**Time motion study to evaluate the benefits a touchscreen workstation on wheel for user interface with electrical health records in a simulated emergency department workflow**

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**1. Executive summary:**

**Introduction:** Given the large patient volume, overcrowding in EDs resulting in delayed patient care is the number one safety concern in first world EDs (1–4). A need for continued improvement in quality of care and workflow efficiency in the hospital setting has led to a shift toward the implementation of technological innovations and information technology (IT) solutions. Touchscreens interfaces have become ubiquitous in our daily lives and have been shown to foster a very comfortable and natural human-technology interactive experience (5,6). One study in a large level 1 ED found that upon implementation of touchscreen tablet computers for use during direct patient care, physicians were spending 38 minutes less per shift at their workstations (7). These findings were associated with positive physicians' perceptions of the adoption of touchscreen tablets as they found these devices to be clinically useful, more efficient, easy to carry around and disinfect, and overall improve patient care than without their adoption. Although portable touchscreen tablets appear promising, there remains a gap in the understanding of how touch screen monitors will impact workflow in the ED. **Hypothesis:** We hypothesize that touchscreen workstation on wheels (WOWs) can benefit the user interactions with electrical health records (EHR) when considering common tasks done in the ED compared to non-touchscreen WOWs. **Methodology:** This will be a randomized, controlled, single-center, 2-intervention-2-period crossover study comparing a touchscreen WOW to a non-touchscreen WOW. The primary outcome will be the combined time to complete all tasks sequentially for each of the interventions. Secondary outcomes include the time to complete each individual task as well as the technology acceptance model (TAMS) post-study survey answers.

**2. Introduction:**

As one of the main entry points into the hospital and a cornerstone of the healthcare system, Emergency Departments (EDs) are a place for immediate patient care for individuals with a wide spectrum of needs. Given the large patient volume, overcrowding in EDs resulting in delayed patient care, known to some as *emergency access blocks,* is the number one safety concern in first world EDs (1–4). Lack of timely care in the ED has substantial implications on patient outcomes and mortality (8–12). As a result, assessing what can be done to mitigate this issue has been a main concern in the international healthcare community, including Canada (3). A recent 2019 study investigating ED data from 25 Canadian hospitals looked at this issue and found that small scale improvements can have a significant impact on the efficiency of the workflow, such as time to complete tasks pivotal to patient care, which can profoundly improve emergency care delays without the need for increased capacity (13). Many of these improvements have lead to increased time spent on bedside tasks rather than stationary workstations away from patients’ loci of care (7). This was observed to reduce interruptions to care, decrease errors of omission, and increase time with patients and their families, which improved patient satisfaction and thus optimize provider service(7).

A need for continued improvement in quality of care and workflow efficiency in the hospital setting has led to a shift toward the implementation of technological innovations and information technology (IT) solutions but literature on the mechanism of impact of these solutions is limited. A recent editorial published in the Emergency Medicine Journal (EMJ) made this point very clear, as the authors emphasized that research on the best technology in the ED is “urgently required” (14). One example is a study by Weng et al. (15), which used data-tracking software to identify scenarios in the ED that maximized workflow efficiency and found scenarios that increased flow efficiency by 4%. Another study in a large level 1 ED found that upon implementation of touchscreen tablet computers for use during direct patient care, physicians were spending 38 minutes less per shift at their workstations (7). These findings were associated with positive physicians' perceptions of the adoption of touchscreen tablets as they found these devices to be “clinically useful”, more “efficient”, “easy to carry around” and “easy to disinfect”, and overall improve patient care than without their adoption. These authors concluded that the decrease in time spent at the workstation can increase physician availability at the bedside, and ultimately make their care more efficient (7).This study is aligned with the recent push for adopting mobile healthcare technology because of its ease of use and perceived benefits to patient care by medical providers (16).

While progress is being made, more research is needed to identify other forms of mobile healthcare technology innovations in ED that can improve workflow efficiency. In fact, multiple review papers looking at technology advancements in the ED have commented on this void, describing the evidence base as “neither consistent nor comprehensive” (17), and “urgently needing better evaluation” (18). Although portable touchscreen tablets appear promising, they are not universally accessible, raise concerns of safety and fragility, and may not be sufficiently powered for some EHRs and their associated software. Furthermore, it is unclear which aspect of these interventions whether its portability, use of a touchscreen, or another element, improved workflow. Touchscreens have become ubiquitous in our daily environment and have been shown to foster a very comfortable and natural human-technology interactive experience (5,6). There remains a gap in the understanding of how touchscreen monitors will impact workflow in the ED.

**3. Rationale:**

It is essential to maximize efficiency and facilitate the workflow in a difficult-to-manage ED setting. Given high patient loads, hospital EDs continuously look for ways to improve the timeliness of care while ensuring no lapse in quality. Often, these improvements come by way of technological innovations, as with the Royal Victoria Hospital (RVH), where implementation of one new workstation on wheels (WOW) with a touchscreen is set to launch this year, replacing one older non-touchscreen WOW. Looking through a Quality Improvement (QI) lens, we aim to assess the impact of a touchscreen WOW through performance and user-perception measures in a simulated ED workflow to estimate its effects on overall ED workflow as well as guide future technological innovations.

**4. Hypothesis:**

We hypothesize that a touchscreen WOW can benefit the user interactions with electrical health records (EHR) when considering common tasks done in the ED compared to a non-touchscreen WOW.

**5. Objectives:**

This study aims to evaluate how the implementation of touchscreen WOW in the ED affects end-user perception and workflow efficiency compared to non-touchscreen WOW.

**6. Methodology:**

**6.1 Research question:**

How do touch screen WOWs benefit physician use of EHRs when completing simulated tasks typically performed in the ED of a tertiary care center compared to non-touchscreen WOWs?

**6.2 Study Design:**

This will be a randomized, controlled, single-center, 2-intervention-2-period crossover study. A group of subjects who comfortable use the ED information systems for clinical care will be randomized to go through intervention A: non-touchscreen WOW (mouse, regular screen monitor, and keyboard) at period 1 and then crossover to intervention B: touchscreen WOW (touchscreen monitor, and keyboard) at period 2 (group 1 or sequence AB). Another group of subjects will be randomized to go through the two interventions in the opposite order (group 2 or sequence BA). We will use programmed statistical software to generate the randomization code. There will be no washout period between the interventions taken by the same group as the tasks to be completed are routinely performed by those participants expected to enroll in this study.

Consent will be obtained for each participant prior to fixed (same for all participants) task training. The participant will then read the instructions they must follow to complete each task using one of the two interventions: non-touchscreen WOW (mouse, regular screen monitor, and keyboard) versus touchscreen WOW (touchscreen monitor, and keyboard). In concordance with a crossover design, all participants will be evaluated for the completion of the same tasks using both interventions one at a time (19). The tasks selected for the experiments corresponding to simulated patient care in the system are 1) self-assignment to patient via Medurge, 2) open triage note and identify blood pressure (listed as “BP”) via Medurge, 3) open most recent chart via Oasis, 4) order “CBC” and “CHEM7” (labs) as “stat” schedule via Oasis, 5) order “chest x-ray” for an indication of “rule out pneumonia” as “ambulatory” and “stat” schedule via Oasis, 6) order “Acetaminophen” 975mg x1 as “stat” dose and activate it via Medurge, 7) order consult to CCU stating “rule out ACS” via Medurge, 8) discharge patient “home” with “own transport” via Medurge. Each task will have between 1 to 10 steps needed to complete the task. Participants in the touchscreen WOW group must not use the mouse at any point during the tasks. Likewise, participants in the non-touchscreen WOW group must not use the touchscreen at any point during the tasks. Each experiment (set of 8 tasks with training prior to starting) is expected to take no longer than 20 minutes.

A continuous observation time-motion study design will be used for data collection during testing (20). This continuous observation is asynchronous in that the tests will be video recorded (21,22). By avoiding direct observation of the participants, we will minimize unintended changes in participants behavior that can bias results - minimizing a phenomena known as the Hawthorne effect (23). A research assistant (SR, JR, or OI) will be present to distribute the pre- and post-study surveys as well as remain outside of the testing zone to ensure fluidity of the tasks and manage any technical difficulties. Events such as the start and end of each task will be tracked using properly configured video-based observation of the participant before the start of each test (24). Dual-encoded event markers (verbal and physical/on the screen) will guide transitions between events and aid in precise documentation (24). Research assistants (SR, JR, OI) will conduct a “time-action analysis” by analyzing the pre-recorded video of the subjects, in order to appropriately time stamp events of interest such as the start and end of each task (21,22).

Post assessment, a technology acceptance model (TAMS) post-study survey will be completed. It will assess the subjects perception of touchscreen utility, efficiency, portability, reliability, capacity to improve care, satisfaction, and ease of use.

**6.3 Eligibility Criteria:**

Inclusion criteria:

-Residents at the McGill University Health Center (MUHC) and Attending physicians from the ED at the MUHC.

Exclusion criteria:

-Individuals incapable of completing computer-based tasks for any reason.

Of note, participants will not be financially compensated for their involvement in this study.

**Participant Demographic and User Experience:**

Refer to Appendix A.

**Post-study TAM survey (scaled using a 7-point Likert scale):**

Refer to Appendix A.

**6.4 Outcome Measures and Statistical Considerations:**

Descriptive statistics of this mixed methods study will be reported for quantitative analyses. Categorical variables including demographics of study participants and survey results will be described through frequencies and percentages. Continuous variables such as time elapsed for task completion will be described through medians and interquartile ranges (25th percentile-75th percentile) or mean and standard deviation measurements if there is evidence of normality; these will be reported for each task respectively. The primary outcome of the study is the combined time to complete all tasks sequentially for each of the interventions. Secondary outcomes include the time to complete each individual task as well as all post-study survey answers (participant’s perception of touchscreen utility, efficiency, portability, reliability, capacity to improve care, satisfaction, and ease of use).

According to the classic analysis of crossover studies, the intervention effect is a within-person effect averaged over the two randomized interventions. Specifically, a classic mixed linear model analysis for crossover trials will be performed in which the main test of interest is the within-person intervention effect adjusted for the period effect and the sequence effect to reduce bias (19)**.** The period effect refers to the period when the subjects will be performing the study tasks while on intervention. Although the design requires an alternation of interventions A and B, we still test for any ‘period’ effect. The groups or sequences AB vs BA are introduced in the analysis as a between-subject factor. An association between this factor and a direct treatment effect is indicated by the presence of an interaction effect. In the presence of such an interaction effect it will be necessary to examine the treatment effect within each group.

We expect very minimal to no carry-over effect (i.e., whether the effect of an intervention “carries over” and impacts results while on the other intervention) because the tasks to be completed by the subjects are routine clinical tasks they perform as residents or staff physicians. Although it is not possible (19) to accurately test for the presence of a “carryover” effect in a traditional 2x2 crossover design (two groups, two periods) such as this one, we will test the effects of a period-by-treatment interaction, which is a possible indicator of a carryover effect.

This is a pilot study, and we expect to recruit a maximum of 24 subjects. We performed a power analysis for a 2 treatment-2 period cross-over design assuming a significance level of 5% and power of 80% (25) implied that this sample size would be sufficient to detect a difference in mean total time to perform all the tasks sequentially of 30 seconds between workflow using touchscreen WOW compared to non-touchscreen WOW. We believe that an increase in workflow efficiency of up to 30 seconds for this sequence of taskwill be acceptable to maintain current workflow efficiency in the ED. Considering that the standard deviation of total time to perform all the tasks sequentially is unknown and there are no previous studies comparing these two interventions to our knowledge, we decided to use a pre-specified effect size of 0.8 (26).

**7. Data collection and security:**

**7.1 Data collection:**

All study participants will be asked to complete a post- study survey as well as all the tasks during testing. In addition to basic demographic questions, surveys will include questions scaled using a 7-point Likert scale defined as either (1) Strongly Disagree, (2) Moderately Disagree, (3) Somewhat Disagree, (4) Neutral (Neither Agree nor Disagree), (5) Somewhat Agree, (6) Moderately Agree and (7) Strongly Agree. Questions will focus on experience and comfort with technology, perceptions of the impact of study interventions, etc. Task-specific data collection will include time taken to complete each task and event markers (beginning and end of each task).

The data that will be collected from the post-study survey can be seen in Appendix A.

**7.2 Security:**

Experiments and their data collection will begin after ethics approval. Data will be kept in a password protected Excel file, in a password protected folder, in the primary investigator´s key-restricted office and will be shared with only those involved in the study. All data will be anonymized by an individual not participating in data analysis prior to the start of the analysis. The original and anonymized data will be maintained for 5 years.

**8. Funding:**

This project has not received funding. Furthermore, as this is a study done in a simulated environment with no financial compensation for study volunteers, there will be a minimal strain on resources.

**9. Dissemination plan:**

Research findings will be shared by journal publications, posters in conferences, and medical grand rounds. Whenever the study results are published or shared during scientific meetings or otherwise, it will not be possible to identify the participants.

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