The hazard of software updates to clinical workstations: a natural experiment

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Abstract
Emergency department (ED) electronic tracking boards provide a snapshot view of patient status and a quick link to other clinical applications, such as a web-based image viewer client to view current and previous radiology images from the picture archiving and communication systems (PACS). We describe a case where an update to Microsoft Internet Explorer severed the link between the ED tracking board and web-based image viewer. The loss of this link resulted in decreased web-based image viewer access rates for ED patients during the 10 days of the incident (2.8 views/study) compared with image review rates for a similar 10-day period preceding this event (3.8 views/study, p<0.001). Single-click user interfaces that transfer user and patient contexts are efficient mechanisms to link disparate clinical systems. Maintaining hazard analyses and rigorously testing all software updates to clinical workstations, including seemingly minor web-browser updates, are important to minimize the risk of unintended consequences.

Introduction
Emergency departments (ED) are staffed by multiple providers and care for high volumes of acutely ill patients; information systems (IS) are essential for their safe and efficient operation. Electronic tracking boards (or whiteboards) have become a core communication tool providing a snapshot view of the ED, displaying all patient locations, care statuses, and provider assignments. More sophisticated ED electronic tracking systems integrate with other hospital IS, allowing ED clinicians to perform essential clinical tasks, such as computerized provider order entry and laboratory and radiology result review. Our hospital has a well-established, custom-developed ED tracking board with patient tiles that display real-time information for each active ED patient and that integrate with other administrative and clinical systems (figure 1).

Timely review of ED radiology studies can be life-saving, but radiologists may not always be immediately available. Emergency physicians must therefore be skilled at interpreting imaging studies, particularly x-rays and head CT, and have immediate and easy access to review these studies.

We designed our ED tracking board to allow users to quickly and easily review current and past radiology studies stored on our institution’s picture archiving and communication system (PACS) with a single-click interface. Users right-click on a patient’s tile in ED Tracking and directly launch into the selected patient’s radiology studies in a commercial web-based radiology image viewer application (figure 1). Patient context and user credentials are sent from ED Tracking to the web-based image viewer so users are immediately brought to the selected patient’s imaging results without the need for separate, time-consuming login and patient selection.

When designed, implemented, and used appropriately, health information technology (HIT), such as the ED tracking board, has the potential to improve healthcare delivery. However, unintended and unanticipated consequences can be caused by HIT due to poorly designed user interfaces, poor workflows, and lack of interoperability. These HIT hazards increase the risk that care processes will be compromised or that patients will be harmed.

In this report, we describe a HIT hazard where a software update unexpectedly severed a key system feature. Specifically, the single-click link between ED Tracking and our web-based image viewer was lost due to a Microsoft Internet Explorer software update. We describe the events that led to this hazard as well as the subsequent actions taken to restore the link. We also determine if web-based image review, an important ED care workflow, was impacted by this event. We hypothesize ED web-based image viewer software use decreased during the loss of link time period due to the additional application launch and patient selection steps required to access images.

Case report
On Saturday, April 16, 2011, our hospital’s IS help desk received multiple reports that the web-based image viewer could no longer be directly accessed from ED Tracking. When users right-clicked on the ED Tracking patient tile to launch the web-based image viewer, a new browser window was opened, but with the error message, ‘Failed to connect to proxy.’ Users were then forced to quit the web-based image viewer. As a workaround, ED users could separately open the web-based image viewer application from the Windows XP Start Menu and enter the patient’s medical record number (MRN) to view radiology studies. This workaround was time-consuming and also required manual entry of the MRN.

IS discovered the link from ED Tracking to the web-based image viewer was only lost on workstations running Microsoft Internet Explorer 6 and the cause of the issue was related to an Internet Explorer cumulative security update (MS11-018) that was released by Microsoft on April 12, 2011 and deployed to hospital desktops over the course of the following weekend (Saturday, April 16, 2011). The image viewer software vendor was notified immediately as well as hospital IS leadership. Due to the criticality of the issue for the ED, and
the belief that a vendor patch would not be quickly released since Internet Explorer 6 is such an outdated browser, a decision was made to update all ED workstations to Microsoft Internet Explorer 8 (IE8).

As IE8 was not yet ready to be implemented throughout the hospital, IS analysts tested the ED clinical applications to assure compatibility with it. Additionally, one ED workstation was updated to IE8 and tested thoroughly by an ED clinician and an IS analyst. Once testing was successfully completed, the IS team manually updated all ED devices on the morning of April 25, 2011. The update process went smoothly and solved this issue without introducing other unintended consequences.

METHODS

The Partners HealthCare Human Research Committee reviewed and approved this study. We compared rates of ED web-based image viewer application use before and after the loss of the link from the ED tracking board. We also compared the rates of radiology PACS workstation viewing of ED images between the two time periods. We hypothesized that web-based image viewer application use would be lower in the loss of link period and that there would be no difference in PACS workstation viewing rates.

Our ED is fortunate to have 24/7 onsite coverage by radiologists who use PACS workstations that were not affected by this event. Radiologists review images in real-time and immediately notify ED clinicians of critical findings. It is therefore unlikely this loss of link affected patient outcomes.

The loss of link period was from Saturday, April 16, 2011 through Monday, April 25, 2011, the 10 days during which this issue affected ED Tracking. The control period was from Saturday, April 2, 2011 through Monday, April 11, 2011, the 10 days immediately preceding the loss of linkage between ED Tracking and the web-based image viewer. The Brigham and Women’s Hospital ED treats approximately 150 patients each day and there is not an a priori reason these two time intervals would have systematic differences in patients, presentations, or imaging use/review.

We obtained a list of all patients seen in the ED during these time periods, including patient name, MRN, age, sex, disposition (admission/discharge/observation), and length of stay. We limited the sample to patients discharged from the ED to minimize the chance that other providers, such as inpatient teams, would also access the web-based image viewer.

Using the list of discharged ED patients during these time periods, we identified all radiology studies performed during each patient’s ED encounter. We then queried the radiology image management system’s audit trail to determine all read events for these studies within 24 h of study completion, the typical maximum ED visit length. We also identified whether the study was accessed using the web-based radiology image client or a dedicated radiology PACS workstation.

We performed descriptive statistics on the characteristics of patients seen in the ED during the two time periods. The image read events were count data, but conditional variance exceeded the conditional mean by over three times and thus standard Poisson assumptions were not met. To account for the over-dispersion, we modeled the ratio of web-based image viewer access to radiology imaging volume before and after the link from ED Tracking was lost using negative binomial regression. Risk ratio, 95% CIs, and p values were reported. A similar comparison was performed for radiology PACS workstation views between the two time periods. Data management and statistical analysis was performed using Microsoft Access 2003 and Excel 2003 (Microsoft Corporation, Redmond, Washington, USA) and Stata V12.1 (StataCorp LP, College Station, Texas, USA). Two-sided p values of less than 0.05 were considered to indicate statistical significance in all analyses.

RESULTS

A similar number of patients were seen and discharged from the ED during the control and loss of link time periods (table 1). Baseline characteristics between patients seen in the study interval and control interval were also similar by sex, age, and length of stay. The volume of radiology studies ordered in the control period (542) was higher than in the loss of link period (450; table 2). Accounting for differences in the volume of radiology studies ordered, the ratio of web-based image viewer access to image volume was significantly less with the loss of link compared with the control time period when the link was working normally (p<0.001; table 2). There was no difference in views using radiology PACS workstations between the two time periods (p=0.120).

DISCUSSION

We illustrated how a routine web-browser update severed a link from ED Tracking and led to an unanticipated decrease in ED clinician review of radiology images. This case highlights the importance of hazard analysis and testing all software updates to clinical workstations, including applications on which HIT applications are built, such as operating system and applications used by clinicians.

| Table 1 Characteristics of patients seen in the Brigham and Women’s Hospital Emergency Department before and after the link to the web-based image viewer was lost |
|---|---|---|
| Total patients seen | 1643 | 1558 |
| Number discharged (%) | 915 (56%) | 887 (57%) |
| Number male (%) | 329 (36%) | 317 (36%) |
| Average age (years) | 41.9 | 42.1 |
| Average length of stay (hours) | 3.05 | 2.94 |

Figure 1 Brigham and Women’s Hospital Emergency Department tracking system. Right-clicking on a patient tile allows users to launch the web-based image viewer client directly to that patient’s radiology studies.
web-browser updates. Further, well-designed user interfaces, such as single-click interfaces, can facilitate efficiency and influence provider practices.

Software related safety concerns are well recognized in aerospace and other safety critical industries, and awareness of HIT unintended consequences and adverse events is increasing.\(^1\)\(^2\) Computer scientists and industrial engineers have developed systematic methods to identify, reduce, and mitigate computer related risks using hazard analysis.\(^3\)\(^4\) Since testing every HIT feature is impractical, hazard analysis can be applied to identify and prioritize specific threats. All software and hardware updates to clinical workstations, including operating system updates, should undergo repeat testing using formal test plans based on hazard analyses. Software features most likely to be affected by updates and integration points between applications (eg, ED Tracking and the web-based image viewer) may be particularly vulnerable to software updates and may be prioritized in test plans.

This case also illustrates the need to keep clinical workstation operating systems and web browsers up to date. Older operating systems and web browsers may not be well supported by their own developers or clinical application vendors. Currently, many software vendors offer the ability to check for and automatically install updates periodically. For example, Microsoft Windows Update provides background updates to the Windows operating system and Internet Explorer browser. While this can help keep software updated and prevent security breaches, it can also lead to unintended consequences if testing is not performed prior to update installation. Healthcare organizations should strongly consider disabling auto-updates, while creating formal processes to regularly update clinical applications and operating system software.

The reduced ED web-based viewing of radiology images when the link was lost was likely due to the time-consuming workaround of manually launching the image viewer application and re-entering the patient’s MRN to view radiology studies. Our ED clinicians may have found it faster to review the studies with the nearby radiologist on a PACS workstation rather than using the workaround. This illustrates the importance of user interface design and its potential impact on clinician behavior, particularly in the fast-paced ED.\(^5\)\(^6\) In this case, the loss of a usability feature (easy link from ED Tracking to the web-based image viewer) decreased a good clinical practice (radiology image review by ED clinicians). We did not assess, nor did we expect, possible harm to our patients due to continuous access to on-site ED radiologists. By making it easy for ED clinicians to review radiology images and improve their training with a simple right-click, the ED Tracking link to the web-based image viewer is an example of how HIT can be used to ‘nudge’ ED providers to review imaging studies at the point of care.\(^7\)

**CONCLUSION**

HIT systems need to be designed to be easy to use, efficient, and match clinical workflows. This case illustrates the importance of usability in system design and how HIT design can be used to influence clinician behavior, such as ED clinician review of radiology imaging studies at the point of care. All software updates, including seemingly minor operating system updates, can lead to unintended clinical consequences. Disabling software auto-update features, maintaining hazard analyses, and rigorously testing all software updates to clinical workstations prior to distribution may reduce the risk of unintended consequences.

**REFERENCES**


