

Telemedicine in the State of Maine: A Model for Growth Driven by Rural Needs

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ABSTRACT

As of mid-2002, Maine had one of the largest state-wide telemedicine systems, comprising over 150 facilities among 90 health, mental health, and social service provider organizations in two collaborative networks. The rapid growth of telemedicine in this rural, economically disadvantaged state is largely attributable to collaborative development and the service activities of the Maine Telemedicine Services division of a rural community health center, HealthWays/Regional Medical Center at Lubec (RMCL). Annual clinical uses of the system across a broad array of interactive videoconferencing applications currently exceed 1,000 instances for institutional telemedicine and 800 instances for home telehealth. The major applications include mental health/psychiatry, endocrinology/diabetes management, primary care, specialty pediatrics, genetics, and dermatology. Primary care usage derives from a relatively novel use of a mobile telemedicine boat to serve small islands off mid-coastal Maine. Strong future growth is expected in prison telemedicine, emergency medical triage, and non-traditional services such as video relay interpretive services for the deaf, domestic violence advocacy and legal services, and case management for community reintegration of juvenile offenders. The relative success of the two large networks managed by RMCL's Maine Telemedicine Services is evident from the criteria that system usage (1) addresses defined clinical needs, (2) has demonstrable organizational support, (3) is accepted by physicians and patients, (4) exhibits measurable cost and clinical benefits, and (5) is moving toward sustainable operations. Potential bases for this success are discussed in comparison with other networks.

INTRODUCTION

MAINE HAS MADE substantial progress in establishing telemedicine for the effective statewide delivery of health care for its rural population. All of the largest hospitals and most of the regional and community hospitals are part of two interlinked networks in the state. Several rural health clinics, mental health agencies, Indian health centers, and other so-

cial service and state agencies are included in this network. A variety of clinical applications were developed, and much does not fit the traditional hub and spoke arrangement. Two aspects of this state-wide system are both unusual and worthy of close examination: (1) the system is structured largely as an open collaborative alliance of independent health care organizations, and (2) a community health center in one of Maine's most rural and poor-

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est areas has played the leading role in fostering network development through technical and clinical support. This paper describes the combined telemedicine network and identifies key strategies that might demonstrate success.

Telemedicine services constitute an appealing health care delivery model for large areas of rural Maine due to their geographic isolation, paucity of local specialty medical services, prolonged periods of hazardous winter driving conditions, and poor road infrastructure. It is difficult for poor elderly residents in much of rural Maine to travel for specialty care. Residents in some isolated areas, such as off-shore islands, have difficulty accessing even primary health care. Also, geographic isolation is a barrier for clinical providers in terms of educational opportunities. Residents in rural areas of Maine exhibit elevated mortality and morbidity for a variety of chronic disorders, including diabetes, specific cancers, and lung, heart, and kidney diseases.¹ Moreover, there is a high suicide rate, especially among the youth and the elderly. A recent epidemic in synthetic opiate abuse had its epicenter among the most rural counties of Maine, where substance abuse services were least available.² Such unmet needs have made telemedicine in the United States and elsewhere a promising approach for delivering medical and supportive services.³⁻⁵

Over the past 5 years, Maine Telemedicine Services (MTS) of the HealthWays/Regional Medical Center at Lubec (RMCL) has attempted to address these disparities by increasing access to health care, mental health, social services, and distance education throughout Maine using ISDN-based videoconferencing technology. The Northern Maine Telehealth Network (NMTN) is a recent fusion of two separate networks, Downeast Telemedicine Network and Northeast Maine Telemedicine Network, which initiated clinical operations in 1998 and 1999, respectively. This new network, NMTN, spans the northern 60% of Maine and includes five large rural counties with an average population density of only 18 persons per square mile (vs. 77 for the United States), a 16% fraction of elderly residents (vs. 13% for the United States), and poverty rates 26% higher than the state as a whole. A separate network called the Maine Telehealth Network was initiated in 2000 to pro-

vide services for remote communities of western and mid-coastal Maine, and to connect with the larger hospitals and mental health service providers in the central and southern part of the state. This is complemented by a rapid expansion of home telehealth through the work of RMCL's Sunrise County HomeCare Services and its partner, the Aroostook Visiting Nurse Association.

The Maine telemedicine system consists of a consortium of networks. Such networks in the United States and other areas of the world have not yet been proven to be self-sustaining and well-coordinated.⁵ We utilized the following criteria for assessing the potential for the success of the MTS network, as suggested by *Telehealth Magazine*, between 1996 and 1999^{6,7}: (1) programs address a defined clinical or health-care need; (2) organizational support is evident; (3) service is accepted by physicians and patients; (4) costs and outcomes are measured; and (5) operations are self-supported or sustainable.

Wootton and Herbert⁸ suggested that the overriding litmus test for telehealth program success is high clinical quality and low cost. Their schema for success includes an additional emphasis on applications becoming a routine practice of medical care. For Yellowlees,^{9,10} sustainability in the end is the overriding factor by which to judge program success.

The present analysis will characterize the operational aspects of telemedicine in Maine, review them against the above criteria, and seek to identify the most relevant program elements for success.

MATERIALS AND METHODS

Organizational structure

The major telemedicine networks in Maine are managed by Maine Telemedicine Services (MTS), which is a division of the non-profit agency HealthWays, the parent organization for the Regional Medical Center at Lubec (RMCL). RMCL is the largest of more than 30 community health centers in Maine, with about 140 full-time and 60 part-time employees. Home care telehealth programs of RMCL are managed by its Sunrise County HomeCare Services division.

Staffing for MTS, excluding that for separate home telehealth programs, has grown from five in 2000 to 10 full-time equivalents in 2002. MTS resources are derived from federal and foundation grants, state contracts, contracts with individual organizations, value-added consultative clinical, telecommunications, and developmental services, network subscription fees, and equipment contracts.

The MTS managed network segments were established as a collaborative partnership through a memorandum of agreement between each participating organization and RMCL. The memorandum of agreement (MOA) includes network goals, membership fees, responsibilities, and benefits, as well as graded increases in membership fee and federal grant support. MTS services delineated in MOA included purchase and installation of equipment, technical support, telemedicine application development, training, coordination and scheduling of continuing medical education events, public and provider education, and negotiation and advocacy work to foster a favorable statewide regulatory and reimbursement environment for telemedicine. Membership responsibilities included installation and coverage of ISDN lines, dedication of at least 25% of an FTE to serve as site coordinator, administrative participation in network steering and advisory committees, cooperation with evaluation and with performance improvement initiatives, and conformity with network credentialing policy.

A subset of eight member organizations of the Downeast Telemedicine Network formed in 2000 a Limited Liability Corporation called "Downeast Telecommunications Services." The purpose of this network was to reduce telecommunications costs and enhance the sustainability of telemedicine operations through a wireless Wide Area Network over a 120-mile distance for video, voice, and data transmissions.

Technology employed

Most of MTS network partners used the Polycom 512 Viewstation, with a 27" or 32" monitor operating over leased ISDN lines at 128–384-K speeds. Some partners used Pictoretel units. The peripheral devices included document cameras, the AMD2500 high-quality examina-

tion camera, AMD stethoscopes, and Welch Allyn otoscopes. Multi-point bridging capability of the Polycom units allowed agencies to connect multiple sites within an organization. Otherwise, participating organizations may purchase bridge time from one of three sources in Maine, including MTS as of summer 2002.

In addition to leased ISDN lines, MTS partners used fractional T1 lines as "virtual" ISDN lines and in one region transmitted over a WAN based on spread-spectrum microwave. Fractional T-1 lines were used by multi-site organizations already linked with T1 lines and for remote sites where ISDN installation was prohibitively expensive. For the mid-coast islands, ISDN service was achieved by extending "drop" lines to an access point on town piers for access by boat.

The two most eastern and northern counties of the Northern Maine Telehealth Network used inexpensive videophone units from 8 × 8, Inc. and the more sophisticated Aviva Patient Station from ATI, Inc., both communicating over regular telephone lines with an Aviva Base Station. Home health care was enhanced through Aviva units equipped with a blood pressure cuff and stethoscope for transmission of vital signs.

MTS network building strategies and services

To build the network, MTS conducted demonstrations of telemedicine at presentations and discussions with potential partner organizations. These meetings helped MTS and partners identify clinical needs that could be provided by telemedicine. Once an organization joined a network, medical staff or administrators participated in bi-monthly steering or advisory committees provided to identify changing needs and to select opportunities for targeting and promoting telemedicine development efforts. MTS held team meetings with management, clinical, technical, and evaluation staff typically twice a month to coordinate work efforts, to solve problems, and to plan strategies.

MTS provided critical servicing including telemedicine demonstrations for providers, training of local site coordinators, protocol development, scheduling, quality assurance, and continuing medical education planning. Site coordinator training involved several hours of one-on-one sessions and group training in

monthly meetings of regional clinical committees. The capabilities of site coordinators in both technical and clinical aspects of their duties were assessed with a competency checklist. The RMCL/HealthWays and MTS medical director worked with primary care physicians and specialists to establish telemedicine applications on the network. Additional training in patient presentation and assisting remote examinations were provided for relevant local mid-level and paraprofessional providers.

MTS staff promoted the network through professional and public presentations, press releases, newsletters, and CME or other events for local providers. MTS also encouraged legislators and government officials to participate in public education events, and staff sat on statewide telemedicine policy and advocacy committees.

MTS also helped organizations write grants for interested organizations to subsidize acquisition of equipment and to fund MTS services for implementation components on a contract basis.

Evaluation approaches

Evaluation data were collected at various stages of development of telemedicine networks in Maine to conduct a comprehensive retrospective review. These data included the following:

- Network membership, equipment installations, demonstrations, presentations, trainings, protocol completion, and staffing
- Network activity by category of "clinical," "educational," or "administrative/other"
- Questionnaire data from participating site coordinators, providers, and patients on satisfaction/effectiveness
- Time and travel savings for all uses of network facilities in the Northeast Maine Telemedicine Network
- Evaluation and satisfaction data from each home health televisit
- Satisfaction/effectiveness surveys given semi-annually to DETNET Steering and Clinical Committee members
- Satisfaction questionnaires from participants in teleconferenced Grand Rounds Continuing Medical Education sessions

RESULTS

Geographic and categorical distribution of telemedicine facilities

Figure 1 shows that the 144 telemedicine facilities of the Northern Maine Telehealth Network and Maine Telehealth Network were located throughout the state by June 2002. Table 1 shows the broad variety of hospitals, clinics, and social service agencies that are members of the two Maine networks. The hospitals on the network included all of the state's five tertiary care hospitals and the majority of its regional and community hospitals. Together, these networks included 73% of all hospitals in Maine.

Telemedicine facilities were present in all 16 counties. About a third (51 facilities) were in the six most rural counties in the eastern, northern, and northwestern portions of the state. Within the remaining 10 counties of central and southern Maine, a third of the facilities (49 facilities) were in rural towns (<10,000), and another third (47) were in towns and cities larger than 10,000 in population (towns in boldface in Fig. 1). The six most rural counties (Washington, Aroostook, Piscataquis, Somerset, Franklin, and Oxford) have no towns over 10,000 and include a population of 260,200 scattered over nearly 21,000 square miles (12/sq mi vs. 77/sq mi for the U.S.; Census 2000).

Provider availability and poverty levels are indicators for medical needs served or potentially served by telemedicine in Maine. The six most rural counties have:

- 50% of state levels of specialty care physicians per 100,000 (excluding family practice, pediatrics, and OB/GYN; 63 vs. 124; Maine Bureau of Health, 2000)
- 76% of the Median Household Income for Maine (\$30,024 vs. \$37,240; Census 2000)
- 150% of Maine's poverty rate (14.2% vs. 10.6%; Census 2000)
- 139% of the state rate of children on Medicaid (38.3% vs. 27.5%; Maine Department of Human Services, 2001)

For most specialty care services, rural patients from these areas must travel substantial dis-

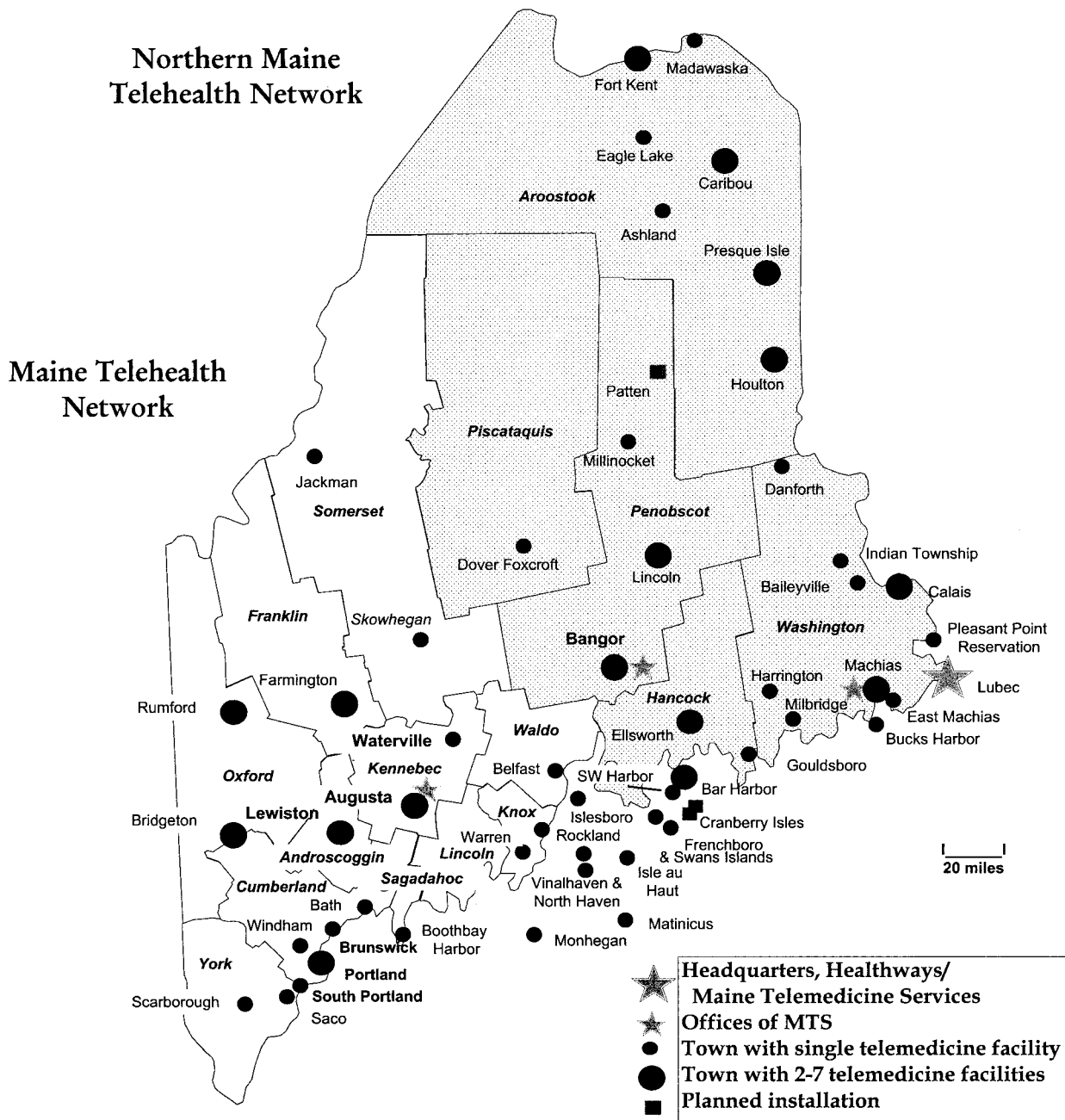


FIG. 1. Geographic distribution of telemedicine facilities of the Northern Maine Telehealth Network (gray) and Maine Telehealth network (white). The 16 counties, shown in boldface italics, include 6 on eastern, northern, and western parts of the state, which are extremely rural (population densities of 4–26 per square mile). Cities in bold type, sites of tertiary care hospitals, are the only ones shown that are 15,000–64,000 in size.

tances, often 2–5 h, to receive care at tertiary care hospitals, in either Bangor and Portland (see map in Fig. 1). Access to primary care is limited for residents in some remote or isolated sites in Maine. In particular, the seven inhabited outer islands of mid-coast Maine have no doctors or clinics. The 1,300 year-round residents must take a ferry to the mainland to receive care.

Growth in telemedicine services for clinical and other uses

Figure 2 displays the growth in utilization for each network segment and for the network as a whole between 1998 and 2002. These numbers exclude store-and-forward applications. In 2000, 34 facilities conducted 983 uses in clini-

TABLE 1. NUMBER AND TYPES OF TELEMEDICINE NETWORK SITES SERVICED BY MAINE TELEMEDICINE SERVICES, AS OF JUNE 2002

Telemedicine facility category	Network segment		
	NMTN	MTN	Total
Primary and specialty medical care	33	24	57
Tertiary care hospitals (200–600 beds)	1	4	5
Regional and community hospitals (30–110 beds)	12	10	22
Community, rural health centers, remote clinics ^a	8	9	17
Indian health centers	3	0	3
Home health agencies	7	0	7
Private medical practices	2	1	3
Mental health and substance abuse treatment	13	11	24
Private mental hospitals	1	1	2
Mental health agencies	11	9	20
State mental hospitals	1	1	2
State administrative and service facilities	8	13	21
Dept. of Corrections—State Prisons	2	4	6
Dept. of Human Services	4	3	7
Dept. of Behavioral and Developmental Services	2	3	5
Dept. of Judiciary—District Courts	0	3	3
Other	27	15	42
Community Action Program sites	12	0	12
Low income legal service sites	3	4	7
Health coalition and prevention organizations	2	4	6
Maine Telemedicine Services sites	3	1	4
Children's service agencies	6	1	7
Domestic violence service agencies	0	2	2
Sign language interpretation agency sites	0	2	2
Residential rehabilitation facility	1	0	1
Medical research organization	0	1	1
Total facilities	81	63	144

^aIncludes Maine Seacoast Mission boat, which serves seven island communities.

NMTN, Northern Maine Telehealth Network; MTN, Maine Telehealth Network. A "telemedicine facility" corresponds to a building with one or more telemedicine units. The 32 medical and mental health hospital facilities listed correspond to 28 hospitals of 44 in Maine.

cal, education, and administrative activities. Volume was distributed almost equally among the three. CME sessions were provided through interactive teleconferencing of Grand Rounds broadcasts from the two largest hospitals in Maine—Eastern Maine Medical Center/Acadia Hospital in Bangor and Maine Medical Center in Portland. Administrative uses included meetings for planning, project management, hospital associations, health care coalitions, and other purposes.

In 2001, activity on the combined networks grew extensively in association with the addition of 51 more sites. From 2000 to 2001, the 85 facilities demonstrated growth in clinical usage by 77%, in administrative uses by 220%, and in educational usage by 18%. Data from the first quarter of 2002 suggests at least comparable

growth rates for clinical and administrative categories (201 and 506 uses, respectively), whereas education uses for the quarter (219) lead to projections of more than a doubling in annual use.

Network usage reported here does not include utilization for "closed system" sites of Eastern Maine Healthcare's Northern New England Telemedicine System. For example, Acadia Hospital reported to MTS the delivery of 638 telepsychiatry/mental health uses in 2001 with affiliated hospitals and clinics that are not part of the MTS serviced network.

These statistics also do not include home tele-health activity in the Northern Maine Telehealth Network. In the last 3 years, the network averaged 70–80 home tele-visits a month, with total cumulative usage from 7/99–6/02 totalling 2,600 for 86 patients (860/year).

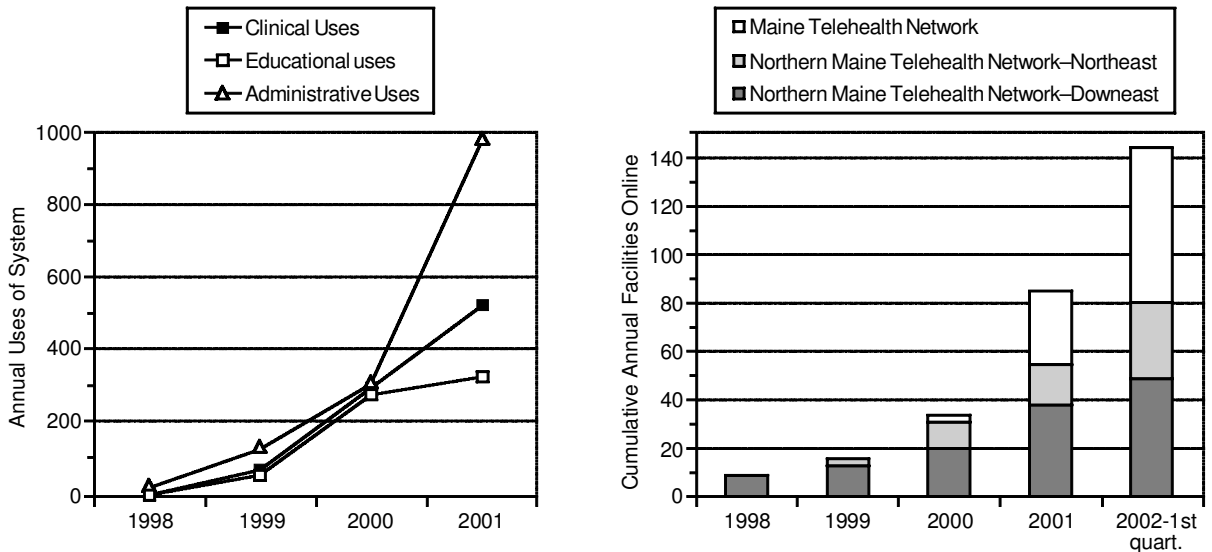


FIG. 2. Growth in Maine telehealth networks facilities and utilization. **A.** Annual network utilization in categories of clinical, educational, and administrative uses. **B.** Networked facility numbers by network segment. Charted values do not include sites of the Northern New England Telemedicine Network, extra subsites within big hospitals, or the schools, educational institutions, and provider agencies for which Maine Telemedicine Services installed equipment but did not provide service development.

Clinical application development

Types of clinical activities on the combined networks in 2001 are illustrated in Figure 3. Mental health and psychiatry (41% of uses) included patient assessment, diagnostic, and treatment sessions, and case management sessions. Specialty consults in endocrinology/diabetes

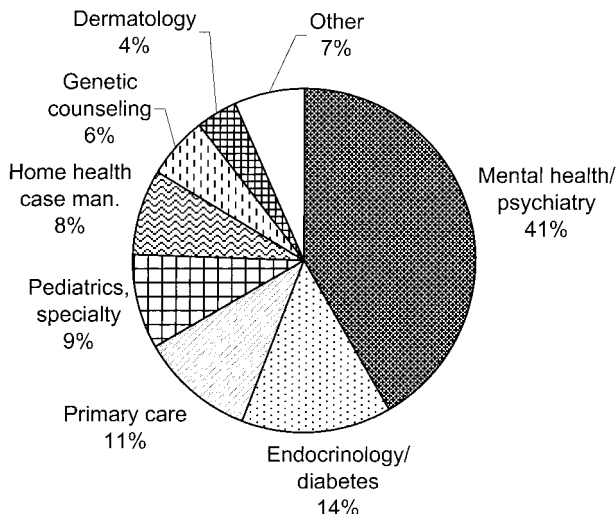


FIG. 3. Clinical telemedicine usage by categories, 2001 ($n = 518$ for 85 facilities).

care, specialty pediatrics, genetics, and dermatology each represented 4–14% of uses and involved services of one to three physicians for patients accessing them from wide areas of the state. The category of specialty pediatrics included consults in subfields of endocrinology, genetics, neurology, and adolescent medicine. Some of the specialty care consults on the networks involved follow-up by mid-level providers, case management, or physician oversight of remote mid-level providers. Primary care sessions largely corresponded to service provided to small islands off mid-coastal Maine via linkage through the Maine Seacoast Mission’s mobile telemedicine boat, *Sunbeam*. The usage for home health case management involved treatment review of active patients by staff of two county-wide home care agencies, RMCL’s Sunrise County Homecare Services and the Visiting Nurses of Aroostook. The patients reviewed were from telehealth categories of chronic medical disease care, mental health care, and hospice care. The category of “other” includes geriatric assessments, tumor board sessions, neurology, ENT, discharge planning, wound care, and nutrition consultative sessions.

The figures do not include home health nursing telemedicine visits. Primary diagnoses

for the 85 patients treated up to May 2002 included chronic heart disease (42%), cancer (23%), and lung disease (14%). Nearly 20% had diabetes as a secondary diagnosis. Since 2001, 14 additional home health care patients have also been treated for depression as part of a separate demonstration project. Some telehealth sessions included assessments carried out by a psychiatric occupational therapist and patient monitoring and medication management sessions with a psychiatric social worker.

In 2001, the Maine Seacoast Missionary Society's 71-foot vessel *Sunbeam* conducted 39 primary care teleconsults. Utilization of the mobile telemedicine system averaged 8–12 sessions per month in early 2002. The availability of consultative services of an emergency physician at Penobscot Bay Hospital in Rockland was added in March 2002 in order to address the need for triage of relatively urgent acute care. As the *Sunbeam* is only in port about two times a month, ongoing needs for occasional emergency medical triage has led to current efforts to establish permanent Polycom placements on some of the islands, with emergency medical technicians or paramedics used as site coordinators.

Development of this primary care telehealth approach for residents of the outer islands of mid-coastal Maine required prolonged and complex efforts. Through the *Sunbeam* and its predecessor vessels, the Maine Seacoast Mission has provided religious and social services for these islands for over 100 years. Placement of a nurse and a Polycom Viewstation 512 and peripheral devices aboard the boat for regular medical clinics revives periodic approaches in the past to use the vessel to accommodate health care needs of the islanders. In order to preserve existing patterns of care, installations of equipment and provider training and scheduling plans were required at multiple sites, including two outreach clinics of community hospitals in Southwest Harbor, a rural health clinic on Vinalhaven, and a regional hospital in Rockland (Fig. 1). Getting ISDN services installed on some of the islands was a prolonged effort, and establishing a weatherproofed connection site at the dock on each island required special engineering work.

Other telemedicine and social service applications in a late stage of development by MTS partners include: (1) video relay interpretative services for deaf patients of numerous hospitals,

(2) crisis mental health assessments and triage for a three-county provider network under contract with Maine Department of Behavioral and Developmental Services, (3) emergency medicine and specialty medical services for adult correctional inmates, (4) case management for community reintegration of juvenile offenders, (5) case management for clients in the service of Maine Department of Human Services, (6) mental health services for children in child care centers, (7) legal services, domestic violence advocacy, and testimony at court hearings for victims of domestic violence, and (8) public health nurse services for school children at some of the 35 schools in Washington County being linked in a distance education project.

Satisfaction data on telemedicine services

In a post-consult survey sample of 65 patient telemedicine sessions at Downeast Telemedicine Network facilities during 1999–2000 (Fig. 4), 95–100% of patients, site coordinators, referring providers, and consulting providers rated themselves as highly or moderately satisfied with the sessions. Problems of any kind were reported in one third of the sessions (e.g., lighting, getting used to audio delay or motion artifacts, small “glitches” in the image). However, respondents found that these problems interfered with the progress of only 4% of the consults (e.g., total audio or connection loss).

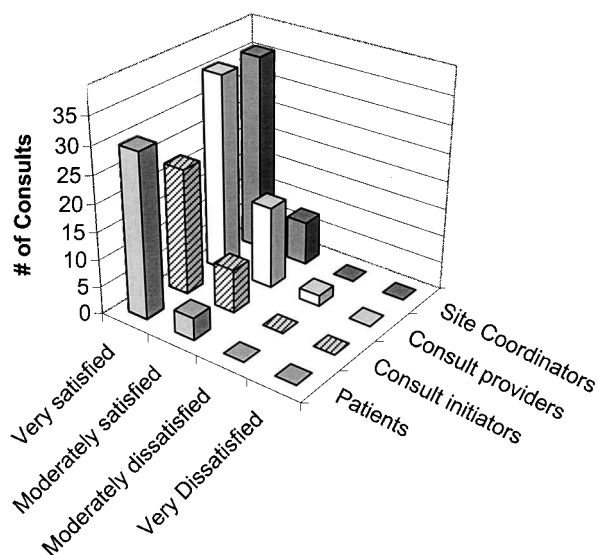


FIG. 4. Satisfaction ratings for a sample of 65 telemedicine sessions with patients via Downeast Telemedicine Network facilities, 1999–2000.

TABLE 2. QUALITY RATINGS ON SYSTEM USAGE IN NORTHEAST MAINE TELEMEDICINE NETWORK, 1/00–5/02

<i>Usage category</i>	<i>Excellent</i>	<i>Good</i>	<i>Poor</i>	<i>Total with rating</i>	<i>Number unrated</i>
Clinical	61%	36%	4%	76	41
Educational	22%	60%	18%	67	51
Administrative	66%	30%	5%	222	193

For another 76 clinical telemedicine uses on the Northeast Telemedicine Network between 2000 and 2002, 61% were rated “excellent” and 36% as “good” in quality ratings provided by site coordinators or by representative participants on case reviews, tumor boards, or case management sessions (Table 2). The 4% of sessions rated as poor resulted from telecommunication connectivity problems.

In 2,619 home health telehealth visits, 95% of patient responses and 98% from staff were “very satisfied” with the sessions. Thirty-one percent of the sessions encountered some problem in the first 10 months of program operation (7/99–5/00), 14% in the subsequent 12 months (6/00–6/01), and 7% in the last year (6/01–5/02). The steady decline reflects clinical performance improvements in multiple areas.

Monthly or bi-monthly regional meetings with MTS staff and site coordinators provided valuable feedback. For example, early surveys of site coordinators revealed confidence in technical proficiencies, but most respondents felt less confident in their ability to coordinate clinical consults. These findings compelled MTS staff to develop practice modes using a mock teleconsult format.

Despite relatively frequent technical problems during educational uses, most participants found the videoconferenced continuing medical education effective. Clinicians ($n = 163$) attending educational sessions between 2000 and early 2002 reported strong or moderate satisfaction 82% of the time (Table 2). Written feedback revealed the need for improvements in audio quality, interactive opportunities and distributing supporting materials in advance.

Cost and clinical outcome benefits

Perceived clinical outcomes from patient teleconsults are shown in Table 3. Results are

based on checklist responses of consulting and referring providers in post-consult evaluation forms from 49 telemedicine specialty consults from Northern Maine Telehealth Network facilities. Somewhat more than half the respondents reported that the session helped establish a treatment plan, while roughly one-fifth to one-third reported that the sessions contributed to patient education, involved mental health therapy, led to a referral, involved an assessment or diagnosis, guided primary care treatment, and/or helped manage a chronic disease. Analyses of specific usages of home telecare systems revealed that telehealth visits most frequently involved evaluation of health status (28%), monitoring of medications (25%), checking of vital signs (22%), physical assessment of heart and lung sounds (9%), patient education (8%), and glucometer or medication pump readings (3%). Thus, many of the traditional short-term impacts of face-to-face health care treatment sessions were accomplished in these telemedicine sessions.

In the patient surveys from the above 49 con-

TABLE 3. PERCEIVED CLINICAL OUTCOMES OF PATIENT-PROVIDER TELECONSULTS, 1/99–3/00

<i>Response category</i>	<i>Percentage selected</i>
Help establish treatment plan	53%
Patient education	33%
Mental health therapy	20%
Referral made	20%
Assessment or diagnosis	18%
Guide primary care treatment	18%
Manage chronic condition	18%
Medication management	14%
Discharge planning	4%
Medical follow-up	4%
Prevent hospitalization	2%

Responses are from surveys of consulting and referring providers on 49 telemedicine specialty consults, including 38% endocrinology, 25% psychiatry, 18% mental health, 13% diabetes education/management, and 7% other.

sults on the query "What is the best thing about seeing your doctor over TV," the top three responses were 53% for "it is more convenient in terms of travel," 26% that "all involved in my health care can be involved," and 13% that "my family members can be involved." Among the 37 respondents who provided travel data, an average of 165 miles was reported saved.

Table 4 shows savings in travel and associated costs achieved through the use of the Northeast Maine Telemedicine Network. Clinical uses associated with reported travel savings included case management, clinical oversight, and case review sessions, such as in tumor board meetings. For 87 such cases, an average of 2.7 providers per session together saved an estimated \$491 per use.

Interestingly, estimated savings on travel for educational and administrative uses of the network were similar, \$496 and \$386, respectively. The average miles saved per session for educational session participants (162 miles) was nearly double that for administration uses (86 miles). Consistent with this difference, administrative uses typically involved meetings among agency sites within the region, whereas Grand Rounds and other CME opportunities came from distant tertiary care hospitals. The major point is that travel savings for educational and administrative uses can be substantial with only moderate use by a health care organization.

Data and activities relevant to sustainability of networks

To initiate networks MTS relied on grants from the Office for the Advancement of Telehealth (OAT), the Department of Agriculture Rural

Utilities Service, the Department of Commerce Technology Opportunities Program (TOP), the Office for Rural Health Policy, and the Robert Wood Johnson Foundation. However, the majority of telemedicine organizations on the network assumed costs for equipment purchases and network membership fees. Grant funds were largely used to cover equipment for rural access facilities and to subsidize other efforts MTS took to develop services.

The major grant from OAT which supported development of DETNET ended in 2000, yet 11 of 13 partner organizations in that project still remain network members. Also, while much of the grant funding that subsidized the development of the Northeast Maine Telemedicine Network ended by the close of 2001, the large majority of its original partner organizations continued with former DETNET sites as members of the new network, Northern Maine Telehealth Network.

While network fees from a large number of member organizations plays a part in sustaining the professional staffing base required for the integrated telemedicine services provided by MTS, grants and service contracts for collaborative projects are expected to remain the major funding support for the network. Consequently, a consistent strategy used is for most MTS staff to work with network partners and with RMCL development staff in ongoing collaborative planning, needs assessment, and proposal writing. With the inclusion of the southern half of Maine through the development of the Maine Telehealth Network, the system began to assume the proportions of effectively a statewide network, increasing the feasibility and opportunities to serve Maine government departments and other organizations with a broad

TABLE 4. SAVINGS ON TIME AND TRAVEL BY PARTICIPANTS IN USAGE OF THE NORTHEAST MAINE TELEMEDICINE NETWORK, 1/00-5/02

<i>Data item from usage log</i>	<i>Clinical uses</i>	<i>Educational uses</i>	<i>Administration uses</i>
Number of network uses with reported travel savings	87	131	443
Total participating remote staff in sessions	231	323	1212
Average number of remote participants per session	2.7	2.5	2.7
Average miles travel saved per staff	104	162	86
Average hours of travel time saved per staff	3.9	3.8	2.9
Savings on travel per session (@\$.29/mile)	\$80	\$116	\$68
Savings on time to travel per session (@\$40/hr)	\$411	\$380	\$318
Total estimated savings per session	\$491	\$496	\$386

geographic scope of operations. Recent examples of the latter include MTS support contracts with the Maine Departments of Corrections and of Behavioral and Developmental Services for mental health, case management, and urgent triage services, and with the Pine Tree Society for Handicapped Children and Adults for video relay of deaf interpretive services at hospitals around the state. Such contracts hold promise as renewable into the long range future.

MTS has consistently contributed to statewide planning, policy, and advocacy efforts on behalf of partners with the aim of improving the supportive regulatory and policy infrastructure for telemedicine. Such efforts include work with a telehealth committee of the Maine Hospital Association that reviews issues such as liability, insurance reimbursement, and credentialing. Senior MTS staff members also participate on a telemedicine task force established by the Governor. MTS has also helped spearhead negotiations with telecommunications companies and with the state Public Utilities Commission that led to a low flat rate for ISDN line charges and to reduced charges for infrastructure work necessary to provide ISDN service to some of the more remote sites, such as Indian Township Health Center. Finally, the frequent presentations and demonstration by MTS staff around the state have had a frequent focus on politicians and opinion leaders as well as with medical providers. The political good will and media attention generated through these efforts have contributed to legislative and congressional support for favorable reimbursement policies as well as political support for federal grant proposals.

DISCUSSION

Over the past 5 years, Maine Telemedicine Services has developed and maintained a statewide telemedicine system with broad geographic distribution of access and service sites and a volume of interactive clinical uses expected to exceed 1,000 instances in 2002. Criteria for evaluating its success will be briefly reviewed followed by a more detailed examination of the significance of the consortium model of network organization for aspects of such success.

Addresses clinical or healthcare delivery needs

Wootton and Herbert⁸ and Yellowlees^{9,10} suggested several indicators to evaluate how this criterion can be met. The Maine Telemedicine Services' collaborative networks provide a wide range of applications, including specialty care consults in over 10 disciplines and continuing medical education programs. The system allows any member organization to connect with another in an open architecture system, and the system is open for new agencies to join the network. The widespread distribution of facilities, including the most rural and economically disadvantaged areas of the state, enhances the opportunities for patients, clinicians, and other users to access services. Among the 144 facilities in the two network divisions in mid-2002, two-thirds were in rural towns of less than 10,000 people. At the same time links with all of Maine's tertiary care hospitals and the majority of other hospitals help assure that many of the services rural residents need are available on the network. Finally, the boat-based service and the home telehealth and telemental health services reach the most remote communities in the state.

Organizational support

MTS provides stable, well financed, and coordinated efforts in the areas of resource development, technical services, clinical operations, training, and advocacy for a favorable regulatory and policy infrastructure. MTS supports evaluation efforts, dissemination of professional literature, and education of providers through presentations, newsletters, and annual conferences. The telemedicine networks, as well as several collaborative grant projects, each have active advisory, management, and clinical committees, with good representation from members at different organizational levels. Thus the MTS networks include formalized management and clinical leadership that are supportive and consistent with the Yellowlees' indicator.¹⁰

Services accepted by physicians and patients

The evaluation data collected by MTS reveals high satisfaction levels with telehealth con-

sumers and providers. The attention to training, piloting of new applications, and regular updates of clinical protocols and guidelines contribute to these results. The telemedicine utilization levels are high when compared to other networks that concentrate selectively on interactive televideo applications.⁶ Although clinical uses of the network comprised 30% of the total volume in 2001, the high utilization for educational and administrative purposes complements clinical uses. Not only do the non-clinical uses enhance the levels of clinical training and the management capabilities of the health care organizations, they appear to help foster clinical use through familiarization of clinical staff and key administrators with the technology.

The indicator that telemedicine becomes a routine method of care, suggested by both Wootton and Herbert⁸ and Yellowlees,¹⁰ is somewhat harder to demonstrate. However, evidence suggests that the MTS managed networks provide a foundation for routine care. The nine specialty care physicians responsible for the majority of consults continue to provide telemedicine consults without any sources of institutional incentives. The primary care services provided to island residents are becoming a routine service through regularly scheduled trips made to each island. Finally, the 3 years of home health telemedicine has led to widespread acceptance of televisits as a standard tool for enhancing conventional home health care.

Demonstrable cost and clinical outcomes

Evaluation data suggests telemedicine in Maine has produced clinical benefits and cost savings. Results indicate that clinical teleconsults improve access to health care and specialist services by reducing travel time and associated costs incurred by patients (average savings of 160 miles driving for residents of one county). Post-consult surveys of providers of both specialty care telemedicine and home health telecare indicate that the content of telehealth sessions is similar to that of in-person appointments.

Health-care providers realized savings in travel time and costs for users. In the highly rural territory of the Northern Maine Telehealth Network, clinicians and agency staff reported estimated travel savings (mileage and

staff time) of roughly \$500 for clinical uses (such as case management), \$500 for educational uses (such as Grand Rounds), and \$400 for diverse administrative uses. In the case of home telecare, staff travel costs of about \$60 per visit are potentially saved based on the untested assumption that a televisit substitutes for one in-person visit (driving time of about 1 h for a 37-mile round trip to patient's home). Although these evaluative results help to demonstrate success to providers and network organizations, further study is needed. The literature contains very few telemedicine studies that assess outcomes.¹¹⁻¹⁶

Programs self-supporting or sustainable

The literature also reveals that very little work is explicitly directed at assessing program success on the criterion of sustainability. Currently, MTS relies on a combination of service contracts with network partners, grant support, and state agency contracts. Recent contracts and pilot projects with state agencies hold promise for a renewable source of revenue that can help sustain telemedicine in Maine.

For providers, sustainability relies on reimbursement from payers for clinical services and on travel cost savings for remote clinician oversight or patient review programs. Travel cost savings for administrative meetings can also be substantial for organizations with multiple sites. For primary care sites, the limited reimbursement for referring providers under Medicare is relatively insignificant when compared to the other sources of cost savings. Many members on MTS networks have continued to pay network subscription fees, site coordinator staff costs, and ISDN line charges after grant funding ended. The fee revenue enhances future stability in network management support.

Recent improvements in Medicare reimbursement policies for telemedicine, Medicaid coverage of many applications, and support from private insurance companies operating in Maine is encouraging. However, research shows that cost effectiveness of organizational investments in telemedicine is dependent on sufficient volume of clinical usage of the system, and determination of what is "sufficient" requires extended study.^{8,14} MTS hopes to collaborate with universities in Maine in formal research on these issues,

as well as in efforts to develop more strategies for sustaining the MTS-managed networks.

Comparison of Maine's telemedicine system to programs elsewhere

Many of the foregoing activities by MTS mentioned as contributors to each category of success represent well recognized best practices for development of telemedicine programs.¹⁷ A major question important to resolve is whether any particular aspects of the program in Maine and its successes are related to the consortium structure of the network compared to the more common hospital or university based network structure.

Examples of networks elsewhere with a consortium form of organization similar to NMTN and MTN and with clinical services in multiple specialties include: the Midwest Rural Telemedicine Consortium (Iowa), the High Plains Telemedicine Network (Colorado), the Northern Sierra Rural Health Network (California), and Inland Northwest TeleHealth Network (Washington). The sizes of these programs are smaller than the combined Maine network, ranging from 20 to 50 sites generating 100–200 patient consults a year (TIE database). A close comparison of Maine's network with these programs is not possible because of the lack of any published details on their operations. However, in terms of size, statewide reach, and percent coverage of hospitals, the system in Maine is perhaps more comparable to several states with moderate to large inter-linked systems (e.g., Georgia, Arizona, and others). The incorporation of state programs, such as corrections institutes, is a common aspect of such programs that Maine is just beginning to develop. Maine's programs also bear comparison to large province-wide programs in highly rural areas of Australia and Canada.^{18,19} Of these, the programs of New South Wales and Queensland are listed as the only two sites in the TIE database of 239 sites worldwide with greater than 100 interactive telemedicine sites.

One plausible reason that Maine's program was able to expand quickly to statewide proportions is that MTS is "non-aligned." As an independent agency with respect to the major hospitals, it is not subject to the direct competitive interactions among major health care pro-

viders in the state and thus can focus on engendering collaboration. At the same time, the very openness of the Maine network system developed under this model has allowed several functional subnetworks to thrive within the larger network environment. These include mental health and home care agencies linking among multiple service sites, state agencies linking among widely separated sites, and large hospitals linking with subsidiary or affiliate hospitals or clinics. These examples of integration and close coordination with relatively "closed" functional networks illustrates that the consortium model of network organization is not mutually exclusive with other models. The advantage for a hospital based network to participate on a larger consortium based network is that this gives them patient access and referral sources from independent health care agencies across geographically wide rural areas. Given this advantage, we expect that more large hospital based programs in other states will move toward consortiums with an alliance type of network in order to reap advantages of forming into functional statewide or regional telemedicine networks.⁵

Significance of clinical telemedicine prevalent in Maine

Only two institutional telemedicine applications in Maine's networks are very common in other networks. The number one application of mental health/psychiatry and the new program in teledermatology are programs with a well-founded research basis,^{20,21} and they correspond to the top two programs for consult numbers in the 2001 ATSP report.⁶ The other specialty services on our networks, endocrinology/diabetes care, genetics, pediatrics, and geriatric medicine, represent relatively uncommon applications compared to other networks.⁶ We are aware of only few published demonstrations or feasibility studies on interactive ISDN-based telemedicine use for endocrinology,²² genetics,^{23,24} geriatric medicine,²⁵ and specialty pediatrics not related to cardiology.^{26,27}

The success of these applications in Maine appears due to the emergence of local telemedicine champions, who successfully overcame common barriers to telemedicine diffusion, such as work flow disruption, reticence to

adopt a new technology, and concerns about liability and reimbursement.^{3,28-30} Facilitating strategies by the MTS medical director and staff to engender and empower these special providers included "roll-out" CME presentations, promotion of their activities in newsletters and press releases, and providing them a forum at an annual MTS statewide telemedicine conference. Part of the basis for success with these applications is also attributable to placement of equipment where the providers practice.

The predominant primary care application in Maine, telemedicine delivered using a mobile ship-based system, appears to be unique. Unlike the situation in Maine, previously reported ship-based telemedicine approaches on military vessels or cruise lines serve the passengers and use the system almost exclusively for specialty care or emergency services.⁵ Other projects serving islands with much larger populations also follow this model.³² The present approach, however, does bear functional resemblance to a mobile telemedicine van system used in rural Oklahoma.³³

The home telemedicine services implemented in Maine represent one of dozens of similar programs elsewhere which take advantage of recent technical breakthroughs in quality of videoconferencing achievable over affordable units utilizing regular phone lines.⁶ Recent analyses suggest that up to half of all homecare visits could be handled through virtual visits using homecare telemedicine equipment, either with or without monitoring devices for heart and lung sounds and blood pressure.³⁴ To the extent that televisits can substitute for some in-person visits without sacrificing quality of care, the approach appears promising for home care agencies to become more cost efficient under the Medicare Prospective Payment System.

CONCLUSION

This review of the two telemedicine networks in Maine revealed that they function successfully according to most conventional criteria. The Maine system enhances access to needed services for its residents. Its membership size and range contributes to its success.

The MTS experience in Maine also suggests that travel savings for continuing medical education and administrative uses might help to subsidize the costs of participating in a network.

The consortium model of network organization appears to work well in Maine because the lead agency, RMCL, is not aligned with major hospital systems in the state. This form of telemedicine network structure may have an advantage over competitive hospital- or university-based networks. In Maine, "closed" hospital-based networks were readily accommodated as subnetworks of the consortium base. This framework contributed to collaboration and the growth of networks across the state.

ACKNOWLEDGMENTS

This work was supported by grants from the Office for the Advancement of Telehealth, Health Resources and Services Administration; Technology Opportunities Program, U.S. Department of Commerce; Rural Utilities Service, U.S. Department of Agriculture; Office of Rural Health Policy, Health Resources and Services Administration; and Robert Wood Johnson Foundation.

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