

Could We Derive Benefit from Implementing Electronic Medical Records in Hospital? A Structured Evidence and Narrative Review

Mampukan Kita Mendapatkan Manfaat dari Penerapan Rekam Medis Elektronik Di Rumah Sakit? Sebuah Ulasan Naratif dan Bukti Terstruktur

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ABSTRACT

services through patient outcomes and users' (physicians' and nurses') perspectives. A structured evidence and narrative review using the PRISMA method, with articles retrieved from online databases including PubMed, Wiley, ScienceDirect and ProQuest. The study's period of review dates back to 1990 years. The advantages of EMRs are decreased length of stay (LOS) and infection rate, plus a reduced probability of readmission once a patient safety event has occurred. EMRs reduce nurse, licensed vocational nurse (LVN) and registry cost per hour. EMRs provide enhanced ability in completing medical records and increased cost per patient day. EMR does not reduce LOS in ICU. Some physicians also complain about the disadvantages. Hospital management should undertake more analysis and consideration prior to deciding whether or not to use EMR.

Keywords:

ABSTRAK

Salah satu metode dipilih oleh banyak rumah sakit untuk mencapai efisiensi adalah penggunaan sistem rekam medis elektronik (RME). Studi ini mengemukakan RME dan hubungannya dengan efisiensi dan kualitas pelayanan rumah sakit melalui hasil pasien dan persepsi pengguna (dokter dan perawat). Sebuah ulasan naratif dan bukti terstruktur menggunakan metode PRISMA, dengan artikel diperoleh dari basis data daring terdiri dari PubMed, Wiley, ScienceDirect dan ProQuest. Periode studi yang digunakan adalah sepuluh tahun ke belakang. Keuntungan dari RME adalah menurunkan lama rawat inap (LOS) dan tingkat infeksi, dan mengurangi probabilitas readmisi ketika risiko keselamatan pasien terjadi. RME menurunkan biaya perawat, dengan hanya mempekerjakan perawat vokasi berlisensi (LVN) dalam melakukan registrasi pasien tiap jamnya. RME mampu menyediakan kesempatan untuk menuntaskan data rekam medis dan dokumentasi klinis pasien. Kerugiannya adalah inefisiensi yang lebih besar di dalam pelayanan bedah akut dan meningkatkan biaya per hari pasien. RME tidak menurunkan LOS di ICU. Beberapa dokter juga mengajukan keberatan dengan inefisiensi dan hilangnya waktu yang diakibatkan oleh RME. Penerapan RME di rumah sakit memiliki untung-rugi. Manajemen rumah sakit harus lebih teliti menganalisis dan menimbang sebelum memutuskan apakah memakai RME atau tidak.

Kata kunci: rekam medis elektronik, rumah sakit, hasil pasien, efisiensi

‘hospital (title/abstract)’ AND ‘electronic medical abstract)’ AND ‘quality (title/abstract)’ AND ‘outcomes (title/abstract)’. A title review led to the selection of six documents, three of which were selected following a full-text review and assessed for eligibility. The Wiley search engine returned

‘hospital (title)’ AND ‘electronic medical records (title)’. Of these, three documents could not be accessed, thus resulting in two documents. All of the documents were selected based on a full-text review and assessed for eligibility. The ProQuest search engine returned a total of 9,022 documents based on a search using the keywords ‘hospital

in 31 documents. A review of the titles led to 15 documents being selected, four of which were chosen following a full-text review and assessed for eligibility. Two articles matching the aim of this study were retrieved from the local journal Portal Garuda. One of these was selected following a full-text review and assessed for eligibility.

Those articles that were included and assessed as being eligible in this review were those that demonstrated a effect of using EMRs. Such effects included reduced length of stay (LOS), a decrease in mortality rate, reduced infection rate and increased user satisfaction. We included the period 2008–2018 and adult patients (19–65+ years old). The articles excluded from this review did not contain any results based on EMR, featured patients under 19 years old and/or were for years prior to 2008.

We subsequently added ‘hospital (all

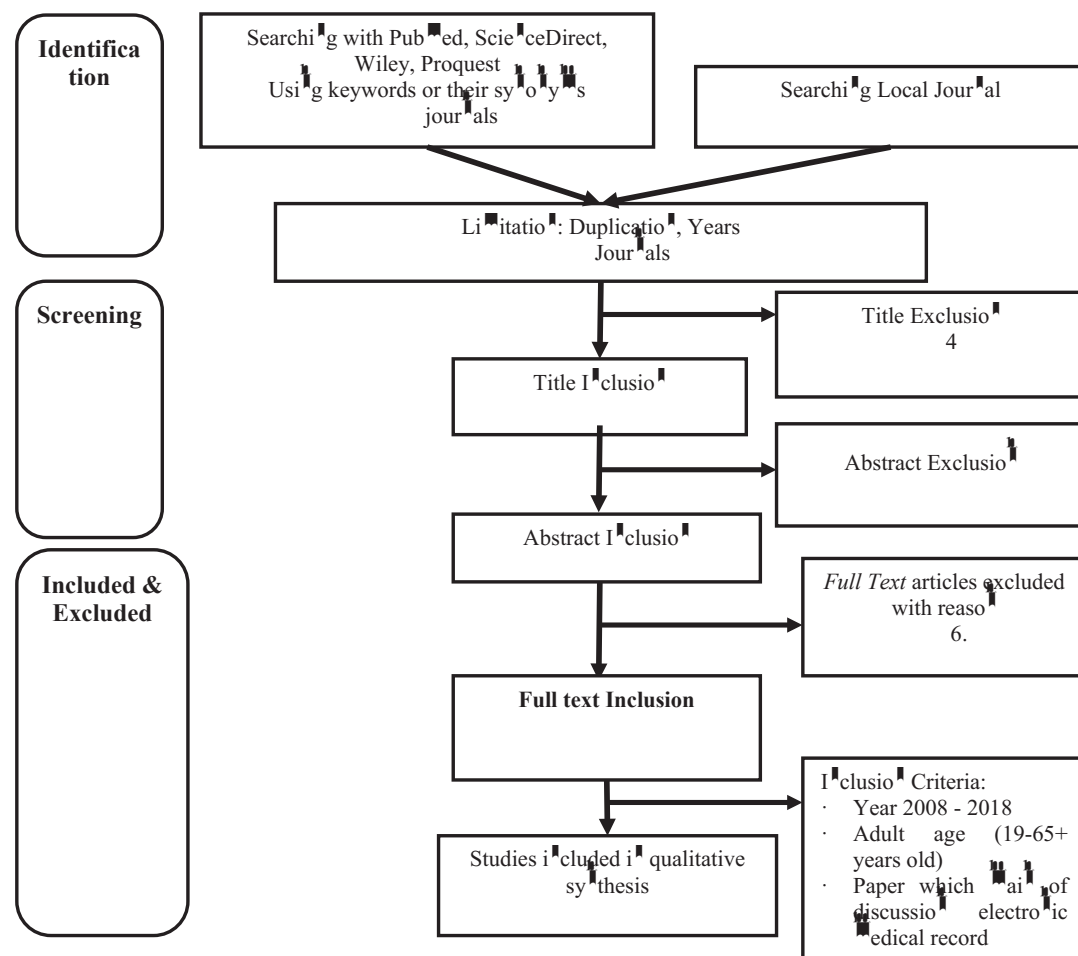


Figure 1. Inclusion and Exclusion Criteria

RESULTS

A study conducted in China found that length of stay (LOS) grew at a rate of 0.027 bed-days per month in the pre-EMR period (January

before subsequently falling by 0.043 bed-days per month in the post-EMR period ($p < 0.001$). From January 2007, when EMR was being used by all physicians, LOS rose by 0.295 bed-days,

expected when compared to the trend prior to

by 0.036 infections per 100 patients per month for the period from before the EMR go-live month in January 2005 to December 2006 ($p < 0.01$), before falling by 0.062 infections per 100 patients per month in the post-EMR period. In January 2007, the infection rate rose by 0.244

rate prior to the EMR go-live month, with the rate of increase standing at 0.048 deaths per 100 patients for the period January 2005–December

the mortality rate fell by 1.039 deaths per 1000 patients ($p < 0.001$), decreasing at a rate of 0.005 deaths per 1000 patients per month in the post-

fell by 33 Reimbi (RMB) per month in the pre-

of 16 RMB per month in the post-EMR period ($p < 0.001$) (Xue et al., 2012).

A 2010 study conducted in California, USA used panel data on California hospitals for the period 1998–2007. The study employed Stochastic Frontier Analysis (SFA) to estimate the relationship between EMR implementation

units and categorised EMR into the following three stages (Furukawa, Raghu, & Shao, 2010):

- Stage 1: EMR in all three ancillary systems (laboratory, radiology, pharmacy) and a clinical data repository (CDR). The CDR system receives feeds from the ancillary systems and provides clinical workers with access to patient information.
- Stage 2: EMR implemented in nursing documentation (DOC), and electronic medication administration records (eMAR), in addition to attaining EMR Stage 1. DOC

enables the creation of nursing care plans for patients, with these plans then used to standardise and document the treatments provided. eMAR serves to automate medication administration at the point of care, provides nurses with access to patient medication data and reconciles the medication administration with physician ordering and pharmacy dispensing.

- Stage 3: in addition to attaining EMR Stages 1 and 2, there has been investment in clinical decision support (CDS) and CPOE. EMR Stage 3 functionality is characterised by the automation of clinical decision processes, including order entry management and support for clinical decision-making.

Contrary to their expectation, EMR, especially in Stages 1 and 2, registered higher

(Furukawa et al., 2010). In conclusion, the

were associated with the implementation of nursing documentation, electronic medication administration reports and CDS (Furukawa et al., 2010).

The implementation of EMR to yield positive impacts for quality improvement. These impacts comprised a media of EMR of 12 minutes compared to a media for paper-based medical records of 10 minutes; however, EMR achieved a rate of 85.71 per cent completeness

per cent for paper-based medical records (Erawati, Nugroho, Sa'jaya, & Hariyanto, 2012). Clinical documentation in EMR was also found to be better than for paper-based medical records, standing at 67.84 per cent for EMR and 66.84 per cent for paper-based medical records, while

with the contents, accuracy and format of EMR (Erawati, Nugroho, Sa'jaya, & Hariyanto, 2012).

In another study on the implementation of EMR, it aimed to estimate the effects of EMR implementation on medical-surgical acute unit

mix, nurse cost per hour and nurse-sensitive patient outcomes (Furukawa et al., 2010). EMR Stage 2 (EMR-S2) and EMR Stage 3 (EMR-S3)

were associated with 5.9–10.3 per cent higher costs per discharge (Table 1). These increased costs were due to both higher cost per patient day

it stated that spending per patient safety event seemed to be systematically lower in the EMR hospitals across all types of events (Eickosa & Bae, 2012). For all safety events, the average spending of a patient safety event was \$55,810 with EMRs, compared to \$60,093 without EMRs. However, for overall surgeries, event or no event, EMR surgeries were shown to be more expensive; the total 90-day spending for surgeries with EMRs was \$29,967 on average, versus \$29,296 for surgeries without EMR (Eickosa & Bae, 2012). This study also mentioned that EMRs were

of death, while the occurrence of a patient safety event was a strong predictor of death (Eickosa

EMR-patient safety event interaction was -.249,

This indicates that EMRs reduce the probability of death once a patient safety event occurs. The excess death rate due to patient safety events in hospitals without basic EMRs is 2.6 per cent (3.4%-0.8%), while the excess death rate due to patient safety events with basic EMRs is 1.7 per cent (2.5%-0.8%). Thus, the excess death rate due to patient safety events is reduced by 34 per cent due to EMRs $\{(2.6-1.7) / 2.6\}$ (Eickosa &

impact on readmissions. Whilst the occurrence of a patient safety event was a strong predictor of

safety event interaction was -.116, statistically

that EMRs reduce the probability of readmission once a patient safety event occurs (Eickosa & Bae, 2012). This research pointed to an excess readmission rate due to patient safety events in hospitals without basic EMRs of 8.9 per cent (23.4%-14.5%), while the excess readmission rate due to patient safety events in hospitals with basic EMRs was 5.4 per cent (18.8%-13.4%); thus, the excess readmission rate due to patient safety events fell by 39 per cent due to EMRs $\{(8.9-5.4)/8.9\}$ (Eickosa & Bae, 2012).

This study went on to present Heckman estimates of the impact of EMRs on spending.

for patient safety is much higher, at .76 (Eickosa & Bae, 2012). This indicates that EMRs result in

a smaller impact on spending caused by patient safety events. The excess spending due to patient safety events in hospitals without basic EMRs was \$31,297 (\$57,583-\$26,286), while the excess spending due to patient safety events in hospitals with basic EMRs was \$26,448 (\$52,465-\$26,017). Thus, excess spending due to patient safety events declined by \$4,849, or 16 per cent, due to basic EMRs $\{(\$31,297-\$26,448)/\$31,2\}$ (Eickosa & Bae, 2012).

Meanwhile, research was conducted in the Netherlands to observe and analyse the impact of EMR on LOS among colorectal cancer patients. The hypothesis was that in hospitals with more advanced EMR capabilities, there is an increased likelihood of a shorter average LOS for colorectal surgery patients, and this was supported by the

distribution of patients' characteristics into two groups – an Electronic Medical Record Adoption Model (EMRAM) low group and an EMRAM high

was found between patients in the EMRAM low group and the LOS in the EMRAM high hospital group, when corrected for case mix, year of operation and type of surgery (laparoscopy or laparotomy). Additional adjustment for patients

Poelgeest et al., 2017).

This study stated that for LOS in ICU, multivariate regression did not reveal a score and smaller LOS (relative median LOS patients with complications there was also no

Their hypothesis suggesting an increase in the likelihood of a shorter average LOS for colorectal

with more advanced EMR capabilities was also not supported by the study's results, with these

Poelgeest et al., 2017).

In a study carried out in the USA, found the mean values to suggest that documentation

administrative issues were the top three areas that physicians expected to be impacted by EMR (Vishwanath et al., 2010). Documentation issues included issues such as the high volumes of documentation required to initialize

patient processing included issues such as the overbooking of schedules and patients arriving without appointments, while administrative issues included aspects such as inadequate

how clinics operate (Vishwanath et al., 2010). Patient safety and care, economic challenges and reimbursement, and basic clinical processes were at the bottom of the issues expected to be impacted by EMR (Vishwanath et al., 2010).

beta value found for administrative issues (0.45) indicated that as physicians' attitudes towards health IT increased by one standard deviation (1.0), their expectations regarding the impact of EMR on administrative issues increased by 0.45 (0.37) standard deviations (Vishwanath et al., 2010). The attitudes of physicians were found

issues, basic clinical processes, documentation, technical issues, communication and

processing derived from EMR (Vishwanath et al., 2010).

difference between pre-implementation expectations and satisfaction levels three months following the implementation of EMRs. In all cases, satisfaction levels fell and did not meet expectations. Interestingly, a comparison of satisfaction levels three months and 20 months after implementation showed a slight increase in such levels, although none of the increases were

A study in hospitals in the American Midwest was conducted in 2010. It comprised semi-qualitative research, with the results indicating that physicians in many ways believed that the use of EMR and CPOE improved the ease of personal performance (Holden, 2010). Aside from making personal performance easier, the physicians perceived EMR and CPOE to improve the quality of performance. In particular, they described more accurate and timely awareness of patient status, trends and other information, with many physicians appreciating that chest X-rays, CT scans and other results were available in real time (Holden, 2010). However, it also outlined how many perceived that EMR and CPOE

and more complex (Holden, 2010). Information such as colleagues' notes, medications on the discharge list and data from other hospitals was

the additional demands and extra steps were perceived to increase the burden on physicians.

Table 1. Research Findings (Holden, 2010)

Variable	Results
Behavioural beliefs	<i>Quality of care was increased with EMR and CPOE use by allowing physicians to access more up-to-date information more quickly, by providing reminders, speeding up the delivery of care and by reducing the number of duplicate procedures that may previously have been ordered.</i>
Patient outcomes	<i>Numerous patient safety benefits were believed to arise from EMR and CPOE use. Of all the participants, 40% (and 78% in Hospital 2) believed that EMR and CPOE use threatened patient safety due to, for example, physician over-reliance on potentially erroneous information, nurses focusing more on complying with EMR use protocol than on independently reviewing order accuracy, orders in the system not being seen or neglected, and physicians speeding through the system or ignoring CPOE alerts because they were accustomed to false alarms, meaning the quality of care outcomes were perceived to be jeopardized by EMR and CPOE use.</i>

Variable	Results
<i>Financial, organizational and other outcomes</i>	Physicians believed that some cost savings resulted from eliminating dictation and paper and from improved billing efficiency for billing departments and individual physicians. However, physicians also believed that EMR and CPOE use led to an inefficient use of resources due to some speciality-specific tools being described as lacking (e.g. for drawing retinal images of ophthalmology patients), while template-based data entry was perceived as not enabling physicians to record a rich, patient-specific story in their notes.
<i>Affective outcomes</i>	Consistent with prior CPOE studies, most (91%) were negative reactions such as frustration, irritation and resentment.
External normative beliefs	Several entities, internal and external to the participants' hospitals or outpatient clinics, were perceived to approve or encourage the use of EMR and CPOE by physicians. Entities discouraging EMR and CPOE use were seldom mentioned.
Personal normative beliefs	Moral normative beliefs related to EMR and CPOE use were most commonly those related to the confidentiality, privacy and security of patient records. Although some perceived that using EMR and CPOE was a moral obligation, others had no moral normative beliefs or belief that EMR and CPOE were morally neutral.
<i>Control beliefs</i> <i>Controllability</i>	For the most part, physicians believed that the use of EMR and CPOE was not under their volitional control since it was mandated by the organization, because some information was accessible only electronically, and generally because EMR and CPOE were believed to have become 'as essential as carrying a pen and a stethoscope', with physicians perceived to be 'reliant on the EMR now'.
<i>Self-efficacy</i>	Physicians reported numerous perceived barriers that might have limited their ability to use EMR and CPOE, included perceived hardware and software barriers.
Other beliefs	50% of physicians noted the need for a fit between the system and other elements of the work system, in addition to a perceived requirement to adapt in order to achieve fit. Physicians provided detailed responses about their perceptions of the roll-out, initial training and technical support, management support and commitment (most believed that their hospital was very supportive and committed), user involvement (some believed they were under-involved whereas others were content with a low level of involvement), post-implementation modifications to the system, and interactions with the vendor.

It stated that a large number of comments on the use of EMR and CPOE pertained to

A total of 70 percent believed that EMR and CPOE saved time or sped up the care process, especially when retrieving information; however, almost every physician was also able to provide

loss created by the use of EMR and CPOE, either through causing delays (e.g. when logging on or waiting for someone to enter data) or by slowing down work processes (Holde, 2010). This study also analysed other variables, with the results described in Table 1.

A study in the USA discussed the effect of EMR adoption in hospitals (Lee et al., 2013). Those hospitals adopting EMR experienced a fall

in LOS of 0.11 days (95% CI: -0.218 to -0.002) and a 0.182 percent lower 30-day mortality, but a 0.19 (95% CI: 0.0006 to 0.0033) percent increase in 30-day rehospitalization in the two years after EMR adoption. The association of EMR adoption with outcomes also varied by type of admission (medical vs. surgical) (Lee et al., 2013).

Also, as a result of faster and more accurate communication and coordination among providers, EMR may contribute to reduced LOS; however, a shorter LOS may increase the 30-day rehospitalization rate because patients in a critical condition may return if they are discharged early, which is a problem that may be captured by EMR (Lee et al., 2013). It found that the effect of EMR on outcomes differed according to the type of diagnosis-related group (DRG) (Lee et al., 2013).

EMR reduced the inpatient mortality rate in surgical DRGs, but it increased 30-day mortality. In medical DRGs, however, EMR increased LOS and 30-day rehospitalization but reduced 30-day mortality (Lee et al., 2013).

A study in Turkey focused on the views of nurses on EMR (Top & Gider, 2011). By analyzing EMR from the perspectives of use, quality and user satisfaction, the study found an average score for nurses' satisfaction with EMRs of 3.28, an average score for using EMRs of 1.96, and an average score for the quality of EMRs of 3.16 (Top & Gider, 2011). It also determined the existence

and user satisfaction of EMRs (Top & Gider,

2011). Among the mean quality scores for EMR systems in a Ministry of Health hospital, university hospital and private hospital; interestingly, 59.0 percent of all of the participants in the study felt that EMR systems were not well integrated into

that as the use, quality and user satisfaction scores.

correlation between the use and quality scores (r

(Top & Gider, 2011). The data showed that the highest correlation was between the quality and user satisfaction scores for EMR systems. All of the three subscales were positively correlated ($p < 0.001$) with each other (Top & Gider, 2011).

A study examining the impact of EMR use on the patient-doctor relationship and communication was conducted in the USA in 2016 (Alkureishi et al., 2016). In this study, it stated that EMR use can improve patient understanding of conditions and treatment plans, in addition

to medical information (Alkureishi et al., 2016). It also mentioned that some

behaviors that appear to facilitate patient-centered communication (i.e. screen sharing, signposting, cessation of typing during sensitive discussions) and that future work should seek to incorporate these best practices into a curriculum for the purpose of teaching providers how to integrate patient-centered EMR use into their clinical

education targeting the continuous of learners can address this gap in training and help foster humanistic patient-doctor EMR interactions in the digital age (Alkureishi et al., 2016).

DISCUSSION

Advantages of Using EMRs

Based on the 12 articles discussed above, we have found that the use of EMRs can provide a number of advantages. These are as follows: reduced LOS, decreased infection rate, decreased mortality rate, a reduction in mortality rate from AMI in years 2-3 of implementation,

clinical documentation, reduced hospitalizations and shall decrease in the number of patient visits to emergency departments as a result of electronically generated reports of investigations containing care recommendations. EMRs were not found to reduce patient safety events; however, once such an event occurs, EMRs can serve to reduce deaths and readmissions. EMRs have also been found to reduce inpatient mortality rate in surgical DRGs. We can combine all of the

termed 'outcomes'. EMR can increase cost per discharge while also leading to a reduction in excess spending due to patient safety events. EMRs can also lead to a decrease in RN and LVN cost per hour.

From the users' (physicians') perspective,

EMRs, which is aligned with the result of the others studies (Erawati et al., Nugroho, Sa'jaya, and Hariyanto, 2012). Physicians also believe that EMR has the potential to generate cost

The reduced LOS associated with EMR suggests that EMR might enable faster physician ordering of tests, procedures and medications, speed up the process/scheduling of discharge and reduce delays in the service ordering process (Lee et al., 2013). The use of EMR has been shown to be related to quality and nurses' satisfaction, in 2011).

The use of EMR can also enhance the patient-doctor relationship due to the fact that doctors are able to educate their patients more

easily, meaning that patients, in turn, are able to improve their understanding of their conditions and treatment plans. With EMR, doctors can share information with patients via a screen or other digital devices without needing to be concerned about patients not being able to interpret their handwriting. EMR can therefore also reduce the risk of patient safety incidents arising due to illegible handwriting.

Disadvantages of Using EMRs

Interestingly, from the 12 articles studied, variables that produced different results, thereby the effect of EMR implementation.

For example, it is mentioned above that EMR has the ability to reduce LOS. But some studies have shown that EMR actually leads to an increase in LOS, thus resulting in higher costs. EMR has also been found to have the effect of increasing nursing hours. While one study

in either ICU or for colorectal surgery patients, it has also been shown to increase the 30-day rehospitalization rate. In medical DRGs, EMR

effect on readmission. Another study found that EMR has no relationship with the mortality rate in hospitals, while EMR Stage 2 has little impact on patient outcomes.

We conclude from the article that EMRs generate an increase in cost per patient stay accompanied by

nursing documentation, electronic medication administration reports and CDS (Furukawa et al., 2010). EMR also has little relationship with nursing skill.

The rate of physician satisfaction in using EMR was low and did not meet expectations. Some physicians consider the use of EMR to increase their workload due to their own lack of ability with digital devices, which was especially true in the case of older physicians. Some physicians also consider EMR to make work processes slower as they have to wait for other people to input some of the data they need. Some physicians also mentioned that they were

using EMR following an order from hospital management and not based on their own volition. Some physicians had concerns with regard to the security of patient data in EMR. They were

of records. Some physicians also thought that EMR had the potential to make their role more

be a variation in the disadvantages related to the stages of EMR.

Challenge and Roles of Change Management Agents

From the results and discussion above, we found that questions remain regarding the implementation of EMR. If hospital management is not able to properly undertake the implementation of an EMR system, there are likely to be obstacles to face. EMR implementation, as one part of a wider health technology system, requires a substantial amount of capital due to the fact that it necessitates an investment in IT systems; as such, an effective EMR system requires a steady system of IT (Veruswati & Asyary, 2017).

The other important element in the success of EMR implementation is commitment (Veruswati & Asyary, 2017). This must come not only from a hospital's management, but also from all components in the hospital, especially from users such as physicians, nurses, pharmacists and other health professionals. It is not always easy to build commitment, which is why change management agents have come to play a crucial role.

Change management agents should begin their work from the very outset of an EMR implementation; that is, as soon as the policy for EMR implementation has been released. To begin with, change management agents can conduct a socialization regarding the nature of EMR, the purpose of its implementation and the reasons for developing the policy. Change management agents should also seek to provide information on

the implementation. Change management agents should seek to become facilitators between the system users, hospital management and the vendors who will build the EMR system. As such,

their opinions, needs and expectations from the system. The challenge is the translating these user needs to the system vendors or Information and Technology Division, and vice versa (Veruswati & Asyary, 2017). This part of the process will potentially require several rounds of communication or meetings to ensure the development of the same perception. By involving the users of a system, we would expect commitment to the implementation of EMR to be self-developing.

The other important part of an EMR implementation is the pre-implementation session. This would typically entail trial sessions to enable the users to adapt to the system. It is also during this pre-implementation stage that change management agents should seek to

agents must be capable of communicating and, if necessary, translating these problems to authorized personnel (i.e. to the vendors or Information and Technology Division) in order to provide solutions to the problems. Change management agents, along with authorized personnel, will then deliver the solution to users and should seek their opinions on it. Change management agents should also ensure they maintain a continuous and personal approach with regard to the users of the system in order to secure their commitment and monitor whether there are any limitations.

Following the EMR go-live, the change management agents should monitor its implementation. This monitoring should include any obstacles and areas of compliance for the implementation of EMR. In conclusion, the change management agents should undertake a comprehensive evaluation of the implementation of EMR. It is preferable for such an evaluation to be carried out on a regular basis (e.g. monthly or every three months) in order to enable the prompt

risks can be mitigated and the objectives of the implementation can be achieved.

The limitation of our study is based on the fact that we were unable to source any articles on the effectiveness analysis of the implementation of

EMR. Therefore, we were unable to access any

It is best if hospitals seek to undertake a comprehensive analysis and evaluation both prior to and after the implementation of EMR. It is also important to involve the ultimate users of the system, notably physicians, during the design and build phase of the EMR. For hospitals that already have a universal health coverage system, the implementation of EMR may be considered due to its advantages in terms of reducing paper-based medical records and increasing patient safety by eliminating illegible handwriting. For hospitals that have already implemented a system of EMR, it is better to enhance their EMR to become Electronic Health Records (EHR) and patients' personal health records.

We would suggest that the next researcher implementing a system of EMR, especially when conducting some research that also incorporates an effectiveness of using EMRs.

CONCLUSION

Despite the fact that the implementation of EMR has the potential to yield both advantages and disadvantages, it remains a contentious and interesting topic for discussion. Some hospitals consider the implementation of an EMR system to be a large investment with the potential to increase the investment cost. Another challenge regarding the implementation of EMR involves the building of commitment not only from hospital management but from all stakeholders in the hospital. Hospital management should seek to undertake more analysis and give greater

but also to the quality of hospital care, prior to deciding on whether or not to use EMR.

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Appendices 1. Synthesized Contents of Literature 1

Journal Parameter	Yajiao g Yue, Huiga g Li g, Xiaocheng Wu, Hai Go g, Bi Li, Yuxia Zhang (2012)	Felyy Erawa ti i, Eko Nugroho, Guardia Yoki Sa Jaya, Su a dar Hariyanto (2012)	Ji hyu g Lee, Yong Fa g Kuo, James S Goodwin (2013)
Title	Effects of Electronic Medical Record in A Chinese Hospital: A time series study	Reka Medis Elektronik: Telaah Manfaat Data dan Pelayan Kesehatan Dasar	The Effect of Electronic Medical Record Adoption on Outcomes in US Hospitals
Method	Monthly data involving 251 physicians and 298,760 patient visits was created by querying the hospital's central database.	Evaluasi dengan tiga dimensi waktu pelayanan dan kegunaan catatan medis pasien sebelum dan sesudah penerapan rekam medis elektronik. Analisis statistik deskriptif. Kepuasan pengguna dan aspek sosial tidak diperoleh dengan observasi dan wawancara kualitatif.	The authors looked at the effect of EMR on outcomes using two methods. First, they compared the outcomes by quarter for Basic EMR, adoption and 30-day rehospitalization, and mortality adopted EMR. Second, they compared hospitals that had adopted EMR to those that had not before and after the EMR adoption, using a generalized linear model.
Variables	Length of stay, infection rate, mortality rate and cost per patient stay.	Waktu pelayanan, kelengkapan catatan medis pasien, kepuasan pengguna, faktor sosio-teknis (proses bisnis pelayanan, dukungannya, para dokter, manajemen, penggunaan rekam medis elektronik, dukungannya, perencanaan, perecanaan adopsi sistem yang baik).	Basic EMR, adoption and 30-day rehospitalization, 30-day mortality, inpatient mortality and length of stay.
Analysis	The authors analysed 60-month data as a longitudinal data using generalized linear model.		

Appendices 2. Synthesized Contents of Literature 2

Journal Parameter	Michael F. Furukawa, T. S. Raghu, Benjamin B. M. Shao (2010)		
Title	Mehmet Topaloglu, O. Gilder (2011)	Medical-Surgical Units	Patient Outcomes: Evidence from California Hospitals, 1998–2007
Method	Nurses' Views on Electronic Medical Records (EMR) in Turkey: A Qualitative Analysis According to Use, Quality and User Satisfaction	The data of EMR in the California from the 1998 to 2007 HIMS Analytics Database. The analytical sample consists of a single inpatient observation representing a medical/surgical unit at that hospital for each year. We used SFA to measure the	Logitudinal analysis of a population of 226 short-term, general acute care hospitals in California. Marginal effects
Variables	The use, quality and user satisfaction of electronic medical records.	units.	Effects of EMR in the ratio of medical-surgical acute unit hour and nurse-sensitive patient outcomes.
Analysis	Pearson's Correlation analysis	Stochastic Frontier Analysis (SFA)	estimated by ordinary least squares. These regressions estimated the within-hospital effect of EMR in the ratio associated with vary across hospitals but are constant over time.
Result	The authors found that the average score for the nurses' satisfaction with EMRs was 3.28, the average score for using EMRs was 1.96, and the average score for the quality of EMRs was 3.16. They also determined that a user satisfaction of EMRs. This study revealed quality scores for the EMR systems in a Ministry of Health hospital, university hospital and private hospital. Interestingly, 59.09% of all participants in this study felt that EMR systems were not well integrated into their	in medical-surgical units. There is emerging evidence that EMR systems are associated with a higher quality of patient care.	EMR in the ratio was associated with a 6.10 percentage higher cost per discharge in medical-surgical acute units. EMR Stage 2 increased registered nurse hours per patient day by 15–26 percentage and reduced LVN cost per hour by 2–4 percentage. EMR Stage 3 was associated with 3–4 percentage lower rates of in-hospital mortality for conditions.

Appendices 3. Synthesized Contents of Literature 3

Journal Parameter	Justi Keasberry, Ian A. Scott, Clair Sullivan, Andrew Staib, Richard Ashby (2017)	William E. Ecirosa, Jaeyong Bae (2012)	Rube van Poelgeest, Julia T. van Groenou, Johanna H. Dainoff, Kit C. Roes, Theo Wiggers, Michel W. Wouters, Guss Schrijvers (2017)
Title	Going digital: a narrative overview of the clinical and organisational impacts of eHealth technologies in hospital practice	How Can We Predict The Cost Curve? Health Economics, Outcomes, and Patient Safety	Level of Digitization in Dutch Hospitals and the Lengths of Stay of Patients with Colorectal Cancer
Method	Systematic reviews and reviews of systematic reviews of eHealth technologies published in PubMed/Medline/Cochrane Library between January 2010 and October 2015.	Authors use MarketScan's data and American Hospital Association's for ratio technology (IT) data to examine whether EMRs can control costs in the ACA's reforms to reduce patient safety events.	Data were collected from the Dutch Surgical Colorectal Audit patient, treatment, and short-term outcome characteristics. All hospitals in the Netherlands register their primary colorectal cancer patients that undergo the resection in this database.
Variables	EMR function, EPrescription function, CPOE function, computerised decision support systems (CDSS) function, hospitalisation, LOS, time to process turnaround, turnaround times and resource utilisation, education, adverse drug events, use of preventive care and drug interaction, alerts, appropriate test ordering with fewer tests per patient.	EMR, the probability that a surgery will have a patient safety event, the probability of a patient death within 90 days following surgery, surgeries with a patient safety event versus those without an event, probability of a 90-day readmission for surgeries with a patient safety event versus those without an event, a 90-day hospital expenditures, surgeries with a patient safety event versus those without an event.	The use of EMR technologies in Dutch hospitals and LOS after colorectal cancer surgery.
Analysis	Reviews of multiple quality issues, hospital settings or remote care or patient-focused technologies were excluded from analysis. Methodological quality was assessed using a validated appraisal tool. Outcome measures prescription (ePrescription) and CDSS.	Multivariate regression analyses.	A univariate regression method was used to test differences adjusted for case mix, year of surgery, surgical technique and general hospitals.
Result	For EMR functions, there was moderate-quality evidence of reduced hospitalisation and LOS and low-quality evidence of improved documentation and process turnaround times. For CPOE functions, there was moderate-quality evidence of reduction in turnaround times and resource utilisation. For ePrescription, there was moderate-quality evidence of substantially fewer medication errors and adverse drug events, greater guideline adherence, improved disease control and decreased dispensing turnaround times. For CDSS, there was moderate-quality evidence of increased use of preventive care and drug interaction reminders and alerts, increased use of diagnostic aids, more appropriate test ordering with fewer tests per patient, greater guideline adherence, improved processes of care effects on patient mortality and overall costs. Reported harms were alert fatigue, increased technology interaction time, creation of disruptive workflows and few prescription errors.	EMRs do not reduce the rate of patient safety events. However, once an event occurs, EMRs reduce death by 34%, readmissions by 39%, and spending by \$4,850 (16%), a cost offset of \$1.75 per \$1 spent on IT capital. Thus, EMRs appear to have costs by better coordinating care to recover patients from medical errors once they occur.	the total LOS (relative median LOS 0.974, CI 95% 0.959–0.989) of patients treated in advanced EMR hospitals (high EMRAM score cohort) versus patients treated in less advanced EMR care settings, once the data were adjusted for the case mix, year of surgery and type of surgery (laparoscopy or laparotomy). Adjusting for complications saw no results (relative median LOS 0.934, CI 95% 0.915–0.954). No support a health care provider's efforts to achieve desired quality

Appendices 4. Synthesized Contents of Literature 4

Journal Parameter	Arvi Vishwath, Sa deep Raja Singh, Peter Winkelstein (2010)	Richard J. Holde (2010)	Mario Alpoer Alkureishi, Wei Wei Lee, Maurice Lyons, Valerie G. Press, Sara Ima, Akua Nkashah-Akra, Deb Werter, Violet M. Arora (2016)
Title	Physicians' beliefs about using EMR and CPOE: In pursuit of a contextualised understanding of health IT use behaviour	Physicians' beliefs about using EMR and CPOE: In pursuit of a contextualised understanding of health IT use behaviour	Impact of Electronic Medical Record Use on the Patient-Doctor Relationship and Communication: A Systematic Review
Method	The current research uses the fixed-method technique of concept mapping to empirically develop the model. The model is the used within a controlled study to track physicians' expectations from a few EMR systems as well as their assessments of the EMR's performance 3 months and 20 months after implementation.	Sei-structured qualitative research interviews were carried out, following the beliefs elicitation approach.	Systematic Review, Parallel searches in OvidMEDLINE, PubMed, Scopus, PsycINFO, Cochrane Library, reference review of prior systematic reviews, meeting abstract reviews and expert reviews from August 2013 to March 2015 were conducted.
Variables	Perceived external and internal outcomes of EMR and CPOE use, perceived external and personal or active pressure to use those systems; perceived volitional control over user behaviour; perceived facilitators and barriers to system use; and perceptions about the systems and how they were implemented.	Perceived external and internal outcomes of EMR and CPOE use, perceived external and personal or active pressure to use those systems; perceived volitional control over user behaviour; perceived facilitators and barriers to system use; and perceptions about the systems and how they were implemented.	Impact of EMR, patient-doctor relationship.
Analysis	Outcome measures were derived empirically from the conceptual model. They included 85 items that measured physicians' perceptions of the EMR's basic clinical processes, (4) documentation of patient encounter, (5) economic challenges and reimbursement, (6) technical issues, (7) patient safety and care, and (8)	Qualitative analysis. Physicians were asked questions to elicit beliefs and experiences pertaining to their use of EMR and CPOE. Questions were based on a broad set of behaviour-shaping beliefs and the methods commonly used to elicit those beliefs.	The authors systematically examined studies qualitatively by comparing the study population, design and outcomes. Studies were sub-divided according to the method of data collection. A structured data extraction table was created to facilitate the collection of these key elements. Articles not meeting the inclusion criteria were excluded. Added to this were studies reviewing articles, expert opinion and a review of conference abstracts from published studies. Authors' review comments to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards, where a systematic review either met the guidelines for submission to a systematic review protocol registry or did not facilitate a meta-analysis due to the varied interventions, methodology and outcomes reported in the included studies.
Result	EMRs as a clinical extension of older CPOEs rather than as a new innovation. The major functional advantages of EMRs are perceived to be very similar to, if not the same as, those of CPOEs. Technology is a major role in shaping physicians' perceptions.	Qualitative analysis revealed numerous themes related to the perceived external and internal outcomes of EMR and CPOE use; perceived external and personal or active pressure to use those systems; perceived volitional control over use behaviour; perceived facilitators and barriers to system use; and perceptions about the systems and how they were implemented. EMR and CPOE were commonly believed to both improve and worsen the ease and quality of personal performance, encouraged by employers and others to use the systems but also had personal role-related and operational concerns about doing so. Perceived facilitators and barriers were numerous and had their sources in all aspects of the work system.	Fifty-three out of 7,445 studies reviewed met the inclusion criteria. The included studies used behavioural analysis (28) to objectively measure communication behaviours using video or direct observation and pre-post or cross-sectional surveys to examine patient perceptions (25). Objective studies reported EMR communication behaviours that were both potentially negative (i.e., interrupted speech, low rates of screen sharing) and positive (i.e., facilitating questions). Studies examining overall patient perception reported no change with EMR use (16); a positive impact (5) or showed mixed results (1). Study quality was not assessable. Small sample sizes