Evaluation of PACS system with economic interests approach in 5th Azar Educational Hospital in Gorgan

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ABSTRACT: Picture Archiving and Communications System (PACS) enables storage and transmission of medical images electronically in different branches of the Teaching Hospitals. The main purpose of this study is to estimate the direct economic savings and benefits resulting from PACS usage in 5th Azar Hospital. The present study is descriptive, analytical and also cross sectional which focuses on the launch of the new system in teaching hospitals. Among the 14 university hospitals of Golestan Province, 5th Azar Hospital was selected as a pilot and the PACS system was established. Then with the cross sectional sampling of cost in the months before and after the launch of the PACS system in 5th Azar center, significant difference was seen in cost and profitability before and after system startup. This confirms the effectiveness of the system.

After launching a pilot system (PACS) in 5th Azar imaging center in 2013, there was a 75.19 percent reduction in the cost of raw film. This resulted in saving about 10866 Rial for each Graph or CT test.

Key words: PACS, Medical Images, Economic Savings

INTRODUCTION

PACS system facilitates the storage, processing and viewing of radiology images and their associated information for physicians. PACS is responsible for the imaging of limbs and organs. In order to disease diagnosis, several tools are designed and available to physicians. Finally, decision on the methods of diagnosis and treatment can be more effective and successful. Treatment decisions through the observed changes in body will be more different from a decision that was based on the patient's symptoms and statements. Particularly in bone diseases and tumors is important. Therefore diagnostic and measuring tools, quality, number and size of images, the speed of transferring images for physicians and the type of images' archive for rapid availability and re-access, all are important factors considered in medical imaging. Numerous and potential benefits of using this system is outlined in reviewing the scientific literature which including: instant access to vital information that will lead to reduced detection time (in emergency and operating room) and eliminating the associated costs of preparation, storage and eradication of radiographic films or to share images and files among other radiologists and physicians also, storage, transmission, and safe data recovery from databases. The need of using these systems has been doubled among physicians and radiologists according to their benefits.

With the emerge of digital and advanced medical equipment and the tendency of medical sciences to the software movement and also hospitals' need to strive towards integrating healthcare information, paraclinical and especially medical imaging parts have taken basic steps in diagnosis and treatment through using information technologies. Undoubtedly, the effort of software and hardware engineers, systems analysts and medical experts is significant and remarkable in this progress. Many new imaging techniques such as radiography, ultrasound and CT.SCAN have been digitized. Medical Image Archiving and Communication Systems (PACS), is among the most advanced system in this field. PACS is a computer-based picture archiving and recovery system in which the diagnostic images obtained from various imaging techniques can be stored and retrieved into digital images. This system consists of stations for displaying and editing of digital
images inside or outside the hospital and provides physicians access to stored images and thus reduce the dependency of the physician to the radiologist. There are many problems in traditional imaging systems. Besides the physicians, radiologists and patients' discontent due to the quality, quantity, and need for repeating the images, the hospital has encountered challenges in terms of maintenance and cost of the films. The main purpose of using PACS system is to improve efficiencies alongside medical diagnostics capabilities. The use of standards in the maintenance and transmission of images is among the most important goals. In terms of management, the purchase and maintenance costs of these films are significant. Medical imaging systems technology, along with imaging devices has been composed of the number of computers in a network. Specifically is used for the storage, retrieval, distribution and display of images. Actually the medical images are stored in a standard or independent format. DICOM is the most important one. Most images archived and classified via PACS are as followings: Ultrasound imaging, MRI, CT, endoscopy, mammography and X-ray.

The system has been replaced the radiology films' hard-copy archive for medical image management which may be corrupted over time and enhances the capacities of conventional systems. On the other hand, staggering cost of radiology films and their maintenance have always been the most important problems that hospital managers are encountered. By removing films, PACS can reduce the cost of buying them. And by creating an electronic archive, the physical archive is virtually eliminated. For the first time in 1982 in a Medical Imaging Conference (IEEE), a system was introduced which could store, display and transfer photos and other data. It was confirmed the same year by the Radiological Society of America in 1984 was considered by European Radiology Congress (ECR). This system was called PACS. Introduction of PACS system dates back to 1980. But its commercial acceptance lasted until 1990. America was actually the first providers of PACS. 1995 to 2002 had been considered as the PACS' primary reception wave and the producer companies focused on the storage, processing power, network and bandwidth. But from this time onwards, opinions were more centralized into the technical evolution, increasing speed, improving quality and increasing reliability. Nowadays, the PACS system is installed by 1200 to 1500 companies in the U.S that dates back not more than a few years. By the end of 2000, only 342 hospitals were using PACS system in the United States (Huang, 2011) (Lemke) But at the end of 2008 the number had reached to 3928 Hospitals (Tieche et. Al. 2000-2008). Currently PACS system is considered as the heart of imaging center and is responsible for the safe storage of images (Ribeiro et. Al 2012). During recent years some hospitals in our country have attempted to install the system, but still it has not been used effectively and in order to reach the ideal conditions, we can use the experiences of leading countries in this field. The main part of a PACS system is composed of imaging tools. Subsidiary parts of this system include: A secure network for the transmission of patient information, workstation for interpreting and reviewing images and an archive for storage and retrieval of images and reports (Foord, 2001). PACS' benefits for patients are as followings: The more effective physicians' care team in one or more locations, faster access to medical imaging services, Quicker Response, re-imaging reduction and ultimately reduction in harmful radiation dose (Tan et. al., 2010). This system has many potential benefits for physicians as are follows: Improvement the quality of images and 7*24 services, Reduction in the number of missing images (Paré et. al., 2007), no more need for re-imaging, Time Saving, more production of medical images, quicker access to the images and finally Providing better services to patients (Eliot et. al., 2002). In this regard, efficient use and facilitate the work of staff and increasing productivity and efficiency will be achieved through workflow Management. Obviously PACS system does not decrease the duration of interpreting for the radiologist. But one of the most important potential benefits of PACS is the possibility of sending images to another location. And in a survey conducted in 1994, 98% of physicians agreed that the PACS system has resulted in more efficient use of time [Tan et. al.,2010)]. Siege et. al. in 2002 in the United States conducted a retrospective research on non-film radiology in Veterans Medical Center in Baltimore, Maryland for nine years. This approach was successful and yielded significant clinical and economic benefits. The central systems HIS / RIS, PACS as well as communication and image management systems entitled as VISTA were used in this study. Increasing efficiency and improving clinical care were followed ultimately. Integration of therapies with hospital information as well as prescribing is among PACS' benefits. The results showed that PACS integration with patients' electronic records is essential in order to maximize efficiency and clinical effectiveness Eliot. et. al., 2002). Siege et. al. In 2004 published an overview study entitled "Ten years without a radiology film and ten lessons" in the American Journal of radiology. They presented their ten-years old experiences on Radiology without film as well as its benefits and challenges in ten separate sections at the first American National Conference. They also announced that the effects of imaging techniques without film can be examined on radiologists, imaging staff, associated physicians and patients. Ten previous sections were as followings: 1- The positive effects of these techniques is significant. 2- PACS system should not be used exclusively as a replacement for film, taking advantage from the potential benefits of digital imaging is recommended. 3- The key to increasing productivity and saving costs is redesigning the work processes which can be achieved through data integration system. Integrated PACS system will increase the savings considerably. The highest savings was seen in personnel costs. PACS system will be very affordable especially shared among the network of hospitals. Doctors' training will be a little challenging however it will increase the productivity. The
PACS usage may increase the radiology services. PACS system has a significant impact on counseling and clinical relevance. Designing of Radiology rooms is not appropriate with PACS system and doing Imaging Without film (Eliot. et al., 2004). PACS system has been developed for Integration of Imaging Systems in order to provide an easy process for patient care. Distributing patients' images and related information to healthcare providers is one of the main components of this system. In fact, from 20 years ago PACS services have been formed in order to improve and expand the communication between radiologists and clinicians. The impact of implementation of PACS system on the radiation dose received by the patient and cost of the radiology department was examined by a study conducted by Marcel Modrak and his colleague. The amount of radiation given before and after the PACS operation was compared. The obtained results regarding the amount of radiation and expenditure during the operation time is substantial [Modráka. et al.].

MATERIALS AND METHODS

The present study is descriptive, analytical and also cross sectional which focuses on the launch of the new system in teaching hospitals. Among the 14 university hospitals of Golestan Province, 5th Azar Hospital was selected as a pilot one and the PACS system was established there. Then with the cross sectional sampling of cost in the months before and after the launch of the PACS system in aforementioned hospital, significant difference was seen in cost and profitability before and after system startup. This confirms the effectiveness of this system.

Findings

In the present study, the effect of PACS system on the average of spending on radiographic imaging equipment as well as in CT based on patient and stereotypes consumption is the basis for comparison.

Radiology Department

Consumption stereotypes in 5th Azar Hospital in radiology department were 56158 pieces until 1392. Of those 63.1% were used for outpatient and 36.9 % for inpatients. The statistics show that the average consumption of outpatient per month was 2100 patients with the 2951 stereotypical images and about 1728 stereotypical images were used for 773 inpatients. The results have been statistically significant (P-value <0.05). Index of consumption stereotypes in the radiology department for each outpatient and inpatient was 1.41 and 2.24 respectively.

CT Department

Consumption stereotypes in 5th Azar Hospital in CT department were 14710 pieces until 1392. Of those 8547 (58.1%) were for outpatient and 6163 (41.9%) for inpatients. The statistics show that the average consumption of outpatient per month was 596 patients with the 712 stereotypical images and about 513 stereotypical images were used for 350 inpatients. The results have been statistically significant (P-value <0.05). Index of consumption stereotypes for each patient was 1.55.

The total number of patients

The total number of patients referred to departments of radiology and CT in 5th Azar hospital by the end of 1392 were 45, 838 patients. 70868 stereotypes had been used for these patients. In 5th Azar Hospital from April until the end of December 1392 medical imaging was done in the form of analog The PACS system had been launched since the beginning of January until the end of the year. At this time, more requested medical images were provided in digital form and only in some cases analog photography has been used for patients and outpatients. Total of 34,481 patients had been admitted in the radiology department among which 26,253 patients (76.1%) were referred before the implementation of PACS system and 8,228 patients (23.9%) were referred after implementation of PACS system. 11,537 patients were admitted in CT section among which 8220 patients (72.4%) were referred before the implementation of PACS system and 3137 patients (27.6%) were referred after implementation of PACS system. The total cost of raw radiography film was 921,206,000 Rials in year 2013. The amount of 838,476,000 Rails which is equivalent to 91 percent of total credit in that year belongs to the time before the PACS system and the amount of 82,730,000 Rails which is equivalent to 8.9 percent of consumption credit on buying raw materials and films after PACS system implementation in order to prepare the raw stereotype. As was reported, in the first nine months of the year before PACS system implementation the total cost was 83,846,000 Rials and 34,473 patients were admitted. Average cost for each patient was 24,323 Rials. In the last quarter of the year, the total cost of films was 82,730,000 Rials and 11,365 patients were admitted. The average cost for each patient was 7,279 Rials. The cost for each x-ray or CT before PACS system implementation was 15,650 Rials and the cost for each test after PACS system implementation was 4,784 Rials. Reports of purchasing Radiology films, CT scans and patients admitted to hospital shows that, the implementation of this system has a significant effect on reducing the cost of the film.
and despite the increasing number of patients we faced to reduction in the cost of the raw film in the last quarter of 2013 which Resulting in the reduction of 75.19 of the cost. Therefore, with the full implementation of the project at this hospital, the final cost can be reduced to a minimum or zero.

**DISCUSSION AND CONCLUSIONS**

As mentioned in the literature review, there are many benefits in using PACS system. The most important ones are as following: Data Integration, Savings in personnel and Imaging Consumables costs, Networked transmission of images, Greater use of radiology services, more use of advisory services and savings in clinical procedures of primary care. Integration of PACS with patients’ electronic records is needed in order to maximize efficiency and clinical efficacy. Fortunately, our university had reached the same result. In the pilot implementation of the system in 5th Azar hospital, In order to eliminate the influence of the monthly distribution of consumable purchasing, total purchase of consumable items has been considered seasonal and as a result, the cost of purchasing films had a growing trend in the first, the second and the third quarter of 2013 considering the growing rate of market prices. But in the fourth quarter of 2013, after launching PACS system, cost reduction was 75.19 %. However, 75 percent of the system has been installation. The cost of purchasing raw film will be eliminated by fully implement of this system. Findings of other researchers were quite evident in this study. Therefore, differences in this survey are statistical careful review on consumption expenditures and numerical reduction in savings. The average of cost for each X-ray or CT was 15,650 Rials before implementing the system. And the average of cost for each X-ray or CT was 4,784 Rials after implementing the system. This indicates that the average savings per image is 10,866 Rials. Implementation of integrated PACS system along with HIS in all of the Golestan province hospitals is recommended to authorities of Golestan University of Medical Sciences and hospitals. Obviously, the credit allocated to set up PACS system is rapidly reversible in the first year of launching and in coming years, saving over spending naturally will lead to lower healthcare costs. In addition to the direct benefits of this research such as bearing the cost of raw films and related medication, It is worth to mention that researchers through examining the indirect benefits including associated and other personnel costs which make the greater part of the costs of the project and also through buying hardware and software equipment such as diagnostic monitors along with Server and PACS software And can open more windows to the hidden benefits of this new technology.

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<tr>
<th>Total number of patients</th>
<th>Number of patients</th>
<th>The number of consumed film</th>
<th>Cost Thousand Rials</th>
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<td>CT</td>
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**Table 1. Admission and cost of buying film according to the seasons**

![Figure 1. Cost of CT and X-ray film for 5th Azar hospital- Gorgan](image-url)
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