SpO₂ Simulator, Fluke Biomedical, Solon, OH), Solar B monitor (GE, Chicago, IL), Nuvon Medical Device Interface (MDI, Capsule Tech, Andover, MA), and EHR (Epic Systems, Verona, WI). The VSS generated a continuous pulse oximetry waveform that was recorded by the monitor. The monitor data was transferred to the MDI at a rate of one measurement every 6 seconds and EHR recorded data every 1 minute. Transient hypoxemia was simulated by alternating 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 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 and linked with MDI data at 10-second intervals and EHR data at 1-minute intervals.

Results: Each episode of hypoxemia is represented by the data displayed in the GE monitor, the MDI (Fig 1). There was an 8- to 10-second delay between simulated hypoxemia and monitor-recorded hypoxemia. MDI-recorded hypoxemia episodes were shorter than simulated hypoxemia episodes. The low SpO₂ values occurred between the sampling interval for the EHR and were not recorded.

Discussion: Our findings demonstrate that transient hypoxemia episodes lasting 30 seconds can be missed when recording EHR data at 1 minute intervals. Our study highlights the need for the EHR to record high-frequency data for improved record keeping. High frequency data can potentially improve the identification of acute events and facilitate the use of EHR data for research (e.g. machine learning) and quality improvement initiatives.

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

References:

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Figure 1

