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# Effectiveness of School-Based Telehealth Care in Urban and Rural Elementary Schools

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# Effectiveness of School-Based Telehealth Care in Urban and Rural Elementary Schools

Thomas L. Young, MD*, and Carol Ireson, RN, PhD‡

**ABSTRACT.** *Objective.* **This study evaluated the quality and cost effectiveness of health care provided in urban and rural elementary school-based telehealth centers, using plain old telephone system (POTS) technology.**

*Methods.* **A telehealth school-based model was developed that used a full-time school nurse, half-time mental-health consultant, linked pediatric practice, and linked child psychiatrist via POTS with an electronic stethoscope; ears, nose, and throat endoscope; and otoscope. One rural and 1 urban center were evaluated. Providers, nurses, children, and parents completed satisfaction questionnaires. Providers and nurses also evaluated how well telemedicine supported their clinical decision making. Parents were asked how use of the center affected them financially and at work.**

*Results.* **Of the combined 3461 visits to school nurses at both centers, 4.3% resulted in 150 telehealth consultations referrals; 142 (95%) were completed during the 2-year project. The most common teleconsult diagnoses were otitis media, pharyngitis, dermatitis, and upper respiratory infections. Provider, nurse, child, and parent satisfaction all were high. Providers' and nurses' decision confidence scores ranged from a low of 4 to a high of 4.8 on a 5-point scale. Average family savings per encounter were 3.4 hours of work time ($43) and $177 in emergency department or $54 in physician costs. Including travel, savings for families ranged from $101 to $224 per encounter. Thirteen children received telepsychiatric evaluations resulting in diagnoses of depression and attention-deficit/hyperactivity, anxiety, and conduct disorders.**

*Conclusions.* **Telehealth technology was effective in delivering pediatric acute care to children in these schools. Pediatric providers, nurses, parents, and children reported primary care school-based telehealth as an acceptable alternative to traditional health care delivery systems. The POTS-based technology helps to make this telehealth service a cost-effective alternative for improving access to primary and psychiatric health care for underserved children.** *Pediatrics* **2003;112:1088–1094;** ***telehealth, access, cost-effectiveness, health care, mental health, school-based health centers, outcomes.***

ABBREVIATIONS. SBHC, school-based health center; POTS, plain old telephone system; PNP, pediatric nurse practitioner; TV, television; ED, emergency department.

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Access to health care services for children and adolescents is a problem in many areas of the United States, both urban and rural.[1–4] Barriers that prevent access to health care services include distance, lack of transportation, poverty and unemployment, inadequate health insurance coverage, and shortages of providers. Because school-based health centers (SBHCs) provide comprehensive health services where the children spend most of their time, they have emerged as an effective tool in overcoming traditional barriers to medical care.[5] More than 1300 SBHCs now serve children from early-start programs through high school across the country.[6] Thirty-nine percent of SBHCs are in elementary schools. Most of the SBHCs provide medical, dental, and mental health services in a coordinated manner. These centers generally offer universal access to all students who attend the school. Nevertheless, most SBHCs struggle to maintain services because of a lack of stable funding. Identifying new models that can reach underserved populations and contribute to consumer savings would be advantageous. Advances in the field of telehealth have created opportunities to use this technology to improve health care access. Telehealth can include a range of health services from education at a distance to clinical diagnosis and treatment. Recently, this new technology has been applied to delivering primary care services. School-based telehealth centers that use this technology with success have been developed.[7–10] To date, most clinical applications have used computer-based and special broadband (T1) telephone lines. This approach is expensive and depends on access to high-tech telephone lines, which thus limits its broad application. Recently, technology called plain old telephone system (POTS) has been developed to allow the use of traditional telephone lines without computer enhancement. Medical diagnostic equipment can be attached, including electronic stethoscopes and ear, nose, and throat endoscopes. The equipment and maintenance costs are significantly less than that of computer-based technologies.

School-based telehealth centers used for the provision of primary care hold the potential for improving access to psychiatric services for children as well. Mental health problems of children have been identified as a major health concern in the United States with >20% of children requiring mental health services at any given time.[11] Access to pediatric psychiatrists is particularly problematic, especially in rural

areas. Technology that can improve access to mental health services would be valuable. An exciting aspect of telepsychiatry is the minimal amount of equipment needed to provide effective service.

## METHODS

### Study Population

The study was initiated to evaluate the potential of POTS technology for primary care services at 1 urban and 2 rural elementary schools. Schools were selected on the basis of financial barriers to health services (as determined by the number of students receiving lunches free or at reduced cost), interest in participating, and geographic location. The urban school, located in a metropolitan area with a population of 225 000, has 380 students, 38.0% white, 51.6% black, 6.7% Hispanic, 0.3% Native American, and 3.5% other. Of the 380 students, 69% received free or reduced lunch rates.

The first rural school is located on the edge of a small town, population 7300, and serves students from a rural area. This school has 540 students, 87.6% white, 7.1% black, 2.3% Hispanic, 0.4% Native American, 0.2% Asian, and 2.3% other. Only 23.7% of the students were eligible for free or reduced lunch. A second rural school was chosen for study but used the telehealth technology very little because a pediatric nurse practitioner (PNP), located at the health department within a 5-minute walk, found it more convenient to see patients face to face than use the telehealth equipment. In addition, the private pediatric practice that agreed to provide pediatrician consultation for that school decided to stop accepting Medicaid and K-Chip insurance, the most common reimbursement for the school population. For these reasons, the technology was moved to another rural school at the end of the first year.

### Study Design

This prospective study used an exploratory design to evaluate the effect of the telehealth technology on 1) the clinical decision-making confidence of the physician, nurse practitioner consultants, and the school health nurses; 2) satisfaction of the student, parents, and providers; 3) clinical process outcomes; and 4) the costs of the program and potential costs savings to parents. A total of 150 telemedicine encounters with students aged 6 to 12 years from 2 elementary schools were studied. The convenience sample was composed of all students at the 2 elementary schools who had parental consent to use the school telehealth services; the school health nurses at the 2 schools; and the pediatricians, pediatric residents, and advanced registered nurse practitioners who served as consultants. The sample included all students (aged 6–12 years) at the 2 elementary schools for whom parental consent was obtained to use the school telehealth services, the school health nurses, and the consultants (ie, the pediatricians, pediatric residents, and advanced registered nurse practitioners).

A small mental health telepsychiatry pilot project is included in this report. All mental health patients had signed consents, and parents were present at the teleinterviews. We report only the number and diagnosis of the mental health encounters because of its small numbers. A comparison of missed school days for the 2 schools before and after the introduction of the telemedicine technology and a cost analysis for the potential cost savings to the school system are reported separately.

### Research Procedure

The study protocol was approved by the Institutional Review Board to allow written consent to be obtained at the beginning of the school year from the parent or the guardian of each student before enrolling them in the project. The consent form was written in English and Spanish. In the consent, parents agreed to participate in the study and that their child could participate.

Student and parent satisfaction with the telehealth consultation was measured with an investigator-designed questionnaire. At the end of the telehealth consultation, students rated their satisfaction with the telehealth encounter with the health care provider, pediatrician or PNP, on a 6-item, 5-point, smiley-face, Likert-type rating scale. Students were asked how well they could see and hear the people on the television (TV), how they liked seeing the physician on TV, how scared they were when they saw the primary care provider on the TV, whether they received the help they needed, how they would feel about seeing the primary care provider on TV again, and whether they would tell their friends to use the TV to see the primary care provider. The school nurse sent the parent survey home with each student after the consultation. Parents were asked to rate their satisfaction with the care provided to their children. They were also asked whether the telehealth visit prevented a visit to a hospital emergency department (ED) or their physician, whether they would have missed work to take their child to a physician, and the amount of lost wages and related travel costs.

Decision-making confidence and satisfaction were measured using an investigator-modified decision confidence scale developed by Sanders and Courtney and adapted by Brennan et al.[12,13] The school nurses responded to 8 items on a Likert-type scale ranging from strongly disagree to strongly agree. Pediatrician and PNP consultants responded to 7 items on a Likert-type scale with the same response categories. The school nurse and the pediatrician or pediatric nurse practitioner completed the decision support questionnaire after each consultation. The decision confidence scales are scored by determining the mean response for each item and the scale. A higher score indicates greater confidence and satisfaction.[13]

Costs of the project were determined by calculating the costs of the application (technology and training), school nurse, and consultant time. This cost was compared with the average cost of a visit to the ED or a pediatrician. The potential savings to the parents included time away from work and travel avoided by having their child's condition diagnosed and treated in the school telehealth program. Parents were asked how many hours of work they would have missed and the associated lost income. Travel costs were based on average miles traveled at 32 cents/mi.

### Telemedicine Clinical Procedure

Each school telemedicine site was staffed with a full-time school nurse and part-time mental health therapist. The consultant clinic site was staffed by pediatricians and pediatric nurse practitioners. A senior child psychiatry resident was the consultant for referred mental health assessments at 1 school site. Telemedicine consultation protocols were developed for the most common presenting problems to ensure consistent and appropriate consultations to the clinic consultant site (example in Fig 1). A 12-step consultation process provided an efficient and documented process for each consultation (Fig 2). This project used a telecommunication system referred to as POTS. POTS uses regular telephone lines and does not require a computer for operation. Motion video with POTS has fewer frames per second than the traditional T1 system, resulting in a slower motion video image. We chose this system to evaluate because successful implementation would result in a system that was simpler and less expensive to operate. The auxiliary equipment attached to the $8 \times 8$ POTS transmitter at the sending school sites included a 27-inch television set; a video camera; an ears, nose, and throat endoscope; and an electronic stethoscope. The photograph shows how this equipment was organized at the school site (Fig 3). Each school site also had 2 regular telephone lines and a fax machine. The receiving clinic site equipment included the $8 \times 8$ transmitter with a built-in camera, a 27-inch television, receiver headphones of an electronic stethoscope, 2 telephone lines, and a fax machine. Staff were trained to use telemedicine equipment by the University of Kentucky TeleCare Center.

## RESULTS

### Primary Care Services

Students made 3461 visits to the school health nurse at the 2 school locations (Table 1). Of those, 150 visits resulted in a telehealth consultation. Seven physicians and 6 advanced registered nurse practitioners served as consultants to the 2 school nurses. The convenience sample of 150 telehealth encounters with students (aged 6–12 years) from 2 elementary schools resulted in 147 completed consultant surveys, 94 school nurse evaluations, 77 student evaluations, and 51 parent evaluations. The most common

# TELEMEDICINE NURSE PROTOCOL

## *EARACHE*

**Description:** Acute otitis media is usually preceded by URI symptoms of at least 2 days duration. Earaches can be due to an external otitis, particularly in the summer. Other sources of ear pain can be from teeth sources, cervical lymph nodes, sore throat, or the TM joint. Fever, ear drainage, or decreased hearing may or may not be present.

**Physical Findings:**

Pain with movement of external ear or tragus(external otitis)
Tenderness underneath the external ear(Lymphadenitis)
Ear drainage
Tympanic Membrane opague, red, decreased mobility

**Management:**

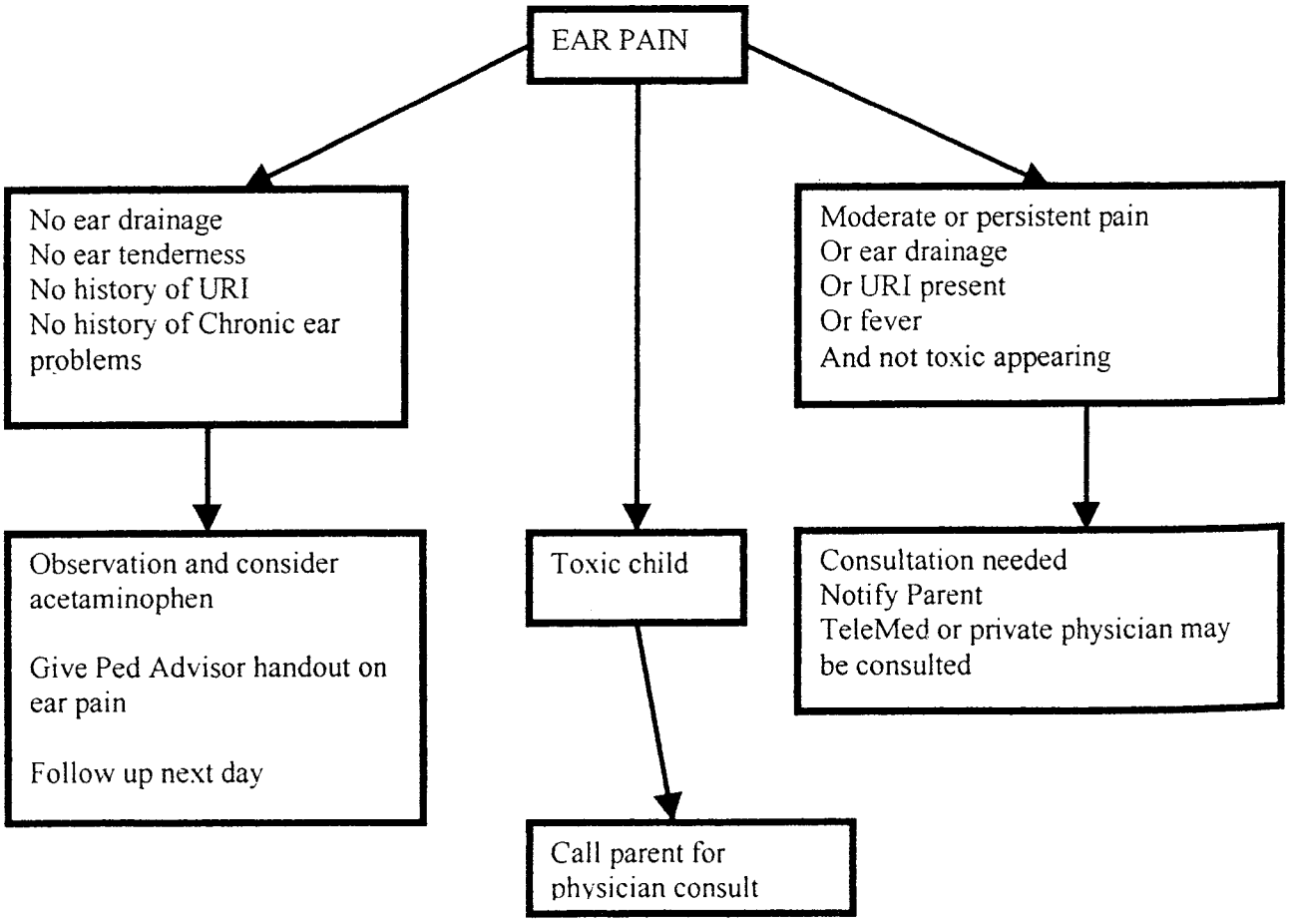


**Fig 1.** School health nurse telemedicine protocol.

reasons for the telehealth encounters in order of frequency were earache and sore throat (Table 2). Of the 150 telehealth consultations, 95% were completed successfully by the initial contact (Table 3). Only 8 cases required an additional face-to-face encounter to complete the evaluation. Consultants reported having access to pertinent medical records for students and the ability to conduct accurate assessments of

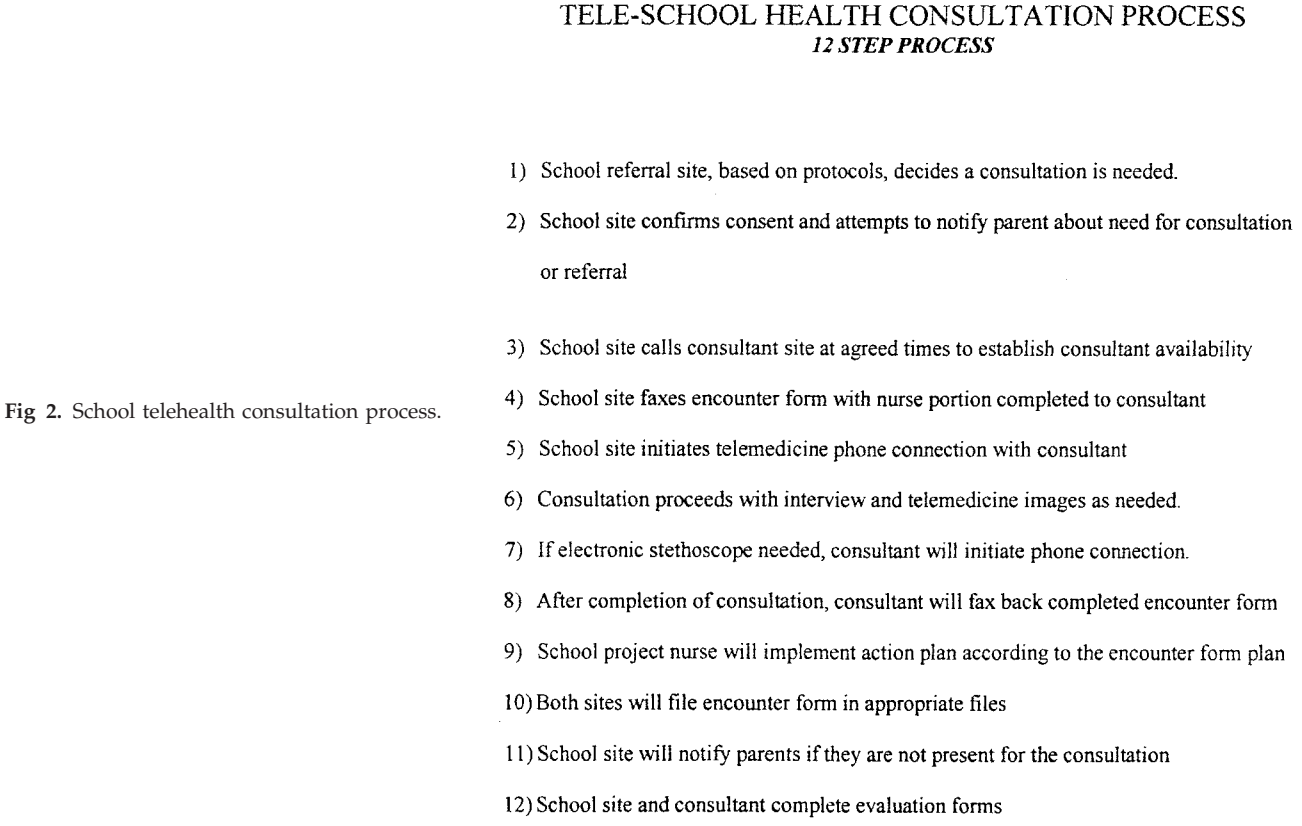


**Fig 2.** School telehealth consultation process.


**Fig 3.** The numbers in the photograph are as follows: 1, endoscope; 2, endoscope monitor; 3, electronic stethoscope; 4, video camera; 5, TV.

**TABLE 1.** School Nurse Visit and Reason by Site for 1 School Year

| Complaint | Urban Site | Rural Site | Total for Both Sites |
|---|---|---|---|
| Stomachache | 428 | 220 | 648 |
| Headache | 344 | 105 | 449 |
| Sore throat | 268 | 144 | 412 |
| First aid | 193 | 249 | 442 |
| Rashes/bites | 185 | 176 | 311 |
| Eye complaints | 147 | 66 | 213 |
| URI | 119 | 182 | 301 |
| Earache | 93 | 97 | 190 |
| Lice | 32 | 50 | 82 |
| Other | 93 | | 93 |
| Total visits | 2026 | 1435 | 3461 |

URI indicates upper respiratory infection.

student medical conditions. These evaluative tools were equivalent to those available during actual office visits. Use of the telehealth camera and peripheral equipment (eg, otoscope, endoscope) enabled the consultants to conduct an accurate physical examination. Overall, the primary care providers were satisfied and confident in treating patient conditions using the telehealth equipment (Tables 3 and 4).

The school nurses were very satisfied with the use of the telehealth consultation process (Table 3). The high mean scores on the decision confidence scales indicated that the telehealth protocols speeded the time between diagnosis and start of treatment and helped with the nurses' decision about the disposition when the child's problem was outside of a standard protocol (Table 5). They also could better inform the teacher and parent(s) about the child's problem, and the telehealth protocols improved the quality of their decision making and increased their certainty about treatment (Table 5).

The students were also positive about the interaction with the physician or the nurse practitioner (Table 3). Most students (89%) could clearly hear and see the people on the monitor. Students (84%) were not scared when they saw the physician on the TV monitor, and 89% would tell their friends about the ex-

**TABLE 2.** Number, Type, and Disposition of Telemedicine Consultations

| Diagnosis | *N* | Urban | | Rural |
|---|---|---|---|---|
| | | 2000* | 2001 | 2001 |
| Earache | 66 | 7 | 18 | 41 |
| Sore throat | 35 | 2 | 11 | 22 |
| Dermatology | 20 | 4 | 3 | 13 |
| URI | 17 | 8 | 0 | 9 |
| Other | 12 | 1 | 2 | 9 |
| Total | 150 | 22 | 34 | 94 |
| Disposition (*n* and %) | | | | |
| Completed | | 142 | | 95% |
| Rx given | | 76 | | 76% |
| Referred | | 8 | | 5% |
| Reasons for referral (*n*) | | | | |
| Rule out pneumonia | | 3 | Chest pain | 1 |
| Arrythymia | | 1 | Cellulitis | 1 |
| Hypertension | | 1 | Ear wax | 1 |

* Partial year.

**TABLE 3.** Satisfaction With School Telehealth

| | % Satisfied |
|---|---|
| Parents (*N* = 60) | 97% |
| Students (*N* = 76) | 93% |
| School nurses (*N* = 84 encounters) | 94% |
| Consultants (*N* = 145 encounters) | 99% |

**TABLE 4.** Decision Confidence of Telehealth Consultants (*N* = 147)

| | Rating |
|---|---|
| I had access to as much of this patient's pertinent medical record as I would for an in-person visit. | 4.24 |
| Using the telemedicine system, I was able to elicit a good history of the patient's medical condition. | 4.72 |
| I was able to identify the real concern(s) of this patient today. | 4.74 |
| I was able to get pertinent physical exam information. | 4.61 |
| I felt confident in treating this patient's problems using the telemedicine equipment. | 4.63 |
| The telemedicine equipment worked well today. | 4.80 |

Ratings are on a scale of 1–5, with 5 being strongly agree.

perience, whereas only 8% would not like to use the telehealth equipment to see the physician again.

Parents likewise expressed satisfaction with the care that their child received using the telehealth equipment (Table 3). One rural parent wrote a letter praising the telehealth program for preventing a trip to the pediatrician in an adjacent city and avoiding a work absence. Table 6 reports average cost of the telemedicine program per student assessment. The majority of parents said that the telehealth system in the school health clinic prevented an ED (urban: 80%; rural: 91%) or a physician visit (urban: 91%; rural: 100%). On the basis of the costs of an ED visit at the local university hospital, preventing an ED visit amounted to an average cost savings for this population of $177 per encounter. Savings for an average physician office visit in this locale amounted to $54 (Table 7). In addition, 71% of urban and rural parents

**TABLE 5.** Decision Confidence of School Nurses (*N* = 94)

| | Rating |
|---|---|
| As a result of telemedicine protocols, I was better able to decide between treatment and referral. | 4.35 |
| Use of telemedicine helped me better inform the referring party (parent or teacher). | 4.57 |
| Telemedicine improved the quality of the decision I made in the school health clinic today. | 4.62 |
| As a result of telemedicine, the speed at which a diagnosis was made and treatment ordered increased. | 4.59 |
| As a result of telemedicine, I have more relevant information for future decision making. | 4.54 |
| Telemedicine helps with the disposition decision when the child's problem is outside of a protocol. | 4.70 |
| The telemedicine equipment worked well today. | 4.38 |

Ratings are on a scale of 1–5, with 5 being strongly agree.

would have missed an average of 5.1 and 3.0 hours of work, respectively, to take their child to the ED or the physician, resulting in an average of $43 in lost wages (Table 7). In addition, the school telehealth visit saved parents travel costs to the ED and/or the physician (Table 7). The total potential avoided costs for families per child ranged from $101 to $224, money that would have been paid out of pocket if the parents had no medical insurance coverage.

### Mental Health Services

In addition to the primary care services, a mental health counselor provided consultations to students, parents, teachers, and school staff (Table 8). The most common diagnoses in students seen by the mental health counselor were attention-deficit/hyperactivity disorder, anxiety disorder, depression, and conduct disorder. Over the 2-year project, 13 complex cases (6 in year 1, 7 in year 2) were referred to a pediatric psychiatric resident for therapy via the telehealth link.

## DISCUSSION

The outcome of this study of school-based telehealth centers clearly supports the concept that clinical services for the most common child health problems presenting in the school setting can be addressed effectively and satisfactorily with current telehealth technology. Pediatric providers, including pediatricians, pediatric residents, and pediatric nurse practitioners, were very confident in the use of this technology to deliver clinical services to children. Most of the providers were unsure of how they would feel about this health care delivery method when the project began, because not being in the room with the patient seemed alien. However, children and parents readily discussed their health concerns through the video linkage, and the parent and child surveys documented their acceptance of the telehealth interaction. Because the study used an exploratory design with no comparison group, additional research is needed to generalize the findings. A follow-up study with independent traditional face-to-face encounters compared with telehealth consultations would be an important next step.

**TABLE 6.** Costs of Program

| School Health Clinic Costs | | Telehealth Visit Costs | |
|---|---|---|---|
| RN costs × 2 schools | $54 000 | Equipment | $4000 |
| Annual no. of health visits | 3461 | Consultants | $4000 |
| Average RN costs/visit | $15.60 | No. of visits | 128 |
| | | Average cost per visit* | $78.10 |

* Includes RN costs, equipment, and consultants.

**TABLE 7.** Avoided Costs to Parents

| Cost Category | % Affected | Amount | Travel Distance | Travel Costs |
|---|---|---|---|---|
| Lost income | 75% | $43 | | |
| ED visit costs | 23% | $177 | Urban = 10.0 mi<br>Rural = 13.5 mi | Urban = $3.20<br>Rural = $4.32 |
| MD visit costs | 94% | $54 | Urban = 12.4 mi<br>Rural = 17.0 mi | Urban = $3.97<br>Rural = $5.44 |
| Avoided costs range | MD visit = $101<br>ED visit = $224 | | | |

**TABLE 8.** School Telehealth Mental Health Services

| Service Provided | 2000 | 2001 | Total |
|---|---|---|---|
| Therapy sessions for students | 288 | 488 | 776 |
| Consultations for parents/teachers about children/students | 52 | 110 | 162 |
| Consultations for staff on general mental health issues | 7 | 45 | 52 |
| Telemedicine evaluations with child psychiatry resident | 6 | 7 | 13 |
| Total encounters | 353 | 650 | 1003 |

That the telehealth nurse was busy with many minor health problems and needed a pediatric consultation on only 4.3% of the visits is not surprising. Nurses found the decision-tree protocols helpful in screening patients for telehealth referrals. Obviously, appropriate screening is essential or consultants would be unnecessarily burdened. Clinical sites worked the consultations into their busy practices with minimal disruption. With receiving sites being the least expensive to equip, it would be reasonable for a school to link to several practice sites to facilitate the establishment of a school-based medical home. When patients who had medical homes were seen, all information was faxed to their primary care provider's office after the encounter to ensure that medical records were complete.

Access to mental health and child psychiatry consultations is a significant problem in many areas of the United States. Although the numbers of mental health consultations in this study were small, they showed significant promise and warrant additional study. The cost of technology to support telepsychiatry is minimal (<$1000) for each sending and receiving site. Mental health centers could easily develop outreach sites to areas where there are no pediatric psychiatrists.

As with any new technology, cost effectiveness must be considered. With the POTS system, the cost of the technology is reasonable. The major cost for school telehealth is the nurse and the mental health staff at the schools. Although staff were present at the school to facilitate the telehealth project, it should be noted that almost 90% of their work involved general school and mental health issues, not telehealth. They were able to care for a broad spectrum of child health issues from first aid to diabetic care. Parents reported significant savings in both work-related costs and direct medical costs. This finding is important because many low-income families have limited ability to take off from work for both financial and job security reasons.

This school-based telehealth center model could easily be coordinated with the medical home concept. The telehealth consultant sites could be located in the local or regional medical homes represented by the student enrollment. When the medical home is not able to participate, information on the consultations could be faxed to them to keep medical records complete.

## CONCLUSIONS

School-based telehealth care can be an effective strategy to improve access to medical and mental health consultations. With the use of the POTS system, health care delivery costs are reasonable and generate savings for many low-income families. Pediatric providers, school nurses, parents, and students all found this model helpful and were confident in its application. Underserved urban and rural areas should consider telehealth care as a model to improve access to medical and mental health care.


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## THE INVENTION THAT HELPED ERADICATE SMALLPOX

"In 1961, Dr. Benjamin Rubin, a researcher with Wyeth Laboratories in Pennsylvania, and Gus Chakros, an engineer with the Reading Textile Machine Company, developed a bifurcated needle that could deliver smallpox vaccine into the skin cheaply and easily, with a minimum of training. The design of the needle was simple yet elegant: It consisted of a short length of steel wire hammered flat at one end and then punched to form two sharpened tines. When the needle was dipped into a vial of freeze-dried vaccine that had been rehydrated with a solution of 50 percent glycerine, a single drop of the viscous fluid was held by a capillary action between the two tines of the needle . . . the bifurcated needle was so easy to use that it was hard to make a mistake: Unskilled villagers could learn the technique by practicing for ten minutes with an orange or a grapefruit. At collecting points where large groups of people gathered, a single health worker could vaccinate about five hundred persons a day; going from house to house, it was possible to perform about 120 vaccinations a day."

Tucker JB. *Scourge*. New York: Atlantic Monthly Press; 2001

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