

# Remote Video Monitoring for High-Risk Patients

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**Abstract** - Hospital patient sitters play a crucial role in the clinical environment – providing constant one-on-one supervision over high-risk patients and reporting any activities that may cause harm to the patient to nursing staff. The use of in-room patient sitters in hospitals is a significant challenge because the cost of sitters creates a huge financial strain on hospital organizations. In addition, as the elderly population continues to grow, the demand for patient sitters will increase, and providing one-to-one continual care for high-risk patients is just not a viable financial plan.

The proposed solution is to utilize an advanced, cohesive network of security cameras to relay live video streams of multiple designated patient rooms to a remote monitoring room for observation of any “dangerous” activity. Two-way audio communication will also be utilized to talk to patients to help prevent any injuries from occurring and to prompt patients to stay in bed and wait for nursing staff to arrive for assistance. In addition, bed exit alarms will be used to make sure high fall risk patients do not injure themselves by falling out of their bed.

This report will summarize the unique technology solution developed to replace patient sitters and will highlight the benefits of adopting a program like this. Ultimately, video monitoring allows for a more efficient approach to staff/patient interactions by remotely maintaining constant supervision of multiple high-risk patients and only prompting nursing staff to intervene if necessary. Another benefit is that it will drastically lower the labour costs of providing constant supervision to patients, as one trained video monitoring technician can supervise multiple high-risk patients while still maintaining patient safety, privacy and a high standard of care.

**Index Terms** - *Remote video monitoring, telesitters, video monitoring technician*

## I. INTRODUCTION

Patient safety and a high standard of patient care must always be maintained in healthcare facilities. Ensuring that patients do not injure themselves while in the care of the hospital environment is always a standard that should be maintained. However, accidental events like falls or injuries can have devastating impacts on a patient's recovery and emotional

wellbeing and can cause serious future complications. Falls, injuries and incidences of self-harm need to be mitigated within healthcare facilities to ensure patient safety is sustained and no further complications arise that can affect patient recovery. This is why many hospital organizations have deployed a patient sitter program to ensure patients with an elevated risk of falls or injuries are constantly supervised.

Patient sitters are a variable staffing resource usually found in healthcare organizations. Hospitals require constant supervision services for their high-risk patient population to ensure accidents like falls and injuries do not occur. Patient sitters provide constant supervision by sitting in a patient's room to watch over them to ensure that any risky behavior is reported to nursing staff. The responsibilities of hospital sitters include ensuring constant supervision of the patient is maintained, alerting nursing staff when the patient needs assistance and maintaining confidentiality of patient information, treatment plan and health status [1]. Patient sitters also can assist patients with basic personal care, mobility assistance and provide emotional support to patients [1]. At most hospitals, patient sitters are not allowed to touch the patient or perform clinical tasks. The main duty of patient sitters is to supervise the patient and alert medical staff if the patient requires help.

Hospitals hire patient sitters for patients that require constant attention and supervision. Examples of patients who require sitters include patients who are suicidal, combative, confused, distressed, dying, at risk of falling or in need of extra supervision to prevent injuries [2]. Based on the scope of patients a hospital sitter is responsible for it is imperative that patient sitters are always awake, alert and attentive so they can closely monitor the patient in their care. Some institutions also require hospital sitters to have shifts up to 12 hours long [3]. If an event does occur that could potentially cause patient harm, the patient sitter must act quickly and inform clinical staff right away. It is crucial that hospital sitters are able to perform their required responsibilities even during a long shift. Patient sitters are also able to provide a sense of comfort and a sense of safety when they are physically located in the patient's room providing supervision.

Most hospitals hire patient sitters from external companies offering patient sitter services. The cost of in-room sitters is a

drastic fee organizations must endure in order to provide constant supervision for patients to maintain their safety while staying in the hospital. The main issue with the use of paid, in-room sitters throughout hospital organizations is that it creates a huge operational expense each year to provide this service. One study documented that the cost for patient sitters per day is roughly \$240.00 USD [4]. Another study found that patient sitters create substantial expenses that can account for 1% to 20% of a hospital's salary budget [5]. It was also found that United States hospitals spend anywhere from \$500,000 to well over \$2,000,000 annually to provide patient sitter services [4]. The use of in-room sitters to constantly watch over high-risk patients is a traditional practice that is used throughout many hospital organizations even though there is very limited evidence supporting that the use of sitters is effective to maintain or improve patient safety [4].

Patient sitters are also not always effective in preventing patient injuries. A number of hospitals reported that patient sitters are likely to get distracted by things like their phone, which takes their attention away from the patient [6]. Also, the shift length of patient sitters usually requires them to work during the night and some hospitals also reported cases of the patient sitter being asleep while on duty [6]. Falls have a serious impact on patient health and wellbeing. Fall prevention is always promoted by healthcare facilities and is an industry-wide goal to maintain patient safety and a high level of care [6]. This paper also documented that evidence showing the effectiveness of sitters in preventing falls was inconclusive [6]. This is why many institutions are adopting video monitoring as a method used in fall prevention rather than utilizing the costly service of patient sitter [6]. The overall conclusion and consensus regarding patient sitters to provide continual monitoring of high-risk patients is that this service is very costly for hospitals and not always effective.

Video monitoring is still a fairly new technology that has been implemented by various healthcare organizations in hopes to reduce sitter costs, while still maintaining patient safety. Since video monitoring is still new, not many studies have been published reporting the effectiveness of video monitoring for fall prevention. A study done by Davis, Kutash and Iv reported that "there were no statistically significant differences in the number of patient fall events" between the use of in-room sitters and video monitoring [4]. However, data from this study also found that there was "a decreasing trend in falls per 1,000 patient days for each unit after video monitoring was implemented" [4]. Another study found that the replacement of in-room sitters with video monitoring resulted in a decreased fall rate by 6% as well as substantial financial savings [8]. Burtson and Vento also stated that video monitoring outperformed or equaled established benchmarks using the Collaborative Alliance for Nursing Outcomes when compared to sitter use, although no statistically significant reduction in falls was reported [9]. Another study done by Denver Health found that within the first 3 months implementing video monitoring, 57 falls were prevented, resulting in lowest fall rates the organization has seen within the last two years before implementation [10].

Some studies also found that many of the current strategies being used for patient fall prevention are not effective in preventing injuries, as these methods do not actually notify staff until it is too late [11]. This is one of the crucial elements that video monitoring offers, as it allows for the VMT to see unsafe actions before the patient actually attempts to get out of bed [11]. Ultimately, having video monitoring and a two-way communication system serves as a proactive approach to patient safety and can result in decreased patient falls and injury prevention [11]. The benefit of adopting video monitoring is that the number of patients requiring this service can increase or decrease without increasing the need for additional staff [4]. Another benefit of video monitoring over in-room sitters is that "nurses can provide lower cost care without a risk to patient safety" [4]. In addition, video monitoring can help families and patients feel less intrusive than with sitters and may result in less patient agitation [11].

## II. BENEFITS OF VIDEO MONITORING

The purpose of video monitoring is to supervise multiple patients remotely, providing a real-time, unrecorded monitoring feed of patient rooms using video cameras [6]. Video monitoring allows for a video monitoring technician (VMT) to monitor multiple high-risk patients at once, which results in a cost-effective solution to the replacement of in-room sitters [6]. After a comparison of six published papers by Ndoda, Fechner, Wordekemper, and Kniewel examining the effectiveness of video monitoring in fall prevention, the research shows that video monitoring is effective in reducing the rate of falls [6]. It also goes on to examining the cost-savings found in these reports, stating that even though a substantial amount of money is usually required to initially start a video monitoring program, most of the studies showed an immediate return of investment and overall costs savings after implementation [6].

At the beginning of each fiscal year, an estimated budget can be set for the anticipated use of patient sitters in the hospital, but usually this budget is never accurate. The reason hospitals have such a diverse spending yearly on patient sitters is that the amount of hours required to hire patient sitters can fluctuate based on the amount of patients admitted into the hospital that require this service. The benefit of adopting video monitoring means that at least one staff member is always assigned to monitor patients remotely for a consistent schedule. This is a fixed yearly cost for the hospital and will not fluctuate yearly. Since video monitoring allows one staff member to supervise multiple patients remotely, there is no fluctuating staffing levels based on the amount of patients admitted to the hospital. Ultimately, the ability for one staff member to monitor multiple patients from one remote location results in a tremendous cost-savings and provides an advanced solution to in-room sitters.

It is also extremely difficult to schedule in advance patient sitters. This is because the use of sitters all depends on if a

high-risk patient is admitted to the hospital. Many times if a patient who requires monitoring services is admitted to the hospital, patient sitter services are then contacted to get a patient sitter. Very rarely are patient sitters standing by in the hospital waiting to be placed with a patient. This administrative challenge results in difficulty in effectively scheduling of patient sitters. From an administrative point of view, video monitoring is a superior method because the video monitoring room will always be staffed by one personnel around the clock.

### III. PROJECT DESCRIPTION

Even though patient sitters provide an important service in health care institutions, they are not a financially sustainable service [7]. The goal of this paper is to describe the process of developing a remote video monitoring program to phase out the use of in-room patient sitters, while still maintaining patient safety and a high standard of care. In-room sitters are utilized throughout the University of Ottawa Heart Institute (UOHI), however they are utilized the most on the nursing floor units of the hospital. By developing a unique technology driven solution, the UOHI is hoping to phase out the use of in-room sitters for a more cost effective solution that will still maintain patient safety. This project focuses on developing a unique video monitoring solution for the UOHI and utilizing evidence based practices to develop video monitoring guidelines and standardized workflows to provide an effective alternative to in-room sitters.

An initial review was conducted into why patients at the Heart Institute would need an in-room patient sitter. After the investigation into the patient population that requires in-room sitters, it was found that constant monitoring was needed for a group of patients categorized in this report as “high risk”. This category includes patients with a high fall risk, high chance of wandering or elopement, patients with delirium or dementia,, patients that pull tubes/lines/medical devices and patients who exhibit post-op aggression.

The video monitoring program for high-risk patients at the UOHI will consist of three separate components: video monitoring camera equipment, a two-way communication system and bed exit alarms. Video monitoring involves the use of in-room mounted or portable cameras with a trained staff member directly supervising patients from a remote location [11]. Two-way audio communication will also be used as the first safety measure to help verbally redirect patients from doing unsafe behaviors that could lead to injuries. And lastly, bed exit alarms will be utilized to alert nursing staff if a patient is too close to the edge of the bed and is about to fall or if a patient leaves their bed.

### IV. CLINICAL ENGINEERING TASKS

The first step in this project required the project leader to assemble a group of key stakeholders needed to ensure this project was successful. The key stakeholders for this project included the biomedical engineering department, information

technology services, facilities management, nursing staff, clinical managers, the patient privacy department, the finance department and the patient quality/risk department. It is important to identify key stakeholders in a clinical engineering project to ensure that all required teams and departments are up to date with any duties, responsibilities and changes in work flow that impact them directly by implementing a new project.

The next step was to complete a clinical needs analysis which examines the clinical requirements that must be met or considered to successfully implement the project. The clinical needs analysis focused on the use of patient sitters in the clinical environment and looked at the scope of patient sitters and any potential impacts of gaps or deficiencies in the current practice. The clinical needs required for patient sitter services was summarized and recorded in Table 1. Once the clinical needs were identified, they were converted into technical requirements that the new technology system had to include. Technical requirements are the technical issues that must be addressed to successfully complete and implement the video monitoring project. Technical requirements are constraints in the design of the new solution. Technical requirements are the deal breakers in this project and if recommended pieces of equipment did not meet one or more of these requirements, it was deemed not suitable for this project.

The next step was the patient privacy considerations that were developed by implementing evidence based research practices. It was decided that the video monitoring system would have no recording abilities and no recordings would be done of patients who utilize this service. After an in-depth review of the video monitoring project by the hospital’s privacy department, it was decided that verbal consent was needed from the patient or their legal caregiver to utilize video monitoring. The privacy department also recommended putting up signage in each patient room when video monitoring was occurring. Another step to ensure patient privacy is maintained is for the video monitoring technician staff member to turn the camera so it facing the wall prior to turning off the camera on the software. It was also decided to have a dedicated remote video monitoring room where all the video camera feeds could be watched in an isolated area.

The staff member who will be remotely monitoring the camera feeds and utilizing the two-way audio system is known as a video monitoring technician (VMT). By having the VMT constantly monitor the video feeds and have access to two-way communication, it will allow them to intervene immediately when potentially dangerous behaviors are observed [11]. Another consideration that needed to be addressed for this project was the workflow process of the video monitoring technician. The VMT staff position requires a detailed ergonomic evaluation and break relief plan that addresses VMT fatigue, while still ensuring that 24/7 monitoring of high-risk patients is maintained.

**Table 1: Clinical needs of patient sitters and technical requirements for video monitoring project**

Clinical Needs	Technical Requirements
<p>"What clinical requirements must be met or considered?" "Clinically, what is it you want to accomplish with this project?"</p> <p>Clinical needs assessment is a process by which information is gathered regarding the scope and potential impact of gaps or deficiencies in the current delivery and practice of health care</p>	<p>"What would we like this system to do? What technical requirements must be met?"</p> <p>Technical requirements are the technical issues that must be considered to successfully complete a project.</p>
<p>Constant supervision using an in-room patient sitter to maintain patient safety and wellbeing.</p> <p>The patient sitter will be responsible for monitoring patients and making sure that there is a prevention of falls, wandering, harm or any risky behavior that could lead to potential injury.</p> <p>High-risk patients must be monitored 24/7, and for the full duration of their stay at the hospital so constant supervision is required even during the night.</p> <p>Nurses must be alerted when patients need help or is at risk of injury or wandering. Sitters cannot intervene; they must alert nursing staff when patients need help.</p> <p>Hospital sitters provide companionship, support and assistance to promote the patient's healing, reduce the risk of infection and guard against injury or falls [1].</p> <p>Sitters give a sense of safety and allow the patient to feel not alone because they are placed in the room with the patient, and provide one-on-one care.</p> <p>High risk patients are at a higher risk for falls so patient sitters must watch the patient even when they are on their beds.</p> <p>Patient sitters are responsible for monitoring one high-risk patient. This means that one patient sitter can only be responsible for up to one patient who is in their direct sight of care.</p>	<p>Video monitoring occurs 24/7 for constant supervision so cameras must always be displaying a live feed.</p> <p>Night vision required as patients can possibly injure themselves or need assistance during the night.</p> <p>Turning on/off video cameras for a patient who does not require video monitoring</p> <p>Bed exit alarms for high-risk patients to alert nursing staff before patients leave the bed.</p> <p>Two-way communication with patient to give verbal instructions when patients are doing unsafe actions</p> <p>The camera should be wired with a POE connection to ensure the video quality is high and network issues do not affect the video stream</p> <p>No recordings will be taking place.</p> <p>Privacy Protection - only authorized personnel will be able to view video feeds, and encryption and hacking security will be used for video feed</p> <p>Fixed camera location - wall mounted so cameras do not get misplaced and room is always setup for video monitoring</p> <p>360 viewing capabilities - camera needs ability to tilt, zoom and pan so full room can be viewed</p>

## V. TWO-WAY COMMUNICATION

Two-way communication is a required component of the video monitoring program. Two-way communication allows for the video monitoring technician to immediately talk to the patient when unsafe actions are observed, allowing them to give verbal instructions to redirect patients as the first step of the safety response process. The benefit of two-way communication is that it gives the VMT a chance to deescalate risky behavior before an injury can occur, and also limits the need for nursing staff intervention if the verbal communication is successful in mitigation of unsafe behaviors and preventing patients from injuring themselves.

Verbal intervention and voice commands would only be suitable for patients who could respond back to the VMT [11]. For example, Cournan, Fusco-Gessick and Wright reported that most of the patients using the video monitoring service at their facility could not follow the commands of the VMT due to their brain injuries or cognitive limitations [11]. The study followed up by saying that a voice command alone being

utilized to interrupt a patient's thought process may not be enough to delay unsafe behavior [11]. It should be noted that the study was done in a brain injury unit, where patients are suffering from cognitive and mental impairments, meaning that the use of verbal intervention would not be as effective as it would be for patients who do not have these limitations.

At the Heart Institute, it is predicted that the majority of the patient population utilizing the video monitoring service will be able to effectively understand commands given by the VMT over a two-way audio system and follow instructions. The VMT will not be using verbal intervention for patients that would not respond well to overhead sounds coming into their room, like dementia patients. It should also be noted that if verbal intervention does not work in deescalating a situation, the VMT is required to alert nursing staff right away.

The two-way communication system that will be utilized in this project is the ASCOM Telligence c600 system. The ASCOM nurse call system is already deployed throughout the Heart Institute, so all the patient rooms on the nursing floors are already equipped with the nurse call in-room intercom system. The staff console device will allow the VMT to dial

into any patient room on the nursing floor so that they can talk directly into the patient's room. The benefit of using the nurse call system is that it works as an intercom, meaning that the patient can respond back to instructions given by the VMT or ask the VMT for nursing assistance. Another benefit is that the nurse call system is already installed throughout the patient rooms, so minimal expansion was required to add another staff console into the video monitoring room.

Ultimately, two-way audio communication is a necessary component for the success of the video monitoring program because it gives the VMT an opportunity to intervene right away when unsafe behavior is observed over the video feeds. By having the remote staff member able to verbally intervene when unsafe actions are witnessed, but still having the ability to watch over the other patients on the system is a significant efficiency for staff workloads. If verbal intervention is successful and nursing staff intervention is not required, that means that nursing staff can attend to other duties and the unit overall can function more efficiently. This is one of the critical differences between a patient sitter and video monitoring. Patient sitters are not allowed to intervene to stop patients from injuring themselves; they are only required to alert nursing staff when unsafe actions are observed. This practice can result in possible patient injuries during the time it takes for patient sitters to alert nursing staff. By giving the video monitoring technician an opportunity to verbally intervene when unsafe actions are observed the staff member is able to take proactive steps to prevent unsafe behavior and mitigate patient safety risks. Maintaining patient safety is the most important consideration when switching to video monitoring, and by implementing two-way communication into the video monitoring system the hospital is able to provide another layer of security to patients utilizing this service.

## VI. BED EXIT ALARMS

Bed exit alarms built into the UMano Medical Ook Snow beds will be utilized in this project to provide another layer of safety and security while monitoring high-risk patients. The bed exit alarm system allows clinical staff to set different bed exit detection modes depending on the type of patient population using the bed.

The Umano Medical beds have four pressure sensors in a bridge configuration that allows for accurate weight distribution readings so that the bed can detect if a bed exit alarm should be triggered based on what type of detection mode clinical staff set for the bed. There are three bed exit detection modes that can be turned on by clinical staff. Detection Mode 1 triggers the bed exit alarm when the patient gets off the bed completely, meaning that 100% of their body weight is removed from the bed. Detection Mode 1 would be set for patients identified as flight risk, elopement risk or for delirium or dementia patients who tend to wander. Detection Mode 2 triggers the bed exit alarm when the patient gets too close to the edge of the bed. Detection Mode 2 would be used for patients with a high fall risk so that when more than 25%

of the patient's body weight is placed on the edge of the bed, the bed exit alarm is triggered. Lastly, the bed exit alarm can be set to Detection Mode 3, which triggers the alarm if the patient moves even a small amount on the bed.

Once the bed exit alarm has been triggered, the bed will activate a loud alarm sound in the patient's room to alert nursing staff. Clinical staff can also configure the audio sound of the alarm. The sound tune of the alarm and the sound audio level of the alarm can be customized depending on nursing staff preference and time of day. The bed also has lights on each of the corners that will turn green when the bed is armed with the bed exit alarm. The lights will also turn yellow and flash when the bed exit alarm is triggered, allowing for an extra visual indicator for when the bed exit alarm is activated.

Another benefit of the Ook Snow beds is that the bed exit alarm can be sent to the nurse's station via the nurse call system. The patient bed can be wired to the nurse call console in each patient room so that if a bed exit alarm is triggered, the nurse's station staff console gets notified over the nurse call system. The patient bed exit alarm can be programmed to also be sent to the video monitoring room so that the video monitoring technician can get notified if the bed exit alarm is triggered and verbally intervene to tell the patient to return to bed.

It should be noted that bed exit alarms are not always effective in preventing patient injuries because the alarm is usually activated too late [11]. That is why the bed exit alarm will be used in collaboration with video monitoring so that all precursor activities that may lead to a bed exit alarm being triggered can be monitored and verbal intervention techniques can also be deployed to prevent patient injuries.

## VII. TECHNICAL MARKET ANALYSIS

Initially, a review was done into the possibility of just purchasing a video monitoring system that is already on the market, but most of these products are extremely expensive to purchase. That is when the video monitoring project was given over to the clinical engineering team to develop and create a unique video monitoring solution utilizing generic video camera equipment. The idea behind creating a unique solution for the UOHI's video monitoring program included buying consumer grade cameras and video monitoring software that would be able to be placed in patient rooms for remote monitoring.

The video and security camera market in Canada alone is a very populated and dense space with a substantial amount of companies and vendors offering a variety of video monitoring products that could have been suitable for this project. Thorough vetting had to be done prior to vendor selection, which is why a full technical market analysis was done before choosing a camera product. Since most cameras that were considered for this project were consumer grade cameras, and

relatively low cost, a request for proposals (RFP) was not needed for this project.

The first step in the technical market analysis was creating a list of the technical requirements (Table 1). As stated above, there are many companies that manufacture and make security cameras suitable for this application. Only a few vendors were chosen to further investigate into their products based on company recognition, consumer rated product quality and overall quality of products. In the initial stages of this project, Axis Communications, Pelco and Honeywell Commercial Security were examined and some of their products were reviewed in detail by project leaders.

All of the technical requirements were deemed critical and necessary. If a vendor recommended a camera product that did not satisfy one or more of the criteria, it was immediately ruled out. The final vendors were then put into an engineering decision matrix to create a weighted score for each technical requirement which would be used as a justification as to why the final vendor was chosen (Table 2). After potential products were eliminated, the final two products being considered were put into a decision matrix and based on the outcome a video camera product developed by Panasonic was selected that met all the technical requirements of this project.

**Table 2:** Engineering decision matrix for final camera models

Criteria	Criteria Weight (1-5)	Panasonic WV-S6130		Foscam F199828P	
		Score (0 - 5)	Weighted Score	Score (0 - 5)	Weighted Score
Pan-Tilt-Zoom	5	5	25	5	25
Design Aesthetic	3	4	12	2	6
Video Quality	5	4	20	2	10
Security	4	4	16	3	12
Cost	2	2	4	4	8
Manufacturer Reliability	3	5	15	3	9
Infrastructure required	2	4	8	3	6
Power outlet nonessential	3	1	3	1	3
POE – power of Ethernet	4	5	20	3	12
HD-1080p or higher	4	5	20	2	8
Infrared Night Vision	5	5	25	5	25
Varifocal (zoom in/out)	3	4	12	3	9
Live stream	5	5	25	5	25
Indication light on camera	2	0	0	0	0
Ease of installation	3	4	12	2	6
Turns on/off easily	4	4	16	4	16
No subscription fees	1	5	5	0	0
Two-way communication	4	1	4	1	4
Easy to use user interface	4	4	16	5	20
		<b>Total</b>	<b>258</b>	<b>Total</b>	<b>204</b>

### VIII. CAMERA EQUIPMENT

The Panasonic video cameras model WV-S6130 are pan, tilt, zoom IP cameras, that allow for complete coverage of the patient rooms. These cameras also have colored night vision technology built into the design, meaning that the patient rooms will be able to be securely monitored even during the night. The Panasonic camera chosen uses industry leading video compression methods and has extreme bandwidth compression because it uses the new Panasonic H.265 Smart Coding. Some of the key features of the Panasonic WV-S6130 include full high definition resolution (1080p), a durable pan/tilt gear mechanism and a full end-to-end encryption system for privacy protection. The camera’s sleek aesthetic design was also a benefit of this product as it allowed for a discrete piece of equipment to be placed into the patient’s room and not take up a lot of space. The Panasonic software also allows an easy to navigate user interface that can efficiently zoom the camera up to 21x, and offers full pan, tilt control of the camera to span the whole room.

The video management software is a product that will be purchased out right from Panasonic, meaning that no additional subscription fee costs will occur. It was also recommended that a joystick controller should be purchased for ease of use of the pan/tilt/zoom features of the camera, as controlling it using a standard mouse makes it difficult to accurately control.

The video management software will also be bought from Panasonic for easy configuration and control of the video cameras. The Panasonic WV-ASM300 video management software is able to split the screen into multiple segments depending on how many cameras need to be seen on one screen. Each fleet of video cameras on each nursing floor unit will be assigned a specific monitor. By having separate monitors for each nursing floor, the VMT is able to easily identify which patients they are watching and if intervention is needed they can efficiently identify patients and call for corresponding nursing staff on the appropriate floor. The Panasonic software will divide the screen into smaller

segments, allowing for the VMT to view all patient rooms being monitored.

## IX. INSTALLATION OF VIDEO CAMERAS

Once the decision was made to purchase 18 units of the Panasonic WV-S6130 pan/tilt/zoom video cameras, the next stage in this project required planning for the installation of the cameras into patient rooms. The patient rooms are located in clinically active areas, thus any construction that needs to be done in these areas have to follow the infection control standards of Infection Prevention and Control Canada.

It was decided to mount the video camera to the wall in each patient room since it does not require cutting into the wall so the installation process is simplified to only installing four screws to stabilize the wall bracket. Since the POE cable will be run along the wall to plug into the wall network data jack, a protective covering will need to be placed over the wire to ensure that it is not hanging on the wall. By switching to a wall-mounting bracket, the amount of time to install these cameras also decreases, meaning that the patient rooms where these cameras are being installed do not have to be down as long for the installation.

Another duty performed by clinical engineers is to work with clinical staff to ensure that all construction work can be accommodated without affecting patient care. The anticipated downtime of each room was communicated to clinical managers of each floor before any construction work began to make sure they were able to accommodate scheduling downtime of the patient rooms. After consultation with the clinical managers was completed, the project leader created an estimated installation timeline plan.

## X. PATIENT PRIVACY

Cournan, Fusco-Gessick and Wright claim that since video monitoring is the equivalent of in-room sitters, and since the video cameras do not have recording capabilities, patient/family consent is not required, as sitters do not require this type of consent [11]. Burtson and Vento document that if recording of patients was to be done, written consent would have to be collected prior, however they decided to forego the recording capabilities of the video monitoring system, thus privacy experts only recommended signage in the room to notify patients video monitoring was occurring [9]. At UHN only verbal consent is required to utilize video monitoring on patients, as no recordings are taking place [7].

After consultation with the UOHI privacy department, it was determined that verbal consent from a capable patient was required prior to video monitoring be initiated. If the patient was incapable of decision-making or did not fully understand the video monitoring system after detailed explanation, their legal caregiver would be allowed to provide verbal consent on their behalf to utilize the video monitoring services. In addition to verbal consent, the privacy department also

recommended the use of signage in the patient's room to notify patients and staff that video monitoring was in progress.

If after full disclosure and explanation of the video monitoring system by nursing staff is complete and the capable patient or their legal caregiver, for an incapable patient, does not provide consent for video monitoring, nursing staff will be required to contact administration services to get an in-room sitter for the patient.

## XI. VIDEO MONITORING TECHNICIAN

Davis, Kutash and Iv reported the use of trained, unlicensed staff members for the role of VMT to provide constant supervision of patients [4]. In comparison, Burtson and Vento trained a core group of certified nursing assistants, hospital secretaries and charge nurses who could all assume the role of VMT or provide break relief if needed [9]. The length of VMT shift also differed between these two papers. One paper had a VMT shift length of four hours in length [4] whereas the other paper had a shift length of 12 hours with three scheduled breaks throughout the shift [9].

During initial discussions, the UOHI was thinking of using modified workers, who cannot fully perform their duties as possible staff for the VMT position, but it was then decided to use unit clerks in the role of VMT. The UOHI is budgeting to have one VMT staff in the monitoring room 24/7, and having the VMT shift be 12 hours long, with multiple ergonomically placed breaks throughout the shift.

Since the VMT will be able to verbally intervene and give patient commands to stop unsafe behavior, trainings will need to be conducted to teach the VMT when intervention tactics should be utilized and what verbal interventions they should say.

## XII. VMT TO PATIENT RATIO

Once the patient population utilizing the video monitoring services was defined, the next step was to construct a suitable staff to patient video monitoring ratio to make sure that patient safety and wellbeing is constantly maintained, even when one staff member is monitoring multiple patients. A report documented in *Modern Healthcare* stated that one trained observation staff member was allowed to monitor up to 18 patients [13], while another report stated that one trained observing staff member was able to monitor up to 16 patients simultaneously [14]. A study done by Cournan, Fusco-Gessick and Wright also documented that a ratio of one VMT to 15 patients was utilized for video monitoring [11]. In addition, UHN has a monitoring ratio of 1 staff to 8 patients [7].

After a review of the different literature sources, as well as a review of how many high risk patients the UOHI sees on average admitted to the hospital, it was decided to have a monitoring ratio of 1 VMT to 9 high-risk patients. After reviewing the UOHI past history, it was found that nursing

floors had not seen more than 9 high risk patients administered to the hospital at the same time. This means that even though there are 18 fully equipped rooms for video monitoring services, the UOHI does not anticipate more than 9 patients at the same time staying at the UOHI. It also means that for budgeting and staffing resources, the video monitoring room will just need one staff member 24/7 to monitor patients.

### XIII. ALERTING CLINICAL STAFF

Cournan, Fusco-Gessick and Wright developed a well-structured alerting process for when a patient is exhibiting unsafe behavior. The first step is to have the VMT trained to be able to recognize unsafe actions that may lead to possible injuries. If unsafe behavior is observed then verbal intervention is used via the intercom system, to give the patient instructions to sit down or the VMT asks them if they require assistance [11]. The next step, if the patient does not respond to verbal intervention, is for the VMT to alert a patient care technician via a phone to report the patient's room number [11]. If the patient is in imminent danger, the VMT will immediately trigger a "Star Alert Alarm" which is a feature built into the video monitoring device used in this study that triggers a sound in the patient's room to notify staff to respond right away [11]. Another study done found that the use of overhead paging was the most effective intervention method for fall prevention, once the VMT saw initial signs of dangerous activity by the patient [6]. Since the UOHI developed its own video monitoring system using video cameras, the alerting process described by Cournan, Fusco-Gessick and Wright needed to be modified to better fit the hospital's system.

The main objective of video monitoring is to provide constant supervision of patients, and to ensure that any incidents that could impact patient safety are prevented. Remote video monitoring allows an efficient method for staff to be notified immediately if a patient is exhibiting risky behavior to provide instant help, while also ensuring constant supervision of other patients using this service is maintained. The first step of risk mitigation and making sure patients are safe is for the video monitoring technician to constantly monitor the video feeds, watching for any early signs of dangerous behavior that could negatively impact the patient's well-being. If the video monitoring technician observes the patient exhibiting risky behavior, the first step of intervention is through a two-way audio communication device. The VMT will be able to dial into the specific patient rooms via the nurse call system if they observe unsafe behavior. The nurse call system will allow for two-way communication into the patients room and allow the VMT to give verbal commands and de-escalation instructions to the patient so that any unsafe behavior can be eliminated. The two-way audio system also allows for the patient to communicate back with the VMT, and if they require additional assistance, the VMT can further alert nursing staff. This first intervention method of two-way audio communication is not always appropriate for all patients. For example, dementia patients might not respond well or

understand the verbal prompts coming from an unknown voice in the room. If two-way communication is not an appropriate tool for limiting unsafe behavior, the VMT will simply just notify nursing staff to intervene.

Cournan, Fusco-Gessick and Wright describe the benefit of having the VMT staff trained to look for unsafe patient behavior as it allows them to efficiently talk to the patient when unsafe behavior is observed [11]. By having verbal communication as the first step of intervention to redirect patients from doing unsafe behaviors, VMTs can try to limit the need for nursing staff assistance, while ensuring that patients do not get injured.

At the UOHI, if the patient does not follow VMT verbal directions or does not communicate back to the VMT's request, the VMT will then be required to page the nurse in charge of that specific high-risk patient directly using a cellphone or a Vocera paging badge. The VMT can know which nurse is assigned to which high-risk patient by checking the hospital's electronic medical record (EMR). The benefit of paging the specific nurse responsible for the patient is that they will already have the knowledge of the patient's history and the patient's treatment plan. By having the nurse responsible responding to intervention calls made by the VMT, the nurse will be able to know the appropriate actions to take to help the patient without need of checking their EMR. If the nurse assigned to the patient does not answer their cellphone or Vocera badge, the next point of contact is the nurse's station. The VMT will be required to call the nurse's station on the specific floor the patient is on and then report the patient's room number so a nurse at the station can intervene. Calling the nurses station as the next point of contact in the alerting process is beneficial because there will always be multiple staff members present at the nurse's station. By calling the nurse's station, the VMT can have assurance that there is always someone to respond and assist the patient. The only drawback is that if the patient requires assistance specific to their treatment plan or condition, the nurse responding may not be familiar with the patient's history and will have to check the EMR.

If the patient is in imminent danger of injuring himself or herself, the VMT will skip calling nursing staff and immediately phone call the hospital's communication bunker for them to issue an overhead speaker announcement on that specific nursing floor to alert all nursing staff on that floor that the patient requires immediate assistance. The benefit of having a multi-tiered alerting process is that steps can be taken to mitigate risky behavior and prevent patient injuries. And by having a multi-tiered alerting system, the VMT is able to know exactly who to contact when unsafe actions are observed, and if the patient is in a dangerous situation the VMT is not waiting for staff to pick up a cellphone, there is a completely different process that alerts everyone on the floor.

### XIV. VMT TRAINING

As with all new technology, training is required for staff before implementation of the video monitoring program can begin. Training for staff on how to use the Panasonic ASM300 video management software will be provided by the vendor and will take place over two half-day sessions. The VMT will be trained to use the monitoring equipment efficiently, including how to pan/tilt/zoom, turn the cameras on and off and creating privacy screens. At the end of the training session, the VMT will be required to trial run the software and all its functions. The VMT will also be required at the end of the training to demonstrate full understanding and performance abilities of the software system.

Burtson and Vento also documented a similar approach to VMT training which included, explaining the rationale for the video monitoring program, outlining the video monitoring guidelines and demonstration of their ability to utilize the video monitoring equipment. The UOHI will also require the VMT to have two days of extra training for the rationale and guidelines for the video monitoring program, and will also require the VMT to complete a competency review, where they will demonstrate video monitoring skills and verbalization of guidelines and processes [9]. In addition to training, a basic user guide PowerPoint will be created as an aid for the VMT to look up basic commands and service help contact numbers.

After installation of video cameras into all 18 patient rooms and the video monitoring technician training is complete, the transition from sitters to video monitoring can begin. To ensure that the video monitoring system works and the alerting process for communicating with the patient and nursing staff is effective, sitters will still be used for a testing period of two weeks, alongside the use of video monitoring. This testing method follows what was done by Burtson and Vento, where the sitter remained in the patient room for a few hours during the start of video monitoring and only intervened if video monitoring verbal redirection and alerting staff was unsuccessful [9]. As Burtson and Vento reported, by implementing a testing stage and validation trial period before completely switching to video monitoring, the trial period was effective in building trust among nursing staff and verifying that video monitoring is an effective replacement method to in-room sitters [9].

Since the video monitoring program will be deployed throughout the nursing floors at the UOHI, an important aspect of this project was making sure nursing staff understood all aspects of this project and were onboard with implementation of the video monitoring project. Nursing staff will be the main personnel group impacted by the implementation of this program. One study found that 81% of staff generally or strongly had a favorable reaction to the use of video monitoring in comparison to patient sitters [11].

The ultimate goal prior to implementation of the video monitoring program throughout the nursing floors is to ensure nursing staff fully understands all components of this project. This will be done by the project leader giving an online

presentation to nursing staff explaining the video monitoring program, and the new duties and responsibilities that nursing staff will need to incorporate into their workflows after implementation of this project.

## XV. VIDEO MONITORING ROOM

Initially the plan was to have a monitoring station on each nursing floor located at each of the nurse's station. This plan mimicked what was done by Davis, Kutash and Iv, where cameras were wired to the central console at the nurse's station [4]. The benefit of having a monitoring station at each nursing station meant it was in close proximity to the designated patient rooms, which allowed for the staff members watching the cameras to immediately respond and go in to the patient's room if they saw concerning behavior. The benefit of the monitoring station on the nursing floors meant that another staff member at the nursing station is able to take over monitoring the cameras while the VMT responds to the patient intervention protocol [4].

While Davis, Kutash and Iv reported the placement of the video monitoring room was successful at the central nurses station, another study done by Courran, Fusco-Gessick and Wright described the placement of the video monitoring room should be in a "quiet location, separate from the nursing station, to minimize distractions" [11]. After consultation with project leaders and key clinical champions of this project, it was decided to place the video monitoring room in the older bunker of the hospital. By placing the monitoring room in a separate location from the highly active nurse's station, VMT distractions and disturbances can be limited. It also provides an extra layer of security and privacy, as the monitors which display live patient rooms will only be seen by the authorized staff member. The location of the old bunker is located right in the center of the communication hub at the UOHI, allowing for access to other personnel for break relief and coverage.

## XVI. COST ANALYSIS

Patient sitters are a huge expense health care facilities must endure to provide constant supervision of their high-risk patients. Patient sitters can only supervise one patient at a time and are required to sit in a patient's room and make sure that they do not injure themselves. Patient sitters are usually hired from an external company, and paid per hour.

With video monitoring the hospital is able to have one staff member supervise multiple patients meaning that only one staff member needs to be paid even when multiple patients are using the service. By replacing the use of sitters in the hospital with video monitoring, the hospital is able to save money by reducing their operational expenses for staffing this service. Even though video monitoring requires a significant initial investment to purchase the video monitoring equipment, these costs are made up by the amount of savings that is produced by switching from patient sitters to video monitoring.

The use of sitters in health care facilities is always a challenging service to budget for accurately from a finance and administrative point of view. The patient population that requires patient sitter services is fairly populated and when the number of patients requiring this service is increased, the number of patient sitter staff members must also increase, which results in a larger financial expense for hospitals. The issue is the inflow of the number of patients admitted to the hospital on a yearly basis differentiates, and there is no accurate way to predict the number of patients the hospital will expect to see that require this service.

Planning a consistent schedule for patient sitters is difficult, and setting an accurate budget in advance for sitters is nearly impossible [4]. Sitters are only required for patients who are deemed high risk and require constant supervision. The number of high-risk patients admitted to the hospital changes constantly depending on a number of different factors, meaning that institutions cannot accurately predicted the inflow of patients requiring sitter services, plan accurate staffing resources, and an accurate budget for each fiscal year for patient sitters [4]. Since sitters are a variable staffing resource, the expense of sitters can change drastically from year to year [4].

Although it can initially be expensive to implement a video monitoring program, as many different pieces of equipment need to be purchased, the overall cost benefit of implementing a video monitoring program will result in cost savings to the hospital in future years. For example, one paper found that a large initial investment was needed to procure the video monitoring technology, however the benefits resulted in greater financial value to the hospital facility as they were able to reduce the use and cost of sitters completely, while still providing a high level of safety for patients and peace of mind for families [11]. Another paper highlighted that even though an initial investment of \$305,000 was needed to implement the video monitoring program, the return of investment cost analysis was estimated to be \$392,000 within the first three months [12].

If the number of patients that require constant supervision is low one year, then the financial expense to provide patient sitters will be low as well. However, if the patient population that requires constant monitoring is increased, the financial cost of providing this service is increased as well. This is why patient sitters are a variable staffing resource in hospital institutions, because they are only required when a patient who requires this service is admitted. Since patient sitters are a variable staffing resource, the hospital will utilize the operational budget to finance hiring them.

The staffing cost trend for video monitoring is the superior method for constant supervision services because it is a fixed yearly cost that does not change even when the patient population using the service fluctuates. The patient sitter trends for hospitals are not consistent and lead to drastic fluctuations for the yearly operational expenses for the service. By implementing the video monitoring program, it will

effectively lower operational costs to provide constant supervision of patients, while still ensuring their safety and wellbeing is maintained.

This is why it is recommended that hospitals, which are facing high expenses on hiring patient sitters, transition to the use of video monitoring as a replacement for this service. Even though a large initial investment is required to purchase new equipment for video monitoring, the return of investment cost savings will occur usually immediately after implementation. This is because the associated operational costs of video monitoring produces significant cost savings when compared to the operational costs of patient sitters.

## XVII. LIMITATIONS OF VIDEO MONITORING

Even though video monitoring is a more cost-effective method to maintain constant supervision of high-risk patients, the complete transition from patient sitters to video monitoring does have limitations. As described in the introduction, patient sitters are required to stay in the room with the patient they are supervising. This in-person interaction can give the patient a feeling of more security and can give the patient a consistent person who is always there. In-room sitters are often a confidante and friend to the patient during their illness, especially for the emotionally vulnerable patients [17]. By having a continual human interaction established between the patient and the patient sitter, it can lead to the patient forming a personal connection with the patient sitter and give the patient a personal companion who's role it is to watch over their wellbeing. This human connection and interaction is a unique product of human nature, and trying to replace these human components with a technology driven system is nearly impossible.

Even though studies have shown that video monitoring is as effective in preventing injuries as the use of patient sitters, high-risk patients might prefer an actual person to stay with them in their room, as they believe this is the more superior supervision method. This heightened feeling of security and supervision by having an in-room sitter is another reason why patients might be hesitant to the use of video monitoring. Video monitoring can also affect a patient's understanding of control and privacy through the use of video cameras always watching them in their rooms [17]. Video monitoring can also lead to fewer deep conversations and companionship during the duration of their stay in the hospital [17]. It is also important to recognize that video monitoring and constant remote surveillance can have emotional effects on many patients.

While video cameras cannot fully replace and mimic all the behaviors and emotional response patients get from having an in-room sitter, there are ways to address these limitations. For example, the inclusion of a communication system to allow for two-way conversations to take place between the patient and staff member. At the beginning of their shift, the VMT will introduce themselves to the patients and let them know they

are here to watch over them. To help the patient feel comfortable with the staff member watching them, the VMT is required to give the patient their name and give a detailed explanation to the patient of the video monitoring program. The hope is that by fully explaining the system to patients and giving them a direct contact to communicate with that it will help to minimize their concerns over not having an in-room sitter. This introduction also gives the patient a direct staff member to talk to if they require assistance and gives the patient comfort in following any directions that the VMT gives them to prevent injuries. The hope is that having the patient know the name of the VMT they will feel more comfortable using the video monitoring program as they will know the person watching over them.

In addition, reassurance from clinical staff that the video monitoring system will still give the patient complete security, safety and continual supervision throughout their duration in the hospital is required. Patients often feel a sense of comfort and are more likely to adopt and follow directions given to them by healthcare professionals. It is important that the patient understands that their safety and well-being is still the top priority even with the use of video monitoring. Also, the placement of the camera in the patient's room is important to minimize any feelings of overbearing surveillance while still monitoring patient movement and activities [15]. Also, the video monitoring program was developed based on guidelines and evidence-based practices, meaning that workflows and procedures that worked well in other institutions were adopted [16].

While the adoption of video monitoring has many benefits and can serve as a more cost effective way to maintain patient safety, it is important to understand the limitations of the technology based system and make sure that patients utilizing this service still have other opportunities to experience human interactions while staying in the hospital. Nursing staff will be reminded that these human interactions are still a very important part of the patient care experience and by phasing out the use of in-room sitters to provide this human interaction with patients, that nursing staff will need to take on this responsibility. Nursing staff will be reminded that even though a VMT is continually watching over the patient remotely, they should still check in on their high-risk patients for in room visits and to offer that human interaction and companionship. The collaboration of the VMT being able to verbally communicate with the patient and nursing staff taking the initiative to check in on patients will help aid in the transition from patient sitters to a technology based system. The hope is that by acknowledging the limitations of video monitoring, steps can be taken to prevent patients from feeling uncomfortable and help establish a new sense of security and safety and help minimize any limitations of technology.

## XVIII. CONCLUSION

In conclusion, video monitoring is an effective solution for the replacement of in-room patient sitters. Patient sitters are an

extremely expensive service for hospitals to provide as the associated operational cost of hiring sitters varies based on the number of patients admitted to the hospital. Patient sitters are also an administrative challenge to effectively plan and budget for each fiscal year. Literature also shows that patient sitters are not always effective to reduce patient falls and injuries.

Due to these challenges, the hospital wanted to deploy a technology based system to replace the use of sitters. This was done by utilizing an advanced, cohesive network of video cameras in addition to a two-way communication system and bed exit alarms. Video monitoring is able to effectively replace the use of in-room patient sitters through the use of video cameras to provide constant remote supervision of multiple high risk patients. Video monitoring is actually the superior method compared to sitters for providing constant monitoring services because video monitoring allows for one staff member to efficiently supervise multiple patients compared to patient sitters that can only provide one-on-one constant supervision. Ultimately, video monitoring is performing the same duties and responsibilities of patient sitters, but just in a more cost effective method.

The benefit of adopting video monitoring is that the operational costs of providing constant supervision will be reduced compared to staffing costs for sitters. This is because video monitoring has a consistent fixed operational cost associated with the service even when the patient population inflow using this service fluctuates. Video monitoring also allows the video monitoring technician to monitor patient video feeds for any unsafe behavior and verbally intervene to stop unsafe actions of the patient. Verbal intervention is a great tool that will help improve patient safety because instructions can be given to prevent injuries from occurring. Ultimately, by implementing video monitoring the hospital is able to provide an efficient technology driven solution to monitor high-risk patients while still maintaining a high standard of patient safety and quality of care.

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