

# Remote telemonitoring is associated with improved patient safety and decreased workload of nurses



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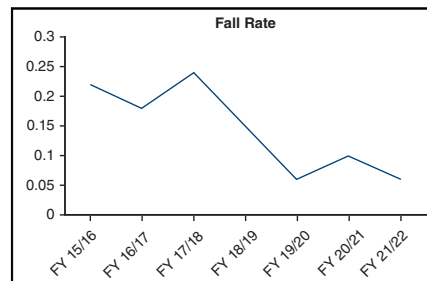
## ABSTRACT

**Objective:** There is significant interest in exploring new technologies to improve efficiency and work-life quality for nurses. We aimed 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 that we developed, consisting of 2-way AV communication and a continuous O<sub>2</sub> saturation monitoring device, has been deployed in all inpatient units within our hospital network, including 3 acute care hospitals and 2 rehabilitation facilities. Data were collected before and after 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 were collected from April 2020 to May 2022. A total of 2087 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 of nursing staff, who were called to the bedside through the RVM alerting technology. Importantly, 8427 safety concerns were managed solely by the technicians without the need for nursing intervention, resulting in 8427 avoided nursing visits to the bedside. The surveyed nurses reported that the RVM technology provided reassurance that additional support was available to assist them in managing their patients. Patients and their families also expressed high degree of satisfaction. Since implementation, the rates of falls and other adverse events have been reduced, with the greatest impact in patients on high-flow oxygen. Code blue and mortality rates decreased from 7% to 1%.

**Conclusions:** The use of RVM has proven to be a successful innovation at our hospital and has led to improved patient safety. RVM was able to reduce 8427 individual nurse visits to the bedside, allowing nurses to manage the care of patients more effectively while improving both patient and staff satisfaction. (JTCVS Open 2023;16:493-7)



Fall rate across the hospital network.

## CENTRAL MESSAGE

Remote telemonitoring is associated with improved patient safety and decreased workload of nurses.

## PERSPECTIVE

The shortage of healthcare professionals and the growing workload on nurses is a global concern, with profound implications for patient safety, healthcare costs, and job satisfaction. In light of this, our study demonstrates the remarkable potential of remote video monitoring technology to enhance patient safety by proactively identifying safety concerns and reducing the need for nurse visits at the bedside. Notably, our data show significant reductions in fall rates and adverse events, especially among patients on high-flow oxygen. Our findings also indicate improved nurse job satisfaction and increased patient and family satisfaction. RVM provides nurses with additional support, making their workload more manageable. Our study offers a promising solution to the challenges of nurse shortages and heavy workloads in healthcare. RVM not only enhances patient safety and reduces costs, but also improves nurses' job satisfaction. It also highlights the relevance and significance of incorporating innovative solutions in healthcare to benefit patients and healthcare professionals alike.

See Discussion on page 498.

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### Abbreviations and Acronyms

AV = audio-video

RVM = remote video monitoring

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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 increased 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.<sup>1-3</sup> 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 nursing staff shortage has led to increases 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. Implementing safe staffing practices has been shown to ultimately lead to cost savings for healthcare organizations.<sup>4,5</sup>

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 2-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.<sup>6,7</sup> The deployment of RVM has yielded promising results, including reductions in falls and other adverse events, in several North American healthcare organizations.<sup>8-11</sup> Our objective in the present study 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

The RVM was initially launched in 2016 as a pilot program in the thoracic surgery and pulmonary medicine (respirology) inpatient unit.

Owing to its success, the program was expanded to all 5 hospital sites in our network over a 3-year period. The system comprises an in-house developed mobile device featuring 2-way AV communication and continuous O<sub>2</sub> 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 8 patients simultaneously across any of the network hospital sites from a centralized location. The technology is deployed in 46 inpatient units in our hospital network, including 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 3 other Canadian provinces.

Prior to implementing the RVM program, healthcare professionals, such as nurses working directly on the wards, were guided and trained using our institutional Policy and Procedures Manual. The primary nurse's roles and responsibilities include identifying patient eligibility for the telemonitoring program, onboarding patients, communicating with the technician to report any change in patient status, and, importantly, reevaluating the need for telemonitoring every 24 hours.

To ensure the safe and effective use of the technology, monitoring technicians undergo comprehensive hands-on training in 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 O<sub>2</sub> saturation 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 by, for instance, asking the patient to remain in bed and pressing the call bell for a nurse. For patients experiencing a drop in O<sub>2</sub> saturation, the technician provides clear instructions and guides them 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, the technician initiates further escalation protocols, including 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 limitations, as well as those at risk of harming themselves by pulling on lines, tubes, airways, 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 ( $\geq 50\%$  fraction of inspired O<sub>2</sub>) 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 and those who have difficulty pressing a call bell, are included as well.

The nursing staff uses the Morse Fall Scale as a tool for assessing a patient's susceptibility to falls. Patients with a score of  $\geq 45$  on the scale are classified 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 a significant hearing impairment, and those with severe delirium, dementia, and/or confusion who are not redirectable. Patients are not placed on RVM if they are already monitored by a bedside sitter, have existing auditory hallucinations, or are in the intensive care unit 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, duration 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

preimplementation and postimplementation mortality rates, obtained through chart review and the Toronto Lung Transplant Program database.

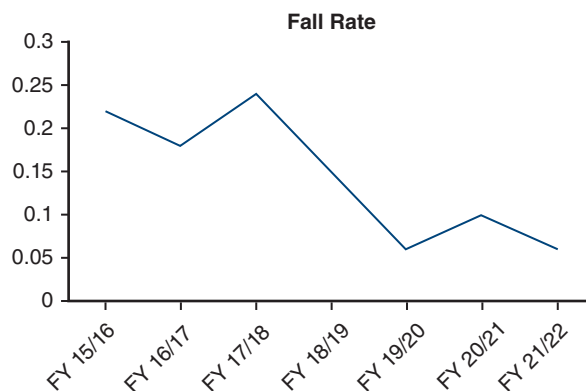
Descriptive statistics were used to analyze the data and identify trends and patterns in key metrics, including the number of falls reported per 10,000 adjusted patient-days, which were compared between the preimplementation and postimplementation periods. Surveys also were administered to frontline 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 5 hospital sites within our organization and 2087 patients were monitored. After excluding 134 patients because of missing data points, a total of 1953 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 sex distribution of 65% males (n = 1269) and 35% females (n = 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) per patient. One patient was monitored for an extended period of 9325.75 hours (388.5 days) in our complex continuing care center.

Various services used the RVM system to monitor patients, including 42% (n = 825) in medicine, 37% (n = 711) in surgery, and 21% (n = 417) in rehabilitation or complex continuing care facilities. The primary purpose of RVM was to observe patients with behavioral concerns, accounting for 67% (n = 15,809) of the patient encounters. Of these, 20% (n = 4841) were at high risk for falls with impulsive behavior; 40% (n = 9463) were at high risk for falls and pulling on invasive lines, airways, or tubes; 4% (n = 866) were at risk of elopement; and 3% (567) were monitored remotely owing to a high suspicion of seizures or risk of self-harm related to mental health issues, such as suicide or eating disorders.

Approximately 31% of patient encounters (n = 7327) had RVM in combination with real-time remote O<sub>2</sub> saturation monitoring, owing primarily to being on high-flow oxygen and at risk of removing their oxygen masks. A total of



**FIGURE 1.** 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 2015/16 to FY 2022/23. The data indicate a significant reduction in fall rates postimplementation of RVM, with the lowest fall rate reported in FY 2022/23. FY, Fiscal year.

11,737 O<sub>2</sub> desaturation events were detected, with 1% of patients (n = 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 the study period, the inpatient mortality rate for patients awaiting lung transplantation in the hospital decreased from 7% preimplementation to 1% postimplementation, as shown in Table 1. Technicians remotely monitoring patients completed a total of 54,716 interventions, including 8427 managed using audio redirection only without requiring the nurse to attend the bedside.

The fall rate, reported as safety events per 10,000 adjusted patient-days, decreased significantly from 1.8 preimplementation to 0.6 postimplementation. Figure 1 shows the overall decrease in patient falls, including patients on RVM and those not on RVM, across all 5 of our hospital sites. With respect to nursing workload, over this period, the use of RVM decreased the number of unnecessary nurse visits to the bedside by 8427. Importantly, during the 2-year period, we observed not only improvements in these important patient safety metrics, but also a significant decrease in the number of bedside sitter hours across all hospital sites, resulting in an overall net institutional savings of \$1.9M in fiscal year (FY) 2020/2021 and a further \$2.5M in FY 2021/2022.

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

**TABLE 1. Mortality rate of pre-lung transplant patients**

Period	Patients on the lung transplant list	Total inpatient ward mortality, %
Preimplementation	144	7
Postimplementation		
2020	186	3
2021	192	1
2022	186	1

Mortality rate of pre-lung transplant patients before and after 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 show a significant reduction in mortality rate after RVM implementation in 2020, 2021, and 2022, with rates dropping from 7% to 1%.

helpful for managing multiple impulsive patients simultaneously and for managing patients in rooms 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 reassurance that someone was watching over them and could call for help quickly if necessary. Interestingly, patients also reported that the RVM technology was not intrusive and felt no different from any other equipment in the room used to keep them safe.

## DISCUSSION

RVM technology has emerged as a promising approach to improve patient safety, reduce fall rates, 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.<sup>8-10,12</sup> Our study shows that RVM technology significantly reduced the number of individual nurse visits to the bedside by 8427 trips. This reduction empowered nurses to allocate their time more efficiently toward 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 should ultimately lead to better patient outcomes and improved patient satisfaction, along with greater job satisfaction of nurses. However, our analysis also shows 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 this study, we observed decreases in fall rates and adverse events, with the most significant impact seen in severely ill pre-lung transplant recipients. The decreased in-hospital wait list mortality rate highlights the positive impact of RVM technology on patient safety. Despite these promising results, however, some important limitations of this study should be considered. First, the study was limited to a single hospital network, which might not be representative of other healthcare organizations. Second, the study relies on data from a retrospective review of RVM use and patient outcomes collected prospectively, which may be subject to bias or confounding factors. Third, the review

did not include a control group or a randomized trial design, limiting our 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. Although open-ended questions can provide valuable qualitative information and insights, they also may 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 implementation of an 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 is important to acknowledge that these goals can vary from across organizations. Concurrently, an evaluation of the organization's technological readiness is of value. This evaluation should encompass key factors, such as ensuring the availability of adequate power sources and the necessary connectivity infrastructure for patient room devices. By addressing existing infrastructure gaps, the organization lays a foundation for the seamless integration of the monitoring system into its operations.

To ensure active engagement and buy-in from frontline 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 necessary foundational knowledge 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 to allow 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 can 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 greater likelihood of achieving overall success.

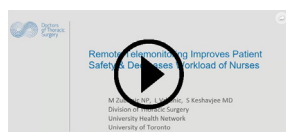


## CONCLUSIONS

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 eliminate 8427 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 effects 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 FY 2020/2021 and \$2.5M in FY 2021/2022 in our institution. Overall, our study suggests that RVM technology is an effective approach to addressing 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.

## Webcast

You can watch a Webcast of this AATS meeting presentation by going to: <https://www.aats.org/resources/remote-telemonitoring-of-patients-improves-safety-and-decreases-workload-of-nurses>.



## Conflict of Interest Statement

The authors reported no conflicts of interest.

The *Journal* policy requires editors and reviewers to disclose conflicts of interest and to decline handling or reviewing manuscripts for which they may have a conflict of interest. The editors and reviewers of this article have no conflicts of interest.

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