REVIEWS

A review of telemedicine in accident and emergency: the story so far

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Abstract

Recent developments in information and communications technology have the potential to revolutionise health care. This has been recognised at government level, and plays a significant part in the new information strategy for the NHS "*Information For Health*". Telemedicine (literally, medicine at a distance) is one of the most successful techniques in this rapidly expanding field, and in preliminary studies has proved to be both successful and popular with patients and health care professionals. In the UK telemedicine has been mainly applied to two major areas of accident and emergency (A&E) practice. These are the transmission of computed tomography scans for urgent neurosurgical opinion and the ongoing support of minor injuries units. The latter also involves transmission and interpretation of radiographs, usually peripheral limb films.

Telemedicine is not a medical subspecialty in itself, but a facilitator of all medical and surgical specialties. While recent modernisation initiatives have permitted A&E departments to purchase a range of telemedical equipment, overall progress is hampered by a lack of large or scientifically rigorous studies, and a complete absence of data on the economic implications of this new technique. This review introduces A&E telemedicine in terms that avoid jargon and complex technical details. After a brief consideration of the origins of the subject, attention is given to recent publications relating to minor injuries support and A&E teleradiology. The technical and clinical feasibility of A&E telemedicine are demonstrated, and a case is made for the transmission and interpretation of minor injuries radiographs using a relatively simple and inexpensive system, supported by timely radiological reporting. After a brief study of various legal and ethical issues, the likely developments of the future are discussed.

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Literally translated, the word telemedicine means "medicine at a distance", though many alternative definitions have been proposed. These include "distance independent medicine",[1] and the rather more unwieldy "two-way transmission of audio-video information or data between two or more points using electronic technology for the purpose of medical care, consultation or administration".[2] The unprecedented technological advances of the 20th century have led to dramatic developments in communications technology, and this in turn has permitted telemedicine to take place by telegraph, telephone, fax and e-mail. While the telephone is regularly used to perform "medicine at a distance",[3] consultation through video-conferencing is now regarded as the general meaning of the word "telemedicine", and is certainly what most people envisage when the term is applied to accident and emergency (A&E).

Telemedicine is a technique, not a technology, but the two terms are often confused. There is also concern that the introduction of telemedical techniques will be driven by the pressures of an innovative technology rather than demonstrated clinical need or effectiveness.[4] For persons in truly remote locations, such as on the world's highest mountains[5] or in Antarctica,[6] the benefits of telemedicine are obvious. Extrapolating this to less remote, but still isolated, settings offers the potential to provide urgent medical advice without the need for the patient to travel long and expensive distances. If this is safe, effective and acceptable to those involved then the benefits to both patients and society are clear.[7] At the very end of the 20th century the technology to make this possible is becoming widespread, approachable and affordable. There is every indication that in some instances telemedicine will soon become a routine practice.[8]

For the specialty of A&E telemedicine offers two major applications; the first of these is closely related to the similarly evolving field of teleradiology, and allows radiological images to be sent rapidly from one location to another. This has been unequivocally successful in the treatment of serious head injuries, allowing computed tomography (CT) images to be transmitted to neurosurgical centres so that patient management can be optimised and timely transfer arranged.[9] The second major

application utilises video-conferencing systems to link a number of sites together, and has enjoyed some success as a means of supporting remote facilities, particularly minor injuries units.[8]

Methodology

In preparing this review the following search strategy was used:

1 Medline 1966 to April 1999 was searched using the OVID interface and the search terms [{exp telemedicine OR telemed$.mp OR telerad$.mp} AND {exp emergencies OR accident.mp OR emergency.mp}] LIMIT to human and English language (92 papers retrieved)
2 The above search was repeated using EMBASE from 1988 to April 1999 (41 papers retrieved).
3 The *Journal of Telemedicine and Telecare*, the *Telemedicine Journal*, the *Annals of Emergency Medicine* and the *Journal of Accident and Emergency Medicine* were all hand searched from 1996 to the present day.
4 References from the papers identified in the above steps were scrutinised and all those with possible relevance retrieved. The references from these papers were similarly examined and retrieved and so on, until no new publications were discovered.
5 Direct communication was undertaken with three leading telemedical researchers and experts in the UK as well as similar people in several countries overseas.
6 Further information was gained by personal visits to four centres and from a meeting of all those involved in UK minor injuries telemedicine, convened in Belfast during October 1998.[10]

All of this information was collated and considered, and is summarised in the following review.

The history of A&E telemedicine

EARLY TELERADIOLOGY

Radiology has always led the telemedical revolution, but while it was possible to send radiographs by telegram as early as 1929,[11] practical development had to wait another 30 years. In the 1960s the first experiments with "two-way television" were undertaken in North America,[12–14] with Kenneth Bird emerging as a champion of teleradiology in Boston.[15] In 1970 Bird and coworkers published a report comparing direct viewing of chest radiographs with images transmitted over a distance of two miles by microwave.[16] Interestingly, this concluded that "observed differences could be accounted for by intra- and inter-observer variability", an assertion that remains controversial even to this day. By the middle of the 1970s the technique was being applied to a wider variety of images, including skeletal radiographs, and transmission distances had increased to more than 20 miles.[17]

EARLY TELECONSULTATION

In 1975 a group working at the Harvard Medical School in Massachusetts compared communication by television to a conventional telephone call for remote nurse practitioners seeking advice from a hospital doctor.[18] This study showed that television consultations took approximately 25% longer and achieved similar levels of patient satisfaction. The overall number of patients eventually seen in person by a physician was the same in the two groups, but it was observed that the immediate referral rate was significantly reduced for patients assessed by television. The authors proposed that the extra information afforded by television allowed the physician to confidently postpone a face to face consultation until a more convenient time, and concluded that "television may have its greatest value in remote sites where the sense of isolation is great and the need to reduce long-distance referrals offsets the costs of the system". This holds true today, and it is the falling cost of rapidly improving equipment that now makes routine A&E telemedicine a very real clinical and economic possibility.

These promising results were challenged in 1977 by a group working in Toronto.[19] Dunn and colleagues compared colour television, black and white television and a hands-free telephone and found no significant differences in diagnostic accuracy, time taken, tests requested or referral rates. Interestingly, there remains an almost total absence of more modern studies comparing video techniques with the humble telephone.[3] While it is apparent that an ability to accurately transmit radiographs and pathology slides will exceed the capacity of the telephone alone it is much less clear to what extent other types of consultation rely upon visual images.

THE 1980s

Following these early evaluations, which were often funded by external sponsors, the development of A&E telemedicine entered a lull throughout the 1980s. Such initiatives were seen as little more than interesting demonstrations as the equipment was too expensive, unwieldy and technically weak to be seriously adopted into routine clinical practice. It was not until the 1990s that the rapid evolution of computing and communications technology re-awakened an interest in telemedicine as a credible solution to a very real problem.

Five years of minor injuries telemedicine

BACKGROUND

Despite continuing growth in A&E the demands placed upon the specialty are also rapidly increasing, with new patient attendances rising by 2% annually.[20] The Audit Commission's report of 1996 highlighted a shortage of medical staff in the specialty, and proposed the closure of up to 30 A&E departments nationally. While this may make economic sense there is considerable pressure on the part of local and rural communities to "keep care local",[21] and in practice it is extremely difficult to close a local A&E facility.

One of the more successful approaches to this problem has been to develop the role of the emergency nurse practitioner (ENP).[22] Such

Table 1 Minor injuries telemedicine projects reported between 1994 and 1999

Date started	*Consulting minor injuries unit*	*Supporting A&E department*	*Number of patients using telemedicine*	*Main findings*	*Main weaknesses*
1994[26]	South Westminster Health Centre, London	Royal Victoria Hospital, Belfast	51	1 During 12 months referrals to A&E and GPs both fell substantially. 2 Use of the telemedical link gradually fell during the study period.	1 Historical controls 2 Several factors probably responsible for the fall in referral rates 3 Lack of local knowledge and personal contact reduced the effectiveness of the project in the longer term.
1994[27]	Peterhead Community Hospital, Peterhead	Aberdeen Royal Infirmary, Aberdeen	120	1 Successful telemedical support to general practitioners working at a remote hospital. 2 A significant number of patient transfers were avoided by the use of telemedicine. 3 The project achieved high levels of patient and doctor satisfaction.	1 Neither a "telepresence" headset nor communication via satellite were found to be useful in this context. 2 The economic benefits are less clear cut than simply the costs of saved ambulance transfers.[28]
1995[29]	Three "rural spoke sites" in North Dakota	Bismark, North Dakota, USA	45 (also an overlapping series of 100 "trauma" patients)[30]	1 Three quarters of emergency consultations were for trauma, and 96% required the transmission of a radiograph; mainly peripheral limb films 2 53% of patients did not need transfer for further care 3 Consultations lasted an average of 3.5 minutes.	1 No control group. 2 No economic comment made
1996[8]	Wembley Community Hospital, London	Central Middlesex Hospital, London	150	1 Most consultations were related to radiographs. 2 Remote ENPs can be effectively supported through the use of comprehensive protocols and a minor injuries telemedicine system. 3 Three month follow up of 99% of the 150 patients managed using telemedicine revealed no changes in diagnosis or further problems. In contrast 1% of those patients treated at the MATS without telemedical support had sought further medical advice 4 A&E consultants interpreting radiographs as part of a teleconsultation performed better than the consultant radiologist who subsequently reviewed the original films	1 Study not randomised 2 No economic comment made
1997[34]	New Jersey, USA	New Jersey, USA	104	1 Randomised, controlled clinical trial. 2 No significant differences were found in return visits within 72 hours, need for additional care, patient and carer satisfaction or time spent in the emergency department.	1 Small sample size with low power. 2 Only 85% follow up achieved. 3 Four patients in the experimental group who did not complete the study protocol were excluded from analysis

nurses can reduce the pressure on medical staff and seem particularly well suited to the management of minor injuries.[23] An increasing number of minor injuries units are now employing ENPs who have also been shown to be as effective as junior medical staff in ordering and interpreting radiographs in this setting.[24] Minor injuries telemedicine offers a way to support ENPs working in remote locations, thus continuing to provide a local service with appropriate reference to central expertise. This approach has recently been endorsed by the British Association for Accident and Emergency Medicine (BAEM).[25]

Table 1 outlines the minor injuries telemedicine projects that have been reported to date, and more information is provided in the text below.

BELFAST

The first UK minor injuries telemedicine link was established in 1994.[26] This project provided support for a minor treatment centre (MTC) in South Westminster, London from the Royal Victoria Hospital in Belfast. The 12 months following the introduction of this link were compared with data from the previous year and are summarised in table 2.

Table 2 Comparing the disposal of patients for the 12 months before and after the introduction of a telemedical link between Westminster MTC and the Royal Victoria Hospital, Belfast

	Total number of patients seen at the MTC	*Number of patients using telemedicine*	*Number referred to GP*	*Number referred to local A&E*
12 months before telemedicine	6729 (100%)	0	802 (11.9%)	155 (2.3%)
12 months after telemedicine	9972 (100%)	51 (0.5%)	383 (3.8%)	147 (1.5%)

The authors recognised that the major difficulty in interpreting these results relates to the use of historical controls. This makes it impossible to determine to what extent the observed changes were attributable to the presence of a telemedical link, or to other factors. The telemedical link was used in just 0.5% of cases, but the number of patients referred to a GP fell dramatically. The number of patients referred to A&E also fell, and by more than the total number of teleconsultations despite the fact that more than 50% of the 51 teleconsultations resulted in the patient being referred to a hospital or GP.

The most probable confounding factor is the increasing experience and confidence of the nursing staff working at the Westminster MTC, though to what extent the telemedical link contributed to this is not clear.

ABERDEEN

A second study was published in 1997, and described an experimental telemedical link between Aberdeen Royal Hospital in Scotland and Peterhead Community Hospital, 60 km to the north.[27] This is the only reported use of telemedicine to support general practitioners working in a remote minor injuries environment in the UK, and studied 120 consultations over a 12 month period. One hundred and ten of these used telephone lines, while a further 10 used communication by satellite.

Minor trauma dominated the conditions for which telemedicine was used and 116 (97%) of

the consultations started with the transmission of a radiograph. In two thirds of these cases a video-conference was then started to discuss the patient and the radiograph, but in one third further discussion was carried out using an ordinary telephone alone. The system was consistently given high ratings for usefulness and value at both ends, and a clear educational effect was observed.

Use of the telemedical link meant that patient transfer could be avoided in 70 patients (58%), and this is analysed in more detail in a companion publication.[28] It is, however, difficult to estimate the true financial effect of avoiding these transfers. The cost of transporting all 70 patients each way by ambulance is quoted at £126 000, but clearly the actual cost to the NHS would have been considerably less than this, if only because some patients would have arranged their own transport. In addition, the capital and operating costs of installing the telemedical system have to be taken into account. The question of economic gain therefore depends upon whether the costs are considered from the point of view of the NHS, the patient or society as a whole.

NORTH DAKOTA, USA

The next account of minor injuries telemedicine comes from North Dakota in the USA. In 1997 Lambrecht published a descriptive series of 45 telemedical consultations in emergency medicine,[29] followed by a series of 100 patients presenting in the more general category of "trauma" (including 33 patients from the emergency medicine series).[30] Lambrecht reports that 73% of the emergency medicine consultations were for trauma, with the remainder being mainly for adult medicine (13%) and paediatric medicine (13%). Once again, 96% of consultations required the transmission of a radiograph, and 53% of patients did not need transfer for further care, though it is unclear whether these patients would have been transferred had telemedicine not been available, and no economic comment is made. All consultations achieved a high degree of physician satisfaction and lasted on average just 3.5 minutes.

LONDON

In January 1996 a minor accident treatment service (MATS) was established at Wembley Community Hospital in London. This was run by ENPs supported by a sophisticated telemedical link to the Central Middlesex Hospital, and by a set of clinical protocols incorporating prompts indicating when telemedicine should be used. A paper describing six months activity at the MATS was published in 1998.[8] During this time 2843 new patients were seen and 150 teleconsultations carried out (5.3%). The most common reason for teleconsultation was again to discuss radiographs. The teleconsultation achieved very high levels of staff satisfaction.

This paper is interesting because it follows up all the patients seen as the MATS over this six month period. Ninety nine per cent of telemedical and 95% of non-telemedical cases were successfully followed up after an interval of at least three months. In the telemedical group no further problems had arisen. In contrast, 26 of the non-telemedicine group (1%) had consulted their GP with the same problem, and had further radiographs taken, but in none had a change in diagnosis been made. The other finding of particular interest was that A&E consultants interpreting radiographs as part of a teleconsultation performed better than the consultant radiologist who subsequently interpreted the original films (using a gold standard derived from a consensus panel of the two A&E consultants and the consultant radiologist). This is attributed to the fact that the A&E consultants had the advantage of being able to see the patient and obtain further clinical information as required, and is supported by additional work from this centre and elsewhere.[31–33]

NEW JERSEY, USA

The only study to address the issue of minor injuries telemedicine through the medium of a randomised clinical trial is also the most recently published.[34] In this study 104 patients who presented with one of 15 defined clinical complaints, and who consented to participate, were randomly allocated to one of two groups. The control group was treated by a local physician in the usual way, while the experimental group was treated by a remote physician facilitated by a "telemedicine nurse". Four patients in the experimental group did not complete the study protocol and were excluded from analysis, while only 85 of the remaining 100 were adequately followed up. There were, however, no significant differences found in return visits within 72 hours, need for additional care, patient and carer satisfaction or time spent in the emergency department. This is a small study, using only a limited number of outcome measures and a short period of follow up, but leads the way for further investigation.

THE INTERNET

One other area that merits discussion is telemedicine using the internet.[35] Although access to the internet is relatively cheap and widespread the telephone system suffers from a relatively slow rate of information transmission, while the internet as a whole is an unreliable medium that raises a number of security and confidentiality issues.

Despite this it may prove possible to find some applications for the internet in minor injuries telemedicine, particularly as the majority of consultations are radiograph based, and the successful transmission of radiographs over this medium has already been demonstrated.[36] In some cases it may be possible to use the internet to send a radiograph to a different location for interpretation, followed by discussion over the telephone.[27] The main limiting factors are likely to be the speed of radiographic transmission and a requirement for reliable patient confidentiality, though mechanisms to ensure anonymity are fairly simple to devise, and have already been resolved by the British Armed Forces.[37]

A&E teleradiology

BACKGROUND

Teleradiology is a sizeable development in itself, and probably represents the most established of the telemedical techniques. It would therefore be inappropriate to attempt a complete description of the subject here, and several comprehensive reviews have recently been published.[38–40] Nevertheless, the two areas in which A&E practice may overlap with teleradiology are in the transmission of CT scans and in minor injuries support.

TELERADIOLOGY FOR EMERGENCY CT

Over the past few years the telemedical transmission of emergency CT scans of the head to a tertiary neurosurgical centre, to obtain an immediate expert opinion, has become commonplace. Despite this there is surprisingly little evidence concerning the effectiveness of this practice, though the few publications that do exist tend to be supportive. A paper from Dublin showed as early as 1992 that the telemedical transmission of CT images significantly reduces the rate of unnecessary and potentially hazardous patient transfer, leading to the possibility of substantial economic savings.[41] This work was supported by a 1997 paper from Hong Kong that described a reduction in unnecessary transfers, a significant increase in the number of therapeutic interventions undertaken before transfer and a decrease in adverse events occurring during transfer.[42] Also published in 1997, a study from Austria specifically considered the economic implications of this practice and concluded that while teleradiology for CT scans was more expensive than conveying the scans by taxi it was considerably faster, and certainly far less costly than transferring the patient by road or air.[43]

TELERADIOLOGY FOR MINOR INJURIES

Ultimately telemedical techniques may allow a remote nurse or doctor working in A&E to obtain an expert radiological opinion on any investigation almost immediately, and while some steps are currently being taken towards this,[44] it is more likely that, for at least the foreseeable future, it will be senior A&E staff who become increasingly familiar with the use of teleradiology to support minor injuries units. As has already been described most minor injures telemedicine is based around radiological interpretation, and there is evidence to suggest that A&E consultants may be very well placed to provide such support.

TECHNICAL STANDARDS

Great controversy arises when attempting to determine a minimum technical standard for teleradiology in the context of minor injuries work. This is because there is a clear difference between what is required to give advice to a minor injuries unit and what is required to issue a definitive radiologist's report. Most published work is undertaken from the point of view of the radiologist, who is anxious to ensure that their report is as accurate as possible.[45] In 1994 this led the American College of Radiologists to publish a very demanding and costly technical standard,[46] which has since been followed by a series of papers evaluating other, less stringent, possibilities.[47 48]

When considering the evidence in relation to minor injuries telemedicine the following four questions are worthy of consideration:

1 What sort of cases are being used?

The majority of teleradiology research has been conducted using chest radiographs as these are known to present a high degree of diagnostic difficulty.[49] It is, however, unclear whether the conclusions drawn from chest films can be applied to peripheral limb radiographs, which make up the vast majority of UK minor injuries radiology. Where studies look at both chest and peripheral limb radiographs together it is the former that tend to cause diagnostic problems.[50] As early as 1987 Kagetsu and colleagues studied 919 unselected radiographs from an emergency department in the USA, and concluded that it was the detection of pneumothoraces and abdominal calcifications that were the "problem areas".[51] More recently, an unselected series of 829 emergency department teleradiological investigations were studied and found to contain only three errors resulting from an inadequate digital image (0.4%), two of which were chest radiographs.[52]

2 What difficulty of cases are being used?

It is not surprising that most studies of teleradiology use a selected case series of high diagnostic difficulty, as this is designed to highlight differences while maintaining a relatively small sample size. The disadvantage of this approach is that it underestimates the accuracy of a digital system, as most cases in which teleradiology will perform at a level equivalent to conventional radiology are excluded.[53] Furthermore, the measured accuracy of the two methods may vary according to the difficulty of the cases selected, invalidating attempts to extrapolate these results to a wider range of cases.[54]

3 Do missed abnormalities have clinical significance?

Of central importance is the clinical significance of missed abnormalities. Many studies that look at the accuracy of teleradiology fail to consider the clinical impact of any discrepancies in interpretation.[55 56] Where clinical significance is taken into account peripheral limb films seem to fare better than other types of radiograph. For example in the paper by Kagetsu and colleagues,[50] errors in digital interpretation that were judged to be of clinical significance occurred in 4.6% of abdominal films, but in only 2.1% of upper limb and 2.2% of lower limb radiographs.

Of similar importance is the effect that the telemedical consultation itself has on radiographic interpretation, as it has been shown that the availability of clinical information improves the ability of both radiologists and orthopaedic surgeons to detect fractures in

trauma patients, but that this effect is more marked in the latter.[33] Doctors working in A&E also seem to benefit from the clinical information available in a teleconsultation, and have been shown to be more accurate in interpreting digital radiographs than a consultant radiologist subsequently interpreting the original films.[8] It therefore seems possible that the ability to obtain accurate and interactive clinical information is capable of compensating for any technical shortcomings in a minor injuries teleradiology system, though this has yet to be fully assessed.[57]

There is some evidence that regular use of teleradiology for several months will improve performance,[31 58] and it has also been observed that age and prior experience play a large part in the success of digital radiological interpretation.[59] Studies in which the teleradiology image is printed onto paper, rather than displayed on a screen, have shown favourable results,[60] and this has been attributed to the fact that the image can be handled in a more conventional manner.

4 What is the accuracy of teleradiology in relation to current practice?

Finally, we must consider the current standards of radiological interpretation that prevail in A&E, and the effect of interobserver and intraobserver variation. Subtle radiological findings are regularly overlooked in a busy department, though the majority of these are of little clinical importance.[61] Nevertheless, most centres have now implemented a system to reduce the risk that a serious abnormality will be missed.[62] All studies of teleradiology demonstrate some degree of interobserver variability,[45 50] and this has to be carefully compared with the accuracy of a teleradiology system. For example, the work of DeCorato and colleagues, which identified three errors attributable to an inadequate digital image, also found 14 mistakes attributable to interobserver error.[52]

An A&E teleradiology system was recently reported by O'Reilly and colleagues from Belfast.[63] This suggested that plain radiographs could be adequately interpreted, for the purposes of minor injuries management, using a low cost and low resolution telemedicine link. This is supported by other papers that have shown that a reduction in the cost and technical specifications of a teleradiology system may still yield adequate images.[64 65]

Legal and ethical considerations

The introduction of A&E telemedicine raises a number of new legal and ethical questions. Nevertheless, the fundamental nature of the clinical consultation remains unchanged, and conforms to identical principles of excellence in practice.[66] In his consideration of this subject,[67] Tremblay states that "standards of clinical practice apply regardless of whether the technology is used or not; therefore, the intervention of the technology does not reduce the obligation to meet standards, and the failure of the technology does not mitigate the failure to reach the standard". This also highlights the importance of ensuring that the equipment used is reliable, of adequate technical specification and that back up facilities exist in case of hardware, software or network failure.[68]

The main question, therefore, is how to apply these familiar concepts to the new technique of telemedicine. Clearly the patient's right to give or refuse their consent remains unchanged from usual medical practice.[69] The possibility that a claim of medical negligence will arise from a telemedical consultation must also be considered by the practitioner.[70] Ironically there may soon come a time when A&E telemedicine is so widespread and accepted throughout the UK that its utilisation is considered to be the best available practice, and failure to use the technique may then be considered inappropriate, or even negligent.[66] A good example of this might be found in the immediate transfer of CT scans for neurosurgical review; it is easy to conceive how a failure to undertake this, leading to demonstrable patient harm, could form the basis of a successful legal claim.

Within this context the question of ultimate clinical responsibility remains unclear, and has yet to be tested in a court of law. Where a nurse practitioner consults a doctor for advice it is likely that the doctor will assume ultimate clinical responsibility,[70] particularly where the doctor is already charged with overall responsibility for the minor injuries unit. Where a doctor consults another doctor for advice the situation is less clear, and impossible to conclusively resolve at present (that is, until it is contested in court). It is, however, encouraging that there is no recorded instance of a major malpractice case arising from the many thousands of telemedical consultations that have already taken place.[69]

The issue of confidentiality is also of great importance and concern. Registration of all computer databases containing identifiable patient records is mandatory under the UK Data Protection Act.[71] This, however, does little to resolve the areas of public concern demonstrated in a survey reported by Tachakra and colleagues in 1996.[72] Here a major worry among the general public was that the consultation would be overheard, and there was also unease concerning the possibility that teleconsultations might be recorded on video. Furthermore, there was a great deal of anxiety relating to information stored and transmitted in a digital format, which was considered to be vulnerable to breaches in confidentiality, particularly where a computer system might be subject to unauthorised access.

Finally, it is prudent for any A&E department that is offering telemedical advice to a minor injuries unit to ensure that such activity is given due attention as part of its clinical workload.[68] This is particularly important as telemedicine takes longer than a conventional consultation and is therefore not a "free" activity.[73] Where accurate activity records are maintained they may help to justify the employment of additional senior A&E staff, particularly if the advent of telemedicine

permits a change in staffing patterns at peripheral sites.

The future of A&E telemedicine

At the end of a century all attempts to predict the future seem little more than tired clichés. Nevertheless, it would appear that A&E telemedicine is here to stay. This is because it meets a demonstrable need to concentrate expertise while still keeping care local, and at the same time offers a mechanism by which nurse practitioners can be supported, and care standardised, over a wide area.[25] This makes the application of telemedical techniques more than a hobby for enthusiasts, and an integral part of the strategy for coping with a steadily increasing demand.[74]

Revolutions in medical care often pass through a series of identifiable stages, beginning with widespread enthusiasm followed by a backlash of concern and criticism. Eventually the new technique will find its niche; not as a cure all, but as a useful addition to the doctors' repertoire when used at the right time, in the right place and on the right patients. This process has recently been eloquently described for the new technique of endovascular aneurysm repair,[75] and can also be applied to telemedicine in general; the honeymoon period is over, and we are now left with the more important task of deciding how and when we can usefully use this new technique.

Although the government has made a commitment to adopt telemedicine only where it has been shown to meet a demonstrated clinical need and be clearly cost effective,[76] such data are still substantially lacking.[7] Perhaps reflecting its greater maturity, valuable papers concerning the economic aspects of teleradiology have recently begun to appear,[77 78] but although a general model has been proposed,[79] there are as yet no equivalents in A&E. Despite these deficiencies, and an absence of larger trials evaluating clinical safety and effectiveness[1], progress is steadily being made. This was clearly demonstrated at a recent UK meeting of persons active in A&E telemedicine, the proceedings of which have been published as a resource document.[10]

Advances in technology are likely to improve the technical quality of both teleradiology and teleconsultation at an ever diminishing cost, and this will also make telemedicine more accessible and familiar. One of the greatest challenges for decision makers of the future will be to choose between a range of highly developed systems in the face of strong commercial pressures.[7] It is estimated that the European telemedical market will be worth a quarter of a billion US dollars by the year 2004,[80] and this is likely to produce a highly competitive sales environment.

As with any technique, those who use A&E telemedicine must be aware of its limitations as much as its advantages, so that they do not attempt to exceed its capabilities.[66] The telephone already works well, but it is essential to ensure that the addition of a clear video picture does not create a false air of confidence.

Writing in the *Annals of Emergency Medicine* in 1997 Schafermeyer said "we must evaluate what is needed and what will be used, not what is possible . . .practice parameters should be developed to ensure quality medical care and cost effectiveness".[81] This must include further consideration of the roles of doctors, nurses and patients in A&E telemedicine,[82] and the integration of these new techniques and ideas into our planning for the emergency services of the future.[83]

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