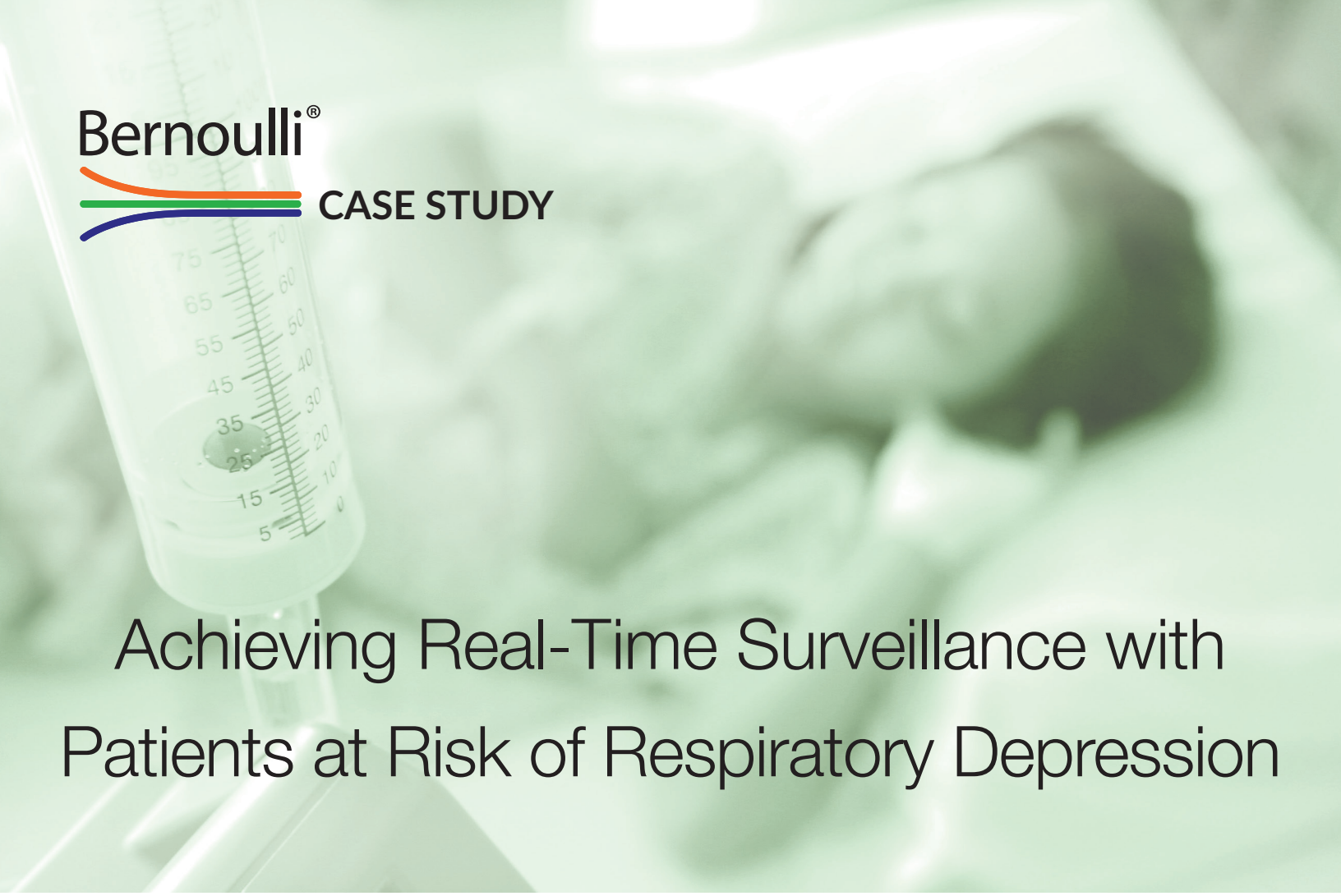


Bernoulli®

CASE STUDY

Achieving Real-Time Surveillance with Patients at Risk of Respiratory Depression

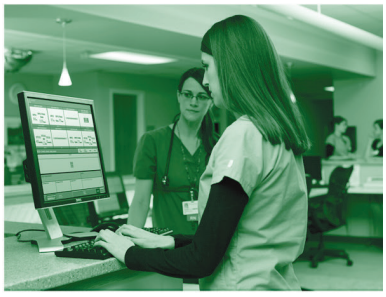
Introduction

Located in a major urban area in the southern United States, an award-winning, 500+ bed, not-for-profit community health system with full-service, acute-care satellite facilities in 120+ locations across the region set out to improve safety and surveillance of patients administered post-surgical opioids, including those receiving patient-controlled analgesia (PCA).

Following an extensive vendor search, the health system selected Bernoulli as their scalable solution to:

- Enable both centralized and mobile clinical surveillance of patients recovering from post-op anesthesia, including those patients administered PCA
- Connect with 120+ medical devices from different vendors
- Reduce the volume of non-actionable alarms
- Prioritize critical alarms to ensure the right information was pushed to the right caregiver at the right time to ensure patient-centered care and timely interaction

An award-winning not-for-profit community hospital chose Bernoulli *One*™ to enable real-time surveillance of post-operative patients who were at risk for respiratory depression. Following the success of that initial implementation, the hospital has subsequently expanded usage to all at-risk patients being monitored by pulse oximetry and capnography, while leveraging the Bernoulli platform for alarm management, reducing the estimated number of alarms by 78%.



The Challenge

Current Landscape: : Increased utilization of PCA and the varied risks inherent in delivering opioids to post-operative patients poses significant risks for sentinel events. It has been well documented that patient populations managing chronic illnesses or co-morbidities, such as sleep apnea and obesity, are particularly vulnerable to respiratory depression. According to the Joint Commission's Sentinel Event database, 29% of adverse events are related to improper patient monitoring.

Current practices for monitoring patients are still not adequate or comprehensive. For example, this reliance on periodic physical spot checks by direct-care clinical staff can leave patients largely unmonitored up to 96% of the time.

For several years, patient safety advocates and governing agencies, including The Joint Commission, Anesthesia Patient Safety Foundation, the Association for the Advancement of Medical Instrumentation, and others have recommended the adoption of continuous respiratory monitoring as a best practice.

However, this best practice remains the exception to the rule. Adoption is beset by significant business and clinical challenges, including the implementation of costly physiologic device technology, the possible addition of full-time direct-care clinical staff, and the difficulty of capturing holistic, real-time patient data in order to facilitate early intervention.

Pilot Program. The health system's leadership decided to standardize sedation monitoring practices and selected Bernoulli's unique platform and extensive interoperability to connect all of the hospital's current devices; its capacity to scale as the hospitals add more devices; and its ability to track non-invasive respiratory rates, end tidal CO2, pulse oximetry, and acoustic monitoring.

According to the health system's director of respiratory care services, hospital leadership decided to pilot Bernoulli with post-operative PCA patients. "There was a broad enough population that we could lock in on it, but not so broad that we got overwhelmed [testing out the Bernoulli system]," he said, noting that the PCA patient population numbered about 10 to 15 per day. The secondary challenge was that this patient population was physically dispersed and not located in one area of the hospital.

The health system also wanted to leverage Bernoulli for alarms in both critical-care and non-critical care environments. "The problem we had was that we did not know we had a problem," the director said. "We knew continuous pulse oximetry was being monitored in the patient room, and any provider who walks in can see the alarm. The difference was when you closed the door, you did not have that data. Bernoulli's implementation team opened our eyes and asked what alarms we wanted monitored, and our response was 'Everything.'"

The Solution

Centralized Patient Monitoring. Bernoulli's unique architecture allows for a scalable, flexible, centralized surveillance solution for interfacing with bedside medical devices. The director cited the solution's ability to track patients throughout the hospital and the platform's ability to continuously add new devices as major drivers in selecting Bernoulli as a partner. The Bernoulli platform improved clinician

response time and patient safety with its ability to distribute real-time patient monitoring to centralized dashboards and mobile devices. The health system's clinical staff is able to leverage real-time information to deliver the right care to the right patient at the point of care before a critical situation presents itself.

The health system also utilized Bernoulli to upgrade its Sleep Disorders Center in one of its satellite locations. The center treats narcolepsy, sleep apnea, and restless leg syndrome. The center's sleep study laboratory includes rooms where patients sleep while staff can monitor activity to better understand sleep patterns. The Bernoulli platform enables the health system to score their studies much faster, detect events that happen overnight, monitor adjustments, and communicate back to primary care physicians.

Alarm Management. Before a solution could be properly implemented, Bernoulli conducted a facility-wide Baseline Alarm Evaluation. A baseline alarm study is a critical tool for conducting evaluations that include time trends, as well as in-depth alarm sensitivity and statistical and predictive analysis. This enables hospitals to standardize alarm management and to develop evidence-based best practices to safeguard patient safety, increase efficiency, improve patient and staff satisfaction, and identify critical areas for improvement.

The study confirmed that more than 78% of the health system's alarms were non-actionable and did not require clinical intervention.

According to the director, a single patient at the health system could trigger 200 to 300 alarms within a 24-hour period. One day during the assessment, Bernoulli's Alarm Baseline Evaluation clocked nearly 2,000 alarms from 120 devices.

> *"The director said "With all those alarms, you can imagine that it does not take long for alarm fatigue to set in,...What we found through the Bernoulli Alarm Baseline Evaluation was that most of the alarms sounding—up to 78%—were technical-type alarms; for example, a sensor came off the patient momentarily, or Wi-Fi coverage dropped out and then reconnected."*

The evaluation allowed the health system's alarm management committee to dig deep into the types of alarms that were sounding. Bernoulli's high-value alarm management provided the health system with greater flexibility in determining critical events, affording the clinical team the ability to perform more advanced clinical monitoring.

The health system also wanted the ability to determine which alarms were actionable based on the duration of the alarming. Bernoulli *One* ™ has the capability to define, group, and categorize alarm parameters that are independent of the device and its default alarm limits.

Several techniques and strategies exist for reducing alarms, including **trending alarms**, which expand or contract patient alarm limits on individual devices; **consecutive alarms**, in which patterns of a consistent alarm detected, occurring over a clinician-defined period of time; **sustained alarms**, which requires setting a minimum time threshold that an alarm limit must be violated prior to sounding the alarm; and **combination alarms**, in which multiple parameters from different devices occurring simultaneously may together indicate a degraded patient condition.

> *"How long do we want a patient to be in an alarm state before we call in the cavalry?" said the director. "This is something Bernoulli really helped us with. The system has the ability to immediately distribute alarms via multiple parameters, rather than a threshold breach, but in many cases I don't want it sent to the clinicians' pager or mobile device unless the alarm exists for 'x' number of seconds or signs of being compromised like high ETCO2 with low RR simultaneously, so we can eliminate motion artifact and self-resolving, non-actionable alarms. With Bernoulli I can configure independent alarm delays easily."*

Results

- Enhance and centralize clinical surveillance of critical and non-critical patients recovering from post-op anesthesia, including those patients on patient-controlled analgesia (PCA).
- Using smart alarms and leveraging better patient connection management, the health system was able to reduce non-actionable alarms facility-wide by 78%.
- The Bernoulli Baseline Alarm Evaluation allowed the health system to determine which alarms were actionable based on the duration of the alarming.

Lessons Learned & Next Steps

The health system is looking to further expand real-time surveillance to several different patient populations, including epidural patients and patients connected to ventilators, as well as the communication to mobile devices of critical lab results. With the high-fidelity, real-time patient data the Bernoulli platform captures, the health system is also looking to upgrade from their current pager system to something more dynamic, such as a smartphone or tablet.

Unlike other solutions, which primarily transmit source data, Bernoulli middleware can be leveraged to pull data from medical devices and combine it with other data in the patient record to create a more holistic and complete picture of the current patient state. Combining analysis with real-time data at the point of collection creates a powerful tool for prediction and decision support. The ability to track patients throughout the hospital, continuously add new devices, and distribute real-time patient monitoring to centralized dashboards and mobile devices should be a major consideration in technology selection.

> *"It's really a testament to where we are with Bernoulli," the director said. "What we are seeing is that if a patient starts to degrade from a pulmonary standpoint, our clinical staff is able to respond and intervene much faster than before."*

The director also cited Bernoulli's seamless integration into everyday workflows.

> *"Soon after installation, Bernoulli became just a part of our day-to-day operations. We're able to safely monitor patients across the entire facility without the constant distraction and fatigue of responding to false alarms. Our nurses and respiratory therapists know it's there and know it's working."*

Summary

The Bernoulli *One*™ platform enabled a large community healthcare system in the southern US, to leverage a scalable, clinical surveillance and alarm management solution to monitor post-op anesthesia and PCA patients, significantly reduce the volume of non-actionable alarms and prioritize critical alarms to ensure the right data was flowing the right caregiver at the right time to ensure patient safety and response.

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About Bernoulli:
Based in Milford, CT, Bernoulli is a leader in real-time connected healthcare, with more than 1,200 installed, operational systems. Bernoulli *One*™, the company's flagship platform, is the market's only real-time, end-to-end, connected healthcare platform that combines comprehensive and vendor-agnostic medical device integration with powerful middleware, clinical surveillance, telemedicine/virtual ICU, advanced alarm management, predictive analytics and robust distribution capabilities into ONE solution. Bernoulli *One*™ empowers clinicians with tools to drive better outcomes, improve the patient experience, and enhance provider workflow.

For more information visit www.bernoullihealth.com

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