ABSTRACT
Teledermatology has been the focus of much interest in recent years. It holds great potential for revolutionizing the delivery of dermatology services, providing equitable service to remote areas and allowing primary care physicians to refer patients to dermatology centres of excellence at a distance. Teledermatology can be applied in one of two ways: it may be conducted in real-time, utilizing videoconferencing equipment, or by “store and forward” methods, when transmitted digital images or photographs are submitted with a clinical history. “Store and forward” teledermatology systems are easy to set up, cheaper and more convenient for the health care provider, but lack the immediacy of patient contact with the dermatologist, and involve a delay in obtaining the diagnosis and advice on management. Studies to date have generally found that real-time dermatology is likely to allow greater clinical information to be obtained from the patient. It must be recognized that teledermatology is potentially a useful communication tool for selected patients in primary care but is unlikely to solve waiting list problems or replace the need for local dermatology services. Before its routine application as a service tool, its reliability, accuracy and cost-effectiveness need to be verified by rigorous evaluation. It is increasingly likely that teledermatology will prove to be a significant tool in the provision of dermatology services in the future.

Introduction
Telemedicine includes all medical activities in diagnosis, therapeutics or social medicine using an electronic transfer medium, for enabling the visual and acoustic information transmission over long distances without the doctor and patient being personally present at the same site and time. The use of imaging systems to improve access to specialist healthcare for geographically isolated populations in the USA began in the late 1950s (1). Teledermatology has been defined as the practice of dermatology at a distance. Recent years have shown a continual growth in the use of telemedicine, as emerging health and information technology becomes cheaper, as performance increases and as telemedicine becomes more clinically acceptable for both patients and doctors. Patients increasingly express a desire for change in the delivery of health care and the traditional doctor/patient relationship, long regarded as the “gold standard” (2).

Other specialties that have embraced and utilized the advent of telemedicine include radiology, cardiology, pathology, obstetrics, surgery, and nursing (3).

Teledermatology offers an obvious method of service delivery directed towards improving access and decreasing cost, by eliminating the distance between the patient and the physician.

There has been enormous interest in teledermatology over the last decade, not only to provide specialist opinion for remote communities but also to see if these systems can reduce the need for patients to attend hospital clinics.
Comparison of “store and forward” and “real-time” interactive modalities

<table>
<thead>
<tr>
<th>Technology type</th>
<th>Image type</th>
<th>Data</th>
<th>Patient-consultant interaction</th>
<th>Equipment -infrastructure cost</th>
<th>Telepresenter requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-time</td>
<td>Video</td>
<td>Synchronous</td>
<td>Direct</td>
<td>Higher</td>
<td>Yes</td>
</tr>
<tr>
<td>Store and forward</td>
<td>Still</td>
<td>Asynchronous</td>
<td>Indirect</td>
<td>Lower</td>
<td>No</td>
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</tbody>
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Materials and Methods

Teledermatology consultations are performed using 2 different modes of technology “store and forward” and “real-time” technological modalities (Table) (4).

Teledermatology consultations can be of the “store and forward” variety using so-called “still” digital images generated by a digital camera. Digital images are simply digital equivalents of traditional photographs. These digital images can be generated, sent, and reviewed at different times. Thus, the patient and consultant are separated not only by space, but also in time, since a consultant dermatologist typically reviews a “store and forward” consultation a few hours or a few days after the consult is forwarded. The consultant then forwards his or her impression back to the referring clinician.

“Real-time” interactive consultations employ videoconferencing technology so that the patient and consultant interact with one another via an audio-video communication link. In this case, the participants are separated in space but not in time. This format allows for interaction between patient and clinician much as a regular clinic based evaluation.

Both modalities have unique features which lends to the debate regarding the advantages and disadvantages of one versus the other. One such issue is the logistical considerations for each consult modality. Real-time interactive consultations require that at least 3 different individuals, the consultant, the patient, and a telepresenter (usually a healthcare professional who facilitates the consultation at the patient’s site, for example nurse or general practitioner), be available at the same time at their respective sites. Time zone differences, for example, present potential problems. Applications by nations’ militaries, and their worldwide deployment of personnel, may result in participants being in widely different time zones making a mutually agreeable consult time difficult. Such logistical constraints are eased with store and forward consultations since image generation and image review do not occur simultaneously, but consultations limit the amount of information available to the consultant compared with real-time interactive consultations (1–4).

Increasing interest in teledermatology has come at a time when there is an increased demand for dermatology services. In the U.K. there has been an almost 50% increase in dermatology referrals for a decade. For achieving a successful service, would be required increase in the number of dermatologists (5).

When comparing diagnostic outcomes of teledermatology consultations with traditional clinic-based consultations there are two important parameters to be assessed – diagnostic reliability and diagnostic accuracy. Diagnostic accuracy refers to whether or not the diagnosis provided by an examiner is correct or incorrect. Diagnostic reliability refers to the level of difference between diagnostic and therapeutic approaches made by two consulting dermatologists.

Several studies have assessed diagnostic reliability and accuracy, using “store and forward” modality and “real-time” interactive technology, as comparison between clinic-based dermatologists and telecon-
Diagnostic reliability, using real time interactive technology has been calculated in a range 0.57 to 0.99 (6-8). “Store and forward” modality has shown reliability from 0.54 to 0.96 (9-12). The existing literature data suggests that teledermatology, whether using “store and forward” or “real-time” interactive technology, performs high level of reliability, comparably with the level of agreement calculated between two different clinic-based dermatologists.

Diagnostic accuracy rates are ranged from 0.53 to 0.71 when accuracy was assessed based on the single diagnosis and from 0.68 to 0.85 when are included differential diagnoses in the accuracy assessments (6-12).

For evaluation of these two important parameters can be used histopathological review of a tissue biopsy, as a gold standard or reference standard or longitudinal clinical follow; however, these are not always a universally available an easy to realize options. Clinic-based examiners’ diagnostic impressions are often used in teleconsultations, because the lack of a true reference standard for accuracy assessments of dermatologic conditions.

To assess the efficiency of teleconsultations, several studies have compared the management recommendations, including skin biopsy request, made by teledermatologists with clinic-based dermatologists. Using a single dermatologist as the arbiter of the treatment plan, found that teledermatologists arrived at a correct plan in 60% to 90% of the cases, were unable to provide a management plan in 11% to 20% and provided less than optimal plan for 8% to 19% of studied cases (7, 10, 13).

**Technical requirements for data transfer and still and live videoconferencing**

Special, computer based technologies are used for transferring data in the telemedicine sessions. There are two ways so sending the information – terrestrial and satellite modality. Terrestrial lines usually are by electrical or optical lines, connecting the patient or the telepresenter from one side and the teleconsultants from the other.

The average conventional telephone line can transfer 33.6 to 56 kbps, so motion handling in video pictures is usually poor. These are usually slow for transferring high resolution digital images.

This is the reason, why digital lines are preferred, e.g. Integrated Services Digital Network (ISDN) lines. These lines allow enhanced digital transmission and increasing the number of ISDN lines increases the data-carrying capacity or bandwidth from 128 kbps (one ISDN line) to 256 and 384 kbps (two and three ISDN lines, respectively). Motion artifacts can be reduced by increasing bandwidth using ISDN lines (14). The key question regarding the transmission of digital images is whether still images will suffice or whether real-time video is required. The requirement of bandwidth depends of the size and the resolution of images sent the turn-around time and the expectation of peak use (4, 14).

Satellite telecommunications have much to offer as in remote areas, in emergencies, on planes and ships and distant military missions dislocated far on the globe from the main medical care unit. They are the best in ensuring the transmission of data in real time. However, there are a number of legal, financial, social, technical and security aspects that need to be worked on. High-resolution video images and data signals sent via satellite links have already made teleconsulting a routine since 1990s, when European Space Agency provided a satellite communication system to link Italian hospitals with a field hospital in Sarajevo in Bosnia, enabling teleconsultations for both civilian and military patients – live videoconferencing and avoidance of unnecessary evacuation or flight diversion for emergency treatment. Despite the great
potential, telemedicine in general and via satellite in particular is still at a very early phase, concerning the multidiscipline approach and the high cost of these services.

**Video imaging requirements**

In teledermatology, the images transmitted have been in two forms: moving images from a video camera or still images captured by a digital camera.

Modern video technologies allow real time consulting between two or more parties. This equipment enables the dermatologist to see the patient through the video link, while the patient has contact with the dermatologist through a small digital camera mounted on the videoconferencing unit. This allows direct interaction between the patient and the consultant. Loane et al. showed that the colour and temporal resolution of live video images could be improved by changing from a hand-held single-chip video camera to a tripod mounted three-sensor RGB (red, green, blue) chip camera (13).

Digital cameras have become readily available with resolutions ranging from 640 x 480 to 4096 x 2736 pixels and 24-bit colour. The minimum resolution needed for dermatology consultation, would be considered to be 1024 x 768 pixels, with resolutions of 1280 x 1024 becoming cheaper having in mind the progress of technology (19). A feature of digital cameras, allowing instant picture review, setting up and discarding of unsuitable views is the LCD (Liquid Crystal Display). Digital images from can be transferred to computer using cable or memory cards and easily sent by transfer lines to the receiver, where images are on digital monitors. The main parameter to affect the quality of display is the number of pixels. Videoconferencing computer based technologies can, to some degree, compensate for inadequate contrast resolution by using a scroll and zoom on the image and the ability to adjust display characteristics. The computers need to be capable of dealing with large image-based data, and typically need to be Pentium II or greater, to have 128 MB of RAM, and a large hard disk, usually greater than 10 MB (or a removable storage system) in order to store high quality digital photo documentation and a large (17-21 inch) high-resolution color monitor (3).

Overall, patients are satisfied with teledermatology as a means of obtaining a dermatology consultation. While some patients prefer a clinic-based consultation, often an equal number of patients prefer teledermatology. In some cases, patients have felt uncomfortable and embarrassed when using a real-time consult link (8). This illustrates an important difference between real-time interactive technology and store and forward technology in regard to patient satisfaction. Without the direct communication between the dermatologist and patient that real time interactive technology allows, it is up to the referring clinician to relay the dermatologist’s recommendations to the patient. In addition to affecting patient satisfaction, this may influence the referring clinician’s satisfaction as well (7, 8, 15-18).

**Conclusions**

Medical science has to balance between the advantages and costs of new technology. As the significance of technical aids has increased, medicine has become more tightly bound to technology. Telemedicine is one of the fastest developing fields, as its development is connected to the development of telecommunication and information technology. The cost of technology is quickly falling compared with the cost of medical specialist’s labour. Because of these factors the efficient use of telemedicine requires strategic decisions at the level of the organization, and arises more research concerning the effects of telemedicine on medical practice and the doctor-patient relationship. The rapid expansion of teledermatology is inevitable and the increased
use of this tool will induce profound changes in the medico-social environment. This article describes the basis of telemedical structure and technical requirements in the dermatology field.

REFERENCES