World Journal of Urology (2020) 38:2377–2384
https://doi.org/10.1007/s00345-019-02882-9

TOPIC PAPER

Current use of telehealth in urology: a review

Peris Castaneda[1] · **Chad Ellimoottil**[2]

Received: 14 April 2019 / Accepted: 19 July 2019 / Published online: 27 July 2019
© Springer-Verlag GmbH Germany, part of Springer Nature 2019

Abstract

Purpose Applications of telehealth have been growing in popularity. However, there is little information on how telehealth is being used in Urology. In this review, we examine current applications of telehealth in urological practices as well as barriers to implementation.

Methods A review was conducted of original research within the past 10 years describing telehealth applications in urology. Articles on telehealth as applied to other specialties were reviewed for discussion on real or perceived barriers to implementation.

Results Twenty-four articles met the inclusion criteria. The most common application of telehealth was using a video visit to assess or follow-up with patients. The second most commonly described applications of telehealth were telementorship, or the use of telehealth technology to help train providers, and telemedicine used in diagnostics. Studies consistently stated the effectiveness of the telehealth applications and the high level of patient and provider satisfaction.

Conclusions Telehealth is sparingly used in urology. Barriers to implementation include technological literacy, reimbursement uncertainties, and resistance to change in workflow. When used, telehealth technologies are shown to be safe, effective, and satisfactory for patients and providers. Further investigation is necessary to determine the efficacy of telehealth applications.

Keywords Telemedicine · Telehealth · Patient-centered care · Health communication

History

The history of telehealth, or telemedicine, dates back to the late nineteenth century, when an article in The Lancet described using the telephone to reduce unnecessary patient visits [1]. By the 1950s, teleradiology and video communication for medical uses had developed [2]. The concept of telemedicine is hardly novel; however, its applications have grown substantially in recent decades. The rapid development of accessible electronic technology has enabled more patients and providers to participate in telemedicine programs.

Telehealth services are now used by hospitals, specialty clinics, skilled nursing facilities, and various types of providers. Patients, as well as providers, are recognizing telehealth as a legitimate—at times preferred—means of conducting healthcare [3, 4]. As of 2012, millions of Americans were using telehealth services and roughly 40% of hospitals in the United States had adopted telehealth in some capacity [5]. Importantly, insurance providers are increasingly recognizing telehealth services. Forty-eight states provide some form of Medicaid reimbursement for telehealth services, and most commercial plans provide select telehealth coverage [6].

The terms ‘telemedicine’ and ‘telehealth’ are frequently used interchangeably. However, the term ‘telemedicine’ predates ‘telehealth’ in the literature. Telehealth reflects the more recent, inclusive idea of the various components beyond just medicine that contribute to a person’s overall state of health [7]. We can think of telehealth as information and communication technologies that improve overall health (of an individual, but also of the broader public health) and which encompass all aspects of medical care, whereas telemedicine refers to technologies used specifically for diagnosing and treating disease [8].

✉ Peris Castaneda
pcastane@med.umich.edu

[1] University of Michigan Medical School, 2800 Plymouth Rd, Bldg 16, 1st Floor, Room 152S, Ann Arbor, MI 48109, USA

[2] Institute for Healthcare Policy and Innovation, University of Michigan, Ann Arbor, USA

Telehealth can be implemented through several different modalities, including standard means of communication like telephone and email, audiovisual recording devices, videoconferencing software, and wearable devices. There are three primary types of telehealth applications: synchronous, asynchronous or store-and-forward, and remote patient monitoring [9]. The combination of modalities and uses provides the opportunity for abundant applications of telemedicine technologies.

Moreover, telehealth can be used to facilitate communication between providers or between providers and patients. Synchronous ('real time') telehealth applications, for example, include remote clinic visits as well as provider consults. Asynchronous applications involve the collection and storage of health information for later review. Such applications include electronic consultations and communication with patients through a health portal. Remote patient monitoring is a type of asynchronous telehealth that involves regular collection of patient health data, such as vitals, and transmission to a provider for monitoring or response. Finally, telehealth can aid the education of trainees or even practicing physicians ('telementorship'). Live or store-and-forward recordings of procedures performed in one institution can be used to educate those at a distant institution.

Despite its rapidly growing popularity, telehealth has garnered little attention in the field of urology. Several telehealth pilot programs have been implemented to augment urological care; however, widespread adoption of telemedicine modalities in urology practice is not yet commonplace. In this review, we examine recent literature on telehealth in urology to determine current and developing patterns of use and barriers to widespread adoption.

Telehealth in urology

Methods

We performed a search of original articles available on PubMed and Google Scholar using the term "urology" and related terminology, combined with one of the following terms: telemedicine, telehealth, e-health, ehealth, telederm*, telecare, telenurs*, telemet*, monitor, telemonitor, mobile health, mhealth, apps, and mobile application.

To capture recent trends in telehealth, we limited the search to articles published within the last 10 years that describe a primary intervention of telehealth in a urologic setting. Only articles originally published in English were included. We excluded review articles and those describing telehealth interventions that had not yet been implemented (Fig. 1).

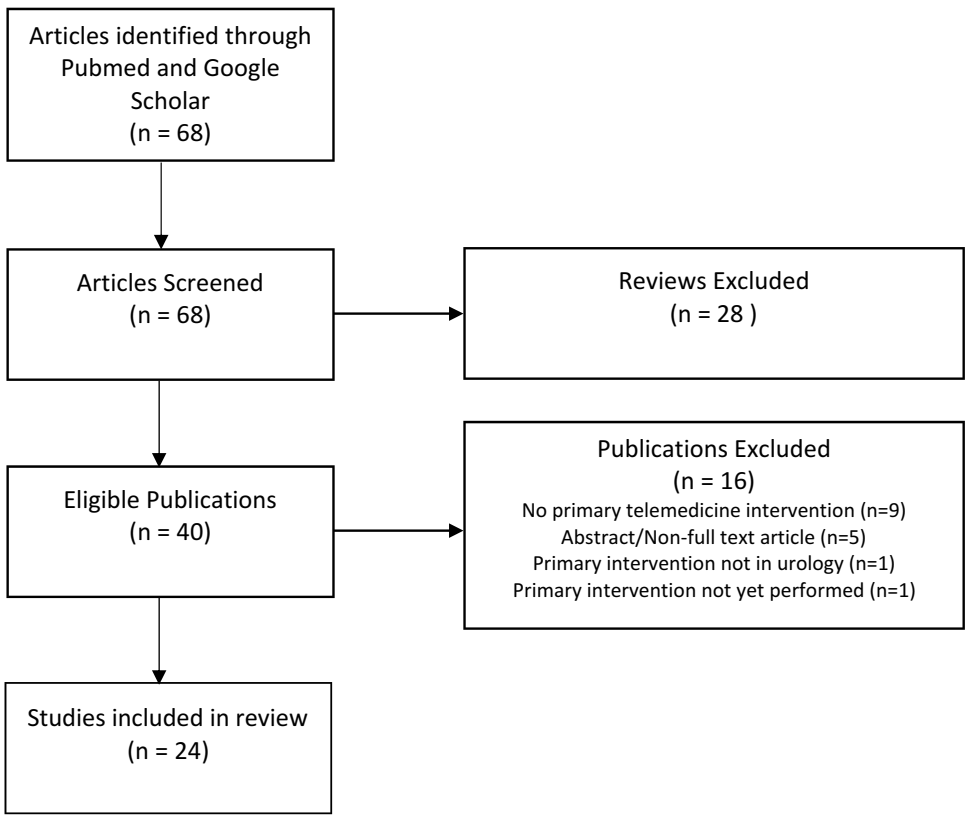

Fig. 1 Selection telehealth of articles for review

Results

Twenty-four articles met the inclusion criteria (Table 1) [10–33]. The most common telehealth modality was video visits, also referred to in the literature as televisits or telemedicine clinics. Video visits were used to aid in preoperative evaluation and postoperative follow-up and management, and in the evaluation of remote or secluded patients with general urologic concerns. Patients participating in video visits included veterans, pediatric patients, and incarcerated patients. Overall, studies reported a high level of patient satisfaction with video visits and found that they were an effective and safe means of conducting follow-up visits.

Six articles described a telehealth application in a pediatric setting. Carter et al. describe a digital package used for monitoring urinary tract health in children under 5 years with neurogenic bladder [12]. Mozafarpour et al. describe a store-and-forward application in which video clips of children voiding taken on parents' mobile phones are sent to the clinical team to aid with diagnosis. The authors suggest that this application saves on cost of healthcare personnel and allows practitioners to observe the urine flow of pediatric patients in a comfortable environment [15]. The remaining four articles describe virtual visits used in the preoperative evaluation or post-op follow-up of pediatric patients [25, 29, 31, 32]. High patient and clinician satisfaction with video visits were cited among those studies that included assessment of patient or provider satisfaction. The most commonly cited problem with video visits was difficulty with the hardware or software.

Four of the 24 articles described telementorship. In Safir et al., remote monitoring and supervision (RMS) allows faculty to supervise residents acquiring endourology skills [21]. A study by Anderson et al. found that patients undergoing endourology procedures were accepting of RMS [22]. Kumar et al. and Fitzpatrick et al. described enhanced evaluation tools that may be used in assessment of trainees [20, 23].

Two studies described different techniques for remote patient monitoring. In Carter et al. parents regularly collected data on their children's weight, temperature, and voiding patterns and transmitted the data biweekly for analysis [11]. By comparison, Agarwal et al. present a pilot study in which wearable electronic devices were used to monitor biophysical markers and activity in real time [11]. Their study of 46 men undergoing robot-assisted radical prostatectomy (RARP) demonstrated a high compliance rate (96% during the day and 75% at night) with wearing a physical activity monitor. Comparing preoperative and postoperative data gathered with a physical activity monitor, the authors found that RARP reduced ambulation by 29% postoperatively and that obese men ambulated 35% less than non-obese men. The authors suggest that physical activity monitoring may be used down the line to provide preoperative counseling or improve postoperative outcomes. Although this study monitored patients in real time, the data gathered were accessed retrospectively.

Mobile health (mHealth) is described in five of the articles, including two in the pediatric setting. In pediatric patients, mobile devices have been used to aid in the diagnosis of conditions such as meatal anomalies and bladder outlet obstruction [15]. Mobile devices were also used to monitor urinary health of children with neurogenic bladder [11]. In Senert et al., urologists evaluated the grade of hematuria using photos of voided urine sent via WhatsApp, a free mobile application. The remaining studies described a mix of teleconferences, telemedicine used for diagnosis, and e-consults.

Many of the studies in our review focus on the feasibility of implementing a particular telehealth application or the quality of the application as compared to its traditional counterpart. Few studies present some measure of outcomes; among these are patient satisfaction, cost, and safety. Shivji et al., Le et al., Agarwal et al., Viers et al., Chu et al., Park et al., and Thelen-Perry et al. issued questionnaires assessing patient satisfaction with the telehealth intervention [11, 16, 24, 27, 28, 30, 32]. While the precise metrics of satisfaction varied among studies, all seven studies report that patients were satisfied overall with the telehealth intervention. Those that compared the telehealth option to the traditional option found that patients were either equally satisfied with or preferential to the telehealth option.

Outcomes

Patient outcomes

Telehealth's value for patients is simple: time and money saved without compromising quality of care. E-consults allow for efficient evaluation of patients without requiring patients to wait for an appointment with a specialist and then pay the cost of travel and the opportunity cost of missing work hours. Studies of e-consult outcomes across different specialties estimate that the proportion of e-consults that do not subsequently require an in-person evaluation is between 62 and 92.1%, representing many visits saved [34–37].

Televisits further reduce patients' transportation costs. A study of patients receiving urological care via telemedicine clinics at the Veterans Affairs Greater Los Angeles Healthcare system revealed a saved average of 290 min of travel time, $67 in travel expenses, and $126 in opportunity cost from missing work [28]. Similarly, a study at the Mayo Clinic showed that patients participating in urologic televisits had similar face time with providers but incurred lower costs, shorter distance traveled, and less missed work time

Table 1 Original research on telehealth in urology in the past 10 years

References	Country	Telehealth category	Description of application
Rabie [10]	USA	e-consults	Teleconsultation is used in the management of prenatally diagnosed urologic anomalies
Carter [11]	USA	mHealth	Telemonitoring of urinary tract health of pediatric patients with neurogenic bladder
Agarwal [12]	USA	Remote monitoring	Wearable electronic devices are used to assess perioperative activity after prostatectomy
Skolarus [13]	USA	Teleconferencing, e-consults	Teleconferencing and e-consults are used by the VHA to improve access to specialty care among patients requiring prostate cancer survivorship care
Holten–Rossing [14]	Denmark	Telemedicine, diagnosis; e-consults	Pathologists are able to access a digital microscope remotely to examine urological cancer specimens and provide consult on a diagnosis over telephone
Mozafarpour [15]	USA	Telemedicine, diagnosis; mHealth	Video clips of voiding are used to evaluate urinary symptoms of children
Le [16]	USA	Telemedicine, diagnosis; mHealth	A sleep questionnaire is completed on a mobile platform to help characterize sleep patterns of patients at a men's health clinic
Pereira-Azevedo [17]	The Netherlands	Telemedicine, diagnosis; mHealth	A smartphone app designed used for prostate cancer screening is tested by medical practitioners for usability
Sener [18]	Turkey	Telemedicine, diagnosis; mHealth	Urologists evaluate the grade of hematuria using photos of voided urine sent via WhatsApp
de Souza-Junior [19]	Brazil	Telemedicine, management; telenursing	Phone calls, emails, and a messaging service are used to provide telenursing to patients who use chronic intermittent catheterization
Kumar [20]	USA	Telementorship/education	An automated recording system is used to develop a statistical model of operational skills
Safir [21]	USA	Telementorship/education	Remote monitoring allows faculty to remotely supervise residents receiving endoscopic training
Anderson [22]	USA	Telementorship/education	Remote supervision of residents by faculty is acceptable to patients undergoing endoscopic procedures
Fitzpatrick [23]	Canada	Telementorship/education	A mobile app that combines a competency evaluation tool and surgical case logs is used in the assessment of surgical trainees
Viers [24]	USA	Video visits	Video visits are used for follow-up visits in postprostatectomy patients
Finkelstein[25]	USA	Video visits	Video visits are used for follow-up visits in postoperative pediatric patients
Sherwood [26]	USA	Video visits	Video visits used to provide general urological care to male prisoner population
Thelen-Perry [27]	USA	Video visits	Patients who had participated in video visits with urology providers were asked about their satisfaction with the visits
Chu [28]	USA	Video visits	Urologic telemedicine clinics are used by the VHA in the diagnosis and management of common urologic conditions
Young [29]	USA	Video visits	Video visits are used for follow-up visits in postoperative pediatric patients
Park [30]	USA	Video visits	Telemedicine clinic is used in the preoperative and postoperative evaluation of patients at the VA
Canon [31]	USA	Video visits	Video visits are used for follow-up visits in postoperative pediatric patients
Shivji [32]	Canada	Video visits	Video visits are used for preoperative assessment and postoperative follow-up of pediatric patients undergoing routine elective procedures
Miah [33]	UK	Video visits	Video visits are used to provide general urological care

[24]. In both studies, patient satisfaction with televisits was very high. Moreover, in the former study, the most prominent urologic complaints were lower urinary tract symptoms, followed by elevated PSA, and prostate cancer; in the latter, all participants were patients with a history of prostatectomy for prostate cancer who were undergoing surveillance. These two studies suggest that televisits improve transportation cost and opportunity cost for patients with common urologic complaints or requiring long-term surveillance.

Multiple single-centered studies have suggested that current applications of e-consults and televisits are safe alternatives or augmentations to traditional consults and in-person visits [38–40]. Moreover, though some have expressed concern that video visits are impersonal compared to traditional visits, evidence suggests that patients may feel more at ease with video visits when conducted from the comfort of their own homes [41]. Using multiple telehealth modalities, we are able to move toward a more patient-centered and cost-conscious system of care.

Provider benefits

For providers, there is significant value in telehealth applications. E-consults allow for more timely provider-to-provider communication and decrease the time between consult requests and specialty provider recommendations [42]. For primary care providers, this allows for quicker incorporation of specialists' recommendations into a patient's care plan. For specialty providers, e-consults can reduce the number of low-acuity patients presenting for in-person evaluation, freeing up clinic space and time for patients who require early urologic evaluation. The improved timeliness of communication between providers may enhance interdisciplinary patient care.

Similarly, televisits allow providers to provide more efficient patient care. An important metric in clinic efficiency is cycle time—the time a patient spends at an office visit from arrival to departure. This includes 'value-added time,' or time spent with members of the care team, and 'non-value-added time,' or time spent waiting [43]. The entire process comprises patient check-in, time spent in the waiting area, patient–physician interaction, and check-out. For video visits, the process is reduced to logging into the visit, interacting with a urologist, and logging off. Preliminary data from the University of Michigan estimate that the average cycle time for a traditional clinic visit is approximately 70 min, while the average cycle time for a video visit is approximately 24 min [44]. The reduced cycle time for video visits not only increases the number of patients in clinic per day; it allows the urologist to spend more time with complex patients. Early studies suggest that providers recognize the potential benefits of these two telehealth modalities. Indeed, in addition to high patient satisfaction, studies consistently demonstrate high levels of provider satisfaction with e-consults and televisits.

Finally, there is much potential in the area of telementorship in urology. Remote monitoring of trainees performing simple procedures may enhance trainees' feeling of independence, while still providing the necessary supervision. Mobile apps that track clinical competencies may be used by trainees and faculty to improve individualized feedback.

Unknowns

There is a small but growing body of evidence demonstrating that the cost of telehealth is outweighed by its benefits to providers, patients, health systems, and society at large [45]. Further expansion of telehealth is predicted to improve the patient experience, health outcomes, clinical efficiency, and access to care [8, 44]. However, much remains unknown about exactly how the use of telehealth will best achieve these goals. A large-scale review conducted by the Agency for Healthcare Research and Quality revealed that while there is sufficient evidence to support the effectiveness of telehealth in the form of remote patient monitoring and remote counseling, evidence of other modalities' effectiveness is mixed [46].

The uncertainty around the effectiveness of telehealth applications, due to conflicting evidence and a dearth of high-quality large-scale studies, is an important barrier to widespread adoption of telehealth technologies [47]. Uncertainty is present even in telehealth applications that have widespread use and which have been in place for many years. For instance, one systematic review found that, while some studies showed significant improvements in mortality and reduction in ICU length of stay with use of ICU telemedicine, others showed no benefit [48].

Barriers to implementation

At the patient level

At the patient level, there are several barriers to increasing use of telehealth. Though telehealth stands to improve patient access to care greatly, access—namely to the Internet or to mobile devices—remains a limiting factor. Where access is not an issue, familiarity with technology and ease of use are barriers to adoption, particularly in older patient populations. Failure of the telehealth infrastructure, even if temporary, may deter continued use [49]. Finally, some studies have reported a perceived difference in quality of care, though there is much evidence to suggest that, overall, patients are satisfied with telehealth alternatives or additions to traditional care.

At the provider level

Several barriers to telehealth implementation have been identified at the provider level. While most providers are aware of telemedicine, many report limited experience using it themselves [50]. Telehealth implementation, in particular those modalities that use newer technologies, will require physician training. The speed and efficiency with which clinicians and staff can complete this training depend on their technological dexterity. Moreover, clinical staff have expressed concern that telehealth technologies, such as home monitoring devices, might present more patient data than they can effectively process and address. Clinical staff may resist the implementation of telehealth technologies, particularly because integrating certain telehealth modalities—for example, video visits—alters the roles of staff members and requires a significant change to the established workflow [51–53]. Finally, some providers feel that an increased reliance on telehealth may break down patient–provider relationships [54].

Regulatory barriers

At the intersection of provider and regulatory barriers are issues of licensure. Physician licensing to practice medicine in the United States is a state-level issue. Some states have enacted licensure laws to facilitate the use of telemedicine, allowing physicians to provide services across state lines. Other states require that physicians be licensed in each state where they treat patients, even remotely [55]. Additionally, state laws vary regarding which types of medicine can be practiced across state lines and through which medium. States differ in their laws dictating whether a new patient–provider relationship can be established over telemedicine modalities, as well as how such a relationship is established via telemedicine and what information must be exchanged before certain services can be rendered [56].

Reimbursement

State level

Differences in state regulations directly impact reimbursement models for telehealth services, providing another important barrier to implementation. In 2018, 35 of 50 states had some form of parity law for private insurance coverage of telemedicine [57], meaning that coverage for and reimbursement of telehealth services is comparable to analogous in-person services. However, states often impose restrictions on the telemedicine services covered, preventing full parity. For instance, states may stipulate specific circumstances or regions—such as rural areas—in which parity laws can apply [58]. Many states limit the type of facility that may serve as a patient's originating site and frequently exclude a patient's home as a qualifying site.

One common restriction is in the applicable technology. Since many states specifically restrict their definition of telemedicine to real-time technologies, asynchronous technologies and remote patient monitoring are not frequently reimbursed. Similarly, email, fax, and telephone, though frequently used to deliver healthcare, are rarely accepted forms of telemedicine for reimbursement [54]. Most states also restrict reimbursement based on provider type and four limit telehealth reimbursement to services provided by physicians only. Additionally, some states reimburse for video visits regardless of medical specialty, whereas others restrict to certain specialties. Few states have full parity, which requires telemedicine reimbursement rates to equal reimbursement for in-person visits.

Federal level

The geographical limitations present in state Medicaid reimbursement policies derive from federal policies governing how Medicare regulates and reimburses for telemedicine services. However, federal policies are understandably more stringent. For example, while states vary in their origin site requirements, federal regulations require patients to travel to an eligible medical facility (e.g., physician's office, hospital) to conduct a video visit. While some states have done away with the requirement that patients reside in a rural area or non-metropolitan statistical area (MSA), Medicare regulation dictates that patients must be located in a non-MSA, a health professional shortage area, or a federal telemedicine demonstration site at the time of the service [58]. This regulation demonstrates a strict adherence at the federal level to the original application of telehealth: increasing access for rural and remote patients. The store-and-forward services reimbursable through Medicare are limited to a list of three types of services provided by dermatology or ophthalmology. Medicare also limits the types of providers who can receive reimbursement for delivering telehealth care to a list of 10 providers [59]. Such regulations have impeded the growth of telemedicine services for Medicare beneficiaries. In 2016, only 0.3% of Medicare beneficiaries reported using telemedicine services.

Conclusion

Telehealth technologies are present in urological practice. Most are in the form of small-scale televisit and telementorship pilot programs. While telehealth as a concept is widely recognized by physicians, it has yet to gain widespread use. Barriers to widespread implementation exist at the patient and provider level, the hospital systems level, and the state

and federal regulatory level. As patients, providers, and policymakers are increasingly aware of telemedicine technology and its potential to improve patient care while cutting costs on both sides, reimbursement policies are becoming more accommodating of telemedicine. To facilitate greater integration of telehealth into the traditional model of healthcare, it is important to identify the clinical contexts in which telehealth is best used and to improve technological reliability to ensure that the use of new technologies is seamless. Though evidence regarding the effectiveness of telehealth modalities is sparse, increased adoption of telehealth will allow for larger studies on effectiveness, cost, and patient satisfaction.

Acknowledgements This work was supported by the Telehealth Research Incubator project grant (MPrOVE Research Challenge Grant).

References

1. Board on Health Care Services, Institute of Medicine (2012) The evolution of telehealth: where have we been and where are we going?. National Academies, New York
2. Institute of Medicine (US) Committee on Evaluating Clinical Applications of Telemedicine, Field MJ (1996) Evolution and current applications of telemedicine. National Academies, New York. https://doi.org/10.17226/5296
3. Powell RE, Stone D, Hollander JE (2018) Patient and health system experience with implementation of an enterprise-wide telehealth scheduled video visit program: mixed-methods study. JMIR Med Inform 6(1):e10. https://doi.org/10.2196/medinform.8479
4. Polinski JM, Barker T, Gagliano N et al (2016) Patients' satisfaction with and preference for telehealth visits. J Gen Intern Med 31(3):269–275. https://doi.org/10.1007/s11606-015-3489-x
5. Adler-Milstein J, Kvedar J, Bates DW (2014) Telehealth among US hospitals: several factors, including state reimbursement and licensure policies, influence adoption. Health Aff 33(2):207–215. https://doi.org/10.1377/hlthaff.2013.1054
6. (2015) Telehealth policy trends and considerations. National Conference of State Legislatures
7. Bashshur R, Shannon G, Krupinski E, Grigsby J (2011) The taxonomy of telemedicine. Telemed e-Health 17(6):484–494. https://doi.org/10.1089/tmj.2011.0103
8. Ellimoottil C, Skolarus T, Gettman M et al (2016) Telemedicine in urology: state of the art. Urology 94:10–16. https://doi.org/10.1016/j.urology.2016.02.061
9. Whitten P, Holtz B, Laplante C (2010) Telemedicine: what have we learned? Appl Clin Inform 1(2):132–141. https://doi.org/10.4338/ACI-2009-12-R-0020
10. Rabie NZ, Canon S, Patel A et al (2016) Prenatal diagnosis and telemedicine consultation of fetal urologic disorders. J Telemed Telecare 22(4):234–237. https://doi.org/10.1177/1357633X15595556
11. Carter B, Whittaker K, Sanders C (2018) Evaluating a telehealth intervention for urinalysis monitoring in children with neurogenic bladder. J Child Health Care 23(1):45–62. https://doi.org/10.1177/1367493518777294
12. Agarwal DK, Viers BR, Rivera ME et al (2018) Physical activity monitors can be successfully implemented to assess perioperative activity in urologic surgery. Mhealth 4:43. https://doi.org/10.21037/mhealth.2018.09.05
13. Skolarus TA, Hawley ST (2014) Prostate cancer survivorship care in the Veterans Health Administration. Fed Pract 31(8):10–17
14. Holten-Rossing H, Larsen LG, Toft BG, Loya A, Vainer B (2016) Consultation on urological specimens from referred cancer patients using real-time digital microscopy: optimizing the workflow. J Pathol Inform. https://doi.org/10.4103/2153-3539.177689
15. Mozafarpour S, Abbasioun R, Kajbafzadeh A-M (2017) The mobile technology era: potential benefits in pediatric urology. J Pediatr Urol 13(5):529–530. https://doi.org/10.1016/j.jpurol.2017.07.003
16. Le HH, Salas RME, Gamaldo A et al (2018) The utility and feasibility of assessing sleep disruption in a men's health clinic using a mobile health platform device: a pilot study. Int J Clin Pract 72(1):e12999. https://doi.org/10.1111/ijcp.12999
17. Pereira-Azevedo N, Osório L, Fraga A, Roobol MJ (2017) Rotterdam prostate cancer risk calculator: development and usability testing of the mobile phone app. JMIR Cancer 3(1):e1. https://doi.org/10.2196/cancer.6750
18. Sener TE, Butticè S, Sahin B, Netsch C, Dragos L, Pappalardo R et al (2018) WhatsApp use in the evaluation of hematuria. Int J Med Inform 111(1):17–23. https://doi.org/10.1016/j.ijmedinf.2017.12.011
19. de Souza-Junior VD, Mendes IAC, Mazzo A, de Godoy S, Dos Santos CA (2017) Telenursing intervention for clean intermittent urinary catheterization patients: a pilot study. Comput Inform Nurs 35(1):653–660. https://doi.org/10.1097/CIN.0000000000000370
20. Kumar R, Jog A, Malpani A et al (2012) Assessing system operation skills in robotic surgery trainees. Int J Med Robot 8(1):118–124. https://doi.org/10.1002/rcs.449
21. Safir IJ, Shrewsberry AB, Issa IM et al (2015) Impact of remote monitoring and supervision on resident training using new ACGME milestone criteria. Can J Urol 22(5):7959–7964
22. Anderson SM, Kapp BB, Angell JM et al (2013) Remote monitoring and supervision of urology residents utilizing integrated endourology suites-a prospective study of patients' opinions. J Endourol 27(1):96–100. https://doi.org/10.1089/end.2012.0406
23. Fitzpatrick R, Paterson NR, Watterson J, Seabrook C, Roberts M (2019) Development and implementation of a mobile version of the O-SCORE assessment tool and case log for competency-based assessment in urology residency training: an initial assessment of utilization and acceptance among residents and faculty. Can Urol Assoc J 13(1):45–50. https://doi.org/10.5489/cuaj.5482
24. Viers BR, Lightner DJ, Rivera ME et al (2015) Efficiency, satisfaction, and costs for remote video visits following radical prostatectomy: a randomized controlled trial. Eur Urol 68(4):729–735. https://doi.org/10.1016/j.eururo.2015.04.002
25. Finkelstein JB, Cahill D, Kurtz MP et al (2019) The use of telemedicine for the postoperative urologic care of children: results of a pilot program. J Urol. https://doi.org/10.1097/JU.0000000000000109
26. Sherwood BG, Han Y, Nepple KG, Erickson BA (2018) Evaluating the effectiveness, efficiency and safety of telemedicine for urological care in the male prisoner population. Urol Pract 5(1):44–51. https://doi.org/10.1016/j.urpr.2017.01.001
27. Thelen-Perry S, Ved R, Ellimoottil C (2018) Evaluating the patient experience with urological video visits at an academic medical center. Mhealth 4:54. https://doi.org/10.21037/mhealth.2018.11.02
28. Chu S, Boxer R, Madison P et al (2015) Veterans affairs telemedicine: bringing urologic care to remote clinics. Urology 86(2):255–260. https://doi.org/10.1016/j.urology.2015.04.038
29. Young K, Gupta A, Palacios R (2018) Impact of telemedicine in pediatric postoperative care. Telemed J E Health. https://doi.org/10.1089/tmj.2018.0246
30. Park ES, Boedeker BH, Hemstreet JL, Hemstreet GP (2011) The initiation of a preoperative and postoperative telemedicine urology clinic. Stud Health Technol Inform 163:425–427

31. Canon S, Shera A, Patel A et al (2014) A pilot study of telemedicine for post-operative urological care in children. J Telemed Telecare 20(8):427–430. https://doi.org/10.1177/1357633X14555610
32. Shivji S, Metcalfe P, Khan A, Bratu I (2011) Pediatric surgery telehealth: patient and clinician satisfaction. Pediatr Surg Int 27(1):523–526. https://doi.org/10.1007/s00383-010-2823-y
33. Miah S, Dunford C, Edison M, Eldred-Evans D, Gan C, Shah TT et al (2019) A prospective clinical, cost and environmental analysis of a clinician-led virtual urology clinic. Ann R Coll Surg Engl 101(1):30–34. https://doi.org/10.1308/rcsann.2018.0151
34. Kim EJ, Orlander JD, Afable M et al (2018) Cardiology electronic consultation (e-consult) use by primary care providers at VA medical centres in New England. J Telemed Telecare. https://doi.org/10.1177/1357633X18774468
35. Parikh PJ, Mowrey C, Gallimore J et al (2017) Evaluating e-consultation implementations based on use and time-line across various specialties. Int J Med Inform 108:42–48. https://doi.org/10.1016/j.ijmedinf.2017.09.005
36. Venkatesh RD, Campbell EJ, Thiim M et al (2018) E-consults in gastroenterology: an opportunity for innovative care. J Telemed Telecare. https://doi.org/10.1177/1357633X18781189
37. Naka F, Lu J, Porto A et al (2018) Impact of dermatology eConsults on access to care and skin cancer screening in underserved populations: a model for teledermatology services in community health centers. J Am Acad Dermatol 78(2):293–302. https://doi.org/10.1016/j.jaad.2017.09.017
38. Ulloa JG, Russell MD, Chen AH, Tuot DS (2017) A cohort study of a general surgery electronic consultation system: safety implications and impact on surgical yield. BMC Health Serv Res 17:433. https://doi.org/10.1186/s12913-017-2375-0
39. Wasfy JH, Rao SK, Kalwani N et al (2016) Longer-term impact of cardiology e-consults. Am Heart J 173:86–93. https://doi.org/10.1016/j.ahj.2015.11.019
40. Vallasciani S, Abdo B, Rauf Z et al (2018) Telehealth for the assessment of patients referred for pediatric urological care: a preliminary cost savings analysis and satisfaction survey. Telemed J E Health. https://doi.org/10.1089/tmj.2018.0159
41. Powell RE, Henstenburg JM, Cooper G et al (2017) Patient perceptions of telehealth primary care video visits. Ann Fam Med 15(3):225–229. https://doi.org/10.1370/afm.2095
42. Vimalananda VG, Gupte G, Seraj SM et al (2015) Electronic consultations (e-consults) to improve access to specialty care: a systematic review and narrative synthesis. J Telemed Telecare 21(6):323–330. https://doi.org/10.1177/1357633X15582108
43. Office Visit Cycle Time. In: Institute for Healthcare Improvement. http://www.ihi.org/resources/Pages/Measures/OfficeVisitCycleTime.aspx. Accessed 16 Mar 2019
44. Ellimoottil C (2017) Video visits in urology: How clinicians, patients benefit. In: Urology Times. https://www.urologytimes.com/modern-medicine-feature-articles/video-visits-urology-how-clinicians-patients-benefit. Accessed 18 Mar 2019
45. Bashshur RL, Shannon GW, Krupinski EA et al (2009) National telemedicine initiatives: essential to healthcare reform. Telemed J E Health 15(6):600–610. https://doi.org/10.1089/tmj.2009.9960
46. (2016) Telehealth: mapping the evidence for patient outcomes from systematic reviewseffective health care program. https://effectivehealthcare.ahrq.gov/topics/telehealth/technical-brief. Accessed 16 Mar 2019
47. Miller EA (2007) Solving the disjuncture between research and practice: telehealth trends in the 21st century. Health Policy 82(2):133–141. https://doi.org/10.1016/j.healthpol.2006.09.011
48. Wilcox ME, Adhikari NKJ (2012) The effect of telemedicine in critically ill patients: systematic review and meta-analysis. Crit Care 16:R127. https://doi.org/10.1186/cc11429
49. Andrews SM, Sperber NR, Gierisch JM et al (2017) Patient perceptions of a comprehensive telemedicine intervention to address persistent poorly controlled diabetes. Patient Prefer Adher 11:469–478. https://doi.org/10.2147/PPA.S125673
50. Levine M, Richardson JE, Granieri E, Reid MC (2014) Novel telemedicine technologies in geriatric chronic non-cancer pain: primary care providers' perspectives. Pain Med 15:206–213. https://doi.org/10.1111/pme.12323
51. Molfenter T, Boyle M, Holloway D, Zwick J (2015) Trends in telemedicine use in addiction treatment. Addict Sci Clin Pract 10:14. https://doi.org/10.1186/s13722-015-0035-4
52. Kahn JM, Cicero BD, Wallace DJ, Iwashyna TJ (2014) Adoption of ICU telemedicine in the United States. Crit Care Med 42(2):362–368. https://doi.org/10.1097/CCM.0b013e3182a6419f
53. LeRouge C, Garfield MJ (2013) Crossing the telemedicine chasm: have the U.S. barriers to widespread adoption of telemedicine been significantly reduced? Int J Environ Res Public Health 10(12):6472–6484. https://doi.org/10.3390/ijerph10126472
54. Yang YT (2016) Health policy brief: telehealth parity laws. In: health affairs. https://www.healthaffairs.org/do/10.1377/hpb20160815.244795/full/. Accessed 26 Mar 2019
55. Hoffmann D, Rowthorn V (2011) Legal impediments to the diffusion of telemedicine. J Health Care Law Policy 14(1/2):1
56. State Policy Resource Center—ATA Main. http://www.americantelemed.org/policy-page/state-policy-resource-center. Accessed 20 Mar 2019
57. Lewis CB (2015) Private payer parity in telemedicine reimbursement: how state-mandated coverage can be the catalyst for telemedicine expansion. Univ Memphis Law Rev 46:471–502
58. (2018) State telehealth laws & reimbursement policies. Public Health Institute/Center for Connected Health Policy. https://www.cchpca.org/sites/default/files/2018-10/CCHP_50_State_Report_Fall_2018.pdf. Accessed 18 Mar 2019
59. (2018) Next generation ACO model telehealth expansion waiver frequently asked questions. Centers for Medicare & Medicaid Services

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.