Remote Telemonitoring is Associated With Improved Patient Safety and Decreased Workload of Nurses

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PII: S2666-2736(23)00282-6
DOI: https://doi.org/10.1016/j.xjon.2023.09.014
Reference: XJON 882

To appear in: JTCVS Open

Received Date: 25 May 2023
Accepted Date: 5 September 2023

Please cite this article as: Zubrinic M, Vrbanic L, Keshavjee S, Remote Telemonitoring is Associated With Improved Patient Safety and Decreased Workload of Nurses, JTCVS Open (2023), doi: https://doi.org/10.1016/j.xjon.2023.09.014.

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COI: None
Funding: None

Central Message:
Remote Telemonitoring is Associated With Improved Patient Safety and Decreased Workload of Nurses

Perspective Statement:
Remote Telemonitoring is Associated With Improved Patient Safety and Decreased Workload of Nurses

Central Picture Legend:
Fall Rate Across Hospital Network

Abstract:
Objective: There is significant interest in exploring new technologies to improve efficiency and work-life quality for nurses. Our objective was to evaluate the impact of a remote video-monitoring (RVM) solution that provides continuous in-hospital patient audio-video (AV) monitoring by technicians.
Methods: The RVM system consists of two-way AV communication and continuous O2 saturation monitoring device that we developed. It has been deployed to all inpatient units within our hospital network, including 3 acute care hospitals and 2 rehabilitation facilities. Data was collected pre- and post-implementation on safety measures including fall rates and adverse events, along with device utilization and number of escalation events requiring nursing intervention. Nurse job satisfaction was assessed with surveys.

Results: Data was collected from April 2020 to May 2022. 2,087 patients were monitored at 5 hospital sites. The technicians identified 54,716 safety concerns that required them to intervene remotely and address with the patient. Of these, 46,289 required escalation to nursing staff, who were called to the bedside through the RVM alerting technology. Importantly, 8,427 safety concerns were managed solely by the technicians without requiring nursing intervention, resulting in 8,427 avoided nursing visits to the bedside. The surveyed nurses reported the RVM technology provided reassurance that there was additional support to assist them in managing their patients. Patients and their families also expressed high degree of satisfaction. Since implementation, fall rates and other adverse events were reduced with the biggest impact in patients on high-flow oxygen. Code blues and mortality rates decreased in incidence from 7% to 1%.

Conclusion: The use of RVM has proven to be a successful innovation at our hospital and has led to an improvement in patient safety. We demonstrated that RVM was able to reduce 8,427 individual nurse visits to the bedside, allowing nurses to manage the care of more patients effectively, while improving both patient and staff satisfaction.

Introduction:
The human resource shortage and heavy workload of nursing staff are global concerns that affect healthcare organizations' performance and patient outcomes. The demand for healthcare services continues to grow, leading to a shortage of nursing staff, resulting in many institutions having to resort to an increase in nurse-to-patient ratios. Studies have shown that a heavy nursing workload can have adverse effects on patient safety, leading to poor patient outcomes and higher costs to the system\textsuperscript{1-3}. Additionally, the heavy workload negatively impacts employee wellness and nursing job satisfaction, leading to higher turnover rates.

The interplay between nursing workload and patient safety is also a critical aspect of healthcare delivery. The shortage of nursing staff has led to an increase in nurse-to-patient ratios, which have a negative impact on patient safety. Poor nurse staffing coverage has been associated with adverse patient outcomes, including falls, pressure ulcers, medication errors, infections, and mortality rates. Implementing safe staffing practices has been shown to ultimately lead to cost savings for healthcare organizations\textsuperscript{4,5}.

To address the challenge of nursing workload, there is a need to explore new technologies to improve efficiency and work-life quality for nurses. Remote Video-Monitoring (RVM) solutions have emerged as a possible solution to improve nursing workload. RVM solutions consist of two-way audio-video (AV) communication that enables technicians to remotely monitor patients and alert nursing staff when needed to attend to the patient. To address nursing workload challenges, we and others have been exploring the use of RVM solutions. The deployment of RVM has yielded promising results, such as the reduction of falls and other adverse events, in several North American healthcare organizations\textsuperscript{6-9}. Our objective was to evaluate the impact of RVM
technology in our network of hospitals through a quality improvement lens as it relates to patient safety outcomes and nursing workload.

Methods

Remote Patient Monitoring Device and Program:

RVM was initially launched in 2016 as a pilot program within the thoracic surgery and pulmonary medicine (respirology) inpatient unit. Due to its success, the program was expanded to all five hospital sites in our network over a 3-year period. The system comprises an in-house developed mobile device featuring two-way AV communication and continuous oxygen (O2) saturation monitoring, placed in the patient's room. Patient confidentiality is maintained as the device does not record patients. To enhance efficiency, a single technician can remotely monitor eight patients simultaneously across any of the network hospital sites from a centralized location. The technology is deployed in 46 inpatient units within our hospital network, which comprises of 3 acute care centers, 1 rehabilitation facility and 1 complex continuing care center. We have also since expanded to remotely monitor patients in other health systems in three other provinces in Canada.

Prior to implementing the RVM program, healthcare professionals, such as nurses working directly on the wards, were guided and trained using our institutional Policy & Procedure Manual. The primary nurse’s roles and responsibilities included identifying patient eligibility for the telemonitoring program, onboarding patients, communicating with the technician to report any change in patient status, and importantly, re-evaluating the need for telemonitoring every 24 hours.
To ensure the safe and effective use of the technology, monitoring technicians undergo comprehensive hands-on training within the program. They are provided with step-by-step protocols on how to recognize and report a change in patient status, such as a drop in SpO\textsubscript{2} or potentially risky behaviors that could lead to adverse events, such as attempting to climb out of bed without assistance. In such cases, the technician first attempts to verbally redirect the patient. For instance, asking the patient to remain in bed and press the call bell for a nurse. For patients experiencing a drop in oxygen saturation, the technician provides clear instructions and guides the patient to put on their oxygen mask and take deep breaths. An example of this guidance would be: “Hello Mrs. Smith. We’re concerned about your breathing. Please put your oxygen mask back on. If you need help, press the call bell for your nurse.” If these verbal interventions are unsuccessful, further escalation protocols are initiated, which include the technician immediately calling the nurse directly. The program emphasizes the importance of effective communication and collaboration between technicians and the healthcare team, working in tandem to ensure optimal patient care.

**Inclusion and Exclusion Criteria:**

Patients at high risk for falls, including those with impulsive behaviors and a lack of insight into their own limitation, as well as those at risk of harming themselves by pulling on lines, tubes, airway or other essential medical devices, are placed on RVM. Additionally, ward patients who are known to repeatedly wander and are at risk of elopement, and those receiving high-flow oxygen (50\% FiO\textsubscript{2} or higher) are placed on RVM. Guidelines are provided for nursing staff to support the decision-making process. Furthermore, patients with environmental or room restrictions that pose safety concerns, such as patients with a tracheostomy in an isolation room, those who have
difficulty pressing a call bell, are also included. The nursing staff used the Morse Fall Scale as a tool for assessing a patient’s susceptibility to falls. A score of 45 or above on the scale indicated the patient’s classification as high risk for potential falls. RVM is considered on a case-by-case basis for patients who do not speak English, those who are deaf or have significant hearing impairments, and those with severe delirium, dementia, and/or confusion that are not redirectable. Patients are not placed on RVM if they are already monitored by a beside sitter, have existing auditory hallucinations, or are in the ICU receiving one-to-one nursing care.

Data Collection:

Data from the RVM database at our institution was reviewed over a two-year period from April 2020 to March 2022. Specifically, the number of patients monitored, their demographic characteristics, length of monitoring, and reasons for observation were reviewed. We also evaluated all the interventions initiated by the technicians, such as verbal redirection through the device or calls to the front-line nursing staff, as well as pre- and post-implementation mortality rates, which were obtained through chart reviews and the Toronto Lung Transplant Program database.

Descriptive statistics were used to analyze the data and identify trends and patterns in key metrics, including the number of falls reported per 10,000 adjusted patient days, which were compared between the pre- and post-implementation periods. Surveys were also administered to frontline nursing staff, patients, and their families to obtain user feedback on the RVM program.

Results
Between April 1, 2020, and March 31, 2022, the RVM system was implemented across five hospital sites within our organization, during which 2,087 patients were monitored. After excluding 134 patients due to missing data points, a total of 1,953 patients were included in the analysis. The patients had a median age of 71.5 years and an average age of 69.7 years, with a gender distribution of 65% males (1,269) and 35% females (684). The RVM system provided 286,538 hours of remote patient observation, averaging 148.5 hours (6.25 days) per patient, with a median duration of 61.5 hours (2.5 days). One patient was monitored for an extended period of 9,325.75 hours (388.5 days) in our complex continuing care center.

Various services utilized the RVM system to monitor patients. This included 42% (825) in medicine, 37% (711) in surgery, and 21% (417) in rehabilitation or complex continuing care facilities. The primary purpose of RVM was to observe patients with behavioral concerns, accounting for 67% (15,809) of the patient encounters. Of these, 20% (4,841) were at high risk for falls with impulsive behavior, 40% (9,463) were at high risk for falls and pulling on invasive lines, airways, or tubes, 4% (866) were at risk of elopement, and 3% (567) were remotely monitored due to high suspicion of seizures or risk of self-harm related to mental health issues such as suicide or eating disorders.

Approximately 31% (7,327 patient encounters) had RVM in combination with real-time remote oxygen saturation monitoring, primarily due to being on high-flow oxygen and at risk of removing their oxygen masks. There were 11,737 oxygen desaturation events detected, with 1% of patients (20) receiving controlled transfer to the intensive care unit. The remaining patients were successfully managed conservatively by directing them to reapply their oxygen mask and encouraging deep breathing. During this study period, the inpatient mortality rate for pre-lung
transplant patients - awaiting lung transplant in hospital, decreased from 7% to 1% post-
implementation, as illustrated in Table 1. Technicians remotely monitoring patients completed a
total of 54,716 interventions, with 8,427 managed using audio redirection only, without requiring
the nurse to attend the bedside.

The fall rates, reported as safety events per 10,000 adjusted patient days, significantly
decreased from 1.8 pre-implementation to 0.6 post-implementation. Figure 1 shows the overall
decrease in patient falls, including patients on RVM and those who were not, across all five of our
hospital sites. With respect to nursing workload, over this period, the use of RVM decreased the
number of unnecessary nurses visits to the bedside by 8,427. Importantly, during the two-year
period, not only did we see an improvement in these important patient safety metrics, but there
was also a significant decrease in the number of bedside sitter hours utilized across all hospital
sites, which resulted in an overall net institutional savings of $1.9M in the 2020/2021 fiscal year,
and a further $2.5M in the 2021/2022 fiscal year.

Open-ended surveys were administered to nursing staff, patients, and families to obtain
feedback on their experience. Out of the 55 surveys administered to nursing staff, 40 (73%) were
completed. The feedback from nursing staff was predominantly positive, with nurses reporting
feeling more comfortable knowing that someone was monitoring patients they were concerned
about. In addition, nurses reported that the use of RVM technology was particularly helpful for
managing multiple impulsive patients simultaneously and for patients in rooms that were not in
high traffic areas. However, some nurses experienced difficulties in answering calls from
technicians while attending to another patient. Feedback from families indicated that they felt more
at ease leaving the hospital, knowing that a technician was monitoring and addressing their family
member’s needs. Patients reported feeling scared, isolated and vulnerable in the hospital, but having a technician in place provided comfort by knowing that someone was watching over them and could call for help quickly when needed. Interestingly, patients also reported that the RVM technology was not intrusive and felt that it was no different from any other equipment in the room used to keep them safe.

Discussion

RVM technology has emerged as a promising and effective solution to improve patient safety, reduce fall rates, and lower constant observation costs, and potentially ease nursing workload challenges within healthcare settings. Our results are consistent with other reports, demonstrating that RVM technology led to reduced falls, decreased patient companion costs, and greater cost-effectiveness compared to traditional in-person monitoring methods. Our study revealed that RVM technology significantly reduced the number of individual nurse visits to the bedside by 8,427 trips. This reduction empowered nurses to allocate their time more efficiently towards essential nursing tasks, mitigating nurse burnout and enhancing patient care quality.

With the decrease in bedside visits, RVM technology enabled the nursing staff to prioritize critical tasks and allocate more time to direct patient care, which we feel will ultimately lead to better patient outcomes and improved patient satisfaction, along with higher job satisfaction of nurses. However, we note that our analysis also revealed that some nurses experienced difficulties in managing calls from technicians while tending to other patients. To address this, procedures have been implemented to ensure that alternative methods of communication, such as calling a backup nurse or the nursing station are used in these circumstances.
In our study we observed a decrease in fall rates and adverse events, with the most significant impact observed among severely ill pre-lung transplant patients. The decrease in in-hospital wait list mortality rates highlights the positive impact of RVM technology on patient safety. Despite these promising results, there are important limitations that should be considered. First, the study was limited to a single hospital network, which may not be representative of other healthcare organizations. Second, the study relies on data from a retrospective review prospectively collected of RVM usage and patient outcomes, which may be subject to biases or confounding factors. Thirdly, the review did not include a control group or a randomized trial design, limiting the ability to truly establish a cause-and-effect relationship between RVM technology and patient outcomes. An additional limitation to consider is the use of open-ended questions in the surveys administered to nursing staff, families, and patients. While open-ended questions can provide valuable qualitative information and insights, they may also introduce subjectivity and potential biases in the interpretation of responses. Moreover, the lack of standardized survey questions and response options can make it difficult to compare and quantify the findings across different groups or settings. This may limit the generalizability of our findings and the ability to draw definitive conclusions about the impact of RVM technology on nursing workload and patient outcomes.

For healthcare organizations embarking on the implementation of a RVM program, we recommend the following steps to ensure its ultimate success. To guide this process, we recommend starting with a needs assessment. This initial phase involves determining the specific objectives the organization aims to achieve through the program. These objectives could range from optimizing operational efficiency and strengthening patient safety to addressing workforce shortages. It's important to acknowledge that these goals can vary from one organization to
another. Concurrently, an evaluation of the organization's technological readiness is of value. This evaluation encompasses key factors like ensuring the availability of adequate power sources and the necessary connectivity infrastructure for patient room devices. By addressing any existing infrastructure gaps, the organization lays the foundation for the seamless integration of the monitoring system into its operations.

To ensure active engagement and buy-in from front-line staff, it is important to establish clear and comprehensive guidelines for the nursing staff regarding the utilization of RVM. After this, conducting training and organizing in-service sessions is essential to equip the staff with the foundational knowledge needed to navigate the new monitoring procedures. Acquiring buy-in and oversight from management is equally important and cannot be overlooked, given the transformative shift in nursing practices that this initiative entails. To facilitate a smooth transition, we recommend initiating the process with a preliminary pilot phase. This allows for the identification of any operational challenges that may arise and facilitates timely adjustments based on feedback from patients, families, and the staff directly involved. The insights gathered during this pilot phase serve as a valuable resource to inform customized adaptations that pave the way for an enhanced program. Armed with these insights, the organization can confidently expand the program to encompass other inpatient units, ensuring a higher likelihood of achieving overall success.

**Conclusion**

The implementation of RVM technology is a successful healthcare innovation that has led to significant improvements in patient safety and nursing workload management. At our organization, RVM technology was able to reduce 8,427 individual nurse visits to the bedside,
allowing nurses to focus on higher priority tasks and devote more time to direct patient care. This reduction in bedside visits can help reduce nurse burnout from excessive workload and ultimately improve the quality of patient care. The RVM technology also had a positive impact on fall rates, and patient mortality with the most significant impact seen in the pre-lung transplant patient mortality rate in hospital. Importantly in today's healthcare landscape, RVM was more cost-effective than traditional methods of providing in-person bedside sitters, resulting in an overall net savings of $1.9M in the 2020/2021 fiscal year and $2.5M in the 2021/2022 fiscal year in our institution. Overall, our study suggests that RVM technology is an effective solution to address contemporary challenges related to patient safety, fall rates, and sitter costs while alleviating nursing workload challenges in healthcare. Future research, including randomized controlled trials and multicenter studies, could help further establish the effectiveness of RVM technology in different healthcare organizations and settings. Additionally, the use of standardized survey instruments with a mix of open-ended and closed-ended questions may help provide more robust evaluable data on the perceptions and experiences of healthcare professionals, patients and families with RVM technology.
References:


Table 1: Mortality Rate of Pre-Lung Transplant Patients

<table>
<thead>
<tr>
<th></th>
<th>Patients listed on lung transplant list</th>
<th>Total inpatient ward mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Implementation</td>
<td>144</td>
<td>7%</td>
</tr>
<tr>
<td>Post-Implementation</td>
<td>186</td>
<td>3%</td>
</tr>
<tr>
<td>2020</td>
<td>186</td>
<td>1%</td>
</tr>
<tr>
<td>2021</td>
<td>192</td>
<td>1%</td>
</tr>
<tr>
<td>2022</td>
<td>186</td>
<td>1%</td>
</tr>
</tbody>
</table>

Table 1 displays the mortality rate of pre-lung transplant patients before and after the implementation of the remote video-monitoring (RVM) solution. The table includes the total number of patients listed on the lung transplant list and the total inpatient ward mortality rates before and after the implementation of RVM. The data shows a significant reduction in mortality rates post-implementation of RVM in 2020, 2021, and 2022, with rates dropping from 7% to 1%.
Figure 1: Fall Rate Across Hospital Network

Figure 1 provides a visual representation of fall rates before and after the implementation of remote video-monitoring (RVM) solutions across all hospital sites in our network. The fall rates are reported as safety events per 10,000 adjusted patient days for each fiscal year from FY 15/16 to FY 22/23. The data indicates a significant reduction in fall rates post-implementation of RVM, with the lowest fall rate reported in FY 22/23.
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