

## CASE REPORT

# Acute postoperative and rehabilitation care managed in a virtual hybrid hospital-at-home after a total knee arthroplasty: A case report

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## Key Clinical Messages

This case report demonstrates a virtual hybrid hospital-at-home program can provide inpatient-level postoperative and rehabilitative care after total knee arthroplasty to a medically complex patient in the comfort of their own home.

## Abstract

Advanced Care at Home combines virtual providers with in-home care delivery. We report a case of virtual postoperative and rehabilitative care in a medically complex patient who underwent a total knee arthroplasty. This new model of care delivery allows effective patient-provider communication and meets patient needs in the postoperative period.

## KEYWORDS

home hospital, hospital-at-home, knee replacement, postsurgical care, telehealth

## 1 | INTRODUCTION

The hospital-at-home model has recently been implemented at Mayo Clinic as the Advanced Care at Home (ACH) program, which offers high-acuity hospital-level care at home. Patients are continuously monitored through an advanced technological kit by qualified providers located in a centralized command center on Mayo Clinic's Florida campus. Additionally, a complex supplier network is available to cover the inpatient needs such as in-person nursing care, laboratory, radiology, physical therapy, and supplies.<sup>1</sup>

During the COVID-19 pandemic, the implementation of telemedicine programs increased exponentially to reduce the influx of patients in hospitals and decrease the

length of stay in the hospital wards.<sup>2</sup> Moreover, surgical services were highly affected by the mandatory cessation of elective surgical procedures.<sup>3</sup>

The impact of telemedicine use in surgical follow-up care in joint replacement surgery has been defined as safe, feasible, and economically beneficial compared to in-person clinic appointments.<sup>4</sup> Total knee arthroplasty (TKA) is a cost-effective procedure frequently performed on patients with end-stage knee osteoarthritis.<sup>5</sup> Following the CARE guidelines for case reports,<sup>6</sup> we describe the acute postoperative and rehabilitative care of a TKA performed on a medically complex patient in Wisconsin coordinated remotely in Florida through the ACH program at Mayo.

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## 2 | CASE REPORT

A 76-year-old gentleman presenting with several years of right knee pain hindering his daily activities was evaluated by the orthopedic service and diagnosed with end-stage right knee degenerative arthritis. Past medical history included atrial fibrillation, severe obstructive sleep apnea, varicose veins in his lower extremities, mixed hyperlipidemia, and gastroesophageal reflux. Treatments for comorbidities included anticoagulation with warfarin, heart rate control with metoprolol, and the use of a continuous positive airway pressure (CPAP) device at night. He also has severe deconditioning and muscle weakness resulting from his immobility due to his knee pain.

The results from a right knee X-radiograph reported a complete loss of medial compartmental joint space with bone-on-bone deformity and varus alignment without evidence of fractures. (Figure 1).

Due to unsatisfactory outcome of non-surgical treatments, the patient was scheduled for a right knee total replacement and underwent a preoperative evaluation. The preoperative evaluation included a physical examination, laboratories, chest radiograph, and an electrocardiogram. Perioperative risk was assessed, and due to both his chronic comorbidities as well as his limited mobility resulting in physical deconditioning, his physician recommended inpatient admission after surgery to ensure stability in heart rate and oxygenation followed by 10–14 days of inpatient rehabilitation with physical and



**FIGURE 1** Preoperative right knee X-ray showing degenerative changes with small effusion, no fractures identified.

occupational therapy in order to insure a safe transition back into the home setting.

The patient was supposed to undergo surgery in late September of 2020, but due to the dramatic increase in COVID-19 cases in Wisconsin, bed capacity in the hospital and inpatient rehabilitation facility was severely limited. The patient was informed that this necessary but elective procedure would be delayed for at least several months, if not longer. Due to ongoing severe pain and worsening deconditioning due to decreased mobility, the patient asked if there were any other options to safely expedite his procedure. He stated that although his procedure was technically elective, his quality of life was very poor and his pain was unbearable, and he feared what would happen if he waited any longer for surgery and rehabilitation. For this reason, ACH was offered as an alternative pathway to delaying the procedure. Risks and benefits of trying this novel approach to postoperative care were discussed with the patient, and he elected to proceed. In early October 2020, the patient underwent a right TKA under regional anesthesia with spinal and adductor canal block. The right knee underwent cemented total knee arthroplasty through a standard midline incision and medial parapatellar approach. Briefly, the femur and tibia were cut to accommodate size 5 components, and the patella was resurfaced. The knee joint was inspected, and any excess cement was removed. A 12.5 mm polyethylene component was then inserted. The knee was taken through its full range of motion without any catches or clicks. The incision was closed, and the knee was irrigated and dressed. No complications were reported during the procedure. The patient was transferred home directly from the post-anesthesia care unit for postoperative care through the ACH program. Upon admission to the program, a technology kit was installed in the patient's home. This kit included biometric devices for monitoring vital signs, an emergency response system with wearable bracelet, a tablet for video consultation, and a two-way telephone connected with the command center in the Florida. Additionally, a backup 72 h power supply and cellular cradle point to back up the Wi-Fi connection were installed. The devices' functionality was checked, and patient and caregiver training for their use was performed.

The orthopedic team and ACH providers offered daily virtual rounds starting on postoperative day one. The patient's pain control plan included hydrocodone-acetaminophen 5–325 mg oral every 4 h as needed and tramadol HCL 50 mg oral every 4 h as needed. In case of breakthrough pain, IV fentanyl was given. On the second postoperative day, virtually rounding teams agreed that the patient was clinically stable for discharge from the acute inpatient phase of the ACH program and ready for transition to the sub-acute, restorative phase where

intense physical and occupational therapy would be given for rehabilitation and strengthening. The orthopedics team scheduled in-person physical therapy consultations to start at the beginning of the restorative phase. The ACH pharmacy team continuously managed anticoagulation therapy with warfarin (5 mg/day). Additionally, the patient continued his home dose of metoprolol for atrial fibrillation, simvastatin for mixed hyperlipidemia, warfarin for anticoagulation, and his CPAP device for obstructive sleep apnea. The outpatient sub-acute plan for pain control included oral acetaminophen, tramadol, and oxycodone (5–10 mg) as needed. Intravenous injection of fentanyl was available as needed if pain was uncontrolled by oral medications. (Figure 2).

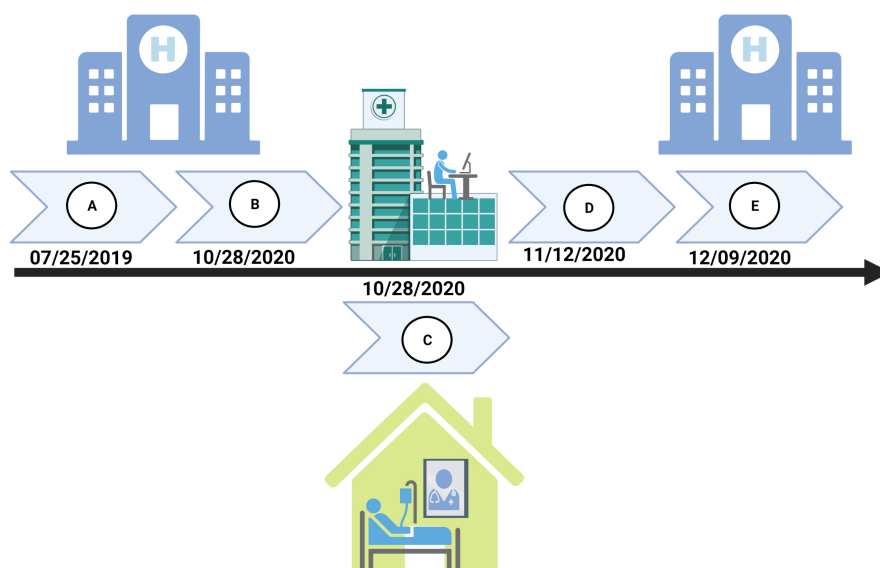
Subsequently, the patient was completely discharged from the ACH program on postoperative Day 15 without any reported complications. The orthopedic team conducted their first in-person visit 6 weeks after the procedure, which revealed a progressive improvement in the patient's pain (scoring 3/10), walking ability, static and dynamic sitting balance, and knee stability. However, due to limited range of motion, manipulation under anesthesia was performed 12 weeks after the total TKA. One month later, during the four-month evaluation post TKA, the right knee demonstrated full extension, 110 degrees of flexion, stability in the varus-valgus stress test, and the patient's ability to walk unaided without pain. Additionally, the patient could use a stationary bike and navigate stairs with caution. Unfortunately, our institution did not record standardized patient-reported outcomes at that time. A postsurgical radiograph image shown in Figure 3 revealed mild soft tissue swelling, the appliance well seated without evidence for loosening, and some vascular calcification, concluding a satisfactory appearance of the new right knee arthroplasty.

### 3 | DISCUSSION

This case report demonstrates that the ACH program implemented by Mayo Clinic is an alternate, safe, feasible, and effective tool for acute postoperative care for patients who underwent TKA. The technological advantages offered by this program allowed the precise monitoring of the patient from the comfort of his home, at a time when traditional hospitalization following elective surgical procedures was severely limited by hospital bed availability during the COVID-19 pandemic. Additionally, individualized care was continuously provided to guarantee an immediate response to routine postoperative care needs and emergency services in the event of life-threatening situations through the combination of the two major methods of telehealth, synchronous and asynchronous.

Since the launch of the ACH program, more than 1000 patients with moderate or high-acuity illnesses, following the All Patients Refined Diagnosis Related Groups Severity of Illness and Risk of Mortality (APR-DRG SOI and ROM) criteria, have been successfully managed. Patient eligibility for the program is based on an exhaustive social and clinical stability evaluation. The ACH team has to perform a list of questions assessing the social patients' environment (home location, supplies, internet, family/caregivers' availability) and their current state of health and comorbidities, previous to the admission.<sup>1</sup> Therefore, the safety of the home environment and the general health condition of each potential patient is thoroughly evaluated to ensure safe care in the home.

Use of telehealth in orthopedic surgery has been previously reported, including clinic follow-up in an early postoperative course after a rotator cuff repair surgery. The patients expressed that the main benefits of telehealth included adequate pain control and time and money saved



**FIGURE 2** Timeline of intervention and outcomes. Acute postoperative care of the patient after total knee arthroplasty (TKA) through the Advanced Care at Home (ACH) program. A. Day of diagnosis; B. Day of surgical intervention; C. Postoperative follow-up through ACH; D. Day of discharge from ACH; E. First postoperative follow-up at the office. Created with BioRender.



**FIGURE 3** Postoperative right knee X-ray image revealing mild soft tissue swelling and the appliance well seated.

due to the reduced need of transportation to the clinic.<sup>7</sup> A meta-analysis evaluating patient and provider satisfaction concerning the use of telemedicine compared with the in-person visit in orthopedic care showed no substantial differences.<sup>8</sup> Similarly, the use of home telemedicine examination in the postoperative knee arthroscopy of 34 patients revealed no clinical difference associated with the range of motion and incision size features compared to face-to-face encounter.<sup>9</sup> Furthermore, the telehealth assessment of skin color change, swelling, tenderness, weight-bearing, and range of motion in a patient with minor trauma yielded greater than 95% accuracy compared to in-person evaluation.<sup>10</sup> The recent evidence suggests telemedicine in orthopedics is safe, cost-effective, and has high provider and patient satisfaction.<sup>11</sup>

The Medicaid and Medicare decision to remove the TKA from the inpatient-only list procedure now favors outpatient postoperative management.<sup>12</sup> However, not all cases are candidates for this type of care. For instance, patient with advanced age greater than 75 years old or significant medical comorbidities such as diabetes, cardiac heart failure, chronic obstructive pulmonary disease, high body mass index, and obstructive sleep apnea disorder are not eligible for outpatient recovery.<sup>13,14</sup> Additionally, patients under anticoagulation protocols with an increased risk of postoperative bleeding or hematoma development should be maintained under rigorous surveillance to avoid complications such as periprosthetic joint infections.<sup>15</sup> Overall, the patient must meet specific criteria to achieve a successful postoperative outpatient recovery.<sup>16,17</sup>

Our case report has shown the utility of a hybrid model of care combining a telehealth platform with an in-person care in the acute phase of TKA postoperative care as an alternative to inpatient recovery. Exhaustive daily patient evaluation by the ACH team coupled with continuous monitoring akin to traditional hospitalization permitted rapid identification of changes in the patient's course for prompt intervention. Additionally, implementing this reliable program as part of the patient's postoperative management can potentially decrease bed occupancy, reduce medical costs, and allow for a more rapid post-procedure recovery with improved patient satisfaction.

The high cost of TKA to the health system makes it necessary to implement strategies that help reduce the costs associated both inpatient hospital stay and skilled rehabilitation recovery. Hence, in 2016, Medicare introduced a Comprehensive Care for Joint Replacement program, which focused on reducing costs and length of stay for elective TKA patients.<sup>12</sup> The ACH program represents an inpatient and skilled nursing or rehabilitation facility alternative to accomplish these goals, especially in managing a medically complex postoperative patient. Currently, the inpatient-equivalent phase (acute phase) receives the same reimbursement as a traditional inpatient stay based off the Centers for Medicare and Medicaid Services Acute Hospital Care at Home waiver.<sup>18</sup> The outpatient therapy services performed in the post-acute restorative phase are reimbursed as traditional outpatient services. Therefore, any financial benefit of postoperative care at home compared to standard hospital protocols would come from cost savings. The most significant cost-saving aspect is the reduction in hospital stay costs. Hospitals charge for each day of a patient's stay, which includes bed charges, nursing care, and other facilities. As it has been seen that hospital overhead and capital costs make up 48% of health-care dollars attributed to hospital care,<sup>19</sup> the overall long-term goal in this postoperative setting substitution would be to eliminate the non-healthcare associated costs (facility construction costs, hospital utilities costs, and environmental services costs, etc.) to drive savings. By reducing the length of hospital stays and shifting care to a home setting, these costs can be significantly lowered. Additionally, home care can decrease the risk of hospital-acquired infections, which not only pose a threat to the patient's health but can also lead to increased expenses due to extended hospital stays and additional treatments. Home care allows for more personalized care, potentially leading to quicker recovery times and thus reducing the overall cost of care. The integration of telemedicine in home care also reduces the need for physical appointments in the immediate post-acute period, further cutting down costs. Home care often involves family and community support, which can provide emotional support and assist with basic care needs,



thus reducing the need for professional services. Although a true cost-analysis of postoperative ACH patients vs. traditional brick-and-mortar postoperative patients is necessary to see whether the theorized cost savings in this patient population holds true, others have found true cost savings (both realized and unrealized) in the non-Covid, high-acuity hospital-at-home patient population. Singh et al found that high-acuity geriatric patients enrolled in home hospital had less costly care from a health and social care perspective (mean  $-\pounds 2265$ , 95% CI:  $-4279$  to  $-252$ ) when compared to traditional admission to a hospital.<sup>20</sup> A study of 169 oncology patients receiving their high-acuity oncology care at home had reduced 30 days costs, a lower hospital length of stay, lower unplanned hospitalizations, and less emergency room visits when compared to 198 usual oncology care patients.<sup>21</sup> These and other programs have shown that there is a role for both realized and unrealized cost savings in the hospital-at-home model of care. However, it is crucial to note that home care might not be suitable for all patients, particularly those requiring intensive postoperative care. The decision should be based on a thorough evaluation of the patient's medical condition, the complexity of the surgery, and the necessary level of postoperative care. The cost benefits can also vary significantly depending on the healthcare system of the country, insurance policies, and the availability of home care services.

## 4 | CONCLUSION

The ACH program can effectively achieve optimal, effective, individualized, and high-acuity hospital-level care in the home setting for acute care after an orthopedic surgical procedure. Leveraging telehealth for improved access to medical care while offering high patient satisfaction are advantages that hospital-at-home offers. Furthermore, on-demand patient-provider communication ensures the patient's needs in the postoperative period are addressed in a timely manner.

### AUTHOR CONTRIBUTIONS

**Margaret R Paulson:** Conceptualization; formal analysis; investigation; writing – original draft; writing – review and editing. **Karla C Maita:** Data curation; formal analysis; writing – original draft. **Francisco R Avila:** Data curation; formal analysis; writing – original draft. **Ricardo A Torres-Guzman:** Data curation; formal analysis; writing – original draft. **Antonio J Forte:** Project administration; resources; software; supervision; writing – review and editing. **Rusty C Brand:** Conceptualization; investigation; resources; writing – review and editing. **Phillip J Seep:** Conceptualization; investigation; methodology; writing – review and editing. **Micheal J Maniaci:**

Conceptualization; project administration; supervision; validation; writing – review and editing.

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Figure 2 was created using [BioRender.com](https://BioRender.com).

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### CONFLICT OF INTEREST STATEMENT

None of the authors have any conflicts of interest to report.

### DATA AVAILABILITY STATEMENT

Access to data is restricted to keep the patient's privacy. However, if deemed necessary, data will be provided by the corresponding author upon reasonable request after approval from the needed institutional committee.

### ETHICS STATEMENT

This study conforms to all standards of the Mayo Clinic Ethics Committee.

### PATIENT CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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