Author's response to reviews

Title: Evolving health information technology and the timely availability of visit diagnoses from ambulatory visits: A natural experiment in an integrated delivery system

Authors:

Naomi S Bardach (bardachn@peds.ucsf.edu)
Jie Huang (jie.huang@nsmtp.kp.org)
Richard J Brand (rbrand@epi.ucsf.edu)
John Hsu (John.T.Hsu@nsmtp.kp.org)

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Author's response to reviews: see over
Dear Editors,

Thank you for the thoughtful reviews and comments on our manuscript (Number 5338528624205929), “Evolving health information technology and the timely availability of clinical diagnostic data from ambulatory visits: A natural experiment in an integrated delivery system.” We are delighted by the opportunity to submit a revision of this manuscript for your consideration.

In the subsequent pages, we provide a summary of the reviewer comments and our responses and manuscript revisions

Sincerely,

Naomi Bardach, MD
On behalf of all of the study authors
From Dr. Middleton:

**Major compulsory revisions**

- It would be useful for the authors to clearly define “electronic diagnostic data”. They should be explicit about which diagnostic is captured in administrative versus the two different clinical systems, and how it is captured, and by whom, in the context and typical workflow of each system. A major potential confounding factor, of course, is that a data entry clerk may enter different data, as well as enter data in a more timely fashion, than a clinician.

  → We agree with the reviewer and have clarified these points in the manuscript. For example, we now use the phrase “visit diagnoses” instead of “diagnostic information.” In the introduction, we now state, “We focused on visit diagnoses as recorded by clinicians either on paper visit diagnosis forms, or through two types of EMR systems in a large, prepaid, integrated delivery system (IDS) over a three-year period. The IDS’s electronic databases captured all diagnoses; for diagnoses recorded on paper, data entry clerks transferred the information into the databases.”

  We also state in the methods section, “For this study, we abstracted data on the date and type of each clinic visit, clinician and patient identification codes, visit diagnoses as determined by the clinician, and date of diagnosis entry into the electronic encounters file, which was part of the legacy automated clinical databases, i.e., preceded the EMRs. Because clinicians or population managers could access the diagnostic information for population or point-of-care use only after entry into the electronic encounters database, we assessed the time between the visit and visit diagnosis entry into the database, using one of the methods described below in the “Predictor” section. Throughout this paper, “visit diagnoses” refers to the diagnostic codes coded for each visit and entered into the electronic database. Diagnostic codes were standard across all KPNC sites and were based on the International Statistical Classification of Diseases and Related Health Problems, version 9 (ICD-9).”

There is no additional interpretation by data clerks in any of the systems under study, i.e., the clinicians enter all of the diagnoses in paper, basic and advanced electronic systems, as is described in the Methods section.

- **The paper is well written but it could be improved if it were more clear about which databases the authors refer to in the discussion.** For example an architectural diagram depicting the administrative database(s), as opposed to the intermediate clinical information system, and the advanced clinical system databases, could make interpretation of this discussion easier for the reader.

  → To improve clarity, we have added a new Table 1 that provides a summary of functions of the database and relationship between the information systems and the database. We also have distinguished between point-of-care interfaces including HIT systems and the IDS’s visit encounter databases.

- **A key result graphic which this reader was looking for but is not presented is a combination graph which shows the impact of different HIT system utilization as the left Y-axis, over time as the X-axis, with a right-sided Y-axis depicting time to**
data availability. Such a combination graph would allow the reader to better interpret the data.

→ Please see two new figures, one of which resembles the figure above (Figure 5 (option 1)) and one of which shows the increased percentage of visits with data available within 1 day as the percentage of visits with HIT use increases for all medical centers (Figure 5 (option 2)). We would be happy to use either figure, and offer the choice to the editors.

**Minor essential revisions**

- *The authors suggest that the large patient sample should wash out any potential biases arising from patient or a practitioner mix over time, however, a subtle association (inverse) may exist between increasingly complex patients and accuracy and timeliness of patient level diagnostic data capture. This could be considered and discussed.*

→ Please see third paragraph on discussion section, which now states: “The problem of clinician delay may be exacerbated by the presence of sicker patients, which are more time intensive to care for and leave less time for documentation. We did not see any evidence for increase or decrease of acuity in the patient characteristics over time (age and number of diagnoses stayed had minimal variation), so it would be unlikely that a decrease in patient acuity would have contributed to the decrease in time to documentation. If the population had grown sicker during this time, then the effects of Advanced may be even more pronounced than they appear in our analysis.”

**Discretionary revisions**

- *It would be useful if the authors can correlate timely acquisition of patient level diagnostic data with improved decision support, clinical process or outcomes, or administrative data management. In particular, more readily available patient level diagnostic information might arise in decreased redundant tests and procedures, improved clinical decision-support compliance, and if medication data are considered, potentially decreased drug allergy, or drug-drug adverse reactions.*

→ We agree that correlations between timely data and clinical processes and outcomes or administrative data management would be quite useful. This study occurs in the context of a much larger study assessing these changes, for which data collection has just been completed and analyses are ongoing. This paper is the first step in demonstrating how clinical changes might occur with the implementation of the EHR. The outcomes of this study inform our ongoing analyses.

- *It would be useful to briefly describe the method of data entry for patient level diagnostic information in all three systems: administrative, intermediate clinical, and advanced clinical.*

→ The predictor section describes the data entry methods for each system—paper forms, basic HIT, Intermediate and Advanced. We have added a new Table 1 to summarize this information.

- *It would be useful to distinguish for patient level diagnostic data which are*
entered in batch mode, and on what schedule, versus those which are entered at the time of each clinical encounter.

This is an interesting point, but one on which we do not have adequate data to report. Generally speaking, the providers enter diagnoses at the time of the clinical encounter, but also have the option of finishing charting later in the day, so could enter data more in a batch mode then. Paper forms sent to the processing center are likely entered in batch mode, but we do not have any survey data or documentation regarding the work flow in the data processing centers.

• The introduction and background literature review of the paper could be strengthened. The authors do not review or cite the study by Tang et al. which assessed the completeness and availability of the clinical record, nor do they cite or discuss the study by Leape et al. at Harvard which analyzed the quality of care delivered and the association of information availability.

We have added to the literature review and included citations by Leape and Tang.
From Dr. Singh:

**Major revisions highly recommended before publication**

1) Overall, I think this paper offers valuable information for HIT skeptics and non-adopters. The biggest change I would advise the authors to make is to “sell” their paper better i.e. give more concrete examples of how timely data availability through large databases can be beneficial. For instance, in addition to discussing syndrome surveillance can the authors come up with additional benefits for general readers? Although the authors have done a nice job of talking about data availability at return visits and have used this as a benefit (which it is), availability of signed notes in the EMR itself can do that. But I think their paper is more than just that; I believe it is more about the benefit of being able to do rapid surveillance on a large scale using large electronic databases.

   → We agree with the reviewer and have made the population level benefits of timely data more explicit in both the introduction and discussion sections. In the introduction section, we now state, “Timely information is critical at both the population and the individual patient levels. For instance, population surveillance for and monitoring of infectious disease outbreaks requires real time clinical information.[5-11] Similarly, coordination during natural disasters also benefits from timely exchange of clinical data, as seen during Hurricane Katrina in 2005.[12, 13]”

In the discussion section, we now state, “The current public health infrastructure is limited and suffers from a dearth of clinical information. Few public health officials receive routine, timely transfers of electronic data, have mechanisms to analyse the clinical data, monitor outbreaks, or even confirm other reports. Most public health localities rely instead on word of mouth reports, phone calls with clinicians, or in-person interviews.[33] Compounding this problem are the limited and often declining resources available for public and population health.

   Electronic data captured by HIT systems offer tremendous promise in improving the availability of timely clinical information for disease surveillance, responses to potential outbreaks, and monitoring of actual outbreaks. For example, an electronic surveillance system implemented in laboratories in two Indiana counties led to a 29% increase in absolute number of *Shigella* species infections identified during an outbreak, and led to same day notification to the health department, decreased from an average lag time of 2.5 days from time of positive result to time of health department notification.[34] We have demonstrated that in an integrated delivery system using a comprehensive EMR, we can capture multiple different types of clinical diagnostic information, not just infectious disease entities.”

2) I would also recommend that the authors clarify what they mean by diagnostic information right at the outset. Readers may be expecting to hear about diagnostic lab tests, imaging etc. which I don’t think is the main focus of the paper.

   → We agree. Please see the response to reviewer #1.

3) Abstract needs work: The author should add a research question or hypothesis and strengthen conclusion in terms of the significance of the paper.

   → Please see revised abstract, with hypothesis stated and conclusion modified.
4) Perhaps, one of the main weaknesses of the paper (as acknowledged by the authors) is inability of the paper to show that timely access to diagnostic information brought about a change in outcome for instance in workflow, patient care, or disease management. Any further light the authors could shed on these issues would make the paper much stronger.

We completely agree with the importance of examining other clinical processes and outcomes. Please see the response to a similar comment made by reviewer #1. This manuscript focuses one of the first steps in a larger study that will address clinical outcomes.

Also, do the authors have any data from their own system on surveillance of either influenza or similar disease even if it is collected now in retrospect? The point is to show that they could have got to the data much faster. What about opportunities to access other types of data in real-time at Kaiser?

We are in the process of analyzing these data and look forward to sharing the results in the near future.

5) I also think they need to elaborate more about benefits of SNOMED, so that future general readers without an informatics background can understand the benefits of HIT.

Please see paragraph in the discussion section for how SNOMED enables greater accuracy of clinical documentation.

“Errors in diagnostic accuracy may occur in two forms: diagnoses incorrectly attributed to the patient (e.g. assignment of hypertension when the patient has never been hypertensive); and diagnoses incorrectly attributed to the patient at the time of charting (e.g. anemia is recorded as a diagnosis even after it has resolved). Advanced HIT may facilitate the second type of error since it enables carryover of information from one visit to the next without a forcing mechanism to verify the information. The use of SNOMED codes, which allow for much more detailed specification of diagnoses than ICD-9 codes, may enable a more structured description of a visit, and therefore a more accurate one; demonstrating this was beyond the scope of this study but could be considered in the future.”

Discretionary Revisions

One would expect to see more diagnostic codes being used as HIT used grew but that did not happen (Table 1). One would expect that advanced HIT would lead to more diagnostic information available per visit over time. This would be another benefit of HIT. Any speculations?

Please see last paragraph in discussion as noted above (comment #5)

Is there a reason why 2007 data was not shown; If possible, it would be nice to see that too.

We did this study with a focus on the uptake and early adoption of the advanced EMR. The majority of medical centers had completed implementation by the end of 2006, as is seen in
Figure 2a. For all medical centers, timeliness of the visit diagnosis data approached 100% once the Advanced EMR system was in place.

**Page 6: Who entered the data from paper?**

⇒ A clerical employee entered data. This is now noted in the text.

**Background:** On page 3 “These systems include many….” sentence is a bit unclear—I think “these” refers to newer EMRs but authors should check the writing.

⇒ Please see re-written sentence

*I would also encourage the authors to think of significance outside Kaiser to enhance benefit and generalizability. For instance, could this facilitate accurate and faster billing for others?*

⇒ We chose to focus on benefits to others that are benefits to Kaiser, and to avoid a discussion of timely billing cycles, as this was not the focus of the delivery system and so there is little data gathered on this aspect of system improvement. The advantage to the timely availability of information for the purpose of patient care is generalizable even to a small private practice as well as relevant to patients in the Kaiser system, and so we chose to discuss that rather than the advantages of shortened billing time.

*One would anticipate that the SNOMED-CT diagnostic codes communicated to the database would be more accurate although the authors have appropriately pointed out that errors in advanced HIT data entry may also occur. Given potential data entry problems and forms getting lost in the paper systems, certain advantages are very likely. It would be helpful if authors have any data on entry errors in paper i.e. accuracy or reliability of entered information.*

⇒ We do not have access to data re: accuracy or reliability in paper, though it would be interesting to assess changes with the use of SNOMED-CT codes.

**Regarding return visits, was ER included? If so they could give the amount of return visits to ER within 3 or 7 days and make a point about some potential benefit. Essentially this will build on their example of asthma.**

⇒ We did not look at return visits in the Kaiser system. We cite a study from Canada showing that 6.4% of asthma patients seen in urgent care return for another visit within 1 week, and the behavior of asthma patients here may be similar. We do agree with the reviewer that on return visits, particularly to the ED with a new provider, access to the most recent information may be particularly crucial to improving clinical decision-making, processes of care and long-term outcomes.

*Related to this benefit, they could choose to talk about electronic access of diagnostic test information—allows results to be viewed earlier etc., which essentially is a universal EMR benefit.*

⇒ Please see the second paragraph of the discussion section, which mentions this.

**Minor Essential**
Page 4 last line needs a comma.
Page 10-clarify 2nd sentence in discussion.
Page 13: Shigella-S should be in caps
→ We have made these changes.