Telemedicine Evaluation of Acute Burns Is Accurate and Cost-Effective

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Background: As the number of US burn centers has declined, access to burn care is increasingly limited. Inexperience in burn wound assessment by referring physicians often results in overtriage or undertriage. In an effort to improve access to burn care in our region, we instituted a program of telemedicine evaluation of acute burns.

Methods: We created a telemedicine network linking our burn center to three hospitals located 298 to 350 air miles away. Participants agreed to perform telemedicine consultation for acutely burned patients admitted to their emergency departments. We compared consults and referrals from these facilities during the period July 2005 to August 2007 (TELE) to those during a 2-year period before instituting telemedicine (PRE-TELE).

Results: During the TELE period, 80 patients were referred, of whom 70 were seen acutely by telemedicine, compared with 28 PRE-TELE referrals. The groups did not differ in age or burn size. Only 31 patients seen by telemedicine received emergency air transport (44.3%), compared with 100% of PRE-TELE patients ($p < 0.05$). Nine other TELE patients were transported by family; 30 other patients were treated locally. Ten remaining patients were transported without telemedicine evaluation. TELE patients transported by air had somewhat larger burn sizes (9.0% vs. 6.5% total body surface area; p = NS) and longer length of stay (13.0 days vs. 8.0 days; p = NS) than PRE-TELE patients. Burn size estimates by burn center physicians made either by telemedicine or direct inspection correlated closely but both differed significantly from those of referring physicians. Providers and patients expressed a high level of satisfaction with the telemedicine experience.

Conclusions: Acute evaluation of burn patients can be performed accurately by telemedicine. This can reduce undertriage or overtriage for air transport, improve resource utilization, and both enhance and extend burn center expertise to many rural communities at low cost.

Key Words: Telemedicine, Burns, Air Transport, Triage.

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In the past 40 years, survival from burn injuries has improved dramatically, whereas per capita burn incidence has decreased by more than half.[1] But despite these advances, the US still has the highest rate of fire-related deaths of any developed nation,[2] and many segments of the population—including children, the elderly, and rural residents—face higher risks of injury and death from burns and trauma.[3,4] Reduced access to treatment may increase these risks[5] and certainly complicates delivery of care. Since 1981, the number of active US burn centers has decreased by 29%[6]; only 41 centers are currently verified by the American Burn Association (ABA) and American College of Surgeons (ACS).[7] These centers cover ever-larger referral areas, routinely run at or near capacity, and face mounting financial challenges from underfunded patients who may be selectively referred.[8] In addition, the improved survival produced by these centers has generated major new challenges in rehabilitation.[9] Even patients with massive burns can return to productive and satisfying lives, but only if given therapy that is prolonged, costly, highly specialized, and available in only a few centers.

As burn incidence has declined, so has most physicians' familiarity with burn treatment, widening the gap in expertise between burn centers and many smaller—particularly rural—hospitals. Air transport is often the only feasible way for remote patients to reach the few remaining burn centers. However, inexperienced providers often estimate burn size incorrectly,[10–13] leading to significant errors in fluid resuscitation and airway management[14,15] and increasing the likelihood of occasional undertriage and, more frequently, expensive and wasteful overtriage.[16–18] In a recent review of our experience with air transport of burn patients, we documented frequent major discrepancies in burn size estimation and several unnecessary intubations. Only 60% of the patients we reviewed clearly required air evacuation and 10% of patients incurred transport costs, which exceeded the total costs of their burn care.[12]

Telemedicine has the potential to address many of these issues. Telemedicine screening has reduced aeromedical transports for a variety of conditions safely and with significant cost savings.[19,20] By providing accurate assessment of burn severity, televideo or digital "store and forward" communication has been used both to improve initial triage and to provide cost-effective and convenient follow-up care.[21–24] Telemedicine has proved readily adaptable to such diverse uses as space flight and humanitarian missions and could prove invaluable in optimizing local resource utilization in

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the event of a mass casualty or terrorist incident.[25–27] In a major recent review of regional trauma care, telemedicine use dramatically reduced transfers to the trauma center with equally impressive reductions in emergency room stay, transfer times, and costs.[28]

We postulated that the routine use of telemedicine for acute evaluation of burn patients in our region could improve the accuracy and cost-effectiveness of triage without increasing undertriage. For these reasons, we conducted this study to evaluate the feasibility and value of telemedicine-based evaluation of acutely burned patients.

PATIENTS AND METHODS

The TABC Project

In 2004, we obtained a grant to conduct a demonstration project from the Technology Opportunities Program, National Telecommunications and Information Administration, US Department of Commerce. With this grant, we established a secure telemedicine network between our burn center and three participating hospitals in the intermountain area: St. Alphonsus Regional Medical Center, Boise, ID; St. Vincents Hospital, Billings, MT; and St. Peters Hospital, Helena, MT (Fig. 1). These facilities were selected because they were each regional hubs for secondary medical care, they had historically referred patients to the burn center frequently, and they expressed interest in the project. Each facility obtained Institutional Review Board approval to participate in the project and agreed to obtain consent from each patient evaluated by telemedicine.

Each facility was provided with an identical, state-of-the-art portable telemedicine studio (see below and Fig. 2). We visited each emergency room to introduce providers to our staff, familiarize them with telemedicine protocols, and carry out some "dry run" connections. Providers at each facility agreed to contact the burn center for immediate telemedicine consultation when acute burn patients were seen in their emergency rooms. The three attending surgeons in the burn center were also provided with telemedicine equipment in their homes to enable round-the-clock access.

We recognized in advance the need to involve participating medical staffs in this project. Physicians at each facility were invited to attend an introductory presentation, and personal communication with the referring physician was performed after each telemedicine consultation. To overcome concerns about autonomy and "turf," we assured the referring physicians that they would retain the right to determine when and how patients would be transferred and found it helpful to discuss each case privately by telephone at the conclusion of the telemedicine examination. These steps helped to protect

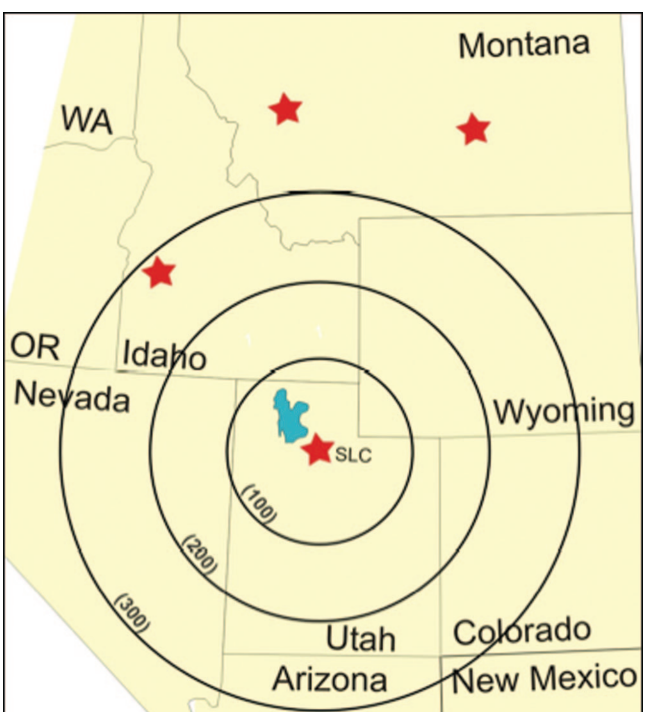

Figure 1. Location of sites participating in the telemedicine project. Circles indicate mileage by air (one way) from Salt Lake City. 1, University of Utah Health Center; 2, St. Alphonsus Regional medical Center, Boise, ID; 3, St. Vincent's Hospital, Billings, MT; 4, St. Peter's Hospital, Helena, MT.

Figure 2. The portable telemedicine cart used in the telemedicine project. Key components are indicated. Photo courtesy of Polycom, Inc.

the referring physicians' status in their own institutions and better defined our role as consultants in patient care.

Technology

Identical portable televideo carts (Polycom VSX 7000, Pleasanton, CA; Fig. 2) were procured for each hospital. Each cart was equipped with both a studio-style video camera and a hand-held macro camera, which could magnify up to 50× for close-up evaluation of wounds. Video carts were linked by a dedicated internet-based VPN connection maintained by the Utah Telehealth Network at the University of Utah. Physicians' homes were connected via DSL (768 kbps) cable connections. All connections were protected by firewalls and were HIPAA-compliant. Each physician in the three burn centers obtained licensure in Idaho and Montana and maintained privileges at each of the participating hospitals.

Data Collection

The TABC project was inaugurated July 1, 2005, and ran through August 31, 2007. All patients for whom telemedicine consultations were performed during this period were grouped as TELE patients. For comparison, we searched our computerized burn registry (TRACS ABA Burn Registry software) for all patients referred from the three participating hospitals during the period June 1, 2003, to July 1, 2005. These patients were termed PRE-TELE patients. Basic data on patient demographics, burn sizes, whether and how transported to the burn center, hospital course, and outcomes were recorded for all patients.

During the TELE period, we distributed separate survey documents to all patients seen by telemedicine, and to their referring emergency department physicians and nurses and burn center physicians, to assess the satisfaction of all participants with each telemedicine encounter. Participating providers also agreed to attend a regional conference on burn care in Salt Lake City at the end of the project.

Statistical Analysis

Data on patient demographics, etiology of burn injury, size and type of injury, details of hospitalization, and outcomes were collected on each encounter as well as results from satisfaction forms. Because of unequal sample sizes, data were expressed as means with interquartile ranges, and comparisons between the groups were performed using nonparametric statistical tests. A p value of 0.05 or less was considered significant.

RESULTS

Patients Evaluated

During the PRE-TELE period, 29 patients were referred to the burn center for patient care (Table 1). All patients were transported acutely by air at the request of the referring physician. In contrast, during the TELE project, 70 patients were seen via telemedicine. Of these, 31 required acute air transport (TELE-AIR, 44.3%; $p < 0.05$ vs. PRE-TELE by Chi-squared). Nine additional patients were referred to the burn center on a semiemergent basis and traveled to Salt Lake City by private vehicle; they were usually admitted in preparation for skin grafting surgery. The remaining 30 patients never traveled to the burn center and were treated locally after telemedicine evaluation. Ten additional patients were transported to the burn center by air without telemedicine evaluation because of technical problems with equipment or refusal of local physicians to use telemedicine. Thus, a total of 80 referrals occurred during this period. The PRE-TELE and TELE groups did not differ in age, gender, or burn size. One PRE-TELE patient had a massive (86.5% total body surface area [TBSA]) burn injury and ultimately expired. All other patients survived.

Patients transferred in the PRE-TELE period had median burns of 6.5% TBSA, compared with 9.0%TBSA for the TELE-AIR patients ($p < 0.05$ by Kruskal-Wallis). This difference was relatively minor; however, the fact that transferred TELE-AIR patients had somewhat larger burns than PRE-TELE patients, coupled with the very small burn sizes among the other TELE patients, suggests that telemedicine was at least somewhat effective in reducing overtriage by air, without contributing to undertriage.

Burn Size Estimates

Estimates of burn sizes were recorded as performed by referring physicians (Refer-MD), burn center physicians using telemedicine (BU-Tele), and burn center physicians on face-to-face examination on arrival at the burn center (BU-arrive). Comparisons of these estimates are summarized in Table 2 and illustrated by scatterplots in Figure 3. Burn center

TABLE 1. Comparison of PRE-TELE and TELE Patient Groups

		TELE Patients				
Characteristic	PRE-TELE	Air Transport	Ground Transport	Air: No-Telemedicne	No Transport	Total
No. of patients	28	31	9	10	30	80
Gender (M/F)	17/11	24/7	7/2	8/2	22/8	61/19
Age (yr)	29.9 (34)*	38.0 (24)	14 (28)	30 (50)	29 (49)	30 (33)
Burn size (%TBSA)†‡	6.5 (15.3)*	9.0 (10.8)	2.5 (3.1)§	6.5 (15.3)	3.0 (2.5)	7.0 (11.1)
Burn size range	0–86.5	2.0–30.5	0.5–6.5	1–52	0–12.0	0–52
Mortality (%)	1/28 (3.6)	0	0	0	0	0

* Values are expressed as medians, with interquartile ranges in parentheses.
† Burn sizes are based on burn center physician evaluation. For patients not transported to the burn center, burn size estimate by burn center physician via telemedicine is used.
‡ $p < 0.05$ by Kruskal Wallis, all groups.
§ $p < 0.05$ by Mann-Whitney U, Ground Transport vs. PRE-TELE, TELE-Air Transport, TELE-No consult.

TABLE 2. Burn Size Estimates of Telemedicine Patients Transferred to the Burn Unit

		Burn Size Estimate (%TBSA)*†			Ratio of Estimates	
Group Arrive	No. Patients Available	Refer-MD n = 29	BU-Tele n = 38	BU-Arrive n = 40	BU-Tele/BU-Arrive n = 38	Refer-MD/BU n = 29
TELE-Air						
Median (IQR)	31	12.3 (9.1)	11.0 (10.9)	9.0 (10.8)	1.00 (0.30)	1.21 (0.58)
Range		2.5–40	1.5–28.5	2–32.5	0.50–2.00	0.62–3.43
TELE-ground						
Median (IQR)	9	4.0 (4.0)	2.5 (2.3)	2.5 (3.1)	1.00 (0.59)	1.11 (1.01)
Range		0.5–6.0	0.9–7.5	0.5–6.5	0.70–2.04	0.92–3.33
All telemed patients						
Median (IQR)	40	11.0 (12.0)‡§	7.0 (11.6)‡	7.3 (10.8)‡	1.00 (0.31)	1.16 (0.61)‖
Range		0.5–40	0.9–28.5	0.5–32.5	0.5–2.04	0.62–3.43

Refer-MD, estimate made by referring physician prior to transport; BU-Tele, estimate made by burn center physician using telemedicine; BU-arrive, estimate made by burn center physician on face-to-face examination of the patient.

* Values are presented as median (IQR).

† Differences in burn size estimates are expressed as the ratio between the two estimates; a ratio of 1.0 means the estimates are identical.

‡ $p < 0.05$ between the three groups; Kendall's W test.

§ $p < 0.05$ vs. BU-Tele and BU-arrive; Wilcoxon signed ranks test.

‖ $p < 0.05$ vs. BU-Tele/BU-arrive; Wilcoxon Signed Ranks Test.

physician estimates of burn size made by telemedicine and direct inspection correlated closely. In contrast, correlation between burn center and referring physician estimates was more variable, and overall less precise, differing by more than 10% TBSA in some instances. Differences between the burn size estimates made by referring physician and those made by burn center physicians using telemedicine (BU-Tele, Fig. 2) or on direct patient inspection (BU-arrive) were significant using Wilcoxon signed rank test.

Outcomes of Treatment

Outcomes of patient treatment are summarized in Table 3. PRE-TELE patients had a median length of stay of 8 days versus 13 days for the TELE-air patients. The same seems to be true regarding hospital charges; however, these are not corrected for the different time periods during which the two groups were seen. The fraction of patients requiring surgery and mean number of operations/patient were not different between the PRE-TELE and TELE-air groups.

Of the nine patients referred by private transport after telemedicine evaluation, four required surgical treatment of burn wounds. Only one patient required overnight hospitalization. This finding represents a "hidden" savings of telemedicine, because all patients transported by air over such a great distance would almost certainly have required at least overnight admission.

The 10 patients transported to the burn center during the telemedicine project who were not evaluated by telemedicine had lower mean length of stay and charges than either the Tele-Air or PRE-TELE groups.

Patient/Provider Satisfaction

After each telemedicine visit, we attempted to assess the impressions of both providers and patients with the telemedicine experience. Satisfaction surveys were designed for burn center physicians, referring MD or RN providers, and patients or family members.

Results of these surveys are summarized in Table 4. We did not succeed in reaching all participants in a timely manner; in particular, patients not transferred to the burn center were often difficult to reach or refused to participate in the survey. However, satisfaction with the telemedicine process was uniformly high among all participants who completed surveys. Referring physicians and patients were largely satisfied with the telemedicine experience; most patients felt that it enhanced their care at the local hospital. This was also expressed in a number of laudatory written comments, e.g. "I think it's wonderful. All small hospitals should have one." Referring physicians felt that telemedicine changed their decision to transport ("strongly agree" or "agree"), in almost half of cases, again suggesting that telemedicine reduced overtriage.

DISCUSSION

The experience reviewed here confirms the value of telemedicine in expanding access to an extremely limited medical subspecialty over a vast geographic area. We found its use facilitated the delivery of care to patients with burn injuries of all sizes. For patients with major burns, telemedicine evaluation helped speed provision of appropriate critical care and justify the expense and risks of air transport; patients with lesser burns were quickly identified for economical ground transport or given definitive local care at great cost savings, all without apparent increase in undertriage.

Our findings confirm that telemedicine evaluation of burn injuries by experienced physicians is more accurate, and correlates more closely with "live" assessment than do the estimates of local physicians, and is accurate enough to use in making decisions about triage. Perhaps most importantly, providers and patients found the telemedicine experience helpful, were comfortable with the technology involved, and felt that it enhanced local delivery of care. Thus, burn center

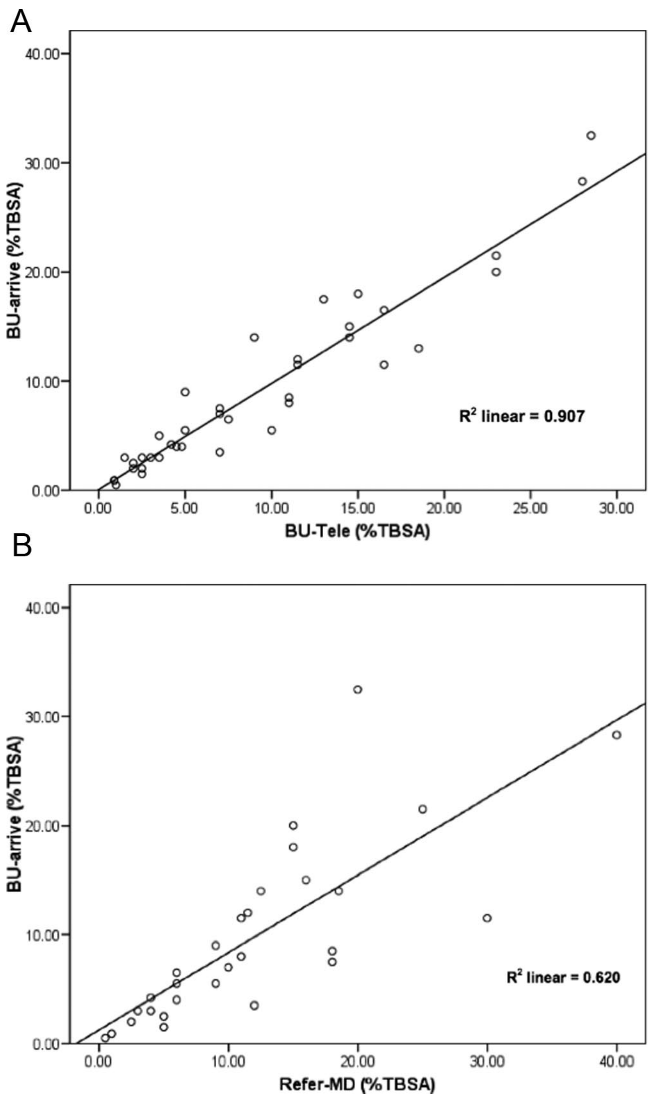

Figure 3. Scatterplots of burn size estimations performed by referring physicians (Refer-MD), Burn Unit physicians using telemedicine (BU-Tele), and Burn Unit physicians on patient arrival in the burn center (BU-Arrive). (*A*) BU-Tele estimations versus BU-arrive. Correlation is extremely good. (*B*) Refer-MD versus BU-arrive: correlation is less, with significant variation in some cases.

expertise was extended to remote facilities at essentially no cost to patients.

These findings are hardly new. The terms "telemedicine" and "telehealth" have been used for more than 30 years to describe the use of electronic communications in medicine. Early audiovisual links between the providers met with success in primary care, radiology, and surgery. Subsequently, telemedicine has been adapted to every conceivable circumstance in which an image transmission can facilitate health care. This has included image-based specialties such as radiology and pathology[29]; interactive care in psychiatry[30]; visual assessment in dermatology and plastic surgery[31–33]; urgent treatment in strokes, critical care, and trauma[34–37]; home-based hospice care,[38] nursing homes, and home health; and in remote locations including the Australian outback,[39] climbers on Mt. Everest,[40] astronauts in space,[41] and soldiers on the battlefield.[42]

Although telemedicine has repeatedly proven cost-effective, "user-friendly" and almost infinitely adaptable, and has been supported by many public funding projects, several barriers to its widespread implementation persist, and several reviews have commented that telemedicine has been slower to catch on and less successful than expected.[43,44] We encountered a number of these in our telemedicine experience; some were anticipated and successfully dealt with, whereas others remain as problems that are yet to be fully overcome.

Obstacles to the growth of telemedicine fall into three categories: lack of an "evidence base," technical and administrative limitations, and persistent problems in changing the "culture" of medicine. The first of these is the lack of rigorous "class I" evidence proving the cost-effectiveness and superiority of telemedicine. Data have been accumulated for some disorders[45] but are still lacking in many areas.[46,47] The Center for Medicare/Medicaid Services has recently stated its reluctance to expand reimbursement for telemedicine because of the lack of comparative analyses showing the efficacy of telemedicine for acute cases.[48] It is thus imperative that additional studies of telemedicine generate data to demonstrate its efficacy to effect more widespread adoption of this technology.[49] However, rigorous controlled trials of telemedicine will be extremely difficult to design, ethically troublesome, and hard to conduct. This factor also presents a cultural barrier to the dissemination of this technology. Although this deficiency is apparent in this review, we think that the documented increased utilization of an otherwise remote resource—specialized burn care expertise—plus the high levels of patient and provider satisfaction among our participants suggest that telemedicine provides a tangible community service that would not be available otherwise.

Practical problems with implementing telemedicine are numerous. The 1996 Western Governors' Action Report on telemedicine emphasized the potential value of this technology in improving medical care in the Western US, but also listed a number of limitations.[50] These included lack of interstate infrastructure, excessive and contradictory regulations, inadequate methodology for reimbursement, problems with licensure and credentialing, and concerns over liability and confidentiality. We overcame a number of these by the design of our dedicated, interstate network, construction of HIPAA-compliant firewalls, obtaining state licensure and hospital credentials for each burn center physician at each participating facility, and conducting our project with Institutional Review Board approval. In doing so, we demonstrated that many fears about the use of telemedicine can be resolved relatively easily. Although some of these concerns remain in many telemedicine situations, they are gradually being resolved through legislation, lobbying, and the ongoing maturation of interstate and intrastate telemedicine programs.

The potential cost of establishing telemedicine services has been mentioned as an obstacle to its implementation, but we believe that is untrue when viewed in context. In this

TABLE 3. Outcomes of Treatment for Pre-TELE and TELE Patients Transported to the Burn Center

		TELE Patients		
Characteristic	PRE-TELE	Tele-Air	Tele-Ground	Air-No Telemed
No. of patients	28	31	9	10
Burn size (%TBSA)*	6.5 (15.3)†	9.0 (10.8)	2.5 (3.1)	7.3 (10.90)
Range, burn size	0–86.5	2–32.5	0.5–6.5	1.0–52.0
Required surgery	15 (54%)†	14 (46%)	4 (44%)	4 (40%)
Operations/patient	1.0 (2)	0 (1)	0 (1)	0 (2)
Range, number of operations	0–27	0–5	0–1	0–4
Length of hospitalization, days	8.0 (24)[3]	13 (23)	0‡	5.5 (16)
LOS (range; days)	1–288	1–61	—	1–98
Hospital charges ($1,000)†	29.6 (84.3)	50.0 (84.1)	3†	11.3 (18.7)
Charges (range; $1,000)	1.7–2,400.0	3.9–355.5	NA	4.2–39.6

Tele-Air, patients seen by telemedicine and transported acutely by air; Tele-Ground, patients seen by telemedicine and subsequently transported by ground to the burn center; Air-no telemed, patients seen during the telemedicine period and transported acutely by air at the request of referring physicians without telemedicine evaluation.
* Burn size estimate by burn center attending physician.
† Figures are median with interquartile range in parentheses.
‡ Only one patient required overnight hospitalization or incurred inpatient hospital charges.

TABLE 4. Satisfaction Survey Results

Category	Response Rate	Question	Strongly Agree (%)	Agree (%)	Other Response (%)
Burn center physicians	65/70 = 92.9%	Able to assess burn size adequately	85.9	14.1	0
		Able to assess burn depth adequately	67.2	29.7	3.2
		Satisfied with the telemedicine visit	76.9	20.0	3.1
		My decision to transfer would have been different without telemedicine	9.7	22.6	67.7
		Referring doctor's decision to transfer would have been different without telemedicine	6.5	19.4	74.1
Referring providers	44/70 = 62.9%	Telemedicine equipment worked properly	52.3	29.5	18.1
		Decision to transport would have been different if only phone consultation had occurred	20.9	20.9	58.2
		Satisfied with the telemedicine visit	86.4	9.1	4.6
		The patient/family was satisfied with the telemedicine visit	87.2	12.8	0
Patients transferred to burn center	29/40 = 72.5%	You felt comfortable with the idea of a telemedicine visit	64.3	32.1	3.6
		You were satisfied with the telemedicine visit	75.9	17.2	5.8
		Telemedicine enhanced your experience at the referring hospital	72.4	20.7	6.8
Patients not transferred to the burn center	14/30 = 46.7%	You felt comfortable with the idea of a telemedicine visit	71.4	28.6	0
		You were satisfied with the telemedicine visit	69.2	30.8	0
		Telemedicine enhanced your experience at the referring hospital	84.6	15.4	
All participants	152/210 = 72.3%	Satisfied with the telemedicine visit	78.2	17.8	3.9

study, we provided telemedicine equipment to participants through a grant. If purchased by participating hospitals, the cost of one portable telemedicine "studio" identical to the ones we used is between $15,000 and $20,000 (depending on some optional features). However, this is approximately the cost of one acute aeromedical transport from any of these hospitals to the University of Utah. The system uses existing internet connections, which can be encrypted by the equipment to be HIPAA-compliant. Thus, the initial cost of this equipment—which can be used for years at virtually no overhead cost—could result in far greater savings in transport costs, as well as enhanced patient convenience, reduced liability for local providers, and improved public image for the participating hospital.

Another commonly expressed concern is that telemedicine services cannot be reimbursed. However, recent legislation has resolved this concern. Although Utah physicians provided their services at no charge during this study, we are in fact now permitted to bill standard consultation rates for these acute evaluations. Referring providers can also bill usual rates for emergency room visits, as well as a facility fee for use of the equipment, which will offset its cost. We also anticipate that future legislation will further facilitate provision of telemedicine services by streamlining licensure and credentialing processes for remote providers.

The most difficult and persistent obstacle to overcome is cultural. Putting it simply, many physicians find telemedicine difficult or intimidating,[51] perceive it as threatening to their prestige, liability,[52] incomes, or "turf," or fail to appreciate its cost-effectiveness or value to patients.[53] The fact that during the telemedicine project 10 patients were referred to the burn center without telemedicine evaluation is symptomatic of the reluctance of some local providers to participate in telemedicine.

Finch et al.[54] enumerated several factors restricting the routine adoption of teledermatology, including "political support, perceived benefit and relative commitment . . . and reconceptualizing professional roles." Other reviews have listed training, technology, and time constraints as barriers to the use of telemedicine[55] and stated that telemedicine requires providers who must be committed and persistent to working with new technology and cooperating in new ways.[44,56]

This cooperation may be fundamentally difficult. Physicians are not taught to communicate remotely, leading to ubiquitous "tensions," which discourage ready consultations between the providers.[57] One of the best ways to overcome these barriers is to assist physicians through their initial telemedicine experiences. This helps overcome providers' fears about technology, demonstrates the ease and convenience of remote real-time consultations, and through face-to-face contacts with remote consultants helps break down the problems of suspicion and "turf," which may interfere with timely or consistent referrals.

In this arena as well, we felt that the telemedicine project succeeded in many ways. One indication of this can be found in the increased number of telemedicine-based referrals to our center during the study period. We think that this reflects three influences: the success of our substantial outreach efforts throughout the duration of the program, the perceived convenience of telemedicine consultation among referring physicians, and a documented growth in popularity for telemedicine evaluation among patients, spread by word of mouth. But despite this success, cultural issues continued to impact our project throughout its duration. As noted above, we agreed early on that referring physicians, who best know their resources and capabilities, would have the ultimate decision whether patients would require air transport. In a few cases, this led to more liberal use of transport than we considered strictly necessary. However, this decision not only made sense medically, but also did a great deal to strengthen our relationship with participants and to validate local physicians within their communities, aspects of the project which we hope will bear dividends as development of our telemedicine network continues.

Telemedicine is just beginning to be used more widely in trauma care, including burns,[36,58] neurosurgery and orthopedics, among others.[59,60] As such, telemedicine may prove critical in helping to permit continued access to essential specialty expertise at a time of declining call coverage and reduced commitment to trauma care.[61] In the emerging paradigm of "acute care surgery," telemedicine may enable appropriately trained general surgeons to provide on-site management of many injuries with telemedicine support from neurosurgeons or orthopedists at home. For these reasons, all trauma surgeons should prepare to familiarize themselves this new technology just as they have with so many other innovations, to comply with the necessary regulations, to ascend the "learning curve" of telemedicine use, and to integrate this advance into their future practices.

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