The Impact of the Evidence-Based Clinical Decision Support Resource "UpToDate" on the Speed and Accuracy of Determining Drug-Drug-Interactions in a Dental Setting: A Randomized Crossover Controlled Pilot Trial

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ABSTRACT

Aim & Hypothesis: The aim of the study was to compare the time dental students need to answer questions about drug-drug interactions (DDI) when using the Evidence-Based Clinical Decision Support Resource (EBCDSR) "UpToDate" to retrieve patient-critical information versus general internet access, during a preclinical session. We hypothesized that the dental students utilizing the "UpToDate" would take less time to identify the correct DDIs and obtain higher examination scores, compared with the group with only internet access.

Materials & Methods: The proposed study design was a randomized blinded crossover controlled pilot and each subject examined four computer-based virtual cases, during two study visits. In the first visit, one group assessed two cases presented in axiUm (Tufts University School of Dental Medicine's electronic health record system), using "UpToDate" access and the other group, using their own electronic resources assessed other two cases with no "UpToDate" access, and determined the DDI. At the second visit, after the ten days wash-out period, the cross-over took place. Each case was followed by three questions regarding the drug-drug interactions, focusing on the use of antibiotics, analgesics and local anesthetics. The mean time duration of the sessions conducted by each subject was captured and calculated. Chi-square tests were used for the statistical analysis of the examination scores. All statistical analyses were performed using SAS Version 9.2 (SAS Institute, Cary, NC).

Results: A total of 50 dental students presented for the first study visit and 44 dental students for the second study visit. The third year dental students utilizing the "UpToDate" took a similar amount of time to identify the correct DDIs compared with the third year dental students with no "UpToDate" access and only internet access (p-value=0.429). Both groups obtained similar examination scores for all the questions related to antibiotics (p-value=0.797), analgesics (p-value=0.850) and local anesthetics (p-value=0.850).

Conclusions: The current study has shown that "UpToDate" can provide answers to clinical questions at the point of care in a timely manner, with a high level of student satisfaction. Future studies might involve a more seamless entry into EBCDSR's using "Infobutton" in the Electronic Health Record (EHR).

DEDICATION

First and foremost, I would like to thank my family for their continuous support.

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LIST OF ABBREVIATIONS

TUSDM – Tufts University School of Dental Medicine

EHRs - Electronic Health Records

EMR - Electronic Medical Record

EBCDSR - Evidence-Based Clinical Decision Support Resource

TUSK – Tufts University Sciences Knowledgebase

HITECH - Health Information Technology for Economic and Clinical Health Act

EBD - Evidence Based Dentistry

ADA - American Dental Association

ADEA - American Dental Education Association

CDSS - Clinical Decision-Support Systems

DHHS - Department of Health and Human Services

WHO – World Health Organization

DDI – Drug-Drug-Interactions

AAA – Analgesic, Antibiotic, Anesthetics

SD – Standard Deviation

N – Number Correct Answers

HCTZ – Hydrochlorothiazide

HIV –Human Immunodeficiency Virus

GERD – Gastroesophageal Reflux Disease

The Impact of the Evidence-Based Clinical Decision Support Resource "UpToDate" on the Speed and Accuracy of Determining Drug-Drug-Interactions in a Dental Setting: A Randomized Crossover Controlled Pilot Trial

Introduction

Literature review

Electronic Health Records (EHRs) are digitally retained healthcare information with the aim of improving the quality of care, education, and research. The data available in the EHRs may present: patient identifying information; medical history; clinical observations; laboratory tests; medical images; treatments; and drugs prescribed.[1] The use of EHRs can be beneficial to the health care provider, if the information contained is used to improve the patient's care. The Department of Health and Human Services (DHHS) is establishing a nationwide network of Regional Extension Centers to assist providers in adopting qualified EHRs and making meaningful use of them. The Health Information Technology for Economic and Clinical Health Act (HITECH) authorized incentive payments through Medicare and Medicaid to the providers when they use EHRs, to improve health care delivery. This funding will provide important support to the creation of a nationwide system of EHRs. The legislation correlates payments directly to the processes and outcomes rendered by the health care providers.[2] Meaningful Use is a program designed to support the health care professionals in using the EHRs to help improve the quality and safety of the national healthcare system. Some of the goals of the Meaningful Use initiative include the promotion of the privacy and security of patient information Context Aware Knowledge Retrieval Application.[3-5] Other goals presented as part of the Meaningful Use initiative are: to improve the quality and safety of the health care services; engage actively patients and families in their care.

Evidence Based Dentistry (EBD) is a concept that is identified as using the best scientific evidence available in selecting the provided treatment option, further on improving the quality of care rendered to the patients. The evidence-based process was introduced in Canada as early as 1980s, as a response to the traditional trend of experience-based practice [1-4]. Multiple reports by both the American Dental Association (ADA) and the American Dental Education Association (ADEA), emphasize the need to use EBD and for dental graduates to become critical thinkers, to be able to understand current research, and incorporate the results into their clinical decision making to improve patient outcomes. In the same perspective, the Commission on Dental Accreditation requires that students be competent at using EBD principles as it pertains to patient care [5, 6].

Dental schools are adopting more ways to integrate educational assessment technology in their curriculum, taking into consideration the role that technology plays for the current generations and making sure that their students will be able to perform successfully in dental practice upon graduation, considering the latest technologies available. The effect of Clinical Decision-Support Systems (CDSS) on clinical outcomes, treatment efficiency, patient satisfaction, cost of treatment and system implementation has been analyzed in different studies in the medical setting. There are relatively few studies that have been published on this topic in the dental setting.

A review published recently (2012), mentions that CDSS are effective tools at improving health care processes, but particular evidence for clinical, economic and efficiency outcomes is sparse[12]. The Context Aware Knowledge Retrieval application "Infobutton" is a

tool embedded in the EHR, that can help at the point of care, offering a list of links to resources to evidence-based clinical information. Context Aware Knowledge Retrieval application "Infobutton" is currently considered a promising tool, that can assist and support the provider in the clinical decision-making process[13]. Several healthcare organizations have adopted the use of Infobutton in their electronic medical record (EMR) systems[14]. It is understandable, that at the beginning, the tool can be challenging during the initial learning process, but the overall experience of these medical providers with Infobutton revealed that the tool brings value in the healthcare provider workflow[13].

Previous studies have shown that Infobutton provides answer to clinical questions at the point of care in a timely manner, with a high level of user satisfaction.[14-17] One of the external sources available, that is used to provide evidence for the Infobutton is www.uptodate.com, a resource mainly used by health care providers in the medical field. UpToDate® is an evidence-based resource used mainly by physicians in their daily clinic activities. This database collects information from more than 5,700 world-renowned physician authors, editors and peer reviewers. They use a rigorous editorial process to synthesize the most recent medical information into evidence-based recommendations, that are proven to improve patient care and quality. According to the Federal Register document published in 2012, the 2014 Edition of EHR Certification Criterion will consider as Standard for clinical decision support the use of Context-Aware Knowledge Retrieval "Infobutton". [18]

As part of this study, Qualtrics was used to administer the survey used. Qualtrics is a private research platform, used by providers for online data collection. Quantitative and

qualitative research data can be analyzed with this software. Tufts customized version of Qualtrics is available for the members of its community for creating and conducting online surveys. Tufts University Sciences Knowledgebase (TUSK) is a knowledge management system, used in supporting the students and faculty members in the learning and teaching processes. The platform allows creating and annotating folders in personalized meaningful ways, as part of this study.

Significance of research

To the authors' knowledge, "UpToDate" has not been used in the electronic dental records used in dental schools. The current study is the first study that assessed the impact of the "UpToDate" on the speed and accuracy of determining drug-drug interactions in a dental school setting and will provide information regarding the students' perception about integrating this tool in their daily practice. The outcomes of this study might provide important data that can be used to improve the quality of patient care in a dental school setting. Dental students might also make quicker and safer decisions, based on the use of this tool at the point of care.

Aim and Hypothesis

1. Specific Aims:

The primary aim of this randomized crossover pilot study was to compare the time students need to answer questions about drug-drug interactions (DDI) when using the "UpToDate" versus general internet access to retrieve patient-critical information, during a preclinical session. The secondary aim of the project was to compare the number of correct answers using the two different modalities ("UpToDate" vs. general internet access). The third aim was to assess the students' perception, utilizing a survey, about the use of the context aware knowledge retrieval application.

2. Hypothesis:

We hypothesized that the time needed to identify the correct DDI using "UpToDate" was less compared with the time needed to identify the correct DDI with no "UpToDate" access, in a preclinical setting. We further hypothesized that the examination scores assessing the DDI were higher for the sessions when "UpToDate" was used, compared with the sessions when there was no "UpToDate" access and only general internet access.

3. Outcomes:

The primary outcome of this study was the time needed for the students to determine DDIs for four different virtual patient cases. The secondary outcome of this project were the examination scores, pertaining to the drug-drug interactions presented in the four virtual patient cases. The third outcome measure was the students' perception regarding the use and effectiveness of the "UpToDate" tool, measured utilizing a survey.

Research Design

This study design was a randomized blinded crossover controlled trial of 60 third year dental students at TUSDM, as identified in Figure 1. The study was a pilot study and based on the experience of the investigators, a sample size cohort of 60 students was deemed to be appropriate. The study was carried out in the Simulation Clinic at TUSDM. Third year dental students at TUSDM, enrolled in the DMD program, that were willing to participate were recruited for this study. Participation in the study was communicated to the students and that the study requires two visits. Participation or the refusal to participate had no effect on the student's academic standing. Each subject determined the drug-drug interactions for four different patients taking various categories of medications, during two different sessions (two cases per session). The cases were stored on the TUSK platform. Each subject had "UpToDate" access for two of the patient scenarios (during session 1) and for the other two scenarios they based their decisions on previous knowledge or resources they found on the internet (during session 2). The other group, based their decisions on previous knowledge or resources they found on the internet for the first two cases (during session 1), and had "UpToDate" access for two other patient scenarios (during session 2), as shown in Figures 2 and 3. By clicking on the Infobutton hyperlink, the participants were directed to the up-to-date website (www.uptodate.com), on the drug-drug-interactions section (Figure 4). A brief summary of each case was presented at the beginning, followed by three questions regarding the DDI (Figure 5). The time required for each case was recorded automatically on the computer using the Qualtrics platform (Figure 6) and at the end of the "UpToDate" session, the participants filled in a survey, regarding their perception about the use of Infobutton

(Figure 7). A 10 days wash-out period in between the two sessions was used. This study was approved by the Tufts Health Sciences Institutional Review Board.

Materials and Methods

An e-mail was sent by one of the co-investigators announcing the TUSDM class of D'16 DMD candidates, the opportunity to volunteer for this particular study. The email was sent 10 days prior to the first visit, giving the opportunity for the dental students interested in participating to ask questions. A reminder email was sent the day before the first visit. At the beginning of the session students were randomly assigned to two different groups: A and B. According to the group they were part of, participants were assigned at individual working stations with similar computers for the internet connection. The computers were previously tested in order to make sure that the internet connection is running (Illustration 1). Group A assessed two cases under "test" conditions ("UpToDate" access) in one time period and two cases under "control" (internet resources) conditions in the other time period; Group B assessed two cases under "control" conditions in one time period and two cases under "test" conditions in the other time period. For the two "test" cases, the subjects had "UpToDate" access; for the two "control" cases the subjects based their decisions on previous knowledge or independent access to internet resources. Step-by-step guidelines were given using the TUSK platform and connecting the participants TUSK log in to a direct connection to the Qualtrics platform (Figure 8). Each student logged in to the TUSK platform in order to receive access and be able to be part of the study. Each participant received instructions regarding the sequence of the surveys/cases planned to fill in/work up, according to the group they belong to. It was clearly mentioned in the instructions for the "test" group to use only the "UpToDate" resource in identifying the correct DDI and no other materials.

Each participant examined in two sessions, a total of four computer-based cases. The cases were selected from a library of cases used by the TUSDM Academic Affairs for introducing axiUm in a preclinical setting. The criteria used for the case selection included:

- minimum two medical conditions, that are frequently encountered in the TUSDM patient population, such as hypertension, diabetes, etc.
- a minimum three prescribed medications.

Case 1 presented with hypertension and type II diabetes mellitus; taking the following medications: diovan, HCTZ, actos, metformin, aspirin and calcium. Case 2 presented with HIV and GERD; taking the following medications: kaletra, bactrim, truvada, protonix. Case 3 presented with schizophrenia, depression, anxiety, history of irritable bowel syndrome; taking the following medications: zyprexa, sertraline, trazadone and citalopram. Case 4 presented with asthma, bronchitis, sleep apnea and osteoarthritis; taking the following medications: cetirizine, advair, albuterol, spiriva and oxycodone.

The time required to complete this survey was recorded automatically by Qualtrics. A timer showing a maximum limit of 10 minutes per case was set up in Qualtrics. At the end of each session, the proposed DDIs were evaluated for accuracy by all subjects utilizing a survey regarding general information about medications. Each correct answer was scored with one point and the maximum score possible was 3 points/case. The questions focused on the indications/contraindications for prescribing analgesics, antibiotics or administering local anesthesia with or without epinephrine.

A 10 days wash-out period in between the test and control group was used. Subjects who were in the "test" group for the first session were in the "control" group for the second session, and vice versa. At the end of the "test" session, each participant completed a survey regarding the usefulness of the resource, available information and the impact on clinical decision-making (Figure 7).

One blinded investigator analyzed the results of the surveys regarding the DDIs about medications and the data from the surveys regarding the students' perception about the resource, usefulness of available information and the impact on clinical decision-making. Identification of the groups was revealed for data analysis.

An outline of the study design is shown below:

Study visits:

(Visit 1) - Session 1

- study explained to the participants
- randomization

A. Group A ("UpToDate" group)

- review case 1
- fill in the DDI survey, once they opened the survey the countdown time started
- review case 2
- fill in the DDI survey, once they opened the survey the countdown time started
- fill in the perception survey

B. Group B (Control group)

- review case 1
- fill in the DDI survey, once they opened the survey the countdown time started
- review case 2
- fill in the DDI survey, once they opened the survey the countdown time started

(Visit 2) - Session 2 (after the 10 days wash-out period, cross-over took place)

A. Group A (Control group)

- review case 3
- fill in the DDI survey, once they opened the survey the countdown time started
- review case 4
- fill in the DDI survey, once they opened the survey the countdown time started

B. Group B ("UpToDate" group)

- review case 3
- fill in the DDI survey, once they opened the survey the countdown time started
- review case 4
- fill in the DDI survey, once they opened the survey the countdown time started
- fill in the perception survey

Statistical Analysis

The mean duration of the sessions conducted by each subject was calculated. The means in each group was compared using an independent sample t-test to assess differences between the groups. The Chi-square test was used to compare the scores on the examinations between the two groups. The recordings and the notes was assessed and major themes that the participants mentioned were identified. Percentages were reported for the surveys evaluating the participants' perception regarding the use of the evidence-based clinical support resource. All analyses were performed using SAS Version 9.2 (SAS Institute, Cary, NC). Any p-value less than 0.05 was considered statistically significant.

Results

A total of 50 students volunteered and presented at the first visit. Only 48 dental students were eligible to be part of the study, as two of them were part of the DMD International Students program and did not start the clinic by the moment the study was initiated. From the total of 48 eligible students presented at the first study visit, a total of 44 dental students returned for the second study visit. Therefore a total of 44 participants were available for analysis for the study. The third year dental students utilizing the "UpToDate" took a similar amount of time to identify the correct DDIs compared with the third year dental students with no "UpToDate" access and only internet access (means for the overall time of 286.5 seconds for the "UpToDate" group and 265.2 seconds for the traditional group with a p-value=0.429) – Table 1. A decrease in the time needed to identify the DDI was noticed for both groups while evaluating the first case compared to the second case, for each session – Table 2. The scatterplot (Figure 11) identifies the time taken by each participant to work-up each of the four cases and a clustering is noted for both groups for the time needed to work-up case 4.

Both groups obtained similar examination scores for all the questions related to antibiotics (p-value=0.797) – Table 3. Slightly higher scores were obtained for the traditional group for the analgesics (p-value=0.850) and local anesthetics (p-value=0.850) (41 correct answers for the traditional group compared with 36 correct answers for the "UpToDate" group) – Table 3. For Case 2, the group using "UpToDate" obtained higher scores compared with the group using the traditional method – Table 4. The group using the traditional method in identifying the DDI obtained higher scores for Cases 1, 3 and 4 – Tables 4 and 5. When

evaluating the performance between the groups (group A vs. group B), it was noted that group A obtained higher scores for the questions related to analgesics and antibiotics; group B obtained higher scores for the questions related to anesthetics – Table 6. The results were statistically significant for the examinations scores related to the antibiotics, with a p-value of 0.005. The dental students provided positive feedback regarding the use of "UpToDate".

The majority of the participants mentioned that the tool was easy to use (37.5%), very often the tool provided the answer they were looking for (50%), it was fast (37.5%) and they agreed to use it again in a similar situation (56.3%) – Table 7.

Discussion

Our study did not support the hypothesis that the third year dental students utilizing the "UpToDate" would take less time to identify the correct DDIs and obtain higher examination scores, compared with the third year dental students with no "UpToDate" access and only internet access. Most of the studies presented in the medical field literature (Del Fiol *et al.)* support the fact the specific links are faster compared with the traditional method. Del Fiol in 2008, in a randomized controlled trial with a control and an intervention group that included individuals that were enthusiastic users of the tool, reported that the intervention group - access to specific links, spent an average of 35.5 seconds seeking for information compared with 43 seconds for the users from the control group. Our study failed to support this idea and showed similar overall times for determining DDI, but a relevant decrease in time was noted for the second cases – when using the specific hyperlink to "UpToDate". A possible reason for this finding can be the fact that the participants did not receive a tutorial at the beginning of the session. When we compared our study with the one previously mentioned, we need to take into consideration the fact that in Del Fiol's publication – the session outcomes measurements were clinicians' self-assessment and therefore prone for bias, compared to our study, where the time was measured precise with the use of an electronic software – Qualtrics. The fact that the Infobutton group was faster for their second case might suggest that the tool was faster once the subjects gained some experience. Some of the participants in Group A mentioned at the end of the visit 1, that as a future reference, a tutorial would be helpful for a better understanding of the tool. One of the limitations to be considered for the time measurement is the fact that the internet speed was similar for all the participants using the Infobutton tool, but the computers used presented

with decreased internet connection compared with their searching tools – such as smartphones or tablets. It is important to mention that the control group were able to use their own devices and are very adept at finding resources. For a better assessment of the primary outcomes, it might have been better to consider connecting the data of each participant for both sessions and measure whether there is a relationship in terms of time when using "UpToDate" or the traditional method.

For the secondary outcome – the examinations scores – our hypothesis was not supported by our data. The current study showed that the third year dental students utilizing the "UpToDate" obtained lower examination scores, compared with the third year dental students with no "UpToDate" access and only internet access. The type of assessment used – multiple choice, may not have truly assessed the outcomes we were looking to measure. Evaluating the examination scores, we need to consider the fact that the value of using specific links, goes beyond the DDI and is able to connect the participant with the latest and strongest information available from the evidence-based decision making perspective. As a dental student just starting working in the clinic, it is very difficult to evaluate critically the scientific evidence available and sometimes we rely on the first information that becomes available online, without testing the reliability of the source. On the other hand, looking at the examination scores we need to understand that identifying the correct DDI is only the first step in the prescription process. In the selection of the four cases, the authors considered the following points: start with a simple case when the drugs can be used and introducing case scenarios that will bring out special points in the drug choice. As emphasized by the WHO in the Guide for Good Prescribers, identifying the DDI and writing a good prescription

is just the first step in the care for our patients. As equally important in the prescription process, are the following steps: educate patients on the appropriate use of medicines and monitor the treatment, including the follow-up visits. Litvin *et al*. in 2012 assessed the impact of a clinical decision support system on antibiotic prescribing. The main outcomes of the study were similar with the present one, in a way that they looked at the use of antibiotics for inappropriate prescription of antibiotics. Compared with the present study, the author mentioned above, concluded with the idea that clinical decision support system shows promise for promoting judicious antibiotic use in primary care. We need to take into consideration that Litvin *et al.* did not have a control group and the number of the subjects testes was limited. This was the first study showing an improvement in antibiotic prescribing when using clinical decision support system.

There were several limitations related to the study design, participants of the study and interpretation of the data. In terms of the study design, some points to be considered are: present a tutorial of the evidence-based clinical support tool; assure the internet connection has similar speed for all the tools being used as an engine search; develop cases that are not too challenging considering the fact that the participants were just at the beginning of their clinical experience; the wash-out period showed an acceptable rate of drop-out of the subjects (less than 10%). Regarding the participants of the study: exclusion criteria should have mentioned the DMD International Students, some of the subjects might have had more experience with medically compromised patients compared to others, but also the fact that the third year dental students are not able to prescribe and all their work is being supervised by a faculty member, compared with the postdoctoral students that write up prescriptions on

a daily basis. Also to aid in interpretation of data, it would been valuable to be able to connect the answers of the participants between sessions and evaluate the performance in terms of time and scores for each individual when using "UpToDate" tool or the traditional search.

This pilot study helped identify a valid sample size for future studies in a clinical dental setting. If we consider time as the primary outcome, a total 126 subjects will suffice for a study with 80% power. The current study is the first study that assesses the impact of the evidence –based clinical decision system on the speed and accuracy of determining drug-drug interactions in a dental school setting and provides information regarding the students' perception about integrating this tool in their daily practice. The outcomes of this study provided important data that can be used to improve the patient care in a dental setting. Students who are exposed to this test might be able to make quicker and safer decisions at the point of care. The fact that the tool was so well received by the dental students emphasizes the fact that the dental education needs to adapt to the needs of the technology savvy generation, and consider introducing new technologies in the dental setting.

There are several issues that could be considered for future areas of research on this topic. A direct "Infobutton" type of tool that is built in to the EHR should be tested for efficacy and quality of care in a dental setting. Since the students at TUSDM are in a "traditional" lecture based curriculum, it might be interesting to conduct this study in a student population that uses problem-based learning to see if there are inherent differences.

Conclusion

The outcomes of this study provide important data that can be used to improve the quality of education provided to dental students and further on the patient care in a dental setting. The current study has shown that "UpToDate" can provide answers to clinical questions at the point of care in a timely manner, with a high level of student satisfaction. Future studies might involve a more seamless entry into EBCDSR's using "Infobutton" in the Electronic Health Record (EHR).

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APPENDICES

Appendix A: Tables

Appendix B: Figures

Appendix A: Tables

Table 1. Primary outcome: time (measured in seconds and recorded by Qualtrics): overall and direct comparison between sessions.

Group / Session	Time (Test)		Time (Control)		p-value
	Mean	SD	Mean	SD	
Overall	286.5	180.6	265.2	161.2	0.429
Session 1 (case 1,2)	283.2	206.0	262.7	168.4	0.611
Session 2 (case 3,4)	290.5	147.2	268.1	154.9	0.525

Table 2. Primary outcome: time (measured in seconds and recorded by Qualtrics): direct comparison between cases.

Group / Case(s)	Time (Test)		Time (Control)		p-value
	Mean	SD	Mean	SD	
Case 1	393.0	220.6	293.3	193.4	0.121
Case 2	183.5	130.0	230.8	134.7	0.242
Case 3	396.3	132.1	355.8	172.0	0.425
Case 4	178.4	39.6	180.4	58.8	0.908

Table 3. Secondary outcome: scores (correct examination scores regarding DDI – triple AAA): comparison between sessions.

Group / Case(s)	Score (Test)		Score (Control)		p-value
	N	%	N	%	
Overall					
Analgesics	36	46.7	41	48.2	0.850
Antibiotics	25	32.4	26	30.5	0.797
Anesthetics	36	46.7	41	48.2	0.850
Session 1					
Analgesics	15	35.7	17	37.7	0.841
Antibiotics	21	50.0	13	28.8	0.043*
Anesthetics	11	26.1	15	33.3	0.467
Session 2					
Analgesics	21	60.0	24	60.0	1.000
Antibiotics	4	11.4	13	32.5	0.029*
Anesthetics	25	71.4	26	65.0	0.551

Table 4. Secondary outcome: scores (correct examination scores regarding DDI – triple AAA): comparison between cases 1 and 2 presented in session 1.

Group / Case	Score (Test)		Score (Control)		p-value
	N	%	N	%	
Case 1					
Analgesics	7	35.0	10	43.4	0.570
Antibiotics	9	45.0	5	21.7	0.104
Anesthetics	10	50.0	12	52.1	0.886
Case 2					
Analgesics	8	36.3	7	31.8	0.750
Antibiotics	12	54.5	8	36.3	0.225*
Anesthetics	1	4.5	3	13.6	0.294

Table 5. Secondary outcome: scores (correct examination scores regarding DDI – triple AAA): comparison between cases 3 and 4 presented in session 2.

Group / Case	Score (Test)		Score (Control)		p-value
	N	%	N	%	
Case 3					
Analgesics	10	55.5	11	55.0	0.972
Antibiotics	3	16.6	8	40.0	0.113
Anesthetics	12	66.6	13	65.0	0.913
Case 4					
Analgesics	11	64.7	13	65.0	0.985
Antibiotics	1	5.8	5	25.0	0.115
Anesthetics	13	76.4	13	65.0	0.446

Table 6. Comparison between groups of participants (group A vs. group B): the overall correct examination scores regarding DDI.

Group / DDI interaction	Group A		Group B		p-value
	N	%	N	%	
Analgesic	39	47.5	38	47.5	0.993
Antibiotic	34	41.4	17	21.2	0.005*
Anesthetic	37	45.1	40	50.0	0.534

Table 7. . Perception of the participants regarding the use of the Evidence-Based Clinical Decision Support Resource "UpToDate" in determining the DDI.

"Infobutton was easy to use:"			
Strongly agree	Agree	Neither agree nor disagree	Disagree
25%	37.5%	31.3%	6.3%
"When I clicked on an Infobutton, the question I was interested in finding an answer to was there:"			
Always	Very often	Occasionally	Never
3.1%	50%	31.3%	15.6%
"Compared to the way I usually get answers to my questions, the Infobutton was:"			
Very fast	Fast	Neutral	Slower
12.5%	37.5%	40.6%	9.4%
"If I you had to do it over again, I would use Infobutton:"			
Strongly agree	Agree	Neither agree nor disagree	Disagree
12.5%	56.3%	18.8%	12.5%

Appendix B: Figures

Figure 1. Schematic design of the proposed study visits – identifying the groups, sessions and the chronology of the cases.

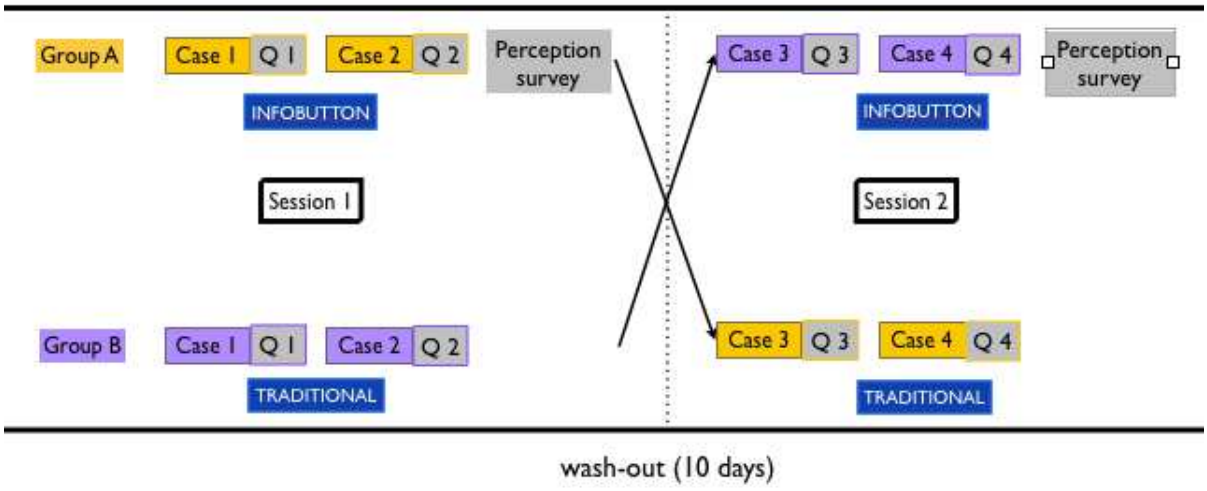


Figure 2. Outline of the virtual patients (Axium) for the control group – no "UpToDate" access.

Tufts School of Dental Medicine

Patient Record

NAME:	Sim Clin, Op/Pros Fixed 3	ADDRESS:	1 Kneeland Street Boston, MA 02111
CHART#:	1130596	PHONE:	(617)
DOB:	7/23/1954		
AGE:	60		

Last approved by: Fidrocki, Edward on 08/30/2012

Comp Health History

SUMMARY OF MEDICAL HISTORY:

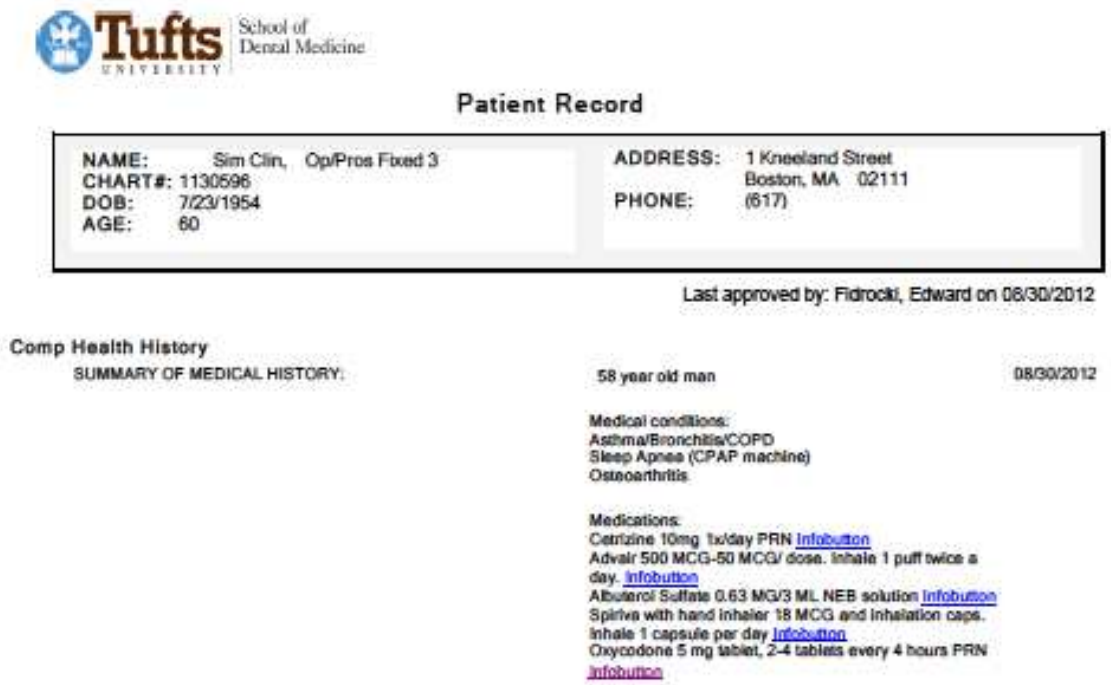
58 year old man 08/30/2012

Medical conditions:
Asthma/Bronchitis/COPD
Sleep Apnea (CPAP machine)
Osteoarthritis

Medications:
Cetrizine 10mg 1x/day PRN
Advair 500 MCG-50 MCG/ dose. Inhale 1 puff twice a day.
Albuterol Sulfate 0.63 MG/3 ML NEB solution
Spiriva with handihaler 18 MCG and inhalation caps. Inhale 1 capsule per day
Oxycodone 5 mg tablet, 2-4 tablets every 4 hours PRN

NKDA

Figure 3. Outline of the virtual patients (Axium) for the control group – with Infobutton/"UpToDate" access.



Tufts School of Dental Medicine

Patient Record

NAME: Sim Clin, Op/Pros Fixed 3
CHART#: 1130596
DOB: 7/23/1954
AGE: 60

ADDRESS: 1 Kneeland Street
Boston, MA 02111
PHONE: (617)

Last approved by: Fidrocki, Edward on 06/30/2012

Comp Health History

SUMMARY OF MEDICAL HISTORY:

58 year old man 08/30/2012

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Sleep Apnea (CPAP machine)
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Cetrizine 10mg 1x/day PRN Infobutton
Advair 500 MCG-50 MCG/ dose. Inhale 1 puff twice a day. Infobutton
Albuterol Sulfate 0.63 MG/3 ML NEB solution Infobutton
Spiriva with hand inhaler 18 MCG and inhalation caps. Inhale 1 capsule per day Infobutton
Oxycodone 5 mg tablet, 2-4 tablets every 4 hours PRN Infobutton

Figure 4. Overview of the "UpToDate", the evidence-based clinical decision support resource used by the test (Infobutton) group.

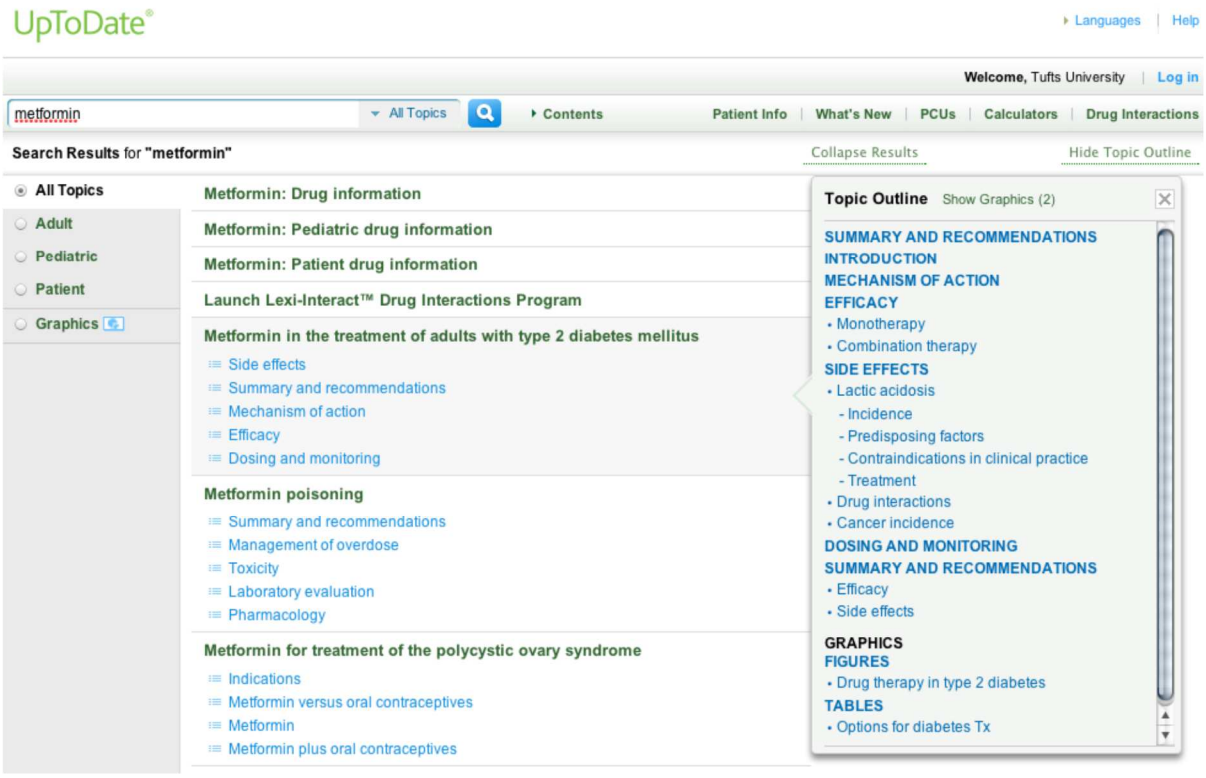

Figure 5. Overview of the questions related to DDI for Case 1 – utilizing Qualtrics.

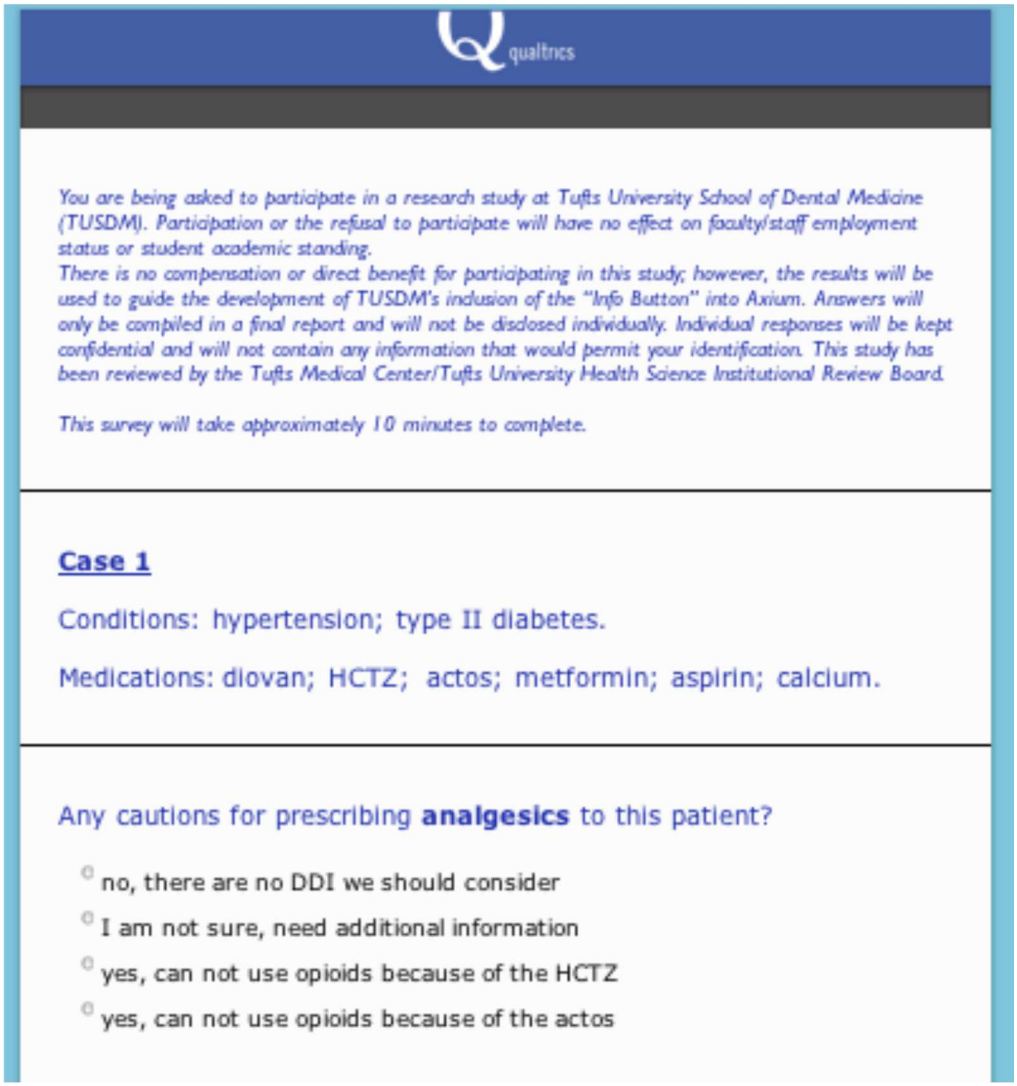

Figure 6. Primary outcome measurement – time, utilizing Qualtrics.

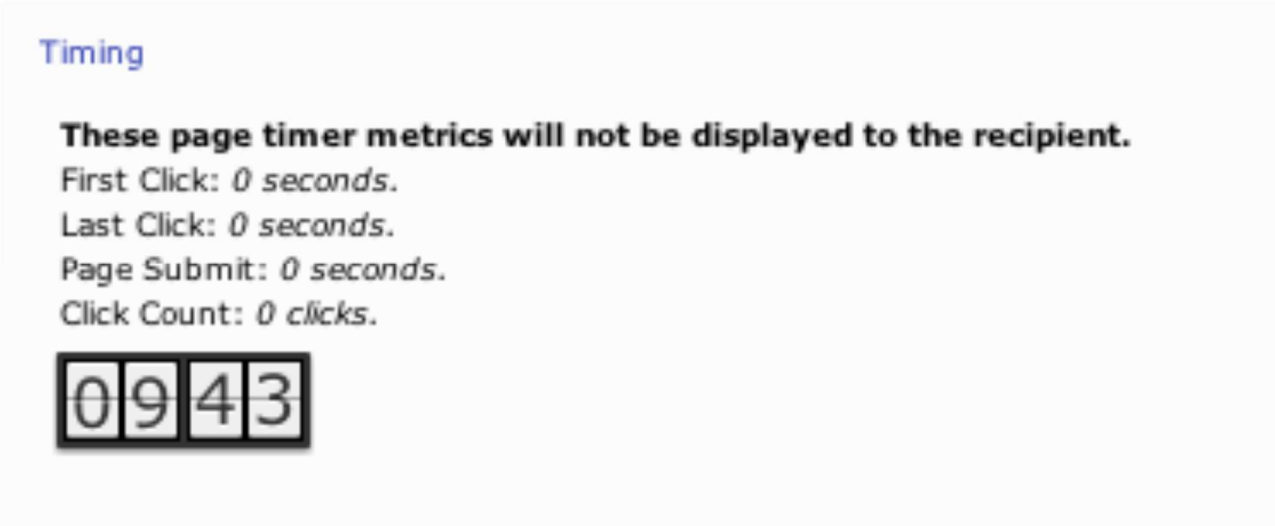

Figure 7. Overview of the perception survey – utilizing Qualtrics.

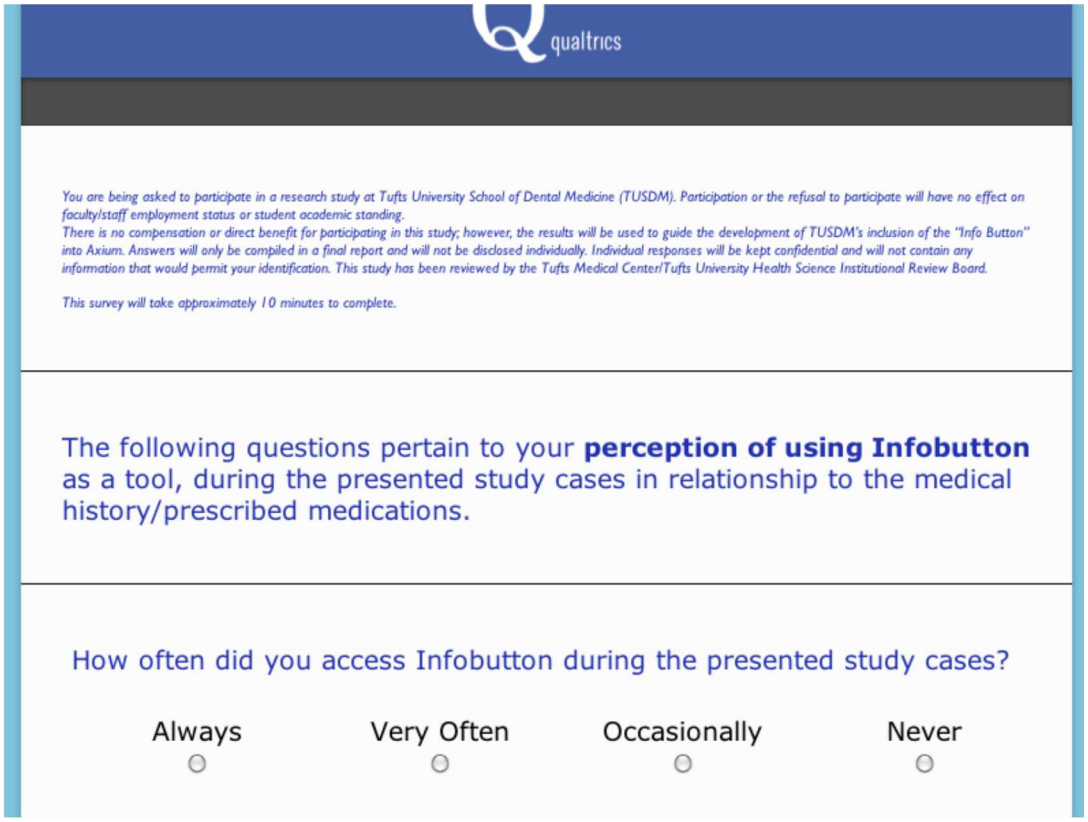

Figure 8. Step-by-step guidelines followed by each participant.

Figure 9. Scatterplot identifying the time (in seconds – measured on the vertical axis) taken by each participant (identified on the horizontal axis) to work-up each of the four cases.

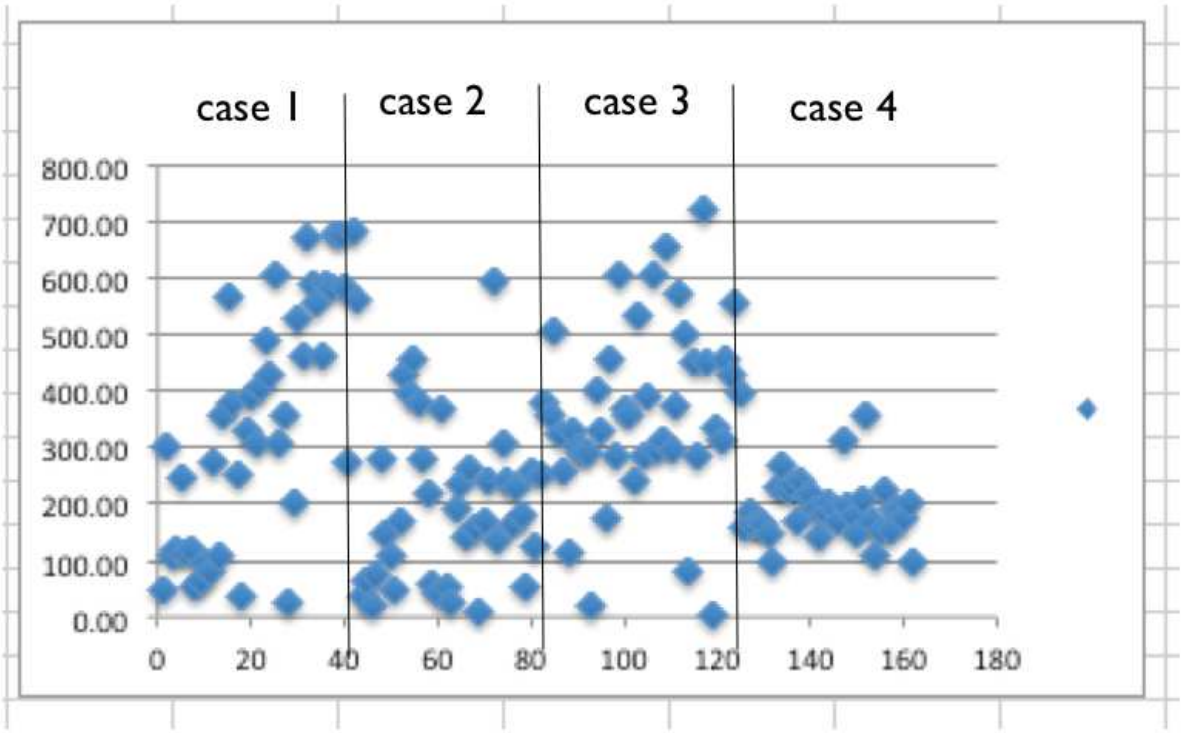

Figure 10. Barchart – direct comparison between the groups (test vs. control) identifying the average time (in seconds – measured on the vertical axis) taken to work-up each of the four cases (identified on the horizontal axis).

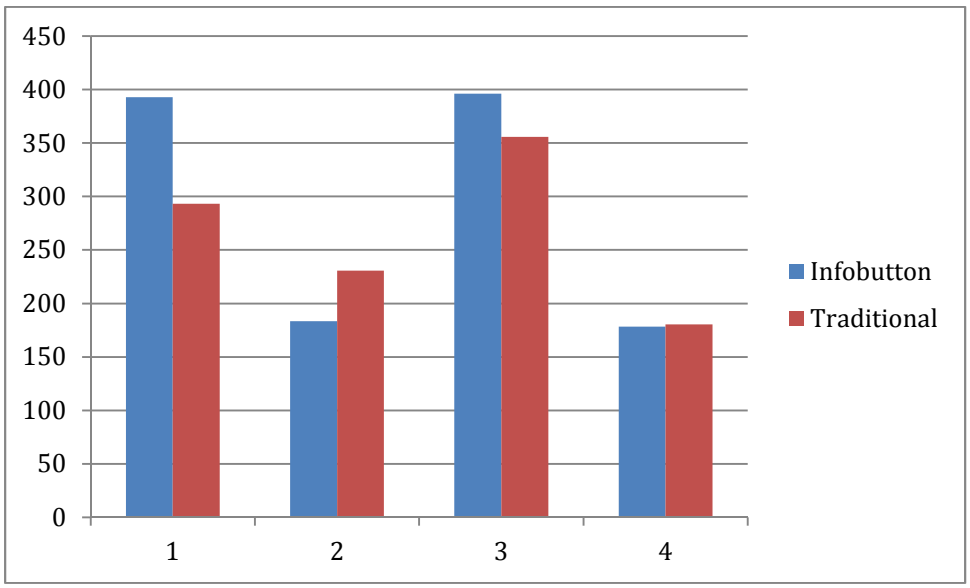

Illustration 1. Photograph taken during study implementation.

Illustration 2. Photograph taken during study implementation.

Illustration 3. Photograph taken during study implementation.