Offshore Telemedicine

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Abstract

Telemedicine can be defined as the use of electronic media for the transmission of clinical data and information from one location to another, considering the strong application of information technology and telecommunications, in order to provide timely clinical health care at great distances. This new approach can link specialized medical service centers in Brazil with offshore oil production facilities. The importance of the right health diagnosis taken at the proper time will make a serious difference in the operation of the facilities which will be located around 300km from land.

The great advantage of telemedicine is the fact that this technology radically transforms the distribution of health education and the practice of medicine, simply by eliminating the distance factor. Moreover, it represents a greater reliability in the diagnosis of offshore patients through real-time video-conference and data collaboration for expert interpretation. This paper presents an overview of telemedicine, its different applications, comparing them according to the level of maturity and applicability. Important results from a case study in a fixed oil platform are analyzed. At the end of this work, the strategy of telemedicine implementation in a Brazilian petroleum enterprise is discussed.

1. Introduction

Covering more than 352 square kilometers, Santos is the largest marine sedimentary basin in Brazilian waters, stretching from the southern coast at Rio de Janeiro and running northward to Santa Catarina State. Within this area, there are nine oil and gas production facilities and one onshore gas processing plant. Two fixed production units and FPSOs (Floating Production Storage and Offloading) are located some 300 km off the coast. These production units have approximately 100 people on board each unit. In emergency situations, injured workers must have medical attention that includes specialists. Assessment and evacuation of patients to appropriate medical care at hospitals onshore takes time, and delays may be crucial to their recovery. Decisions that impact the health of patients should be made quickly. In this scenario, there is a need to have a structured telemedicine system and partnerships with specialized Brazilian hospitals.

Offshore platforms do not have doctors. An injured or ill worker may have to wait a long time for a diagnosis and treatment because transport of a physician to a platform can take several hours. It is also difficult to provide the medical service infrastructure on these offshore units. Recruiting the proper medical professionals to work in such an environment is challenging.

Telemedicine is a familiar subject in the oil industry which has used videoconferencing for medical purposes for a long time, but without the integration of medical devices. It can be defined as the use of information technology and telecommunications as applied to three tasks traditionally performed by physicians and other health care professionals: clinical care, education and biomedical research. In a broad sense, telemedicine can provide health care when patients and providers are physically or temporarily separated. It is the use of medical information exchanged in real-time from one site to another via electronic communications that can benefit the health status of patients. Closely associated to telemedicine is the term “telehealth”, which is often used in a broader context for remote health care, and it may not involve patient examinations. Videoconferencing, the transmission of still images, e-health which may include patient portals, remote monitoring of vital signs, continuing medical education and nursing care centers are all forms of telemedicine and telehealth.

Telemedicine is not a medical specialty, but a means of providing care. Products and services related to telemedicine are often part of a larger investment by health institutions. Telemedicine encompasses different types of programs and services provided to patients. Next, some

applications, mechanisms, types and operating concepts of telemedicine will be discussed.

2. Context of Telemedicine Applications

Because most medical professionals are located in cities and towns, telemedicine applications play an increasingly important role in health care for people in remote locations. They can cover a full spectrum of advances in clinical care and management of electronic health records. They offer indispensable tools for home health care, remote patient monitoring and disease management, not only for rural health and disaster care, but also for nursing homes, assisted care living facilities, and maritime and aviation settings. Special emphasis is also placed on the outcome and impact of telemedicine on the quality, cost effectiveness and access to healthcare.

2.1 Telemedicine Services

A referral to specialized services typically involves a specialist helping a general practitioner in developing a diagnosis. This could represent a live, remote consult between a patient and physician, or it could be the transmission of diagnostic images and/or video along with patient data to a specialist for analysis at a later time. Recent research has shown a rapid increase in the number of specialty areas and sub-specialties that have successfully used this telemedicine approach.

Radiology continues to make greater use of telemedicine with thousands of images “read” by remote providers each year. Other main areas of expertise include: dermatology, ophthalmology, mental health, cardiology and pathology. According to reports and studies, nearly 50 different medical specialties have successfully used telemedicine.

Telecommunications can provide medical data, which may include audio, still images or live video, between a patient and a health care center for use in diagnosis and treatment plans. As an example, this could be to connect a remote clinic and a doctor's office through a direct transmission link or may include communication over the Internet.

Patient monitoring can use devices to remotely collect and send to a station for interpretation. These applications may include specific vital signs, like ECG, blood pressure, or a variety of patient variables. Such services can be used to supplement the work of nurses.

Continuing medical education provides credits for health professionals and specific medical seminars for targeted groups in remote locations. Consumer health information includes the use of the Internet to get the proper health information specialist and to create online discussion groups to provide support.

2.2 Telemedicine Mechanisms

Network programs connect hospitals and third-party care clinics with peripheral institutions and community health centers in rural or suburban areas. Locations can use dedicated high-speed lines or Internet telecommunications to connect. These programs can provide patient care services on a daily basis that are occasionally used for patient care and mainly for administrative or educational use.

Hospitals and clinics often use private networks to link locations point-to-point to provide services directly; or, they hire specialized services for independent healthcare providers in outpatient care settings. Telemedicine is delivering services under contract for radiology, mental health and even intensive care.

Primary care or home health care involves connections with primary care providers, specialists and nurses in patients' homes using an interactive videophone system for the clinic visits. Home monitoring center links are used for monitoring cardiac, pulmonary or fetal patients and for providing related services and assistance to patients in their homes. Web-based telehealth sites offer direct customer service over the Internet. These sites provide direct patient care with telemedicine.

2.3 Types of Telemedicine

Telemedicine can be divided into three main categories: live interactive video, transmission of data and images (store-and-forward) and remote patient monitoring.

Telemedicine store-and-forward involves the acquisition of medical data (such as medical images, biosignals, etc.) and the transmission of that data to a physician or specialist to review offline when

convenient. The presence of a provider is not required. Dermatology, radiology and pathology are among the specialties that can utilize asynchronous telemedicine. A properly structured medical record, preferably in digital form, should be a component of this transfer. The main difference between traditional in-person patient appointments and store-and-forward is that the physical examination and medical history are done at the patient end and not by the remote provider. The "store-and-forward" process requires a clinician to rely on clinical information in the form of recorded audio and images instead of a live physical examination.

Remote patient monitoring, also known as self-monitoring or self-testing, provides medical professionals with a way to monitor a patient's health using various devices in the home. Doctors most often use this method to manage chronic diseases or specific conditions, such as heart disease, diabetes or asthma. The devices can provide comparable health information taken during traditional in-person patient visits. They are cost-effective and achieve high levels of satisfaction among patients.

Live interactive telemedicine services enable real-time healthcare visits and may include telephone conversations or online communication between a health professional and a patient in a remote clinic or at home. Many activities, such as the review of a patient's history, physical examination, psychiatric evaluation, and ophthalmology exam can be done via telemedicine as a substitute for an in-person visit.

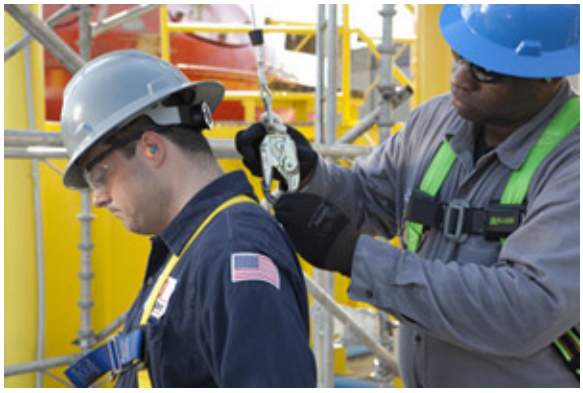
2.4 Operating Concept of Telemedicine

The term "telemedicine" has been associated with videoconferencing and teleconsultation in allowing the exchange of information between doctors and nurses and distant populations at patient care centers.

Today, there are many applications. In one familiar example, a network connection can link doctors inside a large hospital and allow them to videoconference about cases. Such a connection can support medical education programs and the transmission and sharing of images and short videos among providers.

Telemedicine, however, has expanded in scope and purpose to include tele-mammography, tele-ophthalmology and tele-dermatology as practical applications in assessing information about patients, no matter where they are. Proven technologies have overcome the barriers of space and geography and now permit secure access to patient health information outside the presence of a patient.

Some authors consider this area of knowledge to be “information-intensive” requiring greater communication and information-sharing among various partners – patients, providers and producers of equipment and drugs. The use of technology information and telecommunications should designate, under a broader sense, the telehealth concept, as telemedicine is one of its main divisions, and limit it to the field of care services. In a simpler form, telehealth is the delivery of health care remotely in its many forms.



The opportunities related to telehealth are described in a matrix proposed by Goldman Sachs that involves five areas (the five C’s): Content, Commerce, Computer applications, Connectivity and Care. In this matrix, the disciplines are considered: those that relate to the concept of telemedicine as a means or a process, not as an end.

In this perspective, telemedicine can be viewed as “virtualization” of the health care sector with a total focus on providing care at a distance, allowing the use of telehealth applications that can streamline the management and delivery of health care.

On the other hand, telemedicine was the starting point of the use of telecommunications service of care. Internet connectivity has broadened the use and importance of information technology and telecommunications to unimaginable levels.

Therefore, in order to be effective, telehealth should include areas such as health information systems and electronic clinical processes, ensuring two-way communication between providers and patients. It should offer many services and content with implications on the accessibility and quality of care. Telemedicine must make use of computers to support these remote healthcare processes to manage, support and administer care, while training professionals and providing patient information.

In this context, it was very important to adopt a practical approach on the implementation of telemedicine in the studied company. A pilot project strategy was used, as discussed in the following section.

3. Materials and Methods

The method proposed in this paper consists of the implementation of a telemedicine pilot project in an oil company operating in the Santos basin. The approach will involve videoconference capabilities that integrate medical devices, like an otoscope, a stethoscope and an oximetric instrument, in

order to streamline medical care over long distances. The intent of using a telemedicine solution in the E&P (Exploration and Production) segment is to provide remote medical care to all offshore platforms and other remote locations related to the company and studied in this research.
It is not an innovative experiment. The purpose, however, is to bring important answers to questions of broad implementation in the oil operator, considering important aspects such as infrastructure, workflow design, the training of personnel and culture.

Studied aspects:

- Improvement in the quality of medical diagnoses of people on board platforms or remote units of E&P;
- Easier, faster, and more accurate access to the medical information, both in terms of patient history and physical examination of the patient as well as the updating of medical knowledge, enabling better diagnoses;
- Use of videoconferencing with the installed infrastructure so as to obtain second opinions and expert judgment for better patient management;
- Improved screening of patients who need hospital care, reducing the number of helicopter evacuations;
- Standardization of procedures and quality of care;
- Connection with distant doctors, using video cameras with special communication software, sending many kinds of medical images captured through digital cameras or medical devices such as otoscopes, ophthalmoscopes, etc., directly by the system;
- Possibilities of avoiding costly and unnecessary medical displacements.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One important factor to consider is the improvement in the assistance given to victims of accidents or illnesses while on offshore platforms and in areas without specialized medical services. The telemedicine system used by an oil operator will be able to transmit images and audio to an onshore terminal, enabling a distant provider to conduct a clinical examination.

This will include:

- General inspection of the patients;
- Collection of vital information at a distance: blood pressure, pace and heart rate, temperature and pulse oximetry;
- Examination of the head and neck, as well as the ears, nasal passages and the oral cavity;
- Auscultation exams of the chest to hear cardiac and respiratory sounds;
- Examination of the upper and lower static and dynamic members;


TotalExam® 3 Exam Camera

- And, skin exams.

One specific type of telemedicine, called IATV (two-way interactive television), was selected to be used in the pilot-project. IATV is also known as videoconferencing – the real-time communication between two or more actors in clinical practice. It is used when an assisted exam is required. This eliminates the need for the doctor to travel to the patient's location. In this scenario, medical devices, such as an otoscope or stethoscope, will be connected to computers with special software.

In this pilot-project, the main focus was to develop a telemedicine decision support system. The scope of the pilot-project was wider, considering a much larger framework regarding the future use of telemedicine in the O&G industry. With new, integrated technology, telemedicine represents a huge step forward in improving diagnoses when patients are far from medical experts in hospitals. Telemedicine provides decision support systems between "non-experts" and experts. State of the art telemedicine in O&G are decision support systems that focus particularly on the diagnostics through the use of conferencing systems and workflows. The quality of medical images containing this important information is essential.

In the future, the oil platforms studied in this research will implement an optical network system. Until then, one of the challenges to using telemedicine in this scenario involves the telecommunications structure, currently served by satellite and radio links, with intrinsic characteristics of latency that can influence the quality of images.

The pilot-project results are presented in the next section.

4. Results

The results of the pilot-project showed important medical achievements. It proved clinicians could make diagnoses at an onshore hospital with the medical information and images received from the platforms. During the pilot, 124 calls were received in a period of 65 days, an average of 1.9 visits per day, through videoconferencing connections that were considered acceptable.

The diagnosis workflow for using the video link information and medical data in real-time has been established. Both the offshore HSE team and the onshore doctors and specialists in the hospital were comfortable with this collaborative operating model. The ideal workflow between the offshore HSE staff and the medical team on duty was designed to focus on data transmission and images for decision-making by medical experts in the hospital.

Details of the designed workflow are presented below. The telemedicine pilot proved to be a starting point for defining an important service model for the operation of the oil platforms in the studied company.

4.1 Innovation

The strength of this pilot-project was very much dependent upon the involvement of a strong and knowledgeable stakeholder team: hospital experts, HSE personnel, and the doctor on duty (from the company). Their joint effort was essential to obtain the results in the pilot. All entities were motivated to form a strong working group with the expertise in medicine and telemedicine technologies.

The findings showed that most of the doctors were comfortable with the data and the technological services available. Before the telemedicine pilot-project, the traditional workflow for an offshore medical session was:

1. A patient is hurt or sick;
2. The doctor on duty (from the company) is called upon;
Using a videoconferencing or phone system, the HSE personnel and patient offshore are connected with the onshore doctor.
3. Discussion/diagnosis on patient health, concluding with the decision to:
    i. Treat the patient offshore;
    ii. Evacuate the patient.

It was possible to change this traditional procedure, working basically on two factors:

1) Availability of new integrated medical devices;
2) Diagnosis performed directly by a hospital specialist.

4.2 Medical Effects

The HSE personnel experienced the benefits of telemedicine through the support provided by hospital medical specialists. During the pilot-project, consultations took place on diagnoses that would not have happened in conventional circumstances without the support of telemedicine. This scenario raises the level of trust in medical services, not only in critical situations, but also in the identification of diseases at an early stage. Several employees involved in the pilot-project said they were very impressed with the medical service available. Offshore HSE staff remarked they saw an improvement in diagnoses, medical

safety and the quality of health care on the platforms.

4.3 Workflow

HSE personnel take care of the health of offshore workers, conducting exams and providing treatment on board the oil platforms with the direction of a doctor onshore. The doctor on duty is responsible for the patients, and in most cases, the problems are resolved. However, the doctor on duty has limitations in some cases that affect the decision-making process and at those times needs the opinions of medical experts for an action plan. A three-way communication was established between the HSE personnel offshore, patients, the doctors on duty and the medical experts at the hospital (Figure 2).

A typical scenario is:

1. Somebody is injured or sick offshore;
2. The doctor on duty is notified;
Using a videoconferencing system, the connection with the HSE representative and the offshore patient is performed with the doctor on duty.
3. Discussion/diagnosis on patient health;
4. Expertise at hospital is brought into the connection:
    a. Images are sent to the hospital;
    b. Communication is established with all parties;
    c. Concluding with a decision to:
        i. Treat patient offshore;
        ii. Evacuate patient.

In the latter case, before moving the patient, the company doctor should be contacted to confirm the diagnosis and whether the patient should be evacuated.

In the pilot-project, importance was placed on the direct communication between the offshore HSE personnel and the hospital medical experts for ease of workflow during the test period. The HSE personnel, as well as the hospital medical experts, expressed that they were very comfortable with the way the collaboration occurred.

4.4 HSE – Health Safety Environment

The HSE team concluded that this approach will improve the diagnosis and the decision made on the patient. The telemedicine service proved to work very well with the new equipment. When the pilot-project ended, there was greater assurance of and confidence in the medical services offered on the offshore units.

Trust is an important issue in health care. The positive response from employees, some of whom were patients, also contributed to the positive perception of the HSE team. Workers recognized the value of equipment used in the pilot-project and the skills of the HSE staff using the new technology. This sense of trust contributed to the overall satisfaction with the medical services offered in offshore units.

4.5 Optimal Workflow

Videoconferencing and real-time data transmission systems are encompassed by the existing telecommunications infrastructure. Geographical distance is no longer a barrier to the practice of medicine. Both the offshore and onshore segments of the company have been great supporters of this initiative.

One of the benefits of this collaboration was the optimization of the medical experts who can assist several offshore platforms. They were used more efficiently, spending only the time needed to solve problems without devoting time to travel. This is a more efficient way to utilize medical services and, in many cases during the pilot-project period, the participation of other experts solved the immediate health care problems of workers.

The best workflow focuses on solving the medical situations in a high-quality, robust program, utilizing the time of distant specialists in the best way possible.

4.6 Decision-Making Process

Medical images may be crucial to the decisions made in the health care for a patient. Medical experts make the best decisions quickly when they have the information they need. It is understood that the service time of a specialist includes not only the time to analyze data and images, but also the access time for the telemedicine system, videoconferencing session and information consolidation that leads to a diagnosis.

The path to good decision-making in a timely manner depends on access to medical information. HSE personnel are at the starting point of the process, and they have a set of devices available to them to gather information. The most important are: an electronic stethoscope, high resolution cameras (for example, one that can be used as an otoscope), and ECG. The data and images produced are critical to experts in terms of the quality of their diagnoses and the decision-making process.

4.7 From Telemedicine in O&G to the Healthcare System

The feedback from the people involved in healthcare interactions is key to the evolution and redesign of the processes and to the identification of additional user interfaces and attributes. The pilot-project also evaluated technology requirements (Figure 3). This includes the ability to capture lessons learned.

The technology was a key determinant in the project's success. Doctors at the hospital had to feel as confident in performing remote diagnoses as they would when they were together with patients. During the pilot-project, participant surveys were carried out after each session. Questionnaires asked for the physicians' perception of how well the technology was working. The results of the surveys will contribute to continuing improvement of the telemedicine solution.

5. Discussion

Some interesting points of discussion are listed below:

- The telemedicine pilot-project proved the technical feasibility, even using the existing communication systems, such as satellite network and radio links;
- In the first pilot steps, there were doubts about the best way to call the hospital's medical specialists – whether it would be done by HSE team members onboard a platform or by the doctor on duty onshore. The results of the pilot-project clarified the process;
- It will be necessary to train all involved in attendance about the technologies of videoconference and the new digital medical equipment;
- Telemedicine improved the quality of the decisions, due to better collaboration between offshore platforms and hospital experts.

The significant improvement in medical safety and health care quality due to this new technology has been verified in offshore installations. It will be necessary to evaluate the perceptions of employees about this new service model using statistical data from emergency issues and data from clinical visits.

The scalability of the solution should also be studied to understand simultaneous assistance to the offshore platforms. This pilot-project did not consider it.

The pilot-project provides a unique opportunity to experience a new operational scenario which will be demanded with the volume service of the oil platforms studied in this research.

6. Conclusion

The consensus among medical staff was that the technology can associate a large hospital as a partner for support of health services, even as the number of people onboard platforms and new production facilities increases, as is the situation the studied company is facing.

The telemedicine approach will improve diagnoses, medical security and health quality in offshore installations. The HSE personnel and the medical experts at the hospital stated they were very comfortable with the cooperation they received during the telemedicine pilot-project.

Even with the limitations of the existing communication infrastructure, it was possible to perform all the services demanded during the pilot, increasing the reliability of offshore diagnoses and improving support for onshore decisions.

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