Dental Screenings Using Telehealth Technology: A Pilot Study

(Les examens dentaires à l'ère de la télémédecine : une étude pilote)

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Historique

L'étude pilote permettait de comparer les données récoltées au moyen, d'une part, de méthodes d'examens dentaires visuels traditionnelles et, d'autre part, d'une caméra intrabuccale. Les données étaient respectivement regroupées dans un environnement scolaire et transmises à distance par télémédecine.

Méthodes

Aux fins de l'étude, 137 écoliers ont été examinés suivant les méthodes traditionnelles. Deux mois plus tard, 32 enfants ont été sélectionnés au hasard et réexaminés en un seul jour au moyen d'une caméra intrabuccale et de la télémédecine. Les unités de mesure utilisées étaient deft/DMFT.

Résultats

Le fossé de comparaison entre les données récoltées à l'aide des deux méthodes d'examen ne s'est révélé être que minime. Les taux de recoupement entre les méthodes variait de 89 à 100 p. 100.

Conclusion

Dans les régions recluses et mal desservies, la télémédecine peut permettre d'identifier avec précision les troubles bucco-dentaires et servir de véhicule de consultation à distance entre les spécialistes, les praticiens dentaires généralistes, les hygiénistes dentaires et les patients individuels.

Mots clés MeSH : dental care; rural health services; telemedecine/instrumentation

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Le présent article a fait l'objet d'une révision par des pairs.

Introduction

Telehealth is a joining of telecommunications technology with health delivery. Using interactive video, audio and computer technologies as the information transfer platform, medical information can be transmitted over long distances between urban centres and underserviced rural areas.[1]

Through the use of conventional telephone lines, microwaves or satellite link-ups, physicians at a central medical hub can examine and treat patients at multiple satellite locations.[2] Telehealth can be used for situations in which (1) physical barriers prevent the ready transfer of information between the health care professional and patient, and (2) information availability is key to proper medical management.[3]

Much of the framework for telehealth technology is currently in place. Telephones have proven to be economical and reliable for data transmission.[4] Many dental offices are already equipped with intraoral cameras, video monitors and computers,[5] and digital imaging systems[6] are becoming more widespread.

The University of Alberta Telehealth Centre is the collaborative effort of an interdisciplinary health committee. The Telehealth Centre is currently linked to the Two Hills Health Care Centre in eastern Alberta, and steps are being taken to expand telehealth sites to other communities in the province. Many health disciplines including dentistry could make use of this technology in delivering clinical diagnostic services to remote areas that are unaccessed by

Fig. 1: *Dental hygiene students operating telehealth equipment at Two Hills site.*

dental specialists or, in some cases, general dental practitioners.

Many dental public health programs are involved in oral health screenings in school settings throughout the province. This level of programming requires moving equipment and qualified staff to remote locations. It does not allow for direct consultations with dental practitioners since public health dental hygienists or assistants complete this work. As telehealth technology spreads across the province, dental programs could potentially utilize this mode of communication for consultations, diagnostic appointments, data collection and post-treatment evaluation.

This pilot study investigated whether the use of telehealth communication technology and intraoral cameras for completing visual oral health screenings would be comparable to visual screenings in the traditional school setting. Implementation of such technology could potentially reduce the need for highly trained health workers to commute to and from remote areas for purposes of screenings, oral diagnosis and referral. In addition, if images transmitted via telehealth technology correspond to those seen in person, then consultations between specialists in central locations and health care workers in remote areas could be carried out.

Methods and Materials

The University of Alberta Telehealth Centre was established utilizing the LinkCare® System, which was developed by Hughes Training Inc., an Arlington, Texas, company. LinkCare® has a modular design that allows for different levels of equipment and capability that are open, upgradeable and easily integrated. The system ranges from full diagnostic treatment to triage/monitoring, and includes fully interactive audio and video components that transmit consultations, medical databases, real-time ultrasound and moving images (ECGs), heart, lung and blood flow sounds, radiographs, EKGs, EEGs and other diagnostic study records, live video pictures of affected body parts and tissues, and precise still images.

The link between the Telehealth Centre and Two Hills is via telephone lines, although capacity for satellite, microwave and cellular transmission is also a possibility for future connections. A coder-decoder device (CODEC) digitizes and compresses the video and audio signals and transmits images using a relatively small, narrow bandwidth. There are two 20-inch monitors with standard resolution, one for viewing the local site and one for viewing the distant site. The sites are connected by a two-way audio system. Both sites have document cameras with graphic capabilities for presenting still images only and single-chip cameras, which can be panned, tilted and zoomed locally or remotely by a touchscreen controller. The touchscreen controller is used to control all of the operations except the computer. Each site has a VCR, a computer, and diagnostic instruments. A patient camera at the remote site allows for a greater degree of magnification and detail resolution in transmitting live images.[7] The intraoral camera system utilized was the Reveal® system by Patterson Dental.

The subjects for the pilot were children who attended Two Hills Elementary School and who had received parental consent for the regular public health dental screening. A total of 137 children were screened at the school by a registered public health dental hygienist and a registered dental assistant (who acted as recorder), both of whom had been trained by the regional dental officer. This initial screening was to provide baseline data using the traditional method of data collection in the school. The indices used were deft/DMFT. An intraoral mirror, a portable chair and a light source were utilized. Appropriate infection control procedures were followed. All of the 137 children were given a letter of consent for the second screening explaining the purpose of the telehealth screening and the methods employed.

Two months later, the second screening was carried out on 32 randomly selected children in each grade who had received parental consent for the telehealth screening. After time for travel and equipment set up at the Two Hills Health Care Centre, the children were screened using the intraoral camera. Of the 32 screenings, only 27 data results were analyzed as five children had lost teeth in the two months since the school screening, thus altering the deft/DMFT scores from the original screening.

Three dental hygiene students and the regional dental officer conducted the telehealth screenings. One student operated the intraoral camera while another assisted with the children. The same portable light source, intraoral mirrors and infection control procedures were employed as in the school screenings. The images picked up on the intraoral camera were transmitted to the Telehealth Centre, where the same dental hygienist and dental assistant who had participated in the first screening received and

Table I

Screening Results for the Primary Dentition (deft Index)

Number of Teeth	School Screening Number of Children	Telehealth Screening Number of Children
Decay		
0	22	24
1	4	2
2	0	1
3	1	0
To be extracted		
0	23	23
1	3	3
2	1	1
Filled		
0	17	17
1	3	3
2	2	2
4	1	1
5	2	2
6	1	1
9	0	1
10	1	0

Table II

Screening Results for the Permanent Dentition (DMFT Index)

Number of Teeth	School Screening Number of Children	Telehealth Screening Number of Children
Decay		
0	26	24
1	0	2
2	1	1
Missing		
0	27	27
Filled		
0	21	21
1	4	4
2	1	1
3	1	1

Table III

Inter-method Agreement and Reliability for School and Telehealth Screenings

Index Category	% Agreement	Kappa Statistic
Primary decay	89	0.58
Primary to be extracted	100	1.0
Primary filled	96	0.93
Permanent decay	93	0.50
Permanent missing	100	1.0
Permanent filled	100	1.0

interpreted the images using deft/DMFT as their indices.

The telehealth equipment involved two TV monitors (**Fig. 1**). One monitor displayed the camera image being sent to the other location and the other monitor displayed the image being received from the distant site. Audio communication was also available. All verbal communication was clear and understandable. If any difficulty in visualizing a particular surface of a tooth was noted, requests for the camera to be moved were made by the recorders at the Telehealth Centre.

The results of the first and second inspection were compiled through a spreadsheet, charting both the deft and DMFT. The score and number of errors were analyzed for percentage agreement. Chi-squared tests indicated that there were no significant differences between the two screening methods, and statistically, the results were similar.

Results

The initial baseline data obtained from the visual oral health screenings in the school were compared with data obtained from the telehealth screenings for primary tooth decay, primary teeth needing extraction, and primary restored teeth (deft index), and for permanent tooth decay, permanent teeth missing due to caries and permanent restored teeth (DMFT index). Only small variations occurred between the two methods (**Tables I** and **II**). Chi-squared tests were used at $p<0.05$. The groups showed no statistically significant differences.

Kappa statistics[8] were applied to the data to determine agreement in excess of that expected through chance (**Table III**). Perfect agreement existed for the three categories of primary teeth to be extracted, permanent teeth missing and permanent teeth filled. For both the primary and permanent teeth with decay groups, the kappa statistic showed moderate agreement, and for the group in which primary teeth were to be filled, the agreement was very good. The percentage agreement between the traditional school visual screening and the telehealth screening was very close, and in those areas where variation occurred, the kappa agreement showed moderate to very good agreement.

Overall, the screening results between the traditional and telehealth methods of performing dental screenings were similar, with no difference found in the areas of detection of primary teeth to be extracted or filled, and permanent missing teeth.

Discussion

Though not new to medicine, telehealth technology has not become part of every day health care or dentistry. Technical immaturity, economic feasibility and legal considerations may be partly responsible for its restricted role. Cost-effectiveness is also an important consideration in evaluating its potential use. Capital equipment costs for the telehealth system are very high and will vary from facility to facility. The cost of the LinkCare® System, which can have many equipment configurations, can range from approximately $40,000 to $130,000. For dental screenings to be cost-effective using this system, it would likely be necessary for the telehealth infrastructure to be already present. Alberta Health is currently considering expanding the telehealth equipment to more sites within the province, which would allow a "piggyback" effect for completing dental consultation and screening services without having to purchase and install equipment solely for that purpose. If a health facility or clinic purchased telehealth equipment, then the capital costs could be passed on in the form of user fees for the clinicians or groups utilizing the equipment.

This study showed that a number of factors contributed to the cost of each process. Both types of screenings involved a team consisting of a dental hygienist and a dental assistant. Extra personnel were required at both the school and the telehealth facility to help with getting the children to and from the screening site. Set-up time was similar in both settings. Although the telehealth screening time per child was initially a little slower, experience with the system eventually allowed for the two types of screenings to take about the same amount of time.

There were, however, differences between the two methods that would impact on any cost-benefit analysis. The school dental screenings involved the cost and time of travel for the dental staff to go to the school. For the telehealth screenings, the costs involved transporting the children from the school to the health facility (which in this case were assumed by the school), the cost of having a trained person operating the intraoral camera (which may or may not be a person with dental training), and the cost of using the telehealth equipment.

There was no cost to the public health dental program for utilizing the Two Hills Health Centre equipment, as both groups belong to the Lakeland Regional Health Authority. If a system were to be used on a regular basis, and the capital and transmission costs factored into any user fees, then the investment would eventually be covered. Hopefully, the individual cost of using such equipment would not be too prohibitive. Further studies are needed to investigate the very real issue of the economic viability of this technology.

The merits of the telehealth screening method include the fact that it is a potentially mobile system that can be manipulated by trained, non-dental personnel. The telehealth system also allows for clear communication of visual and audio data over great distances, all in real time, thereby significantly reducing travel time and costs for both practitioner and patient. (It can also accommodate patient assessments, history taking, transmission of digital data, radiographs and stilled images, either in real time or on videotape for later use.) The technology could also be used for real time, pre-authorization for dental insurance benefits.

Potential weaknesses of this method include the cost of equipment, especially in start-up cases. As well, for clinicians unaccustomed to using an intraoral camera, some preparation time and practise in visualizing the teeth and oral cavity is required. Training of the distant health care worker in the use of the intraoral camera is also necessary. It was noted, for example, that care needs to be taken during the transmission of the visual image to ensure that correct colour tone and brightness are achieved. Furthermore, if the screening is to be completed without the use of explorers, there will be an accompanying loss of detail in the data recorded as no tactile information will be transmitted. The system was found to be most effective in identifying missing and filled teeth, probably because these two areas are easily visualized and do not require tactile sense to detect. Another reason for this may be that there were very few teeth in these index categories. The percentage agreement in these categories was predominantly on sound teeth. Less agreement was observed in the detection of decay.

No explorers were utilized in the study. It is possible that the dental hygienist was so accustomed to using an explorer for detecting decay that she found using only visual detection less definitive or reliable than detection using tactile sensation. In addition, visual detection of decay may have been hindered due to the unfamiliarity with intraoral viewing of teeth. These factors could have introduced variability in the recording of carious lesions and would have potentially decreased her intra-examiner reliability. If concern existed in a clinical setting about the loss of detailed diagnostic information as a result of not having the remote inspections completed with the use of an explorer, both digital radiographs and standard films could be easily transmitted to enhance the information being collected.

The population pool of the study was small due to time constraints on that school day and to the fact that five children out of the 32 had lost some of their teeth, which impacted on their deft score. Their inclusion in the study would have inappropriately reduced the statistical accuracy of the telehealth screenings. In retrospect, it would have been prudent to reduce the time interval between the first and second screenings to avoid the potential for change in the deft/DMFT status as a result of exfoliation or dental treatment.

Conclusion

This pilot study indicated that the data collected using the telehealth system was similar to that of the traditional, intraoral visual screenings currently completed in public health dental programs. The telehealth system enables reliable, remote observation of oral conditions such as decayed, missing and filled or extracted teeth. It is used to transmit oral images to dental hygienists, dentists or specialists in urban centres for consultation or educational purposes (for example, communication with dental students in satellite locations). Although digital imaging is becoming more widespread and available in dentistry, the use of telehealth technology in remote dental screenings will depend on the existence of telehealth equipment throughout the province. The extensive cost of establishing telehealth sites will require financial support and a utilization across a broad spectrum of health care disciplines. Although networking of this technology may require some initial cost and implementation time, once fully developed, the system could offer a simple and reliable alternative to remote dental care. ■

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