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# Telemedicine in pediatric surgery

Matthew T. Harting [a,*], Austin Wheeler [a], Todd Ponsky [b], Benedict Nwomeh [c], Chuck L. Snyder [d], Nicholas E. Bruns [e], Aaron Lesher [f], Samir Pandya [g], Belinda Dickie [h], Sohail R. Shah [i], for the APSA Informatics and Telemedicine Committee

[a] Department of Pediatric Surgery, McGovern Medical School at The University of Texas Health Science Center at Houston (UTHealth) and Children's Memorial Hermann Hospital, Houston, TX
[b] Division of Pediatric Surgery, Akron Children's Hospital, Akron, OH
[c] Department of Pediatric Surgery, Nationwide Children's Hospital, Columbus, OH
[d] Department of Pediatric Surgery, Childrens Mercy Hospital, Kansas City, MO
[e] Department of General Surgery, Digestive Disease & Surgery Institute, Cleveland Clinic, Cleveland, OH
[f] Division of Pediatric Surgery, Department of Surgery, Medical University of South Carolina, Charleston, SC
[g] Division of Pediatric Surgery, Department of Surgery, UT Southwestern Medical Center and Children's Medical Center, Dallas, TX
[h] Department of Surgery, Boston Children's Hospital, Boston, MA
[i] Division of Pediatric Surgery, Department of Surgery, Baylor College of Medicine and Texas Children's Hospital, Houston, TX

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ABSTRACT

*Importance:* Telemedicine is an emerging strategy for healthcare delivery that has the potential to expand access, optimize efficiency, minimize cost, and enhance patient satisfaction.
*Objective:* To review the current spectrum, potential strategies, and implementation process of telemedicine in pediatric surgery.
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*Conclusions and relevance:* Telemedicine is an emerging approach with the potential to facilitate efficient, cost-effective delivery of pediatric surgical services.
*Brief Abstract:* Telemedicine is an emerging strategy for healthcare delivery that has the potential to expand access, optimize efficiency, minimize cost, and enhance patient satisfaction. The objectives of this review are to explore common terms in telemedicine, provide an overview of current legislative and billing guidelines, review the current state of telemedicine in surgery and pediatric surgery, and provide basic themes for successful implementation of a pediatric surgical telemedicine program.
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**Contents**



* Corresponding author at: Department of Pediatric Surgery, McGovern Medical School at The University of Texas Health Science Center at Houston, 6431 Fannin St, MSB 5.233, Houston, Texas 77030. Tel.:+1 713 500 7300.
*E-mail address:* matthew.t.harting@uth.tmc.edu (M.T. Harting).

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Telemedicine is defined as the use of electronic information and communication technology to provide and support health care when distance separates participants [1]. As technology has advanced, the opportunity to apply this technology to the delivery of health care has emerged, overcoming previous barriers to healthcare with the potential to facilitate efficient, convenient, and/or cost-effective interactions between providers and patients.

Pediatric surgery is a field where highly-specialized care is delivered by a limited number of providers, to patients and families who often travel a significant distance to seek expertise. In the US, data suggest there are more than an adequate number of pediatric surgeons to care for these patients [2]; however, geographic disparities in the distribution of surgeons have created gaps in access to care. Therefore, the distance and travel time necessary to receive pediatric surgical care remain a burden for many children, families, and providers. Telemedicine has the potential to transform the way pediatric surgical providers interact with their patients, alleviating a significant part of the burden by adopting and integrating technologic tools to facilitate the provider–family–child relationship.

The objectives of this review are to explore common terms in telemedicine, provide an overview of current legislative and billing guidelines, review the current state of telemedicine in surgery and pediatric surgery, and provide basic themes for successful implementation of a pediatric surgical telemedicine program.

## 1. Defining telemedicine

### 1.1. Glossary of terms

*Telemedicine* is the rapid access to shared and remote medical expertise by means of telecommunication and information technologies, no matter where the patient or relevant information is located [3]. Though many nuanced definitions exist, the common themes include the use of technology, the existence of distance between two parties, and the delivery of health care.

*Telesurgery* is remote operating through the use of a surgical robot actively controlled by a distant operator [4].

*Telementoring* is performed by an expert that instructs, guides, and/or teaches another individual, usually less skilled in that field or specific procedure, from a remote location via a live audio and/or video feed [5]. Distinct from this is *teleproctoring*, where supervision/assessment of a procedure occurs from a distance using telecommunication technology.

*Telemonitoring* is an application of telemedicine in which physiological and biological data are transferred from the patients' home, intensive care unit, or other location, to a unique, specialized center for the purpose of monitoring patients, interpreting the data, and making clinical decisions [6].

*Teleconsultation* is a consultation by remote telecommunications, generally for the purpose of diagnosis or treatment of a patient at a site remote from the patient or primary physician.

*Distant site* is the location where the provider (physician, advanced practitioner, nurse, or other member of a medical team) delivering the service is located at the time the service is provided via telecommunications system. Other common names include *provider/physician site, hub site, specialty site, referral site*, or *consulting site*.

*Originating site* is the location where the patient or relevant information is located or originating from, usually separate from the location of the physician, provider, or medical team. Other common names include *rural site, spoke site, remote site*, or *patient site*.

*Telefacilitator* is a healthcare professional, such as a registered nurse, present at the remote site with the patient who operates, and is familiar with, the technology necessary for the telecommunication, in addition to assisting with data gathering and components of the physical exam [7].

*Synchronous* is the delivery of telemedicine when the health care professional has direct audio/video contact with the patient [3].

*Asynchronous* is the delivery of telemedicine when information is acquired in one location and reviewed in a fashion where time is incongruent [3].

*Store-and-forward* refers to an asynchronous telemedicine encounter where information is acquired in one location and then reviewed in a fashion where time and location are incongruent [8].

### 1.2. Overview of telemedicine

Telemedicine is the use of computer-based technologies to manage a patient's health by exchanging medical information over a distance [7]. In the 21st century, the use of technology has exponentially increased, becoming ubiquitous with ready access to smart phones, tablets, laptops, and wireless connectivity. The exploitation of this technology facilitates the ability for patients to access a health care professional and aims to establish patient care in places and circumstances that would otherwise prevent, or severely impair, the patient's access to a healthcare system or specific expertise. However, the use of telemedicine precedes the technology we currently use to facilitate modern delivery of care and virtual encounters.

In the early 1900's, a Dutch physiologist developed the first electrocardiograph and transmitted it via telegraph in 1906 [3]. As the technology advanced, so did the applications of telemedicine. Norwegian physicians in the 1920's used radios to advise sick crewmembers on ships on how to manage healthcare [3]. The Australian Royal Flying Doctor service provided consultations using Morse code and voice radio in 1928 [4]. Dr. Michael DeBakey used videoconferencing to display an open-heart aortic valve replacement being performed at The Methodist Hospital in Houston, Texas to physicians in Geneva via satellite in 1962 [9]. In 1967, Bird and colleagues used audiovisual microwave circuits to consult and evaluate more than 1000 patients in Logan Airport from their location in Massachusetts General Hospital in Boston [3]. These early breakthroughs were the birth of telemedicine, but widespread application, to a myriad of situations and circumstances, in various forms, emerged from infancy over the last decade with rapid advances in audio, video, and wireless technology.

### 1.3. Overview of telementoring

When expertise and/or experience is limited at a remote site and a distant provider can add valuable (sometimes critical) knowledge and/or insight, telementoring can bridge the gap. The term often implies a procedure-based specialty consultation, though it can certainly be applied in any specialty. Although telementoring has been occurring informally via telephone for many years, in 1996 Moore performed formal telementoring in 23 urological operations using the AESOP system [10]. Telementoring allows an experienced surgeon to guide and assist those training and performing an operation remotely through the use of technology. Traditionally, surgical training is overseen and administered by in-house faculty but can be limited to the number of experienced faculty at a given institution. Remote mentoring allows trainees to expand their range of mentors. In order for this application of telemedicine to be effective, there is usually a synchronous form of communication between the two parties in which instant exchange of information can occur [4].

## 2. Guidelines, legal / regulatory issues, and billing / reimbursement

### 2.1. Guidelines

The American Telemedicine Association (ATA) is an organization that consists of healthcare professionals, technology and telecommunications companies, and government officials who have a similar goal to improve the delivery of healthcare [11]. Guidelines involving the use of telemedicine were first established by the ATA in 1999 and were specific for the field of telepathology [12]. These guidelines were developed through a process involving rigorous review which resulted in a general consensus. The ATA board of directors ultimately approved the set of proposed guidelines and continues to review and update the guidelines periodically based on current literature in the fields of telemedicine as well as feedback from special interest groups, corporate partners, and institutional members [11,12]. Although guidelines have been established for many different fields of medicine, the ATA has not established guidelines directed at the practice of telemedicine in surgery. The guidelines summarized in Table 1 are those that have been established by the ATA for primary and urgent care and, as of the present time, should be applied to the practice of telemedicine in pediatric surgery.

**Table 1**
Summary of the American Telemedicine Association (ATA) guidelines for the practice of telemedicine.

1. Providers must follow regulatory and licensure requirements, delivering care within the scope of their certification, training, and qualifications.
2. The patient must be physically located in a jurisdiction where the provider is licensed and credentialed.
3. Providers must inform and educate the patient about the nature of telemedicine services compared to a traditional encounter including:
   A. Limits to confidentiality with electronic communication
   B. A backup plan for technical or other challenges
   C. Appropriate expectations for the encounter
   D. The expectation of a professional environment including privacy and lack of distraction
4. Services must be culturally competent, including issues of gender, orientation, location, religion, and socioeconomic status.
5. Providers and patients should be able to converse in a language appropriate for both, with the use of a translator as needed.
6. Privacy and confidentiality requirements stipulated by HIPAA must be followed.
7. Devices used for medical encounters should have appropriate physical and technical safeguards to minimize the risk of data compromise.
8. Patients should be made aware of potential costs of care.
9. Providers should ensure that they have the technical capability necessary to conduct an encounter specific to the needs of the specialty (ie quality of image, specific radiographic imaging, stethoscope, etc).

### 2.2. Legal and regulatory issues

Regulations for practicing telemedicine are currently handled at the state level. These regulations are created by individual state law and state medical board requirements. Each state legislature enacts laws governing health care in their state, while the authority to implement these acts and oversee providers is delegated to state licensing boards. Providers practicing medicine, including telemedicine, must be licensed in the state in which they practice. Each state may also have additional specific requirements for telemedicine, including who may practice telemedicine (i.e., provider type or specialty), the originating site (where the patient is located), type of visits allowed, ability to prescribe medications, and/or reimbursement requirements. Additional important regulatory issues that must be considered when practicing telemedicine include cross-state practice, credentialing and granting privileges, informed consent, and documentation requirements.

#### 2.2.1. Cross-state practice

Telemedicine facilitates the possibility for providers to practice medicine in several states without travel. However, providers must be aware of specific regulations that affect cross-state practice. When a provider is located in one state and the patient is located in another, the originating site (location of the patient) is considered the location where the provider is practicing medicine. In this situation, the distant site provider must be licensed in and follow all regulations of the state in which the patient is located.

To alleviate the licensure burden, some state medical boards issue specific licenses and/or certificates related to telemedicine that may allow out-of-state providers to avoid having to obtain full, unrestricted licensure just to practice cross-state telemedicine. Additionally, the Federation of State Medical Boards has created the Interstate Medical Licensure Compact to expedite licensure for qualified physicians who practice in multiple states. The Compact is an agreement between 22 states whereby licensed physicians can qualify to practice medicine across state lines within the Compact if they meet eligibility criteria [13].

Some states make further exceptions to these cross-state licensure requirements. However, these exceptions are limited and vary from

state to state. Examples of some licensure exceptions include physician-to-physician consultations (i.e. telementoring), medical emergencies, and educational purposes. A good resource for updated licensure requirements is http://www.cchpca.org/state-laws-and-reimbursement-policies [13].

#### 2.2.2. Credentialing and granting privileges

Providers that practice telemedicine must also have privileges to practice medicine at any hospital that acts as the originating site for the patient. However, the process of credentialing and granting privileges for every distant site provider that offers telemedicine consultation to a hospital can become quite burdensome. For this reason, there is an option for an originating site hospital to "privilege by proxy". In this situation, the hospital receiving telemedicine services may accept the credentialing and privileges decision from the distant site hospital if certain requirements are met. However, this option also has to align with the hospital bylaws, along with state laws and regulations [14].

#### 2.2.3. Informed consent

Federal law does not require informed consent specific to the use of telemedicine; however, some states have requirements by regulation and/or Medicaid policies. Under these circumstances the provider must receive and document informed consent, specifically addressing telemedicine, from the patient prior to the use of telemedicine [13].

#### 2.2.4. Documentation

Federal health oversight agencies including the Joint Commission and US Department of Health and Human Services do not specifically address any documentation requirements for telemedicine visits. Therefore, a telemedicine encounter should be documented and the health record maintained in the same manner as an in-person visit. Additional information that is recommended to be included in the documentation is that the visit was conducted by telemedicine, the patient location (originating site), the provider's location (distant site), and the names and roles of all people present during the visit. If informed consent is necessary by state regulations or institutional policy, then it should be documented and maintained as part of the health record [15].

### 2.3. Billing & reimbursement

The nuances of billing and reimbursement are highly varied and dependent on both payer and location. The billing and reimbursement landscape of telemedicine is dynamic and constantly evolving as telemedicine gains more popularity, is being embraced by patients, and is being increasingly adopted by practitioners and institutions. The United States Government Accountability Office (GAO) recently reported to congressional committees the current state of telehealth and remote patient monitoring use in Medicare, Medicaid, and other selected federal programs [16]. While these reimbursement policies may differ from individual commercial payers, their findings do demonstrate the variation and constant evolution of coverage for telehealth services [16].

Medicare, which provides health coverage for people over the age of 65, individuals with certain disabilities, and individuals with end stage renal disease, began paying for telemedicine services after the passage of the Balanced Budget Act of 1997. This statute required Medicare to pay for services such as consultations, office visits, and outpatient psychiatry services using real-time audio/visual telecommunications [16]. However, Medicare requires that the originating site (location of the patient) must be a medical facility (hospital, clinic, or skilled nursing facility) located in a rural health professional shortage area. The distant site provider is paid the same rate for services delivered by telemedicine services as they would be paid for the same in-person service. The originating site is paid a facility fee of $25.00 [16].

In 2014, 68,000 Medicare Part B fee-for-service beneficiaries received some form of telemedicine service. Of those who received these services, 42% of these telemedicine encounters were located within 10 states, revealing that there is an unequal distribution of telemedicine services throughout the country. These patients who had access to telemedicine averaged three telemedicine visits per year and Medicare spent an average of $182.00 per beneficiary [16]. Although Medicare does not have a special category for remote patient monitoring, these services can be bundled with other services in order to be covered. Medicare spent $119 million on remote cardiac monitoring services for 265,000 patients and $70 million on remote monitoring of heart rhythms for 639,000 patients in 2014 [16]. Telemedicine, however, only makes up a small portion of total of Medicare claims each year.

There are several barriers within Medicare and its involvement with telemedicine services that have been identified. The coverage has been noted to be the single greatest barrier, as Medicare places restrictions on the types of telemedicine services covered [16]. Other barriers that have been identified include Medicare's location requirements, cost increases or inadequate payment, provider and patient training requirements, cultural factors, equipment costs, and professional licensure issues [16].

The Centers for Medicare and Medicaid Services (CMS) do not limit the use of telehealth and remote patient monitoring in Medicaid. Instead, each individual state may determine any restrictions and limitations for telehealth coverage. Reimbursements from Medicaid vary widely from state to state. Each state has its own definitions regarding what constitutes telemedicine, and which services may qualify for reimbursement. In fact, states even differ in their use and definitions of terminology such as "telemedicine" or "telehealth". In some states "telehealth" is used to incorporate a broader meaning while "telemedicine" specifies the delivery of clinical services [17].

As of April 2017, 48 states and the District of Columbia provide some form of reimbursement for telehealth services through their Medicaid program. The two states without written reimbursement policies are Massachusetts and Rhode Island. However, some states utilize broad regulatory statements that do not provide specific reimbursement policy, which results in policy that is vague and open to interpretation.

Live video is the most widely accepted telehealth modality amongst Medicaid programs. Every state that offers telehealth reimbursement through their Medicaid program includes some form of reimbursement for live video. However, there is substantial variation in regards to what services are eligible and how the services will be reimbursed. Variations in telehealth coverage by states include the specialties covered, types of services reimbursed (i.e., office visit, inpatient consultation, etc.), types of providers reimbursed (i.e., physician, advanced practice provider, nurse, etc.), and the location of the patient (originating site).

Store-and-forward, an asynchronous telehealth application, is further limited by many state Medicaid programs. As of April 2017, only 13 states provide reimbursement for store-and-forward telehealth services, and many of these states have further restrictions including approved specialties and types of services.

Remote patient monitoring is currently only approved for reimbursement in 22 states. However, many of the states have several restrictions including which clinical conditions can be monitored, and the type of monitoring device and the information collected, and some only offer reimbursement to home health agencies.

Currently private payer reimbursement policies for telehealth vary across the country. There are 35 states that have laws governing these policies; however, not all mandate reimbursement. Additionally, there is variation in whether the amount of reimbursement for services delivered via telehealth has to equal the reimbursement for services delivered in-person.

The Center for Connected Health Policy provides an annually updated resource summarizing telehealth-related laws, regulations, and Medicaid coverage for all 50 states and the District of Columbia (http://www.cchpca.org/state-laws-and-reimbursement-policies).

## 3. Current state of telemedicine in surgery and pediatric surgery

There are a variety of applications of technology and telehealth in the practice of medicine and these are often different based upon the specific field, the setting, and/or the institution/provider. These uses include using mobile phones to take and send images, using telephones for consultations, e-mail use, live feed videoconferencing with patients or colleagues, monitoring patients at home with chronic conditions, intensive care unit (ICU) monitoring, surgical consultation, postoperative care, and many other uses of technology to aid the physician in communication with patients, other physicians, or associate providers. Generally, telemedicine can be divided into four broad categories including real-time or synchronous, store-and-forward or asynchronous, remote patient monitoring, and mobile health [18].

Real-time or synchronous telemedicine has a multitude of uses and is generally the main modality that comes to mind when referring to telemedicine. This modality uses live audio and video feeds to link two providers together or a provider to a patient. This allows for telementoring between two physicians during an operation as mentioned previously, as well as teleconsultations and/or education between two providers. Real-time telemedicine can be used in the clinic setting preoperatively to diagnose a patient and determine if an operation is necessary and can also be used in the postoperative setting to follow patients and monitor their recovery. This is the most common modality reimbursed by health care plans, as discussed earlier [16–18].

Store-and-forward, an asynchronous modality, involves using computers, email, or mobile phones to capture and deliver medical information such as images and send them to a specialist or physician at another location [3,8,18].

The remote patient monitoring modality allows physicians and health care professionals to monitor patients electronically at another location. This modality is often used in patients with chronic conditions such as hypertension, diabetes, and chronic obstructive pulmonary disease [16,18].

Mobile health modality involves using mobile phone apps and online services that are available to patients allowing them to view lab results, medications, appointments, and other details involved in their health and recent physician encounters [18].

### 3.1. Telemedicine in surgery

There are increasing reports of telemedicine being utilized in adult surgical specialties. The specific modality utilized varies widely from pre- and postoperative visits to a few very early applications of telesurgery. These applications also vary in their use of synchronous, real-time audio/visual technology and store-and-forward, asynchronous technology.

Synchronous telemedicine uses technology that allows patients and providers to communicate through both audio and video, providing visualization of the patient and expanding the amount of information that is exchanged between provider and patient. It has been discussed how this form of communication can be extremely useful within the operating room, but it has a potentially broad array of applications in both the preoperative and postoperative periods.

During the preoperative period, the physician is now able to evaluate possible candidates for surgery who are in rural or remote locations, without local access to a surgeon. With the use of synchronous video and audio feeds, physicians are now able to witness and guide a physical exam, performed by the telefacilitator at a remote site. The telefacilitator, generally a registered nurse or other specialist, is present with the patient during the encounter and is also responsible for handling the equipment at the remote site [7].

In the postoperative period, physicians are able to follow-up with patients and manage their care from a distance. This can become extremely useful for patients who do not live in close proximity to the surgeon's practice or the center where the operation was performed. Many studies have evaluated the use of telephone calls, videoconferences from a remote site, collection of data via text messaging such as daily surgical drain output, spirometry results, symptoms, blood pressure and adherence to medications, and digital photography [19]. A recent systematic review of telemedicine for postdischarge surgical care revealed that outcomes were comparable between telemedicine and usual care, and that no difference in the rate of complications appeared to result from the use of a telemedicine approach [19]. Notably, the majority of studies reported significant time, travel, and resource savings to patients and their families without compromising clinical outcomes. Moreover, both patients and providers reported high satisfaction and could clearly comprehend the benefit of incorporating telemedicine into a postoperative care program. Hwa et al used telephone calls for postoperative follow-up visits after umbilical hernias and laparoscopic cholecystectomies, which resulted in no complications and opened 110 clinic spots over a 10-month period [20]. Vieres et al used video conferencing after radical prostatectomies for follow-up and found no urologic complications over a 3 month period, higher patient and provider satisfaction, and overall equal efficacy to clinic visits [21].

In another study, simply using mobile phone-based telemedicine during the postoperative course to assess and monitor for surgical wound complications resulted in rapid resolution of common postoperative questions [22]. If patients were concerned with their surgical wound, they were instructed to contact the surgical team via phone and then to take pictures of the area on their phone and send it to the surgery team. These images were viewed and examined by three physicians who would then contact the patients and instruct them on what steps they should take to resolve their complaint. In this study, 225 photographs were examined owing to complications such as hematomas (66%), bloodstains on bandages (23.3%), exudates (3.3%), allergic skin reactions (3.3%), and tight bandages (3.3%). The physicians were able to identify the problem in each case and resolve the patients concerns in 66.7% of the cases. In the remaining 33% of the cases, the concerns were resolved over the following days with subsequent images [22].

Telesurgery is another use of telemedicine in surgery that involves the use of robotic devices that can be operated by a surgeon at a distant location. Robotic devices such as the Zeus system and the da Vinci surgical system are the most robust and widely-adopted systems. In 2001, the first transcontinental telesurgical operation was performed using the ZEUS system, in which a laparoscopic cholecystectomy was successfully performed in Strasbourg, France while the surgeon operated the system from New York, USA [4,23].

The Zeus System consists of the "patient side" and the "surgeon side" that are connected through asynchronous transfer mode technology (ATM). On the side of the patient, two robotic arms are present allowing for control of the endoscopic camera on one arm and on the other a plethora of instruments can be interchanged, dependent on those required to complete the surgery. The surgeon at the "surgeon side" operates these robotic arms in a nonsterile environment at a separate site. The two sites are also connected through videoconference to allow for communication [23]. The da Vinci® surgical system is also a surgical robot similar to the Zeus® System. This robotic system has two arms for surgical instruments that have unique ends called "endo-wrists" that allow for seven degrees of movement and another arm for an endoscopic camera [5]. Despite incredible advances that allow for the possibility of operations performed by a surgeon from a distance, limitations of patient size and the need for bedside surgical expertise in the event of a surgical complication or technical failure, render routine or daily telepediatric surgery a target with some significant barriers yet to be overcome.

### 3.2. Current and emerging utilization of telemedicine in pediatric surgery

The use of telemedicine in pediatric surgery continues to grow and evolve. Although there are currently few published reports demonstrating the use of telemedicine in the pediatric surgical population there are

numerous growing programs around the United States. Current and emerging uses included telementoring, pre- and postoperative telemedicine visits, direct primary care consultation, remote patient monitoring, burn care, emergency room and urgent care triage, and surgical consultation to community ICUs [24–26].

*3.2.1. Telementoring*

Current applications for telementoring in pediatric surgery tend to include rare, technically challenging cases that are approached in a minimally invasive fashion (i.e. laparoscopy, thoracoscopy) where the primary surgeon has suboptimal experience with the technique. Minimally invasive approaches are more conducive to surgical telementoring because the video feed can be simply reproduced for the telementor to see, and, with telestration abilities, the telementor can annotate over the endoscopic images for further clarity. Telementoring should be implemented in a responsible fashion: it is not a replacement with in-person training or courses, but rather should be an adjunct to the above methods to improve the learning curve for a technique in which the telementee has a baseline experience but there is no local mentor. Published pediatric surgical cases that have been telementored include laparoscopic gastrointestinal surgeries, laparoscopic inguinal hernia repairs, thoracoscopic lung resections, thoracoscopic mediastinal mass excision, and thoracoscopic congenital diaphragmatic hernia repair [27–29]. Obstacles for telementoring include a lack of legislation regarding the medicolegal liability of the telementor as well as no current financial model (ie no billing code) to compensate the telementor for his or her time.

*3.2.2. Pre- and postoperative visits*

Telemedicine has been successfully used for initial pediatric surgical consultation and postoperative care [30]. One of the more common uses is a "hub and spoke" design, where the pediatric surgical subspecialist is at a centralized "hub" location (i.e., tertiary care children's hospital) and the patients present to remote sites ("spoke") closer to home. At the remote site a telefacilitator works with the patient and is able to assist with the physical exam under direction of the distant provider at the centralized "hub" through a two-way real-time audio/visual connection. The remote sites are often clinic space owned or leased by the subspecialty provider's institution.

Another emerging application for postoperative visits is conducting a telemedicine visit directly to the patient's home. This has been used after select routine pediatric surgical procedures with success at several institutions (MTH and CLS institutions). Advantages include enhanced patient experience, family/patient cost savings, and potential institutional benefits of improved access through additional open clinic slots.

*3.2.3. Direct primary care consultation*

In a delivery model similar to the "hub and spoke" design discussed above, some pediatric surgical providers offer direct consultation to select primary care offices. In this situation, the primary care office staff (nurses, advanced practice providers, or physicians) may act as the telefacilitator and consult directly with a surgical specialist while the patient is in their office.

*3.2.4. Remote patient monitoring*

Remote patient monitoring is a growing trend in pediatric surgical patients. This technology allows providers to monitor patients at home through both synchronous and asynchronous applications. Monitoring tools may include pulse oximetry, vital signs, weight, feeding patterns, video uploads, incision checks, etc.

*3.2.5. Burn care*

Telemedicine for pediatric burns offers the ability to expand the outreach of the limited number of pediatric burn specialists. Applications include burn specialists monitoring inpatient burn debridements and wound care without having to be physically at the bedside, triaging new burns to ensure patients receive care at appropriate facilities, and monitoring outpatient burns.

*3.2.6. Emergency room and urgent care triage*

Several health care systems have begun to use telemedicine to assist in triaging patients presenting to local emergency rooms and urgent care centers. Often the goal of these centers is to expedite surgical specialty consultations to determine treatment recommendations, need to transfer to a higher level of care, or appropriate outpatient management. The most common application is for isolated trauma including, burns, fractures, wounds / lacerations, and closed head injuries without radiographic findings. Further, the feasibility of using a robotic telecommunications system to provide remote triage and expert consultation has been demonstrated in pediatric mass casualty situations [24].

*3.2.7. Surgical consultation to community ICUs*

To meet requirements of verification programs, some institutions have opted for a virtual surgical presence in their ICUs. This has led to a greater number of neonatal and pediatric ICUs using telemedicine to provide surgical consultations for their critically ill patients. This provides these institutions greater opportunity to appropriately determine when a patient may need to be transferred for surgical issues and keep the children that may not need surgical intervention.

## 4. Implementation of a pediatric surgery telemedicine program

*4.1. Why incorporate telemedicine into your practice?*

As immediate access to goods and services becomes ubiquitous, the desire for immediate access to healthcare continues to mount. Healthcare is rapidly evolving, with patients continuing to expect optimized quality and efficiency, payers decreasing reimbursement, and physician demands ever increasing; telemedicine can have a profound, positive effect on all these forces. Telemedicine can allow providers and systems to get the right patient, to the right place, at the right time, so that appropriate expertise is available to ensure that optimal care is provided. A summary of proposed benefits and barriers/challenges to practicing telemedicine is shown in Table 2.

**Table 2**
Summary of proposed *benefits* and *barriers/challenges* to incorporating telemedicine into a pediatric surgical practice.

| |
|---|
| ***Benefits*** |
| 1. Increased access to / reach of pediatric surgical expertise: |
| A. Geographically |
| B. Economically |
| C. Temporally |
| 2. Increased patient convenience |
| 3. Optimize patient and family engagement |
| 4. Increased physician efficiency |
| 5. Potential to decrease health care costs |
| A. Patients/families |
| B. Hospital, hospital systems, and institutions |
| C. Payers |
| 6. Standardization of care |
| 7. Opportunity to optimize quality of care |
| 8. Enable consistent monitoring and longitudinal data collection/follow up |
| ***Barriers and Challenges*** |
| 1. Licensure |
| 2. Provider and administrative buy-in |
| 3. Credentialing and bylaws |
| 4. Reimbursement |
| 5. Medicolegal and malpractice concerns |
| 6. Technological (both hardware and software) and connectivity limitations |
| 7. Patient and family acceptance |
| 8. Physical examination limitations |

### 4.2. Initial steps

Initiating a program in telemedicine, or simply establishing the capacity to see patients at a distance, can seem daunting to a provider unfamiliar with the processes, regulations, nuances, and technology involved in programmatic development and implementation of telemedicine services. These steps are common to general program development, with a few nuances specific to (tele) medicine.

#### 4.2.1. Develop a vision

What patient population are you trying to serve? What is the local/regional institutional, provider, and payer landscape? A successful program starts with an idea about who, exactly, you want to connect, on both the provider and patient side. That idea should grow into a vision based on a multitude of surrounding factors including the region, institution, providers, politics, resources, and technologic opportunities.

#### 4.2.2. Institutional and provider buy-in

The most critical and foundational step to developing a successful telemedicine program is initial institutional *and* provider buy-in. Both parties should have alignment in their vision, strategy, and goals for the program. The institution should be prepared to support the program from initial implementation through later growth phases. This support needs to consist of financial, technical, and administrative operational support/resources. Administrative or institutional champions must see the long-term vision and understand the likely short-term challenges. From the provider side, there does not need to be buy-in from every provider across the institution. However, there *must* be physician champions in key target areas that are identified as interested and willing personnel opportunities for telemedicine development/implementation.

#### 4.2.3. Know your specialty and environment

Every specialty has a unique patient population and a thorough understanding of the patients and disease processes will guide appropriate development of telemedicine opportunities. One of the earliest steps (possibly even before Institutional and Provider Buy-in) is to understand the legal and regulatory environment of your state. Each state has different telemedicine regulations, as discussed above. There needs to be a clear understanding of state regulations, state medical board requirements, and institutional credentialing requirements. This may seem like an overwhelming task; however, there are numerous resources that make this information readily available (i.e., http://www.cchpca.org/state-laws-and-reimbursement-policies and http://www.americantelemed.org/home).

#### 4.2.4. Decide on the application that fits your vision

As discussed above, there are numerous different telemedicine modalities available that have improved patient experience, access, and institutional efficiency. Choose the setting and telemedicine application that meets the need of your institutional vision (i.e., outpatient surgical care, remote patient monitoring, inpatient / ICU care, etc.).

#### 4.2.5. Choose your technology

There are numerous telemedicine technologies available through many vendors. Based on your application, budget, and institutional vision and growth strategy, the right technology is likely available. The keys to selection are to ensure a reliable platform that provides privacy to meet HIPAA requirements, offers the ability to scale based on institutional needs, and potential for peripheral add-ons (i.e., stethoscope, digital zoom camera, otoscope, ophthalmoscope, etc.), if necessary. Technological support is important to consider, both for patients and providers, depending on resource availability.

#### 4.2.6. Develop metrics

To demonstrate success of the telemedicine program it is important to develop early metrics that will be prospectively measured. These metrics can be broadly divided into three categories: patient perspective, provider perspective, and institutional perspective. Examples of patient perspective metrics include cost / travel / time savings, access to care, and patient experience. Examples of provider perspective metrics may include efficiency, effects on outreach, or specific program growth. Examples of institutional perspective metrics may include patient access, market share, new revenue (direct and downstream), decreased expenses, or patient experience evaluations.

## 5. Patient perceptions and experience

Patient satisfaction and eagerness to use and accept telemedicine as a standard of care are still uncertain and assessment of patient's views and understanding is highly dependent upon many factors. In a study in Ontario, Canada, a survey measured family costs and attitudes toward telemedicine alternatives in pediatric urology and general surgery outpatient clinics [31]. Of the families that took the survey, around twenty percent traveled more than 200 km round-trip for an appointment at the clinic and over ten percent of families use several means of transportation. A common complaint was that the cost of hospital parking is too high and parking rates should be reduced. In 75% of the families, at least one parent had to miss work to attend the clinic visit and in 25% of families both parents had to miss work. It was found that both parents were more likely to miss work with increasing travel distance. Nearly twenty percent of families also perceived the cost of the visit "somewhat high" and 9.6% of families perceived the cost of the visit "high" when all costs were factored in including the cost of travel, lodging, babysitters, food, parking, missing work, etc. In regards to telemedicine, families felt comfortable or extremely comfortable communicating with healthcare professional through email (69.9%), telephone (82.9%), and video conferencing (52.9%). In comparison, the majority did not want to substitute a visit with the use of email, telephone, or video conferencing. Of those who stated that they would be comfortable substituting an inpatient visit with use of telemedicine, 34.3 % were comfortable with email. 42.7% with telephone, and 38.4% with video conferencing. Patients who were familiar with these telemedicine services were more like to be willing to substitute a clinic visit with telemedicine communication; however, only twenty percent of those families in the survey were familiar with this method [31].

Gunter et al found that patients who underwent follow-ups utilizing telemedicine applications decreased personal costs, minimized travel time, and decreased the need to take days off from work or miss other responsibilities [19]. Surveys showed that the majority of patients were willing to participate in telemedicine and thought it would aid in their communication with the health care provider. Patients who had already participated in a postoperative protocol reported high rates of satisfaction and found the system easy to use. Canon et al revealed that patients were 111% more likely to prefer a remote postoperative follow-up using telemedicine for every 23-milesincrease in distance from the site of the appointment [19].

In study of 1734 individuals who completed a survey after receiving care through a telehealth visit at CVS minute clinics, 32% of these patients expressed a preference for receiving care via telehealth, 57% stated that their telehealth visit was "just as good as a traditional visit", 1% stated that it was "worse than a traditional visit" and the remainder were unsure. In regards to the technology, 95% of patients were very satisfied with their ability to hear and see the health care professional and the images on the screen and 95% of individuals stated that they were "very satisfied" with all attributes. Nearly 100% of patients stated that they would recommend the use of telehealth to someone else and also stated that they would use it again. However, it was found that there was an inverse relationship with the high satisfaction of the assisting nurse and the satisfaction of the telehealth visit [32].

Patient satisfaction should be highly sought in all aspects of medicine and ongoing assessment of patient and family perceptions of telemedicine is critical to optimizing applicability.

## 6. Conclusions

A new era in medicine is upon us. For pediatric surgeons, telemedicine is an emerging opportunity to optimize the surgeon–patient–family relationship. As the regulatory landscape continues to change, so have the numerous applications of telemedicine within pediatric surgery. Utilization of telemedicine continues to grow among US pediatric surgeons owing to its potential to improve efficiency while also providing more cost-effective and patient-centric care.

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