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The Utility of Telemedicine to Manage Post-Operative Pain

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Abstract

Telemedicine is defined as practicing medicine via a virtual interface, including email, telephone calls, text messages, video chatting, and personalized online programs. Telemedicine has increased over the past few decades, mainly in psychology and primary care. Recently, surgical specialties have also begun to utilize telemedicine for post-operative care. There are many studies examining telemedicine's use in managing post-operative pain. This review paper focuses on 17 on postoperative pain management. They found that telemedicine can assist physicians in managing post-operative pain remotely by increasing adherence to post-operative regimens ($p < 0.001$), providing greater individualized care ($p = 0.01$), and decreasing post-operative pain medication dependence ($p = 0.04$).

Keywords

Telemedicine, Post-Operative Pain, Orthopedic Surgery, Urogynecological Surgery, Oncology Surgery

1. Introduction

Telehealth, or telemedicine, is defined as the practice of medicine through a remote electronic interface. This electronic interface can include email, video calls through platforms such as Zoom or FaceTime, phone calls, text messages, and mobile apps [1] [2] [3]. The growth and potential of telemedicine can be widely attributed to significant technological advances made in the past century, but in fact, telemedicine had existed since the early 20th century, when many European countries began utilizing radio to provide healthcare to sailors [4]. As the advent of technology continued to expand, with innovations such as the computer and smartphone, telemedicine has continued to flourish and is now the quickest growing healthcare sector.

Analysis of survey data showed that the number of physicians that utilized telehealth increased from 15.6% in 2018 to 58% in 2020 [5].

Firstly, telemedicine can provide greater access to healthcare for a variety of vulnerable populations. For example, 20% of the US population lives in rural areas, but only 9% of physicians practice in rural communities, and so with telemedicine, these people can be reached [1]. Moreover, telemedicine can be beneficial for the elderly, with advantages ranging from reducing loss to follow-up to increased personalized management [6]. Furthermore, telemedicine is also economically beneficial, as it has been shown that telemedicine provides savings in cost, particularly those associated with transportation to the hospital or physician's office [7].

The utility of telemedicine spans a variety of different specialties, as this mode of healthcare continues to become ubiquitous. Currently, the specialties that utilize telemedicine the most are primary care specialties and psychiatry [5]. Surgery specialties were amongst those utilizing telemedicine the least, as historically, post-operative care was done in person. Surgeons would meet with patients in-person typically one week after the operation to assess the patient's pain and often follow up with them at a designated frequency based on their pain assessment at that follow up visit [8]. However, as this review paper will demonstrate, there has been a plethora of recent studies that show that telemedicine can be just as effective, if not more effective, than traditional, in-person visits to help treat post-operative pain from increasing patient compliance to more optimal adjustments of post-operative pain and exercise regimens.

2. Orthopedic Surgery

One area of medicine with great intrigue with regards to telemedicine is the usage of telemedicine in orthopedic surgery. Timmers, *et al.*'s study is a foundational study that examined the effectiveness of a mobile app in reducing post-operative pain in patients 40 and above who had undergone total knee replacement surgery [9]. Post-operative pain can be a source of issue after a total knee replacement because patients may not spend enough time in the hospital after the surgery to truly understand and practice methods to manage their post-op pain, and moreover, many patients have a pain-related fear of movement, which can further delay their recovery and exacerbate post-operative pain [9]. After consulting surgeons, physician assistants, nurses, and physiotherapists from participating hospitals, the researchers built an app that had text information, photos, and videos that were created to instruct patients on how to manage their pain and also allowed them to report their pain levels to their healthcare providers [9]. They found that patients who utilized the app had significantly decreased levels of pain at rest ($p = 0.001$), during activity ($p < 0.001$), and at night ($p = 0.003$) compared to those patients who had not used this app [9].

Another study also looked at patients that underwent total knee replacement, but the form of telemedicine implemented was an online program where pa-

tients could follow along with exercises demonstrated by an avatar on the screen and allow patients and physical therapists to send text messages or video conference in real-time, as patients were performing the exercises [10]. They found that patients in the telemedicine group were able to better manage their post-operative pain than their counterparts who did not engage in the telemedicine, as patients in the intervention group had an increase in 6-minute walking distance of 88.3 m ($p < 0.001$) while those in the control group had a lesser increase of 79.6 m ($p < 0.001$) [10]. The telemedicine employed in this study allowed patients to have greater access to material and education that would improve their post-operative pain, which could lead to greater patient compliance and thus mitigation of post-operative pain.

Moreover, a study that solely used video conferencing as its telemedicine rehabilitation also found that patients who used this real-time video chat with therapists after their total knee replacement surgery had statistically significant ($p < 0.01$) improvement in post-operative pain compared to baseline [11].

In another study that also looked at patients who underwent total knee replacement, and used video chat strictly as the telemedicine intervention, it was found that those in the telemedicine group had a greater average decrease in pain (−2.30) than those in the control group (−1.79) after 3 months [12]. This demonstrates the ability of telemedicine to allow healthcare teams to modify any post-op instructions and rehabilitation exercise protocols accordingly to alleviate pain just as effectively as would be done in person. Furthermore, a study that also looked at patients who underwent total knee replacement, but used video chat strictly as the telemedicine intervention, observed that those in the telemedicine intervention group had pain levels (82.6 ± 1.4) similar to those in the in person control group (84.4 ± 1.5) [13]. These studies demonstrate the ability of telemedicine to allow healthcare teams to modify any post-op instructions and rehabilitation exercise protocols accordingly to alleviate pain just as effectively as would be done in-person. Researchers also reasoned that patient compliance to treatment was greater in the telemedicine group which further aided their post-op pain relief, as with the telemedicine rehabilitation program, all requisite exercises could be done at the patient's home.

The ability of telemedicine to treat postoperative pain has been studied in other types of orthopedic surgery as well. Herrero, *et al.* found that through a video chat, patients who underwent arthroscopic meniscus surgery had similar postoperative pain scores (3.36 ± 1.9) to those who participated in office-based follow-up (3.19 ± 1.7) [14]. Both groups had similar decreases in pain scores when compared to pre-operative assessment [14]. It is also important to note that while the office-based group had 3 patients have complications, the telemedicine group only had 2 patients who had a complication [14]. This could be due to the fact that with the easier and quicker accessibility of telemedicine, patients who suffered any abnormal pain were able to schedule a virtual appointment with their physician, discuss, and develop a treatment plan to address any poten-

tial complications that could arise or worsen.

The effectiveness of telemedicine in managing post-operative pain has also been studied in rotator cuff surgery. In comparing post-operative follow-ups done over video chat compared to those in the office at 2 weeks, 6 weeks, and 12 weeks post-op, Kane *et al.*, found similar post-operative pain scores between the intervention group at (33.8, 31.4, and 14.0, respectively) and the control group (31.5, 20.4, and 14.3, respectively) [15]. Thus, patients were able to modify post-op treatment plans to mitigate their pain just as successfully over video chat as they were able to in person.

In another type of orthopedic surgery, for fractures of the upper end of the tibia, the ability of telemedicine to manage post-operative pain was comparable to that of in-person visits [16]. This 1 year prospective observational study saw minimal differences in the levels of post-operative pain between the two groups; in the in-person group, 68% had mild pain and 32% had moderate pain while in the telemedicine group, 64% had mild pain and 36% had moderate pain [16].

Similar efficacy of telemedicine was observed in ACL reconstruction surgery as well, with 75% of patients who employed a telephone-call-based cognitive-based physical therapy exceeding the threshold for minimal clinically important difference on the pain catastrophizing scale [17]. Moreover, this study shows that telemedicine can allow for enhanced finetuning of post-operative pain management to make it more optimal for the patient, and also instill greater confidence in patients, which could translate to higher compliance in post-operative regimens, as well.

The far-ranging impacts of telemedicine were also seen in a RCT that utilized a mobile phone messaging robot to deliver post-operative, acceptance and commitment therapy care to patients who had recently had operative fixation of a traumatic upper or lower extremity fracture [18]. With respect to post-operative pain, researchers found that patients in the phone messaging intervention group had lower post-operative pain intensity scores compared to control group patients who did not utilize the phone messaging robot ($p = 0.04$) [18]. Interestingly, it was also found that the intervention group patients used 36.5% fewer opioid tablets than the control group ($p = 0.004$) [18]. Overall, this study shows how telemedicine can be instrumental in helping reduce post-operative opioid utilization.

3. Urology/Gynecology Surgery

The benefits of telemedicine with regards to post-operative pain control and symptomatic management can be seen in urogynecology surgeries as well. A study by Iwanoff, *et al.* used physician-initiated post-operative phone calls 48 - 72 hours to patients as a medium of telemedicine [19]. They found that not only did the physician-initiated post-operative phone calls result in fewer calls by the patient complaining of pain, but that there were statistically significant decreases in complaints of constipation, incomplete bladder emptying, and vaginal bleed-

ing [19]. Thus, this study shows how physician-initiated telephone calls after discharge were able to lead to greater improvements in post-operative pain and complications by allowing for the identification of complications and proper adjustments in pain and symptomatic management earlier than in-person office visits could [19].

Another study also sought to see if telemedicine through telephone calls at 2 weeks, 6 weeks, and 12 weeks after pelvic surgery could manage post-operative pain as effectively as in-person visits could [20]. The researchers found that there were no differences between the telemedicine or control group with respect to Pelvic Floor Distress Inventory-20 scores, pain scores at rest, with normal activity, with strenuous activity, and worst pain that day [20]. Overall, clinicians and patients were able to utilize telephone calls to work together to appropriately adjust post-op treatment plans to mitigate their pain just as successfully as they were able to in person.

The investigation of utility of telemedicine in gynecological surgeries has been explored with the use of a novel eHealth program, as well. In a randomized multicenter trial that examined 215 women who had a hysterectomy and/or laparoscopic adnexal surgery, the researchers utilized a carefully curated online health program that had instructions on post-operative exercises, provided motivational videos, and helped identify any recovery problems [21]. They saw that after 26 weeks, the pain intensity was lower ($p = 0.035$) in the intervention group than compared in the control group [21]. This study clearly demonstrates how telemedicine can be an effective tool to boost patients' confidence in themselves and can in turn increase compliance with post-operative therapies that are essential to reducing post-operative pain [21].

Telemedicine has also shown to have benefits for urologic surgeries in the pediatric population as well. While it is still an area that requires research, in comparing the usage of post-operative video chats with a urologist with 107 virtual visits with children (mean age of 5.3) to 100 in-person visits children (mean age of 6.4), the researchers saw that video was an adequate medium to manage post-operative pain and wound evaluation [22].

4. Telemedicine and General Non-Elective Surgeries

In an RCT that studied 903 patients over the age of 40, the benefits of telemedicine in post-operative pain for non-elective surgeries were also demonstrated [23]. Researchers found that through a telemedicine intervention that utilized a program that measured vital signs in patients daily, had patients complete a daily recovery survey, and enabled patients to send daily pictures of any wounds to nurses and chat with them virtually, patients had decreased pain compared to control group patients [23]. In particular, patients who used telemedicine had 13.9%, 11.9%, and 9.6% less pain than their control group counterparts at 7, 15, and 30 days, respectively [23]. The advantages of telemedicine to treat post-op pain in this study are far-ranging, from earlier identification of post-op pain

medication failure and more optimal adjustment of such pain management medications, to improving patient compliance to post-op pain management therapies.

5. Oncology Surgeries

Cancer surgeries also represent an increasing sector of research from a telemedicine perspective. In a randomized control trial that examined 79 patients who received thoracotomy for lung cancer or lung metastasis, investigators aimed to see if email communication between patient and physician in conjunction with automated telephone calls could result in a greater reduction in post-operative pain when compared to automated telephone calls alone [24]. They found the intervention group to have not only a statistically significant ($p = 0.02$) greater average reduction in post-operative symptoms such as pain, disturbed sleep, distress, shortness of breath, or constipation, but also saw that the intervention group had a quicker decrease in these symptoms, as well [24]. The effects of the combination of telephone and email not only allowed faster changes in patients' pain medication prescriptions, but also allowed a more accessible opportunity for patient education or counseling on how to manage their pain, as well.

Lafaro *et al.* found how in GI and lung cancer surgeries, video-based, virtual PT/OT sessions both before surgery and up to 2 weeks post-discharge could positively impact post-operative pain and symptomatic management, as they saw medians for post-op 6-minute walk test, timed up and go, and short physical performance battery test scores all increase from baseline to post-op [25]. The researchers further believe that these telemedicine-guided improvements could lead to faster resolution of symptoms and return to baseline function, ultimately engendering shorter lengths of stay and lesser hospital readmissions [25].

6. Discussion

There is a multitude of types of telemedicine, such as email, telephone calls, text messages, video chats, and even curated online programs/applications. While each is vastly different, each form of telemedicine has been utilized in unique studies involving different types of surgeries. Through the variety of studies found analyzed in this paper, it can be seen that each of the aforementioned forms of telemedicine is effective in delivering healthcare.

Email as a form of telemedicine, particularly in conjunction with other types of telemedicine such as phone calls, proved to be highly beneficial in an RCT with 100 patients; Cleeland found it helped reduce both the level and duration of post-operative pain and other symptoms ($p = 0.02$) [24].

Telephone calls are also a robust form of telemedicine, with utility in orthopedic and urology/gynecology surgeries. In their pilot study, Coronado *et al.* found that phone calls could be an effective way to deliver cognitive-based physical therapy, helping boost patient confidence and allowing for patient-tailored post-operative management [17]. In urology/gynecology procedures, in their

Table 1. Articles included in the literature review.

Author (Year)	Country	Type of Study	Number of Participants	Type of Surgery Investigated	Type of Telemedicine Intervention Utilized	Statistical Significance
Timmers (2019)	Netherlands	RCT	213	Orthopedic	Curated app	p = 0.001 (rest), p < 0.001 (during activity), p = 0.003 (at night)
Eichler (2019)	Germany	RCT	111	Orthopedic	Text messaging, video chat	p = 0.001
Russell (2011)	Australia	RCT	65	Orthopedic	Video chat	p ≤ 0.01
Piqueras (2013)	Spain	RCT	142	Orthopedic	Video chat	p = 0.284
Moffet (2015)	Canada	RCT	205	Orthopedic	Video chat	Control: 82.8 ± 1.4 Exp: 84.0 ± 1.4
Herrero (2021)	USA	RCT	150	Orthopedic	Video chat	p = 0.668
Kane (2020)	USA	RCT	58	Orthopedic	Video chat	p = 0.638 (2 wks post-op), p = 0.124 (6 wks post-op), p = 0.951 (12 wks post-op)
Sandhu (2021)	India	Prospective observational	50	Orthopedic	Phone call	N/A*
Coronado (2020)	USA	RCT	8	Orthopedic	Phone call	N/A*
Anthony (2018)	USA	Multicenter study	82	Orthopedic	Text messaging	p = 0.04 (pain), p = 0.004 (# opioid tablets)
Iwanoff (2018)	USA	Controlled clinical trial	459	Urology/Gynecology	Phone call	p = 0.13 (pain), p = 0.04 (# of calls)
Thompson (2019)	USA	RCT	100	Urology/Gynecology	Phone call	p = 0.30 (rest), p = 0.47 (normal activity), p = 0.30 (exercise), p = 0.47 (worst pain today)
Vonk Noordegraaf (2014)	Netherlands	RCT	215	Urology/Gynecology	Curated program	p = 0.035
Finkelstein (2020)	USA	Prospective cohort	N/A*	Urology/Gynecology	Video chat	p = 0.11
McGillion (2021)	Canada	RCT	905	General, Non-Elective	Video chat	p < 0.001 (7 days), p < 0.001 (15 days), p < 0.008 (30 days)
Cleeland (2011)	USA	RCT	100	Oncology	Email	p = 0.02
Lafaro (2020)	USA	Pilot study	34	Oncology	Video chat	p = 0.001 (GI cancer); p = 0.01 (lung cancer)

*Means that information was unavailable.

RCT of 100 patients, Thompson, *et al.* saw that telephone calls were just as effective as in-person visits, while Iwanoff *et al.*'s controlled clinical trial with 459 patients demonstrated telephone calls reduced complaints of post-operative pain and other symptoms [19] [20].

Text messaging was shown to be effective, particularly in orthopedic surgery, regardless of who was sending the text messages. In Eichler *et al.*'s randomized control trial study with 111 patients, which incorporated text messaging as one of their telemedicine interventions, they saw a significant improvement in the patient's post-operative exercise test ($p < 0.001$) [10]. In another study that used robot-generated text messaging, patients not only had less post-operative pain ($p = 0.04$), but also a lower usage of post-operative pain medication ($p = 0.004$) [18].

Video chatting was the most robust form of telemedicine, with benefits in orthopedic, urology/gynecology, and oncology surgery. In orthopedic surgery, studies that looked at total knee replacements and rotator cuff surgeries found that patients had decreased post-operative pain levels compared to patients who followed up in person. In a pediatric urology study, video chatting was shown to be just as effective as in-person visits in managing post-operative pain [22]. Finally, in their pilot study of 34 GI and lung cancer patient and caregiver dyads, Lafaro *et al.* illustrated how PT/OT sessions conducted over video chat led to improvements in post-op exercise test scores, such as the short physical performance battery test ($p = 0.001$ for GI cancer, $p = 0.01$ for lung cancer) [25].

There were a few instances where physicians utilized specifically-curated online apps to deliver health information to patients. Timmers *et al.*, in an RCT with 213 patients, created a tailored program used for patients who underwent total knee replacement and found patients who used the app had significantly decreased levels of post-operative pain at rest and with activity ($p = 0.001$, $p < 0.001$) [9]. The utility of such focused applications has been investigated in gynecological surgeries as well, with Vonk Noordegraaf *et al.*, through an RCT with 215 patients, using an innovative eHealth program that resulted in patients having decreased post-op pain intensity scores after hysterectomy and/or laparoscopic adnexal surgeries ($p = 0.035$) [21].

As demonstrated by the table and the aforementioned analysis, the studies in this review support the use of telemedicine to manage post-operative pain (**Table 1**).

7. Conclusions

In summary, as telemedicine continues to grow and intersect different fields of medicine, literature has shown that it can be an effective means for managing postoperative pain. Thus far, the majority of research on telemedicine and post-operative pain management has been done in orthopedic surgery, specifically in total knee replacements and meniscus tear repairs. However, there has been an increase in research on the topic in other medical fields as well, such as urology

and cancer surgery. To further understand the potential and effects of telemedicine on postoperative pain management, it will be imperative to study its usage in other types of surgeries, as well.

The specific impacts that telemedicine can have on postoperative pain management are multifaceted and far-reaching. Studies have shown its ability to increase patients' confidence in themselves and their postoperative regimens, thus increasing their compliance to such protocols. Other research has demonstrated how the ease and accessibility of telemedicine can lead to a decrease in postoperative pain medication usage or modifications to better optimize and individually tailor postoperative treatment plans.

In conclusion, the rise of telemedicine in healthcare is one that has a profound impact on both healthcare workers and patients. It represents an exciting area of scientific investigation and while the potential of telemedicine continues to be researched, current literature has underscored that it can be effectively relied upon to help manage postoperative pain across a variety of surgical disciplines.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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