The Role of Telemedicine in Kidney Transplantation: Opportunities and Challenges

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Introduction
Kidney transplantation is the treatment of choice for patients with advanced kidney disease who are medically and surgically fit to undergo the procedure and have reasonable life expectancy. It provides improved survival and quality of life for recipients and overall cost savings to the health care system (1,2). The process of undergoing kidney transplantation involves several phases of care including pretransplant referral and evaluation, waitlist management, and follow-up. In all phases of care, transplant centers interface with candidates and recipients who live across a wide geographic range, with many patients traveling significant distances to a transplant center (3).

In the United States, 41,077 candidates were added to the waiting list in 2019 and 23,401 received a transplant. There are approximately 220,000 prevalent kidney transplant recipients and 250 centers actively performing kidney transplants (4). With this continually growing patient population and a limited number of transplant providers, transplant centers are in need of innovative models of health care delivery that (1) allow them to reach and monitor candidates and recipients, particularly those that live far away; and (2) improve utilization of transplant center resources. Telemedicine, the practice of medicine using technology to deliver care at a distance, represents an opportunity to do both. The technology used may include telehealth videoconferencing (TVC), the internet, store-and-forward imaging, streaming media, and terrestrial and wireless communication (5).

Although telemedicine has been successfully used by numerous specialties, its utilization in the field of kidney transplantation has been lagging. Telemedicine has the potential to affect and improve the delivery of kidney transplant care through the following: (1) replacing or supplementing in-person visits with virtual visits through TVC, (2) electronic consultation, and (3) remote monitoring and provision of education through mobile technology (6). Here we focus on TVC and highlight opportunities for its use through the various phases of transplant care while discussing potential benefits (Figure 1) and barriers to successful implementation (Table 1).

What Is Telehealth Videoconferencing and How Can It Be Used?
TVC, a form of interactive telemedicine, involves a provider and patient interfacing remotely through video monitors, secure videoconferencing software, and a reliable internet connection. The intent of a TVC visit is to replace or supplement in-person visits, thus reducing the need for travel to the transplant center. In a TVC visit, the provider is typically located at a computer station in the office or clinic (provider site) while the patient connects to the visit through a computer station located in a local health facility (originating site). Alternatively, in specific scenarios, a patient at home can connect to the virtual visit through a mobile platform with videoconferencing software and capabilities. TVC is well suited for specialty care, including kidney transplantation, where patients require travel to centers to see subspecialists who are otherwise not available locally.

Pretransplant Care
After transplant referral, candidates must travel to a transplant center to undergo education and evaluation. Distance to a transplant center can pose as a barrier to access (3). Although candidates will ultimately need to be seen by transplant providers in person, TVC can improve access to care by serving as an initial screening visit. This may allow for improved timeliness to evaluation and significant cost savings for patients, as has been our experience at the Nashville Veterans Affairs (VA) Medical Center (7,8). TVC visits are well suited to assessing higher-risk candidates such as those who are older and have multiple comorbidities. We have found that TVC visits have been able to provide sufficient data to determine who is not a candidate for transplant. However, an in-person visit is required before approval. Although we have not conducted social work or education visits through TVC, these can potentially also be carried out.

Once on the waitlist, candidates can similarly be reevaluated through TVC in accordance with the center’s protocol. This obviates the need for travel and time away from work, resulting in savings for candidates and their caregivers. Additionally, using TVC in the pretransplant phase may allow for increased referrals and the ability to enter the transplant referral process for those who may perceive distance or time as barriers to transplantation. From a transplant center standpoint, it can increase programmatic efficiency by liberating clinic slots to accommodate more referrals and scheduling in-person consultations in a timelier fashion.
Post-transplant Care

During the immediate postoperative period, care is provided primarily by the transplant team and includes management of the surgical wound and surgical complications, active titration of immunosuppression, and administration of antiviral and *Pneumocystis* prophylaxis, among others. This can be an intense period requiring frequent clinic visits and laboratory testing. For stable recipients who live a significant distance from the transplant center, TVC represents an opportunity to see patients remotely and decrease travel burden. There is precedence for postoperative TVC visits in other surgical specialties (9,10), and these have shown that postoperative care can be performed safely and effectively while reducing cost.

For longer-term care within the first year post-transplant, stable patients can similarly benefit from a reduction in the frequency of visits by replacing some of these with TVC visits. Recipients can be followed remotely and issues addressed by the transplant nephrologist while obtaining laboratory tests locally. Once a recipient is stable and enters the long-term care phase of >1 year post-transplant, most transplant centers transition care to the recipient’s local nephrologist. When issues arise that require consultation from a transplant nephrologist, TVC offers an opportunity to provide consultative services without the need for travel. The annual routine visits to the transplant center that most centers require can also be replaced by TVC as long as laboratory testing can be performed locally and arrangements can

### Table 1. Barriers and proposed solutions for telemedicine growth

| Barrier                                | Solutions                                                                 |
|----------------------------------------|---------------------------------------------------------------------------|
| Infrastructure                         | Investment in originating and provider sites                             |
|                                        | Acquisition of appropriate technology                                   |
|                                        | Establishment of health-protected communication between electronic medical records and mobile platforms |
|                                        | Networking with local facilities including community and government facilities to use preexisting space and technology |
|                                        | Investment in personnel                                                  |
| Medical licensure across state lines   | Establishment of parity across state borders for the delivery of telemedicine |
|                                        | Interstate medical licensure                                             |
| Payment models                         | Establishment of payment structure for telemedicine visits by insurance companies |
|                                        | Consistent reimbursement policies across third-party payers              |
|                                        | Liberalization of regulations to allow for patients’ homes as originating sites |
| Transplant center concerns             | Cost-effectiveness studies                                               |
|                                        | Monitor effect on programmatic efficiency                                |
| Provider concerns                      | Appropriate training and education that address delivery of telemedicine care |
|                                        | Available support for troubleshooting                                    |
|                                        | Gather satisfaction surveys to ensure positive experience                 |
| Patient concerns                       | Ensure adequate staffing to support a potentially increased patient load |
|                                        | Gather satisfaction surveys to ensure positive experience                 |
|                                        | Gather outcomes data                                                     |
|                                        | Ensure time and cost savings                                             |
be made for specialized testing to be sent to the center (e.g., sample for donor-specific antibodies for the purpose of immune monitoring). Long-term post-transplant care through telemedicine has been successfully used in recipients of kidney and lung transplants (11–13). This includes experience outside of the United States such as that in Australia where successful routine follow-up of regional recipients of kidney transplants has been carried out through telemedicine, resulting in reduced need for travel and cost savings (12).

**Barriers to Implementation**

There are several issues to consider before implementing a program of TVC in the various phases of transplant health care delivery. In the United States, identifying originating sites where patients can present for TVC visits is probably the most challenging and is primarily driven by reimbursement policies of third-party payers. Centers for Medicare and Medicaid (CMS) guidelines have the largest influence because the majority of candidates and recipients of kidney transplants have Medicare as their primary insurance. Current CMS guidelines (https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNPackages/ Downloads/TelehealthServcsfactsht.pdf) require that originating sites be a specific type of medical facility located in a rural health care professional shortage area or a county outside of a metropolitan statistical area. At our center, we have a TVC clinic located 100 miles away but is not in a location that meets CMS requirements. This has limited the patient population served by the site to only those with private insurance. The VA has been a pioneer in implementing TVC visits and has been able to do so in part due to its large network across the country, which interfaces on the same electronic health system, but also due to facilitative policies and a robust framework to support the delivery of telemedicine (14). Transplant centers that belong to large hospital networks that span a wide geographic area and have facilities in rural locations can learn from the VA model and use their network to their advantage. Some states have telemedicine capabilities in their local health centers, and this is a resource that can potentially be tapped by transplant centers (15).

Once originating sites are identified, financial investment in technology and personnel is required. In addition to obtaining appropriate equipment and software, there must be personnel on site who are available to address immediate needs of patients and assist with the TVC visit. For example, a nurse would be required for a physician to perform a thorough virtual physical examination via a digital stethoscope. Additionally, regulatory written consents may need to be obtained to initiate a transplant evaluation.

Physicians seeing patients through TVC visits must have appropriate medical licensure in the state of the originating site. It is not uncommon for transplant providers to follow patients who live in neighboring states; hence multiple state licenses may be required. Finally, appropriate reimbursement commensurate to the service provided is important for this health care delivery model to grow. Although cost and time savings to patients are beneficial, transplant centers and providers would need to be reimbursed appropriately to make this strategy financially sound. CMS offers coverage through Medicare Part B for a limited scope of telemedicine services with corresponding requirements for reimbursement. Most but not all private insurers have telehealth policies, although with varying coverage.

**TVC in Health Care Systems Outside of the United States**

Although the issues we describe in this article mainly pertain to the United States, many of the principles we discuss can also be applied to health care systems outside of the United States. Cost savings through reduced need for travel may be especially beneficial in underserved regions of the world. Logistic considerations may vary depending on the resources of the health care system and existing regulations. For example, reimbursement policies may not be as stringent in countries outside of the United States; hence TVC visits may potentially be conducted in the patients’ home through mobile phone technology (discussed further below) rather than at a local health facility. Other logistic demands such as a reliable internet connection may be more challenging in certain areas. Finally, cultural differences in patient willingness to participate in virtual visits should be considered.

**Future Directions**

Proposed solutions for barriers to the growth of telemedicine are outlined in Table 1. Expansion beyond the use of TVC in remote clinics, such as the ability to use mobile phone TVC technology in patients’ homes, can lead to greater flexibility and ease in the use of telemedicine. In the United States, this would require liberalization of reimbursement regulations, particularly those that pertain to originating sites. Currently, recipients in the postoperative “global period,” which includes the first 90 days after transplantation, are not governed by reimbursement regulations due to the bundled payment and hence are more flexible in the choice of originating site and could potentially use mobile phone technology to participate in a TVC visit from their home. With liberalization of regulations, there is a potential for this service to expand beyond the global period.

The outbreak of coronavirus disease 2019 (COVID-19) and the challenges posed by a pandemic, such as the need to efficiently screen and triage patients and the need to reduce in-person clinic visits—particularly among patients who are high risk, has led to great interest among multiple stakeholders, including the transplant community, in the utilization of telemedicine (16). As a result, we expect that regulations and reimbursement policies in the United States will rapidly evolve. However, it is unknown if these policy changes will last beyond the crisis period.

The effect of telemedicine on several metrics will need to be studied (17,18). These include patient outcomes, both short and long term, as measured by graft and patient survival. Patient and provider satisfaction in using the technology will need to be assessed and feedback can be used to improve both the patient and provider experience. Finally, although financial savings for patients are apparent, the financial implications for transplant centers using TVC visits will need to be clarified.
Conclusions

Telemedicine through TVC visits represents an opportunity to ease the burden of travel to transplant centers in all phases of transplant care. TVC can replace or supplement in-person visits, potentially improving access to transplantation and affording patients cost and time savings. Current challenges to broad implementation include finding an originating site that allows for appropriate reimbursement of the services rendered, and upfront financial investment by the transplant center in required resources and personnel. The effect of telemedicine on short- and long-term patient outcomes is unclear and warrants further study.

Author Contributions

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