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Effectiveness of telemedicine in a mitral valve center of excellence

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Abstract

Background: The COVID-19 pandemic necessitated a drastic increase in the use of telemedicine. There is little information about the effectiveness of telemedicine in cardiac surgery. We examined clinical outcomes and patient satisfaction among patients who had in-person versus telemedicine preoperative appointments in a subspecialized mitral valve surgical practice.

Methods: We retrospectively reviewed all patients who had elective mitral valve operations between January 2019 and February 2021. Patients were categorized into 2 groups based on the format of the preoperative appointment (telemedicine or in-person). Preoperative characteristics and clinical outcomes were compared between the two groups. All patients who had a telemedicine appointment were sent an online survey to assess their satisfaction with the process.

Results: Among 286 patients analyzed, 197 (69%) had in-person preoperative evaluations and 89 (31%) had telemedicine evaluations. The in-person and telemedicine groups had similar preoperative and operative characteristics. Outcomes did not differ between the 2 groups, including ventilation time (3.7 vs. 4.1 h, $p = .399$), total length of stay (5 vs. 5 days, $p = .949$), 30-day mortality (0% vs. 1%, $p = .311$), and readmissions within 30 days (13% vs. 8%, $p = .197$). Among patients who completed the survey, 91% were "satisfied" or "very satisfied" with the telemedicine preoperative appointment.

Conclusion: Patients who had telemedicine preoperative appointments before mitral valve operations during the COVID-19 pandemic had similarly excellent clinical outcomes to patients who had in-person preoperative appointments before the pandemic. Patients had relatively high levels of satisfaction with telemedicine and almost half preferred telemedicine for future visits.

KEYWORDS

valve repair/replacement

1 | INTRODUCTION

The use of telemedicine is not a novel concept in healthcare delivery. In the past several decades, advancements in technology have facilitated online care. Between 2010 and 2017, the percentage of US hospitals that used video or other telehealth technology had increased from 35% to 76%.[1] However, the use of telemedicine was not widely adopted due to regulatory restrictions and lack of reimbursement.[2] Starting in late 2019, coronavirus disease-2019 (COVID-19) spread across the world and completely transformed inpatient and outpatient healthcare practices. The US Center for Medicare and Medicaid Services (CMS) widely expanded the previously limited coverage for telemedicine visits, and the Centers for Disease Control and Prevention informed providers to consider alternatives to "face-to-face visits," encouraging telemedicine as a suitable option.[3,4] In the span of a few weeks, telemedicine became widely more accessible across many medical and surgical specialties.

The primary objective of this study was to compare the outcomes of patients undergoing elective mitral valve surgery evaluated in-person before the COVID-19 pandemic with those who only had a telemedicine evaluation and underwent operation during the pandemic. Another goal was to assess patient satisfaction through an online survey.

2 | MATERIALS AND METHODS

2.1 | Patient selection and data collection

This study was performed at a single institution, the University of Maryland Medical Center (UMMC). This study received Institutional Review Board approval (protocol HP-00076929). We identified patients who had elective mitral valve operations performed by a single surgeon between January 2019 and February 2021. Nearly all operations were conducted with active resident involvement. Operative techniques have been previously reported.[5] We collected demographic information, medical history, preoperative characteristics, and surgical outcomes from our institutional Society of Thoracic Surgeons Adult Cardiac Surgery Database. All preoperative and postoperative visits were performed in-person through March 12, 2020. Thereafter all preoperative and postoperative visits were performed using telemedicine. Patients whose initial preoperative evaluation appointment was conducted with a telemedicine approach (FaceTime (Apple, Inc.), Zoom (Zoom Video Communications, Inc.), or telephone call were categorized into the telemedicine group ($n = 89$). Patients were categorized into the in-person group ($n = 197$) if their initial preoperative visit was conducted in-person, even if surgery occurred during the pandemic ($n = 18$) or if their postoperative visit was conducted via telemedicine ($n = 34$). The initial preoperative telemedicine appointment was defined as the first visit with the attending cardiac surgeon and nurse practitioner. For patients in the telemedicine group, data were collected on what relevant imaging studies (transthoracic echocardiogram, transesophageal echocardiogram, computed tomography, cardiac catheterization) and vitals (height, weight, blood pressure, heart rate) were available for review by the heart valve team. All patients underwent COVID-19 testing within a 96-h window before operation. All patients were evaluated in person by the attending cardiac anesthesiologist on the day of operation, but were not seen by the attending cardiac surgeon. Patients were scheduled to have a postoperative visit approximately 1 month after surgery.

2.2 | Statistical analysis

All analyses were conducted using SPSS Statistics, Version 27 (IBM Corp.) and a p value <.05 was considered statistically significant. Kolmogorov-Smirnov tests were used to examine the normality of continuous variables, which are reported as median (interquartile range [IQR]), given that all were not normally distributed. Categorical variables are reported as frequency (percent). Mann–Whitney U tests were used to compare the in-person and telemedicine groups on continuous variables and Chi-Square tests or Fisher's Exact tests were used to compare the groups on categorical variables, as appropriate.

2.3 | Survey

A total of 123 patients were identified who had telemedicine preoperative and/or postoperative appointment. Of those, 115 patients were selected who were alive and had an email address on file in their chart. Patients were contacted via email by the study staff and given the details of the study and link to the study, which was set up as an online survey of 15 questions (Appendix A). Informed consent and HIPAA document describing the study and the use of PHI were attached to the email, and the IRB granted a waiver of documentation of consent.

3 | RESULTS

We identified 286 patients who had an elective mitral valve operation. Of those, 197 patients (69%) had an in-person preoperative evaluation before March 12, 2020 and 89 consecutive patients that (31%) had a telemedicine preoperative evaluation thereafter. Preoperative patient characteristics did not differ between the two groups (Table 1), including age (62 vs. 65 yrs, $p = .658$), female sex ($p = .238$), BMI ($p = .726$), STS predicted risk of mortality (PROM; 0.5% vs. 0.5%, $p = .273$), diabetes ($p = .565$), hypertension ($p = .219$), and chronic lung disease ($p = .760$). Rates of concomitant procedures, including CABG, aortic valve procedure, tricuspid valve procedure, aortic procedure, and atrial fibrillation ablation were similar (Table 2). The rate of unplanned procedures was low and similar between the in-person and telemedicine groups, including unplanned tricuspid valve (1.5% vs. 3.4%, $p = .381$) and

JOURNAL OF CARDIAC SURGERY —WILEY—

TABLE 1 Patient characteristics

	In-person (*n* = 197)	Telemedicine (*n* = 89)	*p*
Age	62 (52–71)	65 (55–69)	.658
Female	74 (38)	40 (45)	.238
Race			.525
White	157 (81)	66 (77)	
Black	27 (14)	12 (14)	
Other	11 (6)	8 (9)	
Body mass index	26.2 (23.3–29.9)	25.8 (23.8–29.0)	.726
Diabetes	27 (14)	10 (11)	.565
Hypertension	93 (47)	49 (55)	.219
Dialysis	1 (0.5)	1 (1)	.526
Preoperative creatinine	1.0 (0.8–1.1)	1.0 (0.8–1.2)	.999
Chronic lung disease	10 (5)	3 (3)	.760
Current/former smoker	69 (35)	32 (36)	.850
Liver disease	2 (1)	1 (1)	>.999
Cancer within 5 years	7 (4)	3 (3)	>.999
Cerebrovascular disease	22 (11)	4 (5)	.069
Prior cerebrovascular accident	11 (6)	4 (5)	>.999
History of atrial fibrillation	63 (32)	33 (37)	.398
Endocarditis	10 (5)	7 (8)	.356
Preoperative hematocrit	42.2 (38.8–44.5)	42.2 (38.7–44.6)	.511
Prior myocardial infarction	10 (5)	4 (5)	>.999
Redo surgery	13 (7)	6 (7)	.964
Previous CABG	4 (2)	0	.314
Previous PCI	10 (5)	5 (6)	>.999
Previous valve	11 (6)	6 (7)	.701
Preoperative ejection fraction (%)	60 (55–63)	60 (55–63)	.469
Mitral insufficiency			.886
Trace/trivial	5 (3)	2 (2)	
Mild	4 (2)	1 (1)	
Moderate	7 (4)	2 (2)	
Severe	180 (91)	84 (94)	

(Continues)

TABLE 1 (Continued)

	In-person (*n* = 197)	Telemedicine (*n* = 89)	*p*
Mitral stenosis	21 (11)	7 (8)	.454
STS PROM (%)	0.5 (0.3–1.1)	0.5 (0.3–1.1)	.273

Note: Data are presented as median (IQR) or frequency (%).

Abbreviations: CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; STS PROM, Society of Thoracic Surgeons predicted risk of mortality.

TABLE 2 Operative characteristics

	In-person (*n* = 197)	Telemedicine (*n* = 89)	*p*
Cardiopulmonary bypass time (min)	98 (76–125)	105 (80–134)	.215
Cross-clamp time (min)	84 (67–110)	90 (68–117)	.183
Mitral valve repair	158 (81)	71 (80)	.869
Concomitant operations			
CABG	19 (10)	10 (11)	.680
Aortic valve	9 (5)	6 (7)	.567
Tricuspid valve	53 (27)	31 (35)	.181
Aortic procedure	3 (2)	2 (2)	.648
Atrial fibrillation ablation[a]	61 (31)	34 (38)	.229

Note: Data are presented as median (IQR) or frequency (%).

[a]One patient in the telemedicine group without a known history had atrial fibrillation discovered in the operating room and ablation was performed.

aortic valve (0.5% vs. 0%, $p > .999$) procedures. Operative characteristics were similar between the two groups (Table 2).

The postoperative clinical outcomes did not differ between the 2 groups (Table 3), including perioperative blood transfusions ($p = .686$), total ventilation hours ($p = .399$), median total ICU length of stay ($p = .497$), median postoperative length of stay (5 vs. 5 days, $p = .949$) reoperation for bleeding ($p > .999$), mortality within 30 days ($p = .311$), and readmissions 30 days ($p = .197$). No patients had a stroke in either group.

Among patients undergoing telemedicine preoperative evaluations, the technology used included Zoom in 89%, telephone call in 7%, and FaceTime in 4%. Five of the six patients with phone calls were evaluated early in the telemedicine experience (before the end of June 2020). All patients in the telemedicine group had preoperative imaging available for review by the nurse practitioner and surgeon, including 100% with transthoracic echocardiography, 65% with transesophageal echocardiography, 19% with computed tomography, and 60% with cardiac catheterization.

TABLE 3 Postoperative outcomes

	In-person (n = 197)	Telemedicine (n = 89)	p
Perioperative blood transfusion	66 (34)	32 (36)	.686
Total ventilation hours	3.7 (2.5–5.8)	4.1 (2.9–6.0)	.399
Prolonged ventilation (>24 h)	7 (4)	3 (3)	>.999
Return to intensive care unit	4 (2)	1 (1)	>.999
Total intensive care unit stay (h)	35.1 (23.5–68.4)	41.3 (24.5–70.3)	.497
Total hospital length of stay (days)	5 (4–7)	5 (4–7)	.949
Postoperative mitral insufficiency			.555
None	124 (63)	54 (61)	
Trace/trivial	61 (31)	32 (36)	
Mild	9 (5)	3 (3)	
Postoperative ejection fraction (%)	55 (45–61)	55 (45–60)	.405
Reoperation for bleeding	9 (5)	4 (5)	>.999
Permanent stroke	0	0	–
Pneumonia	0	2 (2)	.096
Renal failure	0	2 (2)	.096
Postoperative atrial fibrillation	42 (21)	27 (30)	.099
New pacemaker	14 (7)	3 (3)	.216
Mortality <30 days	0	1 (1)	.311
Readmission <30 days	26 (13)	7 (8)	.197

Note: Data are presented as median (IQR) or frequency (%).

Patients in the in-person group had a longer median time between initial preoperative evaluation appointment and operation compared with the telemedicine group (49 [34–69] vs. 30 [20–49] days, $p < .001$). This difference remained significant even after excluding the 18 patients in the in-person group who had surgery during the pandemic (47 [33–68] vs. 30 [20–49] days, $p < .001$). There was no difference between the in-person and telemedicine groups in the proportion of patients who completed a 1-month postoperative follow-up appointment (95% vs. 97%, $p = .760$). In the in-person group, 34 of the 188 postoperative appointments (18%) were conducted with telemedicine. Of the 86 patients in the telemedicine group who had a postoperative appointment, all were evaluated using telemedicine. The format was Zoom in 86%, telephone call in 10.5%, and FaceTime in 3.5%.

The survey instrument was sent to 115 patients who had a telemedicine appointment for preoperative evaluation and/or postoperative follow-up. Out of those, 36 patients responded (31%) with 35 from the telemedicine group and 1 from the in-person group. The majority (74%) reported they were very satisfied ($n = 26$) with the audio quality of the preoperative appointments, while 23% of patients ($n = 8$) reported they were satisfied, and 3% of patients ($n = 1$) reported they were dissatisfied (telephone call for this patient). For the 30 patients with preoperative video telemedicine methods, 67% reported they were very satisfied with the video quality($n = 20$), 30% were satisfied ($n = 9$), and 3% were neutral ($n = 1$). Overall satisfaction scores with the telemedicine preoperative appointment were very satisfied in 57% of patients ($n = 20$), satisfied in 34% ($n = 12$), and neutral, dissatisfied, and very dissatisfied in 3% each ($n = 1$ each). When asked if they felt the care of the telemedicine preoperative visit was as good as an in-person visit, 49% of patients ($n = 17$) strongly agreed, 20% of patients ($n = 7$) agreed, 9% of patients ($n = 3$) were neutral, 20% of patients ($n = 7$) disagreed, and 3% of patients ($n = 1$) strongly disagreed. Reports that the telemedicine preoperative visit saved them time and money were strongly agree in 57% patients ($n = 20$), agree in 26% patients ($n = 9$), and neutral in 17% patients ($n = 6$).

The telemedicine method for the postoperative appointment respondents ($N = 36$) were reported as Zoom in 72%, telephone call in 17%, and FaceTime in 11%. The majority (67%) reported they were very satisfied ($n = 24$) with the quality of sound of the preoperative appointments, while 31% of patients ($n = 11$) reported they were satisfied, and 3% of patients ($n = 1$) reported they were very dissatisfied (telephone call for this patient). For the 30 patients with postoperative video telemedicine methods, 57% reported they were very satisfied with the quality of the video ($n = 17$) 57%), 40% reported they were satisfied ($n = 12$), and 3% reported they felt neutral ($n = 1$). Overall satisfaction scores with the telemedicine postoperative appointment were very satisfied in 53% of patients ($n = 19$), satisfied in 22% of patients ($n = 8$), neutral in 14% of patients ($n = 5$), dissatisfied in 3% of patients ($n = 1$), and very dissatisfied in

8% of patients ($n = 3$). When asked if they felt the care of the telemedicine postoperative visit was as good as an in-person visit, 39% of patients ($n = 14$) strongly agreed, 31% of patients ($n = 11$) agreed, 17% of patients ($n = 6$) were neutral, 6% of patients ($n = 2$) disagreed, and 8% of patients ($n = 3$) strongly disagreed. Reports that the telemedicine postoperative visit saved them time and money were strongly agree in 56% of patients ($n = 20$), agree in 25% of patients ($n = 9$), and neutral in 19% of patients ($n = 7$).

The patients were almost equally split on whether they would prefer a future appointment to be telemedicine (47%, $n = 17$) or in-person (53%, $n = 19$), assuming COVID-19 was not an issue.

4 | COMMENT

COVID-19 necessitated total and abrupt adoption of telemedicine patient visits in our subspecialized mitral valve surgical practice and afforded a unique opportunity to compare outcomes and patient preferences with conventional care. The key finding of this study was that telemedicine preoperative evaluation was feasible and associated with equivalent and excellent clinical outcomes.

Overall, our experience was that patients were well-prepared for telemedicine visits and many were able to provide their vitals, including height, weight, blood pressure, and heart rate. All patients in the telemedicine group had a transthoracic echocardiogram available for the attending surgeon to review during the appointment. Many patients had additional imaging available (transesophageal echocardiogram, cardiac tomography, cardiac catheterization) for review at the initial visit or subsequently and before the date of surgery. And while a full physical exam could not be performed, patient-reported vital signs, the patient's general appearance on the call, their ability to stand up and walk in front of the camera, and the available imaging provided the attending surgeon provided adequate information to accurately assess the patient. In addition, by seeing the patient in their home environment, our team gained a deeper understanding of patients' social determinants of health, family dynamics, and living environment, a significant advantage of telemedicine.[6]

Use of telemedicine had no adverse impacts on clinical outcomes among patients undergoing elective mitral valve surgery in this experience. There were no unplanned procedures nor were any cases canceled on the day of operation as a result of incomplete data obtained using telemedicine.

Since March 2020, several studies have reported on the use and effectiveness of telemedicine in different settings. Fryer et al. reported on the implementation of telehealth in obstetric care and suggested that in the future, telehealth can give women the convenience of fewer in-person visits.[7] Grenda et al. reported on successfully transitioning a general thoracic surgery practice to a telehealth model[8] and Ajibade et al. reported on the usefulness of telemedicine in triaging and postoperative monitoring of patients in a cardiovascular surgery practice in the UK.[9] This experience supports the safety and effectiveness of remote technology-facilitated patient visits with a heart valve team in preparation for elective cardiac surgery.

Among patients responding to a survey instrument in this experience, the majority were very satisfied with their telemedicine appointments. Many reported that they felt the quality of care they received through a telemedicine appointment was as good as in-person. When asked if they would choose an in-person or telemedicine appointment in the future (if COVID-19 was not a factor) nearly/almost half favored telemedicine. Patient comments about why they would choose a telemedicine appointment generally mentioned the appointment "saving them time and money" and "avoiding traffic and traveling." While patient comments about why they would choose an in-person appointment included "personal preference," "lack of technology skills," "worry about a big operation," and "wanting to be examined in person," A minority of patients in this experience reported dissatisfaction with either voice or video connection. Improved communication technology will likely enhance the quality of the telemedicine experience in the future. In our practice, we currently offer patients either in-person or telemedicine preoperative appointments and have found that approximately half of the patients choose in-person visits.

The volume of patient visits in this mitral valve practice declined by 54% during the pandemic, as has been previously reported by our group.[10] There is a very strong relationship between surgeon volume and outcomes in mitral valve surgery and referral to geographically distant reference centers of excellence is one proposed approach to improve outcomes in mitral valve surgery.[11] Telemedicine may play a key role in improving patient outcomes by facilitating the evaluation of patients before operation at a reference center without an in-person visit. While we hypothesized that follow-up visits would be more likely to be completed once telemedicine was available, we did not find a significant difference between the groups in the proportion of patients completing a postoperative appointment, and the rates of completed postoperative visits were nearly 100%.

Patients in the telemedicine group had a shorter interval between the initial preoperative appointment and the surgery date when compared to the in-person group. This may be attributed to telemedicine affording patients greater flexibility with scheduling preoperative appointments closer to the date of surgery, overall lower surgical volumes during the pandemic, and practice changes including affording patients the option to obtain preoperative bloodwork and chest X-ray on their own time, rather than waiting for an appointment at the Preoperative Readiness Evaluation and Preparation (PREP) Center.

Limitations of this study include the knowledge that the results of this study may not be generalizable to all cardiac surgical patients and may be limited by the retrospective nature of this study. Additionally, incomplete survey completion may have biased results toward telemedicine.

In conclusion, we found that telemedicine preoperative and postoperative evaluation could be successfully and rapidly implemented in a subspecialized cardiac surgical practice. Patient satisfaction was high, and outcomes were not compromised. Almost half of the patients evaluated remotely expressed a preference for future visits to occur by telemedicine. As the COVID-19 pandemic continues, regulators are re-imposing restrictions on the provision of telemedicine, particularly for out-of-state patients.[12] It is imperative that patient access to reference mitral valve centers is not hampered by unnecessary reregulation.

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CONFLICTS OF INTEREST

James S. Gammie, MD, is a consultant for Edwards Lifesciences and is a founder of Protaryx Medical and Marlin Medical. The other authors declare no conflicts of interest.

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APPENDIX: SURVEY

I have read the consent form (or have had it read to me), that my questions have been answered to my satisfaction, and that I voluntarily agree to participate in this study study. Furthermore, I authorize the use and sharing of my protected health information for the purposes described in the informed consent document, and I permit my doctors and other healthcare providers to share my protected health information with this researcher for the purposes described in the informed consent document.

a. Yes
b. No

1. Who is answering this survey?
   a. The patient
   b. The patient's family member
   c. Other health facilitator
2. Was your preoperative telemedicine appointment done over___?
   a. Phone call
   b. FaceTime
   c. Zoom
   d. Other
3. If other please specify.
4. I was satisfied with the sound quality during the preoperative telemedicine appointment.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
5. I was satisfied with the video quality during the preoperative telemedicine appointment (if applicable).
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree

6. How satisfied were you with using telemedicine for your preoperative appointment with Dr. Gammie and Filomena Koenigsberg (NP)?
   a. Very satisfied
   b. Satisfied
   c. Neutral
   d. Dissatisfied
   e. Very dissatisfied
7. I felt that the care and advice I received during the preoperative telemedicine appointment was as good as seeing Dr. Gammie and Filomena Koenigsberg (NP) in person.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
8. The preoperative telemedicine appointment saved me time and money.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
9. Was your postoperative telemedicine appointment done over ____?
   a. Phone call
   b. FaceTime
   c. Zoom
   d. Other
10. If other please specify.
11. I was satisfied with the sound quality during the postoperative telemedicine appointment.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
12. I was satisfied with the video quality during the postoperative telemedicine appointment (if applicable).
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
13. How satisfied were you with using telemedicine for your postoperative appointment with Filomena Koenigsberg (NP)?
   a. Very satisfied
   b. Satisfied
   c. Neutral
   d. Dissatisfied
   e. Very dissatisfied
14. I felt that the care and advice I received during the postoperative telemedicine appointment was as good as seeing Filomena Koenigsberg (NP) in person.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
15. The postoperative telemedicine appointment saved me time and money.
   a. Strongly agree
   b. Agree
   c. Neutral
   d. Disagree
   e. Strongly disagree
16. If you needed another appointment in the future and Covid-19 was no longer a concern, would you choose telemedicine or an in-person appointment?
   a. Telemedicine
   b. In-person appointment
17. Please explain your choice for the question above.
18. Any suggestions about how the telemedicine process can be improved?