Review Paper ■

The Impact of Electronic Health Records on Time Efficiency of Physicians and Nurses: A Systematic Review

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Abstract A systematic review of the literature was performed to examine the impact of electronic health records (EHRs) on documentation time of physicians and nurses and to identify factors that may explain efficiency differences across studies. In total, 23 papers met our inclusion criteria; five were randomized controlled trials, six were posttest control studies, and 12 were one-group pretest-posttest designs. Most studies (58%) collected data using a time and motion methodology in comparison to work sampling (33%) and self-report/survey methods (8%). A weighted average approach was used to combine results from the studies. The use of bedside terminals and central station desktops saved nurses, respectively, 24.5% and 23.5% of their overall time spent documenting during a shift. Using bedside or point-of-care systems increased documentation time of physicians by 17.5%. In comparison, the use of central station desktops for computerized provider order entry (CPOE) was found to be inefficient, increasing the work time from 98.1% to 328.6% of physician's time per working shift (weighted average of CPOE-oriented studies, 238.4%). Studies that conducted their evaluation process relatively soon after implementation of the EHR tended to demonstrate a reduction in documentation time in comparison to the increases observed with those that had a longer time period between implementation and the evaluation process. This review highlighted that a goal of decreased documentation time in an EHR project is not likely to be realized. It also identified how the selection of bedside or central station desktop EHRs may influence documentation time for the two main user groups, physicians and nurses.

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The electronic health record (EHR) is increasingly being deployed within health care organizations to improve the safety and quality of care.[1] However, to achieve these goals, the EHR must be used by clinicians, and this remains a major challenge. Various factors appear to be associated with EHR use. Maximization of the technical characteristics supporting the system such as speed and value-added functionalities such as order entry systems or automated reports[2–5] have been documented with higher rates of EHR use. User-related characteristics[3,4,6,7] as well as training[5] are also believed to be important. The integration of the EHR into clinical workflow must be taken into consideration in the early phases of planning in order to optimize the integration of the system into routine clinical use. Indeed, the need for a good fit between the EHR and routine clinical practice is recognized as essential,[3,8–12] and time efficiency is one of several factors that is used to assess the quality of this integration.

Clinicians spend the majority of their time providing direct care to patients[13–17] and hope that an EHR could increase this patient-interaction time and consequently the quality of care delivered.[18] On the other hand, provision of care requires the documentation of clinical information as an intrinsic aspect of routine clinical activity and is essential from both professional and legal standpoints. Thus, clinicians will consider a system to be efficient if the system reduces their documentation time,[19] even if the time savings do not translate into better patient care.[20] For this reason, in evaluating the impact of EHR on clinician activities, some studies use documentation time as a primary outcome and direct patient care time as a secondary outcome. The importance of evaluating time efficiency in documentation is also related to the observation that increased time for documentation is one of the most commonly stated barriers to successful implementation of an EHR.[3,10,11,18,21–23]

Electronic health record implementation requires considerable investment with most projects averaging several million dollars (U.S.).[24,25] For the EHR to be successful, it is essential that managers are able to identify and manage elements of EHR implementation that are critical to enhance time efficiency of documentation by physicians and nurses. Clinical information systems and user populations vary in their characteristics, and for this reason, individual studies are unable to identify common trends that would predict EHR implementation success. This paper presents the results of a systematic

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review conducted to estimate the extent to which an EHR affects clinicians' documentation time and to identify factors that may explain efficiency differences observed across studies. In the context of this review, documentation comprises all notes, orders, and referrals that are part of the care plan of a patient and documented in a patient's medical chart.

Methods

Search Strategy

An extensive search of the literature from 1966 to January 2004 was performed using MEDLINE, CINAHL, HEALTHSTAR, and Current Health databases. Search strategies were specific to the database and included the Medical Subject Headings (MeSH) associated with key words that reflected EHRs and workflow. The MEDLINE search strategy included the following terms: *health informatics*, *electronic records*, *medical records systems*, *medical informatics*, *information systems*, *computerized patient records*, *workflow, time and motion*, *task performance and analysis*, *work redesign*. When searching the CINAHL and HealthSTAR databases, the key words *efficiency, organizational*, *hospital information systems*, and *workload* were added to the search strategy used for the MEDLINE database. Only French or English full-text papers published in peer-reviewed journals and proceedings were selected for further review. Editorials, letters, and conceptual papers were excluded. While systematic reviews often limit their selection of papers to randomized, controlled trials (RCTs) as the highest level of evidence,[26] RCTs are not always feasible[27] or the method of choice[28] for the evaluation of the time efficiency of EHRs. Therefore, all papers that addressed the research question were retrieved, regardless of their study design. Abstracts of all papers identified from the search strategy were read and assessed by one of the authors. Abstracts that were rated as relevant to the research question were kept and full-text papers were retrieved for further review. In the absence of an abstract, full-text papers were retrieved and reviewed. Reference lists of selected papers were examined to identify other relevant articles. Finally, publications of key authors, selected based on their expertise and quality of publications in the area of workflow and EHRs, were looked at using the Web of Science Citation Index.

The quality of selected papers was assessed independently by two reviewers using a standardized evaluation process. For papers to be selected for final review, the following criteria had to be met: (1) the study design included a comparison group, (2) documentation or charting time was one of the outcomes, (3) quantitative estimates of time differences were documented, (4) subjects were health professionals, and (5) the working environment was either a home, hospital, or community clinic. Papers that assessed the impact of time efficiency only through direct patient care time measurement were excluded even if the authors assumed that the time difference in patient care could be attributed to increased or decreased time efficiency in chart documentation, as there was no evidence to support this assumption. Documentation was defined broadly to capture all patient-specific notes written in the chart by nurses or physicians, including order entries. Therefore, regardless of whether the term charting, writing notes, ordering, or documentation was used, if the authors made it clear that these clinical activities were for patient care, the study was included in the review. Evaluation disagreements between the two reviewers were resolved by a third reviewer.

Evaluation Process

Previous systematic reviews have used scoring systems to assess the validity of studies selected for review.[29–31] Existing scoring systems did not provide criteria that could be used in evaluating the scope of study designs and divergent methodologies used in the area of workflow assessment. Therefore, papers were rated qualitatively based on the two critical aspects that could influence the validity of the study: study design and methods used for data collection. Using the Campbell and Stanley[32] hierarchy for the internal validity of research designs, studies designed as RCTs were ranked first followed by posttest-only control group designs and one-group pretest-posttest designs in which the main source of internal bias would be related to the effects of temporal trends in care delivery. The method of measurement was ranked according to the precision of the data collection. Data collected by time and motion observer methodology ranked first, followed by video recordings as both provided direct and objective measurement of time. Work sampling techniques and self-reporting surveys were ranked third and fourth respectively, as they provide estimates of time efficiencies but the accuracy is influenced by the overall number of observations made,[33] interevent variability, and self-report biases.[34]

Studies that used time and motion or video-recording techniques measured time as a continuous variable and differences were reported as means (standard deviations) and units were minutes or seconds. Work sampling techniques estimate time using counts of the occurrences of an activity within a specified time period and were thus reported as proportions. To facilitate comparisons across studies and accommodate for the different sampling units, such as patient-physician encounters versus total working shifts, a relative time difference was calculated. The relative time difference was determined for each study as the time (mean or proportion) to document with computer minus the time to document on paper divided by the time to document on paper, producing a negative value when the EHR was time efficient. We calculated 95% confidence intervals for differences in means and proportions to assess the significance of reported differences. When there was insufficient information to compute 95% confidence intervals, the authors were contacted and the data needed to construct the confidence interval were requested. To account for the variability in sample sizes across studies, weighted averages were calculated for both types of sampling units (patients and working shifts). Weighted averages were calculated using the following formula:

$$\text{Weighted average} = \frac{\sum_{i=1}^{n} [SW(i) * RTD(i)]}{\sum_{i=1}^{n} SW(i)}$$

in which sampling weight (SW) = ($n_{group1} + n_{group2}$) and relative time difference (RTD) = (documentation time $_{group2}$ − documentation time $_{group1}$)/documentation time $_{group1}$.

Results

A total of 628 abstracts were read and of these, 63 papers were retrieved and assessed against the selection criteria. Forty papers failed to meet minimum requirements for review, the