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## Enhancing patient understanding of medical procedures: Evaluation of an interactive multimedia program with in-line exercises

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### ABSTRACT

**Introduction:** Standard print and verbal information provided to patients undergoing treatments are often difficult to understand and may impair their ability to be truly informed.

This study examined the effect of an interactive multimedia informational program with in-line exercises and corrected feedback on patients' real-time understanding of their cardiac catheterization procedure.

**Methods:** 151 adult patients scheduled for diagnostic cardiac catheterization were randomized to receive information about their procedure using either the standard institutional verbal and written information (SI) or an interactive iPad-based informational program (IPI). Subject understanding was evaluated using semi-structured interviews at baseline, immediately following catheterization, and 2 weeks after the procedure. In addition, for those randomized to the IPI, the ability to respond correctly to several in-line exercises was recorded. Subjects' perceptions of, and preferences for the information delivery were also elicited.

**Results:** Subjects randomized to the IPI program had significantly better understanding following the intervention compared with those randomized to the SI group ( $8.3 \pm 2.4$  vs  $7.4 \pm 2.5$ , respectively, 0–12 scale where 12 = complete understanding,  $P < 0.05$ ). First-time correct responses to the in-line exercises ranged from 24.3% to 100%. Subjects reported that the in-line exercises were very helpful ( $9.1 \pm 1.7$ , 0–10 scale, where 10 = extremely helpful) and the iPad program very easy to use ( $9.0 \pm 1.6$ , 0–10 scale, where 10 = extremely easy) suggesting good clinical utility.

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*Discussion:* Results demonstrated the ability of an interactive multimedia program to enhance patients' understanding of their medical procedure. Importantly, the incorporation of in-line exercises permitted identification of knowledge deficits, provided corrected feedback, and confirmed the patients' understanding of treatment information in real-time when consent was sought.

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## 1. Background

In order for patients to make informed treatment decisions they must be provided with pertinent information presented in a manner that promotes understanding [1]. Typically, this information is imparted either through a discussion with the physician, a paper consent form, or a combination of both. Unfortunately, the literature is replete with examples showing that patients often do not read conventional consent forms and/or have difficulty understanding the information provided [2–10]. Reasons for this include patient anxiety, insufficient time, poor communication, cognitive abilities, age, limited education, poorly constructed and text-heavy consent forms, medical jargon, and low literacy/numeracy abilities [11–13]. Although several interventions such as shorter consent forms with lowered grade reading levels have been employed to help improve understanding, not all are uniformly effective [11,14–19]. Recently, however, novel techniques employing interactive computer graphics have been shown to be effective in the communication of both medical and research information [20–26]. However, despite this, most empirical research has measured patients' recall of information at various times *after* the information has been given rather than in real-time. The primary aims of this study therefore were to evaluate the effect of an interactive multimedia program with in-line exercises and corrected feedback on patients' real-time understanding and post-procedure recall of information regarding their cardiac catheterization.

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## 2. Methods

### 2.1. Population

This study was approved by the University of Michigan's IRB with a waiver of written informed consent. Consecutive patients (>18 years) scheduled for diagnostic cardiac catheterization were enrolled. Patients who had undergone catheterization within the previous 5 years, those requiring emergency catheterization or stenting, and those who could not read were excluded. Patients were approached to participate at minimum 1 h prior to their procedure at a time when consent is normally sought. Patients were randomized to receive information about their procedure using either our standard (written and verbal) institutional consent protocol (SI) or an interactive informational iPad (Apple Corp., Cupertino, CA) program (IPI). Consent for the actual procedure was obtained for all subjects separately by a cardiology team member, not involved in

the study and who was blinded to the group assignment.

### 2.2. Program development

Based on information from medical textbooks, media, and expert opinion, graphic artists created 2 and 3D computer models of individual body parts. Each model was then combined to create a virtual patient complete with dynamic visualization of anatomical and physiologic functions (e.g., beating heart, blood flow). The principle software programs utilized in the creation of these models were: Maya®, 3-D Studio Max®, and Adobe After Effects®, Photoshop®, and Macromedia Flash®. Once the content and the visual models/simulations were created they were merged to form 9 modules entitled “Your heart,” “Your condition,” “Before your procedure,” “Your procedure,” “After your procedure,” “Risks and benefits,” “Results” and, “Alternatives.” A summary module was also included. Each module was presented sequentially so that relevant information could not be skipped (Fig. 1 example). Visual effects were supplemented by informational text inserts and reinforced with a narrative (voice-over). Additional information could also be accessed by tapping on any “?” icon on the iPad. This feature allowed the amount of information to be tailored to those individuals who needed more.

Embedded between each module were 7 brief interactive exercises (26 items) designed to test real-time comprehension of the information. These required the subject to provide answers to specific questions regarding risks, alternatives, etc., or to perform tasks to indicate the subjects' understanding of the information at the time it was given (Fig. 2 example). For example, in one exercise, subjects were required to locate and tap on the catheter and indicate its intended path by dragging it from the groin up through the aorta, heart, and coronary arteries. Each exercise included corrected feedback to indicate whether the subject had correctly performed a task or answered a question. Correct responses were highlighted in green and incorrect responses in red with audio alerts. In some cases, correct responses initiated a “pop up” with additional information. Although the program was extremely intuitive, trained research assistants were available to help the subjects navigate the program, if required. Prior to final implementation, several iterations of the interactive program were reviewed by the study team (expertise in interventional cardiology and informed consent) for accuracy of content and tested for usability by 3 lay individuals (non-physicians/scientists). This included an assessment of how the information flowed, ease of navigation, and formatting of the questions in the on-line quizzes. The entire program

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