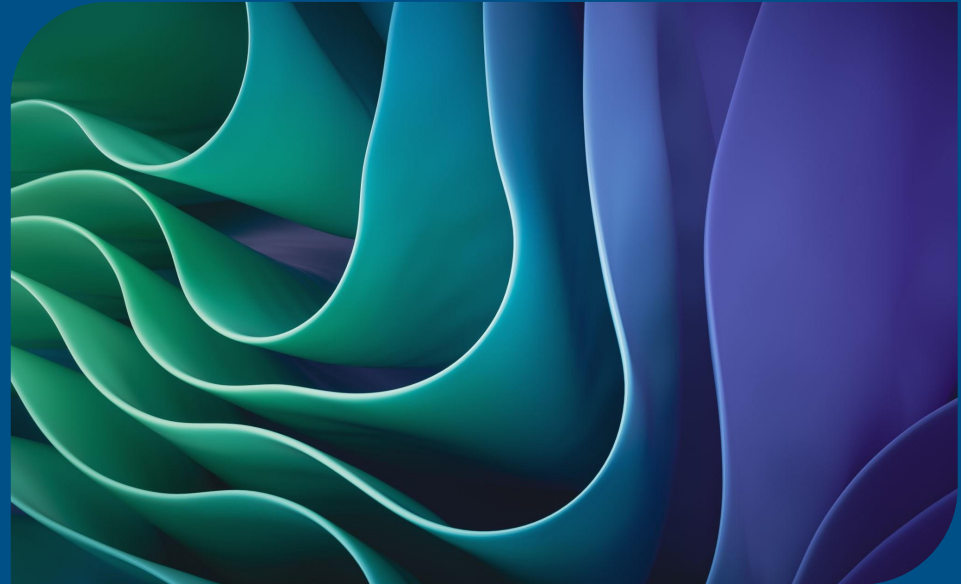


Continuous vs Intermittent Postoperative Vital Sign Monitoring A Cluster Randomized Crossover Trial

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Abstract

In this trial of 798 higher-risk adults recovering from noncardiac surgery, researchers compared routine intermittent vital-sign checks with continuous monitoring that displayed real-time data and alerted clinicians to abnormal values. Continuous monitoring reduced the time patients spent with oxygen saturation below 90% by about 30 minutes during the first 48 postoperative hours. It did not significantly reduce hypotension, tachycardia, or major escalation-of-care events. The findings suggest that continuous monitoring may improve early recognition and treatment of postoperative hypoxemia, but larger trials are needed to determine whether it prevents serious complications or improves survival.

Clinical Problem

The postoperative ward is a monitoring gap.

- ❖ Many serious postoperative complications occur after patients leave the PACU or the ICU
- ❖ On general wards, vital signs are typically obtained every 4 to 6 hours
- ❖ Physiologic deterioration can develop between assessments
- ❖ Early abnormalities in oxygenation, blood pressure, or heart rate may precede a more serious event

Does making continuously measured vital signs visible to clinicians, with real-time alerts, reduce the amount of postoperative physiologic instability compared with usual intermittent monitoring?

Key Terms

Term	Meaning	Why It Matters
<u>Intermittent monitoring</u>	Vital signs are obtained at scheduled intervals, commonly every 4 hours	May miss transient or evolving deterioration
<u>Continuous monitoring</u>	Vital signs measured repeatedly and displayed in real time	Allows detection of changes between routine checks
<u>Hypoxemia</u>	Lower-than-expected blood oxygen level	May reflect respiratory depression, airway obstruction, or pulmonary disease
<u>Hypotension</u>	Low blood pressure	May reduce organ perfusion, depending on severity and duration
<u>Tachycardia</u>	Elevated heart rate	May signal pain, hypovolemia, infection, arrhythmia, or physiologic stress

Study Design

Multiple crossover,
cluster-randomized trial

- ❖ Conducted on 2 postoperative wards over 1 year
- ❖ Wards were assigned to a monitoring strategy
- ❖ Each ward alternated between strategies at approximately 4-week intervals
- ❖ Patients were exposed to the monitoring method active on their ward at that time

Why Cluster Crossover?

- ❖ Reduces contamination between study groups
- ❖ Reflects on how monitoring systems are actually implemented at the ward level
- ❖ Allows each ward to function as its own comparison over time

Study Population

Final analysis: 798 adults recovering from noncardiac surgery

- 404 patients: visible continuous monitoring
- 394 patients: blinded continuous monitoring with routine intermittent checks
- Median age: 70.7 years
- 70% had ASA Physical Status III
- Patients were higher risk because of age and/or cardiovascular risk factors
- Follow-up: first 48 hours on the ward, or until the third postoperative morning

Two Study Conditions

Blinded Continuous Monitoring	Visible Continuous Monitoring
Continuous data were collected but generally hidden from the care team	Continuous data were visible to clinical staff
Routine manual nursing checks remained available	Routine manual checks remained available
Only extreme fail-safe alerts were active	Alerts were triggered at prespecified thresholds
Functionally approximated conventional ward care	Added real-time surveillance and alerting

Primary Outcome: Physiologic Burden

The investigators measured duration, not simply whether an event occurred. Duration of abnormality provides a measure of physiologic burden.

Main Result: Reduced Hypoxemia Duration

Outcome during initial 48 Hours	Visible Continuous Monitoring	Blinded/Intermittent Strategy
Median time with SpO2 below 90%	70.8 minutes	103.5 minutes
Median between-group difference	/~33 fewer minutes	–
Adjusted geometric means ratio	0.86	
Statistical result	P= 0.002	–

Continuous surveillance was associated with a statistically significant reduction in the duration of postoperative oxygen desaturation.

Findings That Were Not Statistically Significant

- ❖ Duration of MAP below 65 mm Hg
- ❖ Duration of heart rate above 110 BPM
- ❖ Overall frequency of documented interventions
- ❖ Major escalation outcomes such as rapid-response activation or ICU Transfer

Statistical Significance vs. Clinical Significance

Statistical significance asks:

“Is the observed difference likely due to chance?”

Clinical significance asks:

“Is the difference large enough to improve outcomes that matter to patients?”

In this trial,

- The reduction in hypoxemia duration was statistically significant
- Whether about 30 fewer minutes of SpO2 below 90% improves patient-centered outcomes remains uncertain

Patient-centered outcomes include:

- Respiratory failure
- Myocardial injury
- Unplanned ICU Transfer
- Length of stay
- Mortality
- Functional Recovery

Why Could Hypoxemia Improve but Not Other Abnormalities?

Possible explanations:

- ❖ Oxygen desaturation may be more responsive to rapid bedside interventions
- ❖ Nurses may respond to an oxygen alert by repositioning the patient, assessing airway patency, encouraging deep breathing, or initiating oxygen
- ❖ Blood-pressure abnormalities may require more complex assessment and treatment
- ❖ Significant hypotension may have been too uncommon to demonstrate a difference
- ❖ The selected alert thresholds may not identify every clinically important abnormality

The Monitoring-to-Outcome Pathway

A monitor improves outcomes only if each step works.

1. Accurate physiologic measurement
2. Reliable data transmission
3. Appropriate alarm threshold
4. Alert reaches the right clinician
5. Clinician evaluates the patient promptly
6. Effective intervention is performed
7. Intervention prevents further deterioration

Alarm Fatigue (Major Implementation Challenge)

Alarm Fatigue occurs when frequent or low-value alarms reduce attention and responsiveness.

Potential consequences:

- Clinicians may become desensitized to alerts.
- Important alarms may be delayed or overlooked.
- Workflow interruptions may increase.
- Staff may lose trust in the monitoring system.

Strengths and Limitations of the Trial

Strengths:

- ❖ Randomized design reduces confounding compared with observational studies.
- ❖ Cluster crossover design evaluated a real-world ward-level intervention.
- ❖ Continuous data allowed precise assessment of abnormality duration.
- ❖ Higher-risk postoperative population increased clinical relevance.
- ❖ The study evaluated not just detection, but whether visible monitoring reduced physiologic abnormalities.

Limitations:

- ❖ Single-center study involving only 2 wards.
- ❖ Limited ability to evaluate rare but important outcomes, such as death or myocardial injury.
- ❖ Responses to alarms were not fully captured in real time.
- ❖ Monitoring interruptions and signal quality were not comprehensively measured.
- ❖ The clinical importance of a 30-minute reduction in hypoxemia remains uncertain.
- ❖ Awareness of being studied may have changed staff behavior in both groups.

Overall Interpretation

This trial supports the fact that real-time access to continuous vital-sign data can reduce postoperative hypoxemia duration on general wards

This trial does not yet prove that

- Continuous monitoring reduces mortality, ICU transfer, or major postoperative complications
- Every postoperative patient needs continuous monitoring
- That monitoring without an affective alert-response system is sufficient

Continuous monitoring appears promising, particularly for high-risk postoperative patients, but its value depends on thoughtful clinical implementation and stronger evidence for patient-centered outcomes.

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