



Review article

The retention duration of digital images in picture archiving and communication systems

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ABSTRACT

Introduction: Every year, a large number of medical images such as MRIs, CT scans, and radiographs are prepared in hospitals, and a lot of money is spent on their preparation. Picture archiving and communication system (PACS) is an integrated image management system for maintaining and storing digital images. The objective of this study was to determine the storage duration of digital images in PACS.

Methods: This was a scoping review study in which we searched the PubMed and Embase databases using a combination of terms related to radiography, storage, and duration. The reference lists of included articles were checked to identify other relevant articles. Moreover, we searched Google to retrieve relevant gray literature and other information sources including guidelines. The selection process was carried out in three stages and was reported based on the PRISMA flowchart and the data were extracted using the data collection form.

Results: Based on the database search 2867 articles were identified, of which 13 articles were eligible for inclusion. Searching for gray literature identified 7 relevant sources. The results showed that based on the institutions' plans and regulations, different countries have different storage policies. In general, to store images between 6 and 240 months for short-term storage and between 0 and 240 months for long-term storage were considered.

Conclusion: Due to financial constraints and storage space requirements, healthcare organizations can provide a solution by drafting guidelines on the appropriate storage duration for medical images. The findings of this study can assist healthcare authorities and healthcare centers in employing PACS systems to manage and minimize storage space for medical images, thereby reducing storage costs.

1. Introduction

Every year, a significant number of images such as MRIs, CT scans, and radiographs are captured and stored in healthcare settings like hospitals and clinics. Managing and retaining such data consumes a great deal of time and financial resources for these healthcare organizations. Digital imaging is widely used due to its convenience and usefulness in various treatment and diagnosis domains [1]. This approach allows for efficient storage and fast retrieval, without incurring additional costs or occupying additional space [2].

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Nevertheless, selecting the appropriate storage technology for medical images is often hindered by two challenges. First, the storage industry experiences rapid advancements, so healthcare institutions may become caught with obsolete equipment and an outmatched storage strategy. Second, institutions need to allocate a significant amount of budget to handle the cost of storage [3]. Thus, it is essential to keep both challenges in mind before deciding upon a suitable storage strategy.

Nowadays relying on modern technologies to enhance healthcare systems is commonplace. Picture Archiving and Communication System (PACS) [1,4] is an integrated image management system that replaces paper images with digital ones. This system contains information such as patient diagnoses, and imaging methods (CT, MRI, and ultrasound), besides profile and displaying the images [5, 6]. One of the PACS modules is image storage, which takes up considerable storage space. Several methods of storage exist, including the 2-part strategy based on storage duration: 1) Short-term storage, which includes active patient images currently under treatment and with instant access, write/read capabilities, and space limitations, 2) Long-term storage that may not allow fast access [7].

The amount of storage space required for a typical chest-X-ray (CXR) image, consisting of 35 imaging planes and 43 cm in size, contains 1760 to 2140 pixels with two bytes for each pixel. Therefore, a storage space of 7.356 megabytes (MB) is required just for one day of CXR imaging. Based on studies, on average the storage space for CT and MRI images will be 0.52 and 0.13 MB [8]. The issue arises with the accumulation of images from each patient examination, as studies note that between 20 and more than 100 images could be created per examination, requiring storage space between 10 and 50 MB. Subsequent examinations could increase the number of images and necessitate additional storage space [9].

In hospitals, the volume of activity in the radiology unit and the annual number of images produced in these facilities pose numerous challenges. This includes acquiring enough space to store the images and retrieving specific images amid an extensive number of images. Healthcare organizations spend a substantial portion of their annual budget on developing PACS systems and storing images in these systems [10]. Due to the large volume of medical images and the rising need for image storage, image storage has become one of the most expensive aspects of information technology [11]. Studies have shown that the validity of the many images stored in PACS will decrease after several years [6]. A study investigating maintaining only images with future informational value showed that during a one-year follow-up, none of the excluded images were requested. Therefore, a significant amount of images can be removed from the archive without influencing clinical duties [12]. Also, studies demonstrated strategies to minimize storage costs for images, such as utilizing compression techniques [13,14].

In Iran, according to the regulations of the Ministry of Health, inpatient medical records are kept for ten years, and the medical images of such patients are also stored in the archive for the same period. This strategy needs large storage space in PACS. To solve the problem of the high volume of images, experts have used different techniques to compress images before storing them, each technique has its advantages and disadvantages [15–17].

Since the storage of all medical images is challenging due to their large volume, and limited budget and storage space [18], developing guidelines regarding the duration of storage provides a solution for healthcare organizations. Therefore, the objective of this study was to determine the storage duration of digital images in PACS in hospitals. This study can help healthcare organizations that use PACS to manage the space required for storing medical images, and subsequently reduce storage costs.

2. Methods

In a scoping review study, we searched the PubMed and Embase databases using the following three groups of keywords (A, B, and C). Category A included mesh terms related to radiology and all its subgroups, Category B keywords related to storage, and Category C keywords related to duration. The keywords of each group were first combined with the operator OR, and then the results were combined using the AND operator (Table 1).

Using the same search string, we additionally searched Google to identify existing gray literature and guidelines. Only the first 20 hits sorted by relevancy in the Google search were reviewed. In a study conducted by Stevinson and Lawlor, it has been shown that it seems unlikely to retrieve more relevant sources by reviewing additional hits [19]. In this study, all the sources that were published until August 2022 were examined, without any date, language, topic, or type limitations.

In this study, all the sources relevant to the storage duration of digital images were included for review. After identifying the sources, duplicates were first removed. Then, two evaluators independently checked all the titles and abstracts of retrieved sources to identify relevant ones. If the selection of a source could not be made based on its title and abstract, the full text was read and evaluated by the reviewers. In full-text screening, the reviewers determined if at least one text term referred to a retention period (e.g., '2-year duration' in 'short-term memory') and if the text terms indicated that the study examined the time of retention (e.g., a study looking at how long images were retained in short-term memory, long-term memory, or both). In the final stage of screening, the evaluators

Table 1
Keywords used to search databases.

A (Mesh terms including all its subterms)	B	C
Radiography [Title/Abstract]	Storage	Period
Picture archiving and communication system [All Fields]	Storing	Duration
Radiology Information Systems [All Fields]	Store	Year(s)
	Maintenance	Month(s)
	Keeping	
	Archive	
	Retention	

investigated any indication of image retention durations in the full texts. To increase the retrieval of the relevant articles, the reference list of the included articles was also checked manually. Disagreements in the study selection and data collection stages were resolved by consensus between evaluators and consulting with a third reviewer. We used a data collection form to collect the required data including author names, source titles, and image retention duration in short-term and long-term memories. Descriptive statistics was used to analyze the data and the agreement between evaluators was calculated by Cohen's kappa.

This study was approved by the ethics committee of the Kerman University of Medical Sciences (IR.KMU.REC.1398.076).

3. Results

Our search in Pubmed and Embase resulted in retrieving 2867 articles. After removing duplicates, 2428 articles were remained for further screening. Screening based on the titles yielded 266 articles. By removing other irrelevant articles based on the review of abstracts, 30 articles remained for further review. The review of full texts showed that most articles did not provide information about the retention duration of digital images. Finally, 13 articles from database search results and 7 Gy literature sources were included in the study (Fig. 1).

The review of the extracted articles showed that PACS requires both short-term storage and long-term storage. Short-term or online storage space acts as a temporary folder that receives files directly from the imaging modalities. Long-term storage space (offline) is a persistent and more permanent form of image storage. Reviewing identified sources in this study showed that there is no agreement for the storage duration of medical images. There are no established plans for this issue, and all medical organizations have specified the storage duration of images according to their goals and policies (Table 2).

Based on the results of the studies, the range for storage duration of images in PACS was between 6 and 240 months for short-term storage and between 0 and 240 months for long-term storage.

By reviewing gray literature and relevant guidelines, 7 relevant sources were identified. According to the guideline provided by the Centers for Medicare & Medicaid Services (CMS), which is a guide on keeping patient records, it has been determined that Medicare

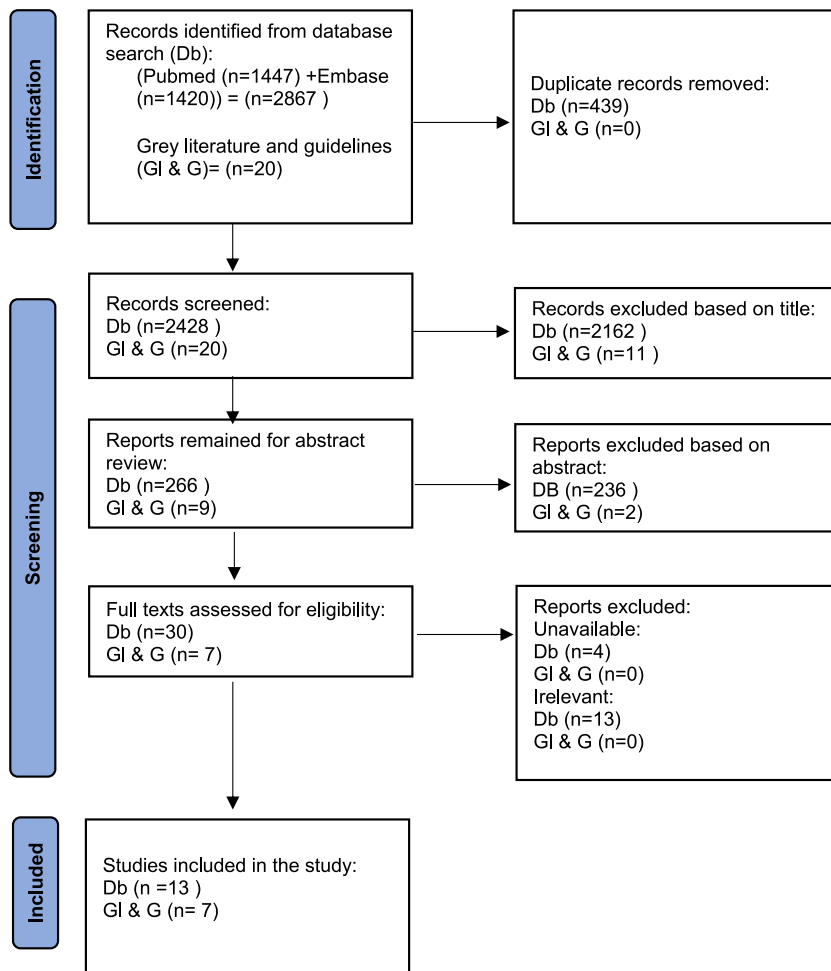


Fig. 1. PRISMA diagram of the study.

Table 2

The results of included studies from database searches.

Authors (reference number)	Title	Short-term storage duration	Long-term storage duration	setting	Type of image	Name of the system used to archive images
Bauman [20]	Large picture archiving and communication systems of the world-Part 2	12-240 months (Mean 51.2)	0-84 months (mean 26.3)	82 organizations using PACS, worldwide	computed radiology(CR); cennputed tomography(CT); digital angiography, digital fluorography; magnetic resonance(MR); nuclear medicine; uiltrasonnd(US).	PACS
Wirth [21]	[PACS: storage and retrieval of digital radiological image data]	12-14 months	-	An academic hospital, German	CR, CT, MR, US, digital fluoroscopy(DF)	PACS
Furuie [22]	Managing medical images and clinical information: InCor's experience.	6 months	More than 24 months	An academic hospital, Brazil	digital imaging and communications in medicine (DICOM)	PACS
Stoica [23]	The medical and medicolegal use of the radiological image storage PACS for an orthopedic hospital.	-	240 months	Orthopaedic Hospital, Romania	CT· MRI	PACS
Wirth [24]	Hard disk online caches in picture archiving and communication systems archives: How big is beautiful?	12-24 months	More than 24 month	A hospital, Germany	current radiographic(CR), CT, and MRI	PACS
Stockburger [25]	An evaluation of the financial impacts of optical disk storage for digital radiography.	6 months	6 years	Hospital	radiographic, CT, MR, US, and digitized film radiographic images	A digital optical disk archive
Piqueras [26]	Worklists, preloading, and archiving strategies; 3 years of clinical experience in the Barcelona PACS	24 months	-	An academic paediatric Hospital, Spain	CR, DF, US, CT, and MRI.	PACS
Bandon [27]	A hospital-wide distributed PACS based on the intranet.	36 months	-	An academic hospital, Sweden	CT, MRI, US, CR	PACS
Nagy [3]	Demystifying data storage: Archiving options for PACS	At least 12 months	-	Hospital affiliated to in Wisconsin, USA	medical images	PACS
Rinehart-Thompson [28]	Storage media profiles and health record retention practice patterns in acute care hospitals.	-	40 months	All acute care general hospitals, USA	images	Storage Media
Geijer [29]	Chest radiography in the intensive care unit. Indications for radiography and effects of selective archiving of films.	-	15 months	hospital	: Chest radiography	Not-mentioned
Blado [30]	Management of the picture archiving and communications system archive at Texas Children's Hospital.	-	For adults 7 years after the last visit, For children till 18 years old plus 5 years	Pediatric hospital, USA	General radiology images except for mammography	Magnetic disk
Geijer [12]	Selective archiving of radiologic images.	12 months	-	Referral Hospital, Sweden	Radiography images	Not-mentioned

and most states mandate that all medical records be stored for at least five years [31]. The Royal College of Radiologists (RCR) issued a guideline in 2008 and compiled recommendations and legal requirements from various sources for the preservation and storage of images. Hospital radiology records, including copies of reports, films, scans, and other imaging records must be kept for five years in compliance with Medicare regulations [32]. In 2016, The RCR in another statement indicated that the radiology images and reports for adults should be kept for up to 8 years after discharge, and for children up to the age of 26. Moreover, mammography images should be stored up to 10 years after the patient's treatment [33].

The American College of Radiology (ACR) announced that according to federal regulations, all radiology documents should be stored for three years, however, Medicare participating hospitals must keep copies of reports, printouts, films, scans, and other images for at least five years. Some states have different retention periods for mammograms. For example, in Rhode Island, physicians, hospitals, or any healthcare facility that performs mammograms are required to keep the images for patients. However, the images can be destroyed if the patient has had no contact with the physician or facility for more than 15 years. In Indiana, following the mandatory five-year retention period for mammograms, the healthcare provider must notify the patient via written notification that they have 30 days to request and retrieve the mammogram for personal use [34].

In the guidelines compiled by Casey, which gathered recommendations and legal requirements on the preservation and storage of medical images from various sources, it has been outlined that the minimum retention periods for radiological records in various states are as follows:

Eight years after the end of treatment (England, Wales, and Northern Ireland), and 6 years after the date of last admission or 3 years after death (Scotland). In England, medical images of children and young individuals should be maintained up to the patient's 25th birthday, or up to 8 years after the patient's death if the patient is under 26 years old. In Scotland, the retention period for images is until the patient reaches the age of 25, or three years after death, if earlier. In mammography screening, the minimal retention period for cases considered normal is 9 years after the patient's last visit. For cases deemed to be suspicious or for patients receiving treatment, the retention period is 15 years following the date of the patient's last visit or 9 years following the patient's death [35]. In the regulations for Massachusetts physicians and handling of patient medical records, it is also mentioned that the documents of adult patients should be retained for at least seven years from the date of the most recent visit. For pediatric patients, the retention period is longer, and the physician must keep the child's patient records for at least seven years from the date of the patient's last visit or until the patient reaches the age of eighteen [36]. Studies have shown that all patient records and images generated must be retained for the mandated retention period defined by state law or regulation. These records and images must be maintained for the maximum period determined by the state's regulations regarding recording medical procedures and assessing malpractice claims [28].

4. Discussion

As a result of the sizable volume of medical images produced in hospitals, managing and retrieving these images, in addition to their storage and preservation, consumes a great deal of time and money. This research reviewed the storage duration of medical images in PACS based on current literature to develop a feasible solution for reducing storage requirements and maintenance costs. In the US, some states mandate the retention of medical and hospital records for 5–30 years. In Massachusetts, for example, medical records are required to be held for 30 years after discharge or final treatment, then destroyed following HIPAA regulations. However, no consistent standard exists for medical image retention, which is left to individual states to regulate and determine the length of time before images are destroyed [37]. The Iranian Ministry of Health's current regulation stipulates that the medical records of routine patients must be retained for a decade, and their medical images will also be stored in the archive for the same period. As a result, vast storage space is required to maintain such a large volume of images within PACS for extended periods.

To our knowledge, the majority of review research that has addressed PACS has focused on assessing its effectiveness and impact on the workflow of medical professionals, such as physicians and other medical staff [38–41]. Additionally, the study by Wetering and Batenburg in 2018 [42] examined the maturation and adaptability of PACS within the hospital setting. This study presents a framework for enhancing PACS within hospitals that could assist policymakers in making decisions regarding system upgrades. However, these prior studies did not propose a solution for determining the storage duration of images in PACS.

One of the notable challenges of healthcare organizations is the storage of radiology images due to their substantial volume. This is primarily because these organizations typically have restricted budgets and a shortage of the space required to store images [17]. Implementing guidelines concerning the appropriate duration to store images could constitute a practical solution for addressing the budgetary and storage space challenges within healthcare organizations. These guidelines should also include recommendations regarding the reformatting and compression of the images. Since reformatting images may not retain adequate details to accurately determine their orientation, it is recommended to give priority to storing basic images [43]. The results of this study can help the Ministry of Health and all healthcare centers that utilize PACS to determine the storage period for medical images and subsequently reduce the burdens associated with storage space and related costs.

5. Limitations

This study had three limitations. 1) Lack of access to the full text of some articles, lead to the exclusion of these articles from our study. 2) Due to the limiting the language to English, articles that were published in languages other than English were excluded from our study. 3) The search was conducted in two databases relevant to the healthcare domain. Therefore, we may have possibly missed articles indexed in the other relevant databases.

6. Conclusion

Due to the substantial volume of digital images produced in hospitals, the process of their storage, maintenance, and retrieval is challenging. In addition to being time-consuming, this process also requires substantial financial investments by healthcare organizations. Consequently, a practical solution for reducing storage requirements and associated costs is necessary. However, there is no unique standard or guideline for healthcare organizations to adopt for managing medical images.

Considering the substantial volume of digital medical images and the budgetary and storage space restrictions in healthcare organizations, developing suitable guidelines for image storage duration can mitigate these challenges. The results of this study can help the health authorities and all healthcare centers that utilize PACS to reduce the issues associated with the management of storage spaces, reduce the storage space for medical images, and consequently decrease storage costs.

Ethics approval and consent to participate

Verbal consent was obtained from the participants and the procedure was approved by the ethics committee of Kerman University of Medical Sciences (ethics code: IR.KMU.REC.1398.076).

Consent for publication

Not applicable.

Availability of data and material

The data generated and analyzed during this study are available from the corresponding author upon reasonable request.

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CRedit authorship contribution statement

Farzaneh Behnam: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Reza Khajouei:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Leila Ahmadian:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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