

Financial Analysis of Continuous Vital Sign Monitoring of Post-surgical Hospital Patients



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Introduction

Vanderbilt University Medical Center recently completed a 1,270 patient two year controlled study evaluating continuous vital sign monitoring of post-surgical hospital patients. A preliminary analysis of the study data has shown an 85% reduction of unplanned ICU transfers and a 69% reduction of unplanned stepdown unit transfers for

the patients on the study versus non-study patients on the same floors during the same time period ($p < 0.001$). Had all patients on the study floor been placed on the study during the study period, over 10 million dollars in hospital charges could have been avoided.

Methods

In early 2008 three hospital patient care floors had a new physiologic surveillance system installed for use in a U.S. Department of Defense sponsored research study. These floors care for lower acuity patients who are not traditionally monitored continuously and are typically discharged to home within three days. Approximately 54% of the patients are post-surgical orthopaedic with the remainder being mostly urology and colorectal patients.

The system consisted of a Nihon Kohden Defensive Monitoring™ Work Station along with NTX wireless transmitters. The NTX device is unique because it allows patients to ambulate on the floors. The system provides the researchers with 4 key vital signs that are recognized by the IHI as the key triggers to initiate a Rapid Response Team or Medical Emergency Team call. Those parameters are non-invasive blood pressure, SpO₂, HR, and respiration rate. In addition, when needed, the Nihon Kohden web interface was used to view EKG, respiration, and SpO₂ waveforms and trends.

Knowing that early detection of patient deterioration allows for quicker therapeutic intervention and improved patient outcomes, the study hypothesized that continuous monitoring would provide useful information regarding the patient's medical status and do so more quickly than the current standard of care (4hr between vital signs recording) thus enabling quicker intervention.

From March 2008 through March 2010, researchers at Vanderbilt University Medical Center recruited 1,270 patients into the study out of a floor population of 13,000. The study enrollment was primarily limited by research staff availability. At enrollment the study subjects were randomly assigned to either an “alert notification” group or a “control” group. The groups were equally distributed. Both groups received a wireless NTX monitor and had vital sign data collected. Our researchers rounded on the

patients periodically to verify the monitor was connected properly and to observe and note the condition of the patient. The primary difference between these two groups was that on the “alert notification” group the researcher received threshold based alerts on their pagers when a patient’s vitals were outside of predetermined limits. The researcher would then notify the responsible floor nurse after determining the alert condition was valid. The researcher would periodically re-notify the floor nurse until the alerting vital returned to normal.

Results

While on study, the patient rate of unplanned transfers from the floor directly to an ICU unit was 85% lower (1.1% to 0.16%) than the non-study patient and the unplanned stepdown transfer rate dropped 69% (1.5% to 0.47%). Table 1 shows the data details and that the results are statistically significant ($p < 0.001$). The rate of unplanned ICU transfers, while on study, for the subset of the study that had vital sign alerts generated was reduced to zero (see Table 2).

Patients who required an unplanned transfer had an admission length of stay that was two to four times the length of non-transfer patients (see median values in table 3). The difference in the median value of the admission charges for a stepdown transfer patient was \$26,000 greater than the non-transfer patients and that increased to \$67,000 (also median difference) for patients moved to an ICU. Based on the non-study rate, if the study patients had not been on study there would have been 14 ICU transfers and 19 stepdown transfers. An additional 12 (14 expected – 2 actual) ICU transfers would have resulted in an additional \$804,000 in charges. An additional 13 (19 expected – 6 actual) stepdown transfers would have resulted in an additional \$338,000 in charges. Across the 1,270 study patients this would have resulted in an average of \$899 more in charges for each patient ($\$804,000 + \$338,000 / 1,270$ patients).

Table 1. Unplanned transfers from the floor to ICU or stepdown unit.

	Not On Study N = 11,579	On Study N=1,270	Test Statistic (Pearson test)
ICU	1.1% (127)	0.16% (2)	$\chi^2=19.49, P<0.001$
Stepdown	1.5% (177)	0.47% (6)	
No Transfer	97% (11,275)	99% (1,262)	

Table 2. Unplanned transfers from floor to ICU/Stepdown showing all study groups.

	Not On Study N = 11,579	Control N=633	Alert Notification N=637	Test Statistic (Pearson test)
ICU	1.1 % (127)	0.47% (2)	0.00% (0)	$\chi^2=19.8, P<0.001$
Stepdown	1.5% (177)	0.79% (3)	0.63% (3)	
No Transfer	97% (11,275)	99% (628)	99% (634)	

Table 3. Admission length of stay for study floor patients showing unplanned transfers

	N	ICU N=130	Stepdown N=186	No Transfer N=12,533	Test Statistic (Kruskal-Wallis test)
Length Of Stay	12,378	7 11 18	4 6 9	2 3 5	$F_{2,12375}=196.18, P<0.001$

a b c represents the lower quartile *a*, the median *b*, and the upper quartile *c*.

Discussion

The study hypothesis that using continuous surveillance would allow more rapid detection of patients with deteriorating conditions appears to be confirmed in these unplanned transfer findings. In addition, it is likely that this early detection allowed earlier treatment that prevented the patient from deteriorating to the point of needing higher acuity care.

The savings in unplanned transfer charges is dependent on the floors existing rate of unplanned transfers. The floors where the study was conducted had an unplanned ICU transfer rate of 1.1%. An 11,000 patient study at an academic medical center in the North East United States found an unplanned ICU transfer rate of 2.8%.¹ If this is more representative of the typical hospital unplanned transfer rate then the savings could be considerably greater. An 85% reduction in a 2.8% transfer rate would result in savings of \$1,865 per patient (assuming the same stepdown rate of 1.5% to 0.47%). These calculations are based on the median length of stay differences and median charges differences as discussed above.

Wireless monitoring systems can cost as little as \$10 per day per patient when optimally utilized; however, if double that rate is assumed easily achievable, the cost for an average three day stay would be \$60 while the average cost avoided would be between \$899 and \$1,865 resulting in a net savings between \$839 and \$1,805 per patient.

Although this paper is focusing on the financial implications, there are clearly benefits to the patient's care and safety.

Conclusion

When used appropriately, a system for continuous surveillance of the vital signs of lower acuity post-surgical hospital patients has been shown to result in significant decreases in unplanned transfers to higher acuity care and avoidance of the costs associated with those transfers.

Had this study been implemented on all patients on these study floors, approximately 1,224 days of hospitalization would have been avoided and admission charges would have been over 10 million dollars less based on the differences in median length of stay and charge difference. This is an average savings of approximately \$899 per patient that can be achieved with a system for continuous monitoring of patient vital signs at a cost of as little as \$30 per patient.

Although these results are remarkable on their own, it is possible the cost savings could be greater when other sources are examined. For example, we have not examined re-admissions or emergency department visits due to surgical complications.

References

1. Rothchild, JM, Woolf, S, Finn, K, Friedberg, MW, et. Al. A controlled Trial of a Rapid Response System in an Academic Medical Center. *The Joint Commission Journal on Quality and Patient Safety*. 2008;34(76):417-425



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