McMaster eBusiness Research Centre

Review of Different Training Approaches to Facilitate Successful Adoption of EMR Systems by Physicians in Hospital Settings

By

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WORKING PAPER No. 54
October 2015

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MeRC Working Paper # 54
October 2015

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ABSTRACT

Background

Despite multiple advantages of electronic medical records (EMRs) for healthcare practices, doctors are often resistant to apply these systems in their work[2-6]. According to research, low computer literacy of clinicians[3,8,12,16], inadequate physician training [3,4,7-15], insufficient support [3,4,17] and lack of change management[5] are among the main barriers to EMR adoption. Of these barriers, healthcare provider training is recognized as one of the main critical success factors of EMR acceptance[4,10,18-27]. Thus, development of effective training strategies for system implementation is critical.

Objective

This paper was aimed to investigate current published literature on a variety of physician training approaches that facilitate EMR adoption in hospitals.

Methods

A non-systematic literature review was performed. Published information was retrieved from Embase, Medline and IEEE Xplore electronic databases, websites of organizations relevant to EMR implementation (HIMSS, American EHR Partners, etc.) and referenced links. Articles were evaluated for eligibility and filtered. Obtained data were represented in a narrative format using tables and figures.

Review

The paper addresses the following aspects of inpatient physician training on EMR adoption: 1) role of the organization in physician engagement and training support, 2) effective planning of EMR education that encompasses training needs assessment, computer literacy enhancement and development of a detailed multicomponent training plan, 3) defining appropriate instructors (vendors, information technology (IT) professionals, training consultants or champions and super-users), 4) optimal training timelines and schedules, 5) setting of training location (on-site, off-site, or both), 6) diversity of training materials, 7) effective training methods, 8) delivery mode variety, 9) evaluation of EMR education effectiveness and 10) components of EMR support.

Discussion

On the basis of literature review, recommendations on the best physician training practices that encourage software adoption are provided.

Conclusion

Training is a critical part of EMR implementation and, to perform it appropriately, an educational approach should be developed individually for each specific hospital facility using tools and suggestions described in this paper.

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INTRODUCTION

Background

In the past decade, implementation of Electronic Medical Record (EMR) systems has been underway in Canada and other countries[1]. EMRs are innovative means to document, store and use medical information from patients in a legible, standardized and structured format. This provision of information electronically is essential for improving quality and increasing the safety of health care.

Despite the promising benefits of EMRs for medical practices, the adoption rate of these systems by physicians remains low[2-6]. A wide range of research papers has been devoted to investigation of reasons for physician resistance to using EMRs in their work. Persistently emphasized barriers to successful implementation of the electronic systems are low computer literacy of end-users[3,8,10,12,16], insufficient training [1,3,4,7-15], inadequate physician support [3,4,17] and lack of change management[5]. At the same time, scientific articles emphasize healthcare provider training as one of the main critical success factors for the acceptance of the EMR[4,10,18-27].

Planning, organizing and providing education for healthcare providers on the use of electronic systems, with subsequent adequate support, are essential parts of EMR project management and leading people through changes brought about by these systems[28-31]. The importance of timely and comprehensive training is hard to overestimate. Training plays a critical role in the successful physician transition from paper-based or hybrid documentation environments to the electronic record environment.

Lack of adequate training can result in serious negative outcomes regarding patient safety[32,33], information confidentiality[32,33] and healthcare quality[14,32]. According to a survey from HIMSS Analytics and TEKsystems[33] that interviewed representatives from 300 hospitals and healthcare providers throughout the United States, insufficient training leads to rework (85%), a low rate of EMR adoption (84%), inapplicability to real-work scenarios (84%), long learning curves (82%) and inability to achieve criteria of meaningful use (77%). To avoid such outcomes, healthcare organizations should develop effective approaches to training, apply best practices of adult education and consider the specific hospital environment and target audience.

Objective

In spite of the identified growing need to educate healthcare personnel on the use of EMRs, few research papers exist on how this training should be performed. The intent of this literature review was to explore available published information on different educational approaches that encourage physician adoption of EMR systems in hospital settings.

The paper addresses the following aspects:

1) what is the role of the organization in EMR training;
2) what are appropriate steps for training planning;
3) what are end-user computer literacy and training levels;

4) who is the most suitable educator for physicians;
5) when the EMR training should occur and an appropriate physician training schedule;
6) what is the optimal duration of training;
7) where is the ideal location for training;
8) what makes effective training materials;
9) what are the methods of training;
10) what is the best training delivery approach;
11) how to measure training effectiveness;
12) what is adequate end-user support.

The review can serve as guidance for hospital EMR instructors in developing appropriate and effective physician training strategies, leading to higher system adoption.

Methods

The scholarly paper represents a narrative literature review with the focus on EMR physician training in hospitals specifically. However, due to lack of literature on the subject, education of other clinical staff in other medical settings was also considered. Three bibliographic electronic databases were searched for the relevant information: Embase, Medline and IEEE Xplore. Embase and Medline were explored to acquire information from the healthcare perspective (European and North American correspondingly); IEEE Xplore was chosen to obtain data on EMR training from the technical perspective. Additionally, sites of the organizations relevant to EMR implementation (e.g., HIMSS, TEKsystems, American EHR Partners, Masspro, Accenture) were searched and referenced studies were examined. The following keywords and their combinations were employed for the literature scan: EMR, EHR, electronic medical record, electronic health record, computer literacy, computer skills, training, education, trainer, educator, implementation, adoption, physician, doctor, provider, end-user, hospital, health care and clinic.

Retrieved articles were evaluated for eligibility, resulting in **inclusion** of peer-reviewed studies, conference reports and information from sites of official organizations related to EMR implementation and **exclusion** of opinion papers, articles that contained unclear information written in unscientific language, and publications without references. One hundred and twenty seven publications were examined for relevant information regarding different aspects of EMR training of physicians in hospital settings (training plan, strategy, materials, modes, time, schedule, effectiveness, and others). The obtained information was represented in a narrative format using tables and figures.

LITERATURE REVIEW

Organizational Commitment

1. Role of the organization in end-user engagement.

EMR implementation is an organization-wide initiative and, therefore, should be driven and supported by hospital leaders at multiple levels, starting with executives, who convey the common vision of care transformation and quality improvement by effective use of the system[34,35,36]. Strong communication on the changes brought about by the implementation, which aims to inform all

classes of end-users, is essential for the readiness of all people involved to learn how to use the new EMR[37,38]. All clinical personnel have to know about the EMR project, its objectives and plans for deployment[39].

Hospital leaders should positively introduce an innovation, such as an EMR system, emphasizing benefits of the system[27,37,38,40]. A wide range of EMR advantages could be listed: 1) increased accessibility of patient charts[27,35,41-44], 2) streamlined clinical workflows[35,44], 3) legibility and completeness of medical records[41,44], 4) reduced redundancy[35,44], 5) availability of decision support tools[35,41,42], 6) decreased instances of medical errors[35,44]; 7) improved internal communication[42,44]. Stories of successful implementation of EMRs in other organizations can also help to convince end-users of the value of a system[34]. Understanding advantages of an EMR leads hospital personnel to be more interested in learning, testing and using it.

While communicating an innovation to different stakeholders, special attention should be paid to one of the main categories of system users – physicians, who are known for the slow adoption of a system[2-6]. It is crucial to engage doctors from the very beginning of the EMR initiative[39-41,45,46]. They should be involved in system selection[2,36,41,47-49], governance decisions[40], EMR design[6,41,44,49], implementation[35,36,39, 46,47,49] and modification[40,41,48,49]. By participating in EMR projects physicians would learn the system[47,49], develop a sense of ownership in the planning and implementation processes[44,49], create specific requirements for EMR design to support their practices[46,49] and provide their feedback for customization of a system to facilitate hospital workflows[40,41,46,49]. As a result, the EMR would be more familiar[47,49] and suitable for physicians, which could lead to better technology adoption and decrease resistance to change[41,44].

Survey results, provided by the American Academy of Family Physicians (AAFP)[50] in 2009, demonstrated a statistically significant difference in satisfaction with EMR between physicians who had been involved in a system selection and physicians who had not participated in a system selection. American EHR Partners[51] demonstrated results of another survey, which confirmed that the providers involved in a system selection were more satisfied with the EMR than their counterparts who were not engaged. Furthermore, this study discovered that the users who did not participate in the EMR selection required 2 weeks of training to reach the same level of EMR satisfaction as was achieved with 3 to 5 days of training by the users who were involved[51]. Thus, participation in a system selection might lead to decrease in training requirements and increase in EMR satisfaction[51]. TEKsystems and HIMSS Analytics[33] highlighted that higher involvement in the EMR project planning would make approximately half of healthcare providers (47%) more confident in the successful system implementation. The results of these studies demonstrate importance of physician engagement in all stages of the EMR project to increase a system adoption.

2. Organization-driven training.

To support better EMR acceptance, a healthcare organization should ensure that all providers, including physicians, are extensively trained to use a system. The need for training should be communicated by executive leadership rather than the project or IT team[31,37,42,52]. The best practice is to make training mandatory[2,35,43,44,52], using a competency-based model[2,28,37]. Physicians should be given clearly outlined requirements of what EHR functions they need to learn within certain

timelines[29,42]. After these sessions, the trainees have to demonstrate proficiency at using these functions[2,28,36,37,42]. Access to the EMR should be granted only to physicians who have passed a competency assessment[2,28,37]. Continuing medical education credits[29,31], awards[35,36] or incentives[27,35,36] could be provided by the healthcare organization to motivate physicians to learn and use a system. Consequences for non-compliance with mandatory training requirements, such as denying physician access to the EMR[36], sanctions related to credentialing[52], blocking procedure scheduling[52] or withholding pay[41], should be also defined and made known. The competency-based model can be used for any system upgrade that requires training[28,44].

Some hospitals prefer to make training "required" rather than "mandatory", softening the demand for compliance[52]. This approach can result in not completing training by some physicians, who would be unprepared to use the EMR when it is implemented. Extra recourses would be needed to support these physicians, adding cost to a system implementation[52]. Thus, training should be recognized as an essential prerequisite to EMR implementation[53] and should be mandated by the executive level of a healthcare organization[52].

3. Organizational sponsorship to invest in training.

Strong organizational commitment to introduce an EMR is a powerful factor in the willingness to invest in training as a key facilitator to successful EMR adoption[34,35,40,54]. Adequate investment is paramount, considering that training is one of the most expensive cost constituents of a system implementation[47,55,56]. According to Kushinka[56], training costs include the following components: 1) closing the facility, reducing appointments or re-assigning workloads to secure time for training; 2) accommodating decreased productivity due to learning curve after system start up; 3) hiring temporary staff to fill gaps; 3) renting training facilities or creating a training center internally; 4) paying overtime; 5) providing time and resources to address the issues that arise from training and 6) creating training materials. The cost of training will vary depending on the type of an EMR system[47], the number of people to be trained[47], basic computer literacy of trainees, the extent of training[47], who are the trainers[47] (a vendor, third party consultant, or super-user), training schedule, diversity of hospital workflows and roles and other issues.

In 2011, Fleming et al.[57] reported results of a study on the cost of implementing an EMR in 26 primary care practices in north Texas, showing that, for an average five-physician practice, each physician requires 23.9 hours of training at a cost of $1,538 (and an additional 5.9 hours of simulation at a cost of $381). The teams responsible for implementation of the EMRs needed 52.5 hours of training at a cost of $2,777 (and 50.0 hours of simulation at a cost $363)[57].

The survey performed by TEKsystems and HIMSS Analytics[33] revealed that hospital executives often underestimate the importance of EMR teaching[36,58], allocating only 16% of the total EMR budget to training and change management over the lifetime of the EMR implementation. Kushinka[56] suggests that the cost of training should be considered as an investment rather than expense because appropriate effective EMR training results in significant dividends improving quality and safety of patient care.

Training Planning

One of the main determinants of a hospital readiness for EMR implementation is a detailed training plan to guide an effective EMR training program[59]. The three phases of planning result in development of a training plan document are 1) conducting a training needs assessment[30,33,34,59,60,61], 2) ensuring that all physicians possess necessary basic computer skills[30,59,60,61] and 3) planning, which aligns with organizational strategic goals and is based on defined needs of trainees[30,60].

1. Training needs assessment.

To perform a training needs assessment, the training team should acquire in-depth understanding of EMR functionalities, actively participating in the EMR project activities that define security, configuration and workflow requirements[30,33,37]. Armed with the knowledge of system capabilities, training staff would perform the training needs assessment keeping in mind how individual provider requirements can be accommodated with available EMR functions[30].

The needs assessment can be conducted in several ways: observing physician behaviour, meeting with representatives of different hospital departments and developing a survey[30]. Results of the training needs evaluation should be documented as detailed descriptions of individual user requirements for attaining appropriate skills to effectively use the EMR and adapt to new workflows[30]. This information is essential to develop an effective EMR training plan.

The evaluation of physician computer literacy is an important component of a training needs assessment[37,56,60,62,63]. Computer proficiency levels of trainees will likely vary substantially[44]. Some physicians might not have basic computer[34,44,53] or typing[2,44,47,53] skills and these deficiencies should be identified as early as possible before EMR implementation[34,44,53,55,56,60,64].

To determine each physician's level of computer literacy, the training team could use a survey[60,63,65,66], which could be found online[63], or custom developed by trainers[63]. ***Tables 1 and 2*** represent versions of questioners for defining computer skill levels. Typical questions of a computer proficiency test determine if a provider can use a mouse[53,60,66], create a folder[60,66], type[2,53,60,66], scan[60,63,66], and so on. An EMR vendor should be able to provide information on any additional prerequisite skills needed for system usage[53,62].

Table 1. Form for evaluation of computer skills (Adopted from Masspro[66] and modified).

COMPUTER SKILLS EVALUATION AND ASSESSMENT

Name (please print): _____
Date:_____
Role:_____
Practice Location:_____

Directions: In order to effectively use an electronic health record system, the practice staff needs to be able to work with computers. The following self-assessment will help your practice plan for any training needed to make the staff comfortable with this technology. Please be realistic in assessing your computer skills; basic computer skills are necessary for success with the electronic health record.
Indicate on a scale from 1 (No experience) to 5 (Very Comfortable) your experience with the following tasks or skills and complete the questions at the bottom of this form.

	No Experience		**Somewhat Comfortable**		**Advanced**
Desktop Skills					
Turn on and safely turn off your computer	1	2	3	4	5
Restart your computer if it becomes locked up	1	2	3	4	5
Open a program using the Start menu	1	2	3	4	5
Name the basic computer system parts (mouse, monitor, etc.)	1	2	3	4	5
Explain the terms: icon, menu, window, click, select, drag	1	2	3	4	5
Use scroll bars and move, resize and close windows	1	2	3	4	5
Use help screens in software programs	1	2	3	4	5
Navigate among folders, create and name folders, delete folders	1	2	3	4	5
Copy or move a file from one folder to another	1	2	3	4	5
Cut/copy and paste text?	1	2	3	4	5
Internet Skills					
Use a web browser like Netscape Navigator or Internet Explorer	1	2	3	4	5
Recognize a URL	1	2	3	4	5
Explain the terms ISP, website, home page, search engine	1	2	3	4	5
Type a URL in an open box	1	2	3	4	5
Use Back and Forward buttons to move through Web pages	1	2	3	4	5
Create a bookmark or save a favourite website	1	2	3	4	5
Locate and click on links in a webpage	1	2	3	4	5
Use a search engine to locate information on the Internet	1	2	3	4	5
Print a webpage	1	2	3	4	5

Please describe your current day-to-day use of computers:
At work:_____
At home:_____

Table 2. Computer skills assessment tool (Retrieved from OntarioMD[60]).

Computer Skill	Yes	No	Tested
File Management – I can/am able to:			
Create and rename a folder			
Move file(s) from one folder to another			
Save and delete a file			
Find a file using a search function			
Zip and unzip a file			
Empty the recycle bin and retrieve a deleted file from the bin if necessary			
Operations – I can/am able to:			
Use the task and tool bars			
Right click the mouse to bring up special menus			
General use of a mouse			
Access computer functions through the 'start' button			
Shut down the computer using the 'start' button			
Reboot using the 'shutdown' function on the start button			
Minimize, restore, close and/or re-size a program's window			
Create a shortcut to a program on the desktop			
Log on and off			
Follow password protocols			
Scan a document			
Perform basic troubleshooting (i.e. if there is a problem with the computer, being able to check to ensure all equipment is plugged in, restart computer if necessary, etc.)			
Printing Basics – I can/am able to:			
Set up a page in portrait or landscape form and use the header and footer function			
Use print preview and send a document to the printer			
Pause or delete a print job			
Change printer settings			
Set a default printer			
Email fundamentals – I can/am able to:			
Check mail, compose mail, and send a new message			
Send an attachment			
Forward mail to someone			
Set up an address book and send email to more than one address simultaneously			
Word Processing Functions – I can/am able to:			
Create and save a new document			
Save a document to a different drive			
Save a document as a different file type (i.e. PDF) or name			
Basic typing			
Check spelling and grammar in a document			
Internet Use - I can/am able to:			
Use search engines and search using keywords			
Print the screen			
Save an image to file, download, and save a file			
Reload a page			

Although a survey is the most common tool to assess computer proficiency, Heichert et al.[67] recommend using a practical skills test approach. Authors claim that providers tend to overestimate their basic computer skills, showing higher levels of literacy in the self-reporting surveys.

Results of a survey or a practical test on basic computer skills should be analyzed and summarized by a training team. Physicians could be grouped into several categories, according to their ability to use a computer. For instance, the following groups could be identified: 1) no computer use, 2) novice (uses email, basic internet), 3) average (uses email, internet, Microsoft Office) or 4) veteran (has previous experience with an EMR)[31]. The information on different levels of computer proficiency is used for the next phase of the training planning process[62].

1. Training Users on Prerequisite Computer Skills

Results of computer proficiency evaluation could reveal the need for basic computer training[28,44,53,55,62] and typing courses[2,44,62,65] to ensure all users' readiness for EMR training and implementation[37,60,65]. A hospital could pay for classes at a local community college[55,63], hire an instructor[55,63], or provide links to the available online tutorials on typing and basic computer skills[60,63].

McCormack[41] recommends that, to help physicians overcome technophobia and encourage health professionals to use computers, a hospital could provide some information from administration, colleagues or patients available only online. The author even suggests loading a few games on hospital computers to attract physician interest and support building skills with equipment[41]. Providing adequate training to increase computer proficiency among physicians is crucial for their preparation to more complex EMR training[65] and better adoption of a system[37,65,68].

2. Developing an EMR Training Plan

After ensuring that all users have basic and adequate computer skills, a training team has to prepare an EMR training plan[60], aligned with hospital strategic goals[33,37], and based on workflows[33,37,65], technical requirements[33,37,65,] and defined training needs of healthcare personnel[33,37,60,65]. A training plan should include the following components:

- **an overall training goal** that reflects the hospital's vision, mission and approach[28,33,37,60,62,69] (e.g., to design and deliver EMR training to all physicians prior to the go-live date[69]) and SMART (Specific, Measurable, Achievable, Realistic, Tangible) training objectives[70] that would allow measurement of the training program outcomes[30,60,69] (e.g., to accomplish role-based one-on-one training on operating room module of the EMR for 15 physicians of the general surgery department by September 16, 2015);
- **target audience** arranged by categories that require different training (e.g., physicians of different hospital divisions)[30,37,62];
- **types of training** – classification of training by category (e.g., demonstration of EMR functionalities, training on EMR navigation, role-based training)[30,60];
- **training modalities** – approaches to deliver training (e.g., one-on-one, instructor-led classroom, self-learning)[30,37,60];

- **training resources** (e.g., hospital EMR trainers, physicians-super-users, vendor instructors)[30,37,60];
- **timeline and schedule**[30,37,60];
- **training content** adjusted for different target audiences[30,37,60];
- **training materials** (e.g., manuals, posters, presentations)[30,60];
- **standards** – guidelines for training materials and delivery design[30];
- **logistics** – training location[30,60], required supplies and equipment[30];
- **tracking** of training completion[60];
- **training evaluation** - methods used to assess effectiveness of a training program[30].

Development of a training strategy that would be suitable for the specific hospital facility is an essential component of training planning[46]. One of the core points to consider is how the EMR system should be introduced to users. Trainers could choose between the "big-bang"[2,34,71] or gradual[2,38,42,47, 60,71,73] approach.

The "big-bang" training, when all key functions of a system are introduced at once, is faster[71] and less resource intensive than phased training. It avoids the complicated stage of a hybrid (half paper and half electronic) environment[71]. However, the "all at once" approach is more risky[72] and less user-supportive due to the lack of learning opportunities it creates.

The gradual approach to training is more preferable[60,73] as it has the following benefits: 1) a more manageable training process[73]; 2) possibilities for users to learn their EMR skills at their individual pace[42]; 3) a decreased productivity loss[71,73]; 4) a reduced negative impact on revenues[73]; 5) an opportunity to modify and improve training process[71]; 6) higher acceptance of the EMR by healthcare providers[73]. Trainers could partition EMR training by software modules[38,42,71,73] (from easier to more complex functionalities), by hospital departments[73] or by physicians[71] (starting from champions and super-users, who would subsequently peer-train their colleagues). The chosen approach to training should be documented and justified in the training plan.

Training could be strategically divided into several sequential steps to establish a clear process. For example, Rae[74] recommends four steps: 1) user need identification, 2) training planning, 3) training delivery and 4) assessment. Kumar et al.[29] expands this model and offers a training process named DRIPDA which includes six activities: 1) Define the need on the high organizational level, 2) Run a pilot in the current organizational environment (with its existing workflows and constrains), involving the maximum diversity of users, 3) Identify and prioritize the training challenges revealed during piloting; 4) Plan the training considering challenges; 5) Deliver the training using appropriate tools; 6) Assess the training. Duggan[75] provides another variation of the EMR training process, which includes five steps: 1) needs assessment and analysis, 2) design of training, which is analogous to planning in other models, 3) development of training material, 4) implementation, which refers to training delivery, and 5) evaluation. The representatives of a national health care consulting firm Divurgent, in a report by Mercer et al.[24], suggest using a six-Ds model for training process: 1) Define, which is similar to training planning in other models, 2) Design of curricula and training materials, 3) Direct – test training program, involving super-users,

4) Deliver training, 5) Distill – evaluate training, and finally 6) Display – celebrate training accomplishments.

The diversity of training process models demonstrates that no strict formula to create a successful training program exists. Each healthcare organization should consider its individual environment, workflows, targeted audience, culture, and multiple other factors to create the most appropriate training approach. The established training process should be reflected in a training plan.

The training vision, mission, strategy, processes and methods should be reviewed and approved by administrative and physician leadership[37]. The training plan would guide training and serve as an effective communication tool for all stakeholders involved in the EMR project. Subsequent sections will describe the majority of the above listed components of a training plan.

4. EMR Educators for Physicians

To achieve successful results of EMR training, it is crucial to have appropriate training personnel[33,34,44]. Potential trainers should be identified at the initial phases of the EMR project, which would allow their early involvement in the processes of the current state evaluation, gap analysis, workflow reengineering, software design, build and validation[30,37]. Participating in these activities, trainers would develop mutually beneficial relationships with the project, application and user teams[37], attain deep knowledge of the EMR[30] and acquire thorough understanding of the hospital environment[30,37]. This would make them more effective educators, who could apply appropriate training approaches to address end-user needs and concerns and help them to learn a system[30].

Finding the trainers with the necessary qualifications, which include clinical experience[44], excellent communication skills[37,44] and strong IT background[44], could be difficult[33]. In the study performed by TEKsystems and HIMSS Analytics[33], more than half of the survey responders highlighted the challenge of identifying the right personnel to develop a training program (57%) or lead the classroom discussions (53%). Looking for the appropriate training staff, several options should be considered: 1) a vendor, 2) an IT professional, 3) a champion and/or super-user and 4) a consulting training specialist. Moreover, online user forums[47] and communication among colleagues[4,9,76] could play a supportive educational role in EMR learning. Each of these groups is described below.

Vendor

It is crucial for hospitals to establish effective partnership relations with their EMR vendor[61,65] that would serve as the first source of information on the software structure[11,56,77], functionalities[11,56,77] and configurability[56,65]. Vendors could play significant role in the EMR training, performing the following activities: 1) supplying hospital staff with a wide variety of training materials (e.g., books[71], manuals[28,71], CD-ROMs[38]) about EMR basic features[34,65], advanced modules[42,65,71,76] and upgrades[38,42,65,71]; 2) conducting one-on-one[65] or group[71] on-site[27,65,71,78,79] classes; 3) arranging distant educational sessions[61] via telephone[27,38,65,71], the Internet[38,56,65,71] or email[65]; 4) organizing EMR conferences[38]; and 5) providing support, addressing technical, user and workflow issues[71,76].

All key elements of the vendor's training services should be clearly stated in a contract between an organization and a vendor to ensure that the hospital's specific requirements would be successfully and timely delivered[27,60]. A contract should include the following details: 1) training timelines and schedules[60,65], 2) educational content (a list of EMR modules)[60], 2) levels of training and support (initial[65], episodic or ongoing[38, 65,71,77]), 3) communication channels[27,38,65,71], 4) types of training[77] (e.g., demonstra-tions[71], simulations, how-to-build[65] instructions), 5) educational materials, 6) training delivery methods[60,71] (e.g., one-on-one sessions, group classes, practical lessons)[56,65], 7) a place[27,60] (vendor- or hospital- sites), 8) training cost[60], and others.

Although training provided by a system vendor is essential, it has several substantial disadvantages, such as high cost[47,56,79], poor vendor accessibility[3,11,47,56] and insufficient training[3,35]. A vendor would know the EMR system structure[11,56,77] and its functionalities[11,56,77], but might not understand specific hospital workflows, roles and needs of end-users and, thus, be unable to match appropriate training content to the particular environment[35,55,56]. Therefore, additional in-house training personnel who are more familiar with the hospital culture and processes would be required to provide EMR education.

IT Personnel

IT professionals could be considered as possible candidates for EMR trainers[34,40,56,64]. However, literature does not suggest they are the best option[34,36,56]. IT experts are crucial for system building and modification, but they are not quite suitable for training healthcare staff on the use of EMR[34,36]. The main reason for this is that IT specialists do not have the same workflows and do not speak the same language as clinicians, thus, it is challenging for them to explain comprehensively EMR features and applications to physicians. Consequently, the most appropriate in-house trainers for clinicians would be clinicians with technical knowledge rather than IT personnel[34,36,56].

Champions and Super-Users

Champions and super-users are recognized as the best trainers for clinicians in the majority of reviewed articles.

Champions are defined by several authors as knowledgeable in technology[6,39,44,80], trusted and well-respected[39, 44,73,80] healthcare professionals who are committed to successful EMR implementation[39,49,80]. They are clinical leaders[71] who should be involved in organizational tactical decisions on the EMR[11,53,71], communication with vendor[27,65], system selection[11,65], design[6,49], implementation[36,39] and modification[40]. Champions should be powerful[53,80], energetic[44], enthusiastic, supportive[49,53] and persuasive[34,39,73] in their activities to promote the organizational vision regarding the EMR to their colleagues[44], advocate software benefits[53,80] and encourage physicians to use a system[39,53,71]. Krall[81] lists the most important champion characteristics that include the ability to plan and facilitate regular end-user meetings, excellent time-management skills, being a good listener, conflict solving capability and strong oral and written communication skills. HIMSS[53] adds to these qualities a positive encouraging personality, non-stop can-do attitude, empathy to obstacles, nimbleness, flexibility in problem solving and humour. Identification of champions is one of the critical success factors of EMR implementation[39,49,80,82,83].

Super-users are defined as tech-savvy healthcare practitioners, who complete an extensive train-the-trainer course on the EMR from the vendor and become the in-house system experts who provide ongoing front-line support to their colleagues-clinicians[44,47, 56,65]. While looking for super-

user candidates, the following essential characteristics should be considered: 1) a high level of computer proficiency[63,65], 2) ability to learn new concepts quickly[63], 3) experience with the EMR[65], 4) excitement about an EMR system[63,65], 5) desire to help colleagues with software learning[63,65], 6) strong leadership[63] and teaching[65] skills, 7) patience[65], 8) respect from peers[63,65], 9) at least one year of experience within an organization[63]. The number of needed super-users depends on the size of healthcare facility and the number of hospital divisions (at least one person for each area is required)[56,60,73].

Super-users could play a range of roles, including the following: 1) internal system trainers for hospital staff, before, during and after EMR implementation[11,28,38,44,52,56,60,65]; 2) software educators for new healthcare staff members[38,65,71]; 3) first-points of contact to ask practical questions about EMR usage[38,63,65,71]; 4) providers of helpful hints, tips, shortcuts and techniques for better system utilization[63,84]; 5) just-in-time problem solvers for basic software issues[42,47,65]; 6) evaluators of the training program effectiveness and modifiers of this program to meet needs of end-users[28,38,56]; and 7) departmental representatives to configure software according to hospital workflows[56,71] and develop division-specific templates[56,71].

To successfully accomplish the listed responsibilities, super-users should receive in-depth training on software structure, functionalities and usage, provided by vendors[11,27,44,56,63,65,71,85]. For instance, as described by Duggan[75], in Evanston Northwestern Healthcare, IL, trainers completed an intensive six- to eight-week course with the concluding proficiency exam. Then they took a two-day "Enhance the Trainer" workshop on adult learning theory, skills improvement and effective training[75]. Finally, they prepared presentations that were videotaped and reviewed with the goal of improvement in training efficiency[75]. Super-users should constantly upgrade their knowledge (e.g., attend vendor conferences, take classes on new versions of EMR)[38,71].

The expert-users should be as accessible as possible[27,56,63,73,76]. Therefore, some of their regular duties should be removed during a system implementation, releasing time that could be devoted solely to supporting colleagues[47]. In the critical times of EMR deployment, accessibility of super-users could be even extended to overnight and weekend hours[73].

The "train-the trainer" practice is proven to be beneficial for adopting an EMR by physicians[86-94]. Super-users, as representatives of specific hospital user-teams, are able to modify EMR modules and tailor a training program to nurture each division's unique culture and workflows[28,38,56,84,95]. These users can comprehensively convey EMR information to colleagues using language that would be understandable and comfortable for them[34], providing real life examples[35], developing practice-pertinent scenarios[35], offering relevant exercises[35] and answering clinic-specific questions[35,63]. Super-users should be constantly available in-house[38,56,63], enabling flexible scheduling for hospital staff training[56] and providing ongoing peer-to-peer support[56]. EMR education by super-users is more cost effective than expensive software training by vendors[38,56]. Therefore, availability of super-users is the crucial factor for successful system training.

The terms "super-user" and "champion" are often used interchangeably[27,34,36,47,65] because of an overlap and similarity between these roles. Both, champions and super-users, represent innovators and early adaptors as described by Rogers in his theory of the diffusion of innovations[35,92]. Both serve as role models[34], leaders and educators for their colleagues. Both actively promote intensive

use of the EMR among their peers[27]. Subsequently, the same people are often appointed to take on both roles.

Training Consulting Specialists

Training consulting firms (e.g., Health Technology Services[96], TBD Consulting[69], Divurgent[24]) could provide specialized help in developing effective EMR training programs for healthcare organizations[47,76]. Some companies offer an entire package of services that include all activities related to system training (establishing training goals and strategy, planning training activities, customizing training curriculum, creating training materials, conducting on-site end-user training and support and more)[96]. Other firms provide mostly consulting help, suggesting best practices, recommending effective methodologies, facilitating communication between vendors and hospital staff to educate internal super-users and assisting with development of more effective training materials[24,69].

Consulting specialists could be valuable for their rich experience in EMR training and implementation[24,69,76,96], sharing lessons learned. However, they might have the following disadvantages: 1) high cost of services, 2) insufficient understanding of hospital workflows, 3) temporariness of provided training and 4) generalized approach to EMR education. Thus, assistance of consulting specialists should be viewed only as an ancillary service that could support developing EMR training strategy and creating an internal team of system educators.

Additional EMR Educational Sources

Helpful extra sources of information about EMRs are **online user forums**[71,85]. Some of them directly link to vendor's websites[47,63]; others represent autonomous online groups of particular software users[47]. Forums serve as share points of communication for healthcare practitioners from different sites to discuss EMR training and usage issues[63]. Online EMR user groups are valuable in that one can learn from colleagues, clarify technical and practical questions, discover effective methods of system usage and exchange experiences[47,71].

Formal[27] and informal[9] **communication among colleagues within a facility** is another beneficial way for EMR knowledge enhancement[76]. Structured user meetings could provide a platform for fruitful discussions about a system that would lead to further software learning[27]. Informal talking to peers and observing them working with the EMR could enable physicians to borrow effective strategies and important tips, ask clarifying questions, and share new ideas and opinions on system utilization[9]. Many studies prove that communication among users substantially increases EMR adoption[86,89,92,93,97-103].

5. EMR Training Timeline and Schedule

Two important processes of training planning are establishing training timeframes and scheduling educational sessions. Most articles suggest that intensive EMR training should start just before the go-live date[2,8,28,35,39,56,61,62,80] (about 3[43] to 12[54] weeks before implementation). If training is provided too early, trainees might forget what they have learned, requiring additional refresher classes during EMR implementation[55]. The only case when earlier training would be beneficial is when it is conducted as a pilot for a limited number of physicians, who would test effectiveness of a training program before applying it to all providers[29,47,75].

Since scheduling training for busy physicians can be a challenging task, the training team should have a training coordinator who would be responsible for arranging training activities and tracking training completion[60,75]. Training schedules should be flexible in training times and dates to accommodate physician needs[42,53]. It is important to provide uninterrupted training sessions when providers are free of patient care[28,35,60,71,76,95,104]. Therefore, physician-friendly training hours could include early mornings[28,35,52,71], lunch hours[28,35,71], late evenings[28,35,52,71] or weekends[7,28,56]. Regular physician workload should be reduced[2,35,41,44,53,105] during training and the initial go-live phase and gradually increased as physicians become accustomed to the EMR[2,35,105]. Some hospitals close the facility[56,78] or particular divisions for several days to accommodate EMR learning.

The duration of training could depend on different factors: 1) system complexity (a more intuitive EMRs might require less training)[6], 2) computer literacy of trainees (less prepared users would need additional training time), 3) availability of an e-learning option (less classroom training would be required)[29] and 4) character of a physician's job (e.g., an emergency physician who works in the fast-paced environment would need more training[106] than a rehabilitation therapist). Different literature sources suggest varying training times: Frisse et al.[78] - 2 to 4 hours, Kirshner et al.[95] - 3 to 4 hours, Bredfeldt et al.[7] - 4 to 5 hours, Laravie[52] - 8 hours, Fullerton et al.[107] - 8 to 10 hours, Fleming et al[57] - 10 hours (8 hours for training and 2 hours for simulation), Wood[108] - 11 hours, Health IT[71] - 20 to 24 hours and Lowers[37] - 12 days (2 to 3 days for each EMR module).

The results of a survey performed by Underwood et al.[51] showed that at least 3 to 5 days of EMR training were needed to reach the highest level of overall satisfaction by those working in their system and an optimum level of usability pertaining to basic EMR functionality. The study also revealed that use of more advanced EMR functions can require more training time (at least 1 week) to achieve reasonable ratings on ease of use[51]. However, approximately half of surveyed healthcare providers (physicians, nurse practitioners and personal assistants) reported that they received 3 or fewer days of training[51]. Another survey conducted by Aaronson et al.[25] revealed that trainees who thought that they received sufficient length of EMR training perceived their system to be beneficial with respect to time-, prevention- and accuracy-related issues and, as a result, were more likely to prefer the EMR over paper documenting.

Within training sessions, different amounts of time could be allocated to different activities (e.g. watching presentations, practicing and so on)[26]. According to Edwards et al.[26], users prefer more time allocated to hands-on activities. To ensure better comprehension of EMR educational material, it is recommended to use an incremental approach[29,38,41,52,95], breaking total training time into several brief slots[28,29,38,39,95] of 2 to 4 hours[29,52,108], so that trainees would not be overwhelmed with information[28,38,41].

According to Ash et al.[109], successful EMR implementation is more often associated with training after the go-live date than training before the system is implemented. Thus, training should not stop with the EMR implementation[33]. Follow-up training sessions should continue during[2,53,56,62] and a few weeks after the go-live period[8,28,53,62,108], endorsing adoption and utilization of a system[56]. Peck[47] suggests providing repetitive short (5 to 7 minutes) scenario-based sessions, during off-hours, to increase physicians' proficiency in their primary job-tasks. Frisse et al.[78] recommend using 10-minute blocks of refresher training at regular administration meetings. The study by Bredfeldt et al.[7] demonstrated that providers were willing to have frequent post

implementation training sessions on a variety of topics. The time required for learning complex software such as an EMR should not be underestimated. Physicians should receive adequate training before, during and after system go-live.

*6. **EMR Training Location.***

Availability of an appropriate location is one of the key factors for effective EMR training[44]. Therefore, careful considerations should be given to selection of a training place, during development of an EMR educational program[44]. The main options are on-site and off-site training[44].

On-site training is considered by Piliouras et al.[79] as the most effective, especially for the clinicians who do not have experience with computer systems, in the initial stages of EMR deployment. These authors listed the following benefits of on-site training: 1) availability of training on an as-needed basis, 2) possibility to tailor EMR education for specific user groups (e.g., hospitalists, surgeons), 3) opportunity for hands-on training within the particular hospital environment and 4) possibility for end users to learn a system, using their own hardware and their own patient data in the offline mode[79].

On-site training allows substantial flexibility in choosing different hospital locations to facilitate better training delivery. The possible training locations could include the following options: 1) meeting rooms, conference rooms or large auditoriums to provide general information on an EMR implementation strategy, communicate hospital-wide changes related to a system deployment, conduct software demonstrations, etc[38]; 2) training classrooms to arrange large- and small- group training sessions that would support theoretical and practical learning of the EMR by hospital staff[8,29,35,36]; 3) doctor's offices to conduct one-on-one educational sessions at a time free of patient care, which would allow an individualized approach and adjustment to busy physician schedules[38,95]; 4) hospital floors to provide at-the-elbow, in-person support for healthcare providers during the EMR implementation period[8,9,36] and 5) lunch or lounge rooms to conduct short refresher educational sessions for clinicians[38,46]. The survey performed by TEKsystems and HIMSS Analytics[33] showed that the majority of healthcare organizations (94%) provide classroom training.

If a hospital has several sites, the decision should be made of whether training will be centralized or decentralized[67]. Centralized training would require dedicated space for training in one of the sites[67]. Decentralized EMR education could be achieved by organizing training rooms at all sites or using a mobile training center on wheels to facilitate educational sessions in all hospital areas[67,107]. Selection of a strategy could depend on the distance between facilities, number of trainers and corporate culture[67].

The only disadvantage of on-site training could be the high cost of this approach if vendor trainers are used[79]. Using a train-the-trainer strategy, where internal super-users could replace high-priced vendors to educate healthcare staff, could significantly reduce hospital costs.

Off-site training has several variants: 1) traveling to the vendor site to receive training on how to build and use the EMR[71], 2) attending software user conferences sponsored by the vendor[38], 3)

visiting similar facilities that have implemented the same system[71] and 4) performing off-site training sessions organized by the hospital [8]. The first three options could be beneficial for super-users[38,71], champions[38,71], EMR project managers[71] and software builders[71]. Due to high traveling expenses, busy schedules of healthcare providers, a limited number of trip participants and other factors, only a small group of hospital representatives could attend these training sessions. The latter option of hospital-organized off-site EMR education could be advantageous for all end-users[8].

Dastagir et al[8] described the experience of Kaiser Permanente, a large integrated health delivery not-for-profit system in the United States, that performed an intensive 3-day off-site physician peer-led proficiency EMR training program that substantially enhanced provider self-perceived efficiency with their EMR system. Training provided outside the hospital enabled doctors to focus on software learning solely, which led to the positive program results[8]. Disadvantages of such an approach are the high cost and the need to close the facility for the time of training.

Some methods of EMR education do not require a specific place. Learning with EMR training manuals[35], flyers, CDs[35,36], videos[35,36] and Web-presentations[8,29,33,35,110,111] could be accomplished at any hospital location that has a computer, which can be used for training. If a healthcare organization allows system access from home, the training materials could be used outside of the hospital[29].

The majority of healthcare organizations use all of the described location options for EMR training in different proportions[35,36]. The selection of location would depend on size of the facility, availability of internal trainers and hospital culture[67].

7. EMR Training Materials.

One of the essential parts of preparation for EMR training is developing training materials that could be used by instructors and end-users before, during and after training sessions[30,112]. Educational materials can be very diverse[112]: 1) posters[46,111] that would be located in the healthcare personnel work spaces, providing reinforcement of the EMR strategy, containing information on the hospital intranet and contacts of resources they could use to ask questions[28,31]; 2) EMR demonstrations that would provide an overview of main system components and functionalities[73]; 3) manuals representing illustrated step-by-step instructions on how to use the system[30,35,39,63,107]; 4) videos that would lead the user through the system modules[26,30,35,36,46,63,75,111]; 5) EMR maps that would show how to navigate through common functions[44]; 6) CDs[35,36,38,60,75]; 7) web-presentations and tutorials that would help the user through the processes of using specific modules[26,36,38,39,75,113]; 8) slides and handouts that would be used for training presentations[30]; 9) quick-reference guides[7,30,31,60,75]; 10) "tip-sheet" fliers that would be readily available for clinicians at workstations[28,31,46,69,95]; 11) "how to" laminated cards, attached to computer devices, that would remind a user of the main steps for performing different actions within an application[7,31,39,69] (***Figure 1*** provides an example of shortcut cards) and 12) newsletters that would include information on system updates[31,60,75].

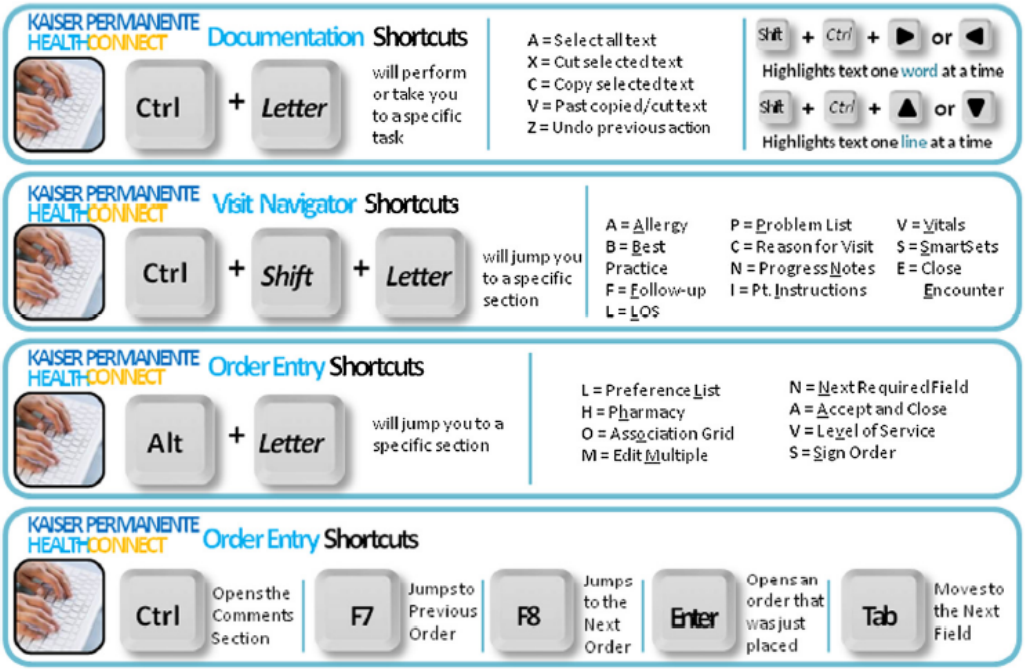

Figure 1. Shortcut cards to remind users of efficient key combinations to accomplish frequent tasks (Retrieved from Bredfeldt et al.[7]).

The first software training materials, such as system demonstrations[73], manuals[28,31,63], quick reference sheets[31], pre-recorded videos[63] and tutorials[63] should be received by a hospital training team from a system vendor[28,31,55,63,73,75]. It would be important to have included in the EMR contract expectations regarding educational materials and documentation that a vendor would need to provide[31]. Some EMR training materials might be found on the vendor site[63] and system-user forums[63]. Some workshop documentation could be borrowed from healthcare organizations that use the same system[75]. Vendor webinars could be recorded to be viewed by hospital staff when needed[55,63]. EMR educational content from a vendor is necessary, but not sufficient for the effective end-user training[35,56,58]. Customization of available training materials is often required for the particular hospital environment with specific workflows, policies and procedures[28,35,55,56,58].

When developing new training materials or modifying existing ones, a training team should remember the following principles: 1) educational content should be structured, having an introduction, agenda, body part (e.g., brief application tutorial), and conclusion or practical aspects (e.g., an interactive scenario, pertinent example, case study, quiz) [30,31,35,114]; 2) training content should be provided in a standard style, which would allow cross-training with consistent materials[47,75]; 3) information should be provided from simple to more complex (from basics to details)[35,114]; 4) content should be easily readable (bullets, spacing, appropriate font should be used)[47]; 5) data should be visualized with illustrations, screenshots[47,75,112], workflows, diagrams and tables. (***Figure 2*** provides an example of a screenshot); 6) information should be job-role-specific[29,35,63,69,75]; 7) web-presentations and tutorials should be brief[114], informative[114] and interactive[35,52,114] to engage the user; and 8) videos and web-materials should avoid distractive animation[35].

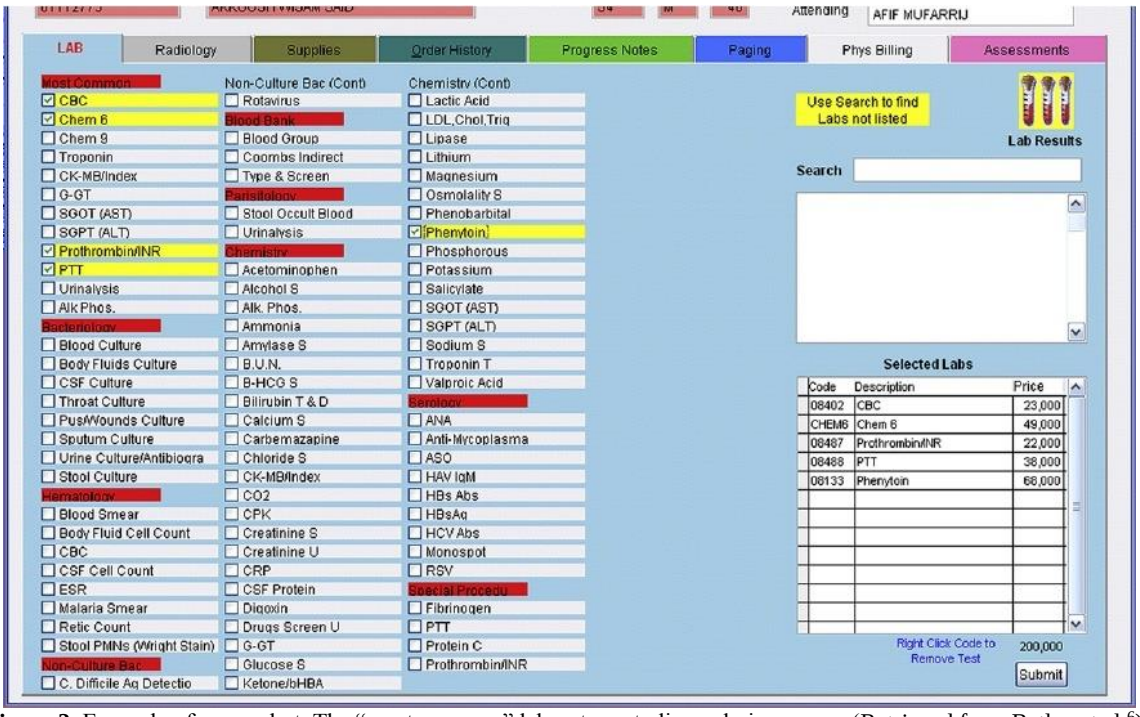

Figure 2. Example of screenshot. The "most common" laboratory studies ordering screen (Retrieved from Batley et al.[6]).

Creating training materials can require substantial amounts of time[31,75]. To speed up and simplify the process of creating educational materials, a training team could use standardized training templates, which would allow focusing on training content rather than on layout of data[31,75]. Different software options can facilitate quick and easy development of e-learning materials (e.g., Adobe Captivate)[114]. New material should be revised by the entire training team to identify and correct for flaws or omissions[47].

Developed training materials should be used before, during and after training. Prior to training, physicians should receive an email with preparatory information, including training goals, agenda, or even a training package to review[31,114]. Instructors could use training manuals, presentation slides and short guides during EMR educational sessions. After training, clinicians should receive supporting information which would be easy to carry[31] and use, such as manuals[107], tri folds[31], quick reference guides[7], "tip-sheet" fliers[31,95], cheat sheets[95], small pocket sized books[31]. Trainers should avoid providing massive and wordy training materials (e.g., a complete EMR binder for a unit) because they will likely not be used[31]. Effective educational materials could substantially enhance the results of training, supporting end-users in their learning.

8. Methods of EMR Training.

A variety of EMR training methods can often be combined to achieve better results. The main variants of system training methods are 1) demonstration of software structure and functions[7,26,28], 2) conversion of data from paper charts to the EMR[2,11,34,43,44,56,57], 3) workshops on system navigation[115], 4) role-based training[27,28,31,33-35,38,47,54,56,63,73,84,116], 5) workflow-based training[11,28,33,35,38,44,47,61], 6) team-based educational sessions[7,28,35,73], 7) scenario-based classes[28,34,35,47] and 8) simulation training[11,44,47,56,61,64, 67,73,104,106,116,118-121]. These are discussed in the next paragraphs.

Demonstration of software structure and functions

Before training on how to apply the EMR in clinical practice, a vendor or a training team should provide general information about the software. This would include communicating the organizational vision of how an EMR would change current hospital state, highlighting benefits of a system and conducting an application overview. EMR demonstrations should familiarize healthcare providers with the main system features and functions[26,28].

Conversion of data from paper chart to the EMR

Another method that could help clinicians to understand a software structure is engaging them in the process of preloading patient records into the EMR[11,34,44]. Physicians would review paper-based medical charts, extract particular information and enter it into pertinent discrete data fields of the EMR[11,34,43,44]. This task could be time consuming[2,34,43,56], but even minimal doctor involvement into data transferring would bring significant benefits[2]: 1) improvement of basic computer skills[44], 2) increased comfort and familiarity with a system[2,34,43,56], 3) learning the difference between paper and electronic data formats[2,34,43], 4) understanding how the EMR works[56], 5) acquisition of EMR navigation skills[2,44], 6) increased system acceptance[56] and 7) opportunity for physicians to evaluate the design of templates and provide informed feedback[56].

Workshops on system navigation

Because structured and fragmented EMR systems are substantially different from paper-based charts, they require new navigation skills that are not used for reading paper documents[115]. Therefore, navigation training should be an essential part of EMR education[115]. Physicians need to develop a spatial cognitive map of a system to effectively navigate through its non-linear structure, retrieving, reading and generating patient data[115]. Lack of navigation skills could lead to an inability to find relevant information and templates[115]. This would result in a preference for using narrative paper documents that summarize all data in one place rather than utilizing distributed electronic notes with data located on different screens[115]. Workshops on EMR navigation can enhance ability to work with the software and increase its adoption[115].

Role-based training

Because healthcare providers have different perspectives, expectations and needs, depending on their daily responsibilities[34], it is important to tailor training sessions to specific roles of end-users[38,63,73,84]. According to a survey performed by TEKsystems and HIMSS Analytics[33], 77% of healthcare professionals desired learning modules to be adjusted to their specific jobs (e.g., EMR education for doctors vs. nurses, resident physicians vs. attending physicians, paediatricians vs. surgeons[31]). Taking role-based training, clinicians would acquire only information on the selected system modules and functions that would be applicable to their practice[28,35,63,73,116]. This approach, which is recognized as one of the most effective in the informatics training literature[35,56], would ensure better engagement of end-users[35,56], shorten learning curves[63,116], lead to better learning outcomes[34] and result in better acceptance of the system[34].

Workflow-based training

Since implementation of an EMR inevitably affects hospital processes[35,38,62,84], it is crucial to map existing workflows and redesign them according to the new abilities inherent in the software[2,11,28,38]. To apply new processes effectively, healthcare staff would need to receive training on numerous revised workflows[11,38,44,47,84] and pertinent EMR modules that would be utilized in those workflows[28,33]. The study by TEKsystems and HIMSS Analytics[33] showed that 88% of healthcare providers highlighted a need for software modules to be tailored to specific workflows. Process-based training would allow updating and standardizing hospital policies and procedures and ensur that all clinicians understood their modified responsibilities in the new EMR environment[35,56].

Team-based training sessions.

Training on processes should also include sessions that gather the entire patient care teams with the purpose to visualize all future workflows and how they will interact[7,28,73]. Team training would require sufficient time to cover the big picture and ensure participation of all team members[73]. Upon completion of each team-based session, a summary document that outlines all new processes should be provided to hospital personnel[61] (***Figure 3*** represents an example of a workflow map that could be included in a summary document). The workflow summary document could be used as a reference in the future[61]. Team-based sessions would help to clarify hospital staff responsibilities and ensure development of collaborative processes[28,35,73].

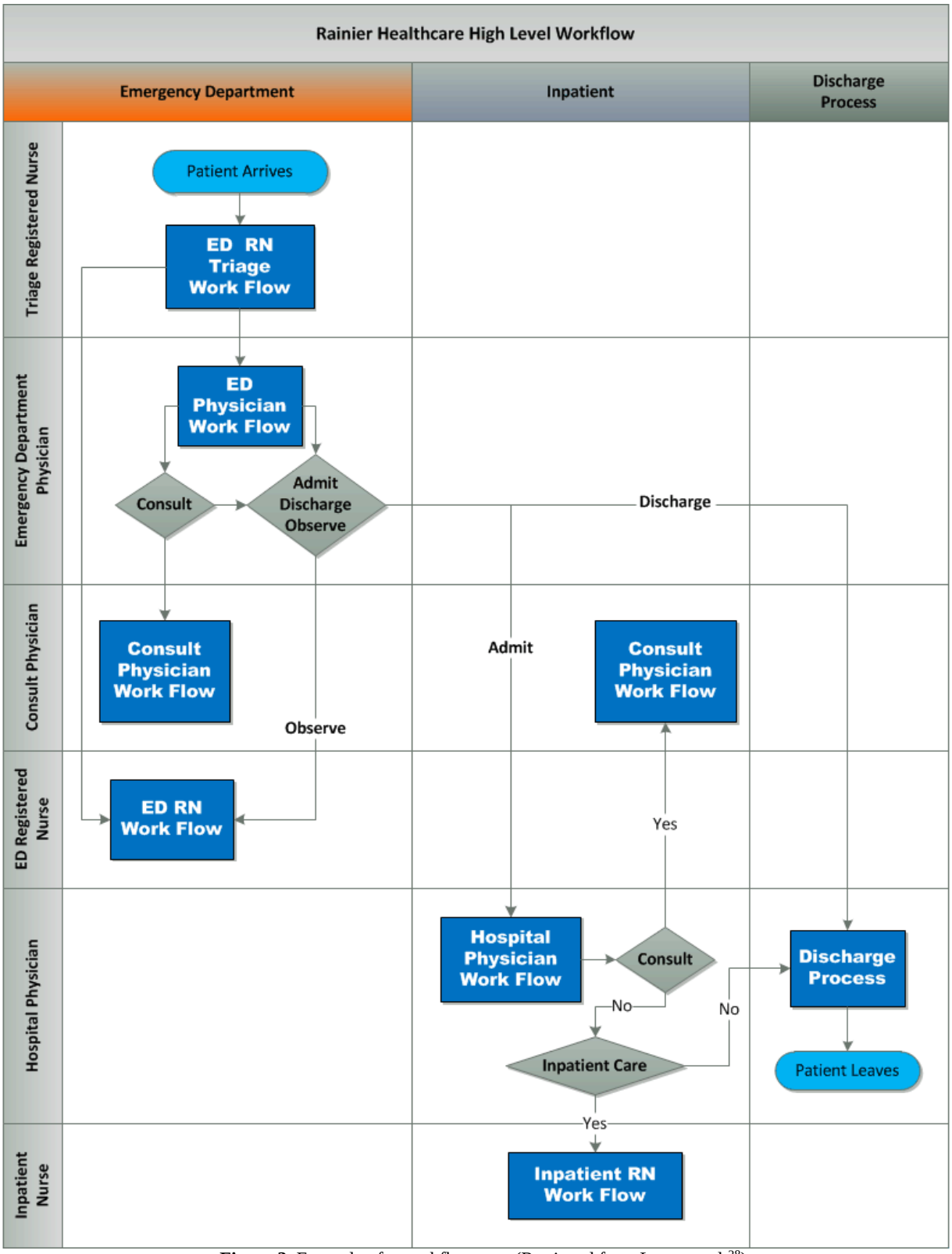

Figure 3. Example of a workflow map (Retrieved from Lopez et al.[28]).

Scenario-based training

According to adult learning concepts, people are natural problem solvers who prefer to receive life-, problem- and task-oriented training rather than content-centered instruction[35,117]. Adults are more motivated to learn if they see practical application of training information[35,117]. Scenario-based training considers these principles, incorporating real-life examples in the EMR educational process[35]. Using this method, instructors would present typical patient scenarios to physicians and give them the opportunity to interact with a system under the trainers' observation[34]. ***Table 3*** shows an example of a patient scenario; ***Figures 4-10*** include EMR screens that could be used by a physician to solve a problem in this scenario. While performing all required steps to plan and implement care for a case-patient, physicians could acquire practical knowledge of an EMR system.

Table 3. An example of a patient scenario (Adopted from Lopez et al.[28]).

	The Patient Scenario
Current Complaint	65-year-old female was transported to the Emergency Room via ambulance with severe left hip pain after following a fall on the ice.
Past History	Patient suffered a Colles' fracture two years earlier that required a cast. Following this fracture, her orthopedist diagnosed her with moderate osteoporosis on the basis of a dual energy x-ray absorptiometry.
Signs and Symptoms	Patient reported severe left hip pain, rating it as 8 on a scale of 1 to 10. She held her hip in a flexed position and could not tolerate extension. Radiography of the left hip and leg were taken.
Diagnosis	Pathologic fracture in the proximal end of the left femur.
Treatment Recommended	Total hip replacement on the left.

Figure 4. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Logging on to the application with a password (Retrieved from Lopez et al.[28]).

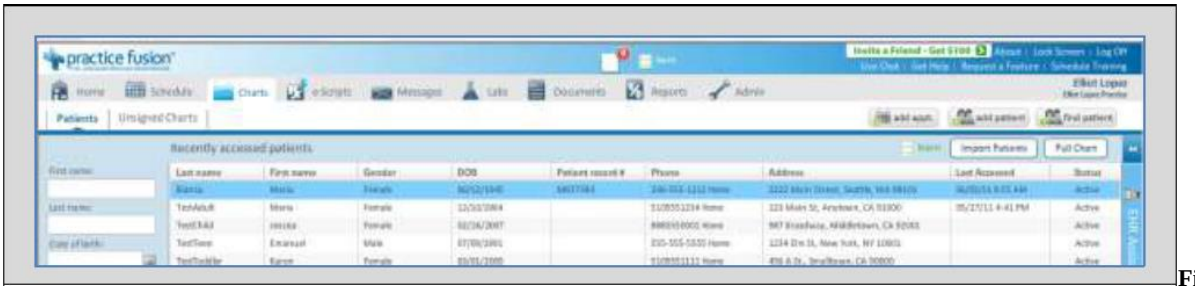

Figure 5. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Locating the patient record (Retrieved from Lopez et al.[28]).

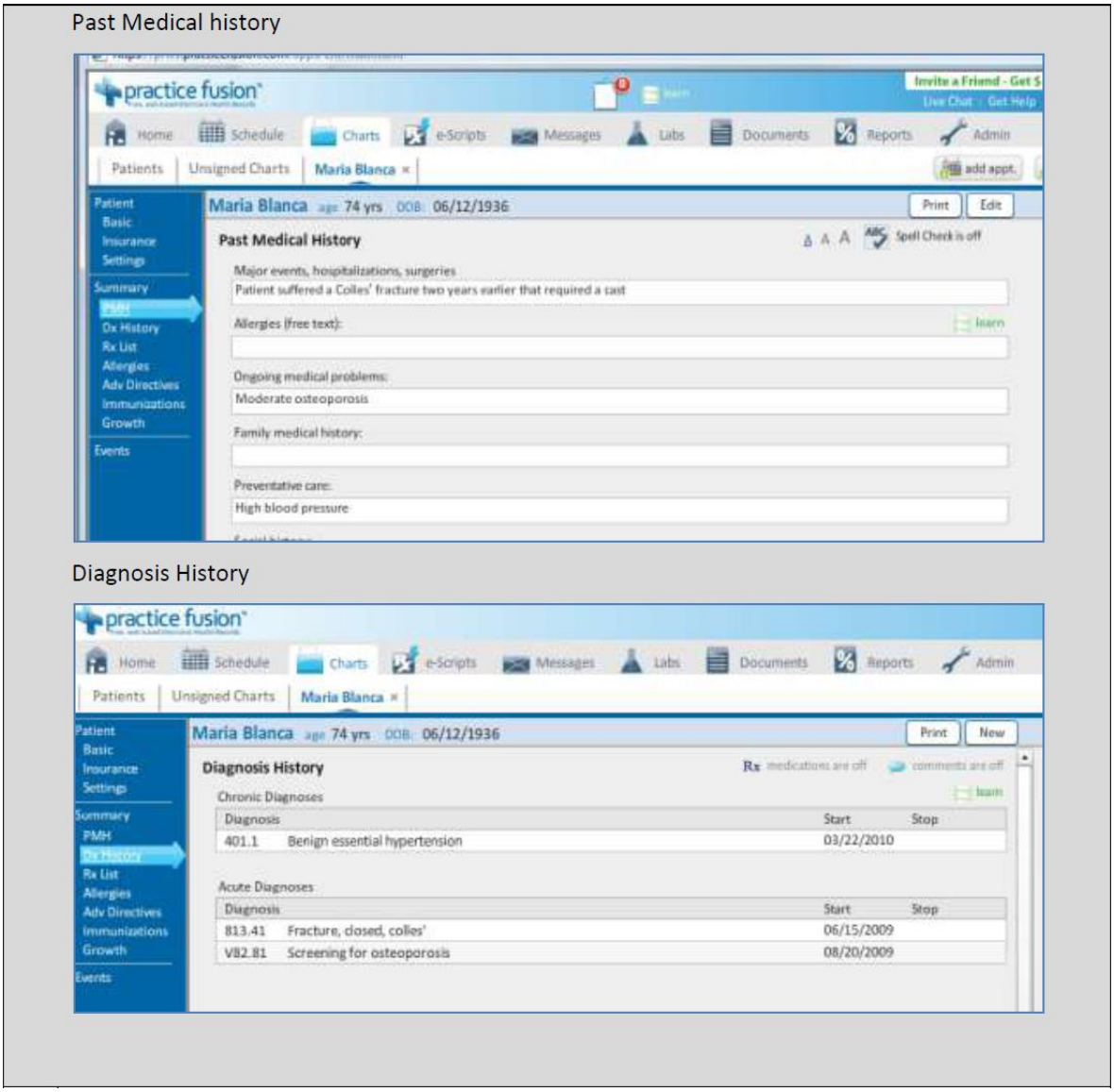

Figure 6. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Reviewing past results and prior visit documentation (Retrieved from Lopez et al.[28]).

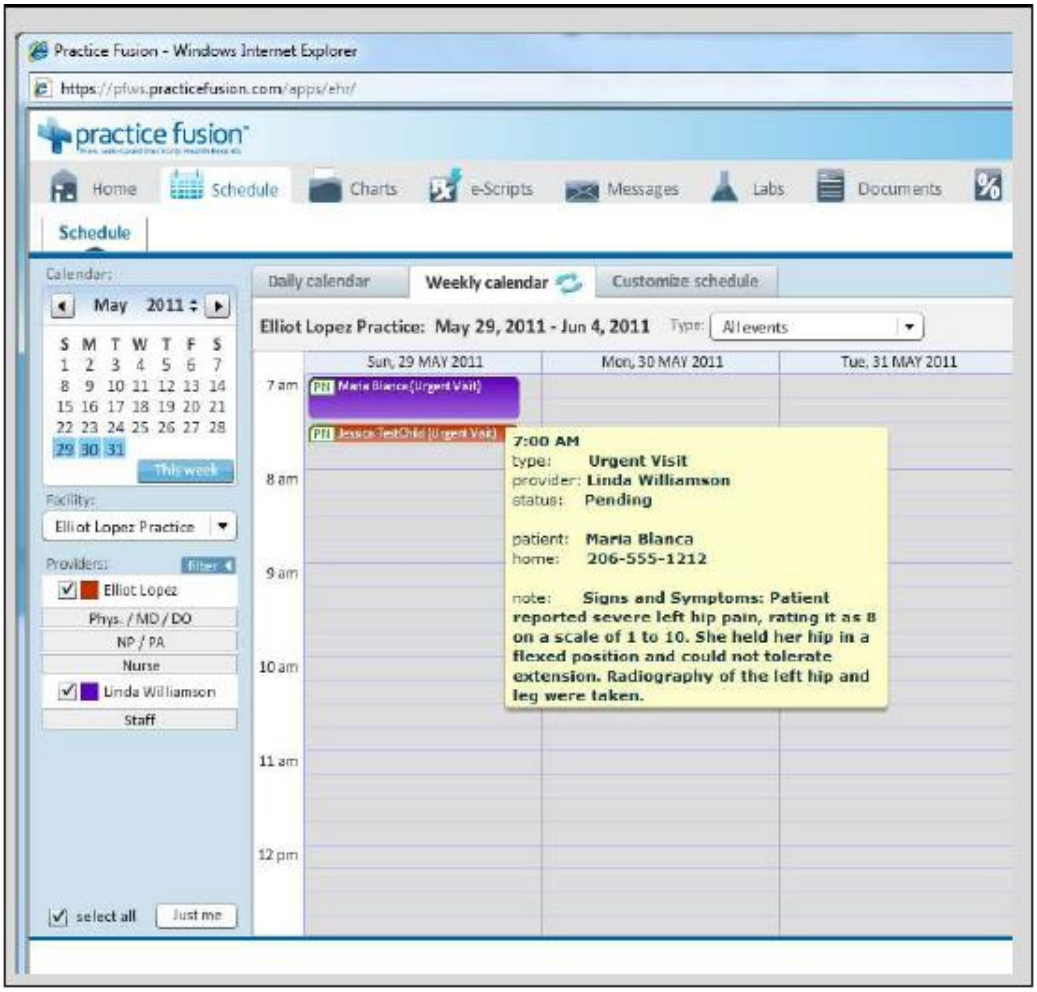

Figure 7. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Reviewing history of present visit and visit reason (Retrieved from Lopez et al.[28]).

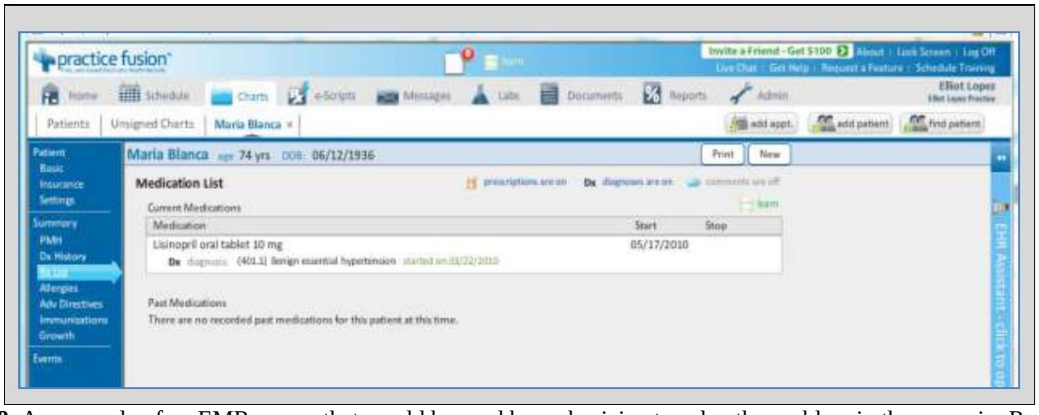

Figure 8. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Reviewing allergy and medication history (Retrieved from Lopez et al.[28]).

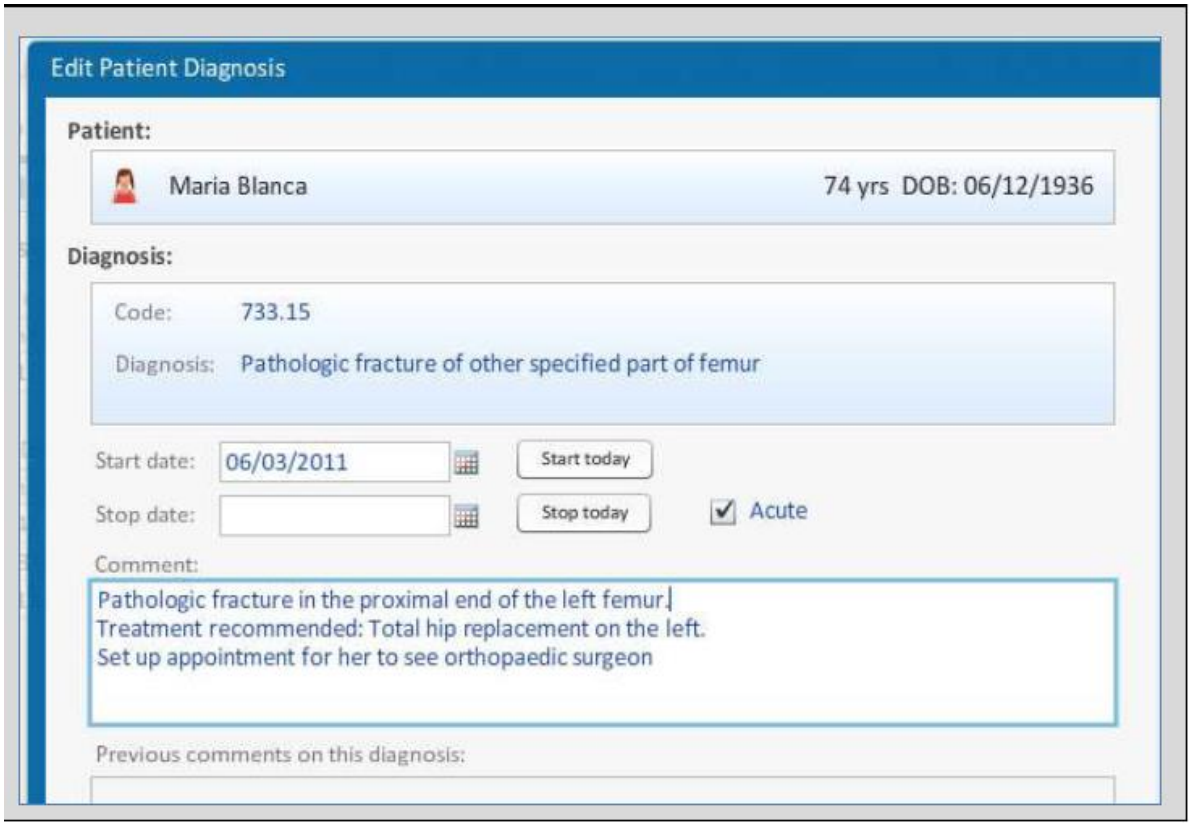

Figure 9. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Performing direct patient assessment (Retrieved from Lopez et al.[28]).

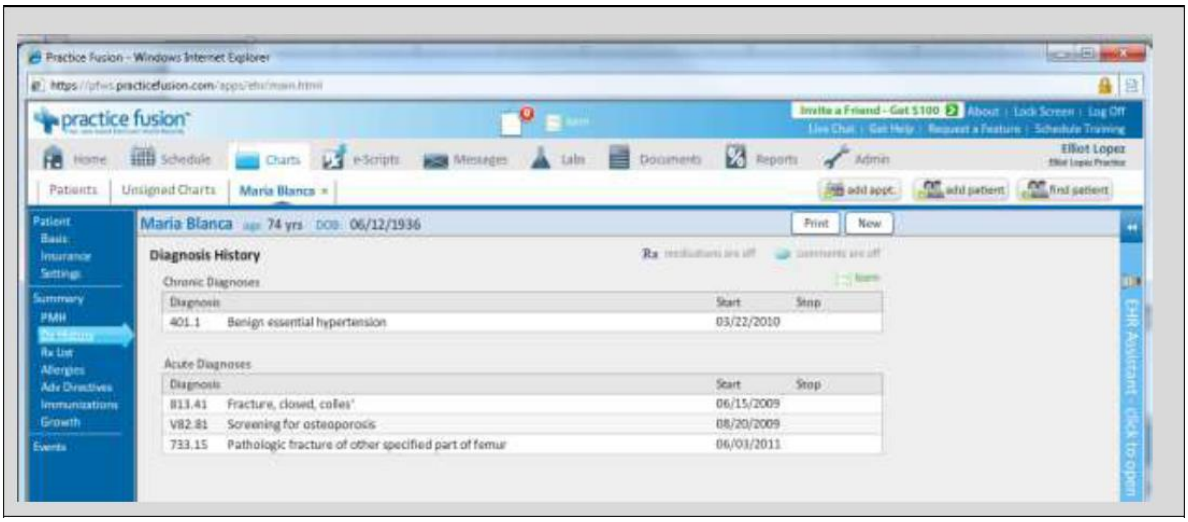

Figure 10. An example of an EMR screen that would be used by a physician to solve the problem in the scenario. Performing and document treatments (Retrieved from Lopez et al.[28]).

Simulation training.

Trainees often find translating EMR theoretical instructions into a real-life environment challenging[8]. To reinforce information received during EMR training and be able to apply it into practice, clinicians should take simulation sessions[11,47,73,118]. Simulation is a methodology that closely replicates multiple aspects of real-world situations to create a safe environment for testing and training[64,119].

For example, as described in a study by Chelton[64], simulation could be used for physicians to practice integration of the EMR into their communication with patients. A simulation session could be videotaped for later reviewing, analyzing and commenting by a trainee, his or her colleagues, the EMR instructor and a patient-actor[64]. Feedback provided on the user performance could help improve existing practice[64].

To serve as an effective educational tool, simulation should be carefully planned to define subjects, tasks, scenarios, requisitions, data collection means, analysis methods and other issues[64]. Simulation could provide multiple benefits for EMR training: 1) practice of system usage in a realistic and safe environment[73,120,121], which is especially important for clinicians who work in fast paced facilities (e.g., the intensive care unit, emergency department)[106,119], 2) opportunity for experiential EMR activities in test[116,122], 3) increase of physician confidence with software navigation and usage[64,122], 4) possibility to develop an individualized approach to work in the EMR[44,64,116], 5) opportunity to learn how to incorporate software utilization into the patient-provider interaction[64,104], 6) additional chances to identify and address EMR process gaps in a simulated environment[64,106] and 7) increased understanding of the software value that could lead to better EMR adoption[64].

To maximize the training effect, all listed methods of EMR education should be used in combination, supporting different needs and requirements of healthcare professionals.

APPROACHES TO EMR TRAINING

EMR training can be delivered in various ways, depending on the healthcare organization diversity, resources, capabilities and constraints[29]. Specific needs of end-users should also be taken into consideration[31,34] in selecting the most suitable approach for each group of learners. EMR instructors can choose from the following training delivery modes: 1) instructor-led classroom training[26,28,29,33,34,35,44,64,95,123], 2) one-on-one training[9,28,34,35,52, 64,95,97], 3) hands-on practice sessions[2,7,9,26,34,36,69,124], 4) e-learning[8,26,28,29,35,36,37,38,52,55, 58,64,69,95,110,111,125], 5) telephone[8,11,36,38] and e-mail[36,78] enabled support and 6) blended training[7,26,29,31,34-37,69,75,78,126]. Each is discussed in the following sections.

Instructor-led classroom training.

Classroom training is recognized as a gold standard of training[35] and is used by most healthcare organizations solely or in combination with other delivery modes[33]. Classroom training could be arranged for small (less than 10 people) or large (10 or more people) groups[95] and organized for particular specialists or mixed teams[44]. Instructor-led classroom training represents didactic lessons with lectures that provide baseline familiarity with the EMR[26,34]. A trainer typically conducts guided observation, describes system structure and demonstrates main software functionalities[26,28]. To create an engaging environment and stimulate critical thinking, an instructor encourages learners to ask questions, provides real-life examples and initiates discussions[29,35]. In a collaborative atmosphere, healthcare professionals can effectively acquire EMR knowledge[35].

Instructor-led classroom training has many benefits as it allows creating a productive communicative environment, answering users' questions, addressing various learning styles,

advertising the EMR project and evaluating the level of proficiency achieved by learners and receiving direct feedback from trainees[35]. However, this delivery mode has several disadvantages: 1) the need for resource allocation (instructors, classrooms, computers and others), 2) challenges to tailor the education for all users' individual paces and 3) long educational sessions, which could negatively affect information absorption[35].

One-on-one training.

Instructor-led training on an EMR could also be provided individually[28,34] to facilitate the specific needs of an end-user[95]. This mode of delivery is particularly preferable among physicians, who value one-on-one training more than traditional classroom instruction[9,35]. The study conducted by Kirshner et al.[95], which surveyed clinicians in a large health maintenance organization, reported that one-on-one training on computer information systems was more effective than other teaching methods. The mean scores of the delivery modes' effectiveness, measured with the 5-point Likert scale (from 1-not effective to 5-very effective) were 4.5, 3.8, 2.6, and 2.9 for one-on-one, small group, classroom and web-based training, correspondingly[95]. Most of the healthcare providers (96%) agreed that the individual educational sessions were worth the time spent demonstrating high levels of satisfaction with the personalized approach[95]. Most (98%) would recommend one-on-one training to their colleagues[95]. A high correlation was discovered between user satisfaction with the training mode and the subsequent increase in efficiency of the computer information system use[95].

One-on-one training is beneficial for several reasons: 1) specific weaknesses of a learner can be identified and addressed[95]; 2) user's questions can be promptly answered[52]; 3) training can be adjusted to the individual learning style and pace of a clinician; 4) a level of achieved user proficiency with an EMR system can be easily evaluated; 5) a trainee can provide direct feedback on the lesson and 6) time and place for EMR training can be adjusted to facilitate a busy physician's access[95]. The main disadvantage of one-on-one training is its high cost[64,97].

1. ***Hands-on practice sessions***

Individual and group training can incorporate the practical aspects of EMR training, allowing providers to use the system while being observed by the instructor[7,26]. Active learning is recognized by physicians as the most effective part of instructor-led training[2,7,26,34]. This is because hands-on activities help acquire knowledge and skills that are relevant to clinicians' individual work patterns[7,26], build specific tools that can be used in the real practice[7], gain confidence in the ability to apply the EMR appropriately and effectively[34] and recognize the value of a system and achieving better learning outcomes[34]. Edwards[26] highlights that adult learners want increased amounts of time devoted to hands-on activities. Several studies indicated that physicians would prefer to learn through using the EMR in practice rather than in traditional classroom settings[9,34,124].

2. E-learning

Another option that could be used for EMR training delivery is virtual training, or e-learning. The main modes of e-learning are **web-conferencing**[35,38,55], which enables remote group training, one-

on-one coaching and ongoing support and a **Learning Management System (LMS)**[69,125] that allows managing trainees, tracking training activities and providing training content[58].

Web-conferencing is a tool that is commonly used by EMR vendors, who often conduct Webex or GoToMeeting sessions on-line[38,55]. This means can also be utilized by healthcare organizations that have several sites. To provide effective education, web-conferencing systems have to meet the following requirements: 1) effective replication of a variety of training methods, including group, one-on-one and supportive training, 2) a *high-usability level, 3) facilitation of day-to-day collaboration, with enterprise grade scalability, reliability and security, 4) integration with other electronic systems, 5) support of a mobile workforce*[58]. Web-conferencing is beneficial as a mode that allows distant training[55,58] and communication at a lower cost[35,55]. However, it does not support hands-on activities and close interaction, which can reduce effectiveness of the EMR education[55,111].

LMSs are widely used in hospitals for asynchronous on-line training[35,69]. The main idea of e-learning provided through LMSs is to transform classroom EMR education into equipollent technology enabled training[26,35]. To accomplish this, a LMS has to meet the following requirements: 1) support electronic self-registration, 2) provide a means of enrolment, 3) facilitate tracking of training and learners' progress[125], 4) enable notifications, 5) support self-paced training and 6) facilitate rapid creation of textual, visual, interactive training content and rich media[58]. Many effective LMSs are available including AT&T Connect[58], BayCare[69], Moodle[29] and others.

On-line training has multiple advantages: 1) cost-effectiveness[29,35,58], 2) possibility to train a large number of users[29,35,58], 3) less training resources and training time required [29,58,69], 4) modifiability of training materials[35,58] to match varying learning styles and levels[28,35], 5) ability to facilitate a trainee's individual pace[28,35,52,58,95], 6) possibility to review training sessions[26,28,69], 7) constant training accessibility and availability[28,29,35,52,125], 8) additional exposure of clinicians to electronic technology[28,35], 9) ease of tracking participation[58,125] and 10) scalability of material distribution[58,125]. However, virtual education has also several disadvantages: 1) LMSs require a certain level of computer literacy[37]; 2) e-learning does not support a communicative environment; 3) trainees have no opportunity to ask questions; 4) if training materials are not comprehensive, users can develop negative attitudes, which could affect EMR adoption[35] and 5) it is hard to evaluate the level of acquired skills[35].

3. Telephone and e-mail to support training

Some authors mention usage of the telephone[8,11,36,38,54] and email communica-tion[7,36,54,78] for training. However, these means should be utilised only as supportive tools for updates[38,78], quick guidelines[36,54,78] and follow ups[7,34] due to their low effectiveness for EMR education[11].

4. Blended training

All listed training delivery modes have strengths and weaknesses, which makes none of them prefect for all educational purposes. Therefore, to achieve maximal EMR training effectiveness, methods should be applied in combination[35]. The literature suggests that blended training or mixed methodology is the best practice of EMR education[34-36,75].

Different variations of training combinations can be effective[34,36,69]. However, the majority of articles recommend the following strategy: 1) using instructor-led (individual or group) training to introduce a new system or module[7,26,29,31,35,37,75] and teach how to perform e-learning[29,35], 2) putting emphasis on hands-on activities to improve practical skills[7,26,34,37], 3) providing supplementary materials as quick reference guides (e.g., manuals, reminders)[7,75], 4) utilizing e-learning for the reinforcement of acquired knowledge, upgrades and refreshing sessions[31,35,37], 5) distributing newspapers to inform about periodic updates[36,75,78], 6) applying preview panes[75], emails[78] for urgent communication, 7) providing CD-ROMs for remote users[75] and 8) using the telephone for support[36].

As blended learning takes the best from each methodology, it has multiple advantages: 1) cost effectiveness[29,35]; 2) the potential to reach a large number of users[29,35,75]; 3) high flexibility that allows adjustment to different learning styles, levels of competency and pace[26,29,35,75]; 4) support of communication with different means, which can lead to better trainee engagement; 5) efficient allocation of resources (instructors, computers, classrooms, and others)[26,29,35] and 6) better learning outcomes. The main disadvantage of blended training is that it has no universal recipe of the best mix of modes. Therefore, each organization should adjust methodologies according to its unique training needs and requirements[34].

Measurement of training effectiveness

EMR training requires evaluation to demonstrate its effectiveness and ways of improvement. The 4 main training assessment categories are learners' reaction[29,60,69,75,127], achieved EMR competency[29,69,75,127], knowledge transfer[29,69,75,127] and return on investment (ROI)[29,75,127]. Each is described below.

Evaluation of the users' reaction is crucial for identifying the strengths and weaknesses of training programs, defining perceived usefulness of training for development of knowledge and skills on the EMR, collecting requirements for improvement of teaching methods and recognizing new topics to incorporate in further curricula. The most commonly applied tool for reaction assessment is a satisfaction survey[8,26,60,75,95]. A survey can be anonymous[26] or named and mandatory or voluntary[26], provided to trainees immediately[75] or sometime after the educational session and presented in electronic[8,26,75] or paper-based[95] format.

The following groups of questions are usually included in a survey: 1) demogra-phics[8,26,95] (e.g., name, age, specialty, experience with EMR), 2) satisfaction with training methodology[8,52,95,127] (e.g., quality of course execution[26], instructor work[26,75,95], training materials[26,75], facilities[75]) and 3) a perceived level of EMR proficiency resulting from training[8,95]. A Likert scale is often used to structure questions with the appropriate answer rating[8,26]. Some questions can be open-ended to encourage expressing individual concerns[8,95]. An example of questions for the satisfaction survey is presented in ***Table 4***. After collection of replies, statistical analysis should be performed to obtain results[8,26,95]. If preliminary surveys[26] were done before, comparison of obtained data can provide valuable information on training process improvement[8,52].

Another means of user reaction evaluation is observation of training sessions[29,127]. Instructors can observe users in interaction and their engagement in an educational process[127]. This evaluation

method can be informal (to obtain general impression on trainees' reaction) or highly structured (to focus on particular points of EMR training evaluation)[127]. Interviews can also provide direct feedback for the clinician reaction assessment[29].

Table 4. An example of questions for a satisfaction survey (Adopted from Edwards et al.[26]).

Satisfaction with Training Survey
Nine Objective Questions
1. The class materials were organized in a logical manner and were a useful aid to learning. **2.** The exercises and examples reinforced the skills taught. **3.** The class has provided me with valuable information about the (name of specific HIT system) that I can apply to my job. **4.** Overall, I thought this was an effective class. **5.** The instructor made good use of available time. **6.** The instructor was well prepared and organized. **7.** The instructor's presentation was clear and easy to understand. **8.** The instructor was knowledgeable on the subject matter. **9.** The instructor was receptive to questions and comments.
Subjective questions
1. Please tell us which materials you found useful and explain why. **2.** What was the most valuable information you learned in this class? **3.** What was the least valuable information you learned in this class? **4.** Please give comments and/or suggestions for this class.

Evaluation of competency allows examining whether EMR training content has been learned by clinicians[28,36,69,127]. This evaluation can be done by applying objective assessment means, such as tests with questions that address training goals[28,69,127] or practical exercises that require trainees to complete a set of tasks in a system[28]. Tests can be provided online through an LMS[29,69]. The results of a proficiency evaluation are valuable for the identification of future super-users and physicians who might need additional support[36]. They also demonstrate effectiveness of EMR education, indicating particular points that require improvement. Information on training proficiency should be documented in competency checklists[28], report cards[7] or user portfolios[127], individually for each provider. These performance records should be provided to physicians[7] along with certificates of training completion[29] to help them in establishing personal objectives and track progress[7]. An example of the competency checklist is presented in ***Table 5***.

Table 5. An example of a competency checklist (Adopted from Lopez et al.[28]).

Competency Checklist

Position:_____ Employee Name:_____ Department:_____

Role:_____

Method of Instruction Key **I** – Instructor-led **E** – e-Learning **O** – One-on-one **S** – Super-user-led	**Method of Evaluation Key** **O** – Observation **T** – Test **V** – Verbal Review	**Self-assessment by Employee**				**Validation of Competency**		
		Never Done	**Needs Review/ Practice**	**Competency Achieved**	**Method of Instruction** (Use Key)	**Date**	**Evaluator**	**Evaluation Method** (Use Key)

A. Prerequisite computer skills							
Mouse & keyboard							
Basic PC operations							
Browser navigation							
Windows and Office applications							
Etc.							
B. EMR system access							
Sign on							
Access authorized modules and functions							
Navigate between screens & applications							
Commonly used buttons & function conventions							
Etc.							
C. Access patient information							
Patient search & select							
View and print basic information							
Etc.							

Knowledge transfer evaluation defines whether physicians have changed their behaviour, applying learned EMR skills in their practice[29,69,75,127]. Competency checklists could be used to facilitate assessment of system application on-the-job[69]. A training team could produce general periodical reports on EMR adoption rates, such as percentage of EMR users in an organization, the average number of recorded encounters per patient and other measures[111].

Evaluation of ROI can be conducted to determine the cost-effectiveness of training and justify future investments in EMR education program[29,75,127].

Ongoing support

According to a study by TEKsystems and HIMSS Analytics[33], healthcare providers rank the requirement for training support as the most critical success factor for EMR implementation. Continuous training is proven to increase adoption and efficient use of a system[7,9,111]. Thus, while developing their training strategy, a training team should take into consideration the need for adequate ongoing support. An effective support approach includes the following components: 1) providing intensive (24 hours per day, 7 days per week[9,36,46]) support during and immediately after go-live period[2,11,27,28,34, 104,107, 108], 2) allocating sufficient resources and establishing points of contact for EMR support[37,108], 3) involving super-users, champions or both in training activities as they can be the most effective providers of EMR education[2,4,8,36,42,44,54], 4) utilizing multiple communication channels (email[54], telephone[34,36,54,123], at-the-elbow in-person contact[2,9,36,54] and others) to enable prompt help to physicians, 5) encouraging peer-to-trainer and peer-to-peer communication on EMR issues through a specialised web-site[28,54]; 6) setting regular meetings for EMR educational purposes[34,47,63,123], 7) distributing numerous training materials in different formats[54,95], 8) offering follow-up training sessions[28,34,37,41,44,78,79,95,111] and short refresher sessions[44,78,79], 9) conducting active monitoring of user needs and practicing proactive training to bridge identified gaps[63,111], 10) educating clinicians on EMR upgrades[39,71,78,79,116], 11) providing advanced proficiency training[8,28,34,41,95] and 12) developing and maintaining an EMR educational program for new employees[44]. Sufficient support will facilitate physicians in their endeavour to embrace all necessary functionalities of the EMR.

Discussion

The objective of this paper was to investigate current practices of EMR training for physicians that facilitate EMR system adoption in hospitals. On the basis of the narrative literature review, I provide recommendations on the best practices of EMR education for doctors in hospital settings.

Recommendations of Best Practices for Inpatient Physician Training on EMR

1. Strong organizational commitment to successful EMR implementation is necessary for development of effective system training programs because it ensures the following critical success factors:

- hospital-wide communication of the common vision of care transformation and quality improvement through adequate system utilization;
- early engagement of physicians in the EMR initiative, including software selection, governance decisions, system build, implementation and configuration;
- recognition of EMR training as a necessary prerequisite to EMR deployment and making training mandatory at the executive level of an organization;
- sufficient investment in EMR education.

2. To define an appropriate educational approach, thorough planning of EMR training should be conducted in three phases: 1) training needs assessment, 2) ensuring an appropriate level of basic computer skills of physicians, 3) development of a detailed training plan, aligned with the organizational strategy. An educational plan should include goals and objectives, segmented target audience, types of training, delivery modes, resources, timelines and schedule, educational content, training materials, standards, logistics, tracking methods and evaluation instruments. It is preferable to divide EMR training process into sequential logical steps and apply phased educational strategy rather than big-bang, partitioning training by software modules, hospital departments, or physicians.
3. System trainers should be defined at early phases of the EMR project to ensure their engagement in processes related to software preparation and implementation. Vendors, IT professionals, consulting training specialists, champions and super-users should be considered as candidates, with the notion that the latter two are the most effective instructors, according to literature[27,34,36,39,47,49,65,80,82,83]. Online user forums and peer-to-peer communication should be taken into account as additional EMR educational sources.
4. EMR training should start just before go-live date and continue during and after system implementation. The duration of initial training should be no less than 3 to 5 days with application of an incremental approach by dividing total educational time into 2- to 4-hour sessions. To accommodate busy physicians, training schedules must be flexible, including after-hours sessions when they are free of patient care responsibilities. Regular doctor workload should be reduced during the initial go-live phase, to accommodate practical learning.

5. The options for training location should be considered, choosing between on-site (hospital meeting rooms, training classrooms, physicians' offices, hospital floors, lunch and lounge rooms) and off-site training (attending vendor facilities, software conferences, other hospital sites and hospital organized off-site training sessions). On-site education is preferable as it is more flexible and convenient for learners.
6. To accommodate various physician needs for EMR training, multiple training materials should be developed and provided, including posters, EMR demonstrations, manuals, videos, EMR navigation maps, CDs, web-presentations and tutorials, slides and handouts, quick-reference guides, "tip-sheet" fliers, "how to" laminated cards, newsletters, brochures and others. Training content has to be structured, readable, visual, attractive, informative, role-specific and comprehensive to support high absorption of information and skills.
7. To achieve better learning outcomes, a combination of training methods must be used, including demonstrations of EMR structure and functions, data transfer from a paper chart to a system, system navigation lessons, role-based classes, workflow-based training, team-based educational sessions, scenario-based workshops and simulation training.
8. The following training delivery modes can be applied for EMR training for physicians: 1) instructor-led classroom training, 2) one-on-one training, 3) hands-on practice sessions, 4) e-learning, 5) remote telephone- enabled support and 6) e-mailing. All of them have strengths and weaknesses; thus, a blended approach that combines listed modes should be used.
9. Evaluation of EMR training effectiveness is crucial for improvement of educational processes. The 4 assessment methods that should be applied are evaluation of learners' reaction, competency testing, knowledge transfer evaluation and estimation of ROI.
10. Since ongoing support is one of the critical factors of successful EMR adoption, the following tactics should be used:1) ensuring round the clock support during and immediately after EMR implementation, 2) allocating an adequate amount of resources for support, 3) involving champions/super-users in training, 4) establishing numerous communication channels to enable prompt help to users, 5) utilizing a specialised web-site for peer-to-trainer and peer-to-peer communication, 6) conducting recurring meetings for discussion of EMR issues, 7) distributing multiple training materials, 8) offering follow-up, upgrading, refresher and advanced EMR educational sessions, 9) monitoring user needs and addressing them with proactive training and 10) providing training programs for new employees.

Limitations

The non-systematic review has some limitations:

1. This paper was devoted to encompass information on an entire training process and serve as a general guide for EMR instructors. Each section could be investigated deeper to retrieve more detailed data.

2. Since, little literature focused specifically on EMR training for physicians in hospital settings, articles devoted to education of other clinical staff in other medical settings were also used for the review. Further research is needed to investigate EMR training of inpatient doctors.
3. The 3 databases that were searched did not provide sufficient scientific data on the topic of interest. Additional information was retrieved from sites of organizations relevant to EMR implementation. This information represented more practical knowledge with a lower level of scientific evidence.

Conclusion

Physician training is an important aspect of EMR implementation that substantially influences system adoption. Thus, great effort should be devoted to developing an appropriate educational strategy for a healthcare organization. A variety of tools, approaches and methods, described in this paper, could be applied to create a beneficial and effective training program. For each hospital, training should be done differently to align with the particular corporate culture, specific healthcare processes, the EMR system itself and the organizational environment.

REFERENCES

1. McGinn CA, Grenier S, Duplantie J, Shaw N, Sicotte C, Mathieu L, Leduc Y, Légaré F, Gagnon MP. Comparison of user groups' perspectives of barriers and facilitators to implementing electronic health records: a systematic review. BMC Med. 2011 Apr 28;9:46.
2. McAlearney AS, Sieck C, Hefner J, Robbins J, Huerta TR. Facilitating ambulatory electronic health record system implementation: evidence from a qualitative study. Biomed Res Int. 2013;2013:629574.
3. Ajami S, Bagheri-Tadi T. Barriers for adopting electronic health records (EHRs) by physicians. Acta Inform Med. 2013;21(2):129-34.
4. Castillo VH, Martínez-García AI, Pulido JR. A knowledge-based taxonomy of critical factors for adopting electronic health record systems by physicians: a systematic literature review. BMC Med Inform Decis Mak. 2010 Oct 15;10:60.
5. Likourezos A, Chalfin DB, Murphy DG, Sommer B, Darcy K, Davidson SJ. Physician and nurse satisfaction with an electronic medical record system. J Emerg Med. 2004; 27(4): 419–24.
6. Batley NJ, Osman HO, Kazzi AA, Musallam KM. Implementation of an emergency department computer system: design features that users value. J Emerg Med. 2011 Dec;41(6):693-700.
7. Bredfeldt CE, Awad EB, Joseph K, Snyder MH. Training providers: beyond the basics of electronic health records. BMC Health Serv Res. 2013 Dec 2;13:503.
8. Dastagir MT, Chin HL, McNamara M, Poteraj K, Battaglini S, Alstot L. Advanced proficiency EHR training: effect on physicians' EHR efficiency, EHR satisfaction and job satisfaction. AMIA Annu Symp Proc. 2012;2012:136-43.
9. Holden RJ. What stands in the way of technology-mediated patient safety improvements? A study of facilitators and barriers to physicians' use of electronic health records. J Patient Saf. 2011 Dec;7(4):193-203.
10. Boonstra A, Broekhuis M. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions.BMC Health Serv Res. 2010 Aug 6;10:231.
11. Hummel J, Evans P. EHR implementation with minimal practice disruption in primary care settings: the experience of the Washington & Idaho Regional Extension Center. Qualis Health [Internet]. 2012 Nov [cited 2014 Jan 5]. Available from: http://www.healthit.gov/sites/default/files/ehr-implementation-wirec.pdf
12. Vishwanath A, Scamurra SD. Barriers to the adoption of electronic health records: using concept mapping to develop a comprehensive empirical model. HIJ. 2007 Jun;13(2):119-34.
13. Terry AL, Thorpe CF, Giles G, Brown JB, Harris SB, Reid GJ, Thind A, Stewart M. Implementing electronic health records: key factors in primary care. Can Fam Physician. 2008 May;54(5):730-6.
14. Price M, Singer A, Kim J. Adopting electronic medical records: are they just electronic paper records? Can Fam Physician. 2013 Jul;59(7):e322-9.

15. Police RL, Foster T, Wong KS. Adoption and use of health information technology in physician practice organisations: systematic review. Inform Prim Care. 2010;18(4):245-58.
16. Or C, Wong K, Tong E, Sek A. Private primary care physicians' perspectives on factors affecting the adoption of electronic medical records: A qualitative pre-implementation study. Work. 2013 Dec 17.
17. Miller RH, Sim I. Physicians' use of electronic medical records: barriers and solutions. Health Aff (Millwood). 2004 Mar-Apr;23(2):116-26.
18. Graham-Jones P, Jain SH, Friedman CP, Marcotte L, Blumenthal D. The need to incorporate health information into physicians' education and professional development. Health Aff (Millwood). 2012 Mar;31(3):481-7.
19. Pageler NM, Friedman CP, Longhurst CA. Refocusing medical education in the EMR era. JAMA. 2013 Dec 4;310(21):2249-50.
20. Stephens MB, Gimbel RW, Pangaro L. Commentary: The RIME/EMR scheme: an educational approach to clinical documentation in electronic medical records. Acad Med. 2011 Jan;86(1):11-4.
21. Kushniruk A, Borycki E, Joe R, Otto T, Armstrong B, Ho K. Integrating electronic health records into medical education. In: Ho K, Jarvis-Selinger S, Novak Lauscher H, Cordeiro J, Scott R, editors. Technology enabled knowledge translation for eHealth: principles and practice, healthcare delivery in the information age. Canada. Springler Science+Business Media; 2012.
22. Ludwick D, Manca D, Doucette J. Primary care physicians' experiences with electronic medical records: implementation experience in community, urban, hospital, and academic family medicine. Can Fam Physician. 2010 Jan;56(1):40-7.
23. Noraziani K, Nurul' Ain A, Azhim MZ, Eslami SR, Drak B, Ezat S, Akma ASN. An overview of electronic medical record implementation in healthcare system: lesson to learn. WASJ. 2013;25(2):323-32.
24. Mercer L, Felt P. Designing your EMR training program. Divurgent [Internet]. 2014 [cited 2014 Feb 2]. Available from: http://www.divurgent.com/images/EMRTrainingProgram.pdf.
25. Aaronson JW, Murphy-Cullen CL, Chop WM, Frey RD. Electronic medical records: the family practice resident perspective. Fam Med. 2001 Feb;33(2):128-32.
26. Edwards G, Kitzmiller RR, Breckenridge-Sproat S. Innovative health information technology training: exploring blended learning. Comput Inform Nurs. 2012 Feb;30(2):104-9.
27. Keshavjee K, Bosomworth J, Copen J, Lai J, Kucukyazici B, Lilani R, Holbrook AM. Best practices in EMR implementation: a systematic review. AMIA Annu Symp Proc. 2006:982.
28. Lopez E, Moran D, Yang F. EMR training program MedIT 235 Capstone Project [Internet]. 2014 [cited 2014 Feb 2]. Available from: http://nwhit.org/wp-content/uploads/2011/06/Elliot-Lopez-T4-Capstone_Project.pdf.
29. Kumar A, Bhatia S, Chiang IJ. Deployment of an in-house designed training process in a quaternary care hospital. Technol Health Care. 2013;21(5):469-78.
30. Coplan S, Masuda D. Project management for healthcare information technology. Toronto: McGraw-Hill; 2011. Chapter 5, Change management; p.225-30.

31. McCarthy C, Seager T, Schoolfield S, Bower RD, McMahon P, Coplan SR. Linking people, potential and progress. Paper presented at: HIMSS 12 annual conference and exhibition; 2012 Feb 20-24; Las Vegas, United States.
32. Marshal M. Training for EHR implementation: how much is enough? The Pulse. Adult Learning & Technology Training Issue Newsletter [Internet]. 2013 Dec 1 [cited 2014 Feb 2]. Available from: http://orange.utb.edu/mmarshall1/UTB/TECT4305/project3.pdf
33. TEKsystems, HIMSS Analytics. EHR implementation survey: proactive consideration and planning lead to successful EHR implementation [Webinar on the Internet]. 2013 Jun 10 [cited 2014 Feb 2]. Available from: http://www.himss.org/Events/EventDetail.aspx?ItemNumber=18332
34. McAlearney AS, Robbins J, Kowalczyk N, Chisolm DJ, Song PH. The role of cognitive and learning theories in supporting successful EHR system implementation training: a qualitative study. Med Care Res Rev. 2012 Jun;69(3):294-315.
35. Youssef W. Evaluation of EHR training as a catalyst to achieve clinician satisfaction with technology in acute care setting [Master thesis]. Victoria B.C:University of Victoria; 2013.
36. College of Healthcare Information Management Executives. The CIO's guide to implementing EHRs in the HITECH era. 2010 [cited 2014 Feb 2]. Available from: http://www.cio-chime.org/advocacy/CIOsGuideBook/
37. Drewniak R. EHR implementations: success lies beyond the build. Health Leaders Media [Internet]. 2009 Apr 28 [cited 2014 Feb 2]. Available from: http://www.healthleadersmedia.com/page-1/TEC-232196/EHR-Implementations-Success-Lies-Beyond-the-Build
38. Lowers R. EMR success: Training is the key. Med Econom. 2004 May 7;81:TCP11.
39. Lorenzi NM, Kouroubali A, Detmer DE, Bloomrosen M. How to successfully select and implement electronic health records (EHR) in small ambulatory practice settings. BMC Med Inform Decis Mak. 2009 Feb 23;9:15.
40. Accenture. Secrets of success on the EMR journey to meaningful use: leading hospital CIOs reveal key lessons learned [Internet]. 2011 Jan 4 [cited 2014 Feb 7]. Available from: http://www.accenture.com/ca-en/Pages/insight-secrets-success-emr-journey.aspx
41. McCormack J. Wooing physicians. Provider organizations are using a variety of strategies to persuade physicians to adopt electronic records in ambulatory care settings. Health Data Manag. 1999 Oct;7(10):56-8,60,62 passim.
42. Thompson M. Conquering physician EHR training. Prognosis Innovation Healthcare [Internet]. 2013 Apr 30 [cited 2014 Feb 7]. Available from: http://www.prognosisinnovation.com/physician-ehr-training/
43. Martinsburg WV. A West Virginia Health Center discusses implementing electronic health records [Internet]. 2012 [cited 2014 Feb 7]. Available from: http://www.healthit.gov/providers-professionals/shenandoah-community-health-center-case-study
44. Gelmon SB, Droppers O. Community health centers and electronic health records: issues, challenges, and opportunities. Portland: Northwest Health Foundation; 2009 Nov 19.
45. Cresswell K, Morrison Z, Crowe S, Robertson A, Sheikh A. Anything but engaged: user involvement in the context of a national electronic health record implementation. Inform Prim Care. 2011;19(4):191-206.
46. Fenton SH, Giannangelo K, Stanfill M. Essential people skills for EHR implementation success. J of AHIMA. 2006 Jun;77(6):60A-D.

47. Downing Peck A. EHR implementation: training pays dividends. Med Econom [Internet]. 2013 Jul 25 [cited 2014 Feb 2]. Available from: http://medicaleconomics.modernmedicine.com/medical-economics/RC/ehr-implementation-training-pays-dividends
48. Øvretveit J, Scott T, Rundall TG, Shortell SM, Brommels M. Improving quality through effective implementation of information technology in healthcare. Int J Qual Health Care. 2007 Oct;19(5):259-66.
49. National Learning Consortium. Change management in EHR implementation [Internet]. 2013 Apr 20 [cited 2014 Feb 8]. Available from: http://www.healthit.gov/sites/default/files/tools/nlc_changemanagementprimer.pdf
50. Edsall RL, Adler KG. The 2009 EHR user satisfaction survey: responses from 2,012 family physicians. Fam Pract Manag. 2009 Nov-Dec;16(6):10-6.
51. Underwood WS, Brookstone AJ, Barr MS. The correlation of training duration with EHR usability and satisfaction: implications for meaningful use. A Report from American EHR Partners [Internet]. 2011 Oct 20 [cited 2014 Feb 8]. Available from: http://kinwahlin.wordpress.com/2011/10/25/the-correlation-of-training-duration-with-ehr-usability-and-satisfaction-implications-for-meaningful-use-americanehr-partners-20-october-2011/
52. Laravie L. Strategies for physician EMR training [Internet]. 2013 Jun 3 [cited 2014 Feb 8]. Available from: http://info.hayesmanagement.com/blog/bid/65065/Strategies-for-Physician-EMR-Training
53. HIMSS. EHR implementation success factors for practices with 6-10 physicians [Internet]. 2010 Oct 7 [cited 2014 Feb 8]. Available from: http://www.himss.org/ResourceLibrary/ResourceDetail.aspx?ItemNumber=7376
54. Ministry of Health of Kenya. Standards and guidelines for electronic medical record systems in Kenya [Internet]. 2010 [cited 2014 Feb 2]. Available from: http://www.nascop.or.ke/library/3d/Standards_and_Guidelines_for_EMR_Systems.pdf
55. Prasad A. 8 cardinal sins of EMR training. Revenue XL [Internet]. 2014 [cited 2014 Feb 2]. Available from: http://www.revenuexl.com/blog/bid/23066/8-Cardinal-Sins-of-EMR-Training
56. Kushinka SA. Training strategies: EHR deployment techniques. California Healthcare Foundation [Internet]. 2010 Jun [cited 2014 Feb 2]. Available from: http://www.chcf.org/publications/2010/03/ehr-deployment-techniques
57. Fleming NS, Culler SD, McCorkle R, Becker ER, Ballard DJ. The financial and nonfinancial costs of implementing electronic health records in primary care practices. Health Aff (Millwood). 2011 Mar;30(3):481-9.
58. Rapid and effective training for electronic health records (EHR) in healthcare communities. AT&T [Internet]. 2011 May 20 [cited 2014 Feb 2]. Available from: http://www.corp.att.com/healthcare/docs/ehr_training.pdf
59. California Academy of Family Physicians. Health information technology (HIT) toolkit for family physicians. FAFP EHR readiness assessment tool [Internet]. 2011 [cited 2014 Feb 9]. Available from: http://www.himss.org/files/HIMSSorg/content/files/Code%2049%20FAFP%20Readiness%20Assessment.pdf
60. OntarioMD. Physician training requirements guide [Internet]. 2014 [cited 2014 Feb 9]. Available from:

https://www.ontariomd.ca/idc/groups/public/documents/omd_file_content_item/omd011996.pdf
61. Smith PD. Implementing an EMR system: one clinic's experience. Fam Pract Manag. 2003 May;10(5):37-42.
62. HRSA. U.S. Department of health and human services. What training materials are available? [Internet]. 2014 [cited 2014 Feb 9]. Available from: http://www.hrsa.gov/healthit/toolbox/RuralHealthITtoolbox/Selection/trainingmaterials.html
63. Guerrero A. Five best practices for training staff on using a new EHR [Internet]. 2013 May 17 [cited 2014 Feb 9]. Available from: http://profitable-practice.softwareadvice.com/five-best-practices-for-training-staff-on-ehr-0513/.
64. Chelton BS. A qualitative study to evaluate the effectiveness of simulation as a training method in implementation of electronic medical records [Doctoral Dissertation]. Medical University of South Carolina; 2009 [cited 2014 Feb 9]. Available from: http://lowcountrydigital.library.cofc.edu:8080/fedora/get/lcdl:32390/PDF1.
65. Matthews T, Prognosis Health Information Systems. Overcoming the top five barriers to EHR implementation. White Paper [Internet]. 2012 [cited 2014 Feb 9]. Available from: http://www.prognosisinnovation.com/pdf/Overcoming%20Barriers%20Whitepaper.pdf
66. Masspro. Computer skills evaluation and assessment [Internet]. 2014 [cited 2014 Feb 9]. Available from: http://www.himss.org/files/HIMSSorg/content/files/Code%2049%20Masspro%20DOQIT%20Computer%20Skills%20Evaluation%20and%20Assessment.pdf
67. Heichert S, Drury BM, Wise PB. Readiness assessment: you know you're ready when. In: Schulte M, editor. Go-Live: smart strategies from Davies Award-winning EHR implementations. Chicago: HIMSS; 2011.
68. Meinert DB, Peterson DK. Perceived importance of EMR functions and physician characteristics. *JSIT*. 2009 Jan; 11:57-70.
69. TBD Consulting, Inc. Enterprise-wide training of electronic medical records (EMR) software. 2009 [cited 2014 Feb 9]. Available from: http://www.tbdconsulting.com/Site/media/Case_Studies/Healthcare_Case_Study_Enterprise-wide_Training_of_EMR_Software_1_31_10.pdf
70. Wagner N. Week three: planning [unpublished lecture notes]. Business K731: Proj Manag; lecture given 2013 Sep 25.
71. Health information technology. AMA. Chicago: AMA; 2009.
72. Eason KD. Information technology and organizational change. Bristol: Taylor & Francis; 1988.
73. Healthland. EMR implementation in critical access hospitals, small community hospitals and affiliated clinics [Internet]. 2014 [cited 2014 Feb 9]. Available from: http://www.healthland.com/_asset/0nfj15/EMR_in_CAH_and_Small_Community_Hospitals.pdf
74. Rae L, editor. How to measure training effectiveness. 3rd ed. Aldershot: Gower Publishing; 1997.
75. Duggan CM. Designing effective training. J of AHIMA. 2005 Jun;76(6):28-32.
76. Smith J. Maximizing the value of EMRs. BC Med J. 2011 Dec 10;53(10):566-7.
77. HealthIT. Who should train my staff? [Internet]. 2014 [cited 2014 Feb 22]. Available from: http://www.healthit.gov/providers-professionals/faqs/who-should-train-my-staff

78. Swanson T, Dostal J, Eichhorst B, Jernigan C, Knox M, Roper K. Recent implementations of electronic medical records in four family practice residency programs. Acad Med. 1997 Jul;72(7):607-12.
79. Piliouras T, Yu PL, Huang H, Liu X, Siddaramaiah VKA. Selection of electronic health records software. Challenges, considerations, and recommendations. IEEE LISAT Conf, 2011 May 6. P.1-5.
80. Studer M. The effect of organizational factors on the effectiveness of EMR system implementation – What Have We Learned? Electr Healthcare. 2005;4(2)92-8.
81. Krall M. Clinical champions and leaders for electronic medical record innovations. Perm J. 2001;5(1):44.
82. Smith PD. Implementing an EMR system: one clinic's experience. Fam Pract Manag. 2003;10(5):37–42.
83. Wager KA, Lee FW, White AW, Ward DM, Ornstein SM. Impact of an electronic medical record on community-based primary care practices. JABFP. 2000;13(5):381-2.
84. HealthIT. Electronic health record implementation training: a crucial step [Internet]. 2014 [cited 2014 Feb 22]. Available from: http://www.healthit.gov/providers-professionals/faqs/how-should-i-train-my-staff
85. Iowa Foundation for Medical Care. Not 10, but 11 EHR training tips [Internet]. 2014 [cited 2014 Feb 22]. Available from: http://www.google.ca/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCYQFjAA&url=http%3A%2F%2Fmhcc.dhmh.maryland.gov%2Fhit%2FehrVendors%2FDocuments%2Fwww.internetifmc.com_%2Fprovider%2Fdocuments%2F11_ehr_training_tips.pdf&ei=A1QIU7PRAcmiyAHVwYHACg&usg=AFQjCNHfLSuRZPMlkHOHwyDKLJDrG5HaQg
86. Ammenwerth E, Iller C, Mahler C. IT-adoption and the interaction of task, technology and individuals: a fit framework and a case study. BMC Med Inform Decis Mak. 2006, 6.
87. Teich JM, Osheroff JA, Pifer EA, Sittig DF, Jenders RA. Clinical decision support in electronic prescribing. Recommendations and an action plan. Report of the joint clinical decision support workgroup. J Am Med Inform Assoc. 2005;12:365-76.
88. Rouf E, Chumley H, Dobbie A. Electronic health records in outpatient clinics. Perspectives of third year medical students. BMC Med Educ. 2008;8:13.
89. Ash JS, Bates DW. Factors and forces affecting EHR system adoption. Report of a 2004 ACMI Discussion. J Am Med Inform Assoc 2005;12:8-12.
90. Shah NR, Seger AC, Seger DL, Fiskio JM, Kuperman GJ, Blumenfeld B, Recklet EG, Bates DW, Gandhi TK. Improving acceptance of computerized prescribing alerts in ambulatory care. J Am Med Inform Assoc. 2006;13.
91. Weir C, Lincoln M, Roscoe D, Moreshead G. Successful implementation of integrated physician order entry application: a systems perspective. Annual Symp Comput Appl Med Care. 1995. P. 790-4.
92. Ash JS, Lyman J, Carpenter J, Fournier L. A diffusion of innovations model of physician order entry. Proc AMIA Symp. 2001;22-6.
93. Joos D, Chen Q, Jirjis J, Johnson KB. An electronic medical record in primary care. Impact on satisfaction, work efficiency and clinic processes. Proc AMIA Symp. 2006;394-8.
94. Poissant L, Pereira J, Tamblyn R, Kawasumi Y. The impact of electronic health records on time efficiency of physicians and nurses. A systematic review. J Am Med Inform Assoc. 2005;12:505-16.
95. Kirshner M, Salomon H, Chin H. An evaluation of one-on-one advanced proficiency training in clinicians' use of computer information systems. IJMI. 2004;73:341-8.

96. Health Technology Services. Electronic health record (EHR) training [brochure]. Health Technology Services; 2013.
97. Ford EW, Menachemi N, Phillips MT. Predicting the adoption of electronic health records by physicians. When will health care be paperless? J Am Med Inform Assoc. 2006;13:106-12.
98. Clayton PD, Narus SP, Bowes WA III, Madsen TS, Wilcox AB, Orsmond G, Rocha B, Thornton SN, Jones S, Jacobsen CA, et al. Physician use of electronic medical records. Issues and successes with direct data entry and physician productivity. Proc AMIA. Symp AMIA. 2005;141-5.
99. Saleem JJ, Patterson ES, Militello L, Render ML, Orshansky G, Asch SM. Exploring barriers and facilitators to the use of computerized clinical reminders. J Am Med Inform Assoc. 2005;12:438-47.
100. Trimmer K, Beachboard J, Wiggins C, Woodhouse W. Electronic medical records use an examination of resident physician intentions. Proc of the 41st Annu *HICSS*. 2008 Jan 7-10. P. 249.
101. Callen JL, Braithwaite J, Westbrook JI. Contextual implementation model. a framework for assisting clinical information system implementations. J Am Med Inform Assoc. 2008;15:255-62.
102. DesRoches CM, Campbell EG, Rao SR, Donelan K, Ferris TG, Jha A, Kaushal R, Levy DE, Rosenbaum S, Shields AE, Blumenthal D. Electronic health records in ambulatory care – a national survey of physicians. N Engl J Med. 2008;359:50-60.
103. Jerome RN, Giuse NB, Rosenbloom ST, Arbogast PG. Exploring clinician adoption of a novel evidence request feature in an electronic medical record system. J Med Libr Assoc. 2008;96:34-41.
104. Aydin CE, Forsythe DE. Implementing computers in ambulatory care: implications of physician practice patterns for system design. Proc AMIA Annu Fall Symp. 1997:677-81.
105. Krum WL, Latshaw JD. Training. In: Implementing an electronic health record system. Walker J, Bieber E, Richards F, editors. London: Springer Verlag; 2005.
106. March CA, Steiger D, Scholl G, Mohan V, Hersh WR, Gold JA. Use of simulation to assess electronic health record safety in the intensive care unit: a pilot study. BMJ Open. 2013;3:e002549.
107. Fullerton C, Aponte P, Hopkins III R, Bragg D, Ballard DJ. Lessons learned from pilot site implementation of an ambulatory electronic health record. Proc (Bayl Univ Med Cent). 2006;19:303-10.
108. Wood D. EHR/EMR training tips for clinicians [Internet]. 2011 Nov 9 [cited 2014 Feb 22]. Available from: http://www.amnhealthcare.com/latest-healthcare-news/ehr-emr-training-tips-clinicians/
109. Ash JS, Fournier L, Stavri PZ, Dykstra R. Principles for a successful computerized physician order entry implementation. AMIA Annu Symp Proc. 2003:36-40.
110. Atreja A, Mehta NB, Jain AK, Harris CM, Ishwaran H, Avital M, Fishleder AJ. Satisfaction with web-based training in an integrated healthcare delivery network: do age, education, computer skills and attitudes matter? BMC Med Educ. 2008 Oct 15;8:48.
111. Chronaki CE, Kontoyiannis V, Mytaras M, Aggourakis N, Kostomanolakis S, Roumeliotaki T, Kavlentakis G, Chiarugi F, Tsiknakis M. Evaluation of shared EHR services in primary healthcare centers and their rural community offices: the twister story.

Proc of the 29th Annu Int Conf of the IEEE EMBS Cité Internationale; Lyon, France. 2007 Aug 23-6. P. 6421-4.
112. Roberts F. What are the key EHR training strategies? [Internet]. 2013 Nov 14 [cited 2014 Feb 22]. Available from: http://curemd.wordpress.com/2013/11/14/what-are-the-key-ehr-training-strategies/
113. Edmonson SR, Esquivel A, Mokkarala P, Johnson CW, Phelps CL. Using technology to teach technology: design and evaluation of bilingual online physician education about electronic medical records. AMIA 2005 Symp Proc. 2005. P. 946.
114. Topaz M, Rao A, Masterson CR, Bowles HK. Educating clinicians on new elements incorporated into the electronic health record: theories, evidence, and one educational project. Comput Inform Nurs. 2013 Aug;31(8):375-9.
115. Han H, Lopp L. Writing and reading in the electronic health record: an entirely new world. Med Educ Online. 2013 Feb 5;18:1-7. doi: 10.3402/meo.v18i0.18634.
116. Haugen H. The advantages of simulation training. How to improve EMR adoption. Health Manag Tech. 2012 Apr;33(4):10-2.
117. Zmeyov S. Andragogy: Origins, Developments, Trends. International Review of Education. 1998; 44(1):103-8.
118. Palmer RC, Simms-Cendan JS. Implementing an electronic health record as an objective measure of care provider accountability for a resource-poor rural area in the Dominican Republic. 7th Int Conf on Appr Healthcare Tech for Developing Count; 2012 Sep 18-19; London. P. 1-6.
119. Castanelli DJ. The rise of simulation in technical skills teaching and the implications for training novices in anaesthesia. Anaesth Intensive Care. 2009;37:903-10.
120. Efthimiadis EN, Hammond KW, Laundry R,Thielke SM. Developing an EMR simulator to assess users' perception of document quality. 43rd HICSS; 2010 Jan 5-8; Honolulu, HI. P. 1530-1605. DOI: 10.1109/HICSS.2010.145
121. Landman AB, Redden L, Neri P, Poole S, Horsky J, Raja AS, Pozner CN, Schiff G, Poon EG. Using a medical simulation center as an electronic health record usability laboratory. J Am Med Inform Assoc. 2013 Nov 18. doi: 10.1136/amiajnl-2013-002233.
122. Lou JQ, Oviawe E, Thomson W. Integration or information technology in nursing simulation training. 2nd ICETC; 2010 Jun 22-24; Shanghai. P. VI-547-51. Payne TH, Perkins M, Kalus R, Reilly D. The transition to electronic documentation on a teaching hospital medical service. AMIA Annu Symp Proc. 2006:629-33.
123. Payne TH, Perkins M, Kalus R, Reilly D. The transition to electronic documentation on a teaching hospital medical service. AMIA Annu Symp Proc. 2006:629-33.
124. Takian A, Sheikh A, Barber N. We are bitter, but we are better off: case study of the implementation of an electronic health record system into a mental health hospital in England. BMC Health Serv Res. 2012 Dec 31;12:484. doi: 10.1186/1472-6963-12-484.
125. Jimenez A. E-learning supports EHR implementations. In addition to meaningful use we need to define meaningful training. Electr Health Rec. 2010 Nov; 22-3.
126. Goetz Goldberg D, Kuzel AJ, Feng LB, DeShazo JP, Love LE. EHRs in primary care practices: benefits, challenges, and successful strategies. Am J Manag Care. 2012 Feb 1;18(2):e48-54.
127. Carr W. Designing an effective training evaluation process [Internet]. 1999 [cited 2014 Mar 3]. Available from: http://www.ispi.org/pdf/suggestedReading/Carr.pdf

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