Teledentistry in dental specialist education in Finland

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Summary
Specialist dental services are available unevenly in Finland. A project to implement information and communication technologies in dental specialist education started in 2002 and was concluded in 2005. University lectures were transmitted to various training locations using IP-based videoconferencing (384 kbit/s–1 Mbit/s). Lectures and seminars were carried out on average twice a week. 17 of the 26 postgraduate students answered a questionnaire in which they rated the quality of picture and sound on a 4-point scale. The overall rating of videoconferencing as a tool in specialist training was excellent in 15%, good in 62%, neutral in 15% and poor in 8%. In the absence of teledentistry, the trainees needed to travel to the University of Turku approximately 80 times each year. Over a three year training period (one year in university, two years in other cities), the overall potential cost saving per student was estimated to be at least €43,600.

Introduction
In Finland, specialist education in dentistry is provided by the Institute of Dentistry at the University of Turku. The specialist education is a 3-year postgraduate programme; the training posts are full-time, salaried appointments. Part of the training takes place in several health centres and hospitals in west Finland. The clinical treatment services given by the trainees are integrated into the public health care system, offering the residents (trainees) a representative range of patients while making the expertise of the faculty in dental schools available to the whole population.

Specialist dental services are available very unevenly in Finland. Some smaller towns and sparsely populated regions lack some of these services. It has been estimated that need for new dental specialists in Finnish health care centres in the next ten years is much greater than current specialist training programmes can produce.¹

The aim of the present project was to determine how information and communication technologies could be used in dental specialist education so that the need for travel is reduced and a greater interactivity between teachers and students is achieved. Reductions in travel time would also result in an increased availability of the trainees’ services at their residence clinics.

Videoconferencing and computer applications have been used in education, consultations, meetings or other occasions where two-way audiovisual communication is essential.²–⁸ Videoconferencing has also been found useful in several dental projects.³–⁶,⁹,¹³ Videoconferencing and computer assisted consultation have been shown to reduce travelling needs and costs.⁹–¹² However, videoconferencing and computer assisted consultation have not been utilised in specialist dental education in Finland. The present project thus represents one of the first studies of teledentistry in Finnish dental specialist education.

Methods
The project started in 2002 and was concluded in 2005. A total of 26 dental specialist trainees participated. They were resident in eight different cities: Turku, Tampere, Vaasa, Seinäjoki, Jyväskylä, Forssa, Salo and Pori. Ten students specialised in orthodontics, eight in general dentistry, six in oral and maxillofacial surgery and two in oral health care.

The first trial of videoconferencing between two dental clinics was implemented in 2002 between Seinäjoki Health Care Centre and the Dental Clinic of Tampere University Hospital, approximately 180 km away. After that, teledentistry was developed for the trainees, keeping in mind the needs of odontology specialist training, distance learning and clinical consultation. In 2005, the suitability
of the technologies was studied and a cost estimation was carried out.

**Equipment**

Lectures were transmitted from the university to the training locations using IP-based videoconferencing (384 kbit/s–1 Mbit/s), see Figure 1. The University of Turku had a multipoint bridge that allowed 12 videoconferencing sites to be connected simultaneously. The major dental units used set-top videoconferencing units (Polycom FX). In addition to standard audiovisual equipment for videoconferencing, laptop computers, document cameras, digital cameras and wireless intra-oral cameras were used (Figure 2).

As part of the training programme it was occasionally necessary to consult a specialist for diagnosis and treatment planning. For this purpose digital cameras were used to obtain dental pictures that were transmitted along with digital X-ray images to a specialist. The patient was photographed with a digital camera with a close-up lens. After a sufficient number of clinical photographs or digital images of X-ray films had been obtained, the consultation was sent via email using PGP encryption with the photographs as attachments and with the patient’s identification data removed.

**Use of equipment**

Lectures were given mainly on Fridays. The lectures were given in various fields of medicine and dentistry, otorhinolaryngology, stomatognathic physiology, and oral and maxillofacial surgery. Every Tuesday afternoon an oral and maxillofacial seminar was conducted. Professors and assistant tutors acted as lecturers. Students had the opportunity to ask questions, and were also able to display images of their clinical cases during the lectures. Treatment planning was also discussed via videoconferencing.

The students were asked to rate the quality of picture and sound separately, and also to give a general rating of videoconferencing as a tool in their training on a scale of 1-4 (1 = excellent, 2 = good, 3 = neutral, 4 = poor).

**Cost analysis**

The cost of teledentistry was estimated by calculating the travelling costs incurred due to travel from the training post to the University of Turku, estimating the wage costs of the trainees incurred by the time needed to travel to Turku, and including the purchase and operating cost of the equipment.

**Results**

Videoconferencing was used more than 100 times in the initial phase 2002-2003, and subsequently the use of
teledentistry steadily expanded. Altogether 17 of the 26 postgraduate students participating in the training programme answered a questionnaire concerning the use of videoconferencing in the training course. The response rate was 65%. The age of respondents was 30-50 years. 11 of the respondents were female (65%) and 6 were male (35%).

The speciality of the students was: 5 in general dentistry, 4 in oral and maxillofacial surgery, 7 in orthodontics and 1 in care of health. Six of the students gave videoconferencing lectures and seminars during the study. Ten of them followed lectures in “satellite” cities and 16 of them in the classroom from which the lectures were sent out. Two students used videoconferencing as a consultation tool.

The quality of images was rated as good by 6 respondents (29%), neutral by ten (48%) and poor by five (24%). None of the respondents rated image quality as excellent. The sound quality was rated as excellent by 7%, good by 57%, neutral by 29% and poor by 8%. The overall rating of videoconferencing as a tool in specialist training was excellent in 15%, good in 62%, neutral in 15% and poor in 8%. Of the teaching sessions, only one was considered to have failed and this was for technical reasons (TCP/IP connection problems).

Cost analysis

Lectures and seminars were carried out on average twice a week. Thus in the absence of teledentistry, the trainees needed to travel to the University of Turku approximately 80 times each year. Distances from the training clinics to the University of Turku varied greatly (range 50–350 km).

The travel costs incurred per student were 12,800 euros per year (using the cheapest mode of travel available). The cost in lost work incurred due to travel was estimated to be 250 euros per day (6.5–7 h of dental work), resulting in a yearly expense of about 18,000 €. This is the cost in wages to the employer resulting in the loss of income from patient consultations by the trainees (average 25 euros per patient per 30 minutes). Since the trainees obtained a fixed salary, in effect the employers bore the full loss in income due to travel to Turku. However, approximately half of the seminars and lectures were conducted in the evening, which theoretically would make it possible to attend the lectures after work. Therefore the total wage cost was estimated as 9000 euros per year per student. Overall therefore, the total cost per student that could be avoided by teledentistry was at least 21,800 € per year. Thus, for the three year training period (one year in university, two years in other cities), the overall potential saving per student was at least 43,600 €.

The equipment was estimated to have cost 6000 €, including the display monitors. The connection and maintenance costs were estimated to be 1000 € per year per site. Therefore, the purchasing and running costs for the three year training course amounted to a total of 10,000 € per site. Thus, even if the equipment was used solely for the specialist training and discarded after the completion of the course, the overall saving would be at least 40,000 € per student.

Discussion

The present study suggests that videoconferencing is suitable for long distance learning in dentistry. Despite some initial technical problems, the equipment used in the project was found to be adequate: only 8% of the respondents deemed videoconferencing to be inferior to traditional methods. Since this was the first time most of the lecturers or students had used videoconferencing or other teledentistry equipment, it was clear that initial problems due to inexperience were bound to arise. Overall, however, the performance of the technology was adequate. The technology also resulted in a greater interactivity between lecturer and students, since the students were for the first time able to display some images of their own patient cases, which was not done during a conventional lecture.

The main effect of the technology implemented during this project was obviously to reduce travel time and expenses significantly, but in addition the trainees were able to increase their much needed dental services in residential clinics. Increasing the use of teledental consultations from rural areas to university clinics and central hospitals would also decrease the need to send patients to these, resulting in further savings.

We have shown that long distance education can be implemented in dental specialist education in Finland by using appropriate technologies. The telemedicine tools have the potential to increase the total number of dental specialist trainees and specialists in sparsely populated areas.

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References

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An analysis of the images attached to referral messages in an email-based telemedicine system for developing countries

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Summary
Little is known about the quality of the images transmitted in email telemedicine systems. The present study was designed to survey the quality of images transmitted in the Swinfen Charitable Trust email referral system. Telemedicine cases were examined for a 3 month period in 2002 and a 3 month period in 2006. The number of cases with images attached increased from 8 (38%) to 37 (53%). There were four types of images (clinical photographs, microscope pictures, notes and X-ray images) and the proportion of radiology images increased from 27 to 48%. The cases in 2002 came from four different hospitals and were associated with seven different clinical specialties. In 2006, the cases came from 19 different hospitals and 20 different specialties. The 46 cases (from both study periods) had a total of 159 attached images. The quality of the images was assessed by awarding each image a score in four categories: focus, anatomical perspective, composition and lighting. The images were scored on a five-point scale (1 = very poor to 5 = very good) by a qualified medical photographer. In comparing image quality between the two study periods, there was some evidence that the quality had reduced, although the average size of the attached images had increased. The median score for all images in 2002 was 16 (interquartile range 14–19) and the median score in 2006 was 15 (13–16). The difference was significant (P<0.001, Mann-Whitney test).

Introduction
The Swinfen Charitable Trust (SCT) has operated a store-and-forward telemedicine referral system since 1999.1 The aim is to provide advice to doctors in developing countries. All specialist medical advice is provided free of charge to the referring doctors by a panel of about 250 volunteer consultants. A valuable component of the process is the medical photographs that are attached to referral messages, since they often provide important diagnostic information.

Digital cameras have become a common item of equipment amongst doctors and are readily available in major cities throughout the developing world. Improving the photographic skills of the referring doctors would enable faster completion of cases, as it could save the consultants requesting a ‘re-shoot’ from the referrer. In some instances, consultant doctors have not been able to provide advice due to the poor nature of the images attached to referral messages. This problem was recognized in 2004 when the SCT published a photographic guide to assist the referrers in improving their photographic technique.2 Copies of the guide were sent to all referring doctors in the network.

Little is known about the quality of the images transmitted in email telemedicine systems generally, or in that of the SCT specifically. The present study was...