

► Low-bandwidth telemedicine for pre- and postoperative evaluation in mobile surgical services

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Summary

Low-bandwidth telemedicine was used for the pre- and postoperative evaluation of patients treated by a mobile surgery service in remote Ecuador. Realtime and store-and-forward telemedicine was employed, using PCs connected via the ordinary telephone network. Between February 2002 and July 2003, 144 patients were studied preoperatively and 50 postoperatively. It was possible to establish 20 satisfactory preoperative realtime connections, which allowed good-quality, simultaneous audiovisual transmission. Thus, there were 124 preoperative assessments done by store-and-forward telemedicine and 50 postoperative assessments. Diagnoses and management plans made by a surgeon using telemedicine were compared with those made independently by a second surgeon, who saw the patient face to face. Due to poor quality of the transmitted images, 43 patients were excluded from the preoperative study and 13 from the postoperative study. In the 101 preoperative evaluations, there was agreement in 78 cases (77%); in the 37 postoperative evaluations, there was agreement in 36 cases (97%). Telemedicine may reduce the time required on site for preoperative planning, and may provide reliable postoperative surveillance, thus improving the efficiency of mobile surgery services.

Introduction

The Cinterandes Foundation operates a mobile surgery programme in 15 of the 22 provinces of Ecuador. This is a free service to patients for whom care in distant medical centres is a financial, sociological and physical hardship. The mobile surgery unit¹⁻⁴ complements primary care in remote areas. High-quality surgical care is delivered to remote populations, with a low percentage of complications and high acceptance by patients and local physicians.⁵ Over the last nine years 4380 operations have been performed in general surgery, urology, gynaecology, reconstructive surgery, ophthalmology and otolaryngology in the programme.

Initial selection of patients for surgical intervention is done by a rural or family doctor, according to the guidelines of the American Society of Anesthesiologists (ASA).^{4,5} A team from Cinterandes examines potential patients on site to make a definitive diagnosis and formulate a treatment plan. The mobile surgical unit is then despatched to the communities to perform the appropriate surgery. The team makes postoperative visits after eight days, one month, six months and one year.

When the surgery is carried out in distant provinces, only the list of patients is known beforehand, and the preoperative examinations take place once the unit arrives at the distant site. These screening clinics are typically oversubscribed, intensive and result in many disappointments for patients who are not appropriate surgical candidates or simply cannot be accommodated in the time available. These clinics may consume as much as a third of the time of the team.

The Cinterandes Foundation is also a teaching unit of the Faculty of Medical Sciences of the University of

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Cuenca. In the last 30 years, telemedicine has been explored and applied in various ways by participants in mobile surgery programmes.^{6,7} In collaboration with Virginia Commonwealth University and the Medical Information and Technology Application Consortium (MITAC), teleconsultations have been conducted between the eastern rainforest region of Ecuador and the USA, as has shared monitoring in anaesthesia.^{8,9}

The present study was designed to evaluate the use of telemedicine for preoperative and postoperative teleconsultations.

Methods

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Sites

Except for a few population centres, all of Ecuador is rural and most of the country is remote. The study was conducted at sites where there were no other surgical services available and transportation to a definitive health-care facility required travel over poor roads. All 15 sites were remote from the home base of the programme, requiring a journey of 1–15 h. All sites were primary care centres and the programme augmented primary care by providing intermittent surgical services.

Equipment

Realtime and store-and-forward telemedicine between the surgeon at the base in Cuenca and the patient at the remote site could be scheduled in advance. At the base, a desktop computer was used, and at the remote site a laptop computer was used (Figure 1). The computers were connected via the ordinary telephone network. Realtime videoconferencing used NetMeeting and CUSeeMe software, with Kodak or Winnov videoconferencing cameras and headsets with microphones at each site. Store-and-forward telemedicine used email or NetMeeting.

Preoperative study

For the preoperative study, the clinical history and physical examination of the patient were performed at the remote site. Digital photographs were taken of the patient's pathology and of X-rays or ultrasound images. The on-site surgeon made a diagnosis and operative recommendations, which were then sent via email or NetMeeting to the base office, where another surgeon independently made a diagnosis and operative recommendations. The two surgeons compared their diagnostic impressions via email or NetMeeting at the time the patient was examined.



Figure 1 Telemedicine interaction between doctors at (a) remote sites and (b) Cinterandes HQ

Postoperative study

For the postoperative study, a surgeon performed a direct examination of the patient at the remote site and recorded the findings. These, together with digital photographs of the healing wounds, were sent by email and/or NetMeeting to the base. With these data, the surgeon at the base recorded his impressions independently. The records were compared later by the surgeons on return from the remote location.

Results

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Between February 2002 and July 2003, 144 patients were studied preoperatively and 50 postoperatively. Realtime videoconferences were attempted in about half of the cases, and in about half of the attempts

(approximately 55) the videoconferences were not very useful, because of restricted bandwidth or disconnections of the link. However, it was possible to establish 20 satisfactory preoperative realtime connections, which allowed good-quality, simultaneous audiovisual transmission. Thus, there were 124 preoperative assessments done by store-and-forward telemedicine and 50 postoperative assessments. There were no technical problems with store-and-forward telecommunication.

Due to poor photographic quality of the transmitted images, 43 patients were excluded from the preoperative study and 13 from the postoperative study. Therefore, the actual number of patients in whom a telemedicine comparison was carried out was 101 preoperative and 37 postoperative.

In the 101 preoperative evaluations, there was agreement in 78 cases (77%) and disagreement in 23 cases. In the latter cases, the photographic quality was acceptable, but the evaluators felt that additional photographs from other angles or distances would have been helpful. The lack of agreement was always due to the interpretation of images. Specific disagreements for the most common consultations are listed in Table 1. The poorest agreement involved store-and-forward gallbladder ultrasound investigations. After allowing for the diagnostic disagreements, there was total (100%) agreement about the therapeutic regimen.

In the 37 postoperative evaluations, there was agreement in 36 cases (97%).

Discussion

Poor-quality photographs in 56 patients (29%) represented a significant failure. Without realtime communication between the two sites, it was difficult to request different or additional photographs, wasting time for both doctor and patient. The poor image quality was due to poor photographic technique. It is important to note that, with realtime consultation, the photographs were never rejected.

Table 1 Agreement in 101 preoperative consultations

Diagnosis	Agree		Disagree	
	n	%	n	%
Cholelithiasis	5	63	3	37
Inguinal hernia	18	69	8	31
Other hernia	12	75	4	25
Phimosis	17	85	3	15
Miscellaneous	26	84	5	16
Total	78	77	23	23

In the postoperative evaluations, the evolution of the postoperative wounds was clearly seen, both of normal wounds as well as of minor or subtle abnormalities, such as ecchymosis or oedema.

Videoconferencing was not always possible for patients due to the time required for installation, connection and actual teleconsultation. Patients were not willing to spend more time than usual during their appointments. This would be improved if a permanent videoconferencing system were available at the remote locations, eliminating the time required for installation and connection.

In summary, telemedicine is a useful complement even with a limited telecommunications infrastructure and may save time and increase preoperative efficiency with a store-and-forward evaluation. In the postoperative period, telemedicine can minimize postoperative visits. Perhaps all late follow-up visits could be eliminated and the examination performed at a distance. When programmes extend over long distances, telemedicine might be used exclusively for postoperative consultations.

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References

- Rodas E, Fierro R, Ordóñez G. Cirugía móvil. Un nuevo modelo de tratamiento. [Mobile surgery. A new way of treatment.] *Acad Ecuador Med* 1995;**2**:9333
- Rodas E. Mobile surgery a new way of treatment. *Bul Cal Soc Anest* 1996;**45**:5-9
- Rodas E. Cirugía móvil. [Mobile surgery.] *Soc Ecuador Cirugía* 2001;**1**:40-5
- Rodas E, Vicuña AL, Vélez C, et al. *Unidad Quirúrgica Movil: Manual de Procedimientos*. [Mobile Surgery Unit: Procedure Manual.] 2nd edn. Cinterandes Foundation, Universidad de Cuenca, 2001
- Rodas E, Vicuña AL, Pesantez M, Abad B, Rodas EB. *Cinterandes Report 2001*. Universidad de Cuenca, 2001
- Rosser Jr JC, Bell RL, Harnett B, Rodas E, Murayama M, Merrell R. Use of mobile low-bandwidth telemedical techniques for extreme telemedicine applications. *J Am Coll Surg* 1999;**189**:397-404
- Broderick TJ, Harnett BM, Doarn CR, Rodas EB, Merrell RC. Realtime Internet connections: implications for surgical decision making in laparoscopy. *Ann Surg* 2001;**234**:165-71
- Doarn CR, Fitzgerald S, Rodas E, Harnett B, Prabe-Egge A, Merrell RC. Telemedicine to integrate intermittent surgical services into primary care. *Telemed J E Health* 2002;**8**:131-7
- Rodas EB, Latifi R, Cone S, Broderick TJ, Doarn CR, Merrell RC. Telesurgical presence and consultation for open surgery. *Arch Surg* 2002;**137**:1360-3