

*Prepared by the CIHR-funded Knowledge to Action research group: Sara Khangura, Jeremy Grimshaw, David Moher*

This report covers a broad collection of recent literature and evidence around the electronic health record (EHR).

Evidence summarized from systematic reviews is highlighted in blue boxes, like this one. Systematic review evidence is generally favoured over other study designs, because it incorporates evidence from multiple primary studies, instead of reporting evidence from just one study.

All papers summarized in this document are available by request to [skhangura@ohri.ca](mailto:skhangura@ohri.ca).

Many sections conclude with a “Bottom line” subsection that provides a statement summarizing the studies highlighted in this document; these statements are not meant to address all of the evidence in existence on the subject, rather, that which is featured in this document.

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### Background

- In 1991, the Institute of Medicine released a landmark report recommending that electronic health records (EHRs) be implemented in health systems within 10 years<sup>1</sup>;
- Almost 20 years later, only a small proportion of health providers have implemented EHRs.<sup>2 3</sup>
- A meta-analysis of diffusion rates of EHRs in the U.S. shows that uptake has slowed in recent years. The study concludes: “EHRs are the future, and resistance is futile; however, current exigencies and uncertainties are slowing, not accelerating adoption.”<sup>4</sup>
- The very definition of what comprises an EHR remains in flux e.g. Web-based patient self-entry systems to fully integrated and interoperable systems linking multiple providers.<sup>5 6</sup>
- Empirical evidence on the benefits of EHRs is scarce;<sup>7 8</sup>
- Much of the published evidence on EHRs is conflicting; a broad variety of research disciplines representing widely varying approaches and perspectives contribute to this body of literature and this has been indicated as partly to blame for these discrepancies.<sup>9</sup>

### Benefits and Barriers to Uptake of EHRs

#### Benefits

- Multiple benefits to implementing EHRs have been posited, though few have been proven:

#### Systematic Review Evidence

- A 2008 large, NHS systemic overview of the literature on EHRs finds that: “**empirically demonstrated benefits** relating to introduction of EHRs are currently limited to **improved legibility, time savings for some professionals (nurses), and the facilitation of higher order functions such as audit, secondary analysis of routine data and performance management.**”<sup>7</sup>  
(emphasis added)

- Other **proposed** benefits of EHRs <sup>4 10 11 12</sup>
  - Efficiency of health services delivery;
  - Time savings for all health professionals and patients generally;
  - Cost savings;
  - Fewer clinical and medical errors associated with inadequate or incomplete information;
  - Improved patient safety;
  - Improved quality of care;
  - Improvements in public health.

### **Barriers to Uptake** <sup>13 14 15 16 17 18 19 20 21 22 23</sup>

- Physician and nurse reticence due to:
  - Demonstrated high cost of implementation;
  - Fear of crippling interruption to practice workflows;
  - Time required for training staff;
  - Concerns about interoperability;
  - Anticipation of a limited ROI;
  - Fear of losing professional autonomy;
  - Contradictory discourse in the literature;
  - Concern about rigid inflexibility of documenting with EHRs;
  - Comfort-level, skill and experience with paper-based records.
- Variable nomenclature and syntax between EHR systems reduces the potential for interoperability between care providers;
- Wide recognition that smaller health practices will encounter greater difficulty in implementing EHRs.

#### **Bottom Line**

There is yet little empirical evidence demonstrating benefits of EHRs; many proposed, and likely, benefits are often touted as certainties. Barriers to EHRs stem primarily from the uncertainty of would-be end users.

### **Will EHRs improve the quality of care?**

#### **Systematic Review Evidence**

- A 2009 systematic review of 7 countries' experience implementing health information systems (including EHRs) concludes that there was neither benefit nor harm between systems implementation and quality of care.<sup>24</sup>
- A 2008 systematic review on the benefits and costs of Electronic Patient Records (EPRs) concludes that "...concerning the influence of EPRs on quality of care, the studies do not provide a clear answer to the question of benefits..."<sup>25</sup>

- A 2004 systematic review of 26 studies evaluated several outcomes related to the quality of patient-physician encounters and generally found an increase in provision of preventive care, prescriptions that follow clinical recommendations and adherence to guidelines.<sup>26</sup>

- A 2006 systematic review of health information technologies (including EHRs) and their effect on quality, efficiency and costs finds: "Three major benefits on quality were demonstrated: increased adherence to guideline-based care, enhanced surveillance and monitoring, and decreased medication errors. The primary domain of improvement was preventive health..."<sup>27</sup>

- A yet-unpublished overview of systematic reviews of reminders for physicians (a common feature of EHRs) finds a modest association between reminders and improved quality of care.<sup>28</sup>

- A 2007 before-after study examining data from four community-based practices found a modest improvement in physician adherence to guidelines after implementation of EHR.<sup>29</sup>
- A 2007 study of data from six Community Health Centres over the course of a year found that while EHR-related costs had not been recovered, quality of care indices saw significant improvements.<sup>30</sup>

#### **Bottom Line**

Earlier systematic reviews and some primary studies indicate that EHRs have a positive effect on quality of care; however, later systematic reviews seem to show a neutral effect; evidence is yet conflicting regarding EHRs and quality of care.

### **Will EHRs improve patient health outcomes?**

#### **Systematic Review Evidence**

- A 2004 systematic review analyzed 3 studies that addressed patient outcomes; no benefit was reported.<sup>26</sup>
- A 2008 analysis of several large U.S. patient datasets found little to no association between the use of EHRs and improvement of patient outcomes.<sup>31</sup>

### Bottom Line

There is a paucity of evidence associating EHRs with patient outcomes; that which exists shows no effect.

### Will EHRs improve patient safety and/or reduce clinical errors?

- An NIH-funded study of two U.S. Veteran's Affairs hospitals examined whether data was consistently entered into the EMR (electronic medical record) for abnormal CT scans of abdominal aortic aneurisms; it found that 29% of abnormal scans went undocumented leading authors to conclude that patient safety was not improved by the EMR.<sup>32</sup>

### Systematic Review Evidence

- A 2006 systematic review of health information technologies (including EHRs) and their effect on quality, efficiency and costs identified "...decreased medication errors." As a major benefit.<sup>27</sup>
- A 2006 systematic review of two studies examined the impact of handheld EHRs and concluded that, while more documentation took place, there was more incorrect documentation combined with an increase in time taken for documentation.<sup>33</sup>
- A 2009 systematic review of 7 countries' experience implementing health information systems (including EHRs) concludes that there was neither benefit nor harm between systems implementation and patient safety.<sup>24</sup>
- Researchers examined clinicians' failure to inform patients of abnormal lab results in both community- and academic center-based settings; practices with and without EHRs showed no significant difference in the rates of failure to inform patients of abnormal lab results, leading authors to conclude that the EHR did not positively impact clinical errors of this kind.<sup>34</sup>

### Bottom Line

There is yet insufficient evidence to draw concrete conclusions about the impact of EHRs on patient safety and reduction of clinical errors.

### Will EHRs be cost effective?

- An oft-cited 2005 RAND cost-benefit estimate proposes estimates of cost-savings to health systems associated with EHRs; while these are impressive e.g. \$81 billion USD saved/year<sup>35</sup>, they are based on yet-unproven projections.<sup>36</sup>

### Systematic Review Evidence

- A 2008 systematic review on the benefits and costs of Electronic Patient Records (EPRs) concludes that "... there is considerable evidence for a reduction of costs by the use of an EPR, but little sign of an improvement in treatment quality."<sup>25</sup>
- The 2008 update of a systematic review of health information technologies found that overall data indicate modest cost benefits; however these tend to be long-term and highly variable across different practice settings.<sup>37</sup>
- A 2008 report from the US Congressional Budget Office summarizing evidence supporting the adoption of health information technologies (including EHRs) describes the evidence on cost-benefit as based on projections and ultimately as "limited and conflicting"<sup>38</sup>.
- A 2010 assessment of the cost and quality of care resulting from hospital computerization (n=4000) concludes that "As currently implemented, hospital computing might modestly improve process measures of quality but does not reduce administrative or overall costs."<sup>39</sup>
- A 2007 literature review of informatics systems designed to improve care for chronic disease found that both cost effectiveness and guideline adherence were significantly improved.<sup>40</sup>
- A 2006 literature review and commentary points out that while EHRs have been copiously touted as cost-savers, many reports in the literature indicate otherwise.<sup>16</sup>
- A 2003 cost-benefit analysis of EHRs in ambulatory primary care settings concludes that EHRs can result in positive return on investment, but that this is dependent on multiple factors.<sup>41</sup>

### Bottom Line

Many articles cite modest cost-benefits associated with EHRs, however, these are often based on results from small trials or projections based on modeling; empirical evidence supporting the cost effectiveness of EHRs remains limited and conflicting.

## Will EHRs save time and/or improve the efficiency of health services delivery?

### Systematic Review Evidence

- A 2008 systematic review analyzed 6 studies that addressed EHRs with respect to consultation times – 3 studies found an increase in consultation time, 1 found a decrease in consultation time and another found no difference.<sup>26</sup>
- A 2006 systematic review of quality measures around the use of EHRs indicates that decreased use of health services has been demonstrated, but authors note that this outcome is limited to larger health service providers and unlikely to translate to smaller practice settings<sup>27</sup>.
- A 2009 systematic review of whether critical care information systems save time on charting found conflicting results such that a conclusion about benefits or lack thereof could not be stated.<sup>42</sup>
- A 2009 systematic review examined the impacts of Regional Health Information Systems (RHISs) and found that, while studies were of variable scope and quality, RHISs “improved the clinical data access, timely information, and clinical data exchange and improvement in communication and coordination within a region between professionals.”<sup>43</sup>
- A 2008 report from the US Congressional Budget Office summarizing evidence supporting the adoption of health information technologies (including EHRs) describes the evidence around efficiency as conflicting.<sup>38</sup>
- A 2009 Kaiser Permanente Hawaii retrospective before-after analysis shows that office visits were significantly reduced after the introduction of EHR.<sup>44</sup>

### Bottom Line

While there is some evidence supporting an association between EHRs and efficiency, there is also evidence which does not support this conclusion; additional evidence will be required to draw firm conclusions.

## Will EHRs improve physician and/or patient satisfaction?

### Systematic Review Evidence

- A 2009 systematic review of 7 U.S.-based studies examined patient satisfaction with EHRs and found that: 1/7 studies reported a positive effect on patient satisfaction, 5/7 studies reported a neutral effect and 1/7 reported a negative effect; authors conclude further research is needed.<sup>45</sup>
- A 2004 systematic review found that results were mixed with both patients and physicians expressing enthusiasm for EHRs while also expressing significant concerns about the impact of their use on a variety of outcomes e.g. patient confidentiality.<sup>26</sup>

### Bottom Line

Evidence on patient and physician satisfaction is yet scarce.

## Challenges and Proposed Solutions to EHR Implementation

### Challenges

- A 2007 analysis of trends in EHR research states “...we can safely say that in their current form EPR and EHR-systems have proven to be rarely sustainable for various reasons. Inhibitors and enablers of sustainability include clinical, technical, sociotechnical, as well as political & business factors.”<sup>46</sup>
- In a 2008 commentary a physician notes that “...adopting EHR... is not an easy task: our colleagues resist their use; they are costly; the case for a return on investment for an ambulatory practice has not been well established; incentives to use are misaligned; implementations may be difficult; and often such systems disrupt or inhibit workflow.”<sup>47</sup>

### Key challenges identified by health practitioners who have implemented EHRs

- One small practice that implemented an EHR system outlines the following major challenges:
  - cost of implementation was not offset by efficiencies of the EHR;
  - technical support needs are considerable and difficult to meet;
  - interruption to workflows were considerable;
  - stress on staff and the practice in general was significant.

- Authors conclude that: "...substantial investments will be needed to shepherd small offices through what is an arduous process. We believe that many practices will examine the current environment and defer a decision to adopt an electronic health record, and given our experience, it would be hard to disagree with them."<sup>48</sup>
- Another small practice describes a much smoother transition to using EHR. A small, rural practice credits their success to:
  - an existing relationship with the software vendor;
  - changes in the roles of staff members;
  - physicians exercising patience and practice with coding;
  - a staged approach to implementation.<sup>23</sup>

### Proposed Solutions

#### Systematic Review Evidence

- A 2009 systematic review of 7 countries' experience implementing health information systems (including EHRs) in primary care identified the following factors that impact implementation:
  - Quality of the graphical user interface and feature functionality;
  - Quality of the implementation project's management;
  - Users' previous experience with information technology systems.
- Proposed solutions include:
  - Strong leadership i.e. a physician who champions the project;
  - Use of strategic project management techniques;
  - Establishment of standardized nomenclature and processes;
  - Comprehensive training for staff.<sup>24</sup>
- A 2009 Cochrane review of 10 studies examining strategies to improve uptake of information technologies among health professionals acknowledges that some strategies i.e. use of electronic databases and digital libraries show modest positive effects; authors conclude that more study is needed.<sup>49</sup>
- A 2008 synthesis of 3 qualitative studies identifies essential components of successful EHR implementation as:
  - a project champion;
  - realistic expectations of the challenges of implementing an EHR;
  - addressing existing staff attitudes toward IT;
  - providing adequate training to staff.<sup>50</sup>

- A 2010 review article challenges conventional assumptions that physicians are to blame for low uptake of EHRs: "Electronic medical records vary greatly in capability, quality, and cost. Some are well liked and heavily used; others are disliked and resisted. Doctors will become enthusiastic users if the electronic medical records are helpful in the care of their patients."<sup>51</sup>
- A 2007 review article recommends strong physician leadership and a staged-approach to successful implementation.<sup>52</sup>
- System interoperability has been highlighted as a necessity to successful implementation of EHR.<sup>17</sup>

#### Bottom Line

There are significant challenges associated with implementing EHRs; smaller health care practices are disproportionately saddled with these challenges; proposed solutions require significant investments of time, funds and effort.

### EHRs: More Research?

- Most insist that more EHR research is necessary; however rigorous study of EHRs presents particular methodological challenges that will be difficult to overcome and must be addressed to produce evidence that is sound and reliable.<sup>26 53</sup>
- Some have argued that traditional research methods should give way to a more contextual, qualitative evaluation that is carried out while a complex intervention like EHR is rolled-out, informing the process as it unfolds.<sup>54</sup>
- A group of U.S. researchers have proposed a series of steps designed to improve development and implementation of EHRs, including: "...setting EHR implementation in the context of healthcare process improvement, building safety into the specification and design of EHRs, safety testing and reporting, and rapid communication of EHR-related safety flaws and incidents."<sup>55</sup>

#### Bottom Line

- There is conflicting evidence around the benefits and drawbacks of EHRs due to a multitude of complex factors associated with their adoption and implementation.
- Variability in the quality and usability of EHR systems has been indicated as a significant problem; research may be best focused on what it is about successful EHRs that benefit patients, their health practitioners and the health systems within which they operate.

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