Telesurgery information management systems in university hospitals of Tehran

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ABSTRACT

This is a descriptive study with research population coming from "telesurgery information management systems" in 23 teaching hospitals of Shahid Beheshti and Tehran universities of medical sciences in 2011.The study used stratified and simple random sampling methods for subject selection, followed by observation and interview for data collection. According to the results, video camera with 100% application, was the most frequently used equipment in the hospitals for telesurgery data gathering. Visual data analysis for developing three dimensional models was common just in 10% of hospitals. Fiber Optic and satellite, with 40% application rate, were the most frequently used telecommunication equipments in the hospitals**.** The study indicated the significance of accurate and appropriate management of telesurgery information as the first step for appropriate implementation of telesurgery programs in Iran.

Keywords: Telesurgery; Information Management; Telesurgery Information Management

INTRODUCTION

In surgical operations, medical staffs require rapid and safe diagnosis for operation plans, and surgical treatments. This is accomplished by using various kinds of data, such as vital sings, patient records, and communication among the staff that can be collected from the operating field itself. Meanwhile, issues like data acquisition, storage, transfer, processing and display form the basis of telesurgery [1] in which the surgeon is not at the patient's immediate site. Instead, he/she uses tele-electronic devices to visualize and manipulate the operation site. The ultimate goal of telesurgery is to make surgical expertise available to patients who, for whatever reason, are inaccessible; for example, it can be appropriate for patients who may be located somewhere far from the surgeon (as in a remote rural area or the outer space), or for those who may be in a hazardous environment (as a battlefield or the scene of a nuclear accident). It may also be used when there is some other forms of barrier or danger that could affect the surgical team (e.g. radioactive contaminations or contagious diseases), or when the surgical team themselves may pass some risks to the patient to be operated (as an immunodeficient patient) [2].

The traditional operating room (OR) was purposefully isolated to limit disturbing factors such as traffic, infection, distractions to the surgeon, and invasion of patient privacy. This isolation also implied limited access to outside consultants, information resources or records systems, making it difficult to record and chronicle the surgical events in the order of their happening. Currently, telemedicine, telecommunication and information tools abound in many hospitals. The OR can import images, library citations, old records or medical advices. With the expansion of laparoscopic surgery, the OR has superb cameras to capture the surgical events in digital format. The image can be readily transmitted to other digital devices for consultation in the OR, thereby enabling the consultants to see exactly what the

surgeon is seeing; they can accordingly engage in meaningful dialogue with the surgeon and send text or visual materials to aid the primary surgeon [3]. It is now possible to harness all the information flux in an OR to enhance intra-operative safety, using fully automated data recording devices serving as computerized decision support tools. Integration of streamline data for easier access of the clinician will decrease redundancy, improve information access and enhance patient safety. There is an opportunity for a new layer of software to communicate with various systems to provide necessary information for the physician or other healthcare workers at any time, from any location and in any format necessary to support the safety mandate in the OR[4]. The purpose of Surgical Care Information Management System (SCIMS) is to provide a model for recording approaches to surgical practice in the operating room. This system allows comprehensive documentation of surgical technique into an electronic record with real time integration of multiple data inputs within the operating room. Electronic recording of a surgical procedure includes multiple video views, audio notes and a deconstructed procedure tree which are collectively synchronized with a central clock. The system considers the capability for integrating the software system with a user-friendly software interface to capture and archive all actions taken by the primary surgeon during a standard surgical procedure. The Surgical Care Information Management System (SCIMS) development has therefore been undertaken with a user-centered approach to create a system that mirrors the actions of the surgeon and documents these actions [5]. The vital role that information plays in ensuring the provision of quality health care is obvious [6]. It plays a key role in providing appropriate therapeutic services to patients, and pursuing the goals of health care departments. For this reason, accurate and methodical management of information, including telesurery data, is of particular importance.

So bearing in mind the significance of telesurgery in promoting surgical care, on the one hand, and the fact that the issue of telesurgery information has been left unattended in Iran, on the other, current study was carried out to investigate the status of telesurgery information management systems in university hospitals of Tehran. The results are expected to be of special importance to those in charge of patient care, including hospital managers, surgeons, and medical informatics experts. The results can also help to improve the current processes and to develop efficient methods of information management nationwide. The adoption of suitable methods of information management in telesurgery will promote patient care processes and service quality resulting in the submission of better care by health care providers which entails surgeon satisfaction.

MATERIALS AND METHODS

The study as a descriptive piece of work chose its research population from "Telesurgery information management systems" in 23 teaching hospitals affiliated to Beheshti and Tehran Universities of Medical Sciences in 2011.

The study adopted stratified and simple random sampling method. Data collection was done by observation and interview using a checklist. A number of descriptive statistics was used to analyze of the data.

RESULTS

Data elements such as the name and description of procedures together with preoperative, intra operative and postoperative diagnoses were documented in all hospitals. Other data elements, as can be seen in table 1, were also documented in 70% of hospitals. The findings of the study performed in hospitals with telesurgery technology are presented in table one. As for data processing, it is necessary to indicate that most of the hospitals in this study used surgical classification system such as ICD-9-CM in order to analyze their telesurgery data. Also, according to the results, coding and classification of the procedure was done in all hospitals. In 100% of hospitals surgeons analyzed the data from a distance to make more informed decisions. Nonetheless, the analysis of visual data for making three dimensional models was common in just 10% of the hospitals [table 2]. All hospitals in this study used real time and "store

and forward" methods for transferring their telesurgery data [table 3].

Table 1. Frequency distribution of hospitals in relation to the collected data on telesurgery information system

Types of Data	Frequency	Percent
Patient demographics data	8	80
Health care providers' demographic data	7	70
Anesthesiologists' demographics data	8	80
Procedures' name	10	100
Description of procedures	10	100
Pre-operative diagnosis	10	100
Intra-operative diagnosis	10	100
Post-operative diagnosis	10	100
Estimates of blood loss	7	70
Tissue samples taken	7	70
Data about sutures and bandages	8	80
Data on complications during surgery	8	80
Data about results of surgery	8	80
Data about patients' status in recovery room	7	70
Pharmaceutical data	9	90

Table 2. Frequency distribution of hospitals in relation to the data that had been stored in telesurgery information management system

Types of data analyzed Frequency		Percent
Analyzing data to achieve diagnosis from a distance	7	**70**
Analyzing patients' images to create three-dimensional models for a preplan design in a virtual field	1	**10**
classifying and coding the data on operations using medically oriented classification systems	**10**	**100**

Table 3. Frequency distribution of hospitals in relation to different ways of transferring information in a telesurgery information management system

Ways of transferring information	frequency	Percent
Asynchronous transfer method (transfer after storing information)	10	100
Real time transfer	10	100

Regarding hardware and software equipments which can be used for telesurgery data management, all hospitals, according to the results, used microphone for recording oral data while 80% of them used video cameras and 10% adopted tools like telephone, computer, PDA and laptop. The laparoscope technique was adopted in 50% of hospitals under study. None of the hospitals under study used other equipments such as tablet computers, data glove and helmet mounted display (HMD) [table 4]. About the equipments used for telesurgery data analysis, 90% of hospitals in this study had adopted ICD-9-CM classification system for coding surgical procedures. Computer Aided Design or Computer Aided Manufacture (CAD/CAM) was used only in 10% of the hospitals. Other data processing tools such as Computerized Integrated System (CIS), Health Common Procedure Coding System (HCPCS), Systematized Nomenclature of Medicine (SNOMED) and Operational Procedure Coding System (OPCS) were not used in any of the hospitals under study [table 5].

Table 4. Frequency distribution of hospitals in relation to various tools used for data collection in a telesurgery information management system

Data gathering tools	Frequency	Percent
Telephone	5	50
Fax machine	1	10
Scanner	2	20
Digitalized camera	4	40
Video camera	10	100
Microphone	8	80
Personal digital assistance(PDA)	5	50
Personal computer	7	70
Voice recognition system	2	20
Hand writing reorganization system	0	0
Document camera	2	20
Tablet computer	0	0
Laptop	5	50
Helmet mounted display(HMD)	0	0
Data Glove	0	0
Laparoscope	5	50
Robotics arm	1	10

Table 5: Frequency distribution of hospitals in relation to hardware and software facilities used for processing data in telesurgery information management system

Data processing tools	Frequency	Percent
Computerized Integrated System(CIS)	0	0
Computer Aided Design- Computer Aided Manufacture (CAD/CAM)	10	100
ICD-9-CM Classification System	9	90
ICD-10-PCS Classification System	1	10
ICD-10 Classification System	10	100
Health Common Procedure Coding System(HCPCS)	0	0

The hospitals under study used telecommunication media such as Fiberoptic, digital subscriber lines (DSL), in order to transfer data. 40% of hospitals used satellite facilities, 30% adopted leased line media and internet connections. 20% of hospitals used wireless networks in order to transfer telesurgery data.

Besides, 10% of hospitals used Integrated Services Network (ISDN), Local Area Network (LAN) and Radio Frequency (RF) while 20% of them adopted Voice Over Internet Protocol (VOIP). None of the hospitals, however, used other media facilities such as Coding and Decoding (CODE) software or telecommunication technologies such as public switch telephone network (PSTN) or integrated digital system network (ISDN), Microwave, Geographical positionary system (GPS) and Infrared and Geographical mobile system (GMS) [table 6].

Table 6. Frequency distribution of hospitals in terms of type of facilities or hardware and software equipments used to transfer data in telesurgery information management system

Data transferring tools	Frequency	percent
Fiber optic	4	40
Public Switch Telephone Network (PSTN)	0	0
Integrated Service Network (ISDN)	1	10
Digital Subscriber Line (DSL)	2	20
Microwave Frequencies	0	0
Radio Frequency (RF)	1	10
Infrared Technology	0	0
Geographical Mobile System (GMS)	0	0
Local Area Network (LAN)	1	10
Satellite	4	40
Internet	3	30
Wireless Network	2	20
Voice Over Internet Protocol(VOIP)	2	20
Coding and Decoding Software (CODE)	0	0

Video transferring (H221, H230, H242) and sound transferring standards (G711, G722, G723) were practiced in 40% of the hospitals. Text transferring standards between device information systems (HL7), and digital imaging and communication in medicine (DICOM) were used in 30% of the hospitals. Nonetheless, the hospitals under study failed to use other standards such as text transferring systems (T120), national council for prescription-drug programs (NCDPD), health industry number (HIN), national provider identifier (NPI), universal physician identification number (UPIN) and universal healthcare identifier number (UHIN) [table 7].

Table 7. Frequency distribution of hospitals in terms of the application of various standards on collecting, processing and distributing telesurgery information in telesurgery information management system

Standards	Frequency	Percent
Transmission control protocol / Internet protocol (TCP/IP)	7	70
H series Standards (H221,H230,H242)	4	40
G series Standards (G728,G722,G711)	4	40
Health level 7 Standards (HL7)	3	30
Digital Imaging and Communication in Medicine (DICOM)	3	30
Joint Photographic Expert Group (JPEG)	2	20
Motion Pictures Experts Group (MJPEG)	2	20

DISCUSSION

Proper management of data would enable the physician to obtain rapid access to necessary information. The significance of "Telesurgery information management" in collecting, analyzing, storing, and retrieving information is pretty obvious. Effective telesurgery information management, using scientifically approved standards, could help to process a large volume of telesurgery data successfully.

Medical information on telesurgery is available in digital format. Patients' medical information may be of the following types: text, voice, still image [e.g. X-ray, computed tomography (CT),

Magnetic Resonance Imaging (MRI)], and dynamic videos. Thus, it is essential to design a medical information database for managing a huge amount of heterogeneous data [3,7].

Owing to the fact that paper forms cannot comprehensively reflect all surgical services which are delivered by the health care professionals, telesurgery information is provided in multimedia forms (sound, image, text). Indeed the development of a multimedia database is a prerequisite for proper management of telesurgery information. A database developed this way could form an integral part of electronic health records registering all events which happen in operating rooms. Unfortunately, however, there have been no serious attempts by health authorities to adopt suitable strategies for telesurgery multimedia data collection in the hospitals under study thus far. Hence, creating electronic database for storing and archiving surgical data, using EHR, is essential. The need for developing such databases becomes more obvious if it is born in mind that the hospitals under study did not have any suitable database for storing talesurgery data despite their undeniable significance for diagnostic purposes.

As for telesurgery data processing, it is necessary to indicate that statistical classification of data on surgical procedures in telesurgery operations is one of the important data processing activities. As such, coding and classification of telesurgery data play a crucial role in achieving educational, managerial, research and reimbursement goals. Another issue which needs to be referred to in this stage is analysis and interpretation of telesurgery data. This can upgrade data by transforming them into a type of information that is more appropriate for telesurgery programs.

Telemedicine and telesurgery mainly deal with transmission of information which is mostly provided to satisfy a specific request [e.g.in diagnosis or clinical management][8,9].Thus, all patients' multimedia diagnostic data will be sent to experienced surgeons, located far away, through telecommunication pathways. Then, experienced surgeons will analyze the received data, and send back his or her recommendations in special diagnostic information formats. This method is appropriate in sharing and disseminating newest scientific information and rare surgical procedures, mentoring coworkers and fulfilling educational purposes. As telesurgery technology in Iran is commonly used for telementoring and teleproctoring reasons, the analysis of diagnostic data was performed in most hospitals under study.

Visual data processing, construction of three dimensional models and development of visual preplans, as different processing methods, will provide the physician with the opportunity to practice their surgical procedures virtually before performing the true operation. This could minimize physicians' errors when carrying out the real surgery in the operation rooms. Nonetheless, according to the results, such methods were used in just 10% of the hospitals using CAD/CAM systems. Although the capability of CIS systems in model making, in pre, intra, and post- operative data collection and in patient care management has extended significantly in many countries, such systems have not been used in Iran yet.

CIS and CAD/CAM systems transform preoperatively collected image data and other information such as statistical anatomical atlases and pre-existing surgical plans into computer models of individual patients; thereby, assisting clinicians in developing an optimized interventional plan. Next, the patient is brought into the operating room and the interventional plan is also transferred to the central computer controlling and overseeing the procedure in the operating room. New images are collected about the patient and the CIS combines this data with the preoperative plan. The actual surgery may begin once the refined surgical plan is ready [9,10].

Regarding the hardware and software equipments which are needed for managing telesurgery information, a variety of technologically appropriate tools are generally needed to perform telesurgery. As mentioned before, telesurgery technologies in Iran are mostly in teleproctoring and telementoring forms. Data transferring in telementoring can be performed by telephone, fax machines [9,11,12,13] and scanners [9] in most simple forms, or it can be performed by the email [14,13] and in the most advanced condition it can

be implemented by equipments such as videoconferencing systems.

However, in most hospitals under study, equipments such as ordinary microphones, video cameras, video projectors and TV sets were used instead of more appropriate tools such as high definition video conference devices, mainly for financial reasons. However, according to numerous studies, equipments such as standard video conference systems, video cameras, microphones, TV monitors and telecommunication tools such as ISDN and CODEC software [7,13,14 ,15] and microphones [13,16] are necessary in telesurgery technology programs. PACS system [15,17], MPEG [13] and VIOP and the EHR software [3,13,14] are some other tools that are commonly used in telementoring programs. In this study, however, most of the hospitals did not follow the necessary standards in selecting appropriate equipments. About telerobotic telesurgery, we should acknowledge that today telerobotics systems have been designed in such ways that they can gather all required information in the operating room. This system acts as an information system. Efforts to integrate this system with EHR are undertaken in an attempt to complement telesurgery information management system. More recently developed prerequisite tools for successful execution of telesurgery telerobotics systems are as follows: cameras for three dimensional images, infrared based video cameras, ultrasounds, X-rays devices, MRI [18], high definition monitors for real time display of movies [19], microphones [19,20], speakers [16,19,20], consoles (for controlling the robots), voice recognition tools [19,21], computers [19], web browsers, EHR software [3,9,14,13], CAD/CAM system, CIS [22], three-dimensional cameras, laparoscope, different kinds of Andescopes [9,12,15,17,18,19,23], videoconference devices [7,15] and Wotesta/Winivicos systems [24] form different varieties of telesurgery tools among which Telesurgery and telerobotic technologies are still at their infancy in Iran, without being implemented as actual telerobotic telesurgery. However, designing of the robolenz surgical system, as a surgical robotic assistance system, by Iranian researchers, is an example of scientific endeavors in fulfilling our telesurgery goals in future.

This system is equipped with laparoscope, control by pedal and voice recognition systems. In order to enhance quality of telerobotic programs, the audio or video data captured during this program in operative rooms should be displayed in real time form for expert surgeons whose workstations are located at a distance far away. In this method, the provision of sufficient band width would be an important requirement.

So adapting and using appropriate telecommunication medias such as ISDN [11,13,15,17,20,24] DSL [1,11,25], satellite [1,11,13,14,17,20,25] , mobile phone [5,9], microwave [11,24], GSM/GPRS [9,24], for its sufficient band width, and also high speed data transferring devices, are significant steps in executing telesurgery programs in Iran. In addition, when more advanced telesurgery programs, such as the actual telesurgery practice, are introduced, data transfer speed would become more important. Otherwise, the issue of delays in sending or receiving audio-video data will be raised. Such delays can be very dangerous with irreparable aftermath for patients in the operating rooms. Application of standards can serve as suitable criteria for measuring healthcare quality. Moreover, in order to establish a suitable link between different software developers and the business, similar standards are required.

The adoption of telemedicine and telesurgery would involve the application of numerous standards, such as H261, H221 and H242 for video data transfer, G series standards [G711,G722,G728] for sound data transfer, JPEG, MPEG and T120 standards for text data transfer, HL7 for data exchange [17], digital imaging and communication in medicine (DICOM) [9,17,22] and ACSX12N[6], national council for prescription drug programs (NCDPD), national provider identifier (NPI), health industry number (HIN) and universal physician identification number (UPIN) [26].

It is accordingly important for the officials to get familiar with such standards and have them implemented in their affiliate hospitals.

Developing good standard frameworks, providing necessary facilities for their use and obtaining hospital compliance for their execution are some essential steps for proper implementation of telesurgery technology programs in Iran.

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