

ORIGINAL CONTRIBUTION

Flexible Bedside Monitoring and Assisted Consultation in Rural Emergency Departments

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Introduction

Because of limited resources in the delivery of emergency medicine, telemedicine has rapidly developed. Telemedicine can allow physicians in receiving facilities to assess patients prior to medical transport and to compose transport teams to handle necessary interventions for acute medical conditions, such as stroke^{1,2} or myocardial infarction.³ In addition, telemedicine can allow patients to stay in community facilities during evaluation by medical specialists. In a study by Armstrong, 70 patients out of 120 (58%) who would have been sent out for referral stayed in the community hospital as a result of telemedicine;⁴ in another study, 53% of emergency department (ED)

alternative staffing arrangements in rural facilities.^{6,7} For example, an emergency medicine pilot program at Kirby Hospital in Monticello, Ill., allowed physician assistants (PAs) and nurse practitioners (NPs) to conduct the initial assessment of patients in the community and call a distant emergency department physician for consultation on complex cases. The program reported cost savings of \$178,000 for its successful use of PAs in the place of traditional emergency medicine physicians, who are difficult to recruit in isolated rural areas.⁷

Recent outcome studies have found telemedicine to be an effective method of emergency room treatment compared to standard emergency room care.⁸ Although various procedures and protocols have been used in these studies, it is not clear whether basic information transfer plus traditional telephone consultation would be acceptable to referral facilities. In this study we attempted to determine the acceptability of bedside monitoring to rural hospital emergency departments. We also examined whether modern transfer of such data plus telephone consultation would be useful as a tool in telemedicine.

Methods

This study was reviewed by the IRB chairperson and met criteria for exempt status. The remote monitoring program was piloted from March 1998 through February 1999. Participating rural hospitals were members of an independent community hospital network. The nine hospitals participating in this study were stratified according to whether their EDs provided standby or basic ED services. Hospitals with standby ED services provide on-call physician staffing. Hospitals with basic services provide 24-hour physician-staffed ED coverage. This combination of hospitals providing basic and standby ED coverage was chosen to see if utilization of emergency medicine physician consultations provided by a tertiary medical center varied according to the size and physician coverage of emergency room services available in rural communities.

Each hospital ED was equipped with a Propaq Encore bedside monitor. The monitors were networked by modem to a central monitoring system at the tertiary medical center. The Propaq Encore monitor required 19.2 Kbps line bandwidth and standard telephone lines to transmit standard vital signs plus a five-lead ECG, non-invasive blood pressure, oxygen saturation, CO₂, and episodes of apnea. The goal of the transmission of vital signs from remote facilities to a tertiary care facility was to provide expert consultation and surveillance services where they did not exist in the community, thereby facilitating patient management decisions such as admission, discharge, or transfer. The central monitoring unit can store up to 96 hours of patient data.

For remote hospitals requesting a consultation over remote monitoring, the tertiary medical center offered 24-hour access to an attending physician in emergency medicine. When the remote ED needed a patient consultation, they would link the Propaq monitor by modem to the central monitoring unit at the tertiary medical center and display the remote patient data for the attending physician to review. The transfer of data was followed with a telephone call from the remote physician to the attending at the tertiary medical center.

Prior to the deployment of the remote monitors, medical staff at the remote hospitals were surveyed regarding their opinions about the value of monitoring and the perceived quality of care that was provided in the local emergency department. Forty staff members from standby emergency departments and 45 staff members from basic emergency departments participated.

During the course of the pilot, staff in the participating standby and basic EDs completed brief questionnaires for each use of the monitor regardless of whether patient data were transferred by modem. The questionnaires asked sites whether the use of the monitor involved a modem connection, whether staff spoke with an attending at the tertiary medical center, and patient

disposition. Rural hospital staff were asked to respond to several areas of difficulty regarding emergency care: not having the necessary data, not having access to the right consultant, and experiencing technical problems via phone, fax, or computer. Using a 5-point Likert-type scale, satisfaction was also measured with a variety of components of emergency care prior to the implementation of remote monitoring (Table 2). The continuity-corrected Wilcoxon-Mann-Whitney Test was used on these data to test the null hypothesis that the distribution of selected ordinally scaled response variables was the same in the two study groups.

Results

Rural Emergency Department Characteristics

Table 1 illustrates the characteristics of the EDs participating in this study. The rural hospitals where emergency care was delivered differed significantly both in terms of facility and their distance from the tertiary medical center. Regarding distance, standby EDs were located further from the medical center. The mean distance in miles was greater (156.1) for standby EDs than for basic EDs (69.54). Hospitals with standby EDs had fewer total beds (mean=33.5) than hospitals with basic service (mean=115).

Rural ED characteristics are also presented in Table 1. In the study population, standby and basic EDs were significantly different in their staffing arrangements. Standby emergency facilities had a smaller proportion of emergency room nurses versus basic emergency departments (37.5% vs. 75.6%, $p<.05$) and a higher proportion of other medical staff (37.5% vs. 13.3%, $p<.05$), including paramedics, emergency medical technicians, and nurse practitioners. Hospitals with basic EDs were more likely than hospitals with standby emergency departments to report that they had specialist consultants available all of the time (11.1% vs 5.3%, $p=.28$), although 76.4% of standby ED staff reported that they had consultants available at least some of the time (28.6% vs. 0.0%, $p<.05$).

Table 1. Emergency Department Descriptive Statistics

Remote ED Characteristics	Standby (n = 40)		Basic (n = 45)		p-value
	Number	%	Number	%	
Mean (range) Distance in Miles from Medical Center	156.11	(73.04-220.01)	69.54	(36.69-120.71)	
Mean (range) Hospital Bed Size	33.5	(24-56)	115	(49-186)	
Emergency Room Visits 1998	22,115		116,121		
Mean (range) Emergency Room Visits 1998	5,529	(2,886-9,201)	23,224	(8,562-41,866)	
Staff Participants					p < .05
Community physician	3	7.5%	0	0.0%	
ER Nurse	15	37.5%	34	75.6%	
ER Physician	3	7.5%	5	11.1%	
Hospital Administrator	3	7.5%	0	0.0%	
ICU Nurse	1	2.5%	0	0.0%	
Other	15	37.5%	6	13.3%	
Years of Experience					p = .17
<5 years	18	48.6%	18	40.0%	
5-9 years	12	32.4%	10	22.2%	
10 or more years	7	18.9%	17	37.8%	
Percent of Time Consult Needed					p = .38
None	0	0.0%	1	2.3%	
<10%	13	35.1%	12	27.9%	
11%-20%	16	43.2%	13	30.2%	
21%-30%	6	16.2%	13	30.2%	
>30%	2	5.4%	4	9.3%	
Specialist Consultant Availability					p = .28
All of the time	2	5.3%	5	11.1%	
Most of the time	15	39.5%	15	33.3%	
Some of the time	12	31.6%	7	15.6%	
None of the time	1	2.6%	2	4.4%	
Don't know	8	21.1%	16	35.6%	
Most Common Method for Getting Advice					p = .14
Own medical staff	11	32.4%	18	46.2%	
Telephone	12	35.3%	16	41.0%	
Did not seek advice	4	11.8%	4	10.3%	
Face to face visit with consultant	4	11.8%	0	0.0%	
Fax	1	2.9%	1	2.6%	
Fax or e-mail with phone follow-up	2	5.9%	0	0.0%	
E-mail	0	0.0%	0	0.0%	
Necessary Data Not Available in ED					p < .05
Yes	6	28.6%	0	0.0%	
No	15	71.4%	24	100%	
Needed a Different Consultant					p = .48
Yes	14	66.7%	19	76.0%	
No	7	33.3%	6	24.0%	
Technical Problems					p = .64
Yes	12	57.1%	16	64.0%	
No	9	42.9%	9	36.0%	

The most common problem reported by staff ED was having access to the right specialist. However, not having access to necessary patient data was reported by staff in standby EDs. Compared to basic EDs, standby EDs reported greater satisfaction with the timeliness of ER decisions (4.28 vs. 3.96, $p < .05$) and with having the management and administrative support to develop a new monitoring system (4.14 vs. 3.18, $p < .05$). Basic emergency department staff, however, expressed higher satisfaction with the confidence they had in patient management (3.56 vs. 4.18, $p < .05$).

Monitor Use and Remote Monitoring Connection

The Propaq monitor was used locally 1,135 times by the nine participating hospitals. Seventy four percent of this volume came from the hospitals with standby EDs. 1,025 (90.3%) of the patients were retained locally: 450 patients were admitted to the hospital, and 575 were released from the ED.

Nine modem links occurred (0.8% of all monitored patients); three of these were in standby EDs, and six were in basic EDs. Of the nine modem links, eight physician-to-physician consults occurred. Of the eight patient consults, two (25%) resulted in patient transfer - one from each type of ED.

Although 78.3% of surveyed standby emergency room staff and 58.1% of basic emergency room staff said they required a physician-to-physician consultation less than 20% of the time, the actual assisted consultation with the ED physician using a modem-equipped bedside monitor occurred less than 1% of the time. On a scale of 1 to 5 where 5 means "strongly agree" and 1 means "strongly disagree," stand-by and basic ED medical directors did not show statistically significant differences of opinion on the value (1.67 vs. 1.43, $p = .60$) or need for remote monitoring with an emergency medicine consultant (1.67 vs. 1.71, $p = .93$).

The hospitals rated the need for the stand-alone monitor more highly, however. The clinical usefulness of bed

side monitoring was rated significantly higher by standby ED staff (4.00 vs. 2.14, $p < .05$) indicating that standby EDs are more likely to feel that they do not have adequate sources of clinical data to make medical decisions. Furthermore, all six standby ED medical directors and nurses strongly agreed with the statement that they would like to continue using the monitor in their ED (5.00 vs. 4.14, $p = .11$).

Discussion

In an assessment of why the remote monitoring component of the study was not used more widely, ED nurses and physicians said that the use of the monitor and modem disrupted the routine practice of consulting with the accepting physician by phone when patient transfer was imminent. Physicians representing basic EDs, and subsequently larger hospitals, said that often it was easier to get a local consultant on the phone to discuss a case than to take the time to send vital sign data to a tertiary medical center for reading and interpretation. Several staff members said that the modem connection would have been more useful if remote emergency physicians had had access to a clinical specialist, such as a cardiologist or a medical intensivist, and a means of visualizing the patient (ie, video).

Up until 1995, telemedicine programs infrequently reported any need for consultations in the ED. In his review of the telemedicine literature, Grigsby suggests that most emergency care can be handled adequately by personnel in rural community hospitals through the arrangement of patient transfer. He also notes that emergency care tends to be highly routine and therefore less adaptable to emerging technologies; often it is not even considered.⁹ Nonetheless, telemedicine literature more recently has reported a desire among rural hospital staff to develop telemedicine for emergency care. In a list of priority areas for developing telemedicine, cardiology, emergency medicine, critical care, and obstetrics ranked the highest.¹⁰

In this study, basic EDs were significantly more likely to use the modem connection to the medical center than the standby departments despite their larger size

and closer geographic location to the medical center. However, in general it was rarely used. In 75% of cases involving the modem connection, a patient admission resulted; only two cases involving the modem involved a patient transfer. Due to these small numbers, it is difficult to ascertain whether the decision to make the call was based on a perceived need to transfer the patient or a desire to keep the patient in the community. These results may not support the hypothesis that remote monitoring reduces the need to transfer, but may rather indicate that the population of patients presenting in the standby EDs is generally less acute.

In summary, although a monitoring and voice only telemedicine program was accepted in concept by rural EDs, consultation utilizing bedside monitoring occurred less than 1% of the time. Traditional means of consultation, utilizing simple telephone calls to established consultants continued to be the preferred means of obtaining expert advice. A further study is underway placing video in rural EDs for pediatric consultation. The addition of video consultation may prove more useful as shown in other studies.

Table 2. ED Satisfaction

ED Satisfaction	Standby (n = 40)	Basic (n = 45)	p-value
Timely decisions in ER	4.28	3.96	p < .05
Management/administrative support	4.14	3.18	p < .05
Confident about patient management	3.56	4.18	p < .05
Confident about decisions	4.48	4.15	p = .06
Adequate staff	3.38	2.90	p = .11
Information exchanged for ER transfer	3.74	4.03	p = .11
Confident about ED care	4.30	4.03	p = .12
Patient volume to support	3.67	3.97	p = .20
Transfer coordination	3.50	3.85	p = .20
Satisfied with monitoring	3.50	3.21	p = .34
Proficient with monitoring	3.73	4.00	p = .49
Good community perception of ED	3.92	4.05	p = .57
Monitoring is important	4.89	4.87	p = .57
Consultants are important	4.53	4.42	p = .68
Financial ability to support	3.00	3.03	p = .94

Likert-type scale: 5 = Strongly agree, 4 = somewhat agree, 3 = neither agree/disagree, 2 = somewhat disagree, 1 = strongly disagree

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Crotaline Fab Antivenom for the Treatment of Pediatric Rattlesnake Envenomation

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Objective: Pediatric cases comprise approximately 22% of rattlesnake envenomations in the U.S. The recent introduction of Crotaline Fab antivenom and withdrawal from the market of the traditional antivenom preparation has changed the way rattlesnake envenomation is treated. Although in some hospitals Crotaline Fab antivenom may be the only antivenom currently available, there is little data regarding its use in children. Our objective is to provide the first data regarding safety and effectiveness of this new drug in the pediatric population.

Methods: Data was collected prospectively and retrospectively for all pediatric rattlesnake envenomations treated at two urban hospitals during the year 2001. Cases were included if there were signs of envenomation at presentation, patient age 13 years or less, and administration of Crotaline Fab antivenom. Cases were excluded if Antivenin Crotalidae Polyvalent was given. Primary outcome variables were snakebite severity scores throughout the course of therapy, number of vials of Crotaline Fab antivenom given, occurrence of allergic reactions, need for surgical therapy, and the presence of permanent sequelae or serum sickness identified at telephone follow-up.

Results: In the 12 study cases, age ranged from 14 months to 13 years. (mean=6.9, sd=4.2) Presentation snakebite severity scores ranged from 2 to 9. (mean=5.3, sd=2.3) Total Crotaline Fab antivenom doses ranged from 4 to 22 vials. (mean=12.7, sd=5.4) Initial control of symptoms was achieved with 4-16 vials (mean=7.7, sd=3.7) and severity scores stabilized or improved within 24 hours in all patients. Recurrence of local swelling occurred in one case despite scheduled doses of antivenom. No cases required surgical intervention and no permanent sequelae were identified. No immediate or delayed hypersensitivity reactions occurred.

Conclusion: In this group of pediatric patients treated for rattlesnake envenomation, Crotaline Fab antivenom was safe and appeared to be effective.