Clinic-to-clinic telemedicine has been shown to be an efficient and effective means of providing diabetes care to remote, underserved regions. Improved access to care has the potential to improve the health of and reduce health care costs for individuals in underserved regions. This article reviews the evidence related to, benefits of, and barriers to this mode of care.

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Type 1 diabetes is one of the most common chronic illnesses of childhood and adolescence. According to the American Diabetes Association (ADA), an estimated 215,000 people < 20 years of age have diabetes (type 1 or type 2). Each year, 15,600 youths are newly diagnosed with type 1 diabetes, and 3,600 are diagnosed with type 2 diabetes; 1.9 million Americans ≥ 20 years of age are newly diagnosed with diabetes (5,205/day).1,2

Although the number of pediatric patients with diabetes is increasing, there remains a shortage of pediatric endocrinologists to provide care for these patients. Lee et al.3 found that, for every 290 children with type 1 diabetes, there is one board-certified pediatric endocrinologist. However, this ratio varies depending on location, from 370:1 in the Midwest to 144:1 in the Northeast. Two states—Montana and Wyoming—have no board-certified pediatric endocrinologists. Average wait times for an appointment exceeded 2 weeks in 68% of hospitals, with an average of 10 weeks.4 Eleven percent of patients must travel > 80 miles for an appointment.5

Shortages of and long distances between pediatric endocrinologists in certain regions of the country have created a need for efficient and practical alternatives. Families have had to travel for hours to receive diabetes care, and specialists have spent considerable time periodically providing consultations at remote clinics. Most general pediatricians and internists do not feel comfortable treating children with diabetes because of the complexity of management regimens and rapid changes in treatment options. The ADA recommends clinic visits for patients with type 1 diabetes every 3 months,6 not including attendance at additional educational sessions and classes. Visits to a distant center often place substantial hardships on families, requiring parents to miss work and children to miss school. Similarly, the burden on specialists to spend hours on the road to attend outreach clinics greatly reduces clinical productivity.

These factors, and the changes in medical practice associated with health care reform, led Bashshur et al.7 to make a special appeal in support of the use of telemedicine for endocrinology. Telemedicine has proven to be an efficient alternative in the handful of institutions that have instituted it.

Telemedicine, as defined by the American Telemedicine Association,8 is the “use of medical information exchanged from one site to another via electronic communications to improve a patient’s clinical health status.” Electronic communications can take the form of video conferences, e-mail messages, faxes, texts, voicemail messages, or other interactions via smartphones. A combined approach offering clinic visits and supplemental data exchange/dose adjustments has been the most effective to date.8

The authors will confine this discussion to clinic-to-clinic telemedicine rather than provision of care in the home or asynchronous
The project no longer receives grant currently in its twelfth year of operation. Malasanos et al.9 estimated that the received by patients and families, with 89 days in the second year of the project9 has instituted telemedicine clinics to provide medical care and online education to patients with type 1 diabetes in Florida’s rural Volusia and Flagler counties. Video conferencing technology enables virtual meetings involving a nurse in Volusia County, a patient or family, and endocrinology staff from the University of Florida to conduct a nursing evaluation and review patients’ diabetes self-management data, including blood glucose logs (Figure 1). A specialist at the university evaluates the findings and discusses changes in the treatment plan. Care is established with the FITED endocrinologist at an initial in-person visit for all newly diagnosed patients, and the physician holds an annual local clinic for all patients.

The use of telemedicine clinics in this underserved region of Florida for 2 years resulted in a decrease in hospitalizations of children with diabetes from 13 to 3.5 per year, as well as a reduction in emergency department visits from 8 to 2.5 per year. In addition, access to health care improved; the mean visit interval decreased from 149 days before FITE to 98 days in the first year after its implementation and 89 days in the second year of the program. The telemedicine clinic was well received by patients and families, with >90% expressing satisfaction and a desire to continue with the program. Malasanos et al.9 estimated that the telemedicine program saved $27,860 per year, excluding Medicaid transportation cost savings.

The FITE diabetes project is currently in its twelfth year of operation. The project no longer receives grant funding and has been self-sustain-

**Figure 1. Telemedicine clinic.**

During the study period, four of the consultations were for patients with new-onset type 1 diabetes. Implementation of appropriate and urgent clinical treatment was carried out via immediate telephone response. Education was then provided via video conferencing by the specialist for the patients, families, and local health providers. Continued education lectures to the rural health care teams throughout Queensland were held by teleconferencing.11

Through the telepediatric service, travel time for patients and families, as well as for subspecialists, was decreased. The local physicians maintained regular contact with their patients to provide primary medical care, and participating in the telemedicine visits allowed them greater understanding of the management of their patients’ diabetes. Other efficiencies were attributed to the preparation by local physicians before the actual video conference.11 When comparing the costs of telepediatric services for all subspecialties to the potential costs of patients traveling to see subspecialists in person, Smith et al. estimated an annual net savings of $600,000, mostly resulting from decreased costs associated with patient travel.10

### Teleconsultation for type 2 diabetes in Austria

Abrahaimian et al.12 reported improved health status in adults with diabetes in Austria. Their system provided teleconsultation for four general practitioners (GPs) as needed for any of their patients with type 2 diabetes.
who had acute complications or complicated care. Only 94 consultations were requested, yet the whole group benefited from the GPs’ improved treatment strategies. More frequent use of antihypertensives, cholesterol-lowering medications, and insulin were noted. Hospital stays were less frequent and shortened. A1C and blood pressure levels were reduced. Screening for renal and ophthalmological complications improved.

School-based telemedicine in New York

Because children spend ~7 hours/day for 10 months each year in school, Izquierdo et al.13 sought to evaluate the feasibility and effectiveness of a school-based telemedicine clinic to improve care for children with type 1 diabetes. Twenty-five schools in Onondaga County, N.Y., were randomized to a telemedicine intervention in addition to usual medical care or to usual medical care alone. A telemedicine system between the school and diabetes center that included the school nurse, students with or without parents, and a diabetes nurse practitioner allowed school nurses to launch consultations when they saw an acute need and also during prescheduled regular monthly meetings. As would be the case for an in-person visit, treatment orders were written at the conclusion of the televisits. A diabetes educational curriculum was also available to the school nurses and other school staff.

During the first 6 months, A1C values increased from baseline in the usual care group but decreased in the telemedicine group. Urgent visits to the school nurse for diabetes-related problems, urgent calls to the diabetes center, and hospitalizations decreased significantly over time in the intervention group compared to the usual care group. There was one hospitalization for diabetic ketoacidosis in the telemedicine group compared to four hospitalizations in the usual care group. The telemedicine intervention was well accepted by participants, with 91% noting that they would use the telemedicine services again. Positive effects on psychosocial measures were seen in the telemedicine group.

Remote monitoring of glycemic control

An increasing number of type 1 diabetes patients and a shortage of endocrinologists prompted Chase et al.14 to study remote monitoring of glycemic control as a means of decreasing the number of clinic visits. The modem group had biannual clinic visits, and transmitted information was discussed approximately every 2 weeks with treatment changes made as needed. The control group had quarterly clinic visits. During the 6-month study, there was no detrimental effect on A1C, and occurrences of diabetic ketoacidosis and hypoglycemia were similar between the two groups as was the degree of patient satisfaction. The average cost per patient in the modem group was $163 compared to $305 in the control group, without consideration of travel and missed work costs.

Unpublished experiences with clinic-to-clinic telecare

Some clinicians have not published their experiences with clinic-to-clinic telemedicine for children with diabetes. In Tallahassee, Fla., for example, a private practice setting has instituted an initiative modeled after the FITe program to care for children with diabetes and endocrine disorders in the regional public health clinic. The clinic has been well received by families and the health care team. In Denver, Colo., a telemedicine network has been established to care for children with diabetes across the state of Wyoming. In its first year, the program has already had a positive effect on patient care.

Comparison of asynchronous and synchronous telecare

Verhoven et al.15 reviewed studies of telecare for adults with diabetes, comparing asynchronous care (the use of e-mail, cell phones, or automated messaging systems) to synchronous teleconsultation (real-time, face-to-face contact via video conferencing) (Table 1). Sixty-three programs had asynchronous characteristics, 18 had synchronous characteristics, and 9 involved a combination of the two. The interventions varied, providing information exchange, monitoring, education, care coordination, or a combination of different services.

The analysis revealed different contributions from asynchronous and synchronous teleconsultations. Specifically, asynchronous interventions reported more improvements in clinical values and self-efficacy. Synchronous application studies more often reported improvements in usability of technology and cost reductions because they resulted in lower travel costs for patients and providers and decreases in unscheduled visits. The best quality of life and health status improvements occurred in interventions that used a combined approach.

Real-time diabetes monitoring for type 1 diabetes

The U.S. Armed Forces have recently implemented a real-time diabetes monitoring system for patients with type 1 diabetes.16 The MedApps HealthPAL device is used to transmit data from the glucose meters directly to patients’ portal account via cell phone networks in real time. In the future, using this device in remote locations served by Tripler Army Medical Center (e.g., countries in the Pacific Rim that have access to cell phone and Internet but limited medical care) will increase overall access to health care.

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<th>Table 1. Asynchronous Versus Synchronous Telemedicine</th>
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Telecare for other diabetes-related services

Telemedicine programs providing other facets of diabetes care, especially ophthalmology and wound care services, have been reported to improve patient outcomes and access to care. It is also beneficial in increasing the number of patients receiving these recommended services and is an effective means of providing retinal examinations. In British Columbia, a technical and nursing team traveled to aboriginal reserves to transmit retinal exams and diabetes data to specialists in Vancouver. There were high levels of patient satisfaction, improved adherence to recommended treatments, and decreased costs compared to transporting patients to the nearest city.17

Telemedicine networks in remote regions

Although there are few reported experiences with clinic-to-clinic telemedicine in pediatric diabetes management, there are numerous telemedicine networks that serve as the main source of health care in vast regions of the United States in areas such as Alaska, Washington, and Wyoming. These networks connect local providers—some with minimal medical training—to specialists in medical centers.

Similarly, in Peru, e-mail and radio communications permit outreach to health posts throughout the province selected for the trial. A study of this system18 found that fewer total and urgent referrals to health posts resulted in an annual net savings of $320,126. Likewise, telemedicine clinics established for two islands in the Bay of Naples19 and in Croatia 20 resulted in an annual net savings of $320,126. Likewise, telemedicine resulted in an annual net savings of 4,970 patients, and the majority of those trials evaluated home monitoring and self-management. Several of the studies had similar endpoints, including A1C, quality of life, and self-efficacy. Most of the studies showed positive outcomes, leading Wootton21 to question whether there was a publication bias.

Serving the Underserved Through Telemedicine

According to the National Council of State Legislature website, “For states with large rural populations, telehealth has emerged as a cost-effective alternative to traditional face-to-face consultations or examinations between provider and patient.”22 The use of telemedicine clinics holds promise in overcoming barriers to health care (e.g., distance, lack of public transportation, and provider shortages) in various geographical and socioeconomic settings and thus improving access.

Telemedicine systems that provide consultations to remote regions offer more rapid diagnosis and treatment of patients and enable the transfer of education and skills among providers. Programs that have evaluated costs have shown reductions in health care costs when comparing telemedicine clinics to in-person visits in remote clinics. With decreased travel to clinic visits, families and patients miss fewer days of work and school.

Reimbursement Climate

Medicare beneficiaries are eligible for telehealth services if they live in a rural health professional shortage area (an area with insufficient numbers of health care providers) or in a county outside of a metropolitan statistical area (defined as one city with a population of ≥ 50,000). Physicians who treat patients via telehealth services that include interactive audio and video telecommunications systems and allow for real-time communication in these areas can submit claims for reimbursement. Telehealth billing uses typical codes with a modifier for services such as consultations, emergency department visits, and outpatient visits.23

Medicaid is governed by the states rather than the federal government; therefore, reimbursement for telehealth services is not mandated and varies among states. Details about individual state policies are available on the National Conference of State Legislatures website (Figure 2).22 Individual states decide what services are covered, where in their state telehealth services are covered, what types of providers are covered, and how much to reimburse for each service.

Forty-two states now provide some form of Medicaid reimbursement for telehealth services.24 To date, 19 states have enacted telemedicine parity laws, which mandate private sector insurance companies to cover telehealth services, and 9 states as well as the District of Columbia have proposed or pending legislation.23 Many private insurance companies do not reimburse for these services unless mandated to do so by telemedicine parity laws. Despite mandating coverage, not all states require reimbursement rates for telehealth services that are comparable to face-to-face services.

Figure 2. States with Medicaid coverage for telemedicine services. Available from the National Conference of State Legislatures website, along with a complete table of the types and locations of allowed services.22
In addition to improving access to care, decreasing hospitalization is one goal of telemedicine. Hospitals do not benefit from reduced admissions unless they are part of a managed care organization. This lack of profitability and questionable reimbursement for clinical services has limited the number of hospitals that are willing to invest in telemedicine practices. Billing for data review is not reimbursed in many markets unless it is part of a clinical visit. The U.S. military has billing codes specifically designated for reviewing electronically transmitted blood glucose logs and for sending e-mail responses to patients and families.16

To encourage the adoption of telemedicine on a broader scale, reimbursement by Medicare and Medicaid and telemedicine parity laws will need to be more reliable and consistent.

Improving Technologies
Younger physicians and patients have grown up with computers and are comfortable with video conferencing, uploading data, and keeping records online. Older systems involved several pieces of equipment and required some technical assistance, but newer systems are simpler to use “plug and play” technologies offering simultaneous input from video, medical records, and peripheral devices. Devices that can be streamed live to a desktop computer include anything with a digital output, such as ophthalmoscopes, electrocardiograms, and ultrasound machines.

Data connection between two sites used to rely on expensive high-speed ISDN (phone) lines and could cost $100 per month at each site and $1 per minute for connection. Connection now can be accomplished with standard encrypted high-speed data connections and typically have no per-minute charges. The newest systems offer wireless connection through tablets or cell phones, bringing the clinic to wherever a specialist goes. Similarly, the price of telemedicine systems has dropped considerably, although there is still a wide price range depending on the capabilities desired.

Having an electronic medical record system already in place is helpful for health care settings interested in offering telemedicine services. With the advent of federal health care reform measures, most large care centers are instituting electronic record systems.

Role of Telemedicine in Health Care Reform
Telemedicine is the ideal solution to many of the mandates in health care reform:
- Improved access to health care: bringing specialist care to community health centers or directly to patients’ homes
- Provision of a medical home: keeping all facets of patients’ care in generalists’ offices by bringing specialists in via teleconference
- Emphasis on effective maintenance and treatment of chronic conditions and preventing hospital readmissions: providing preemptive care before transport to the hospital or transfer to tertiary care becomes necessary
- Shift from fee-for-service to pay-for-performance: removing restrictions on the time and place for medical care and education, thus making new opportunities for effective care available

Bashshur et al.7 singled out childhood diabetes as a specialty severely underserved and getting worse, making it a prime target for telemedicine. They supported the plan to provide teleconsultations on an urgent, as-needed basis to allow improved involvement and aggressive treatment by general practitioners.

Privacy Issues
There are serious privacy concerns about the electronic transmission of medical information, particularly with reported security breaches in the hospital industry. Points of risk include the room in which patients are located, the room in which providers are located, local hard drives (both the ability to inadvertently store downloaded data and the possibility of other programs or browsers admitting viruses), USB port access, the strength of encryption protocols, and printed materials that include private health information. Asynchronous (store-and-forward) transmission has additional risks involving the stored materials and routes of transmission.

Consultation with an information technologist is important for any providers considering adopting telehealth programs. Considerable effort has gone into certifying systems that are compliant with the Health Insurance Portability and Accountability Act. Once selected, the software employed should be updated regularly to maintain security.

Licensure Requirements
State laws are inconsistent regarding the licensure and liability of health care providers who provide telemedicine services for patients in another state. Currently, the physicians are considered to be practicing in the state where the patients are located. Therefore, physicians are required to have a license in each state where they have a telemedicine outreach clinic. Furthermore, if the remote clinics are in a hospital, the physicians must have privileges in that hospital.

The credentialing process can be time-consuming and expensive. Reciprocal licensure is granted by some states, typically in the most underserved regions of the country. There is an organized effort to push for a unified national license. Congress strongly supported the practice of medicine within the military with one state license. Expanding national licensing to the practice of telemedicine, locum practice, or even in-person satellite clinics would greatly simplify the process.

Conclusion
The principal consideration when making a decision about starting a telemedicine clinic is whether patients in the target population are receiving the same quality of care provided to those nearby. If there is a lack of access detrimental to their health (e.g., infrequent visits, poor disease control, or frequent hospitalizations), then it is quite likely that providing the standard of care will result in improved health status.

Results from the FITE diabetes project8 suggest that the use of telemedicine in populations with limited access to medical care greatly reduced urgent care and hospitalizations. There was greater expense involved in providing the standard of care, but the return on this investment was substantial.

The mandates of health care reform require that there be equal access to health care; providing the standard of care to remote populations in a way that is affordable and accessible can be accomplished with telemedicine. The personal costs of
attending frequent clinic visits for people with a chronic disease cannot be ignored. Telemedicine in a nearby clinic, school, workplace, or even at patients’ homes will decrease the burden of missed school and work days on patients’ families.

Data from the few published studies on clinic-to-clinic diabetes care suggest that the use of telemedicine clinics in place of quarterly in-person clinic visits provides that same level of medical care. In a time of ever-increasing demands on pediatric endocrinologists, telemedicine is an important aspect of current and future medical practice. It allows physicians to provide state-of-the-art medical care to patients living in the most remote regions of the country or to those across the city who do not have the means for transportation to a clinic.

Much work remains to be done, however. More studies are urgently needed to assess the long-term effects of diabetes telemedicine on outcomes, cost-effectiveness, and patient satisfaction. The health care and technology industries should be focused on developing less expensive, more user-friendly telemedicine systems with security that allows for safe transmission of patient information and data. To encourage the growth of telemedicine services, Medicare, Medicaid, and private insurers must increase their reimbursement for these programs, and multistate licensing should be adopted.

References

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