Original Article on Thoracic Surgery

Telemedicine in thoracic surgery

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Background: We describe the safety, feasibility and patient satisfaction using telemedicine in the preoperative as well as postoperative period of thoracic surgery.

Methods: A prospective safety, proof of concept and quality improvement project on a consecutive series of patients who had preoperative and/or part of their postoperative care via telemedicine.

Results: Fifty-six patients (18% outside the United States) agreed to participate. A video conversation with patients and families was used to decide resectability, discuss risks, benefits, and alternatives of treatment and to agree on the date and type of surgery after medical records and imaging reviewed initially via email. All 56 underwent the planned operation, 55 on the date agreed upon. Eight (14%) patients met the surgeon for the first time on the morning of surgery: 38 (68%) had robotic pulmonary resection, 9 (16%) robotic esophagectomy and 9 (16%) robotic thymectomy. All had R0 resection. There was minor morbidity in 10 patients. There was no major morbidity or 30- or 90-day mortality. Postoperative visits via telemedicine only was performed in 25 of 56 patients (45%). Unscheduled postoperative telemedicine visits prevented six patients from unnecessary visits to local emergency departments. Patient satisfaction achieved the highest scores in the four areas of provider communication.

Conclusions: Telemedicine is safe and avoids some preoperative and postoperative visits to surgeons' offices. In selected patients it safely determines oncologic surgical resectability and patient fitness for major thoracic surgery, provide outstanding early safety and oncologic outcomes and high patient satisfaction. In addition, it reduces the need for some postoperative emergency department visits and in most patients it can eliminate postoperative travel to the surgeon's office.

Keywords: Thoracic surgery; postoperative care; robotic surgical procedures; telemedicine; patient satisfaction

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Introduction

Telemedicine is the use of medical information that is exchanged from one site to another through electronic communication to improve a patient's health (1). It differs from physician to patient telephone calls, emails, or texts in that the physician or provider's face and voice are seen and heard during the patient visit. Its growth has been slowed by medical-legal issues, state licensing disagreements, Health Insurance Portability and Accountability Act (HIPAA)-compliant platforms, billing concerns, provider hesitancy and the patient culture of wanting to physically see their doctor. Although telemedicine has been used in medicine (dermatology, emergency medicine, primary care) (2-4) for patient-physician interaction and in tele-radiology and tele-pathology (5,6) for provider-to-provider collaboration, there have been few reports to show its safety in determining the oncologic resectability and/or physical fitness of patients who are to undergo elective surgery of any type, including thoracic surgery. Its safety for replacing both preoperative

visits, with a physical exam and explanation of the risks, benefits, and alternatives to surgery in person, as well as replacing postoperative visits, with incision inspection and pathology review, has also not been fully studied in high-risk surgery patient populations (7).

A common complaint of our patients was the cost and the time to travel into New York City for office visits. Therefore, as part of a quality improvement project we studied the feasibility and safety of limiting and/or eliminating some of the preoperative and postoperative office visits via telemedicine prior to elective thoracic surgical procedures. The objective of this study is to report the technique, deliverability, feasibility, safety and patient satisfaction of telemedicine in the practice of one academic thoracic surgeon. Another goal was to determine the frequency with which patients choose the option of telemedicine preoperatively and the ability to adequately discuss the benefits and risks of surgery prior to physically meeting the patient while maintaining high patient satisfaction and quality outcomes.

Methods

Entry criteria

As part of one academic surgeon's (RJ Cerfolio) quality improvement project, we performed prospective review on a consecutive series of patients selected by the surgeon who were offered and agreed to undergo elective thoracic surgery after a telemedicine visit(s), which occurred before any in-person face-to-face clinic visit occurred. The intent was to offer all patients a telemedicine visit, and it was done if they or the referring physician emailed RJ Cerfolio directly or if they called the thoracic surgery office for an appointment. Patients who were sent directly to RJ Cerfolio's clinic as an add-on same-day appointment were not offered a telemedicine call initially. If the patient expressed interest in the telemedicine process, a standard telephone call which explained the telemedicine process was discussed. The telemedicine video-phone call was made on a HIPAA-compliant institutional cell phone at an agreed upon time, most commonly in the evening so the patient's family members could be present. We explained that this call was: part of a quality improvement study that we were conducting to improve our patient's experience and reduce travel and wait times, it was not billed to them or their insurance and was to last 15–20 minutes. The patient's medical information and imaging were provided to us prior to the call and was reviewed to ensure the patient was a surgical candidate. We explained we were not using the New York University (NYU) Langone Telemedicine platform because it was not yet formalized for the surgical department. We obtained the patient's permission to discuss their private medical history in front of the family members who were on the telemedicine call. Follow-up telemedicine calls were used if more testing or medical information was required. All patients who were offered a telemedicine visits were tracked and included in our results, including those who: (I) decided to have surgery after one or more telemedicine visit(s) but still desired an in-person visit with the surgeon in the clinic; (II) the type of operation was agreed upon during the telemedicine call and it was not changed; (III) and the date of the operation was agreed upon during the telemedicine call. A subset of patients was tracked but their surgical outcomes were excluded in this study if the telemedicine call was only able to consider the role of surgery, to set up a clinic appointment to further in-person discussion, type or date of surgery, alternative treatment options, or if the patient could not agree to surgery until they physically met us. Patients were also excluded from this study if telemedicine was used only in the postoperative care of the patient after surgical resection. In addition, those patients who had a telemedicine visit preoperatively only after an initial visit in-person were also excluded from this study since they met us prior to a telemedicine call. Radiologic films such as computed tomography (CT) and positron emission tomography (PET) scans were either sent as a video and/or mailed on a disc and were then placed in the patient's electronic medical record. Other records such as past medical history, physical exam, pulmonary function tests (PFTs), stress tests, and/or echocardiograms were emailed or faxed as well usually prior to the telemedicine visit and placed in their electronic medical record. The telemedicine visit was not placed in our electronic medical record.

Medical clearance for anesthesia was obtained by the NYU Langone Anesthesia Preadmission Testing Department prior to the patient's surgery. Type and screen blood testing was performed on the day of surgery. Institutional Review Board (IRB) approval was waived since this was a quality improvement initiative (NYU study number 18-00780).

Patient consent, HIPAA, telemedicine platform

Patients gave written consent for the procedure after

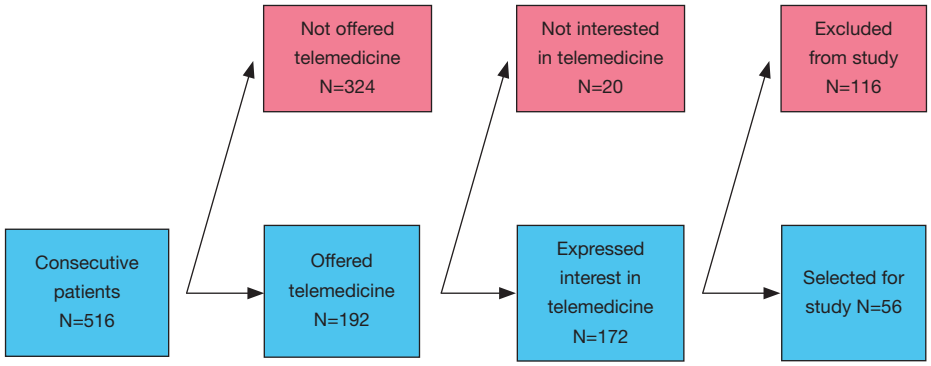

Figure 1 Patient selection for study. Of the 516 patients seen consecutively by surgeon RJ Cerfolio, 192 were offered entry into the telemedicine study, 172 patients expressed interest but only 56 patients elected to enter the study.

meeting the sole surgeon in the series (RJ Cerfolio), who then completed his physician exam and came to an agreement with the patient to proceed with surgery later that day or later in the week. This method was approved by our institution's regulatory department and quality improvement team. All telemedicine calls involved only the surgeon RJ Cerfolio.

Patient evaluation prior to travel

As previously reported, the workup for these patients was the same as for those that did not have telemedicine visits. For patients with non-small cell lung cancer (NSCLC) it was standardized (8) as was that for those with esophageal cancer (9). Some pre-operative staging tests, such as endobronchial ultrasound (EBUS) were performed at a facility near the patient's home prior to travel in selected candidates to rule out the presence of metastatic N2 lymph node disease. Similarly, esophagogastroduodenoscopy (EGD) and endoscopic esophageal ultrasound (EUS) were used in all patients with esophageal cancer with biopsy of suspicious nodal or metastatic locations and lesions and were performed at facilities near the patients' home. Integrated PET/CT and CT scans were used in all patients as previously described.

Patients who underwent thymectomy with or without myasthenia gravis had their medical therapy optimized prior to travel to New York City. Selected patients had plasmapheresis and/or intravenous immunoglobulin therapy. Cardiopulmonary risk was individualized and assessed via pulmonary function testing in all patients, with cardiac stress testing in selected patients. In marginal patients, cardiac stress testing was pursued to avoid cancelation or delay on the morning of surgery. There were no absolute contraindications to offering a telemedicine visit, except in those patients who did not desire it, were uncomfortable with it, or were unable to use the technology. All patients with NSCLC, esophageal cancer, and thymic pathology were offered a minimally invasive robotic approach. The only contraindication to robotic resection was a tumor size 11 cm or greater.

The Society of Thoracic Surgeons (STS) database definitions of length of stay, anastomotic complications and other morbidities, 30-day mortality, and/or 90-day mortality were used (10). Complications, including anastomotic leaks, were defined using the modified Clavien-Dindo classification for surgical complications. Complications reported were grade II or above (requiring intervention) (11).

Results

Over 13 months, 516 consecutive patients contacted and/or saw the sole surgeon, of which 192 patients were offered telemedicine. Of the 192 patients, 172 expressed interest in the process and after emails explaining the process, 56 patients accepted and met the entry criteria for this study. The patient flow is shown in *Figure 1*. An example of a telemedicine visit is illustrated in *Figure 2*. *Table 1* shows the demographics of these 56 patients as well as the duration of the initial calls. There were 38 patients with lung cancer, of which 2 had EBUS performed at their home institution. Forty-eight patients (86%) met the surgeon in clinic after the telemedicine visit and after verbally agreeing to the operation as well as to the surgical date. Although there was generally no change in the type of operation performed or the surgical date (except one patient), 86% still desired

this face-to-face clinic visit prior to the operation. The median length of time of these visits is shown in *Table 2* and ranged from 2 to 11 minutes. One patient changed the date of surgery. Surgical delay on the day of surgery occurred in only one patient—an international patient secondary to financial issues. There were no delays secondary to anesthesia or blood work concerns. *Table 2* depicts the early outcomes in these patients. There were no major postoperative complications and 10 (18%) minor postoperative complications as shown. There was no 30- nor 90-day nor operative mortality.

Figure 2 Example of a telemedicine visit (12). Available online: http://www.asvide.com/article/view/32068

As shown in *Table 3*, 50 of the 56 patients had at least one postoperative telemedicine visit as part of and/or all of their postoperative visit. Therefore, 33 patients avoided an in-person visit altogether with a telemedicine visit only, 17 patients desired both an in-person and telemedicine visit and 6 patients only had an in-person visit with no telemedicine visits. In addition to the scheduled post-operative telemedicine visits, 6 patients had urgent problems (complaints of fever in 3 patients, question of chest tube site infection in 2 patients, and pain and malaise in 1 patient) and they communicated by text message with the sole surgeon in this study. All 6 patients had plans to go to their local emergency department, but a non-scheduled urgent telemedicine call was performed and this prevented all 6 patients from going to the emergency department. All 6 patients successfully convalesced at home without readmission or any further emergency department visits or added nursing visits at home.

Patient satisfaction surveys were sent to all patients in this series, and 45 responded. Forty-three of the 45 patients (96%) gave the surgeon the highest mark in all four areas of patient's communication ("overall communication", "courtesy/respect", "listening carefully", "explained in a way you understand"). The remaining two patients gave him the second highest mark in one, "explained in a way you understand" and the highest in the other three areas.

Table 1 Patient demographics and indications for surgery

Variables	Lung mass (n=38)	Mediastinal tumors (n=9)	Esophageal cancer (n=9)
Median age [range] (years)	63 [14–87]	52 [14–79]	71 [47–80]
Gender, n [%]	13 [34] male; 25 [66] female	4 [44] male; 5 [56] female	6 [67] male; 3 [33] female
Race	White: 31 [82]; Black: 3 [8]; other: 4 [11]	White: 8 [89]; Asian: 1 [11]	White: 8 [89]; Black: 1 [11]
Disease process	Lung mass: 38 [100]	Myasthenia gravis only: 5 [56]; thymic mass: 4 [44]	Esophageal adenocarcinoma: 9 [100]
Hypertension	19 [50]	2 [22]	6 [67]
Congestive heart failure	2 [5]	1 [11]	0 [0]
Diabetes mellitus	6 [16]	0 [0]	3 [33]
Median body mass index [range]	26.2 [21.0–39.0]	30.2 [23.0–36.0]	29.6 [23.0–44.0]
Coronary artery disease	6 [16]	2 [22]	0 [0]
Chronic obstructive pulmonary disease	6 [16]	1 [11]	0 [0]

Table 2 Outcomes of pre-operative video-telemedicine calls, operations performed, and early outcomes

Variables	Lung mass (n=38)	Mediastinal tumors (n=9)	Esophageal cancer (n=9)
Median duration of initial telemedicine call [range] (minutes)	14 [9–19]	13 [10–21]	23 [16–32]
Number of patients who desired in person clinic visits prior to resection, n [%]	35 [92]	5 [56]	8 [89]
Median time of clinic visit [range] (minutes)	4 [2–9]	3 [2–8]	7 [2–11]
Median number of telemedicine calls [range]	1 [1–3]	1 [1–4]	2 [1–4]
Delays going into operating room, n [%]	1 [3]—issue with payment	0	0
Type of operations performed	Robotic lobectomy: 26; Robotic segmentectomy: 12	Robotic total thymectomy: 9; left-sided: 7; right-sided: 2	Robotic Ivor-Lewis esophagectomy: 9
Median operative times [range] (minutes)	108 [45–190]	78 [55–117]	361 [195–450]
R0 resection, n [%]	38 [100]	9 [100]	9 [100]
Lymph nodes removed, median [range]	21 [12–39]	Not applicable	18 [10–39]
Actual blood loss, median [range] (cc)	20 [10–70]	10 [10–50]	30 [20–150]
Blood transfusion	0	0	0
SICU stay in days	0	0	0
Minor morbidity	Atrial fibrillation: 4; air leak >2 days: 2	0	Urinary retention: 1; atrial fibrillation: 1; fever: 2
Major morbidity	0	0	0
Readmission	0	0	Dehydration, malaise: 1
30-day mortality	0	0	0
Final pathology with subtype if applicable	Squamous cell carcinoma: 3; adenocarcinoma: 16; acinar: 2; papillary: 5; lepidic: 2	Hodgkin lymphoma: 1; thymoma: 2; cystic teratoma: 1; normal thymic tissue for myasthenia gravis: 5	Adenocarcinoma: 9
TNM and stage	T1aN0M0: 11; T1bN0M0: 1; T2aN0M0: 7; T2aN1M0: 2; T2aN1M0: 1; T3N0M0: 3; T1bN2M0: 1; T3N2M1*: 1; Complete response: 1; M1**: 10	Not applicable	Complete response: 4; T1bN0M0: 1; T3N0M0: 1; T2aN1M0: 1; T3N1M0: 1; T3N2M0: 1
90-day mortality	0	0	0

*, nodule in the other chest; **, metastasectomy.

Conclusions

Telemedicine will play a significant role in the future of medicine, not just for patient care but also in medical education and training. The platform used for a billable telemedicine visit must be HIPAA compliant and safe. Both Medicare and Medicaid now allow charges for selective types of telemedicine. These types of regulations which exist mainly for political-economic reasons constrain and delay what is improved customer service to our patients. In this study, we were able to negotiate these obstacles by making patients aware that our video-telemedicine call was part of a study for quality improvement, was not being billed nor being placed in our electronic medical record as a

Table 3 Outcomes of the post-operative telemedicine visits

Variables	Lung mass (n=38)	Mediastinal tumors (n=9)	Esophageal cancer (n=9)
Median post-operative day that telemedicine call occurred [range]	8 [4–15]	5 [3–9]	12 [9–29]
Median number of postoperative telemedicine calls [range]	1 [1–3]	1 [1–4]	3 [2–4]
Number of non-elective telemedicine calls and reasons for call	Fever: 1; chest tube site erythema: 2	0	Fever: 2; pain, malaise: 1
Emergency room/in-person evaluations required after call	0	0	0
Number of patients desired in persons post-operative visits	13	0	4

billable event at the time of this study.

The primary objectives of this study are to show the feasibility, safety, popularity and usefulness of telemedicine in select patients who required elective thoracic surgery both pre-operatively and post-operatively. The safety concerns were met. No patient required further testing prior to resection and there was no significant morbidity or mortality in this series nor delays the day of surgery for anesthesia clearance. There were no unforeseen post-operative cardiac or other major complications, despite the fact that patients were all cleared for the operations at their home institution. Patient risks were satisfactorily vetted using telemedicine with home PFTs and, if needed, cardiac stress tests.

Despite the success of our telemedicine in this study, of the 192 patients who were offered a telemedicine option, only 172 were interested and after full vetting only 56 (29%) opted into this study. This suggests that many patients still prefer a traditional office face-to-face visit with their thoracic surgeon. Of the 56 patients that chose a telemedicine visit, 48 (86%) still desired a face-to-face meeting with the surgeon at least 1 day prior to surgery after agreeing to the operation, the type of surgery to be performed and the date. The usefulness of the telemedicine visits in these patients is shown by the fact that these visits were short, only reviewed the operative plan and confirmed what had been discussed via the telemedicine visit. It saved valuable office time. Since this is a quality improvement project, comparative data of matched patient population cannot be shown. However, we can state that the median traditional non-telemedicine initial clinic visit in the sole surgeon's experience is 13 minutes, more the double the amount of time for visits in this study. Even if one argues that the time saving of the doctor is no different (based on adding the median time of the telemedicine call(s) to this in clinic visit) the ability to save the patient an extra trip to the hospital or office must be considered. Patients reported extremely high satisfaction with the telemedicine process, and when compared to our other non-telemedicine visits in general their satisfaction was higher. This is of little surprise since they had to travel into New York City less often to receive the same care.

Another goal of this study was to test the oncologic suitability of patients having major cancer surgery performed after a telemedicine call and the quality of preoperative staging at their home institutions. Since all patients with esophageal cancer had neoadjuvant therapy, and those with thymic pathology did not require further staging, only patients with NSCLC required assessment in this area. In this study, we show that all patients with cancer underwent an R0 resection. The patients with lung cancer who had M1 disease clinically was from a nodule in the other chest and the others with M1 disease had lung metastases. Only two patients out of 38 (5%) had unsuspected N2 disease yielding a similar rate of 9% in the literature to patients who were staged without telemedicine (13). Thus, the oncologic suitability of the staging via telemedicine in our study was outstanding.

Telemedicine is not new to our practice, especially in the postoperative setting. We have been using it to replace and/or supplement postoperative visits in our institution for well over 6 years. And is now our preferred method. In this study, it allowed 6 patients who were on their way to the emergency department to avoid these trips. In our experience, many unnecessary visits to emergency rooms end up leading to medically unnecessary and expensive hospital readmissions that provide little value. During the telemedicine visits, we were even able to clearly view the

patient's incisions and intravenous sites, ensure that there were no signs of infection, and reassure that they could stay home and monitor the situation safely from home.

One of the strengths of this study is the use of tight definitions to define our telemedicine visits. We eliminated many patients who use telemedicine as an adjunct to clinic appointments. In our opinion, these provided great value as well, but these patients were not included in this study. Patients who used telemedicine but did not consent to surgery or the date were also considered failures in this study and reported as such in *Figure 1*. However, this type of adjunctive telemedicine still has value (reduces patient anxiety by meeting the surgeon before the scheduled appointments) and we believe will increase in popularity. Other strengths include the fact that it was a consecutive series of patients (all types of patients were offered) and the study was performed prospectively.

There are several weaknesses to this study. First, one of the main obstacles to telemedicine is a HIPAA-compliant platform that allows for billing, protects patient's data and allows physicians to see patients during the day and enter them into the electronic record. We did not use the NYU Langone Health information technology that is being implemented by other departments in our healthcare system as it was not yet available for the surgical departments at the time of this study. We did not have any complaints of privacy issues. Second, we cannot confirm that all patients were offered a telemedicine visit in the same way. Different office assistants answered the phone for initial patient calls and we did not have a written script that was used. One potential financial disadvantage of telemedicine is the loss of downstream revenue from adjunctive testing including additional CT/PET scans, blood work, PFTs, or cardiac evaluation tests. We noted we were also more likely to ask for a cardiac stress test from the patient's home institution to ensure the patient was safe for general anesthesia, in order to reduce the likelihood that our anesthesiologists would cancel the operation.

In conclusion, we have shown that telemedicine is safe and can avoid some preoperative and postoperative trips to surgeons' offices in selected patients. It can safely determine oncologic surgical resectability and patient fitness for major thoracic surgery, provide outstanding early safety and oncologic outcomes and high patient satisfaction in selected patients. It may also reduce the need for some post-operative emergency department visits. This is a novel report and we believe the first of its kind that shows the safety and efficacy of using preoperative telemedicine for patients prior to major chest surgery. Further studies in this exciting and relatively new arena are warranted.

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Footnote

Conflicts of Interest: RJC serves as an unpaid editorial board member of *Journal of Visualized Surgery* from Feb 2018 to Jan 2020. RJC discloses relationships with AstraZeneca, Bard Davol, Bovie Medical Corporation, C-SATS, ConMed, Covidien/Medtronic, Ethicon, Fruit Street Health, Google/Verb Surgical, Intuitive Surgical, KCI/Acelity, Myriad Genetics, Neomend, Pinnacle Biologics, ROLO-7, Tego, and TransEnterix. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Data collection and management was approved by the institutional review boards at The University of Alabama at Birmingham (IRB #X110112008) and New York University Langone Health (IRB #18-02501). Individual patient consent was obtained to enter patient data into the prospective database.

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