

Impact Evaluation of PACS Implementation in Minia Oncology Center 2019-2021, Ministry of Health and Population Egypt: A Retrospective Study

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Abstract

Background: The Picture Archiving and Communication System (PACS) plays a critical role in modern healthcare by preserving and retrieving medical images. To the best of our knowledge, this study stands as the first of its kind conducted within the Egyptian healthcare landscape, aiming to evaluate the transformative effects of PACS in an oncology setting specifically in the Minia Oncology Center. This study highlights the primary objective of PACS which lies in enhancing the routing, retrieval, and display capabilities of medical images within radiology departments. The PACS acts as a centralized repository for imaging data and reports. The transition from film-based imaging to PACS-based digital systems signifies a paradigm shift in healthcare, leveraging technological advancements to enhance patient care, streamline operations, and optimize resource utilization. **Methods:** Minia Oncology Centers is a governmental center and it belongs to the Ministry of Health and Population at Upper Egypt. It provides a lot of medical, surgical, and diagnostic oncological services for the Minia governorate population. The study involved a comparative analysis of various metrics pre and post-PACS implementation. Descriptive statistics such as means, standard deviations, and percentages were calculated to assess changes in image retrieval times, report delivery intervals, and cost-related variables. **Results:** The results of this study vividly demonstrate the transformative impact of PACS implementation within the Minia Oncology Center's radiology department. The PACS significantly enhanced workflow efficiency, substantially reduced image-reporting delivery times for routine and emergency cases, and notably streamlined patient data management. The statistical assessments conducted, including paired t-tests and chi-square tests, underscored the significance and reliability of these observed improvements post-PACS implementation. This is translated into better patient care and marked cost reductions associated with film-based systems. **Conclusion:** This study provides compelling evidence of PACS's substantial impact on the Minia Oncology Center's radiology department. The system's implementation resulted in improved workflow efficiency, faster image retrieval, and enhanced collaboration among healthcare professionals. The PACS not only facilitated better patient care through improved diagnostic accuracy but also significantly reduced operational costs associated with traditional film-based imaging methods.

Keywords: Picture archiving and communication system (PACS); Radiology department; External communication; Service outcomes; Cost-effective

Introduction

The Picture Archiving and Communication System (PACS) plays a critical role in modern healthcare by preserving and retrieving medical images. To the best of our knowledge, this study stands as the first of its kind conducted within the Egyptian healthcare landscape, aiming to evaluate the transformative effects of PACS in an oncology setting specifically in the Minia Oncology Center. The radiology department at the Minia Oncology Center has demonstrated the importance of PACS which is a tool required in modern hospitals, for the preservation and retrieval of medical pictures, workflow efficiency within the radiology department, and improvement of the outcome of care by ensuring that the patient's health records are complete, correct, and up-to-date. Also one of the major roles of a paperless environment is to ease the process and workflow in digitalized hospitals [1].

Medical images require routing, storing, and retrieving for which the invention of a specialized system such as PACS. It is required to fetch, archive, and process images from one or many sources. In our center, the PACS is integrated with more than one imaging modality such as X-ray, magnetic resonance imaging, computed tomography, and mammography [2].

This system helps users to change picture display parameters such as quality, zoom, and contrast and to compare pictures through a workstation computer. The PACS has become an alternative to traditional film-based imaging since the 1980s due to many advantages such as optimizing image quality and accessibility, improving the connection between clinical units and the radiology department, increasing physicians' productivity and efficiency, decreasing the time of reports and sending radiology reports, reducing the number of lost images, lowering the need to physical space for picture archiving, reducing personnel costs and expenses related to films and relevant chemical substances, decreasing the need for re-imaging and patients' exposure to harmful rays, and reducing the average waiting time for patients [3].

The PACS Solution is a platform consisting of a group of software and hardware components that have been specifically chosen to provide maximum performance and scalability [4]. The primary objective of this study was to assess the impact of implementing the PACS at the radiology department of Minia Oncology Center since its inception in July 2019. We try to evaluate its effect on the subsequent two years after its implementation. The study aimed to comprehensively evaluate the system's influence on improving imaging interpretation, streamlining patient data management, enhancing cost-efficiency, and empowering healthcare professionals with advanced visualization tools to support oncology patient management and facilitate multidisciplinary decision-making [5,6].

Material and Method

Minia Oncology Center Overview

The Minia Oncology Center offers comprehensive medical, surgical, and diagnostic oncological services to the population of the Minia governorate. The PACS implementation passes through three stages, its beginning was in 2019 followed by partial implementation in 2020 with an incomplete setup of available imaging modalities at our center, and then the last stage of full use in 2021. Those stages are only related to technical factors. The study involved a comparative analysis of various metrics pre and post-PACS implementation. Descriptive statistics such as means, standard deviations, and percentages were calculated to assess changes in image retrieval times, report delivery intervals, and cost-related variables.

Our data are collected from both the IT department and the Patient Accounting Unit of Minia Oncology Center.

Impact Assessment of PACS

The PACS implemented a systematic approach to managing patient data, significantly improving the organization and accessibility of radiology reports and images. Enhanced visualization tools allowed for efficient electronic manipulation and enlargement of images for all radiologist users as they showed increased numbers over time.

The PACS facilitated remote access to patient images across different clinical locations, enabling swift patient history analysis and timely treatment onset. This is very beneficial in routine work and emergency cases. The system's computer-based nature significantly reduced costs associated with film, print, ink, and staff salary, promoting economic efficiency.

Results

The center observed an increasing trend in the number of cases across different oncology departments and specialties over the years (Table 1).

Table 1. A number of several different types of cases come to our center per year

Year	No. of oncology new cases	No. of outpatient cases	No. of inpatient cases	No. of chemotherapy sessions	No. of radiotherapy sessions	No. of surgical cases
2019	4540	75222	3279	12819	7963	878
2020	3693	76125	3272	13376	11683	1206
2021	3603	108026	4600	18502	13640	2063

PACS effectively managed and displayed images from various medical imaging instruments, including CT (Computer Tomography), MRI (Resonance Magnetic Imaging), mammography, and plain X-ray (Table 2). PACS implementation has notably streamlined patient data management in our radiology department. Radiologists can now efficiently store, retrieve, and organize patient radiology reports digitally. The system's digital storage capability ensures easy access to reports and images, allowing physicians to manage data consistently.

Table 2. Total number of radiology studies per modality per year

Year	CT	MRI	Mammography	Plain X-ray
2019	11344	5024	1060	4470
2020	8395	4391	2415	5115
2021	13853	6557	1970	4543

CT = Computer Tomography; MRI = Resonance Magnetic Imaging

A substantial increase in the number of radiology users after full PACS implementation indicated system improvement and compliance to adapt to the increased number of users (Table 3). The involved numbers of users are the total number of users within the radiology department in the corresponding year.

Table 3. Number of users corresponding to different stages of PACS implantation per year

Year	PACS	No. of users in the radiology department
2019	Beginning of PACS Implementation	4
2020	Partially use of PACS	6
2021	Fully use of PACS	25

Implementation showcased enhanced efficiency both in routine and emergency oncological cases with t and p values of testing variables (Table 4). The statistical analysis reveals compelling evidence of enhanced efficiency post-PACS implementation. The significant negative t-values and low p-values in image-report delivery times for both routine and emergency oncological cases (-30.02 to -69.4, p < 0.001) underscore a substantial reduction in the time taken to retrieve and deliver critical medical reports. These findings directly correlate with observed outcomes, reflecting the tangible

improvements in workflow efficiency and timely patient care.

Table 4. Image-report delivery time of routine and emergency oncological cases corresponding to different stages of PACS implementation per year with their testing variables

Year	PACS	Image-report delivery time in routine cases (hours)	Image-Report delivery time in an emergency (hours)
2019	Beginning PACS Implementation	72	4
2020	Partially use of PACS	48 ^a	3 ^d
2021	Fully use of PACS	≤ 24 ^{b,c}	1 ^{e,f}

^a 2019 vs. 2020: t stat = -30.02 (p-value<0.0001); ^b 2019 vs. 2021: t stat = -69.4 (p-value<0.0001); ^c 2020 vs. 2021: t stat = -25.57 (p-value<0.0001);

^d 2019 vs. 2020: t stat = -1 (p-value=0.34); ^e 2019 vs. 2021: t stat = -4.81 (p-value=0.0009); ^f 2020 vs. 2021: t stat = -4 (p-value=0.0031);

A significant reduction in the number of printed films demonstrated the efficient system's cost-effective nature, the provided cost numbers are in Egyptian pounds (EL) with t and p values of testing variables (Table 5, Figure 1).

Table 5. Number and cost of printed films corresponding to different stages of PACS implantation per year with their testing variables and cost difference with their percentage

Year	PACS	No. of films/year	Cost of laser/paper film (EL)	Total cost of printed films (EL)	Difference of cost/2019 (EL)	Difference percentage of cost /2019 (%)
2019	Beginning PACS Implementation	41395 *	12	496740		
2020	Partially use of PACS	7214 *	12	104895.75	391844.25	78.9
		3491 **	5.25			
2021	Fully use of PACS	7036 **	5.25	36939	459801	92.6

* laser film; ** paper film;

No of films/year (all films): 2019 vs. 2020: t-stat=-82.45, p-value<0.0001; 2019 vs. 2021: t-stat=-94.32, p-value < 0.0001; 2020 vs. 2021: t-stat=-47.73, p-value<0.0001;

Total cost of printed films: 2019 vs. 2020: t-stat = -302.75, p-value<0.0001; 2019 vs. 2021: t-stat=-428.55, p-value<0.0001; 2020 vs. 2021: t-stat=-81.64, p-value<0.0001

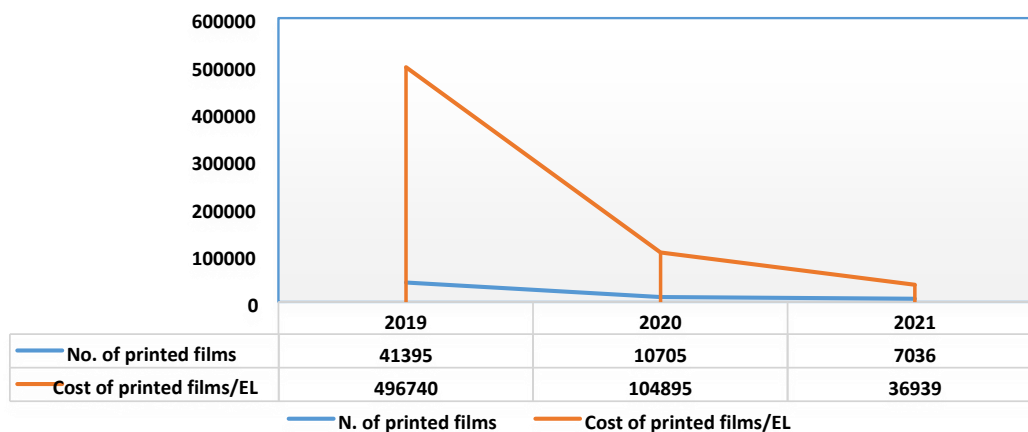


Figure 1. Coast effective value by reducing the number and cost of printed films

PACS enabled a comparative analysis of previous imaging modalities for improved patient

outcomes in both CT and MRI studies as examples (Table 6).

Table 6. Number of compared studies at CT and MRI for the same patient corresponding to different stages of PACS implantation per year

Years	PACS	No. of compared studies for CT of the same patient	No compared studies for MRI of the same patient
2019	Beginning PACS Implementation	Not applicable	Not applicable
2020	Partially use of PACS	1-2	1
2021	Fully use of PACS	4-5	3

Discussion

The PACS emerges as a pivotal asset within hospital settings, particularly in the radiology department. Its implementation has distinctly revolutionized patient data management, offering a streamlined approach to storing, retrieving, and organizing radiology reports. This digital transition has significantly enhanced efficiency by facilitating easy access to patient data, replacing cumbersome manual retrieval methods (Table 4), and results in line with the scientific literature [7].

Moreover, the cost-saving advantages brought forth by PACS are substantial. The statistical analysis further substantiates the observed reductions in expenses. The significant negative t-values and low p-values in the decrease of printed films and associated costs emphasize the financial benefits brought about by PACS (-81.64 to -302.75, $p < 0.001$) (Table 5, Figure 1). This helps in optimizing resource utilization within the radiology department. The elimination of film-based systems has resulted in noteworthy reductions in expenses associated with film, printing, ink, and staff salaries. PACS stands as a financially prudent solution in healthcare infrastructure [8].

Additionally, PACS's comprehensive suite of visualization tools has substantially bolstered image analysis capabilities. The system allows detailed image zooming and advanced visualization, providing a robust toolkit for interpreting and studying medical imaging data. The diverse set of tools embedded within PACS significantly contributes to a more comprehensive and insightful analysis of medical images with an increased number of users (Tables 3 and 6). These tools enable detailed image examination, advanced visualization, and in-depth study of medical imaging data, empowering healthcare professionals to derive more comprehensive insights [9].

In essence, PACS is indispensable for ensuring the completeness, accuracy, and timeliness of patient health records through its routing, storing, and retrieval of medical images. Its positive impact on improving productivity, workflow efficiency, and patient care within radiology departments and across healthcare settings underscores its significance in modern healthcare infrastructure.

Conclusion

Our study provides compelling evidence of PACS's substantial impact on the Minia Oncology Center's radiology department. The system's implementation resulted in improved workflow efficiency, faster image retrieval, and enhanced collaboration among healthcare professionals. PACS not only facilitated better patient care through improved diagnostic accuracy but also significantly reduced operational costs associated with traditional film-based imaging methods.

List of abbreviations

PACS = Picture archiving communication system

CT = Computed Tomography

MRI = Magnetic Resonance Imaging

EL = Egyptian pounds

IT = Information Technology

Conflict of Interest

The author declares no conflict of interest.

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