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Evaluating latest developments in PACS and their impact on radiology practices: A systematic literature review

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ABSTRACT

Aim: The present systematic review was conducted to analyze the empirical literature examining various features of current picture archiving and communication system (PACS) as well as to evaluate the impact of the most recent developments in PACS on radiology practices.
Methods: A systematic review of English-literature published between 1st January 2004 and 31st December 2015 on qualitative evaluation of characteristics of latest PACS and their effect on radiological practices was done by searching six online databases i.e. Springer Link, Scopus, Science Direct, CINAHL Plus, Google Scholar and Pubmed using the keywords. Study outcomes, technological advancements and effect on radiologist were extracted and summarized from each study.
Results: Finally 17 articles from different regions of the world were included in the review. Of them, 5 articles investigated the users acceptance of the PACS, 5 studies measured the compliance level of various PACS features, 3 studies assessed the present and future of tele-radiology, 2 studies evaluated the effect of PACS on the work practice of radiologist, 1 research focused on examining PACS success model and 1 article investigated the PACS maturity framework.
Conclusion: Advent of PACS has revolutionized the radiological practices, however there are evidences for further improvements to make the next-gen PACS more user friendly and with enhanced functionality.

1. Introduction

Picture Archiving and Communication System (PACS) is an advanced technology which not only forms a "centralized repository for all imaging data" but also acquires and transmits the radiological images and its report (such as X-ray, CT-scan, MRI and other nuclear medicine-related images) to the physicians digitally, thus replacing the film-based radiological images [1]. The primary objective behind implementation of PACS was to make images available and accessible on multiple workstations simultaneously which will aid in clinical-decision making and providing efficient patient care [2,3]. Since its inception in clinical practice, PACS has undergone rapid improvements and changes [2,3]. Nevertheless, there is a lack of evidence if these improvements add on to enhance the functionality of the PACS, how it is perceived by the users and what impact it is having on the radiological practice. Moreover, what features need to be implemented in the next-generation PACS needs to be investigated.

PACS employs internet as a means for systematizing, archiving, retrieving, distributing, and transferring images to different healthcare centres [2–5]. This technology when exploited further can provide advanced technological solutions, such as holographic PACS, which couples a single department through new storage technologies; enterprise PACS, which supports vertical and horizontal integration between specialities and departments; and virtual PACS, which crosses the enterprise, which will enhance PACS performance [1].

Proper implementation and assessment of a modern PACS concerning architecture and introduction in an already operating hospital are well studied. These studies focus on how an existing hospital is digitalized by connecting all the hospital instruments to the central repository. Study by Hussein et al. [6], demonstrates that establishment of PACS makes it easy to get connected with other healthcare centres, thus increasing the use and expansion of the technology. Moreover, accurately establishing PACS is crucial as it will not only save physician's time, but will also decrease patient waiting time, and enhance the medical efficiency [7]. A study by Dubey et al. [8], highlighted that proper training of PACS user was one of the factors responsible for its successful implementation.

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Other advantages associated with PACS usage includes increased communication between the radiologist and the referring physician, decrease in instances of missing images, higher image access speed, provide internal and external members access to images, increase physician's job satisfaction, and make all the departments more efficient [9].

PACS is a cost-effective technology as it reduces expenditure related to film, chemicals, film processors, physical storage space, and the manpower needed in traditional film based environments [3]. Nonetheless, swiftly changing information technology (IT) increases the cost of PACS which limits its universal establishment.

1.1. Aim

We, therefore aim to conduct a systematic review to determine the evidences of the technical characteristics of the best PACS as well as estimate the impact of the recent developments in PACS on the radiology practices between 2004 and 2015. In this decade information technology has evolved rapidly which gives an opportunity to access the latest developments and trends in PACS.

2. Methodology of literature review

Basic methodology for systematic review was followed for the literature survey.

2.1. Search strategy

Scientific literature databases like Science Direct, Springer Link, Scopus, CINAHL Plus, Google Scholar, and Pubmed were searched between 2004 and 2015 using medical subject heading and keywords. The full search strategy is shown in Table 1. Multiple keywords were selected based on their relevance to identify the future trends in information technologies, approach to improve the functionality of the current PACS, and the organizational efficiency of the clinical practice. The following keywords were finalized, 'Picture archiving and communication system', 'PACS', 'Future trends', 'next generation' 'Organizational efficiency', 'Productivity', 'Clinical practice', 'Evaluation', 'Improvement', 'Cloud computing', 'Information storage and retrieval', and 'Ubiquitous'. The keywords were combined to form MeSH terms that were used for searching each database. Articles pertaining to empirical studies on human and published in English language were considered.

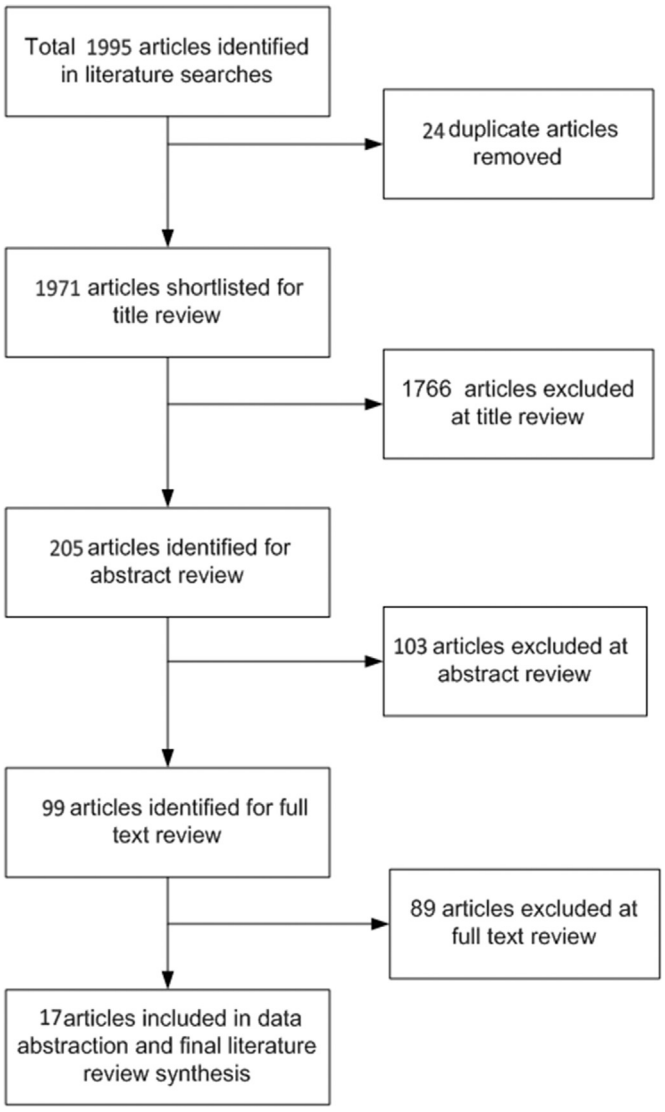

Fig. 1. The literature review process with the number of studies identified, excluded and included.

Table 1
Databases and search terms used to identify literature.

Database	Search terms
Springer Link	(Radiology information systems* OR PACS OR 'picture archiving and communication systems') AND (Future trends) OR (next generation) OR (Organizational efficiency) OR (productivity) OR (clinical practice) OR (evaluation) OR (improvement) OR (cloud computing) OR (information storage and retrieval) OR (ubiquitous) OR (user interface) OR (design)
Scopus	(Radiology information systems* OR PACS OR 'picture archiving and communication system$') AND (Future trends) OR (next generation) OR (Organizational efficiency) OR (productivity) OR (clinical practice) OR (evaluation) OR (improvement) OR (cloud computing) OR (information storage and retrieval) OR (ubiquitous) OR (user interface) OR (design)
Science Direct	(Radiology information systems* OR PACS OR 'picture archiving and communication system$') AND (Future trends) OR (next generation) OR (Organizational efficiency) OR (productivity) OR (clinical practice) OR (evaluation) OR (improvement) OR (cloud computing) OR (information storage and retrieval) OR (ubiquitous) OR (user interface) OR (design)
CINAHL Plus	(Radiology information systems* OR PACS OR 'picture archiving and communication system$') AND (Future trends) OR (next generation) OR (Organizational efficiency) OR (productivity) OR (clinical practice) OR (evaluation) OR (improvement) OR (cloud computing) OR (information storage and retrieval) OR (ubiquitous) OR (user interface) OR (design)
Google Scholar	picture archiving and communication system picture archiving and communication systems
Pubmed	(Radiology information systems* OR PACS OR 'picture archiving and communication system$') AND (Future trends) OR (next generation) OR (Organizational efficiency) OR (productivity) OR (clinical practice) OR (evaluation) OR (improvement) OR (cloud computing) OR (information storage and retrieval) OR (ubiquitous) OR (user interface) OR (design)