



Telemedicine-based new patient consultations for hernia repair and advanced abdominal wall reconstruction

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Abstract

Purpose Telemedicine has emerged as a viable option to in-person visits for the evaluation and management of surgical patients. Increased integration of telemedicine has allowed for greater access to care for specific patient populations but relative outcomes are unstudied. Given these limitations, we sought to evaluate the efficacy of telemedicine-based new patient preoperative encounters in comparison to in-person encounters.

Methods We performed a retrospective analysis of adult patients undergoing new patient evaluations from April 2020 to October 2021. Telemedicine visits consist of both video and telephone-based encounters. Visit types, patient demographics, preoperative diagnosis, travel time to the hospital, and prior imaging availability were reviewed.

Results A total of 276 new patient encounters were conducted ($n = 108$, 39% telemedicine). Indications for evaluation included inguinal hernia ($n = 81$, 30%), ventral hernia ($n = 149$, 54%) and groin or abdominal pain ($n = 30$, 11%). Patients undergoing telehealth evaluations were more likely to have greater travel distance to the hospital (91 km vs 29 km, $p = 0.002$) and have CT image-confirmed diagnoses at the initial visit (73 vs 47%, $p < 0.001$). Patients who were evaluated for a recurrent or incisional hernia were more likely to be seen through a telemedicine encounter (69 vs 45%, $p < 0.001$).

Conclusions We report the efficacy of telemedicine-based consultations for new patient preoperative evaluations related to hernia repair and abdominal wall reconstruction. Telemedicine is a useful modality for preoperative evaluation of new patients with hernia and advanced abdominal wall reconstruction needs. Understanding this patient population will allow us to optimize telemedicine encounters for new patients and improve access to care for patients in remote locations.

Keywords Telemedicine · Virtual care · Abdominal wall reconstruction · Downstream care utilization

Introduction

Telemedicine utilization has grown significantly over the past decade with an accelerated growth phase during the COVID-19 pandemic, allowing patients more options for effective evaluation [1–3]. Advocates of telemedicine highlight its efficiency in evaluation and the ability to improve access to care, expanding provider reach beyond traditional geographic barriers [4]. Prior to the COVID-19 pandemic, telemedicine integration was largely focused on

straightforward and predictable patient encounters such as the immediate postoperative period and long-term surveillance evaluations [5, 6]. The regulatory changes brought about by the pandemic have led to more providers expanding telemedicine use to the preoperative setting, including initial consultations.

Telemedicine enhances opportunities for patients in rural settings, those with limited ability to travel, or difficulty with scheduling to seek specialty-level care [1, 4, 5]. However, the adoption of telemedicine as a direct alternative to in-person preoperative assessment has been questioned by recent studies demonstrating increased care utilization (e.g., additional short term follow up encounters, additional testing) associated with telemedicine-based care [7]. For surgeons in particular, the inability to perform a physical exam has discouraged many from utilizing telemedicine for initial consultation. In a recent survey among members of the Abdominal Core Health Quality Collaborative (ACHQC), surgeons

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identified these issues as perceived barriers to telemedicine expansion in the future [8].

To date, there is no data comparing outcomes of telemedicine-based evaluations to traditional in-person evaluations for initial general surgical consultations. Our abdominal wall reconstruction and hernia repair program serves as a large catchment in the Western United States and has been interested in evaluating telemedicine-based care to minimize the burden of travel and expenses faced by our patient population seeking care. As such, we evaluated new patient preoperative telemedicine-based and in-person encounters to understand the efficacy and downstream care utilization for patients presenting with advanced abdominal wall reconstruction and hernia repair needs.

Methods

Hernia repair and abdominal wall reconstruction program

Our hernia and abdominal wall reconstruction program is a major referral center for patients in the Pacific Northwest. All patient encounters were performed by board-certified surgeons with abdominal wall reconstruction and minimally invasive surgery fellowship training. Given the regulatory changes as a result of the COVID-19 pandemic, all eligible patient encounters beginning in March 2020 were offered the choice of a telemedicine-based or in-person visit. Telemedicine-based visits were completed through either audio-only (telephone) or video-based modalities. Visits were conducted through the electronic health record's secure virtual visit platform via video-capable mobile phone, tablet, or computer. (Epic, Verona, WI).

Patient selection and data accumulation

Patient eligibility for telemedicine-based care was determined by surgeons prior to visit scheduling and coordination. Our program has defined inclusion and exclusion

criteria that have been developed from person experiences as well as results from a recent national survey assessing hernia surgeon utilization of telemedicine services. (Table 1) [5, 8] Based on these criteria, patients are offered telemedicine-based or traditional in-person care. For patients selecting telemedicine, they may use either video-based or audio-only modalities, based on patient preference. New patient encounters of patients evaluated using telehealth strategies (audio-only or video-based) between April 2020 and October 2021, and in-person evaluation between February 2021 and October 2021, were included in this study. All new patient preoperative encounters were performed by fellowship-trained abdominal wall reconstruction surgeons (SBO, VCN).

Comprehensive data for telehealth and in-person encounters were captured prospectively in a secure database. Comprehensive data abstraction is completed by a group of trained reviewers utilizing structured templates. All patient encounters are abstracted to avoid selection bias and accurately represent our patient population. Patient encounters included in this study were classified as new patients, consisting of patients never previously evaluated at our hernia center.

Demographic data were collected to include age, race, gender, marital status, and origination state and ZIP code. Hernia recurrence risk factors and other medical factors including American Society of Anesthesiologists (ASA) status, smoking status, diabetes status, and body mass index (BMI). Chart review included hernia characteristics, performance of virtual physical exam during telemedicine encounters, prior hernia surgical history, and any current diagnostic studies available at the time of the encounter. To assess the efficacy and compare telehealth and in-person evaluations, we reviewed the end of encounter plan for each patient. Downstream care utilization was classified into the following endpoints: (1) supplemental in-person evaluation, (2) further diagnostic testing, (3) medical optimization, (4) non-operative intervention, and (5) operative intervention.

We collected data for telehealth and in-person encounters separately and used raw totals to compare percentages between groups. Travel distances and times to the hospital

Table 1 Relative inclusion and exclusion criteria for preoperative telehealth encounters

Relative inclusion criteria	Relative exclusion criteria
Primary, incisional, and recurrent ventral hernias in patients with cross sectional imaging	Groin pain associated with the following concerns: Chronic postoperative inguinal pain
Primary inguinal hernias with confirmatory cross-sectional or ultrasound studies	Athletic pubalgia Chronic mesh infection
Evaluation of patients requiring concurrent operations with other specialists (e.g., surgical oncology)	Multiply recurrent hernia with prior anterior and posterior repair
First-time recurrent inguinal hernia with imaging confirmation and prior operative reports	Ventral hernias associated with following concerns: Chronic wound infections Enterocutaneous fistula Diastasis recti Lack of diagnostic imaging

were determined using Google Maps and identifying the shortest distance from the patient's home ZIP code to the hospital address. Rural designation was made using the United States Health Resources and Services Administration classifications of rurality based on ZIP code [9]. Statistical significance of data was determined using Student's *t*-testing, Chi-square, and Fisher's exact testing, as appropriate. Statistical significance was set at $p < 0.05$ and all tests were two-sided. All analyses were performed in SPSS version 27 (IBM Corp, Armonk, NY).

Institutional review board

This study was approved by our institutional review board (Oregon Health and Science University; Portland, OR). The retrospective nature and minimal risk classification of this study did not necessitate patient consent.

Results

Patient characteristics

A total of 276 new patient encounters were conducted during the study period. Of all new patient encounters, 39% ($n = 108$) were telemedicine evaluations. For telemedicine evaluations, 52% ($n = 56$) were classified as video-based, with remaining encounters conducted with an audio-only approach. In-person evaluation was associated with patients who were male (67.9 vs 53.7%, $p < 0.05$), Hispanic (13.1 vs. 3.7%, $p < 0.05$), and originated from the state of Oregon (89.3 vs. 82.4%, $p < 0.001$). Visits performed through telemedicine modalities were more likely to be with patients who had an ASA > 2 (59.3 vs 41.1%, $p < 0.01$), live in a rural designated area (32.4 vs. 17.3%, $p < 0.01$), and have a longer commuting distance to the clinic (91.2 vs 28.8 km commute, $p < 0.01$). Both in-person and telemedicine modalities saw patients of similar age, employment status, and need

Table 2 Patient specific factors

Characteristics	In-person ($n = 168$) <i>N</i> (%)	Telemedicine ($n = 108$) <i>N</i> (%)	All ($n = 276$) <i>N</i> (%)	<i>P</i> -value
Age, years; median [IQR]	56 [44–66]	62 [48–68]	58 [47–67]	0.18
Male	114 (67.9)	58 (53.7)	172 (62.3)	0.02
Race/ethnicity				
White Non-Hispanic	141 (83.9)	101 (93.5)	242 (87.7)	0.03
Hispanic	22 (13.1)	4 (3.7)	26 (9.4)	
Other	5 (3.0)	3 (2.8)	8 (2.9)	
Married/domestic partner	89 (53.0)	49 (45.4)	138 (50.0)	0.27
Employment status				0.82
Unemployed/retired	97 (57.7)	64 (59.3)	161 (58.3)	
Self employed	13 (7.7)	10 (9.3)	23 (8.3)	
Employed	58 (34.5)	34 (31.5)	92 (33.3)	
Additional requirements				0.09
Disabled	4 (2.4)	0 (0)	4 (1.4)	
Interpreter	9 (5.4)	2 (1.9)	11 (4.0)	
None	155 (92.3)	106 (98.1)	261 (94.6)	
ASA > 2	69 (41.1)	64 (59.3)	133 (48.2)	0.004
Insurance				0.09
Medicaid	50 (29.8)	21 (19.4)	71 (25.7)	
Medicare	47 (28.0)	44 (40.7)	91 (33.0)	
None	9 (5.4)	4 (3.7)	13 (4.7)	
Private	62 (36.9)	39 (36.1)	101 (36.6)	
Rural designation	29 (17.3)	35 (32.4)	64 (23.2)	0.005
Origination state	17.3	32.4%	23.2	
Oregon	150 (89.3)	89 (82.4)	239 (86.6)	< 0.001
Washington	18 (10.7)	10 (9.3)	28 (10.1)	
Other	0 (0)	9 (8.3)	9 (3.3)	

ASA American society of anesthesiologists, *IQR* interquartile range

for additional assistance (language interpreter or disability). (Table 2).

Rates of hernia recurrence risk-factors among both in-person and telemedicine groups were similar, including smoking status, diabetes status, and those with a BMI > 35. Patients seen in-person were significantly more likely to present without imaging available at the time of their visit (33.3 vs 10.2%, $p < 0.001$), while those seen through telemedicine were more likely to present with a current CT scan (73.1 vs 47%, $p < 0.001$). (Table 3).

Reason for consultation was similar among both in-person and telemedicine encounters. The majority of encounters consisted of evaluation for ventral hernias (54%), with the

remainder for inguinal hernia, groin and abdominal pain, and flank or parastomal hernias. Recurrent or incisional hernias were more commonly seen among patients seen through telemedicine modalities (68.5 vs 45.2%, $p < 0.001$). (Table 3).

Downstream care utilization

Patients seen in-person demonstrated significantly higher rate of operative plans coordinated at the time of encounter (57.1 vs 42.6%, $p = 0.02$). Medical optimization and referral for a supplemental physical exam were more common among telemedicine encounters. (Fig. 1) Operative plans established at the end of the encounter included minimally

Table 3 Encounter-specific outcomes

Characteristics	In-person ($n = 168$) N (%)	Telemedicine ($n = 108$) N (%)	All ($n = 276$) N (%)	P -Value
Hernia recurrence risk factors				
Smoking status	26 (15.5)	12 (11.1)	38 (13.8)	0.37
Diabetes (HbA1c > 6.5%)	28 (16.7)	17 (15.7)	45 (16.3)	0.87
BMI (BMI > 35)	44 (26.2)	32 (29.6)	76 (27.5)	0.58
Imaging available at time of evaluation				
CT	79 (47.0)	79 (73.1)	158 (57.2)	<0.001
US	37 (22.0)	20 (18.5)	57 (20.7)	0.54
MRI	5 (3.0)	8 (7.4)	13 (4.7)	0.14
No imaging available	56 (33.3)	11 (10.2)	67 (24.3)	<0.001
Reason for consultation				
Inguinal hernia	54 (32.1)	27 (25.0)	81 (29.3)	
Ventral Hernia	87 (51.8)	62 (57.4)	149 (54.0)	
Flank/parastomal hernia	6 (3.6)	10 (9.3)	16 (5.8)	
Groin/abdominal pain	21 (12.5)	9 (8.3)	30 (10.9)	
Hernia etiology				
No hernia	21 (12.5)	9 (8.3)	30 (10.9)	<0.001
Primary	71 (42.3)	25 (23.1)	96 (34.8)	
Recurrent/Incisional	76 (45.2)	74 (68.5)	150 (54.3)	
Operative Plans^a				
Mesh explant ventral	3 (3.1)	4 (8.7)	7 (4.9)	0.32
Open AWR	17 (17.7)	15 (32.6)	32 (22.5)	
Open IHR	4 (4.2)	2 (4.3)	6 (4.2)	
Open PHR	3 (3.1)	1 (2.2)	4 (2.8)	
Open VHR	7 (7.3)	4 (8.7)	11 (7.7)	
Other	2 (2.1)	0 (0)	2 (1.4)	
MIS IHR	43 (44.8)	14 (30.4)	57 (40.1)	
MIS AWR/VHR	17 (17.7)	6 (13.0)	23 (16.2)	
Median distance of commute for in-person evaluation (kilometers); median [IQR]	28.8 [14.0–83.9]	91.2 [17.8–193.6]	34.1 [14.6–135.8]	0.002
Median duration of round-trip commute for in-person evaluation (minutes); median [IQR]	31 [22–65]	65 [20–165]	37 [21–101]	0.02

HbA1c hemoglobin A1c, *BMI* body mass index, *CT* computed tomography, *US* ultrasound, *MRI* magnetic resonance imaging, *AWR* abdominal wall reconstruction, *PHR* parastomal hernia repair, *VHR* ventral hernia repair, *IHR* inguinal hernia repair, *MIS* minimally invasive surgery

^aIn $N = 142$ patients with surgical plan established at first encounter

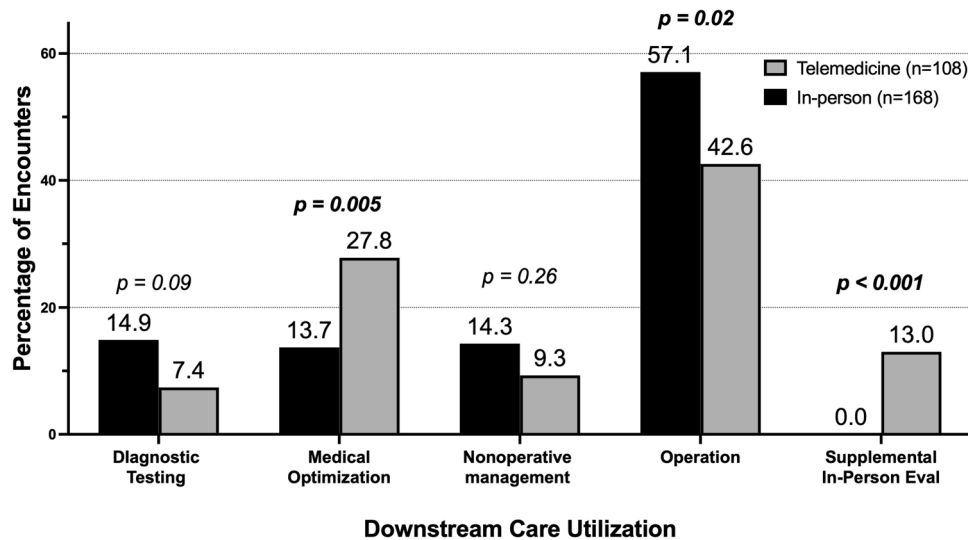


Fig. 1 Downstream care utilization among different modalities of care. In-person evaluations (solid black) were associated with higher rates of diagnostic testing ordered and finalized operative plans recommended relative to telemedicine-based evaluations (gray). Telemedicine-based encounters were associated with higher rates of rec-

ommendations for medical optimization. Operative recommendations were finalized for 57.1 and 42.6% in-person and telemedicine-based encounters, respectively. 87% of telemedicine-based encounters had plans finalized with no further needs for supplemental in-person evaluation

invasive inguinal hernia repair (40.1%), open abdominal wall reconstruction (22.5%), and minimally invasive ventral hernia repair (16.2%)—with comparable rates among both in-person and telemedicine groups (Table 3). All medical optimization recommendations were in patients presenting with ventral, parastomal, or flank hernias.

Discussion

In the first study to compare preoperative telemedicine-based and in-person consultation outcomes for patients seeking hernia repair and abdominal wall reconstruction, we demonstrate that telemedicine is an effective modality for improving access to care. We found that despite telemedicine being utilized in patients with more severe comorbidities, rural residency, and more complex hernia pathology, downstream care utilization was appropriate, with a small subset of patients requiring supplemental in-person examinations. Patients utilizing telehealth consultations derived significant benefits related to reduced commutes and time spent traveling to a tertiary medical center.

Proponents of telehealth have long highlighted its potential to address disparities that exist for patients attempting to access advanced medical care [10–14]. These disparities in access to care are magnified for patients seeking minimally invasive and contemporary approaches to hernia care [15]. We are encouraged to find that those utilizing telemedicine services in our patient population had a higher proportion of rural designations and saved many hours in commutes

to our medical center. Overall, patients evaluated through telemedicine-based modalities saved nearly 3 times as much in commuting distances compared to the in-person group for round trips to and from our medical center. For those utilizing telemedicine, advanced operative plans (e.g., minimally invasive approaches to inguinal and ventral hernia or abdominal wall reconstruction) were established in three-fourths of patients. Beyond the initial encounters that were analyzed in this study, our program provides digital health solutions for all phases of patient care. Thus, we believe that engaging with patients via telemedicine may translate to even more potential downstream benefits—essentially only mandating travel to our medical center for their operative encounter.

The expansion of telemedicine evaluations in this cohort was a direct consequence of reduction in traditional barriers that have inhibited the expansion of telemedicine strategies, especially for patients seeking initial surgical consultations [16–18]. Clearly, this initial iteration of telemedicine in the preoperative setting will require thorough investigation for further optimization. Downstream care utilization has been highlighted by groups who have demonstrated that initial applications of telemedicine favor the modality more as a supplement, rather than substitute, for in-person care [7]. We found that 87% of patients evaluated in the telemedicine setting required no supplemental in-person evaluations to establish a durable care plan. These patients had plans coordinated including medical optimization, non-operative management, further diagnostic testing, and operative planning. It is safe to say that these particular encounter plans would be comparable to the plans that would be formulated

for patients presenting to an in-person clinic. Though 13% of patients required supplemental in-person evaluation, we consider this an opportunity for improved access to care—with subsequent encounters more focused on a specific issue that could not easily be addressed during the telemedicine consultations. During the subsequent in-person encounters, we found that we were able to build further patient rapport, clarify patient questions, and confirm a plan which required a physical examination—usually in a much more condensed in-person clinic appointment because much of the preliminary work up had been performed via the initial telemedicine encounter. In spite of this success and the relatively low burden of supplemental in-person evaluations, it will be important to further analyze the factors associated with this outcome to improve the telemedicine workflow [19]. We believe that these metrics related to downstream care utilization will provide many opportunities of iterative improvement of our current relative inclusion- and exclusion-criteria for telemedicine encounters (Table 1).

The high-rate of audio-only encounters performed for the telehealth cohort (48%) demonstrates viability of this modality in evaluating new surgical patients. Use of audio-only encounters has increased secondary to an internal review demonstrating that video based physical exam did not impact the decision making in our patients. Further, we found that connectivity and patient engagement with video-enabled devices was relatively low. These findings are consistent with concerns that were raised in a recently conducted survey of hernia surgeons in the Abdominal Core Health Quality Collaborative, who cited connectivity and engagement as perceived barriers to future telehealth expansion [8]. The decision to provide audio-only evaluations was further bolstered by a large volume of data related to the predictive nature of cross-sectional imaging for abdominal wall reconstruction [20–22]. In particular, recent work by Elhage et al. have demonstrated that findings on cross-sectional imaging are predictive of need for advanced reconstruction techniques (e.g., myofascial advancement flaps), as well as postoperative outcomes related to surgical site infections [23]. As such, we have broadened our options for preoperative telemedicine evaluations to include audio-only options for patients presenting for ventral or inguinal hernia repair consultations that imaging-based confirmation available for review at the time of consultation. We believe that our ability to provide advanced reconstruction with component separation techniques through imaging review, is a function of the lower wound morbidity associated with posterior component separation [24]. Patients are often classified as needing a retromuscular repair, rather than a definitive component separation. Intraoperative decision making and compliance of the abdominal wall then dictates if the retromuscular repair will require extension from a

retro-rectus dissection to a posterior component separation with transversus abdominis release. The information from imaging and review of the patient medical record enable our team to risk stratify patients with validated instruments developed specifically for hernia repair and abdominal wall reconstruction. Applications such as the Carolinas Equation for Determining Associated Risks (CeDAR) and the Quality of Life (CeQOL) are regularly utilized by our surgeons to guide preoperative discussions with patients undergoing higher-risk abdominal wall reconstruction operations [25, 26]. To ensure that patients that are evaluated via telemedicine-based modalities are appropriately risk-stratified for other elements of perioperative risk, we have developed care pathways with our Department of Anesthesia and Perioperative Medicine to ensure all patients have an assessment with our anesthesia team who are familiar with our team's operative techniques and the physiologic impact these operations may have on patients. Through this multi-faceted and multi-disciplinary approach, we have been very pleased with the outcomes for our telemedicine patient population.

Our study is not without limitations. As the first study to review new patient preoperative telemedicine-based evaluations among hernia repair and abdominal wall reconstruction patients, this study focused exclusively on the decision making associated with a given clinical encounter. Long-term follow-up will be necessary to determine if the preoperative decisions rendered were associated with differences in outcome relative to more traditional in-person encounters for similar case-types. Further, our study exclusively evaluated hernia-related diagnoses which are amenable to radiographic confirmation. Given our selection criteria, a large number of patients with no imaging available at the time of referral to our program were excluded from a telemedicine consultation, resulting in a higher proportion of patients presenting to our in-person clinic with primary hernias or a lack of imaging. Similarly, patients with more advanced hernias with imaging obtained in advance of referral were eligible for telemedicine encounters—resulting in a higher rate of medical optimization and lower rates of recommendations for operative intervention. It remains to be seen if telemedicine may be expanded to more readily include patients lacking imaging and the impact this strategy may have on downstream care utilization. Finally, our study has limited data related to the overall patient experience. Though surrogate markers for efficacy (e.g., time saved from commute) were included in this study, patient reported experiences will need to be more accurately assessed to determine the impact telemedicine encounters have on overall satisfaction. In this context, we believe that future work should actively assess patient experiences related to perceptions of physician bedside—and “websites”—manner. As the field of surgery evolves to have potentially more telemedicine-based

care, establishing best practices and enhancing our ability to truly connect with patients will likely improve the outcomes associated with the use of telemedicine-based services [27].

In conclusion, we report our findings of the first study to evaluate preoperative telemedicine-based consultations for patients seeking hernia repair and abdominal wall reconstruction. We demonstrate that telemedicine-based encounters are effective approaches to increasing access to care for rural populations presenting with advanced abdominal core health needs. Moreover, telemedicine-based consultations were associated with appropriate encounter-related plans, with a relatively low impact to downstream care utilization related to supplemental in-person evaluations. We encourage surgeons to consider telemedicine-based evaluations to address disparities and geographic barriers to patients requiring advanced hernia repair and abdominal wall reconstruction.

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Data availability The authors agree to sharing of requested data for purposes of transparency.

Code availability Not applicable.

Declarations

Conflict of interest Authors of this manuscript have each reviewed their conflict of interest/disclosure and funding/support relationships and deny any competing interests that potentially or inappropriately influence their work or conclusions in this manuscript.

Ethical approval, Human and animal rights and Informed consent This study was approved by the Oregon Health & Science University Institutional Review Board.

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