Author's response to reviews

Title: Comparison of Alphabetical versus Categorical Display Format for Medication Order Entry in a Simulated Touch Screen Anesthesia Information Management System: An Experiment in Clinician-Computer Interaction in Anesthesia

Authors:

Anil A Marian (anil-marian@uiowa.edu)
Franklin Dexter (Franklin-Dexter@Uliowa.edu)
Peter Tucker (pete@petetucker.com)
Michael M Todd (michael-todd@uiowa.edu)

Version: 5 Date: 20 April 2012

Author's response to reviews: see over
Reviewer's report
Title: Comparison of Alphabetical versus Categorical Display Format for Medication Order Entry in a Simulated Touch Screen Anesthesia Information Management System: An Experiment in Clinician-Computer Interaction in Anesthesia

Version: 4 Date: 6 March 2012

Reviewer: Alexander Avidan

Reviewer's report:

General comments
The author performed a study addressing an important issue in AIMS design: How to arrange buttons for drug data entry. Data entry for drugs administered during anesthesia, next to automatic recording of data from physiological monitors and anesthesia machines, is one of the most important goals of AIMS.

The success of an AIMS relies not only on its technical specifications, but on how user-friendly is the system. As drug data entry is performed frequently during the course of anesthesia, the corresponding buttons for drug entry have to be designed and arranged in a user-friendly manner. It seems logic, that a categorical display is more convenient than an alphabetical one. But not everything in medicine and computer science (and in the combination of those both) that seems logic is necessarily true. That’s why this study adds important information not only for specific anesthesia related computer systems, but for medical information systems in general.

The authors designed the study in such a way, that the simulator (iPad) resembles the two display formats in question (categorical and alphabetical) similar to the ones planned for the AIMS to be installed. The study design took into account the different levels of anesthesia practice. It includes two learning phases: one non-anesthesia specific (countries) and one specific for the study planned, in alternating orders for both display formats. The participants had to find, within 2 minute, as many as correct buttons for various consecutively displayed drugs or fluids for each display format. The results of the study showed, that more drug data entries can be made with categorical than with alphabetical display in a specific time frame. The error rate for both display types was low. The study unfortunately does not take into account the difference stages of drug data-entry in anesthesia: During and/or after induction a fairly consistent group of drugs is entered one after the other (e.g. midazolam, fentanyl, propofol, muscle relaxant). Later during the course of anesthesia, single drug administrations are performed (adding of single dosages of fentanyl, inotrops, muscle relaxants etc). In this study, only single drug data-entry was simulated and no multiple ones. It is also not clear from the study design, what happens to the drug buttons on the different tabs after the participant presses a button: Do all the buttons disappear, is a certain default tab displayed or does the form stay open on the last tab used? If so (the last tab used stays open with all the drug buttons), this may be one explanation why within 2 minutes with categorical display more drug data-entry are possible than the alphabetical one. For example in Trial 1, nine of the ten first drugs all appear on the common tab. If that tab stays open after a drug is chosen, it is no surprise that data entry with categorical display is faster than with the alphabetical one. The current study design does not take this into account and important information such as what making the study results stronger is missing.

Thanks for all these comments. The screen was modeled to be exactly as on the EPIC AIMS medication entry screen that was been implemented. Once a drug is chosen, the form stays open on the last tab used just like the EPIC system.

Another important point are the color codes used for the different drug buttons. These color codes make it much easier to find the correct button within a list of different drugs. It would be interesting to know if the same result would be found in a study where all buttons have the same color (for example black writing on white background). This may be important in other fields of medicine where color codes for drugs are not used.
Yes

**Conclusion of review**

The authors conducted a study to evaluate whether alphabetical or categorical display of buttons for drug data-entry in AIMS is more effective. The study design is original, simulating closely a real-world application. The result can also be applied to other medical information systems. However, some of the methodology is not clear. I recommend revising the manuscript according to the comments.

**Specific comments**

Page 4, line 2:
“flows in from the anesthesia machine and the physiological monitor”: rephrase, doesn’t sound professional  
Done

Page 4, line 4:
“airway information”. Change to “information on airway management”  
Done

Page 4, line 5:
(“anesthesia provider”): remove the apostrophes.  
Done

Page 4, line 7:
“20-100 intravenous drug-dose entries”: Preferable to write “dozens of drug-dose entries” (not only intravenous, may also be PR, IM).  
Done

Page 4, line 10:
“often in less than 30 seconds”: Preferable: “often within seconds or minutes”  
Done

Page 4, line 10:
“The rate of required entry”: Change to : “The rate of required drug data-entry”  
Done

Page 4, line 11:
“relative short induction and emergence period: From my personal experience I don’t have the impression that there many drugs given during emergence period (If at all…..).  
We have edited this part per the suggestion

Page 4, end first paragraph and last line
Repetition that you didn’t find any information on the study subject in the literature.  
Done

Page 4, last line
“Many of the common AIMS use keyboard entry”: Where do you that from? Is that really true? Metavision from iMDsoft has keyboard and touch screen data entry.  
We have deleted and edited this section part per suggestion

Page 5, line1/2
“uses touch-screen, a rapidly proliferating interface for medical systems”. Where do you that from? References? For example in our hospital, users preferred to use mouse over touch screen.
We have edited this section per the suggestion

Page 5, line 2
“We therefore undertook a study to determine which of……..”. The fact that you use touch-screens should not be the reason you perform this study. The results of this study are equally important for a system with touch-screens or mice/keyboards.
Yes, we agree and have edited this portion accordingly

Page 5, line 6
“Results were used in the design..”. Change to “Results were used for the design…”
Done

Page 5, Methods, 2nd paragraph
As far as I understood, this is not a specific iPad application, but a website built on ASP.net technology. The study could have been performed also with any other tablet. Change accordingly. Explain what is “asynchronous”. "Asynchronous post" basically means that the web application wrote back to the database without impacting the performance of the User Interface. Since it is a web application, latency was our primary concern. With most web applications when a user clicks a link he has to wait for the next page to fully load before he's able to do anything else. The asynchronous post, in this case, means the result was recorded without impacting the participant from documenting the next drug.

Delete “virtually”. Delete “via a wireless connection” (not important, anyway tablets are connected to the Internet/Intranet with wireless only).
We edited this section to address these concerns. See below

“After each selection, the database compared the time the trial started with the current time. If the difference exceeded 2.0 minutes, the entry was negated and the participant was notified that the trial had ended." Much too complicated, far simpler to say: Each trial part lasted 2 minutes.
We have edited this section to address these concerns. See below.

The iPad program was Web-based, utilizing ASP.net, jQuery and SQL Server. Each time a participant selected a drug, the server recorded the result of that selection. Each trial lasted 2.0 minutes. The number of entries completed within the 2 minutes was recorded, along with any entry errors.

Page 6, line 8:
Anesthesia providers participated in the study when not doing patient care, although the study was conducted in the operating room environment.
In my opinion this is not necessary. I'm quite convinced that you would not have received IRB for doing the study during patient care……..
We have edited this section to “The study was conducted in the operating room environment but not during periods of patient care.”, so that the “operating room environment” does not get confused with “during a case” by the reader.

Page 6, Testing Protocol:
“the Apple iPad”: Change to “an iPad (Apple Inc, Cupertino, CA”.
Done

Page 6, last line:
“The participant was presented”: Change to “The participants were presented”
Done

Page 7, line 12
Change “2.0 minutes” to “2 minutes”.
Done
Page 9, line 3
“drugs entered via the categorical”, shouldn’t it be “drugs entered via the alphabetical”?
Drugs entered via the categorical screens had more drugs chosen in 2 minutes, irrespective of the participants doing alphabetical first or categorical first. The sentence is actually correct.

Page 10, line 8
Third time you mention that this is the first study…etc.etc.! Repetition, shouldn’t be in the discussion.
Done

Page 10, line 17
Abbreviation (“CTA”) not necessary as not used a second time in manuscript..
We retained the abbreviation due to the editing the manuscript slightly. (See below)

Page 10, line 12
“Our study looked at how design variation (alphabetical versus categorical) and user variation (users with different levels of clinical experience) affects the task and the occurrence of errors.”
Not part of discussion, part of introduction.
We have edited this part and this is part of introduction. However we retained some information here to explain the readers the relevance of use of Cognitive Task Analysis in this study.

Page 11, Conclusion:
It’s a hearsay that medical records rely increasingly on touch screen interfaces.
May be in the future more tablets than PC will be used, but there is no evidence.
The different designs tested in this study are equally important for touchscreens and mouse/keyboard. Revise the conclusions.
We have revised the manuscript and conclusions accordingly. The touch screen that we use for EPIC AIMS (which is modeled to work on a touch screen interface) is a PC screen and not a tablet. There are at least 40 academic institutions in the US and many more private groups that are now implementing EPIC, though, as expected, anesthesia is the last specialty to go through the transition.

Authors’ contribution
Put into past (“helped to design the study, conducted the study, analyzed the data etc.)
Done

Legends to all figures are too short. Reader should understand the figures without reading the text. We have edited this.
Level of interest: An article of importance in its field
Quality of written English: Needs some language corrections before being Published
Statistical review: Yes, but I do not feel adequately qualified to assess the statistics.
Declaration of competing interests: I declare that I have no competing interests

Reviewer's report
Title: Comparison of Alphabetical versus Categorical Display Format for Medication Order Entry in a Simulated Touch Screen Anesthesia Information Management System: An Experiment in Clinician-Computer Interaction in Anesthesia

Version: 4 Date: 10 April 2012
Reviewer: Jeffrey Green
Reviewer’s report:

**Major compulsory revisions**
None

**Minor essential revisions**
1. At the top of page 5 change the word “preferable.” User preference was not addressed in this study. Suggest using speed and accuracy instead.
   
   Done

2. On page 10 in the first paragraph change “nonetheless touch screen as being used more often.” Rewording will help with the readability.
   
   Done

3. Please address the question of a selection bias in subject selection. How were anesthesia providers approached to participate? Who selected them? Were they isolated while participating or did the providers participate in groups?
   
   The first author (AM) selected the participants. This was a "convenience sample" as described in the methods. The participants were "isolated" and each participant did the study separately accompanied by the first author for initial introduction and explanation.

4. The Y-axis for the bar graph should have a label indicating “number of drug entries.”
   
   Done

**Discretionary revisions**
1. The authors should address the colors of the labels for medications. The colors are an important visual clue that may be a confounding variable in the study, even though both methods used colored labels. It would also be good to mention that the colors selected are standard for anesthesia medications.
   
   Yes, we have addressed this in the manuscript per the suggestion.

2. The study would be strengthened by addressing the reproducibility of the results to keyboard/mouse entry rather than touch screen. Although the touch screen format is gaining popularity among medical devices, most AIMS are not touch screen. Therefore this limits the applicability of the results.
   
   Due to the other reviewer comments (see below), we revised the conclusion to make this more generally applicable:
   
   (From Reviewer AA: It’s a hearsay that medical records rely increasingly on touch screen interfaces.
   
   May be in the future more tablets than PC will be used, but there is no evidence.
   
   The different designs tested in this study are equally important for touchscreens and mouse/keyboard. Revise the conclusions)

3. Please comment on using the same sequence of drugs between trials in each format. Could this have contributed to the learning effect?
   
   The sequence of drugs was different in each trial. The learning effect was expected since providers take time to get used to any software that is new for them. For analysis only the 3rd trials were compared to avoid problems with learning curve. The use of the training task involving countries was a creative and effective tool.

4. Is the question posed by the authors well defined? Yes

5. Are the methods appropriate and well described? Yes, except for subject selection

Please refer to our previous comment from above
6. Are the data sound? Yes
7. Does the manuscript adhere to the relevant standards for reporting and data deposition? Yes
8. Are the discussion and conclusions well balanced and adequately supported by the data? Yes
9. Are limitations of the work clearly stated? Yes
10. Do the authors clearly acknowledge any work upon which they are building, both published and unpublished? Yes
11. Do the title and abstract accurately convey what has been found? Yes
12. Is the writing acceptable? Yes

13. In a keyboard entry AIMS, it’s not uncommon for users to search for drugs using a fuzzy search function. For example, in a drug entry dialog, the user would type “atr” and atropine would pop up. It would strengthen the work to compare the alphabetical categories method to the fuzzy search method to finding drugs.

In the editor’s institution, a combination of categorical tabs and fuzzy search leads to clinically acceptable drug entry in a combination touch screen keyboard AIMS.

We agree. The system we were implementing, EPIC AIMS, was based purely on a touch screen entry with no fuzzy logic attached. Hence we were limited to performing this study on a touch screen platform.

Level of interest: An article of importance in its field
Quality of written English: Acceptable

**Statistical review:** No, the manuscript does not need to be seen by a statistician.

**Declaration of competing interests:**
I am an advisory board member for Draeger Medical, Inc. for the AIMS product Innovian. I do not receive any compensation for this position. I do not believe this position would have any competing influence on this manuscript.