

The role of telemedicine in postoperative care

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Abstract: Telemedicine has become one of the most rapidly-expanding components of the health care system. Its adoption has afforded improved access to care, greater resource efficiency, and decreased costs associated with traditional office visits and has been well established in a wide array of fields. Telemedicine has been adopted in several domains of surgical care. In recent years, the role of telemedicine in postoperative care has caught attention as it has demonstrated excellent clinical outcomes, enhanced patient satisfaction, increased accessibility along with reduced wait times, and cost savings for patients and health care systems. In this narrative review, we describe the history of telemedicine, its adoption in the field of surgery and its various modalities, its use in the postoperative setting, and the potential benefits to both patients and healthcare systems. As telemedicine continues to emerge as a powerful tool for health care delivery, we also discuss several barriers to its widespread adoption as well as the future utility of telemedicine in postoperative care.

Keywords: Telemedicine; postoperative care; surgery; clinical outcomes; patient cost and time savings; mobile health; telehealth

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Introduction

According to the Institute of Medicine, telemedicine is defined as “the use of electronic information and communication technologies to provide and support health care when distance separates participants” (1). With the proliferation and widespread adoption of technology, including the personal computer and smartphone, the electronic arsenal available to medical fields has exponentially risen. Since its implementation in the early 1950s, telemedicine has become a rapidly-expanding tool in medicine (1-6). The adoption of telemedicine has afforded improved access to care, ameliorated resource efficiency, and decreased costs associated with traditional office visits and has been applied in a wide array of fields in medicine (5,7-12). In addition to physicians’ offices, home health agencies, and skilled nursing facilities, over 50% of acute

care hospitals are currently using telemedicine at some level (13). The telemedicine market is expected to reach the value of \$30 billion dollars by 2019, which is anticipated to grow by 20–50% each year (14).

In recent years, telemedicine has been adopted in several domains of surgical care, including preoperative and postoperative care (15-17). The role of telemedicine in postoperative care is of significant interest and it has demonstrated excellent clinical outcomes, enhanced patient satisfaction, increased accessibility along with reduced wait times, and cost savings to patients and health care systems (15). The evolution of surgical care should focus on providing the highest quality of patient care with a special emphasis on patient and provider satisfaction, meanwhile maintaining optimal access to care. Thus, the benefits of telemedicine merit continuing consideration and utilization by all providers in the surgical field.

History of telemedicine

The National Aeronautics and Space Administration (NASA) has been at the forefront of telemedicine implementation and its application (18). Since the early days of sub-orbital flight, remote monitoring of crew members and environmental health have been integral parts of NASA's space operations (19). When the Space program was initiated, telemetry of flight suit data allowed ground controllers to analyze and interpret a crew member's basic physiologic parameters (19). Although data were collected and recorded during this time, it remained unlinked in real-time to crew members during these early missions (19). It wasn't until the Apollo Project [1968–1972] that a biosensor harness, an integrated suite of equipment allowing for real-time transmission of health parameters to the ground control, was generated (20). Since the Space Shuttle program [1981], tracking and data relay have allowed constant real-time communication of biomedical information, which has served as a beacon for the integration and evolution of telemedicine. Overall, NASA's ability to monitor and maintain crew health and telemedicine system performance in spaceflight has proved to be a well-coordinated effort, providing for the advancement and integration of telecommunication in the field of medicine (18).

Adoption of telemedicine and use in postoperative care

Although initially viewed as a futuristic concept through its early adoption and implementation by NASA, the telemedicine industry has rapidly grown and gained acceptance by both patients and providers. For the last two decades, the United States (U.S.) Department of Veterans Affairs (VA) has been at the forefront of telemedicine. In 2014, 1.2 million telemedicine visits were conducted for approximately 700,000 Veterans across 44 different medical specialties (21). Additionally, the VA system has prioritized telemedicine utilization in furthering care to its veterans and its use is now even a healthcare performance goal for the 2014 to 2020 fiscal years with \$1.2 billion allotted for telemedicine efforts in the 2016 VA budget (21,22).

Although telemedicine in surgery gained interest in the late 2000s, the VA health care system, with its robust and long-running video visit program, has played an integral role in adoption of telemedicine in the field of surgery (23). In 2013, the VA health care system conducted

one of the first and largest pilot programs examining whether a telephone visit could safely substitute a traditional office visit for elective general surgery cases, including elective laparoscopic cholecystectomy and open hernia repair (24). During this 10-month study period, excellent clinical outcomes and high patient satisfaction were achieved (24). Several follow-up studies confirmed these findings in the VA healthcare system and also in a wide variety of surgical fields including subspecialties of general surgery, urology, plastic surgery, neurosurgery, and obstetrics and gynecology (15,21,25-30).

Telemedicine modalities

Evolution in technology has effectuated a systemic change in the ways health care is delivered to patients. A robust and reliable broadband connection is preemptive to provision of efficient care over long distances. A comprehensive broadband signal transmission system, or the "pipe," comprises elaborate infrastructure that enables flow of data at modest speeds. Recent improvements in these infrastructure facilities globally have given way to cost-effective access to wider bandwidths that allow higher data transmission rates. This has stemmed the emergence of renewed interest in telemedicine (31).

In recent years, telemedicine in postoperative care has been implemented via a multitude of modalities. Short message service (SMS) text messaging, smart-phone applications, automated calls and wearable devices have become some of the most widely used modalities (21). SMS-based communications have been widely adopted over the years, and are used twice as frequently compared to application-based interventions (32). Generally, any cellphone or computer can send and receive SMS texts, providing a very basic and easy-to-use modality for patient communication. Despite SMS messaging being used for over a decade, mobile health (m-health) applications and fitness trackers are considered to be the fastest growing segment fueling the growth of telemedicine today. These applications have the potential for a superior interface between patients and providers with numerous modalities of communication including pictures and videos (32). Despite these benefits, some clinicians feel that application-based modalities can be a potential barrier to delivery of health care to patients over a distance, since not all patients have access to smartphones and computers, which are required to use these applications (32).

Although there are some concerns regarding the underuse of mobile phones and m-Health applications in certain populations, including the elderly and the lower socio-economic class, numerous studies indicate that both young and old patients are able to utilize these modalities and can greatly benefit from them (33,34). Overall, both SMS messaging and m-Health applications have emerged as a great avenue to shorten length of hospital stay and improve quality of care delivered to patients by potentially identifying complications earlier, and therefore decreasing 30-day readmission, improving recovery, and reducing health care costs in post-operative patients (34,35).

Utilization of telemedicine in the postoperative period

Although telemedicine has been richly adopted in various aspects of surgical care, its utilization in postoperative care has become of great interest (15). Telemedicine during the postoperative period has been used predominantly in three manners (15), which include (I) scheduled follow-up (24,36-44), (II) routine monitoring (44-48), and (III) management of arising issues as needed (49,50). Recently, the replacement of traditional clinic visits with telemedicine has become highly popular. Numerous studies have demonstrated the potential for replacing traditional follow-up clinic visits with either a telephone call (24,25,39), automated messaging (51), or an online videoconference chat, which can occur from either an affiliated institution (37,38,42) or the patient's home (40,41,43). Some interest in picture-focused smart phone-based services for surgical wound care evaluation has also emerged (52-54).

Routine monitoring of patients has also gained interest. In some settings, clinicians have used this method to assist in patients' reporting of postoperative symptoms through either an automated telephone survey (45) or via a videophone (47). Other clinicians, however, demonstrate routine monitoring of specific objective clinical data including ileostomy output (55), blood pressure and medication adherence (47), surgical drain output (48), and home spirometry results (46,56). Although not as commonly utilized, there are reports of patients conveying specific postoperative concerns as they arose through automated messaging systems (49,57) and communications based on smartphone digital photography (50). Overall, there is a tremendous potential for providers to communicate remotely and deliver excellent care to patients in the postoperative setting through a variety of means.

Clinical outcomes of telemedicine in postoperative care

Telemedicine has shown promise in improving outcomes for patients in the postoperative setting. It is imperative to say that in the absence of excellent clinical outcomes, all the secondary benefits of any healthcare intervention become of limited use. Recent literature contains growing evidence for excellent clinical outcomes following the introduction of telemedicine in the postoperative setting. Studies report that clinical outcomes are comparable to the outcomes in the setting of traditional clinic follow-up (15). As an example, in elective low-risk procedures like laparoscopic and open inguinal hernia repair, laparoscopic cholecystectomy, parathyroidectomy, arthroplasty and pediatric urological procedures, complication rates generally range from 0 to 4.8% which are not statistically different from the complication rates following traditional clinical follow-ups postoperatively (24,37,39,41,42). High-risk non-elective procedures, including those involving orthopedic trauma have known higher rates of complication. The complications reported following these procedures are similar in settings of traditional clinic follow-ups and telemedicine (40). It is worth noting that no studies have reported statistically higher complication rates with telemedicine visits when compared to complication rates in traditional clinic follow-ups (15).

The potential shown by telemedicine in the postoperative setting has led some authors to question the need for routine traditional office visits for low-risk procedures. Chen *et al.* found that for elective appendectomy and cholecystectomy, providers would spend an average of 7.8 hours in traditional office visits for every intervention that needed to be performed, which included staple removal, suture removal, drain removal, medication changes, additional imaging, and future follow-ups (58). Such findings have left some clinicians to propose that for low-risk elective procedures, follow-ups via telemedicine can be a better option (15). However, select patients may require traditional office visits for follow-up, while others may not require any follow-up at all. Regardless, it appears that telemedicine use in the postoperative setting affords excellent clinical outcomes comparable to those following up in traditional clinic visits across a wide array of surgical specialties. Further work is ongoing to determine the optimal patient populations and surgical specialties that are best suited for telemedicine adoption.

Patient satisfaction of telemedicine

Patient satisfaction is an integral component of good surgical care. The use of telemedicine in postoperative care should therefore entail high patient satisfaction and willingness for participation. In general, patient willingness towards telemedicine use in the postoperative setting is high. For example, in the fields of transplant, general, and vascular surgery, a sizable proportion of patients (90%, 77%, and 90% respectively) reported willingness and confidence in provider ability to conduct remote postoperative care including blood pressure monitoring, medication adherence guidance, and evaluation of postoperative wounds (47,54,59,60).

Furthermore, patients who participate in postoperative care involving telemedicine report both high patient satisfaction and ease of use. Finkelstein *et al.* demonstrated that 90% of patients were satisfied with home spirometry monitoring following lung transplant (46), while Segura-Sampedro *et al.* reported high levels of satisfaction with surgical wound remote follow-up by smart phone after appendectomy (52). Some studies in the fields of urology and orthopedic surgery actually report higher patient satisfaction rates for telemedicine care than traditional office visits (41,43). Others, however, report mixed views with about 50% patients preferring some form of telemedicine as the means to deliver postoperative care (61). Overall, across the literature, patient satisfaction and ease of use are high for telemedicine in the setting of post-operative care. Nevertheless, future studies focusing on larger patient populations testing a more rigorous cascade of clinical outcomes will help determine which patient populations will best suit utilization of telemedicine for post-operative care following various types of surgery.

Provider satisfaction of telemedicine

Since the early days of implementation of telemedicine for post-operative care, patient satisfaction has received precedence over provider satisfaction. However, this does not negate the fact that in addition to a high degree of patient satisfaction, providers also express satisfaction towards various telemedicine modalities for delivery of post-operative care. Following radical prostatectomy, urologists reported a high level of provider satisfaction for video visits (88%) versus office visits (90%) (36). Urologists also reported high levels of provider-perceived quality of medical history (82% *vs.* 72%), therapeutic management

(85% *vs.* 86%), and patient satisfaction (97% *vs.* 86%) for video visits when compared to traditional office follow-up (43). For monitoring burn patients postoperatively, providers reported being “very satisfied” in over 90% of telemedicine encounters (44). In general, surgical providers appear to have a high degree of satisfaction similar to patients. Some providers, however, express concerns regarding the effectivity of use of telemedicine in their current clinical workflow of traditional office visits (43). As telemedicine in postoperative care is still in its infancy, continued implementation and repeated revisions of clinical workflow may help to alleviate these concerns in the near future.

Time and cost savings for patients

Both time and cost savings contribute majorly toward high patient satisfaction. In their systematic review of 21 studies evaluating telemedicine use in the postoperative setting, Gunter *et al.* reported both significant patient time and cost savings (15). As opposed to driving from their residence, patients saved between 79.6 to 367.2 round-trip miles and 77.5 to 317 minutes of total travel time (24,37-40,42,43,61). These round-trip miles and travel time saved directly translate into monetary savings for families, ranging from \$36 to \$357 dollars saved on travel (24,37-40,42,43,61). In addition, several studies report that patients and their families can potentially avoid taking time off from work and other responsibilities and prevent spending one or more nights in a hotel by utilizing telemedicine for postoperative care (15,40,43). Canon *et al.* determined that for every 23 miles away from their clinic, patients are 111% more likely to prefer telemedicine for postoperative follow-up (37). Since many university hospitals provide care to wide geographic regions and have subsets of patients with significant traveling distances, patients are more likely to prefer remote follow-ups through the use of telemedicine. This should encourage the health care systems to adapt to this growing need of the patients.

In addition to patients saving both travel time and travel distance, some studies report that telemedicine can afford significantly decreased “cycle time,” which is the total time spent from the beginning to the end of a clinical encounter (23). This eliminates time spent on non-clinical activities like waiting at the start and end of appointments and being moved to the examination room (23). Following minor procedures such as total joint arthroplasty, an average Skype call per patient as short as 2.71 minutes has been

reported (41). For elective general surgery procedures, significant differences in patient-reported visit times with online postoperative care (patient time, median; 103 min. versus 15 min.; $P < 0.01$) have been reported (25). The degree of change in “cycle time” however, is dependent largely on the procedure performed. Following radical prostatectomy, similar wait times (18.4 *vs.* 13 min.; $P = 0.20$) and total time devoted to clinical care (17.9 *vs.* 17.8 min.; $P = 0.97$) between video visits and office visits have been reported (43). However, this has not altered the high patient and provider satisfaction rates. As telemedicine provides a significant time and cost saving advantage to the majority of patients, its application should be considered in all postoperative patients who are eligible.

Telemedicine for rural settings and patients with transportation barriers

Academic and non-academic centers throughout the country provide surgical care to distinct patient populations in diverse geographic regions. Telemedicine use in postoperative care can directly impact the clinical care provided, especially to patients in rural communities and urban areas with poor access to transportation (23). Approximately 52% percent of patients living in rural communities have access to smartphones and can participate in postoperative telemedicine care (62). Also, there are numerous patients in urban areas where mobility and transportation issues are prevalent. Telemedicine has been applied to these patient populations in under-developed countries, with rudimentary transport systems, with success. If surgeons continue to adopt these practices for providing postoperative care, profoundly more patients will be able to follow up and receive excellent care.

Healthcare system savings and revenue generation

The use of telemedicine in delivering postoperative care is still in its infancy and its implications on healthcare system cost savings and revenue generation are largely to be determined. However, early reports and projections are promising. Daily telephone calls to postoperative ileostomy patients facilitated decreased readmission rates and a savings of \$63,821 for the total hospital cost of a dehydration-specific readmission (63). Other countries have shown promise by demonstrating that telemedicine may save as much as \$600,000 over a 5-year period for regional

hospitals in Queensland, Australia (64). Furthermore, in the U.S. several studies report that telemedicine for postoperative care can generate a substantial number of additional clinic slots for new patient evaluation at the VA health system (24,25). Not only does this play an important role in improving access to surgical care and decreasing wait times, but this is also projected to increase the number of elective operative cases secondary to increased new patient evaluations. Currently, there are several studies underway to determine the full financial implications of utilization of telemedicine in the postoperative setting (65). Overall, it appears that the post-operative use of telemedicine should not only generate cost savings for healthcare system, but it also should spawn a substantial amount of additional revenue if the added elective surgeries are conducted secondary to additional new patient evaluations.

Ethical considerations of telemedicine

Reports on breaches in critical data have been on the rise in the past decade (66). In the U.S. alone, data breaches were reported for 29 million patient health information (PHI) records by HIPAA-covered entities between 2010 and 2013 (67). With the expeditious growth in electronic health deployment since 2012, the frequency and magnitude of electronic health care data breaches are likely to increase (68,69).

The soaring susceptibility to data breaches makes it challenging to establish a practical health care delivery system, which involves the exchange of confidential information between the participants. It is imperative to say that concern over privacy is legitimate and gaining patient confidence requires a robust privacy and security plan. Current standards for all m-health applications are that encounters be secured to the “greatest practical extent through... Integrated Services Digital Network (ISDN), Advanced Encryption Standard 5 (AE5) encryption, or virtual private network for Internet transmissions” (70). Although some HIPAA-compliant messaging applications exist, most applications are lacking on grounds of security and privacy, which poses concerns for patients (71). In addition, standard SMS texting cannot be encrypted, causing additional concerns. As not all patients have access to smartphones in which HIPAA-compliant applications may be downloaded and used, patient privacy and confidentiality remains a serious issue (71). As telemedicine applications continue to evolve, the current focus on protecting and maintaining PHI on secure systems with

minimal data leakage remains crucial to both providers and patients (71).

Current barriers to further adoption of telemedicine use

Excellent clinical outcomes, high patient satisfaction, time and cost savings, healthcare cost savings and revenue generation, and improved access to care are among the numerous benefits of telemedicine application in the postoperative setting. However, there are several barriers, both at federal and state level, that hinder its adoption (21). First, current licensure and practice laws for health professionals require health care providers to practice on a state-by-state basis. As telemedicine has proven to be safe to be applied across state borders, the requirement to duplicate licensure and adherence to different practice rules may prevent underserved populations from receiving care by many providers who are unable to fulfill these prerequisites. There are some states, however, which allow licensure reciprocity across state borders. Only a handful of states, however, are currently extending conditional licensure to physicians across borders for establishing telemedicine practices. In addition, failure of provider reimbursement poses hurdles in inter-state healthcare delivery. As of 2017, there are 29 states which require state-regulated health plans to reimburse telemedicine visits (23). Other barriers that keep the patients from benefiting from telemedicine include, but are not limited to, select states having requirements of being accompanied by a healthcare professional during the visit, being physically present in a medical facility or in a physician's office during evaluation, and providing a written consent to the provider before receiving care (23).

At a national level, the Centers for Medicaid and Medicare Services have been incorporating telemedicine technologies in recent years. Although five years ago the Medicaid and Medicare reimbursement was problematic to an extent, several efforts have been made to waive these barriers. In May 2017, the bipartisan Congressional Telehealth Caucus reintroduced several bills aimed at addressing the current Medicare barriers for telemedicine efforts, which include expansion of the scope of reimbursed services along with redefining rural qualifications (23). Some major commercial payers, including United Healthcare and Blue Cross Blue Shield, have recently waived their origination site requirement and now allow for reimbursement of in-home video visits (23). Overall,

such interventions will help introduce change and make telemedicine a much more feasible option to provide and receive healthcare. Given such efforts and enthusiasm for the Medicare program, many anticipate that surgeons will greatly adopt telemedicine for postoperative care for patients located at home within the next five years (23).

Conclusions

Telemedicine has become one of the most rapidly-expanding components of the health care system. In recent years, the role of telemedicine in postoperative care has received significance as it has demonstrated excellent clinical outcomes, a high degree of patient satisfaction, decreased driving distance and wait times, and cost savings to both the patient and health care systems. The evolution of surgical care should continue to focus on providing the highest quality patient care with a high degree of patient and provider satisfaction, meanwhile allowing the greatest access to surgical care. Telemedicine in postoperative care appears to attain these goals and should be considered as a viable option for healthcare centers. Future work focusing on patient confidentiality and widespread dissemination and implementation of telemedicine in surgery is on the go.

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Footnote

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