Workflow Improvement of Electronic Health Record Usage in a Tertiary Pediatric Burns Clinic

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Abstract

Background As a high patient-throughput clinic, the Royal Children's Hospital's multidisciplinary burns clinic's efficiency of clinic workflow and streamlined patient assessment is crucial. The clinic has been using a customized "burns assessment tool" (BAT) as part of its integrated electronic health record (EHR) since 2016.

Objectives The aim was to assess the usage patterns of the BAT at baseline, followed by re-evaluation following interventions to improve efficiency and utilization of the BAT.

Methods This study was a prospective observational time–motion quality improvement study. Observations of 19 clinicians in the pediatric burns clinic by five trained observers using a validated time–motion capture tool (TimeCaT 3.9) to map clinician workflow, with specific reference to time spent on a list of predetermined tasks, were conducted. Baseline data were collected for 7 weeks followed by three cycles of interventions and observations over 5 months.

Results At baseline, the median time for a patient visit was 24.56 minutes (range: 2.78–73.72 minutes, interquartile range: 14.17–27 minutes), with most of the time spent on documentation (34.6%) and patient contact tasks (26.0%). In each of the study cycles, the median time spent on documentation within the EHR was significantly reduced compared with baseline (cycle 1 29.8%, $p = 0.08$; cycle 2 20.4%, $p \leq 0.01$; cycle 3 27.32%, $p = 0.04$). The time spent on patient contact increased when comparing baseline to data of cycles 1, 2, and 3 (25.96 vs. 33.27% of visit, $p = 0.04$). There was no significant change in absolute time spent on the BAT during the study.

Keywords
- workflow
- electronic health records
- burns
- clinic
- ambulatory

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Conclusion The study findings of clear, significant, and sustained improvement in documentation efficiency and the corresponding increase in patient contact time after interventions were introduced reinforce the importance of integration of an EHR with clinical workflow.

Background and Significance

Electronic health records (EHRs) have been introduced into the ambulatory setting with the aim to improve the end-user experience for both clinicians and patients. However, it has become increasingly evident that the most effective EHR introductions enhance clinic efficiency by integrating electronic interactions with clinical workflow.

EHRs that are not effectively integrated may lead to unintended adverse consequences including duplication in documentation, long clinic wait times, and dissatisfaction of health care end-users and patients.[1–3] This is particularly relevant in high-volume clinics with repetitive workflows, where standardization of care and efficiency is paramount to enabling effective operation.[4–6]

One such example is a multidisciplinary burns clinic at our institution, the Royal Children's Hospital. As the state's tertiary referral center for pediatric burns, this clinic has high throughput and can have significant increases in attendance volumes at short notice due to the nature of how burns injuries occur. The multidisciplinary clinic team includes staff from surgery, nursing, physical therapy, orthotics, nutritional services, occupational therapy, education, play therapy, social work, and mental health. As such, the streamlining of clinic flow (including the EHR workflow) where patients are seen and assessed consecutively by multiple providers is crucial, regardless of patient volume, severity of burn, or complexity of presentation.

Objectives

The clinic has been using a customized burns assessment tool (BAT) within an integrated EHR since 2016. Despite its ability to record documentation, there have been concerns around both the efficiency and user experience of the tool within this specific clinic setting. Thus, the aim of this time–motion quality improvement (QI) study was to assess the usage patterns of the BAT at baseline, and after interventions to improve the integration, efficiency and usability were introduced.

Methods

Study Site and Burns Assessment Tool

The Royal Children's Hospital's burns clinic runs twice a week with several multidisciplinary providers and an average of four medical staff members per clinic.

Prior to the EHR introduction, the burns clinic utilized a paper-based assessment form for each patient attendance. In April 2016, a campus-wide EHR (Epic Systems, Wisconsin, United States) was introduced, where this paper form was converted to an EHR-based form (BAT).

The initial BAT was designed to utilize EHR functions to document the key aspects of patient interaction in the pediatric burns clinic (►Fig. 1). The tool comprises separate sections for burn event history, burn wound description, burn wound size (Lund and Browder), medical assessment, and management plan. EHR documentation tools, such as an electronic Lund and Browder chart for estimation of burn wound area, have been previously described and reported to increase documentation compliance.[7] While the BAT was designed in consultation with clinicians, the initial design did not include representation from multidisciplinary clinicians with burns experience working within the clinic. Therefore, the design of the BAT was neither aligned to or representative of the specific burns clinic workflow nor intuitive to end-user experience.

The burns and surgical history sections contain read-only information entered elsewhere in the patient's chart, while the remaining three sections allow the user to input free-text patient information. All the information captured with the BAT, including a management plan, can then subsequently be easily transcribed into the clinic note using a formatted note template.

Unfortunately, the BAT has limited integration with clinical workflows of how the patients are seen and evaluated. As a result, clinicians have since identified key challenges with the tool such as data entry duplication, redundancy of information, missing data select options, and having to scroll consistently through multiple sections to find relevant information or fields. Given the BAT had not been revised from EHR Go-Live till the commencement of this study, it was therefore also no surprise that the uptake of the tool has tapered off with time—with users preferring to free-text information as a workaround.

Study Timeline and Design

Baseline data were collected for 7 weeks commencing August to October 2019. A further three cycles of observation were conducted, with two specific interventions introduced during the study period (►Fig. 1). During this time, discussions regarding structural improvements to the BAT were designed in comprehensive consultation with the burns medical team, with a primary focus on ensuring a well-integrated, smooth EHR workflow for medical assessment and documentation.

Cycle 1 (8 weeks, October–December 2019) was after the introduction of the first intervention. This comprised usability and nomenclature modifications within the BAT with a focus on streamlining the review of patient information. This included decreasing dead space and font size to ensure more information appeared on the screen at a glance and renaming

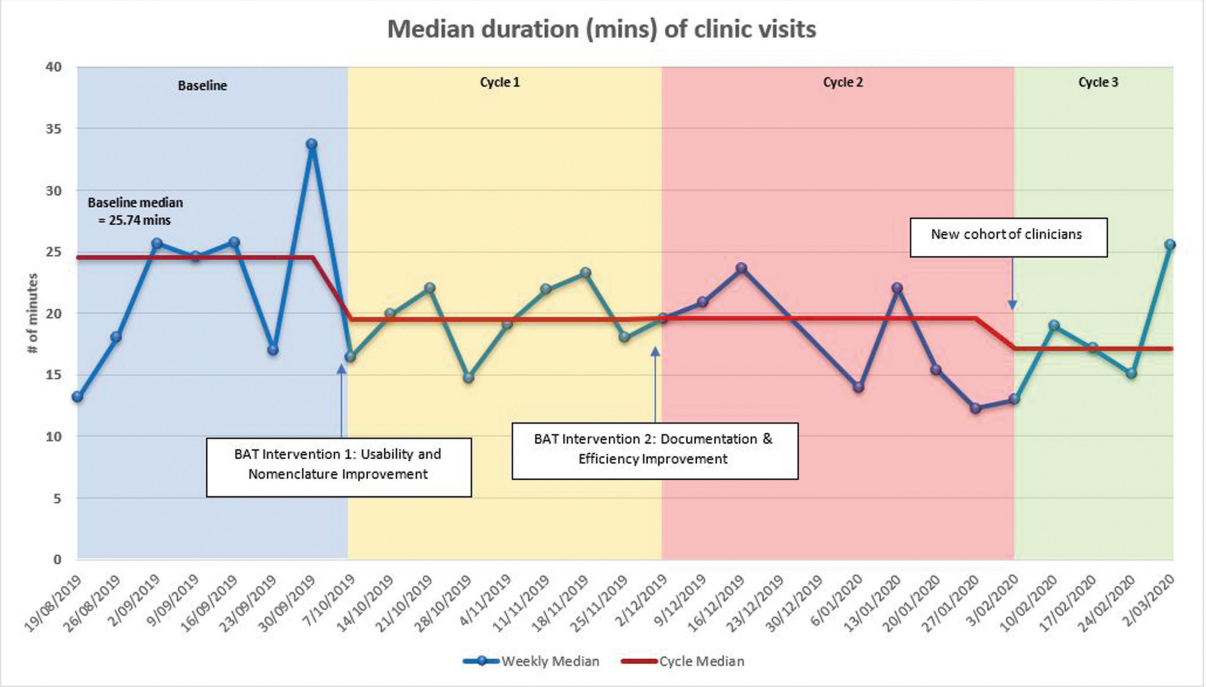

Fig. 1 Median duration of clinic visits (minutes).

header sections to fit best practice guidelines and ensure clinicians could easily and quickly identify appropriate assessment tools and scores. Cycle 2 (7 weeks, December 2019–February 2020) was after the introduction of the second intervention which comprised major BAT structural and documentation efficiency improvements. These were designed to reduce duplicate entry of information, make previously entered data easily visible to clinicians, and to selectively display only relevant fields based on clinical decision support metrics. For example, instead of having to enter a separate screen to enter a burn assessment score, then return to the main clinic screen, then proceed to a note to re-enter the data separately, clinicians were able to use quick-click buttons to complete an assessment and have a summative score pulled into their clinic note and letter. One of the most popular changes was the insertion of a diagrammatic avatar of a child, so that clinicians could visualize "at a glance" the location of all burns and a summary of the latest data. They could also interactively click and document on either a new or existing burn directly from that view. Based on specific documentation selections, clinician decision support would assist clinicians by cascading open appropriate follow-up questions, as well as suggest various allied health and referral options. This improved efficiency by only displaying necessary and relevant options, reducing the cognitive burden on clinicians.

Cycle 3 (5 weeks, February–March 2020) observed a new cohort of junior doctors starting in the clinic (though senior doctors remained unchanged), who had not previously used the BAT. Data collection in Cycle 3 was ceased early due to COVID-19 (coronavirus disease 2019) impacting clinic workflow.

Data Collection

A total of 19 clinicians in the pediatric burns clinic were observed by three trained observers across the duration of the study. Doctors and patients were approached by observers for consent to participate prior to their clinic encounters. Participants included all levels of seniority—16 residents and 3 attending consultant staff.

At least two observers were present at each clinic visit. Observers maintained a distance from clinicians during each observation and did not interact with the clinician to accurately capture time duration and context data. A validated time–motion capture tool (TimeCaT 3.9) was used to map clinician workflow, with specific reference to time spent on a list of predetermined tasks mirroring clinic workflow.[8]

These tasks included review tasks (chart review in the EHR, chart review and documentation outside of the EHR, e.g., reading letters from general practitioners, and filling in patient travel forms), patient contact tasks (history, clinical examination, and counselling of patient), documentation tasks (BAT documentation, notes documentation, and communications documentation), orders tasks (orders for medical photography, orders for theater case request and consent, and other electronic orders), clinic wrap-up tasks (visit diagnosis, billing information, and other wrap-up tasks), burns dressings tasks (taking dressings off and putting dressings on), communication tasks (in person with another clinician and over the phone) or waiting (time in clinic spent waiting, unrelated to performing tasks).

Recruited observers all had a health background and were thus familiar with ambulatory clinics and their workflow. They were given identical training sessions in using the EHR and were given 10 hours of preparatory observation prior to

Table 1 Inter-observer reliability assessment (IORA) for burns clinic

	Communication	Hands-on task	Location
	P-K	P-K	P-K
IORA	93.9%	97.77%	98.71%
S1 vs. S2	0.88K	0.97K	0.94K
IORA2	95.73%	90%	100%
S2 vs. S3	0.92L	0.86K	1K

Abbreviation: P-K, proportion-kappa.

formal data collection. To ensure observations were consistent, the observers also underwent inter-observer reliability assessment (IORA) prior to real-time data collection. The IORA provided within TimeCaT 3.9 was utilized and allowed for assessment of the degree of agreement in the naming, timing, and sequence of activities. The tool represents proportion-kappa (P-K) as a measure of overall inter-observer agreement. We ensured that IORA indicated consistent agreement between our observers before data collection began (►Table 1).

Data Analysis

Data were analyzed using descriptive and comparative statistics, to provide benchmarks for pre- and postintervention evaluation. Time and percentage observations were described as median with interquartile range (IQR). The Kruskal–Wallis nonparametric test was used to compare independent samples and groups. Statistical significance was described as $p < 0.05$. Statistical analysis was performed using Stata v15.0 (2019, StataCorp LLC, College Station, Texas, United States).

Results

A total of 651 patients and 126.95 hours of clinic visits were observed during the study period. At baseline, the median time for a patient visit was 24.56 minutes (IQR: 14.17–27), with most of the time spent on documentation (34.6%) and patient contact tasks (26.0%). Although there was an overall trend downward in total patient visit duration after both interventions by approximately 7.4 minutes, there was no corresponding statistically significant decrease in median consultation time per patient ($H[3] = 2.64$, $p = 0.45$; ►Fig. 1).

In each of the study cycles, the median time spent on documentation within the EHR was significantly reduced compared with baseline, particularly during cycle 2 (baseline: 34.6%, cycle 1: 29.8%, $p = 0.08$; cycle 2: 20.4%, $p \leq 0.01$; cycle 3: 27.32%, $p = 0.04$) (►Fig. 2). Furthermore, when comparing cycle 1 to cycles 2 and 3, the documentation time was significantly reduced in cycle 2 ($p = 0.01$), but not in cycle 3.

The time spent on patient contact increased when comparing baseline to overall postintervention data (25.96 vs. 33.27% of visit, $p = 0.04$; ►Fig. 3). There was no significant change in the median absolute time spent on the BAT during the study, nor change in the median absolute time spent on reviewing patient information, ordering, or communication tasks during the study period.

Discussion

Enhancements to the EHR BAT designed to integrate with clinic workflow had a significant positive impact on clinic efficiency and percentage of time spent with patients during burns clinic visits. To the authors' knowledge, this is the first Australian study to utilize QI methodology to improve

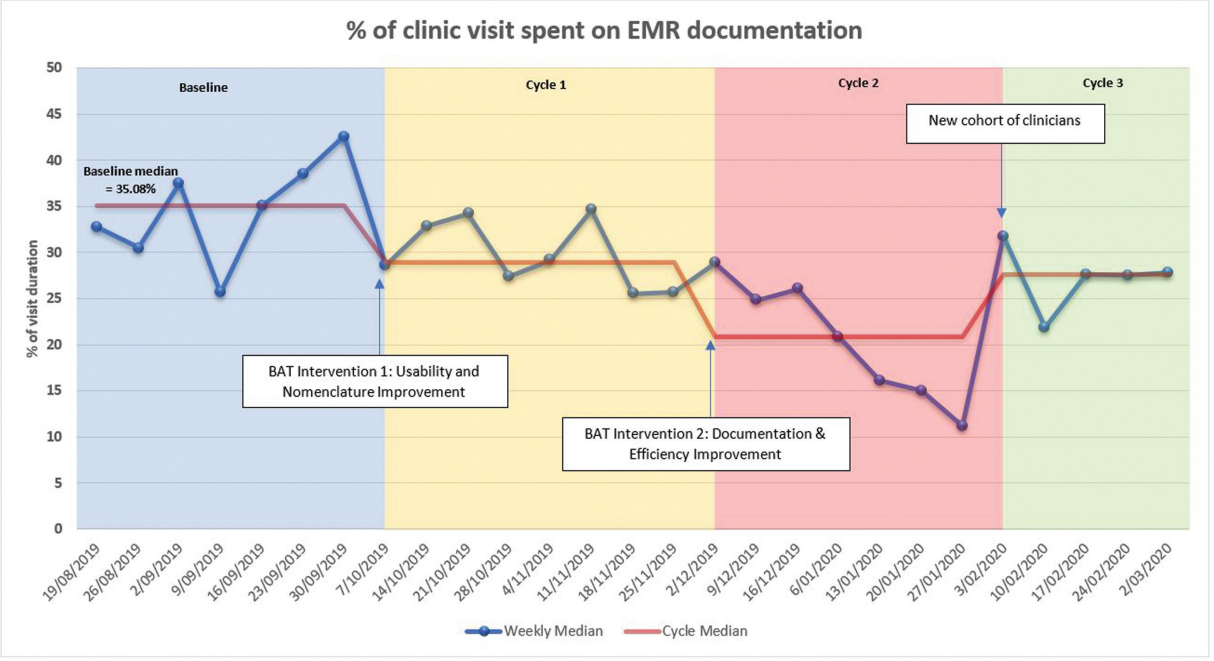

Fig. 2 Percentage of clinic visit spent on EMR documentation. EMR, electronic medical record.

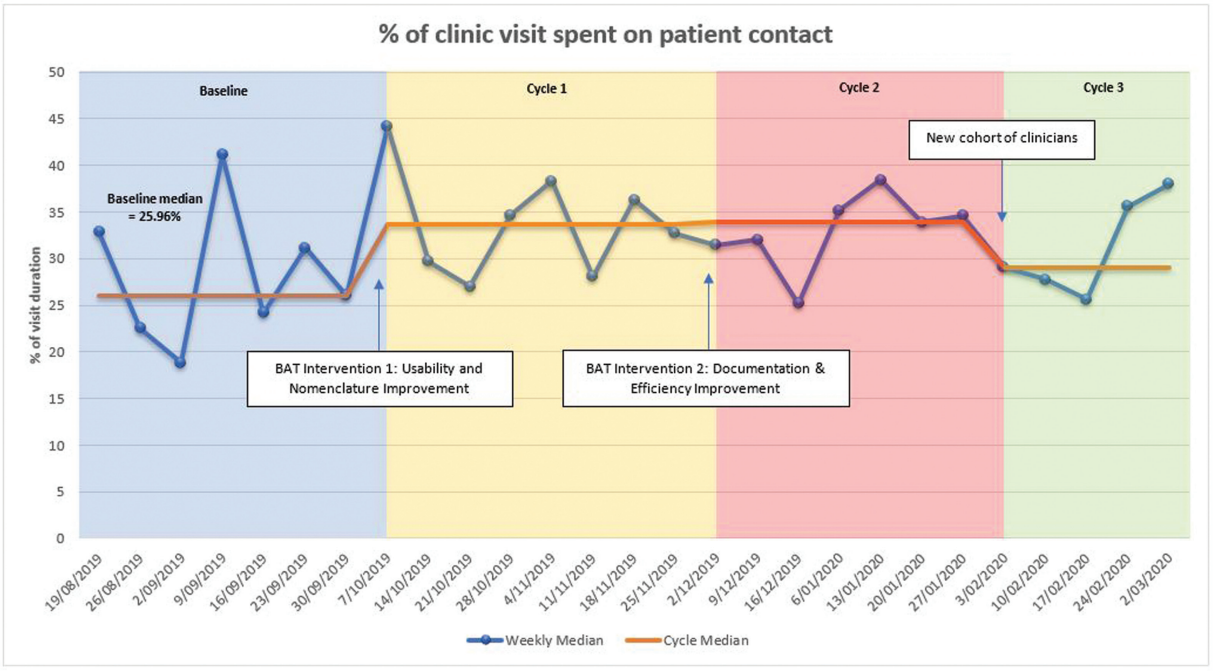

Fig. 3 Percentage of clinic visit spent on patient contact.

integration of EHR use with clinical workflow within a tertiary pediatric burns center. Similar studies have demonstrated improvements in workflow in other clinical settings, and support the need for ongoing QI and optimization programs for improved patient care.[9–11]

The key to the improvements seen in this study stem from the close relationship between EHR interventions and clinical workflow. When collecting baseline data, detailed evaluation and analysis of clinician workflow, perceived inefficiencies, and user feedback were conducted. Utilizing the plan-do-study-act QI cycle, interventions were then designed specifically based on baseline observations, and targeted to improve clinician workflow rather than overall clinic design.

This approach is likely linked to the clear, significant, and sustained improvement in documentation efficiency, and corresponding increase in patient contact time after interventions (revised BAT) were introduced. Although the total length of patient visits did not significantly drop, clinicians had more time to spend with patients rather than documenting on the EHR—a bonus for patient satisfaction. It is worth noting that while there was no significant change in the median absolute time spent on the BAT, there was a significant decrease in documentation time and an increase in time spent on direct patient contact.

This implies that a more user friendly BAT enabled documentation to be more efficient, with a significant reduction in need for duplicate documentation. This was despite no other separate EHR improvements to documentation or clinician workflows during the study period. A further benefit of utilizing the BAT in this manner was the capture of data as discrete variables, allowing a significant enhancement in any data audit or QI studies by ensuring a standardized dataset as opposed to free-text capture.

Although there was an understandable decrease in efficiency in cycle 3 due to the introduction of new clinicians who had not previously used the BAT, they were still more efficient than clinicians at baseline.

Rumball-Smith et al have recently shown that the majority of health care providers do not use EHR to their full capability.[12] Possible reasons include obscure interface access, lack of clarity on available features, or difficulty with using or accessing features within the EHR. Importantly, positive usability ratings and perceived improvement in quality of patient care have been shown to be key factors for a successful adoption of EHR.[13] Thus, to maximize uptake, any introduction of an EHR tool or improvement has to be both relevant and applicable to the contextual clinical workflow.

The duration of the study, which spanned three cycles across different time periods during the year, helped to reduce potential variability via seasonal variations of burns presentations and medical clinician rotations. The number of clinicians, as well as their varying levels of experience, also reduced sampling bias and took into account the variability of workflow practices amongst different clinicians even within the same setting. However, within each cycle, seasonal variations may impact on the absolute time measured, as there may be more burns patients or more complex patients during the summer months. Therefore, we have chosen to represent our results as percentages, to better represent the data that may be confounded by the difference in clinical workload over the different cycles of the study.

The design of this study, as a prospective observational time–motion QI study, has many benefits in improving the efficiency of clinic workflow. Although resource-intensive, time–motion studies have previously been reported in the literature in the ambulatory setting.[14,15] Improving the

quality of health care through EHR use has also been the focus of many publications in recent years.[16,17]

An added strength to our study was the background of our observers, who had both clinical experience and EHR experience. This enabled a crucial consultative process, which was lacking in the original creation of the BAT. This process, which involved an understanding of the burns clinic workflow, enabled the interpretation of the feedback and the changes implemented, to allow for an integrated BAT that fit the specific requirements of that clinic.

Due to the nature of the study (longitudinal QI methodology), clinician improvement could be due to increasing familiarity with the EHR system with time. Nonetheless, given that all clinicians had at least 6 months of prior use of the EHR and BAT, the significant improvements relating to cycle 2 after structural changes as well as user feedback suggest that this is due primarily to the intervention. This study was also limited by its setting in a single tertiary pediatric burns clinic and may not be applicable to other ambulatory settings. We are confident, however, that a similar QI model focused on clinical workflow integration can be applied to ambulatory settings that have standardized workflows and a high throughput, in either the adult or pediatric setting.

Conclusion

The study findings of clear, significant, and sustained improvement in documentation efficiency and the corresponding increase in patient contact time after interventions were introduced reinforce the importance of integration of an EHR with clinical workflow to realize clinical and efficiency benefits in an ambulatory setting.

Given the multidisciplinary nature of most burns clinics, future studies are aimed at expansion to evaluate workflow integration with EHR for the wider burns team to maximize whole clinic efficiency and throughput.

Clinical Relevance Statement

- The success of electronic health record (her) in the ambulatory setting is dependent on effective EHR integration with clinical workflow.
- Qualitative improvement methodology can be utilized to improve integration of EHR use with clinical workflow, as demonstrated within a tertiary pediatric burns center.
- Provider and clinic efficiencies were positively impacted by optimizing an existing tool, reinforcing the importance of integrating EHR with clinical workflow to realize clinical and efficiency benefits.

Multiple-Choice Questions

1. EHRs that are not effectively integrated may lead to unintended adverse consequences including:
   a. Duplication in documentation
   b. Long clinic wait times
   c. Dissatisfaction of health care end-users and patients
   d. All of the above

   Correct Answer: The correct answer is option d. As demonstrated in the case example, Option D is the correct answer as all of these are potential adverse outcomes or negative impacts caused by nonintegration of EHR into clinical workflows.

2. Integration of an EHR with clinical workflow in an ambulatory setting is important to:
   a. Reduce health care costs
   b. Realize clinical and efficiency benefits
   c. Reduce patient visit times
   d. Increase familiarity with EHR

   Correct Answer: The correct answer is option b. The most important benefits that stem from workflow and EHR integration are clinical and efficiency benefits. The other options may be true, but are unlikely to be a result of clinical workflow integration.

Protection of Human and Animal Subjects

No human subjects were involved in the project. This was a study of EHR use where human subjects were not part of the research question.

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Conflict of Interest

None declared.

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