

Delivering Health Care in Rural Cambodia via Store-and-Forward Telemedicine: A Pilot Study

HEATHER A. BRANDLING-BENNETT, M.D.,^{1,2} IRIS KEDAR, M.D.,^{2,3}
DANIEL J. PALLIN, M.D., M.P.H.,^{1,4} GARY JACQUES, M.D.,⁵ GRAHAM J. GUMLEY, M.D.,⁵
and JOSEPH C. KVEDAR, M.D.^{1,2,6}

ABSTRACT

Since 2001, a monthly telemedicine clinic has helped provide health care to residents in a remote region in Cambodia. Physicians at Massachusetts General Hospital and Brigham and Women's Hospital in Boston, Massachusetts, and Sihanouk Hospital of HOPE in Phnom Penh, Cambodia, provide consultations via e-mail to a mobile nurse in the district of Rovieng, Cambodia. We describe the operations of the monthly clinic and report the results of a retrospective case review of the first 28 months of consultations. We also report the results of a satisfaction and willingness to pay survey. A total of 264 visits were made during the 28 monthly sessions. Mean duration of chief complaint at initial visit declined from 37 months to 8 months during the first and last 6 months of the study period, respectively. Thirty-six percent ($n = 76$) of new patients complained of abdominal pain. Nine percent ($n = 20$) of new patients were given an empiric diagnosis of goiter. The percent of patients requiring referral to a hospital outside of the village decreased over time. All patients surveyed were either "very satisfied" or "satisfied" with their care, and most patients were willing to pay for a visit, with a median amount of USD 0.63. We conclude that store-and-forward e-mail consultative support for mobile nonphysician health care workers is a feasible model for delivering care in the developing world. Further research is needed to demonstrate improvement in health status, cost effectiveness, and sustainability.

INTRODUCTION

HALF THE POPULATION in the world's poorest countries lacks access to health care.¹ Provider shortages are likely to persist, as many countries do not have the means to train adequate numbers of medical personnel.² Cambodia ranks 174th among member states of the

World Health Organization on overall health system performance.³ The average Cambodian has only 0.35 contacts per year with organized health services—the lowest contact rate in the region.⁴ This is in part because of a limited provider workforce; there are only 30 physicians per 100,000 people, compared to 270 in the United States.³

¹Harvard Medical School, Boston, Massachusetts.

²Partners Telemedicine, Boston, Massachusetts.

³Department of Medicine, Section of Dermatology, The University of Chicago Hospitals, Chicago, Illinois.

⁴Brigham and Women's Hospital, Boston, Massachusetts.

⁵Sihanouk Hospital Center of HOPE, Phnom Penh, Cambodia.

⁶Department of Dermatology, Massachusetts General Hospital, Boston, Massachusetts.

Rovieng is a remote district in Cambodia, with no running water, electricity, telephone, or regular transportation service. Access to health care is extremely limited. There is a health care facility in the district staffed by a medical assistant, however, physicians rarely visit Rovieng, few medications are available, and malaria smears are the only feasible laboratory tests. In 2000, a school in the village of Th'naut Malou in Rovieng received a donated computer, solar panel, and satellite dish allowing for Internet connectivity. A monthly telemedicine clinic was subsequently established in February 2001 to serve the approximately 4000 residents in Th'naut Malou and continues to operate.

Communications technologies have the potential to help overcome some of the challenges of providing health care in remote regions, by transporting medical knowledge to even the most traditionally inaccessible areas of the globe and increasing provider efficiency.² Only a handful of programs have described their clinical experience in the medical literature prompting a call for publication of outcomes from telemedicine projects in the developing world.⁵⁻¹⁰ We report the results of a pilot study of the case load of the clinic in Th'naut Malou, Cambodia, describing the type and chronicity of patient complaints and patients' satisfaction and willingness to pay for services.

MATERIALS AND METHODS

A Cambodian nurse and an administrative assistant embark on a 5-hour car trip from Phnom Penh to Rovieng each month. The telemedicine clinic is held at the health center over a 2-day period. On the first day, the nurse takes a medical history and performs a physical examination on each patient. The assistant transcribes this information into a laptop computer and takes digital images of the patients. At the end of the day, the patient information and images are sent via e-mail, using the satellite at the nearby school, to physicians at Sihanouk Hospital Center of HOPE in Phnom Penh, Cambodia, and Partners Telemedicine in Boston, Massachusetts. All electronic communications are written in English. Patients sign

or thumbprint a consent form agreeing to have their images and information transmitted via e-mail. Sihanouk Hospital is a privately funded charity hospital. Partners Telemedicine is a department of Partners HealthCare, a nonprofit organization founded by Massachusetts General Hospital and Brigham and Women's Hospital, Boston, Massachusetts.

Physicians from Partners and Sihanouk respond by e-mail in time for the second clinic day. Patients return to the clinic and the nurse in Rovieng makes treatment or referral decisions based on the recommendations from physicians at both hospitals. At present, physicians from both hospitals respond to all cases. If there is disagreement between consultations, the nurse uses his or her judgment in deciding whose advice to follow. All patients seen at the clinic receive telemedicine consultations. In February 2002, the capabilities of the clinic expanded and the telemedicine nurse is now able to draw blood in the village for testing in the laboratory at Sihanouk Hospital in Phnom Penh. Each month the nurse brings medications including antibiotics, analgesics, an anthelmintic, an H₂-blocker, a β -blocker, and a diuretic. If a patient requires medications not available at the clinic, urgent treatment, extensive laboratory tests, or any imaging studies, they are triaged to a hospital. Patients are either sent to Kampong Thom Provincial Hospital, a 2- to 3-hour drive from the village, or to Sihanouk Hospital in the capital city of Phnom Penh, more than 5 hours away by car.

We studied the first 28 sessions of the monthly clinic to identify number of patients seen, patient characteristics, average duration of chief complaints at initial visit, most common chief complaints and empiric diagnoses, and percent of patients referred for care outside of the village. Statistical analyses were performed using linear regression; 95% confidence intervals were calculated using the standard error of the estimate. *p* Values <0.05 were considered significant.

In April 2003, we surveyed a sample of patients who had previously been seen at the telemedicine clinic. A randomized list of patients who visited the clinic between February 2001 and December 2002 was generated. Sixty-three previous telemedicine patients 18 years

or age or older were approached and agreed to participate in the survey study. Trained native speakers obtained informed consent and interviewed participants. The survey protocol was approved by an institutional review board at both Sihanouk Hospital Center of HOPE in Phnom Penh, Cambodia and Massachusetts General Hospital in Boston, Massachusetts.

RESULTS

The monthly clinic was held 28 times from February 2001 through June 2003 (no clinic was held in November 2001). The clinics were attended by 214 patients, who made 264 visits. An average of 9 patients were seen each month. The number of patients seen at the clinic decreased by 2.7 patients per year of clinic presence (95% confidence interval, 1.6–3.9, $p < 0.0001$), as shown in Figure 1.

The mean age of patients at first visit was 39 years (standard deviation [SD] 19 years), with a range of 3 months to 80 years; 61% ($n = 131$) of patients were female and 39% ($n = 83$) were male.

At initial visits, each patient had an average of 2.6 chief complaints. Data on duration of primary chief complaint were available for 209 of 214 initial visits. The mean was 23 months (95% confidence interval, 18–28) and the median was

7 months. Duration of primary chief complaint decreased by 16.5 months per year of clinic presence (95% confidence interval 8.4–24.7, $p < 0.0001$). During the first 6 months of the study period, the mean duration of primary chief complaint at initial visit was 37 months (median, 12 months), and during the last 6 months of the study period the mean duration was 8 months (median, 3 months), as shown in Figure 2.

The most common chief complaints at initial visit are shown in Table 1. Review of the consultations revealed that 9% ($n = 20$) of new patients were given an empiric diagnosis of goiter, and a suspicion of iodine deficiency was raised.

Patients were referred outside of the village if physicians recommended further diagnostic testing or treatment not available in the village. Data on this were available for 62% ($n = 164$) of the 264 consultations. Thirty percent ($n = 49$) were referred to the regional hospital in Kampong Thom, and 14% ($n = 23$) were referred to hospitals in Phnom Penh. Four patients refused to leave the village for treatment or did not return for the second day of clinic, and were therefore not referred. The percent of patients referred for care outside of the village decreased by 50.9% per year of clinic presence (95% confidence interval, 26.9%–74.9%; $p < 0.001$), as shown in Figure 3.

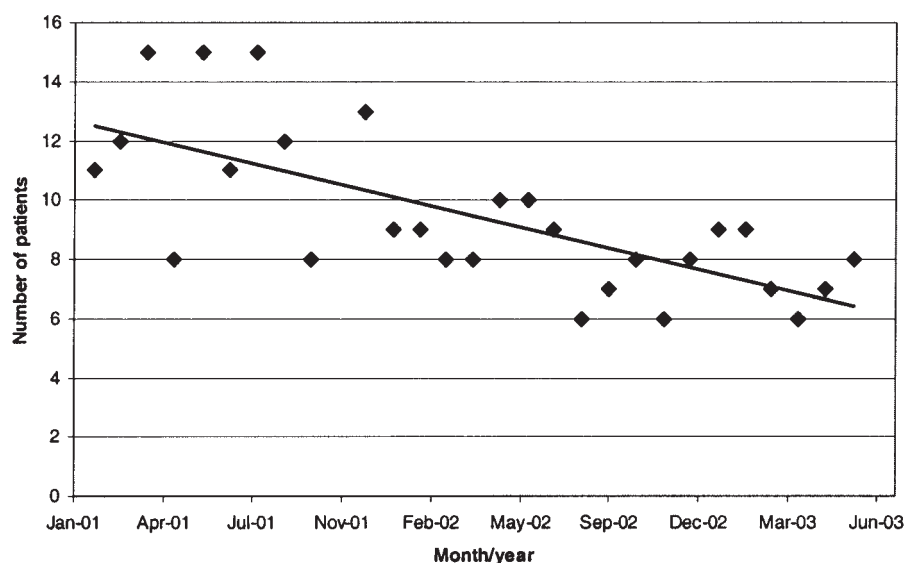


FIG. 1. Number of patients seen at the clinic each month.

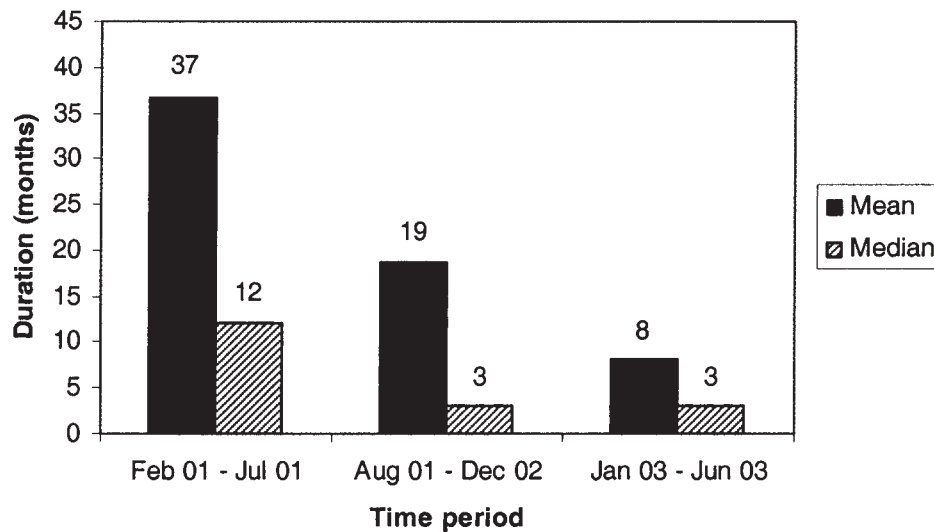


FIG. 2. Mean and median duration of primary chief complaint at beginning, middle, and end of study period.

A random sample of patients was surveyed retrospectively regarding their satisfaction with the telemedicine clinic. All were either "very satisfied" (46%, $n = 29$) or "satisfied" (54%, $n = 34$). None reported being "neither satisfied nor dissatisfied," "dissatisfied," or "very dissatisfied." Seventy-eight percent ($n = 49$) of patients reported that they would be willing to pay for a visit (median USD 0.63, range USD 0 to USD 50.63). Ten percent ($n = 6$) reported willingness to pay USD 3 or more.

DISCUSSION

We present our experience with a telemedicine clinic in rural Cambodia from February

2001 through June 2003, as well as a preliminary assessment of the project. The residents in Th'naut Malou have little or no access to medical care outside of the clinic. Our experience with the store-and-forward telemedicine clinic suggests that remote consultative support for a mobile nurse is a feasible mechanism to bring health care to remote regions in the developing world.

Although this was a limited case review, certain conclusions are suggested. The duration of primary chief complaints was long (mean, 23 months; median, 7 months) and highlights the previously unmet need for care. The mean was greatly influenced by the 30% of patients who had a chief complaint of 24 months or longer. The decrease in mean and median duration of chief complaint over time intimates we have begun to address health care needs through the telemedicine clinic. The proportion of cases requiring referral to a regional hospital decreased during the study period. A number of factors may have contributed to this decline. Potential factors include decreased severity of disease over time, improvement in communication between the nurse and the remote consultants, education of the Cambodian nurse, and enhanced clinic capabilities (such as blood draws in the village so fewer patients had to leave the village for basic laboratory tests). Also, the number of patients seen in clinic decreased over time. Subsequent to the analysis of the

TABLE 1. MOST COMMON CHIEF COMPLAINTS

Symptom	Percent of patients (No.)
Abdominal pain	36% (76)
Palpitations	19% (40)
Chest pain	18% (38)
Headache	17% (36)
Weakness	16% (34)
Cough	15% (33)
Shortness of breath	14% (31)
Dizziness	12% (25)
Fever/chills/sweats	9% (20)
Neck mass	8% (17)
Tender neck	8% (17)
Blurred vision	7% (16)
Joint pain	6% (13)
Numbness	6% (12)

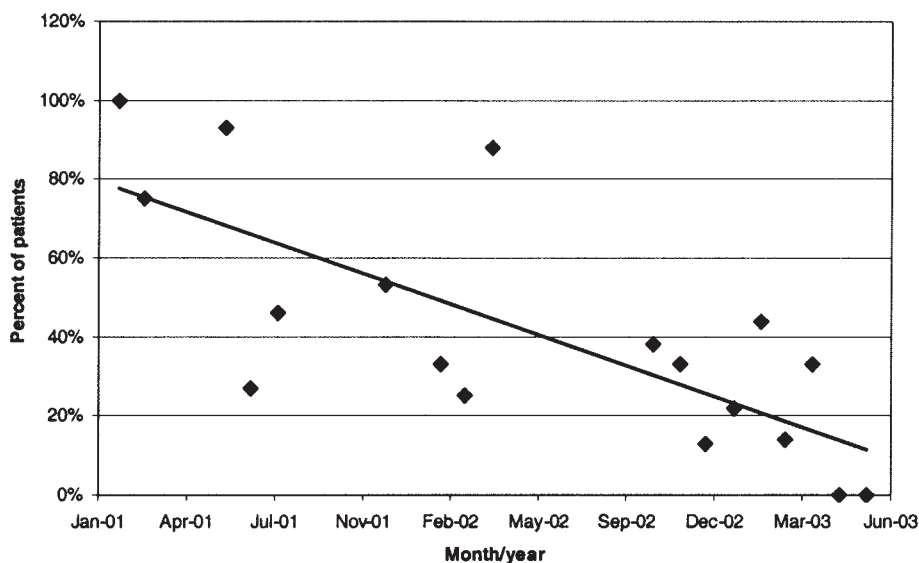


FIG. 3. Percent of patients referred for care outside the village over time.

data presented in this paper, the number of patients seen monthly has leveled off. It is our belief, from discussions with the individuals involved in the day-to-day operations of the clinic, that this represents reaching a steady state of medical need in this patient population (i.e., the backlog of patients with long-term problems is resolving).

Ongoing review of the consultations allowed us to use telemedicine as a tool for disease surveillance, helping to identify and track public health issues. Thirty-six percent of patients at the telemedicine clinic in rural Cambodia complained of abdominal pain. While an imperfect benchmark, this figure can be contrasted to the 1.5% of ambulatory visits in the United States that are the result of abdominal complaints, according to the 2001 National Ambulatory Medical Care Survey.¹¹ The high prevalence of abdominal pain in our clinic population is most likely the result of intestinal parasitic infections,¹² as well as to the high prevalence of *Helicobacter pylori* infection in adults in developing countries.¹³ Our medical advisory committee is in the process of creating treatment algorithms for the most common chief complaints. In addition, after the first year of consultations, a high prevalence of goiters raised a suspicion of iodine deficiency. Endemic iodine deficiency was confirmed by reviewing a national goiter survey conducted in

1996–1997 by the Ministry of Health in Cambodia. Only 13.8% of households in Cambodia used iodized salt as of 2000.¹⁴ Salt in Rovieng is from a field and is not iodized. We are now working on an iodine supplementation program. Future observations may lead us to detect public health problems not previously identified.

The survey study demonstrated a high level of satisfaction with the clinic and helps us begin to understand local willingness to pay for clinic visits. While the monetary amount patients were willing to pay may not seem large, it becomes more significant when one considers that the average annual per capita income in Rovieng is about USD 40. According to an informal survey, the average fee for a visit at rural health clinics in Cambodia is approximately USD 0.25; most of our patients were willing to pay at least twice that amount. As our program moves to a model of local self-sufficiency, even a small copayment from patients may help promote the sustainability of the clinic.

Few other studies have demonstrated the feasibility and value of store and forward e-mail support in the developing world. The Swifen Charitable Trust has used low-cost e-mail consultation support for physicians in Bangladesh, the Solomon Islands, and Nepal from specialists in the United States, United

Kingdom, and Australia.^{5,6,9} In primarily descriptive papers, the telemedicine consultations were reported to be both useful and cost effective. Programs focused on education, however, are more developed than clinical initiatives.^{10,15} SatelLife, for example, is a U.S.-based organization that provides an estimated 4000 health care professionals in 30 countries access to e-mail and medical education resources.¹⁶ Most clinical telemedicine programs in developing countries are occurring on a relatively small scale or only amount to proposals of intent.¹⁰

Many lessons have been learned from our experience with the telemedicine clinic in rural Cambodia. Initially, some diagnostic tests and treatments recommended by U.S. physicians were not available in Rovieng or even anywhere in Cambodia, limiting the utility of the consultation. In an effort to minimize such recommendations, an orientation document describing the capabilities in Cambodia was distributed to consulting physicians. We also found that generalists provided more useful information to our colleagues in Cambodia, perhaps because they were more willing to make empiric diagnoses, rather than request further diagnostic work-up, which was often not available. We now send the majority of consultations to primary care physicians. In addition, we are increasing the capabilities of the clinic and enhancing the educational aspect of the telemedicine project. For example, we are working on the ability to perform simple laboratory tests in the village so that the nurse and consultants do not have to rely solely on empiric diagnoses.

Our case review had limitations, the most significant being small sample size and lack of follow-up data. Follow-up reports from the village have been inconsistent, and data on referral of patients to outside hospitals were only available for 18 of 28 months. This lack of follow-up data made it difficult to assess how the consultation advice was utilized. We are working to improve medical record keeping, which will in turn enhance our ability to report outcomes. We recognize we have yet to show improvements in clinical outcomes.

In addition, we need to create and evaluate a sustainable model for expansion, including an assessment of cost effectiveness. We recog-

nize that our current model of providing consultations is valuable as a demonstration of feasibility, but will need modification to achieve cost effectiveness and scalability. Our next steps include developing additional programs that move to a model of local self-sufficiency. We envision educating nonphysician health care workers to deliver the bulk of care and providing them with support from physicians for the most challenging cases. The first line of consultation will be Cambodian physicians, with U.S. physicians providing advice on an ad hoc basis. We plan to integrate the telemedicine clinics into the existing health care system so that the clinic can network with provincial hospitals. We envision that areas with access to even minimally trained medical personnel could use telemedicine as a consultative and educational service, expanding access to expert medical diagnostic and treatment advice at minimal cost.

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REFERENCES

1. United Nations Development Programme. *Human development report 1997*. Oxford: Oxford University Press, 1997.
2. Wright D. The International Telecommunication Union's report on telemedicine and developing countries. *J Telemed Telecare* 1998;4(Suppl 1):75-79.
3. Cambodia National Institutes of Statistics. *Cambodia demographic and health survey 2000*. www.nis.gov.kh/

- SURVEYS/CDHS2000/AboutCDHS2001.htm (Last accessed September 2003).
4. United Nations Development Programme. *Cambodia human development report 1997*. www.un.org/kh/undp/publications/nhdr/1997.pdf (Last accessed September 2003).
 5. Vassallo DJ, Swinfen P, Swinfen R, et al. Experience with a low-cost telemedicine system in three developing countries. *J Telemed Telecare* **2001**;7(Suppl 1):56–58.
 6. Patterson V, Hoque F, Vassallo D, et al. Store-and-forward teleneurology in developing countries. *J Telemed Telecare* **2001**;7(Suppl 1):52–53.
 7. Otake LR, Thomson JG, Persing JA, et al. Telemedicine: Low-bandwidth applications for intermittent health services in remote areas. *JAMA* **1998**;280:1305–1306.
 8. Cooke FJ, Holmes A. E-mail consultations in international health. *Lancet* **2000**;356:138.
 9. Vassallo DJ, Hoque F, Roberts MF, et al. An evaluation of the first year's experience with a low-cost telemedicine link in Bangladesh. *J Telemed Telecare* **2001**;7:125–138.
 10. Wootton R. Telemedicine and developing countries—Successful implementation will require a shared approach. *J Telemed Telecare* **2001**;7(Suppl 1):1–6.
 11. Cherry DK, Burt CW, Woodwell DA. *National ambulatory medical care survey: 2001 Summary. Advance data from vital and health statistics* **2003**;337:1–44.
 12. Bundy DA, Hall A, Medley GF, et al. Evaluating measures to control intestinal parasitic infections. *World Health Stat Q* **1992**;45:168–179.
 13. Suerbaum S, Michetti P. Helicobacter pylori infection. *N Engl J Med* **2002**;347:1175–1186.
 14. International Council for the Control of Iodine Deficiency Disorders. *IDD prevalence and control program data: Cambodia*. www.people.virginia.edu/~jtd/iccid/mi/idd_085.htm (Last accessed August 2003).
 15. Mitka M. Developing countries find telemedicine forges links to more care and research. *JAMA* **1998**;280:1295–1296.
 16. Groves T. SatelLife: Getting relevant information to the developing world. *BMJ* **1996**;313:1606–1609.

Address reprint requests to:

Joseph C. Kvedar, M.D.

Partners Telemedicine

Two Longfellow Place, Suite 216

Boston, MA 02114

E-mail: jkvedar@partners.org