Clinical impact and value of workstation single sign-on

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ABSTRACT

Background: CHRISTUS Health began implementation of computer workstation single sign-on (SSO) in 2015. SSO technology utilizes a badge reader placed at each workstation where clinicians swipe or "tap" their identification badges.

Objective: To assess the impact of SSO implementation in reducing clinician time logging in to various clinical software programs, and in financial savings from migrating to a thin client that enabled replacement of traditional hard drive computer workstations.

Methods: Following implementation of SSO, a total of 65,202 logins were sampled systematically during a 7 day period among 2256 active clinical end users for time saved in 6 facilities when compared to pre-implementation. Dollar values were assigned to the time saved by 3 groups of clinical end users: physicians, nurses and ancillary service providers.

Results: The reduction of total clinician login time over the 7 day period showed a net gain of 168.3 h per week of clinician time – 28.1 h (2.3 shifts) per facility per week. Annualized, 1461.2 h of mixed physician and nursing time is liberated per facility per annum (121.8 shifts of 12 h per year). The annual dollar cost savings of this reduction of time expended logging in is $92,146 per hospital per annum and $1,658,745 per annum in the first phase implementation of 18 hospitals. Computer hardware equipment savings due to desktop virtualization increases annual savings to $2,333,745. Qualitative value contributions to clinician satisfaction, reduction in staff turnover, facilitation of adoption of EHR applications, and other benefits of SSO are discussed.

Conclusions: SSO had a positive impact on clinician efficiency and productivity in the 6 hospitals evaluated, and is an effective and cost-effective method to liberate clinician time from repetitive and time consuming logins to clinical software applications.

1. Introduction

Physician dissatisfaction with electronic health records (EHRs) in the Meaningful Use era has been significant [1–3]. For many physicians, EHRs and computerized provider order entry (CPOE) are among the largest, most dislocating changes in clinical practice and workflow in a generation. Physicians have expressed concerns over perceived usability, interruptions in clinical workflow and patient relationships, as well as the time added to an already heavy work volume. Superimposed on these challenges is the imperative for all care givers to maintain the highest possible security for protected health information through HIPAA compliance. It has been observed that what makes passwords effective – complexity and frequent change – also makes them hard to remember [4].

We estimate in our system that clinicians and physicians in particular were required to recall and periodically refresh from 8 to 20 or more passwords at the application level to access each, many requiring different user names and passwords. Other hospitals have stated their clinical users typically logged in to 8–10 or more applications [5,6]. Time lost by clinicians navigating, entering multiple passwords and resetting them when forgotten is valuable time that competes with and diverts from their care of patients. We regarded implementation of single sign-on (SSO) as a relatively rapid and easy way to help facilitate our clinicians' adoption and use of EHR technology, including CPOE and digital documentation.

SSO technology enables a clinician or care giver to login in usual fashion with a keyboard when first beginning work at the hospital and then streamlines all subsequent logins during that shift. SSO automates the login process, enabling clinicians to login only once to their desktop in order to gain expedited access to all their applications. It eliminates the clicks, key strokes and need for complex passwords that have become anathema to many clinicians. Because

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care givers are highly mobile and routinely pressed for time, there is great potential value in providing them roaming access to the information and systems they need at the point of care and as they move through the hospital.

Our enterprise objective in implementing SSO was to provide clinicians improved and expedited access to key clinical applications, and to eliminate password confusion and wasted time in password management, while enhancing HIPAA compliance in access authentication. Once logged in, clinicians need only tap or swipe their enabled identification proximity badge on card readers placed at all computer workstations (except those reserved for downtime access). No matter where clinicians may work within the hospital, use of a proximity badge to tap in and out (or "tap and go") enables them to pick up exactly where they left off and conveys rapid no click access to health records and other functionality as they change location. When the clinical user moves to another device in the facility, a simple tap on the badge reader brings the current state of the last computer used to the new screen.

SSO reduces repetitive, manual logins with automated processes, and expedites authenticated access to desired clinical software applications used by the clinician for the balance of a 12 h shift, after which login in the usual fashion must be repeated to enable another shift of accelerated logins. SSO provides support for all types of applications including terminal, client server and cloud-based applications. Our SSO platform has a simple graphical user interface (GUI) based tool for creating application SSO profiles. No coding is necessary, and we are able to profile and deploy new applications rapidly. Password administration enables automation of application password change processes, removing this task from the care provider. Providers can focus on patient care, not on continually managing new passwords to meet organizational password requirements. Clinical applications can be automatically launched, or closed, when a user signs in, depending on their location in the hospital. By automatically starting the required applications and signing providers in, more time is liberated for patient care, and clinicians spend less time navigating technology. SSO automatically locks workstations when care providers leave and re-authenticates them when they return to where they left off. This eliminates the need to manually lock sessions or use sometimes unreliable inactivity timers, and prevents loss of work in the system due to distraction or diversion. The process minimizes disruption to clinical workflows while meeting regulatory compliance and security requirements.

It was determined that the mostly highly effective implementation of SSO required a migration from workstation personal computers (PCs) to a thin client with processing occurring within the Cloud. In addition, we migrated from physical PCs to a virtual desktop infrastructure (VDI) in order to enable clinician roaming from service line to service line in the hospital using the new SSO access. During early implementation, 45 different clinical software applications were profiled and enabled for single sign-on.

Fontaine et al. reported previously in this journal that proximity card authentication significantly increased clinicians' perceived speed of login and decreased inappropriate shared login on clinical workstations [7]. Hope and Zhang evaluated perceptions of satisfaction with SSO in the emergency departments of a mid-sized integrated delivery network, finding that SSO increased clinical user satisfaction [8]. Heckle and Lutters sought to document the factors affecting SSO adoption using ethnographic research methods, and noted that SSO was not consistently effective or a good fit for collaborative work areas [9]. This report builds on past efforts to evaluate SSO technology by complementing these self-reported data and qualitative research methods with direct sampling of actual login times prior to and following implementation of SSO in 6 hospitals. We then quantified annualized and facility level clinician time savings and the associated financial value, using national

reports of mean hourly wages of different clinical end users on the multidisciplinary care team who roam the hospital and would benefit from SSO. The objective of this study was thus to assess the impact of SSO implementation in reducing clinician time logging in to various clinical software programs, and in financial savings achieved by migrating to a thin client that enabled replacement of traditional hard drive computer workstations.

2. Methods

2.1. Study setting

We present a quantitative evaluation of the impact of the implementation of single sign-on login technology for access to computer workstations in 6 CHRISTUS Health hospitals. CHRISTUS Health is a mid-size independent delivery network in 6 U.S. states and 3 foreign markets with more than 350 services, 47 hospitals and over 15,000 physicians. CHRISTUS Health Information Management and Health Informatics began implementation of SSO across the enterprise in 2015. Initial implementation of SSO at CHRISTUS Health focused on enabling SSO among physicians, mid-levels and nurses. Subsequently, access was expanded to include ancillary services, such as respiratory therapists, dieticians, physical therapists, and other care providers who roam the hospital. Our electronic health record is MEDITECH Client Server Version 5.66 and our SSO product is OneSign Version 5.1 from Imprivata.

2.2. Study design

We share quantitative data on clinician time savings and recurrent computer hardware expenditure savings resulting from the implementation of SSO. Utilizing average national hourly wage rates, we translate the hours of time saved by various clinicians in reduced login activity into dollar cost savings produced when clinicians are liberated to be clinicians and care for patients.

The software utilized to implement SSO enables precise quantification of the number of logins by multidisciplinary care givers within each facility and across all 6 facilities on which analyses were completed. Our SSO product, OneSign Version 5.1 from Imprivata, and our virtualization software provided by Citrix, provide us with data-based reports on current and retrospective SSO utilization by clinicians including: number of deployed users; number of active users; number of logins; SSO application frequency of access profile; average logins per user; and average application events per user. While care giver satisfaction was not systematically surveyed, anecdotal reports of increased satisfaction among end user clinicians was captured and will be described.

2.3. Sampling techniques

We selected a 7 day observation period of SSO usage in May 2016 across 5 general community/general hospitals and 1 children's hospital in Texas and Louisiana. Measurements were completed of mean login duration to representative workstations pre-SSO and post-SSO implementation. Post-SSO involved 2 login durations: the first login of the day to the desktop (which required slightly more time than pre-SSO), and subsequent logins to the EHR utilizing the card reader or swipe technology (which required less time per login than pre-SSO).

2.4. Sample size

There were 65,202 logins to the enterprise EHR (MEDITECH Client Server 5.66) by clinicians in 6 facilities over a 7 day period post-SSO in May 2016 (also used to approximate pre-implementation logins). Potential SSO clinical users across the

enterprise are 22,011. Of these, 5078 were based in the 6 hospitals evaluated, of which 2256 were active users (44.4%).

To determine and validate actual initial login and reconnect times, we completed 2 samplings of 20 logins for each facility separated by approximately 1 week and derived the mean. We replicated this sampling of actual login durations in each of the 6 hospitals evaluated. Sampled workstations were on different floors and service lines of each facility. We have no a priori reason to suspect any substantial or systematic variation or changes in system performance between samplings, and none was evidenced from repeat sampling.

2.5. Data collection tools

Citrix Studio was our virtualization analytics tool and we generated manual reports from the Imprivata OneSign appliance. Hands on evaluation of sample login times were completed manually and systematically (as described above) at each of the 6 hospitals on end point user devices (thin clients).

2.6. Data analysis and management

Mean login durations were multiplied by the number of total first of shift and subsequent logins across all 6 hospitals for a 7 day period of evaluation and reporting in May 2016. We report on the total time required for clinicians to login pre- and post-SSO implementation and quantify the benefit resulting from decreased clinician login times. We utilized multiple national estimates of median or mean hourly pay rates for members of the multidisciplinary care team in order to translate hourly and shift savings to dollar/cost savings, including physicians, nurses, respiratory therapists, dieticians and physical therapists. For the desktop virtualization, we estimated the recurrent annual expenditure savings created by replacing computer workstation hard drives with a thin client utilizing Cloud processing to facilitate rapid login and other computing functions of clinical workstations.

We calculated the dollar cost savings or value in liberating time for each of 3 categories of clinicians utilizing SSO – physicians, nurses and ancillary personnel (including physical therapists, dieticians and respiratory therapists). Clinician time liberated by SSO enables them to focus on care delivery to patients, increasing (presumably) patient throughput and volumes, and thus indirectly revenue. More time spent on patient care rather than logging in to clinical information systems may also presumably improve quality and both patient and provider satisfaction. In our SSO implementations in these 6 facilities, 28% of clinical users were physicians, 54% were nurses, and 18% were from ancillary departments. We estimated hourly wages of each clinical group with intent to err on the conservative, as follows. For nurses, we utilized the national average wage of $34.50 [10]. We collapsed physical therapists, dieticians and respiratory therapists into a single category of ancillary users and averaged their respective average hourly wages as $32.20.

Estimation of physician hourly wages was more complex because of considerable income disparity between specialties. First we divided physicians into 4 general groups corresponding to our highest EHR users who issue the greatest total enterprise volume of orders through CPOE: (1) hospitalists; (2) emergency medicine physicians; (3) general surgeons; and (4) all other physicians collapsed. We estimated from our CPOE use and order issuance data that each group comprises approximately 25% of EHR and related applications use, and therefore, physician SSO use as well. These estimates are based on our high level analysis of historical and current CPOE use rates and volumes of total orders issued by specialty.

We collapsed all other medical specialties into a single category and averaged the physician hourly wage rate reported in the

U.S. Department of Labor occupational employment statistical data base rate ($95 per hour) with that reported by Becker's Hospital Review 2015 data ($165 per hour) for a rate of $130 per hour [11,12]. For hospitalists, emergency medicine physicians and general surgeons, we averaged 3 reported hourly rates for each specialty from Salary.com, the Medscape Physician Compensation Report 2016, and Becker's Hospital Review 2015 data [12–14]. This yielded an hourly mean wage of $108 for hospitalists, $144 for emergency medicine physicians and $170 for general surgeons. Averaging the hourly wage of the 4 categories of physicians yielded a generic physician hourly wage of $138. We preferred to err in our estimates on the conservative side with respect to the financial value and impact of SSO, and suspect that in many U.S. markets, actual physician hourly wages will exceed these estimates.

Workstation hardware purchase savings are realized by migration to a thin client during SSO implementation. The cost of a WYSE device or thin client at $200 per unit supplants the current PC upgrade/replacement cost of $900 per unit. We estimated and report prospective multi-year savings on PC replacement costs.

2.7. Inclusion and exclusion criteria

Although SSO was implemented on mobile workstations, because of a high degree of variation in their set up and deployment from facility to facility, we could not compensate for this variability and so excluded mobile access points from our analyses. This variation includes type of computing device deployed, whether a thin client is deployed on a mobile workstation, and variances in mobile wireless coverage and penetration. These mobile workstations represent approximately 18% of all workstations on which SSO was deployed in the 6 hospitals evaluated.

3. Results

Pre-SSO implementation, manual keyboard login was measured as requiring a mean of 29.3 s, equal to a total 530.7 h of clinician login time over 7 days assessed. First of shift SSO to the EHR is a 2 step login: accessing the Windows desktop requires a mean of 30.1 s and then 4.5 s to access the EHR, a total of 34.6 s. Login failures and inadvertent logins to a prior user's account were very infrequent and considered negligible for the purpose of analysis.

Post-SSO implementation, 12,936 logins were first of shift (at 34.6 s each), requiring 124.3 h of clinician first EHR login time over 7 days. During the remaining 12 h shift, when clinicians reconnect to the EHR the time required per login was 16.4 s, a reduction of 12.9 s from pre-implementation. The number of subsequent clinician logins was 52,266, yielding a total of 238.1 h of reconnect time to the EHR over 7 days. Total post-SSO clinician login time over 7 days is the sum of initial login plus subsequent login hours, or 362.4 h total (Table 1).

Reduction of clinician login time over a 7 day period across 6 hospitals was 530.7 h pre- minus 362.4 h post-implementation, a net of gain of 168.3 h of clinician time liberated over the 6 hospitals (14.0 shifts of 12 h), or 28.1 h (2.3 shifts) per facility per week. Per annum, 1461.2 h or 121.8 shifts of mixed physician and nursing time are liberated per facility. Our first phase implementation of 18 hospitals will yield 2192 shifts or 26,302 h of clinician time saved (Table 1). However, if login occurs with less than 20 min transpired since last EHR activity (the enterprise standard EHR inactivity log off time), subsequent login time is reduced to 11.9 s. Percentage of reconnects within 20 min is not available but if substantial, the above metrics underestimate considerably actual time saved.

The financial impact estimates, as shown on Table 2, conservatively translate the mean reduction in clinician login time per facility per year (1461.2 h) into a facility annual savings (or libera-

Table 1
Single Sign-On Reduction in Clinician Login Times and Associated Cost Savings.

Login Performance Parameter	Frequency	Cost Savings
Total number of logins to enterprise EHR over 7 days (6 hospitals)	65,202	
Active clinical users of Single Sign-On (6 hospitals)	2256	
Mean pre-SSO manual keyboard login total time required per facility (7 days)	88.5 h (7.4 shift equivalents)	
Mean post-SSO clinician login time per facility (7 days)	60.4 h (5.0 shift equivalents)	
Mean post-SSO reduction in clinician login in time per facility (per week)	28.1 h (2.3 shift equivalents)	
Mean post-SSO reduction in clinician login time per facility (per year)	1461.2 h (121.8 shift equivalents)	$ 92,146
Expected total post-SSO clinician login time savings when 18 hospitals implemented (per year)	26,301.6 h (2191.8 shift equivalents)	$1,658,745

Table 2
Single Sign-On Cost Savings by Professional Category.

Professional Category	Percentage of All SSO Users (Annual Hours Liberated 6 Facilities)	Estimated Hourly Wage	Annual Value of Liberated Time/Cost Savings Per Facility	Annual Value of Liberated Time/Cost Savings 18 Facilities
Physicians (Hospitalists, Emergency Medicine Physicians, Surgeons and all others)	28% (7364.5 h)	$138.00	$56,456	$1,016,301
Nurses	54% (14,202.9 h)	$34.50	$27,222	$490,000
Ancillary (Physical Therapists, Dieticians and Respiratory Therapists)	18% (4,734.3 h)	$32.20	$8469	$152,444
All Professional Categories	100%	–	$92,146	$1,658,745

tion of clinician time) equal to $92,146 per year, per facility. When 18 hospitals in our first implementation phase are live on SSO, the 26,301.6 h of clinician time saved will produce a recurrent enterprise annual savings equivalent of $1,658,745. If our conservative estimates undervalue the hourly wages and associated savings by 10%, the annual savings increase to $1,824,620; if undervalued by 20%, the hourly wage savings increase to $1,990,495.

Estimated savings in averted new PC purchases due to replacement of PCs with WYSE thin client devices is estimated at $2.7 million over the next 4 fiscal years ($675,000 per year). We estimate that the net total cost of SSO implementation was approximately $700,000 (including WYSE device virtualization, but excluding other system elements that were already in place at go live or that serve other utilities and objectives). Our annual maintenance cost for SSO is $219,000. With the savings rendered by SSO in terms of clinician shifts at $1,658,745 total per annum, the additional savings on new PC purchases brings the annual total recurrent savings to $2,333,745 across our enterprise.

While we collected no survey or interview data systematically, anecdotal reports from over 80 physicians and nurses utilizing SSO while Health Informatics rounded in the hospitals after implementation conveyed a very high degree of satisfaction with its deployment.

4. Discussion

Our finding of 28 h of clinician time saved per week and 1461 h saved annually per facility is comparable to estimates conveyed in other reports [15–17]. Our time savings however are not estimates, or self-reported [7–9], but are actual observed login time reductions quantified by our software application. Thus SSO has had a significant favorable impact on clinician efficiency and productivity in these 6 hospitals. However, our financial gains are considerably lower than reported from a survey of information technology professionals, where estimated cost savings were $2675 per clinician per year [17]. We can only postulate that actual data on login time reduction, and the resulting quantified cost savings, may differ from perceptions self-reported by survey.

A limitation was our systematic exclusion of mobile workstations from analysis due to the great variation in their technology implementation across and within facilities. Because the set up of these workstations varies so greatly between (and within some) facilities, it would have been exceedingly difficult to measure login times in a standardized and consistent manner. Anecdotal reports from clinical end users suggest that SSO performance on mobile workstations is not substantially different from stationary ones. Moreover, our system will be likely moving toward the elimination of these mobile workstations on wheels in favor of in room stationary ones for a variety of reasons, including wireless connectivity and battery life problems as well as infection control concerns. Thus their impact on the long term value of SSO will be eventually eliminated. We suspect that many other hospital systems in the U.S. are moving in a similar direction. However, when mobile workstations do vary in performance, we acknowledge that it is more often in favor of prolonging login times and diluting the impact and value of SSO.

SSO implementation required that we overcome several challenges and barriers. These related primarily to the initially unanticipated need to update or upgrade other components of information technology infrastructure or software. The demands of SSO technology and maintaining a satisfying and effective end user experience focused on improving the processing capability of existing computer workstations with SSO. Without such an upgrade, enabling expedited login and rapid access to the diverse clinical software programs utilized by physicians and nurses was taxing our existing workstations' capabilities, with evident poor performance

of SSO and resultant end user dissatisfaction. Consequently, legacy computer workstation processors were systematically replaced with a thin client (WYSE device) that shifted processing from a local device to the CHRISTUS Private Cloud. This solution dramatically improved SSO, overall workstation and EHR performance, at a fraction of the cost of upgrading computer processors. However, as noted, this process of discovery at the pilot site hospital occurred with considerable dislocation and initial dissatisfaction among clinical end users in that facility.

Another challenge in SSO implementation occurred during the early adoption period when clinical end users would misattribute workstation or Wi-Fi performance problems to SSO, for which SSO was not the system component that was actually problematic. While this period of issue misattribution persisted for some time, as SSO performance achieved a high level, such faulty misattribution of issues to SSO decreased.

5. Conclusions

Based on this evaluation of the impact of SSO implementation, SSO is delivering substantial clinical value, recurrent annual ROI and net cost savings to the first 6 facilities implemented within our hospital system. Single sign-on technology appears to be an effective and cost-effective method to liberate clinician time from repetitive and time consuming logins to clinical software applications. Further, our experience was that the introduction of SSO technology facilitated adoption of key component functionalities and applications within our EHR as reported by physician users, which aligns with the implementation experience of other hospitals [7–9,15–17]. SSO implementation and its best performance may demand and is much facilitated when combined with migration to a thin client device and VDI. This reduces the need for costly PC replacement and upgrades, and produces substantial hardware expenditure savings.

Other value that is difficult to readily quantify was delivered by our implementation of SSO, including increased clinical end user satisfaction with the hospital system's clinical information technology services. Clinicians reported high SSO satisfaction with the improved ease/speed of access to clinical workstations and applications. Indeed, within weeks of implementation in a particular facility, other members of the clinical care team, such as respiratory therapists and other ancillary personnel who roam the hospital using multiple workstations requested access to SSO. With the management of physician and particularly nurse turnover an ongoing challenge for many hospital systems, any improvement in these clinicians' satisfaction with the hospital work environment and clinical workflow can enhance the organization's retention efforts and reduce the costs associated with high turnover. Further, the security and integrity of our HIPAA compliance has been substantially increased through the deployment of SSO and its rigorous authentication. Finally, we suspect and are currently evaluating whether IT help desk or service calls related to password resets have been reduced by the implementation of SSO. Reducing the burden on a hospital or system's helpdesk due to clinicians forgetting complex passwords could liberate these resources to focus on other needed service support.

In an era of where the evolution of EHR usability is an imperative to overcome the concerns of clinicians, and with the introduction of serial dislocating clinical information technologies such as CPOE and digital clinical documentation, we suspect that SSO can help ease the EHR adoption burden, and can help facilitate clinician, and particularly physician, adoption. Our implementation of digital documentation overlapped with that of SSO in these 6 facilities, and both physician end users and the clinical informaticists supporting them reported that the introduction of SSO significantly

Summary table

- Single sign on (SSO) is an emerging technology intended to facilitate easier and faster use of EHRs and other clinical information technology applications.
- Single sign on utilizes authentication to increase information security, but quantitative evaluation of its financial value to healthcare institutions has not been reported.
- This study of SSO implementation in 6 general hospitals found meaningful time savings for physicians, nurses and ancillary end users of clinical information technology.
- These time savings translated into substantial recurrent financial return from SSO implementation.
- Migration to a thin client as part of SSO implementation also yielded substantial financial return on investment.
- Anecdotal reported clinician satisfaction with SSO was high.

enhanced adoption of digital documentation and made CPOE use substantially easier. Indeed, one survey of information technology specialists found that 60% believed that SSO solutions have supported their efforts to demonstrate "meaningful use" of EHRs and related systems, and 70% stated that SSO is important or very important to the adoption of EHRs in their healthcare organizations [17].

Anecdotal reports from physician and nurse end users following our implementation suggest that SSO was a very strong "clinician satisfier" in an era of high dissatisfaction with EHRs and related clinical information technology. Our experience in this regard aligns with that of other hospitals reporting high clinician satisfaction and a sense that SSO enabled them to focus their attention on the patient rather than information technology [3–4,15–17]. While not "game changing" in terms of overall impact on clinician time required by clinical information technology, SSO offers an incremental real and meaningful liberation of clinician time and improvement in clinical workflow. SSO implementation in hospitals is recommended where multidisciplinary clinician utilization of EHRs and related technology is substantial, and where clinical workflow involves substantial roaming throughout the facility. SSO can save time, improve security and increase clinician productivity and satisfaction in today's complex healthcare organizational workflows.

Acknowledgements

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