

Papers

▶ Telemedicine and developing countries — successful implementation will require a shared approach

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Summary

Telemedicine is often proposed as a solution to certain health-care problems in the developing world. There seems to be little published experience on which to make judgements. A literature search revealed 39 articles, of which only two related to any kind of direct clinical work; most of them were review articles or editorials. The majority of the work reported was educational in nature, and there has been little clinical experience. It seems probable that telemedicine can help with the education of health-care workers and patients; it seems likely that it could bring major benefits to the *organization* of health-care. Without proper trials, it will be impossible to determine the place of health-care in the developing world. Trials are the only way in which rational decisions can ultimately be reached regarding whether scarce resources should be devoted to telemedicine in developing countries, or whether they should be employed in more conventional health-care measures whose outcomes are known to be cost-effective.

Introduction

Despite continued interest in the use of telemedicine in the industrialized world, it cannot yet be considered to have entered the mainstream of health-care. For example, since the rules were changed to permit Medicare reimbursement for realtime teleconsultations in under-served areas of the United States, a tiny fraction of such services have been charged for—in the year 2000, there were 21.4 million Medicare services, of which 179 (i.e. 0.0008%) involved telemedicine¹. Nevertheless, interest in telemedicine persists, and surveys in the United States suggest that telemedicine activity continues to grow² (Fig 1).

There are many factors responsible for the undiminished interest in telemedicine. Although there is a dearth of information to prove its cost-effectiveness—which some people feel represents a barrier to its widespread adoption³—it is unarguable that telemedicine can be used to improve access to health-care in places where there are restrictions, perhaps for reasons of geography or because of shortages of health-care staff. While the industrialized world certainly contains regions in which equitable access to health-care is a problem, it is in the developing world that such problems are most severe.

What then is the place of telemedicine—or its related techniques of telehealth, online health or e-health-care—in the developing world? It is three years since I last discussed

this question⁴, which is a long time in terms of developments in information technology (IT) and telemedicine. What has changed? The majority of the world's population (about 80%) still live in economically disadvantaged countries. They are still in poor health relative to the privileged minority who live in industrialized countries. Their governments spend less on health-care, both relatively and in absolute terms (Table 1).

The problems of health-care in the developing world have not gone away. What is known about the use of telemedicine in the developing world?

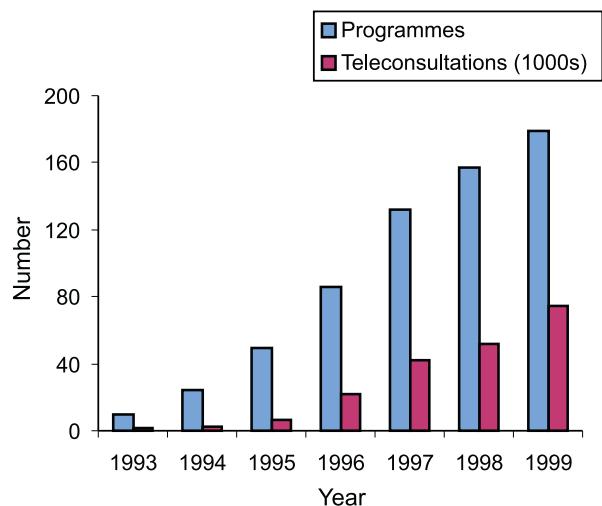


Fig 1 Telemedicine activity in the United States² (1993–99).

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R Wootton Telemedicine and developing countries

Table 1 Indicators of population health and expenditure on health-care in industrialized and developing countries⁵⁵

Country	Life expectancy at birth (years)	Infant mortality rate (per 1000 live births)	GDP per capita (PPP US\$) ^a	Public expenditure on health (% GDP)	Doctors (per 100,000 people)	Nurses (per 100,000 people)
<i>Top five^b</i>						
Canada	79.1	6	23,582	6.4	221	958
Norway	78.3	4	26,342	6.2	–	–
United States	76.8	7	29,605	6.5	245	878
Australia	78.3	5	22,452	5.5	–	–
Iceland	79.1	5	25,110	7.0	–	–
<i>Bottom five</i>						
Burundi	42.7	106	570	0.6	6	17
Ethiopia	43.4	110	574	1.6	4	8
Burkina Faso	44.7	109	870	1.2	–	–
Niger	48.9	166	739	1.3	3	17
Sierra Leone	37.9	182	458	1.7	–	–

^aStandard of living is measured by purchasing power, based on real gross domestic product (GDP) per capita adjusted for the local cost of living (purchasing power parity, or PPP).

^bRanked in terms of the United Nations Human Development Index.

Telemedicine in the developing world

In principle, telemedicine can be used for a wide range of health-care purposes. These fall into three main categories:

- (1) clinical (diagnostic and therapeutic);
- (2) educational;
- (3) administrative.

For some years, there has been interest in the possibilities of using telemedicine in the developing world. Several major conferences have been held, a world survey was carried out⁵ and there have been reports of telemedicine activity in 30 or 40 different developing countries. Nonetheless, the majority of such reports appear to be largely anecdotal, many amounting to little more than declarations of intent.

The accepted source of unbiased information, although not the only one, is publications in peer-reviewed journals. I therefore carried out a Medline search, using the search terms:

telemedicine *or* telehealth *or* teleradiology

and

developing world *or* developing country.

This search identified a total of 39 articles. They were classified as:

- (1) *clinical experience*—an informal report of one or more clinical cases involving telemedicine and patients in a developing country;
- (2) *feasibility study*—background work on some aspect of telemedicine in the context of developing countries;
- (3) *review article*—review of some aspect of telemedicine (e.g. clinical or educational) in developing countries, but not reporting specific clinical cases;

- (4) *opinion/comment*—editorial or opinion piece (i.e. not a review article);
- (5) *non-peer-reviewed source*—magazine articles or newspaper reports;
- (6) *not relevant*—articles identified in the Medline search which were not relevant to the topic (e.g. those that contained misleading keywords).

Of the 39 articles identified in the Medline search, there were two reporting clinical work^{6,7} and two reporting a feasibility study^{8,9}. There were 20 review articles or opinion pieces^{4,5,10-27} and 15 were classed as irrelevant or from a non-peer-reviewed source (Fig 2).

In addition, a further 16 articles about clinical work were identified from other sources (mainly from personal knowledge of newly published work not yet indexed in Medline, or published work which did not appear in the search)²⁸⁻⁴³.

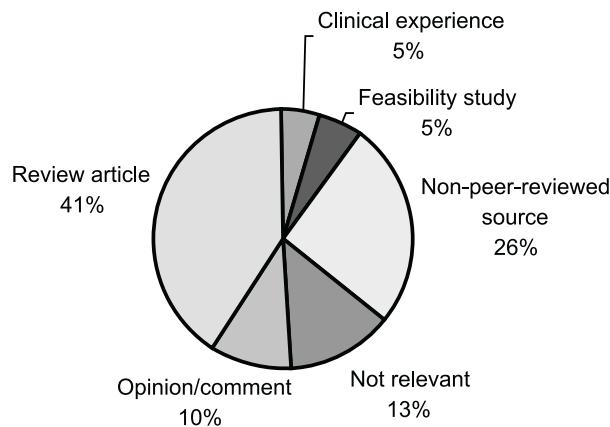


Fig 2 Classification of telemedicine articles found in a Medline search (n=39).

What are the main uses of telemedicine?

The literature shows that the main uses of telemedicine in the developing world, so far, are educational. A well known example is the SatelLife organization based in the United States, which provides email and other information services to more than 4000 health workers in 30 developing countries^{21,43}. Specific patient-related queries are dealt with, but the main network traffic concerns the provision and dissemination of general information. The backbone of the SatelLife operation is the Internet, a communications medium which can also be used for administrative purposes, such as for reporting outbreaks of disease, something which can be achieved more quickly this way than by use of official channels⁴⁴.

Most of the educational and information provision work has been done in asynchronous mode, since realtime telemedicine generally requires expensive, high-speed communications. For example, postgraduate training provided from Canada to Kenya and Uganda required the use of a satellite link³². However, realtime surgical mentoring has been reported recently using low-quality video-pictures transmitted over the ordinary telephone network³⁶.

What has been the clinical experience?

So far as clinical work is concerned, nothing substantive has yet been reported. There seem to have been no clinical telemedicine services which have survived beyond the first few years. Various pilot trials have been reported to have begun, but there have been no subsequent reports about what happened. Some pilot trials have taken place under rather artificial circumstances, for example taking advantage of satellite communications provided for military purposes³³. The cost-effectiveness and sustainability of such services is unknown.

Low-cost clinical telemedicine has been demonstrated using email and digital cameras^{28,38}. One of the more successful clinical programmes to date is run by a charitable trust in London, which supplies specialist clinical advice to doctors practising under difficult conditions⁴⁵. The Swinfen Charitable Trust has assisted doctors at several hospitals in Bangladesh, Nepal and the Solomon Islands^{46,47}. An evaluation of the first year's telemedicine referrals from Bangladesh suggested that the advice provided to the referring doctor had been both clinically useful and cost-effective⁴⁵. Yet—and this is not intended as a criticism of a fine piece of pioneering work—it is difficult to imagine that it will be sustainable, still less that it could be scaled up significantly in size, since it is basically a manual system. The problem of scalability is a fundamental challenge, at present unsolved, to the widespread adoption of telemedicine generally.

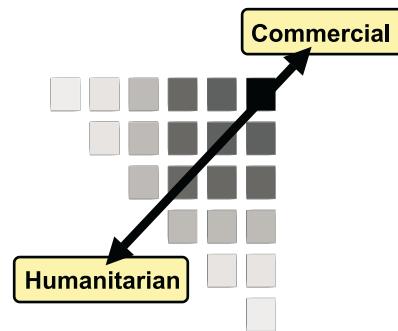


Fig 3 Why telemedicine in the developing world? A spectrum of interests.

Proposed uses

Over the last few years a wide range of telemedicine proposals have been made, covering all three categories of use. Some are relatively modest, but very ambitious proposals have been made as well, such as a satellite-based telemedicine operation to serve over 600 million patient visits per annum, across the entire subcontinent of India⁴⁸.

When assessing proposals for telemedicine in the developing world, a variation of the Yellowlees test is often useful. Yellowlees pointed out that many self-professed 'experts' in telemedicine have little actual experience on which to base their pronouncements⁴⁹. This means that their credibility may be rather limited. In an analogous way, it is always worth analysing the motives of those who propose telemedicine work in the developing world, and plotting them on the spectrum from the purely humanitarian to the purely commercial (Fig 3). Again, when this has been clarified, it may have a bearing on the credibility of what is being proposed.

Questions for the future

Telemedicine is unlikely to be a panacea. It will not help directly with infrastructure problems such as the provision of sanitation or drinking water. However, it may help indirectly, by improving the *organization* of health-care (Table 2). It can certainly help with education of health-care workers and patients. It may also help with clinical care—not for all cases, but for those requiring specialist advice, either from within or outside the country in question.

It is worth emphasizing that sophisticated and expensive technology is not a prerequisite for successful telemedicine in developing countries. As the work of the Swinfen Charitable Trust and the SatelLife organizations demonstrates, useful clinical and educational results can be achieved using low-cost methods. As with the rest of telemedicine⁵⁰, the guiding principle seems to be that it is important to be clear about what problem you are trying to solve.

R Wootton Telemedicine and developing countries

Table 2 Common health-care delivery problems in developing countries

Infrastructure problems	Organizational problems
Unreliable electricity supplies	Isolation and lack of continuing medical education for health-care staff
Unclean water and poor sanitation	Poor training and supervision of health-care workers
Poor telephone services	Poor referral systems (and no feedback for the referrer)
Lack of medical supplies, especially drugs	Not enough doctors and other health-care workers
Lack of transport	Too many patients

When telemedicine for developing countries is discussed, various counterarguments are commonly put forward⁴. These include the following:

- (1) Can health-care workers do anything on the basis of the advice they receive? That is, was the advice offered appropriate in the context of the health-care system in which the health-care workers were practising?
- (2) Is it an appropriate use of resources? That is, would the resources be better used in another way? The cost-effectiveness of conventional public health measures, for example, is known, whereas the cost-effectiveness of telemedicine is largely unknown.

Another important question, relating specifically to diagnostic applications, concerns quality control:

- (3) How do you know that the advice offered was in fact correct? Lack of quality control is a general problem with telemedicine, not confined to telemedicine for developing countries.

None of these questions is intrinsically impossible to answer. All can be resolved on the basis of pilot trials, properly evaluated. Without evaluations, and in particular without sharing the experience gained, telemedicine in general cannot advance⁵¹.

The ethical and moral issues

What is the cost-effectiveness of telemedicine in the developing world? Until we know whether significant health-care improvement is possible using telemedicine (and the limited evidence so far is entirely qualitative), then we can hardly have a sensible discussion about widespread implementation.

If we believe that telemedicine has the potential to improve health-care, then we also have a moral duty to ensure that it is properly tested and evaluated. This is the *only* way in which a rational decision can ultimately be reached regarding whether scarce resources should be devoted to telemedicine in developing countries, or whether they should be used for more conventional health-care measures (e.g. the provision of clean drinking water, proper sanitation, or child immunization). This represents a bigger ethical issue for developing countries, since resources are relatively more

precious than in industrialized ones. There is more leeway in the health-care system of the United States for an unsuccessful telemedicine project, for example, than there is in the health-care systems of the countries of sub-Saharan Africa.

The knowledge gap

Anecdotally, it seems that all the same faults of telemedicine in the industrialized world are occurring in telemedicine projects in developing countries. Such faults include:

- (1) excessive expectations;
- (2) unsustainable funding models;
- (3) lack of trials and evaluation data;
- (4) lack of published results and sharing of expertise.

If this is the case, then there is a knowledge gap—a failure to learn from the experience of others. There is also a parallel duty on those in the industrialized world with relevant experience to ensure that the information is readily available to those in developing countries. For example, telemedicine guidelines should be published via the Web. Calls for publishers in the industrialized world to provide free information to poor countries have been made before^{52,53}, but there are now signs that this is beginning to happen⁵⁴.

How can telemedicine advance in the developing world?

Despite many reports of telemedicine activity in developing countries, there are few published studies in the peer-reviewed literature. Does this represent a problem in the writing-up of the work, in its performance, or both? Whichever is the case, sharing of experience is important, so that mistakes are not repeated and successful applications can be replicated. This means concentrating on two things:

- (1) writing up and publishing the experience, preferably in the peer-reviewed literature;
- (2) carrying out formal evaluations whenever practicable.

Arguably, such functions would be assisted by coordination by an international organization of some kind. Equally, this might be a role for national telemedicine societies.

Conclusion

The published literature clearly shows that telemedicine for the developing world is at a very early stage. There are very few publications in the peer-reviewed literature and most of them are in the nature of review articles or editorials. The majority of the work is educational, and there is only limited clinical experience. Furthermore, the applications exhibit the problems well known in telemedicine generally, such as lack of long-term funding and an absence of quality control. Despite interest in telemedicine from international bodies such as the International Telecommunication Union⁵, no organization has emerged to take an overall coordinating role in running trials, performing evaluations and disseminating the results. The few evaluations which have been carried out have been small, and often run in an ad hoc way, rather than being designed from the outset as scientific trials. (This is not a criticism—any kind of evidence is better than none at all.) Without international support, the development of telemedicine in the Third World will remain, much as it does in the industrialized world, a cottage industry.

It is not yet clear what role, if any, telemedicine will play in health-care in, say, 10 years' time. Without proper trials, it is impossible to determine the place of telemedicine in the developing world. It is impossible to answer the big question: *In terms of global health-care, is telemedicine actually relevant?* It is a failure in our collective responsibility to the developing world that such questions have yet to be tackled in a systematic way.

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J Bengner *et al.* Image effects on the accuracy of telemedicine

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▶ The effect of resolution, compression, colour depth and display modality on the accuracy of accident and emergency telemedicine

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Summary

There are no current recommendations regarding the minimum technical specification for realtime telemedicine consultation in accident and emergency (A&E) practice. We assessed the effect of image resolution, compression, colour depth and display modality on perceived image quality and telediagnosis. Test sets of digitized radiographs and clinical images were subjected to a series of standardized manipulations and the resulting output files were evaluated by an expert panel using image scoring and receiver operating characteristic (ROC) analysis. For telemedicine in A&E work, the minimum technical specification should be regarded as images containing at least 250,000 pixels, compressed at up to JPEG 50 (or GIF for colour images) and displayed on a high-resolution computer monitor. These specifications resulted in average file sizes of 17 kByte for digital images and 9 kByte for radiographs.

Introduction

Telemedicine allows peripheral and minor injuries units to be supported by a central accident and emergency (A&E)

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department; these units reduce the need for patients to travel long distances, and telemedical support changes the staffing requirements at these remote sites¹. In the UK, the formal evaluation of information and communications technologies is a priority for both central government and the National Health Service, and is of particular relevance to the current A&E modernization programme. The SECT project (standards, effectiveness and costs of telemedicine