

Early detection of general surgery complications using remote patient monitoring: a life saved

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Abstract

A rare postoperative complication was detected in a 65-year-old male after abnormalities were identified through a newly implemented Remote Patient Monitoring (RPM) program at Stony Brook University Hospital (SBUH). After the RPM alerted the patient's attending surgeon of abnormal vital signs, the patient was urged to visit the SBUH's Emergency Department, where the patient presented severely ill, tachycardic, with dry mucous membranes as well as right lower quadrant pain without rebound 12 days post-interval laparoscopic appendectomy. Laboratory results demonstrated high alanine aminotransferase, aspartate aminotransferase, alkaline

phosphate, and elevated white blood cell count. Upon imaging the patient was found to have a large ill-defined hypodense multi-lobulated lesion within the right lobe of the liver supporting a diagnosis of pyogenic liver abscess. The patient was admitted to the hospital and given IV broad spectrum antibiotics, fluids, and pain relief. The patient then underwent ultrasound-guided hepatic abscess drain placement, showing significant improvements within the following days of hospitalization. By enabling the use of RPM in general surgery, telemedicine may enhance the care of patients at risk for surgical complications and save lives.

Introduction

Using technology-enabled information exchanges, telehealth care appears to have tremendous potential to transform future general surgical clinical care practices.¹ Using wireless devices, Remote Patient Monitoring (RPM) can be used to transmit a patient's most critical post-operative information to their surgical team. Recently, there has been an increased use of telehealth visits augmented by remote monitoring;² however, publications investigating the impact of RPM remain limited.³

For Stony Brook University Hospital (SBUH) Department of Surgery's general surgery patients, a new telehealth care program including RPM was established in 2020. To evaluate the effectiveness of this general surgery program, a new SBUH-approved Quality Assurance (QA) project was initiated to monitor our general surgical patients' postoperative care and reduce hospital readmission rates more closely. In partnership with VitalCare, a company that provides RPM devices, SBUH patients undergoing general surgical procedures (*i.e.*, appendectomies, cholecystectomies, and hernia repairs) from 01/01/2021 to 10/01/2021 were all offered the opportunity to participate in an innovative, postoperative RPM program. Patients were enrolled prior to their procedure via telephone inquiry, at the bedside, and prior to discharge from the hospital following their procedure. A total of 66 patients consented for enrollment. Most of the patients in the RPM program reported to be satisfied with the quality of service provided, felt that the RPM device facilitated detection of complications as well as provided better access to healthcare services.

Before their surgical hospitalization discharge, volunteers received their personalized RPM kit (Figure 1). Along with their other general surgical discharge instructions and surgical staff contact information, this kit contained a blood pressure cuff, pulse oximeter, weight scale, and tablet. Patients were instructed to record their vital signs for at least once a day for up to two weeks following their procedure. Additionally, each volunteer received the standard discharge package of information including detailed medication management instructions. Upon returning home, the VitalCare team

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monitored these patients' vital signs once daily; all abnormal readings were reported immediately to the patient's surgical team.

To monitor our general surgery patients' access to and timeliness of post-operative care, enhance their education and understanding, as well as to improve the overall quality of their general surgical care received, our SBUH-approved QA project set in place routine patient assessments and self-evaluations.^{1,4} Although earlier detection of post-operative complications that may generally prevent future unnecessary readmissions and emergency visits, it is also important that QA programs identify situations where an emergency room referral with planned readmission might be the recommended strategy to assure patient safety; thus, this case study presents a rare situation where a patient's life was saved due to early detection of a liver abscess via this newly implemented RPM program. The details for this rare case study are presented below.

Case Report

A 65-year-old male with a history of perforated appendicitis presented at the Stony Brook Medical Center's Emergency Department (ED) with right sided abdominal pain 12 days post-interval laparoscopic appendectomy. As background, the VitalCare team remotely identified this patient challenge on postoperative day 12 based on tachycardia detected via their VitalCare RPM dashboard. Following VitalCare detection of this abnormality, their staff promptly contacted this patient at home on postoperative day 12; during this call, the patient reported excessive sweating, diarrhea, and a weight loss of 3 pounds in one day. Thus, VitalCare directly contacted this patients' attending surgeon. Based on surgeon's discussion of these findings (postoperative day 12), the patient was immediately referred to the ED.

In the ED, the patient presented as severely ill with dry mucous membranes as well as right lower quadrant pain without rebound. In discussions with the Emergency Room (ER) physician team, the patient stated that the pain radiated to the right shoulder and ranked 8 on a Numerical Rating Scale (NRS) from 0-10. Moreover, the patient had taken 500 mg Tylenol with little to no relief. The patient had trouble sleeping, had night sweats, felt tired, had no appetite, and urine was red-tinged. Past medical history was remarkable for a perforated appendicitis that had occurred during the prior year, and a history of hypertension, hyperlipidemia, Type II Diabetes Mellitus

(DM2), Chronic Obstructive Pulmonary Disease (COPD), and Benign Prostate Hyperplasia (BPH). Their rectal temperature was 38.1 °C, heart rate of 98, respiratory rate of 16, and Blood Pressure (BP) of 105/64. Their liver panel and Complete Blood Count (CBC) showed high Alanine Aminotransferase (ALT) (235 International Units per Liter, IU/L), Aspartate Aminotransferase (AST) (162 IU/L), alkaline phosphate (325 IU/L), and elevated White Blood Cell (WBC) count of 23.94 cubic milliliter of blood (K/uL; normal range runs from 4.8 to 10.8). Upon imaging with an Intravenous (IV) dye contrast during Computed Tomography (CT), the patient was found to have a large ill-defined hypodense multilobulated lesion (11 x 10 x 10 cm) within the right lobe of the liver (Figure 2).

Following this RPM-driven emergency room visit, the patient was admitted to the hospital with a diagnosis of liver abscess. They were started on IV medications including piperacillin-tazobactam (4.5 grams) and vancomycin (1.5 grams), ringers lactated (1000 milliliters [mL]), and 975 grams of acetaminophen taken orally. The patient then underwent ultrasound-guided hepatic abscess drain placement where a total of 85 mL of purulent material was aspirated and sent to microbiology for additional testing. An additional 210 mL of purulent fluid was aspirated in the following days. This patient was discharged in stable condition back to his home following a 10-day hospital stay with a Peripherally Inserted Central Catheter (PICC line) for continued IV antibiotics for an additional 14 days.

Discussion

Pyogenic liver abscesses are rare surgical complications, whose diagnosis and treatments may be quite complex.^{5,6} The most common causes of pyogenic abscesses are biliary and intra-abdominal infections, direct extension from cholecystitis, perinephric abscesses, subphrenic abscess, hematogenous spread, post-operative complication, and foreign bodies.⁶⁻⁹ If not promptly diagnosed and evaluated, pyogenic liver abscesses are life-threatening.¹⁰

In this case report, the RPM program was instrumental to save this patient's life. Specifically, the RPM measurements of tachycardia and weight loss prompted the VitalCare team to call the surgeon, who promptly contacted the patient, assessed their problem, and coordinated their admission to the ED for more extensive assessment. Jia *et al.*¹ examined the use of a Care Coordination Home



Technology

- Cellular Enabled Tablet with High-Speed Internet Connectivity
- Pulse Oximeter
- Blood Pressure Monitor
- BMI Weight Scale

Services

- Clinical: Daily monitoring by VCS Registered Nurse
- Patient Onboarding: Personal 1-1 outreach to train patients
- Logistics: Outbound & Inbound shipping
- Technical Support: all technical questions covered by VCS
- Management: Project Management Oversight

Figure 1. Remote Patient Monitoring (RPM) kit sent to patients postoperatively.

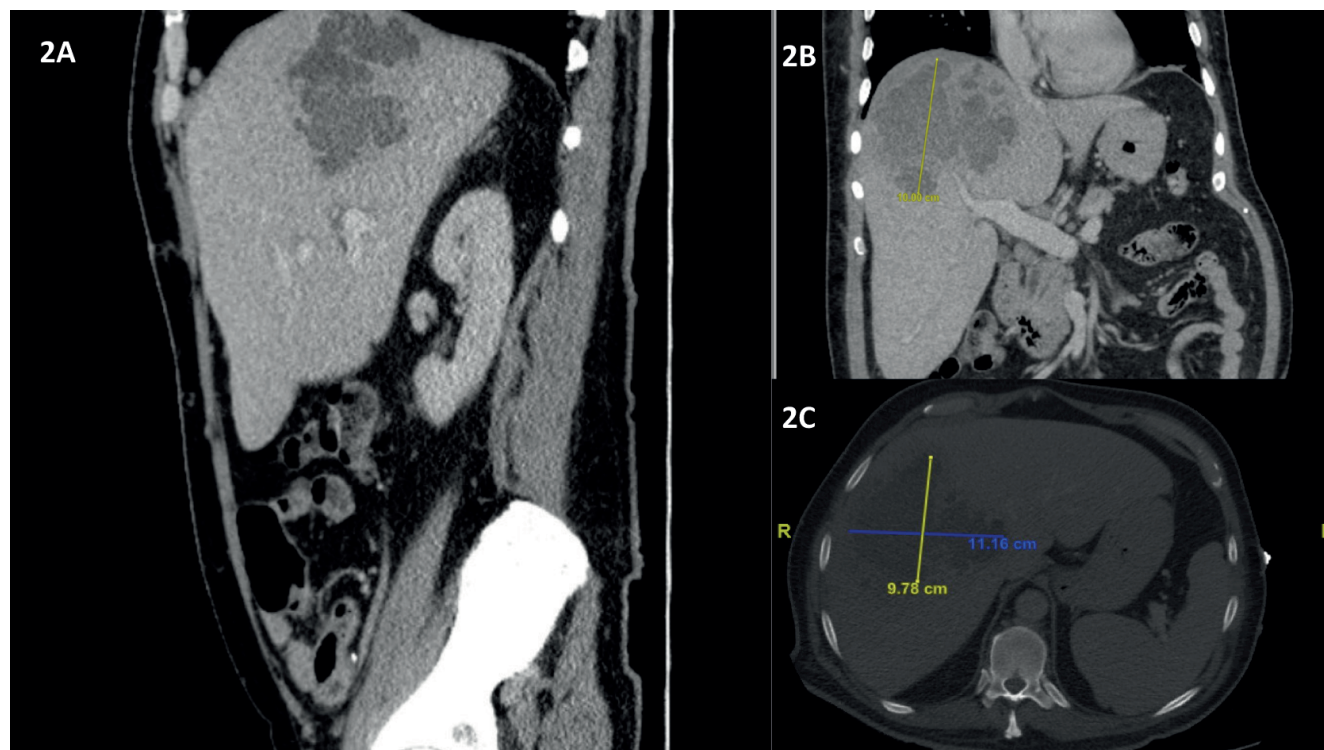


Figure 2. Images in sagittal (A), coronal (B), and axial (C) views of our patient's multiloculated pyogenic liver abscess.

Telehealth (CCHT) to prevent hospitalizations in four different Veteran Affairs (VA) medical centers. Their results were promising and compared to a matched control group, the CCHT group was less likely to be admitted for preventable hospitalizations than their non-enrollee counterpart over a 4 year follow up period. Additionally, a recent review from the Agency for Healthcare Research Quality (AHRQ),¹¹ comprehensively evaluated the latest high quality systematic reviews regarding telehealth and its applications. The results highlighted a clear benefit in the use of telehealth above all when used for remote patient monitoring in "at risk" patients that have more complex, chronic conditions and may be prone to cardiovascular or respiratory complications.¹¹

Conclusions

Although telehealth has been extensively studied for post-surgical patients' follow-up care, the potential of RPM in general surgery patients has not yet been fully described. A paucity of RPM investigations exists evaluating the impact of RPM follow-up strategy for general surgery. With RPM, there is potential for cost reduction inherent in hospital readmissions from a cost-perspective; for this program specifically, costs were \$850 per RPM kit, \$100 for shipment, enrollment, disenrollment, and sanitization of equipment, monthly data hosting at \$40 per month, and daily nurse monitoring through VitalCare at \$80 per month. Another potential benefit of RPM is the ease-of-use from home and accessibility for a wide range of patients, including the elderly. While caregivers are often instrumental in aiding elderly patients in navigating the RPM software, the VitalCare team's direct communication and training with the patient help to bridge potential gaps in regard to technological literacy even in cases when caregivers are not available. Most importantly, as shown in this case, RPM served as a part of a life-saving intervention for a patient. This has provided the impetus for our Stony Brook

University general surgery team to expand our telehealth services. Specifically, the "at risk" general surgery patients will be targeted for RPM; thus, potential of RPM to improve the quality of our general surgical care may be more rigorously evaluated across an integrated continuum of surgical care. In summary, this case provides a call to action for healthcare institutions around the world to further explore telemedicine opportunities to remotely monitor postoperative patients and improve the quality of their patients' care.

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