EDUCATING PATIENTS AND PHYSICIANS ABOUT BARIATRIC EMBOLIZATION THROUGH USE OF INTERACTIVE MEDIA

by
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Abstract

A third of Americans are overweight or obese. Current weight loss options for obese patients are diet and exercise, medical management, or bariatric surgery. A new treatment undergoing clinical trials at Johns Hopkins Hospital is bariatric embolization, a minimally invasive, non-surgical, image-guided procedure. This procedure may induce weight loss by altering hormone production in the stomach by blocking specific blood vessels using micro beads. One such hormone is ghrelin, a hunger inducing hormone produced in the fundus. Because bariatric embolization is an emerging procedure beginning clinical trials at Johns Hopkins Hospital, no visual media exist to describe it.

A user-centered design approach was employed to create an educational digital interactive module for both patients and physicians to communicate information about bariatric embolization, including why it may be needed, the steps of the procedure, possible risks, and the current state of research. Need finding studies were used to guide the content of eighteen color illustrations that were used to create 26 short animations. Together these formed the basis of the visuals for the interactive. It was tested on both clinicians and non-clinicians and a second iteration of the interactive was produced for the BEAT Obesity website. Further improvements will be made based on future qualitative testing, and the interactive will be expanded based on the data gathered through the bariatric embolization clinical trials.

Once fully developed, this interactive will offer a model for future interactives that can explain other medical procedures. Evaluating the effectiveness of the module has contributed to medical illustration by showing the benefits of a user-centered design approach to interactivity when describing medical procedures.
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Introduction

Overview of Obesity and its Treatment

Obesity, defined as having a BMI of 30 or greater, is a serious public health concern and is known to be a contributor to diabetes, heart disease, cancer and stroke. Obesity rates have tripled since 1980 and as of 2014, one third of Americans are overweight or obese (Wolf et al 2014). That number is currently increasing and by 2030 more than 42% of Americans are expected to be obese.

The first treatment for obesity is lifestyle intervention such as diet and exercise (Larder et al 2012) which can lead to an average of 7% weight loss if the patient has high compliance. This is the least invasive and preferred treatment option. However, the usual outcome is a regaining of the weight that was lost (Stefater et al 2012). Bariatric surgeries such as sleeve gastrectomy, gastric banding, and Roux-en-Y gastric bypass surgery are highly invasive final options and are known to result in an average of 50% weight loss. This may be an initially beneficial result, however many health complications can occur with bariatric surgeries relating to surgical and nutritional complications (Madoff et al 2013). Depending on the bariatric procedure, some complications could include gastric leaking, malnutrition, infection, gastritis, or production of kidney and gall stones. Bariatric Embolization offers a treatment option that is the middle ground between dieting and exercise and the highly invasive nature of bariatric surgeries.

Overview of Bariatric Embolization Procedure

A new treatment undergoing clinical trials at Johns Hopkins Hospital is Bariatric Embolization, a minimally invasive, non-surgical, image-guided procedure (Madoff et al 2013). This procedure may induce weight loss by altering hormone production in the stomach by blocking specific blood vessels using micro beads. One such hormone that may be affected is ghrelin, a hunger inducing hormone, produced in the fundus of the...
stomach (Fig.1). Another hormone that may be affected is glucagon-like peptide-1 (GLP-1), a hormone mainly produced in the intestines that provides the signal that makes a person feel full. With the decrease in ghrelin and an increase in GLP-1, the concept is that over time the patient will lose weight due to the reduced level of hunger and increased satiety on a regular basis.

![Diagram of gastric artery and catheter]

Figure 1. A micro catheter being inserted into the left gastric artery

**Current Information on Bariatric Embolization**

There is currently very little information available on Bariatric Embolization. No information exists in textbook form, and information that is currently available can only be found in very specific areas on the internet such as scientific journals and online articles. These online resources are primarily designed and directed towards researchers and clinicians and as such present a difficult to understand description of the bariatric embolization
procedure for the vast majority of patients considering weight loss procedures. The high level of technical language and a lack of diagrams and visual representations make it even more difficult for the lay person to understand.

**Review of Research in Bariatric Embolization**

Bariatric Embolization has been gaining attention within the medical field and small sector of public media due to its potential for wide use in obesity treatment. Early data on gastric artery embolization was reported in both 2007 and 2008; it was found that weight gain was slowed in swine that underwent embolization when compared to those that had not (Areppally et al 2008). A study performed on dogs in 2012 produced similar results with a decrease in body weight and subcutaneous fat (Bawudun et al 2012). In 2012, similar weight loss results were found at Duke University using porcine models (Paxton, 2013). These four animal studies highlighted the possibility of Bariatric Embolization in treating patients suffering from obesity.

The first human study was performed in Tblisi, Georgia where the procedure was reported to result in 13 kg of weight loss for 5 patients one month after the procedure (Kipshidze, 2013). The first left gastric arterial embolization procedure performed on a patient in the United States was at Dayton Interventional Radiology in collaboration with Ohio State University (Syed, 2014). Currently, beginning clinical trials are underway at Johns Hopkins Hospital in order to understand the viability of the procedure. The exact effects on ghrelin, GLP-1, and the viability of the procedure are yet to be known. However, there is great potential for bariatric embolization to have widespread effects on how obesity is treated.
Why a Digital Visualization?

Because Bariatric Embolization is an emerging procedure, no visual media exist to describe it. Physicians are interested in understanding the details of the procedure and its viability for patients. In addition, patients considering weight loss options would benefit from learning about this procedure; therefore, a strong opportunity for educational media exists.

A vast majority of people use a computer or mobile device when finding medical information online. There are several positive factors for the widespread dissemination of this project. It will be hosted on the Johns Hopkins Hospital website, a frequently viewed site for medical information with a strong reputation within the medical field and a high level of trust within the public sphere. A digital visualization that is the first to visually describe the bariatric embolization procedure will expose a large audience to a resource created by a member of the medical illustration field. The strong emphasis placed on need finding through direct observational studies, interviews, and market research, will ensure that the completed module fulfills the needs of these primary audiences. Evaluating the effectiveness of the module through usability testing has great potential to contribute to the medical illustration field by showing the benefits of a user-centered design approach to interactivity when describing medical procedures.

Audience for the Digital Visualization

Obesity is an epidemic problem in the United States and as such, primary care practitioners including internal medicine physicians, nurses, physician assistants and family care physicians are one primary target audience for these visualizations. This is due to the fact that these are the care givers who patients suffering from obesity would most likely see first before being directed to specialized care providers. Another primary audience is obese patients considering treatment. Families of obese patients can also be looking for information on specific procedures and procedural options. According to preliminary demographic
research, which will be described in more detail in the Methods section, the majority of patients seeking treatment for obesity are women (80%) in Hispanic and African American populations.

**Thesis Objectives**

The main goal of the thesis project was to design an educational digital interactive module (referred to hereafter as the interactive) that provides basic information about how Bariatric Embolization is performed as well as the risks and benefits in order to educate and raise awareness about the procedure for patients and primary care providers. Another goal was to practice use-centered design when creating the interactive. This was achieved using a need finding process including interviews and observational studies of patients and clinicians. These were followed by usability studies and multiple design iterations to produce an end interactive that reflects the needs of the users.
Materials and Methods

Equipment References

The following interventional radiology equipment was used for reference when creating the illustration assets for the interactive: ProtectIV Plus Safety I.V. Catheter. Photos of the Tenor* guidewire, Impress* angiographic catheter, Merit Maestro* micro catheter and other interventional radiology devices were taken as reference for the illustrations.

Software Used for Project Development

Need finding:

• Smart Voice Recorder is a mobile application used for recording audio using a mobile device.

• QDA Miner Lite is a program used for qualitative analysis.

2D asset creation

• Adobe Illustrator CC is a graphic design software program used for creating vector graphics.

• Adobe Photoshop CC is a digital art software program used for creating raster graphics.

Audio

• Blue Yeti Studio USB Microphone for audio recording

• Adobe Audition CC is an audio editing software program.

Interactive design

• Adobe Edge Animate is an application that allows for creation of interactive and web based digital projects using CSS3, HTML5 and Javascript.
Overview of Methods

For this thesis, emphasis was placed on learning and understanding the user-centered design process. Although popularly associated with design in the technology industry, user-centered design is a term describing the attention given to end users or consumers at each stage of the process of building the product, whether it is a service, item, or interface. It is a user and consumer centered philosophy, in comparison to traditional design methodologies in which the user was expected to accommodate to the product. There is an inherent assumption within the user-centered design process that the designer cannot fully understand what the consumer wants or needs unless they work in collaboration. The process that I’ve followed when creating the interactive will be described briefly.

The first stage was to gather background material on the content of the interactive. This included literature review, observing interventional procedures on porcine models and patients in clinical trials, discussing the procedure with Clifford Weiss, MD, and reading about similar procedures in order to understand the general process of arterial embolization.

The second stage was to research the potential users of the interactive. Typically a need finding phase to identify the wants or needs of a user is conducted. However for this project several design constraints had been previously identified by the primary stakeholder. The delivery format was a website, therefore the module would be delivered digitally and used independently as opposed to a print format. The interviews were conducted for the purpose of gaining a better understanding of what specific formats were desired and to understand preferences regarding learning through online resources. Ethnographic research methods such as interviewing users and observational studies were conducted. The purpose was to understand the needs and wants of the user so that the final product was as close to fulfilling those needs as possible.
The findings from the studies mentioned above were collected and qualitatively analyzed in order to identify trends or correlations in terms of user needs and desires. Using the collective data, a prototype of the product was made and shown to users. Usability feedback was received and used to create a more refined product for the final version.

**Defining Content and Scope**

The project content and scope were discussed and identified in consultation with Clifford Weiss, MD. Overall, the interactive was designed to function as an introduction to basic information about bariatric embolization: what it is, how it is done, and expected results. In terms of detailed content, the interactive needed to educate patients on at least these points:

1. One third of Americans are overweight or obese
2. Bariatric embolization helps the patient lose weight by reducing hunger
3. Altering the hormone production and function of the stomach will make the patient less hungry
4. Bariatric embolization is performed by inserting tiny beads into an artery that feeds the stomach
5. One risk factor is that, following bariatric embolization, the patient may not be able to have bariatric surgery.
6. Bariatric embolization is a procedure still undergoing clinical trials

An interactive was needed to educate physicians on at least these points:

1. Bariatric embolization is a minimally invasive, catheter directed, outpatient procedure
2. Bariatric embolization is performed by causing mild ischemic change in the gastric fundus
3. Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying is predicted to cause the loss in weight
4. Bariatric embolization is performed by delivering micro beads into the left gastric artery
5. A possible risk of bariatric embolization is that the patient may not be a candidate for bariatric surgery, at a later date
6. Common side effects of bariatric embolization are pain and vomiting
7. Bariatric embolization is a procedure that is undergoing early clinical trials

**Identifying Project Constraints**

Project constraints were described by Dr. Clifford Weiss. It was determined that the learning module would be hosted on the BEAT Obesity website, and on Dr. Weiss’ lab webpage hosted by Johns Hopkins Hospital. The format was identified as a pop up interactive that appears after clicking on a link on the webpage. Future implementation will be discussed in greater detail with the Johns Hopkins Medicine Technology Innovation Center.

Bariatric embolization clinical trials will not be complete until mid-2015, following the completion of this thesis in March 2015. Therefore, outcomes from the trials can not be incorporated into the interactive.

**Identifying the Target Audience**

There are two primary audiences for this interactive, both equally important. The first audience is composed of primary care clinicians who are interested in the viability of this new weight loss procedure. This group includes primary care and general internal medicine physicians, nurse practitioners and physician assistants.

The other primary audience are obese patients who may benefit from bariatric embolization as an alternative to bariatric surgery. These may be patients who have tried methods such as diet, exercise and medications and have found them to be ineffective. These patients tend to be female, over 40 years of age, and of Hispanic or African American origin.
Patients’ family members, friends and others curious about emerging weight loss procedures are also part of this lay audience. Both audiences can access content specific to their needs from the BEAT Obesity website and the Johns Hopkins Hospital website.

Primary lay audience:

- Obese patients considering weight loss procedures
- Morbidly obese patients considering treatment options (90% of those interested in the bariatric embolization clinical trial study are women)
- Hispanic and African American patients
- Patients who have tried diet or other treatments and have failed to lose weight
- Patients who view obesity as a personal problem of bad choices
- Patients who tend to have cardiovascular issues and type 2 diabetes
- Patients over 40 years of age
- Patients who use online resources to find medical information (61% of the US population)

Primary audience of clinicians:

- Care givers heavily involved in primary care
- Internal medicine physicians
- Primary care physicians
- Physician assistants
- Nurse practitioners
Secondary lay audience:

- Family members of morbidly obese patients
- Friends of morbidly obese patients

Secondary audience of clinicians:

- Specialty clinicians who are more involved in weight loss procedures compared to other specialties
- Endocrinologists
- Cardiologists
- Gastroenterologists
- Dieticians and nutritionists
- Interventional radiologists
- Medical students

**Interviewing Patients and Clinicians**

Clinicians and patients were interviewed. The goal of the interviews was to learn user preferences regarding educational material to learn about new medical procedures. Potential clinicians to be interviewed included interventional radiologists, primary physicians, internal medicine physicians, gastroenterologists and pediatric physicians. Lay audience members who were identified to be interviewed included obese patients, and their family and friends.

The interviews were conducted either over the phone or in person, and were generally kept to a maximum of half an hour. The purpose of the interactive was introduced at the onset of the interview. The interviewer verbally asked 10 questions (the questionnaire is included in appendix 2). The questionnaire contained questions asking where the participant finds their medical information, what mode or media they prefer when viewing medical
information, and what specific information about procedures were most important to them. Responses to these questions helped determine the visual style of the project and the order the information was presented in the interactive.

The interview findings are discussed in detail in the Results section. The clinician interview subjects included: Dr. Tara Hebert (internal medicine) at the East Baltimore medical center, Dr. Kimberley Steele (general surgery) at the Hopkins Bayview Medical Center and Dr. Larry Cheskin (internal medicine) at the Center for Weight Management at Johns Hopkins Hospital.

Seven non-clinicians were interviewed in order to gain a better understanding of what the general patient lay audience may need in an educational interactive. This group included obese patients, students at the Johns Hopkins School of Medicine, and other graduate students not associated with the School of Medicine. Due to scheduling limitations, two patients were interviewed in total; other non-clinicians were recruited as alternatives to patients. These interview findings are discussed in detail in the Results section.

**Thematic Coding**

Thematic coding, or thematic analysis of written interviews, is the process of assigning “codes” or terms to specific lines or phrases of text in order to analyze and categorize the responses. For example, if an interviewee mentioned that they enjoy listening to podcasts when learning about new material, then that part of the interview may be coded as “learns from audio” which may indicate that audio narration should be considered for the digital interactive. Thematic analysis was conducted on nine of the interviews. Five of these were audio recorded and transcribed. Four of the interviews were recorded by written notes. These interviews were imported into QDA Miner Lite, a qualitative analysis program (Fig. 2).
Figure 2. The main screen of the QDA Miner Lite program

Once “codes” were assigned to all text, the frequency of the codes was viewed by selecting Analyze > Coding Frequency… > Search. This produced a Coding Frequency window which listed the codes by the number of times each code appears (Fig. 3). This method was used to identify the top expectations and desires of the target audience regarding learning about an unfamiliar procedure to treat obesity. These results are described in more detail in the Results section.
Observational Studies of Clinician-Patient Interaction

Observational studies are used in user-centered design to gain further insight into target users by observing their actions in the context of a specific activity. These observations aid designers in learning about user concerns and mental models. For this thesis, clinician-patient interaction was observed to gain better understanding of patient needs when learning about a new procedure. There are several methods of gaining qualitative observational data. The method employed for this project is referred to as the “fly-on-the-wall” method. The individual performing the research study observes actions of the participants while taking relevant notes and without interacting with them.

Two patient screenings were observed. One was in the Interventional Radiology department of the Johns Hopkins Hospital; an additional one was observed in the Bloomberg Childrens Center of Johns Hopkins Hospital. The goal of these patient screenings...
was to identify participants for the bariatric embolization clinical trials, and as such, the procedure and the clinical study were described to them by the physician. Their voluntary participation in the clinical trial was requested. The patient screenings were conducted in person, with the patient and doctor within the same room. I observed from the corner of the room while taking written notes to gain a better understanding of the screening process.

The other learning environment I observed was a one hour informational session on bariatric surgery presented by Dr. Kimberley Steele, a general surgeon specializing in bariatric surgery at the Johns Hopkins Bayview Medical Center. In the informational session Dr. Steele described the three most common types of bariatric surgery to an audience of five obese patients considering bariatric surgery. Taking notes on the questions asked by the participants highlighted and clarified the concerns of the patients. Noting the order of information presented by Dr. Steele provided an understanding of one organizational method of teaching the essentials of a particular procedure. I was able to observe which points were emphasized by the presenter. This gave a better understanding of what topics physicians are concerned about conveying to obese patients who are considering weight loss procedures. Impressions taken from these observational studies are described in more detail in the Results section.

**Viewing Embolization Procedures**

Several bariatric embolization procedures were observed in order to gain full understanding of the technical aspects of the procedure. Two bariatric embolization procedures performed on swine were viewed in the laboratory. One bariatric embolization procedure performed on a patient as part of the clinical trials was viewed at the Johns Hopkins Hospital. Bariatric embolization can be performed using either femoral artery or radial artery access. The three procedures I observed used femoral artery access.
Creating the Script for Narration

A five minute narration was developed. The script for the narration (Appendix 1) was written based on background reading, observation of procedures, feedback from the patient and clinician interviews, as well as speaking to the primary stakeholder of the project, Clifford Weiss, MD. The script underwent multiple iterations and edits based on feedback from the advisor of the project, Corinne Sandone, and the preceptor, Dr. Weiss.

Preparing Audio

Audio was recorded using a Blue Yeti Studio USB Microphone and Adobe Audition Creative Cloud (CC) (Fig. 4). 44000 Hz and 32 bitrate files were saved as WAV files. Each informational section of the interactive was recorded as a separate audio file. After all audio had been recorded, the files were edited in Adobe Audition CC before they were imported into Adobe Edge CC.

Figure 4. Screenshot of the main document window of Adobe Audition CC. The text in this image is not intended to be read
Noise reduction was accomplished by selecting an area of the audio which was as noiseless as possible, then selecting Effects > Noise Reduction/Restoration > Capture Noise Print. (Fig. 5)

Figure 5. Screenshot of the Noise Reduction menu and Capture Noise Print option
The Captured Noise Print function was used to reduce the noise in the overall audio file by selecting the entire timeline, then selecting Effects > Noise Reduction/Restoration > Noise Reduction (process). This process ensured clear sound in the audio narration. (Fig. 6)

Figure 6. Screenshot of Noise Reduction menu and Noise Reduction option
A Noise Reduction window appeared and the reduction was applied by clicking “Apply”. (Fig. 7)

![Noise Reduction Effect window](image)

Figure 7. Screenshot of the Noise Reduction Effect window. Not all text in this screenshot is intended to be legible.

The audio for import was then amplified by selecting Effects > Amplitude and Compression > Amplify (Fig. 8).
Once the Effect – Amplify pop up window appeared, a value of 15 dB was entered into the Left and Right Gain to increase audio volume.

The echo in the audio recording was reduced by first selecting Effects > Special > Mastering. This opened the Effect Mastering window where a variety of audio components relating to sound quality could be custom edited. The following settings were used: Reverb
amount at 0%, Exciter amount at 0%, Widener amount at 0%, Loudness Maximizer at 0% and Output Gain amount at -8 dB. The Low Shelf Enable was set at 110 Hz -2.2 dB and 6.1 Q. The High Shelf Enable was set at 4200 Hz, -1.1 dB and 4.1 Q (Fig. 9).

Figure 9. Screenshot of the Effect Mastering panel. The text in this image is not intended to be read. Refer to the thesis text.

The final edited audio was saved in a smaller format as a 24000 Hz 64 Kbps 32-bit mp3 audio file.

**Illustration Assets for Animation**

The contour drawings for the illustration assets used as the main visuals within the interactive were all produced using Adobe Illustrator. The contours were imported into Adobe Photoshop CC and saved as web assets in PNG-24 file type to minimize file size.
Three different color palette choices were developed using Adobe Color, an online application that provides collections of color schemes for web use. These three different color palettes were shown to patients, non-clinicians, and clinicians in order to assess which was the most aesthetically pleasing. By the end of the first usability viewing session, the following was found to be the most popular choice. The relevant hex colors are: #05be0 (blue), cafcd7 (light blue), f7e867 (yellow), a9cf55 (light green), and 588f27 (dark green) (Fig. 10).

![Color Palette](image)

Figure 10. The color palette selected for the interactive

**Producing the First Prototype of the Bariatric Embolization Interactive**

Responsive design is a feature that allows users to view content on tablets, computers and mobile devices dynamically resizing the material to fit the layout and screen size. The first step in creating the interactive was to make it display responsive design. This was done by enabling the responsive scaling option within Adobe Edge Animate CC, found within the main document window (Fig. 11).
The first prototype was organized into 12 separate Adobe Edge CC composition files to reduce file size for quick load time. Each composition was created individually within Adobe Edge CC and represented a different section of information. For example, the section explaining the bariatric embolization procedure was its own composition, as was the portion explaining the risks of the procedure. This allowed each of the different composition files to be loaded as the user explored through the interactive, reducing the initial wait time for the interactive to load.
The interactive is designed for two audiences, as previously described. The branching for these audiences is from the home page, as depicted in the flow chart (Fig. 12).

![Flowchart of the first prototype depicting branching for patient and clinician users](image)

Figure 12. Flowchart of the first prototype depicting branching for patient and clinician users

From the intro screen, the user selects “Patient” or “Doctor”; the respective patient or doctor section appears for the user (Fig. 13). These sections are written at two different levels. The patient section was designed for a 9th to 10th grade reading level and uses lay terms. The narration for the clinician users assumed a higher level of familiarity with medical
terminology and provides greater detail on the hormonal processes and on aspects of the Interventional Radiology procedure. The bariatric surgery section was not included. Both user groups have the option to click unfamiliar medical terms to provide a definition of the term.

![Intro to Bariatric Embolization](image)

Figure 13. Screenshot showing the intro screen of the first prototype of the interactive

Edge Commons was used to set up this function. Edge Commons is an extension library for performing extra tasks within Adobe Edge Animate CC. The Edge Commons zip package was downloaded from the Edge Docks website. This file was then loaded into the scripts by clicking on the “+” icon in the scripts panel of the Adobe Edge Animate library. Then “Add JS file from disk…” was selected, and the Edge Commons file was selected (Fig. 14).
Figure 14. Screenshot of “Add JS File from Disk...” selection

With Edge Commons loaded, other compositions could then be loaded below the primary navigation if coded to do so. A symbol (content area) was coded to load content when specific elements in the primary navigation bar were clicked (Fig. 15).

Figure 15. Screenshot of the script used in Adobe Edge CC to load a composition file

Each element in the primary navigation, located on the top of the composition, loads a new composition below the primary navigation area when clicked. For example, the “Bariatric Surgeries” section was an independent composition, as was the “Procedure” section. This way, when the user clicked on one of the primary navigation items along the top, the Edge composition relating to that element would load in the large space below the primary navigation (Fig. 16).
Gastric sleeve surgery is a restrictive surgery. The stomach size is made smaller by removing more than half of the stomach. This is the most common bariatric surgery. Some risks are malnutrition, leaking from the stomach, and pain in the esophagus.

Figure 16. Screenshot depicting the area where compositions load upon user interaction with primary navigation items

After this initial setup, each of the primary navigation compositions were developed individually. For each composition, there were some constant elements. All compositions had a progress bar showing how much time was left in the animation, a sound toggling button to turn off/on audio, a play/pause button, and number buttons that would bring the user to particular sections of the animation when clicked (Fig. 17).
The sound button was coded so that when the “sound” symbol appears the audio is playing, and when the “mute” symbol appeared, the audio narration is paused in the composition. This was done by coding an “if else” statement onto a button that was on top of the sound assets (Fig. 18).
The play/pause button was coded so that when the “play” button appears the animation and audio are both playing. When the “pause” button appears the animation and audio are both paused. This was coded using an “if then” statement which was coded to be activated “on click” when the user interacted with the play/pause button (Fig. 19).
Figure 19. Screenshot of the script used in Adobe Edge CC to play/pause the animation

There are various points in the interactive where certain elements can be clicked on to reveal more information, for example, the definition of a medical term. This function was created by making an invisible button (symbol) directly over the area to be interacted with. A trigger was added in the timeline so that the interactive button appears only when specific points in the timeline are passed (Fig. 20).
The interactivity is indicated by a blue glow, signifying to the user that this element can be clicked. When the user clicks on the element, a separate pop up window appears with extra information such as the word or phrase that may be unfamiliar to the user viewing the interactive. This was coded using the basic .show and .hide functions.

Once the information in the pop up window is viewed, clicking anywhere on the screen returns the user to the animation. This was coded using a .hide function to activate on click.

**Jumping to Unique Points in the Timeline**

The jump to unique points in the timeline was coded by placing an invisible button over each circled number asset on the navigational bar. When a user clicks one of the numbers, they are taken to the corresponding point in the animation timeline. This was done by creating an “on click” code that specified what part of the timeline the user is to be taken to, and the video and audio would continue playing from that point onwards (Fig. 21).
After the first prototype was completed, the next step in the user-centered design process was to have users view the product and provide feedback in terms of usability and knowledge retention.

**Understanding Usability Testing in Interactive Design**

Several books were reviewed in order to gain a better understanding of the basics of usability testing and its place within designing interactive products. These included *A Practical Guide to Usability Testing* (Dumas, 1999), *Rocket Surgery Made Easy* (Krug, 2009), *Designing Interactions* (Moggridge, 2007), *The Elements of User Experience* (Garrett, 2010), *The Design of Everyday Things* (Norman, 2013) and *A Project Guide to UX Design* (Unger, 2012).

Recognizing the limitations of interactive design instruction within the Johns Hopkins University School of Medicine, interactive design departments of local universities were explored. Faculty in these programs were consulted on creating questionnaires for conducting usability testing. Faculty contacted include: Dr. Kathryn Summers and Dr. Greg Walsh of the Information Arts and Technologies department of the University of Baltimore; and Andres Zapata, MA, an interactive design professor at the Maryland Institute College of Art. Mr. Zapata conducted a four hour professional usability test performed by a Baltimore based design studio. I observed this test to understand how data was recorded, how the interview questions were asked to participants, and the methods document that was used when conducting the study.

The first usability study of the interactive developed for this thesis was conducted in the University of Baltimore usability lab in order to gain practice in conducting the study. An interaction design graduate student provided feedback on how my methods could be improved in terms of script language, directions given to participants, and the questionnaire.
Usability Test of the Bariatric Embolization Digital Interactive

A questionnaire was created in order to assess the effectiveness of the prototype of the bariatric embolization interactive. One questionnaire for clinicians was created. A separate questionnaire for a lay audience was created. A pre-view (before the user has seen the interactive) questionnaire and a post-view questionnaire (after the user has viewed the interactive) were created for each group. A total of four separate questionnaires were produced. The aim of the usability study was to assess two factors: the general knowledge imparted to users through the interactive, and the ease of use of the interactive.

An overview of the 30 minute usability and viewing session was the following: the participant was given the two page pre-viewing questionnaire to fill out. Upon completion of the questionnaire, participants were shown three different color mockups of the intro screen. They were asked to indicate a color palette preference. Participants were shown two different interfaces for the digital interactive and asked to indicate a preference. Then, they were shown the full interactive using a laptop. The participants were instructed to go through the interactive from start to finish and to explore further if they so desired. While this was occurring, I took notes recording observations of areas they found interesting or confusing, sections returned to for further exploration, use of the interactive elements and verbal feedback.

After participants completed exploring the interactive, I asked open ended questions to gain further feedback. These included broad questions such as, “What did you like or dislike about the interactive?” or “What did you think about the visuals in the interactive?” Participants then filled out a post-viewing questionnaire which had the same knowledge based questions as the pre-viewing questionnaire. This was used to evaluate knowledge retention. The post-viewing questionnaire also included usability related questions such as ease of use of the interactive, ease of language, and opinion on the total length. The
participant was thanked for their time, completing the usability session. A more detailed version of the usability study method used is found in the methods document, provided in the Appendix (Appendix 3).

**Producing the Second Prototype of the Interactive**

Based on analysis of the usability and viewing sessions, several design modifications were made. The second iteration of the bariatric embolization educational digital interactive was considered the final version of the interactive, for the purpose of this thesis.

For the second iteration, the interface was modified. Each section of the interactive was split into several other steps in the script (Fig. 22). The information was cut into smaller sections which could be viewed individually by clicking on the respective number elements (Fig. 23).
Figure 22. Flowchart of the second iteration of the interactive
Figure 23. Screenshot of the interface of the second iteration of the interactive

The assets within the Adobe Edge composition were reorganized to accommodate this change. The timeline was divided into different subsections. When a user clicked a circled number in the interactive, they would be taken to that section of the timeline which would then start playing the animation and audio narration. A stop trigger was placed before the start of each subsection of the timeline so that when a subsection finished playing, it would not automatically start playing the next subsection. This allowed the user more control on the pacing, providing opportunity to replay or skip sections of the interactive.

The primary navigation was designed to change color on user mouse over, signifying to the user that it could be interacted with. For example, while in the Intro section, the label for Bariatric Surgeries, the next section in the primary navigation would start glowing to
indicate to the user where to click next to continue through the interactive. This same logic was applied to the circled numbers so that the user would intuitively understand where to click, without having to read instructions.

Based on user feedback, the illustration assets were further refined and more color was added using Adobe Photoshop CC. The animation was refined and more subtle movement was added for viewer interest. The script was rewritten based on feedback received from patients and physicians, especially in the Risk section. The risks were organized by importance and likelihood of occurrence. The script was rerecorded using Adobe Audition CC and refined using the steps described earlier. A “home” button to bring users back to the main screen was added on the bottom right area of the interface.

A second round of viewing sessions to gain additional feedback on usability was not able to be completed within the scope of the thesis.
Results

Final Design

The final design was an interactive that was split into two 5 minute long pathways: the patient pathway and the clinician pathway. A primary difference was that the patient pathway used a greater number of lay audience terms. The patient and clinician pathways had six different sections of information relating to bariatric embolization: Intro, Bariatric Surgeries, Why Bariatric Embolization, Procedure, Risk, and Outcome. The Intro section gave a brief overview of the obesity problem within the United States. The Bariatric Surgeries section provided an overview of the three most common procedures. The Why Bariatric Embolization section provided a brief introduction to the concept of bariatric embolization. The Procedure section gave an illustrated overview of the procedural steps involved in bariatric embolization. The Risk section provided information on the risks associated with bariatric embolization. Lastly, the Outcome section described information on the expected benefits and results of bariatric embolization. The information in each of these sections were split into smaller subsections that could be accessed by clicking the circled numbers at the bottom of the interactive (Fig. 24). The Intro section had three subsections, Bariatric Surgeries had four, Why Bariatric Embolization had two, Procedure had 10, Risks had five and Outcome had two. The clinician pathway Procedure subsection had an additional element describing use of an alternate vessel for embolization.
The bariatric arterial embolization procedure takes about 1-2 hours. During the procedure, the patient is sedated and lying on their back on an x-ray fluoroscopy table.

1-2 hours

Within the entire interactive, there were various instances where users could click on and interact with medical terminology to access a definition. The interactivity was signified to the user through use of a purple glow. For example, in the patient pathway, Bariatric Surgeries section, a user could click on the purple glowing term “Gastric Leaking” to view a pop up that explains its definition (Fig. 25, Fig. 26). In terms of interactivity, the patient section had 14 instances where the user could interact with a word on the screen to view the definition. The clinician pathway had seven instances where the user could interact with a word on the screen to view the definition.
Figure 25. Screenshot showing a purple interactive element over a medical term (gastric leaking). The text in this image is not intended to be read.

Figure 26. Screenshot showing a pop up window explaining the medical term
Results of Need Finding

Seven non-clinicians were interviewed in the process of need finding. Primary concerns for this audience were understanding how a procedure was performed and its associated risks and benefits. Almost all non-clinicians interviewed would use the internet to find health information. In terms of media accessed from the interactive, most looked up text and visuals but would rarely look up animations. When using an interactive, non-clinicians indicated a desire to be able to manipulate the interactive in terms of speed and ability to jump to different points of information.

Three clinicians were interviewed in the need finding phase. The overwhelming primary concern for clinicians was understanding the risks of a given procedure: how much research had been conducted, and the efficacy and reliability of the procedure, particularly for an emerging procedure. In terms of looking up information on medical procedures, clinicians in this group described performing quick searches on the internet to find information through websites, but rarely searching for animations or videos. There was a large emphasis on the constraint of time, and all three responded that they would not view any module that took more than 5 to 10 minutes of their time.

The observational studies consisted of two screening interviews conducted by Dr. Weiss, and one group information session led by Dr. Steele. The screening session was the first time a patient spoke directly to a physician about bariatric embolization. One surprising finding was the lack of questions posed by many of the patients in both the screenings and group informational session. Some patients appeared disinterested. For example, an audience member was observed falling asleep during the group informational session. A notable observation from the group informational presentation: the presenter heavily emphasized and repeated the idea of patient compliance and the risks involved with undergoing any of the bariatric surgeries. She spoke slower in these sections to emphasize the importance of this content.
The thematic coding exercise using information collected from interviews with three clinicians and six non-clinicians produced several important observations. The top priority for the users, as a whole, was their interest in learning about how the procedure was performed. There was high interest in being able to manipulate material in the interactive, and in the authenticity of information presented. Users were also interested in the outcomes following a procedure and the risks involved, in that order. In terms of media use, most learned from illustrations, videos, and then animations, in that order when searching for medical information online. None of the participants interviewed used books for exploring information on medical procedures.

Results of the Usability Test for Prototype 1

Pre- and post-viewing questionnaires provided a general idea of the educational effectiveness of the interactive. Self reported understanding of the material was indicated by the user on a Likert scale (5 indicated very good understanding; 4 indicated good understanding; 3 indicated understand it somewhat; 2 indicated little understanding; 1 indicated no understanding). Averages of subjective understanding were measured by adding up responses and dividing by the total number of users. For example, if two users answered “very good understanding” for the question “what is your current understanding of bariatric embolization?”, this would be $2 \times 5 = 10$ and so on. The total points were then divided by the number of users who answered the question, resulting in a average response. Some key findings are presented here:

- The majority of participants (8 out of 10) reported using a computer as a main device as opposed to a tablet or mobile device.
- For non-clinicians, subjective (self reported) understanding of bariatric embolization increased from an average of 2.7 (understand it somewhat), to 4.3 (good understanding).
• For non-clinicians, the number of knowledge based questions answered correctly increased from an average of 3.4/6 correct to 5/6 correct after viewing the interactive.

• Many users (4/10) chose the incorrect answer for the question “what is a possible risk of bariatric embolization?” in the post-viewing questionnaire.

• Understanding the text, images, and completing the module was rated “easy” by all users.

• The length of the module was rated “satisfactory” by all users.

Nine users were asked to vote for a preferred color palette. The following are the three color palettes that were presented, and the respective votes received for each (Fig. 27, Fig. 28, Fig. 29).

![Figure 27. Color palette choice 1, received 4 votes total](image)

![Figure 28. Color palette choice 2, received 2 votes total, including some comments that the palette felt “uncomfortable”](image)

![Figure 29. Color palette choice 3, received 3 votes total](image)
Two different interface designs were shown to users, both described in the Methods section. The first interface had each section of information as one continuous animation. In the second interface each section was further split into smaller subsections of information. Of these two options, two users preferred the first interface, and four users preferred the second interface. Two of these votes includes qualitative viewings from classmates.

Observational notes were taken while presenting the prototype of the interactive to the users. These revealed that almost all the users became confused at the end of the Intro section. They were unsure about how to continue to the next section. Many continued pressing the play button or the circled number buttons before trying anything else. A purple glow over the primary navigation tab for the next section was added to address this. Most users did not click on the interactive medical vocabulary, indicating they were unaware of the interactivity. When users did discover that vocabulary could be interacted with, they did click on them, but often were frustrated with how quickly the interaction opportunity would disappear. This was addressed by having the interaction opportunity remain on the screen until the user chose to go to the next section.

Significant direct feedback on the prototype of the interactive was collected from both non-clinician and clinician user groups. Recurring challenges were reported. Both groups spent time on the Intro screen trying to click the patient and doctor silhouettes, believing that they were interactive. To address this, the silhouettes were made to be clicked to enter the respective patient or clinician pathways. The spacing of the circled numbers confused users because it was not apparent that this system was referring to relative points in the timeline. Some viewers did not recognize the circled numbers to be functional buttons. Both these issues were addressed when the animation progress bar was removed.

In terms of content, the Risk section was overwhelming at times due to the amount of information being presented. This was addressed by allowing the user to go through the information at their own pace by not having the information be one continuous animation. A desire for more aesthetically pleasing visuals and animations was indicated by users. This
was addressed by improving the illustrations through adding color and further detail. Many enjoyed the addition of audio narration and very rarely did anyone try turning off the sound. Many clinicians mentioned that most medical professionals would not know what the hormones GLP1 and ghrelin were unless they were specialists, so interactive opportunities were added for those vocabulary in the clinicians pathway. A home button was desired by many participants so that they could return to the alternate pathway at any point when using the interactive. This was added in the bottom right corner of the interactive. Non-clinician users and especially clinicians, stated that they would have preferred more information on how much research had been done and how many patients had undergone the bariatric embolization procedure at this point in time. An extra section on research will be added to the clinician section. A second usability test was not conducted due to time constraints.

The interactive will be embedded into the BEAT Obesity website in the near future, and a link to the interactive will be provided on the Johns Hopkins Hospital Interventional Radiology department page.
Discussion

Need Finding Limitations and Future Considerations

Need finding is conducted to gather information on where to focus the design solution. The level of need finding success is related to the ease of access to observational opportunities and interview subjects. Ideally, the primary audience interviewed in the need finding process were obese patients considering bariatric embolization, and clinicians. The patient pool available for need findings interviews were primarily the five patients enrolled in Dr. Weiss’s clinical trials for the bariatric embolization study. One challenge from the beginning of the project was the difficulty in talking to patients due to scheduling problems. Patients would often cancel or change appointments. In order to obtain more qualitative data, other members of the lay audience such as neighbors and classmates were interviewed. In future projects it may be helpful to expand the initial pool of interviewees by setting less stringent limitations. Instead of focusing solely on interviewing patients interested in bariatric embolization, other patients could be interviewed, such as those considering bariatric surgeries. This would aid in gathering a greater amount of qualitative data on where to focus the design. The clinician audience gave highly detailed feedback. A significant portion of their feedback was focused on how the interactive could look for patients. In future projects it may be helpful to emphasize that the primary information needed by clinicians themselves in an educational interactive is valid feedback.

The first interviews were more difficult to conduct due to lack of familiarity with the process. One challenge for the beginning interviews was maintaining consistency in the questions asked. This lack of consistency made the data collected from the initial interviewees potentially unreliable. In future projects, a consistent list of questions should be asked of all interviewees. Greater explanation and more background should be given to the interviewees.
in terms of why questions are being asked. This will give interviewees a better understanding of what type of information is being requested from them and should reduce the frequency of one word responses; these are too direct to be of much use in guiding the project.

**Usability Test Limitations and Future Considerations**

A primary goal of the usability test was to determine if users gained improvement in knowledge of bariatric embolization after viewing the interactive. However, in the patient group the interactive was shown to, all had researched and learned a great deal about bariatric embolization beforehand, either through self-research or through speaking with Dr. Weiss. This made it difficult to assess differences in knowledge before and after viewing the interactive. For future projects it would be useful to show the interactive to patients before they have a screening session with their physician about the procedure. This will allow better assessment of the effectiveness of the interactive as a teaching tool.

In the process of observing non-clinicians explore the interactive, there were instances where visible and audible reactions were given by the test provider based on interviewee responses to the interactive. Reactions by the test provider should be kept to a minimum in order to prevent bias of the user towards the interactive.
Future Applications for the Bariatric Embolization Interactive

The bariatric embolization interactive that has been designed for this thesis could undergo further development. One such development is embedding the interactive within a website focused on bariatric embolization. More responsive design could be developed to allow viewing of the interactive on smaller devices such as mobile phones. Currently, it is responsive and readable from average monitor sizes down to ipad size dimensions. Results from the clinical trials could be incorporated into the Outcome section of the interactive. The design of this interactive module could serve as a model for other educational modules on different medical procedures.
Conclusion

The Bariatric Embolization interactive module is currently the most expansive visualization of the bariatric embolization procedure available. It is based on the most recent research of one of the leading experts in bariatric embolization, Dr. Clifford Weiss, as well as from viewing the procedure performed on human and animal models. The creation of the interactive involved a user centered design approach including observational interviews, user testing and an iterative development process.

The Bariatric Embolization interactive is a resource for patients who may be interested in an alternative weight loss procedure. It is a resource for clinicians who may be unfamiliar with the procedure. The Outcomes section of the interactive is ready to be populated with data and information from the clinical trials of the bariatric embolization procedure. The interactive will be easy to access; it will be embedded within the BEAT Obesity website, as well as linked to the Johns Hopkins Interventional Radiology website.
Appendix 1

**Patient Script** used for second iteration of the interactive

The numbers refer to the subsections

( ) = exploratory information that appears in the module with user interaction.

Intro section

1. Obesity is a serious problem in the United States. 1/3 of Americans are overweight or obese and that number is increasing. It is expected that by 2030, more than 42% of Americans will be obese.

2. The primary and most non-invasive treatment for obesity is still diet, regular exercise and working closely with a counselor to help lose weight.

3. The most invasive method is surgery, which is reserved for patients who cannot lose weight through other means. At this point in time, there are 3 bariatric surgeries that are widely performed in the US.

Intro on bariatric surgeries section

1. Gastric sleeve surgery is a restrictive surgery. The stomach size is made smaller by removing more than half of the stomach. This is the most common bariatric surgery. Some risks are malnutrition, gastric leaking, and pain in the esophagus. (Gastric leaking is when an opening along the stapled portion of the stomach allows food to leak into the body cavity. This is a serious complication and occurs in 1-5% of patients who undergo gastric sleeve surgery.)

2. In gastric banding surgery, the upper part of the stomach is tightened by an inflatable
band to limit the amount of food that can be eaten. Some of the risks are gastritis, scarring, infection, and gastric band erosion through the stomach. (Gastritis is when the lining of the stomach becomes swollen or inflamed. This is typically caused by infection, too much alcohol use, stress, or certain medications. Gastric band erosion is when the band wears away the stomach at the area it is placed, which may result in ulcer or infection.)

3. In Roux-en-y gastric bypass surgery a small stomach pouch is made, then connected to the small intestine. Some possible risks are gastric dumping, malnutrition, vitamin and protein deficiencies, and production of stones in the kidney or gall bladder. (Gastric dumping is when undigested food in the stomach moves too quickly to the small intestines, resulting in nausea, vomiting, or diarrhea.)

4. Still under clinical trials, Bariatric Arterial Embolization is a minimally invasive treatment for obesity that is an alternative to surgery.

Intro to Bariatric Embolization

1. A new weight loss procedure called Bariatric Embolization (BAE) has been developed at Johns Hopkins Hospital. It is a non-surgical, minimally invasive, outpatient procedure. (An outpatient procedure is one where a patient does not have to stay at the hospital overnight.)

2. It may help with weight loss by changing the hormone production and function of the stomach so that you feel less hungry. It may cause a decrease in ghrelin, a hormone known to increase hunger. Although the effects of hormones on obesity are not well understood, Bariatric Embolization may reduce ghrelin by making changes to the fundus of the stomach. (Ghrelin is the only known hormone that makes you feel hungry. Most of the ghrelin is produced in the gastric fundus. Levels rise before meals and when dieting. Ghrelin levels fall less than an hour after eating. The fundus is the upper part of the stomach where 90% of the ghrelin hormone is made.)
Bariatric Embolization procedure

1. The Bariatric Arterial Embolization procedure takes about 1-2 hours. During the procedure, the patient is sedated and lying on their back on an x-ray fluoroscopy table.

2. Local anesthesia (similar to novocaine) is used to numb the area where the catheter will be inserted. Either the femoral artery in the groin or the radial artery in the wrist is entered by going through the skin.

3. The catheter is moved up the aorta and into the celiac artery.

4. Digital subtraction angiography is used to visualize this artery to map out blood vessels that supply the stomach, liver, pancreas and spleen. (In digital subtraction angiography blood vessels are visualized by inserting contrast through the catheter and into vessels. The fluoroscopy camera takes pictures of contrast and provides the doctors with real-time images of the procedure)

5. A smaller catheter is directed into the arteries that supply the fundus of the stomach. (The fundus is the upper part of the stomach where most of the ghrelin hormone is made.)

6. Branches of this artery are blocked by using tiny particles. This is called “embolization”.

   This decreases the blood flow to cells in the fundus which make ghrelin, a hormone that makes you feel hungry. After blockage, ghrelin production may go down and a different hormone: GLP-1, may go up. (These tiny particles, called Embosphere™ microspheres, are the most studied type of microspheres. They are microscopic in size and are routinely used in other procedures. GLP-1 is a hormone that provides the signal that makes you feel full. Most of it originates from the intestines.)

7. More images are made to check how much of the fundus’ blood supply has been blocked.

8. The catheter is then removed and pressure is applied to the skin where the catheter was inserted, either the groin or the wrist.

9. If the artery in the groin was used, a patient has to lie flat for up to 4 hours in the recovery
room after the procedure. If the artery in the wrist was used, a patient must wear a radial compression wristband for 1 to 2 hours. Patients go home after the recovery period, the same day as the procedure. Patients should avoid significant exertion for 48 hours. (A radial compression wristband is a device that places direct pressure on the artery in your wrist until bleeding has completely stopped.)

10. A patient may be asked to take medications to protect the stomach. For 2 weeks before the procedure, and 6 weeks after, a patient could possibly take a daily oral proton pump inhibitor and a daily oral cytoprotective agent. (Proton pump inhibitors are medication that reduce the production of acid in the stomach and are frequently used to treat ulcers and Gastroesophageal reflux disease (GERD). Omeprazole is a commonly used proton pump inhibitor. Cytoprotective agents are medication that prevent ulcers by coating and protecting the stomach lining from irritation. Sucralfate is a commonly used cytoprotective agent.)

Risks of Bariatric Embolization

1. Due to changes in blood flow to the stomach, some patients may experience nausea, vomiting, and abdominal pain immediately after Bariatric Embolization. Because of this, the doctor will prescribe a specific diet to reintroduce your stomach to food. In comparison to bariatric surgeries, malnutrition is not a serious concern following Bariatric Embolization.

2. Common risks of arterial intervention include bleeding, allergic reaction to contrast, and temporary pain at the site where the vessel is accessed.

3. In animal studies, gastritis and ulceration occurred about 40% of the time. However these symptoms have not been observed in patients thus far. (Gastritis is when the lining of the stomach becomes swollen or inflamed. This is typically caused by infection, too much alcohol use, stress, or certain medications.)

4. It is possible that a small number of particles may lodge into areas outside the targeted
area; this is referred to as non-target embolization. However the chances of this occurring are very low due to careful technique including highly selective and gradual embolization of the left gastric artery.

5. The ability to have future gastric bypass surgery after Bariatric Arterial Embolization is unknown.

Results of Bariatric Embolization

1. Overall, patients are expected to lose about 20% of their total weight within 6 months after the procedure. Weight loss is made easier by Bariatric Embolization, but an important part of long term treatment is following lifestyle changes such as diet, regular exercise and working closely with a counselor.

2. Again, this is an alternative procedure that is still undergoing early clinical trials. The long term effects are still unknown, and are being studied.

Clinician script used for the second iteration of the interactive

( ) = exploratory information that appears in the module with user interaction.

Intro section

1. Obesity is a serious problem in the United States. 1/3 of Americans are overweight or obese. It is expected that by 2030, more than 42% of Americans will be obese.

2. The primary and most non-invasive treatment for obesity is still diet, regular exercise and working closely with a counselor to help lose weight.

3. The most invasive method is surgery, reserved for patients who cannot lose weight through other means.
Intro on bariatric surgeries section

1. Gastric sleeve surgery is a restrictive surgery. The stomach size is made smaller by removing more than half of the stomach. This is the most common bariatric surgery. Some risks are malnutrition, gastric leaking, and pain in the esophagus. (Gastric leaking is when an opening along the stapled portion of the stomach allows food to leak into the body cavity. This is a serious complication and occurs in 1-5% of patients who undergo gastric sleeve surgery.)

2. In gastric banding surgery, the upper part of the stomach is tightened by an inflatable

Intro to Bariatric Embolization

1. A new weight loss procedure called Bariatric Embolization (BAE) is being developed at Johns Hopkins Hospital. It may help induce weight loss by changing hormonal and mechanical function in the stomach by causing mild ischemic change in the gastric fundus.

2. Bariatric Embolization is a minimally invasive catheter directed outpatient procedure, currently in clinical trials. Its effect on appetite-driving gut hormones of obesity are not well understood. However it may cause a decrease in ghrelin and an increase in GLP-1. (Ghrelin is the only known orexigenic hormone. An orexigenic is a compound, drug, or hormone that can increase appetite. 90% of the ghrelin is produced in the gastric fundus. Levels rise before meals and when dieting. Ghrelin levels fall less than an hour after eating. GLP-1 is a hormone that provides the satiety signal and stimulates insulin secretion.)

band to limit the amount of food that can be eaten. Some of the risks are gastritis, scarring, infection, and gastric band erosion through the stomach. (Gastritis is when the lining of the stomach becomes swollen or inflamed. This is typically caused by infection, too much alcohol use, stress, or certain medications. Gastric band erosion is when the band wears away the stomach at the area it is placed, which may result in ulcer or infection.)

3. In Roux-en-y gastric bypass surgery a small stomach pouch is made, then connected to the
small intestine. Some possible risks are gastric dumping, malnutrition, vitamin and protein deficiencies, and production of stones in the kidney or gall bladder. (Gastric dumping is when undigested food in the stomach moves too quickly to the small intestines, resulting in nausea, vomiting, or diarrhea.)

4. Still under clinical trials, Bariatric Arterial Embolization is a minimally invasive treatment for obesity that is an alternative to surgery.

Bariatric Embolization procedure

1. The Bariatric Arterial Embolization procedure takes about 1-2 hours. The procedure is performed with the patient sedated and placed on an x-ray fluoroscopy table.

2. Local anesthesia is applied to the skin where the catheter will be inserted.

   Either the femoral or radial artery is entered via percutaneous access.

3. The catheter is directed up the aorta and into the celiac trunk.

4. Digital subtraction angiography is performed to visualize the anatomy of the celiac trunk, including blood supply to the stomach.

5. A micro catheter is directed into the left celiac artery which supplies the gastric fundus.

6. The left gastric artery is embolized using embospheres to block the gastric arteries supplying the cells in the fundus. Hormonal and mechanic changes could result in the stomach such as a decrease in ghrelin, increase in GLP1, and delayed emptying. The decrease in ghrelin would lead to a decrease in hunger for the patient, resulting in lower caloric intake and eventual loss of weight. (Embosphere™ microspheres are the most clinically studied round embolic and are approved by the FDA for embolizing vascular tumors and vascular malformations. GLP-1 is a hormone that provides the satiety signal and stimulates insulin secretion. Most of it originates from the intestines. Ghrelin is the only known orexigenic hormone. It is a potent appetite stimulant. Most of the ghrelin is produced in the gastric fundus. Levels rise before meals and when dieting. Ghrelin levels fall less than an hour after eating.)
7. If there is still significant blood flow remaining to the fundus at this time then the decision may be made to embolize parts of other arteries such as the gastroepiploic or short gastrics as well.

8. Digital subtraction angiography is performed again to assess for the degree of stasis in the gastric arteries.

9. The catheter is then removed and pressure is applied on the catheter insertion site, which may have been either the femoral artery or the radial artery.

10. If the femoral artery was accessed, a patient must lie flat for up to 4 hours in the recovery room. If the radial artery was accessed, a patient must wear a radial compression wristband for 1 to 2 hours. Patients go home after the recovery period, the same day as the procedure. Patients should avoid exertion for 48 hours.

11. A patient may be asked to take medications to protect the stomach. For 2 weeks before the procedure, and 6 weeks after, a patient could possibly take a daily oral proton pump inhibitor and a daily oral cytoprotective agent. (Omeprazole is a proton pump inhibitor. It decreases the amount of acid produced by the stomach. It is commonly used to treat conditions of excess stomach acid. Sucralfate is a commonly used cytoprotective agent. It coats and protects the stomach lining from irritation.)

Risks of Bariatric Embolization

1. Due to changes in blood flow to the stomach, some patients may experience nausea, vomiting, and abdominal pain immediately after Bariatric Embolization. A specific post-procedural diet is prescribed to reintroduce food. In comparison to bariatric surgeries, malnutrition is not a serious concern following Bariatric Embolization.

2. Common risks of arterial intervention include bleeding, allergic reaction to contrast, and temporary pain at the site where the vessel is accessed.

3. In animal studies, gastritis and ulceration occurred about 40% of the time. These symptoms have not been observed in patients thus far.
4. It is possible that a small number of microspheres may lodge into areas outside the targeted area; this is referred to as non-target embolization. However the chances of this occurring are very low due to careful technique including highly selective and gradual embolization of the left gastric artery.

5. The ability to have future gastric bypass surgery after Bariatric Arterial Embolization is unknown.

Results of Bariatric Embolization

1. Overall, patients are expected to lose about 20% of their total weight within 6 months after the procedure. Weight loss is made easier by Bariatric Embolization, but an important part of long term treatment is following lifestyle changes such as diet, regular exercise and working closely with a counselor.

2. Research on human subjects is limited. However, Harvard University researchers in 2013 had noted that patients who underwent left gastric artery embolization to treat GI bleeding, on average lost 8% of their body weight within 3 months. A single-arm, prospective study performed on 5 patients in the Republic of Georgia in 2013 found an average of 31 pounds of weight loss after 1 month, 15.9% lower BMI at 6 months without ulceration or significant complication. Early clinical trials are underway at a few select locations in the United States.

3. Again, this is an alternative procedure that is still undergoing early clinical trials. The long term effects are still unknown, and are being studied.
Appendix 2

Questionnaire used for need finding interviews

1. Do you keep up with new medical information/procedures or advancements?
2. Can you give an example?
3. Why were you looking up this information?
4. When you’re learning about that new procedure, what are your steps to understanding it?
5. What is your favorite resource?
6. What kind of media?
7. What computers or devices do you use most when looking up medical information?
8. If you could build the perfect module explaining BAE, can you describe how you would build it?
9. What is the most important information for you to learn about when learning about a new procedure?
Appendix 3: Usability Study 1 Methods Document

Bariatric Embolization
Educational Interactive Media

Usability and Knowledge Retention Study

Methods Document
February 6, 2015

Edwin Choi
Graduate Student, Art as Applied to Medicine
Johns Hopkins School of Medicine

60
Purpose

The purpose of this study is to assess the usability of the digital educational interactive on bariatric embolization:

1. Navigation behavior through the interactive from start to finish
2. Overall experience, including color choices, design elements and comprehension

It will also test knowledge retention from the interactive, in order to determine it’s educational effectiveness:

For patients, they should understand:
1. That 1/3 of Americans are overweight or obese
2. Bariatric embolization helps the patient lose weight by making them less hungry
3. By altering the hormone production and function of the stomach, it will make the patient less hungry
4. Bariatric embolization is performed by inserting tiny beads into an artery that feeds the stomach
5. A risk factor is that future bariatric surgery after bariatric embolization, may not be possible
6. Bariatric embolization is a procedure still undergoing clinical trials

For physicians, they should understand:
1. Bariatric embolization is a minimally invasive catheter directed outpatient procedure
2. Bariatric embolization is done by causing mild ischemic change in the gastric fundus
3. Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying is predicted to cause the loss in weight for patients
4. Bariatric embolization is performed by delivering micro beads into the left gastric artery
5. A possible risk of bariatric embolization is that bariatric surgery for the patient may not be possible in the future
6. Common side effects of bariatric embolization are pain and vomiting
7. Bariatric embolization is a procedure that is undergoing early clinical trials

This information will be anonymous and will be used for design improvements within the interactive.
Methods

1. 5 to 10 users (50% physicians, and 50% patients or non clinicians) will be asked to complete an approximately 2 page pre-test questionnaire (shown later in this document. There is a specific pre-test for patients, and one for physicians).

2. The first prototype of the digital interactive (completed on 2/5/15) will be provided through a laptop connected to a mouse. The user will complete the bariatric embolization digital educational interactive from start to finish. This should take 7 minutes. Each participant will be tested individually.

3. The user will be asked to complete an approximately 2 page post-test questionnaire that asks questions pertaining to bariatric embolization, in order to test retention of knowledge. It will also feature questions for feedback on usability.

4. Each session should last a total of 30 minutes.

Test Structure

1. Welcome the participant into the room. Have them sit net to the moderator. The laptop will be in front of the participant and the interactive will be loaded onto the screen.

2. The study will be explained to the participant, “Thank you for coming. I’m a graduate student from the medical art department here at Hopkins and I’m here to do a usability study on an educational interactive that explains the bariatric embolization procedure. I’m not testing you, I’m testing the interactive so there is no right or wrong answer. I’ll give you a 2 page pre-test questionnaire for you to fill out before you start the interactive, which will also serve as a consent form. Afterwads, I’ll ask you about your impressions, and then give you a 2 page post-test questionnaire to fill out for feedback. All your feedback is confidential, will only be used for improving the design of the interactive, and you can stop at any time. Do you have any questions before we get started?” Have the participant fill out the pre-test questionnaire. If they are a physician, hand them the physician pre-test questionnaire. If they are a non-clinician, hand them the patient pre-test questionnaire.

3. After the pre-test questionnaire is filled out, begin the interactive by saying, “Ready to start the interactive? Great, while your going through it feel free to offer me any feedback or opinions and I’ll take note of them. Let me know when you feel like you’ve completed it.” Let the participant go through the approx 7 minute interactive from start to finish.

4. After the participant is finished going through the interactive, some open ended questions will be asked in order to obtain their overall impression, “ have some open ended questions I wanted to ask you to get your overall opinion on the interactive. What were your likes and dislikes? What did you think about the overall visual design? Anything you thought should be added or taken away? I also have the audio script here if you want to point out
any specific parts. Were there any parts that were confusing? Great, so the last part is the 2 page post-test questionnaire. If you could fill this out that would be great. Let me know when your finished.” They will then be handed the post-test questionnaire. If they are a physician, hand them the physician post-test questionnaire. If they are a non-clinician, hand them the patient post-test questionnaire.

5. After the post-test questionnaire is completed, say, “Thank you for taking part in the study. What will happen now is that once I gather feedback from a larger number of participants I’ll use that to redesign the interactive.” Your feedback is really appreciated. Do you have any last questions or comments?” End study session.

The following 8 pages contain the following materials:

1. Pre-test questionnaire for patients
2. Pre-test questionnaire for physicians
3. Post-test questionnaire for patients
4. Post-test questionnaire for physicians

For the knowledge based questions, the correct answers are in bold.
Pretest questionnaire (for patients)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

Your completion of this survey or questionnaire will serve as your consent to be in this research study.

1. What is your age?

2. What device do you primarily use to research medical information online?
   1. Computer
   2. Tablet
   3. Mobile device
   4. Other (please describe here: ______________________)

3. Have you ever used an instructional module on the internet?

4. What is your current understanding of bariatric embolization?
   1. No understanding
   2. Little understanding
   3. Understand it somewhat
   4. Good understanding
   5. Very good understanding

5. What is the state of obesity in the United States?
   a. 1/3 of Americans are overweight or obese and it is increasing
   b. 1/5 of Americans are overweight or obese
   c. Obesity is on the decline
   d. I don’t know

6. What is the goal of bariatric embolization?
   a. To increase energy to help you exercise longer
   b. To help you lose weight by making you generally less hungry
   c. To increase appetite for healthier foods such as fruits and vegetables
   d. I don’t know

7. How is this goal achieved?
   a. By making the stomach into a smaller size
   b. By altering the hormone production and function of the stomach
   c. By eating healthier foods with lower sodium and fat content
   d. I don’t know
8. Bariatric embolization is performed by:
   a. Inserting tiny beads into a specific artery that feeds the stomach
   b. Surgically creating a smaller stomach
   c. Administering drugs that promote weight loss
   d. I don't know

9. What is a possible risk of bariatric embolization?
   a. Future malnutrition due to malabsorption
   b. Increased appetite for food due to hormonal changes
   c. May not be able to undergo bariatric surgery in the future
   d. I don't know

10. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. It is a procedure undergoing clinical trials
    c. It is a procedure that may be researched in the future
    d. I don't know

11. What is the highest level of education you have completed?
    a. Did not complete high school
    b. High school/GED
    c. Some college
    d. Bachelor's degree
    e. Master's degree
    f. Professional or doctorate degree
Post-test questionnaire (for patients)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. Completing the interactive module was:
   1. Very easy
   2. Easy
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
   Comments:_____________________________________________________

2. Understanding the text in this module was:
   1. Very easy
   2. Easy
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
   Comments:_____________________________________________________

3. Understanding the images in this module was:
   6. Very easy
   7. Easy
   8. Neither easy nor difficult
   9. Difficult
   10. Very difficult
   Comments:_____________________________________________________

4. How was the length of this module?
   1. Too short
   2. A little short
   3. A good length
   4. A little long
   5. Too long

5. Rate what you feel is your current understanding of bariatric embolization after using this module:
   1. No understanding
   2. Little understanding
   3. Understand it somewhat
   4. Good understanding
   5. Very good understanding
6. What is the state of obesity in the United States?
   a. 1/3 of Americans are overweight or obese and it is increasing
   b. 1/3 of Americans are overweight or obese and it is decreasing
   c. 1/5 of Americans are overweight or obese
   d. I don't know

7. What is the goal of bariatric embolization?
   a. To increase energy to help you exercise longer
   b. To help you lose weight by making you generally less hungry
   c. To increase appetite for healthier foods such as fruits and vegetables
   d. I don't know

8. How is this goal achieved?
   a. By making the stomach into a smaller size
   b. By altering the hormone production and function of the stomach
   c. By eating healthier foods with lower sodium and fat content
   d. I don't know

9. Bariatric embolization is performed by:
   a. Inserting tiny beads into a specific artery that feeds the stomach
   b. Surgically creating a smaller stomach
   c. Administering drugs that promote weight loss
   d. I don't know

10. What is a possible risk of bariatric embolization?
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. May not be able to undergo bariatric surgery in the future
    d. I don't know

11. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. It is a procedure undergoing clinical trials
    c. It is a procedure that may be researched in the future
    d. I don't know

12. Please write any other comments you may have about this module.
Pretest questionnaire (for physicians)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. What is your age?

2. What is your medical specialty?

3. What device do you primarily use to research medical information online?
   1. Computer
   2. Tablet
   3. Mobile device
   4. Other (please describe here: ________________)

4. Have you ever used an instructional module on the internet?

5. What is your current understanding of bariatric embolization?
   1. No understanding
   2. Little understanding
   3. Understand it somewhat
   4. Good understanding
   5. Very good understanding

6. What kind of procedure is bariatric embolization?
   a. A minimally invasive catheter directed inpatient procedure
   b. A minimally invasive, catheter directed, outpatient procedure
   c. I don’t know

7. How is the goal of losing weight achieved?
   a. By causing ischemic change in the pylorus of the stomach
   b. By causing mild ischemic change in the gastric fundus
   c. By causing mild ischemic change in the duodenum
   d. I don’t know

8. What is the predicted mechanism that creates this result?
   a. Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying
   b. Mechanical changes in the stomach causing faster gastric emptying
   c. Changes in the absorption capability of the stomach and gastrointestinal tract
   d. I don’t know
9. Bariatric embolization is performed by:
   a. Delivering micro beads into the left gastric artery
   b. Inserting micro beads into the right gastric artery
   c. Inserting micro beads into the gastric branches of the left gastroepiploic artery
   d. Inserting micro beads into the celiac artery

10. What are possible risks of bariatric embolization
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. May not be able to undergo bariatric surgery in the future
    d. Gastric ulcerations

11. Circle all "common" side effects of bariatric embolization
    a. Malnutrition in the long term if prescribed vitamins are avoided
    b. Pain
    c. Scar tissue formation
    d. Vomiting
    e. Diarrhea
    f. I don't know

12. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. It is a procedure undergoing early clinical trials
    c. It is a randomized controlled trial that is undergoing phase ¾ clinical trials.
Post-test questionnaire (for physicians)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. Completing the interactive module was:
   1. Very easy
   2. Easy
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
   Comments:________________________

2. Understanding the text in this module was:
   1. Very easy
   2. Easy
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
   Comments:________________________

3. Understanding the images in this module was:
   6. Very easy
   7. Easy
   8. Neither easy nor difficult
   9. Difficult
   10. Very difficult
   Comments:________________________

4. How was the length of this module?
   1. Too short
   2. A little short
   3. A good length
   4. A little long
   5. Too long

8. What kind of procedure is bariatric embolization?
   a. A minimally invasive catheter directed inpatient procedure
   b. A minimally invasive, catheter directed, outpatient procedure
   c. I don't know
9. How is the goal of losing weight achieved?
   a. By causing ischemic change in the pylorus of the stomach
   b. **By causing mild ischemic change in the gastric fundus**
   c. By causing mild ischemic change in the duodenum
   d. I don’t know

10. What is the predicted mechanism that creates this result?
    a. **Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying**
    b. Mechanical changes in the stomach causing faster gastric emptying
    c. Changes in the absorption capability of the stomach and gastrointestinal tract
    d. I don’t know

11. Bariatric embolization is performed by:
    a. **Delivering micro beads into the left gastric artery**
    b. Inserting micro beads into the right gastric artery
    c. Inserting micro beads into the gastric branches of the left gastroepiploic artery
    d. Inserting micro beads into the celiac artery

12. What are possible risks of bariatric embolization
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. **May not be able to undergo bariatric surgery in the future**
    d. Gastric ulcerations

13. Circle all “common” side effects of bariatric embolization
    a. Malnutrition in the long term if prescribed vitamins are avoided
    b. **Pain**
    c. Scar tissue formation
    d. **Vomiting**
    e. Diarrhea
    f. I don’t know

14. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. **It is a procedure undergoing early clinical trials**
    c. It is a randomized controlled trial that is undergoing phase 3/4 clinical trials.

16. Please write any other comments you may have about this module.
Appendix 4: Results of Usability Study 1

Bariatric Embolization Educational Interactive Media, Usability Test 1 Results and Analysis

Edwin Choi
Graduate Student, Art as Applied to Medicine
2/15/15
Objectives

The purpose of this study, conducted in February 2015, was to assess the usability of the digital educational interactive on bariatric embolization:

1. Navigation behavior through the interactive from start to finish
2. Overall experience, including color choices, design elements and comprehension

It was also for testing knowledge retention after using the interactive, in order to determine its educational effectiveness:

For patients, they should understand:
1. That 1/3 of Americans are overweight or obese
2. Bariatric embolization helps the patient lose weight by making them less hungry
3. By altering the hormone production and function of the stomach, it will make the patient less hungry
4. Bariatric embolization is performed by inserting tiny beads into an artery that feeds the stomach
5. A risk factor is that future bariatric surgery after bariatric embolization, may not be possible
6. Bariatric embolization is a procedure still undergoing clinical trials

For physicians, they should understand:
1. Bariatric embolization is a minimally invasive catheter directed outpatient procedure
2. Bariatric embolization is done by causing mild ischemic change in the gastric fundus
3. Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying is predicted to cause the loss in weight for patients
4. Bariatric embolization is performed by delivering micro beads into the left gastric artery
5. A possible risk of bariatric embolization is that bariatric surgery for the patient may not be possible in the future
6. Common side effects of bariatric embolization are pain and vomiting
7. Bariatric embolization is a procedure that is undergoing early clinical trials
Participants

7 participants were tested total. 2 Clinicians and 5 non-clinicians. All were recruited from within the Johns Hopkins University School of Medicine. Expedited IRB approval was obtained for testing patients. The general background of the participants are the following: gastroenterologist, interventional radiologist, 2 graduate students within the school of medicine, 1 patient, 2 non-clinicians in administrative positions.

Methodology

The methodology is described in the Methods Document which can be found separately.

Data Collected

The facilitator collected qualitative data in the form of participant comments and participant observations. Qualitative data was collected in the form of pre and post test questionnaires.
Pretest questionnaire for non-clinicians (# of respondents who chose this answer). Correct knowledge questions are in bold.

1. What is your age? 28, 50, 40, 60, 26, 31, 31

2. What device do you primarily use to research medical information online?
   1. Computer (5)
   2. Tablet (2)
   3. Mobile device (2)
   4. Other (please describe here: __________________________)

3. Have you ever used an instructional module on the internet? (5 yes) (2 no)

4. What is your current understanding of bariatric embolization?
   1. No understanding (2)
   2. Little understanding (2)
   3. Understand it somewhat (1)
   4. Good understanding (2)
   5. Very good understanding

5. What is the state of obesity in the United States?
   a. 1/3 of Americans are overweight or obese and it is increasing (6)
   b. 1/5 of Americans are overweight or obese
   c. Obesity is on the decline
   d. I don’t know (1)

6. What is the goal of bariatric embolization?
   a. To increase energy to help you exercise longer
   b. To help you lose weight by making you generally less hungry (5)
   c. To increase appetite for healthier foods such as fruits and vegetables
   d. I don’t know (2)

7. How is this goal achieved?
   a. By making the stomach into a smaller size (1)
   b. By altering the hormone production and function of the stomach (4)
   c. By eating healthier foods with lower sodium and fat content
   d. I don’t know (2)

8. Bariatric embolization is performed by:
   a. Inserting tiny beads into a specific artery that feeds the stomach (4)
   b. Surgically creating a smaller stomach (1)
   c. Administering drugs that promote weight loss
   d. I don’t know (2)
9. What is a possible risk of bariatric embolization?
   a. Future malnutrition due to malabsorption (1)
   b. Increased appetite for food due to hormonal changes (2)
   c. May not be able to undergo bariatric surgery in the future (3)
   d. I don't know (4)

10. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals (3)
    b. **It is a procedure undergoing clinical trials** (3)
    c. It is a procedure that may be researched in the future (3)
    d. I don't know (3)

11. What is the highest level of education you have completed?
    a. Did not complete high school (1)
    b. High school/GED (1)
    c. Some college (4)
    d. Bachelor's degree (1)
    e. Master's degree (1)
    f. Professional or doctorate degree
Post-test questionnaire for non-clinicians (# of respondants who chose this answer). Correct knowledge questions are in bold.

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. Completing the interactive module was:
   1. Very easy (3)
   2. Easy (3)
   3. Neither easy nor difficult (1)
   4. Difficult
   5. Very difficult
   Comments: 

2. Understanding the text in this module was:
   1. Very easy (4)
   2. Easy (3)
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
   Comments: 

3. Understanding the images in this module was:
   6. Very easy (5)
   7. Easy (2)
   8. Neither easy nor difficult
   9. Difficult
   10. Very difficult
   Comments: 

4. How was the length of this module?
   1. Too short
   2. A little short
   3. A good length (7)
   4. A little long
   5. Too long

5. Rate what you feel is your current understanding of bariatric embolization after using this module.
   1. No understanding
   2. Little understanding
   3. Understand it somewhat (1)
   4. Good understanding (3)
   5. Very good understanding (3)
6. What is the state of obesity in the United States?
   a. 1/3 of Americans are overweight or obese and it is increasing
   b. 1/5 of Americans are overweight or obese and it is decreasing
   c. 1/5 of Americans are overweight or obese
   d. I don't know

7. What is the goal of bariatric embolization?
   a. To increase energy to help you exercise longer
   b. To help you lose weight by making you generally less hungry
   c. To increase appetite for healthier foods such as fruits and vegetables
   d. I don't know

8. How is this goal achieved?
   a. By making the stomach into a smaller size
   b. By altering the hormone production and function of the stomach
   c. By eating healthier foods with lower sodium and fat content
   d. I don't know

9. Bariatric embolization is performed by:
   a. Inserting tiny beads into a specific artery that feeds the stomach
   b. Surgically creating a smaller stomach
   c. Administering drugs that promote weight loss
   d. I don't know

10. What is a possible risk of bariatric embolization?
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. May not be able to undergo bariatric surgery in the future
    d. I don't know

11. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. It is a procedure undergoing clinical trials
    c. It is a procedure that may be researched in the future
    d. I don't know

12. Please write any other comments you may have about this module.
Pretest questionnaire (for physicians)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. What is your age? 40, 56, 28

2. What is your medical specialty? internal medicine (2), interventional radiology

3. What device do you primarily use to research medical information online?
   1. Computer (3)
   2. Tablet (1)
   3. Mobile device (1)
   4. Other (please describe here: ____________________________)

4. Have you ever used an instructional module on the internet? (1 no, 2 yes)

5. What is your current understanding of bariatric embolization?
   1. No understanding
   2. Little understanding
   3. Understand it somewhat
   4. Good understanding (1)
   5. Very good understanding (2)

6. What kind of procedure is bariatric embolization?
   a. A minimally invasive catheter directed inpatient procedure
   b. A minimally invasive, catheter directed, outpatient procedure (3)
   c. I don’t know

7. How is the goal of losing weight achieved?
   a. By causing ischemic change in the pylorus of the stomach (1)
   b. By causing mild ischemic change in the gastric fundus (1)
   c. By causing mild ischemic change in the duodenum
   d. I don’t know (1)

8. What is the predicted mechanism that creates this result?
   a. Hormonal and mechanistic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying (3)
   b. Mechanical changes in the stomach causing faster gastric emptying
   c. Changes in the absorption capability of the stomach and gastrointestinal tract
   d. I don’t know
9. Bariatric embolization is performed by:
   e. Delivering micro beads into the left gastric artery
   f. Inserting micro beads into the right gastric artery
   g. Inserting micro beads into the gastric branches of the left gastroepiploic artery
   h. Inserting micro beads into the celiac artery

10. What are possible risks of bariatric embolization
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. **May not be able to undergo bariatric surgery in the future**
    d. Gastric ulcerations

11. Circle all “common” side effects of bariatric embolization
    a. Malnutrition in the long term if prescribed vitamins are avoided
    b. **Pain**
    c. Scar tissue formation
    d. **Vomiting**
    e. Diarrhea
    f. I don’t know

12. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. **It is a procedure undergoing early clinical trials**
    c. It is a randomized controlled trial that is undergoing phase ¾ clinical trials.
Post-test questionnaire (for physicians)

Please answer the following questions anonymously to help improve the educational module on bariatric embolization. Thank you for your time.

1. Completing the interactive module was:
   1. Very easy (1)
   2. Easy (2)
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
Comments:

2. Understanding the text in this module was:
   1. Very easy (1)
   2. Easy (2)
   3. Neither easy nor difficult
   4. Difficult
   5. Very difficult
Comments:

3. Understanding the images in this module was:
   6. Very easy (1)
   7. Easy (2)
   8. Neither easy nor difficult
   9. Difficult
   10. Very difficult
Comments:

4. How was the length of this module?
   1. Too short
   2. A little short
   3. A good length (3)
   4. A little long
   5. Too long

8. What kind of procedure is bariatric embolization?
   a. A minimally invasive catheter directed inpatient procedure
   b. A **minimally invasive, catheter directed, outpatient procedure** (3)
   c. I don't know
9. How is the goal of losing weight achieved?
   a. By causing mild ischemic change in the gastric fundus (2)
   b. By causing mild ischemic change in the duodenum
   c. I don’t know

10. What is the predicted mechanism that creates this result?
    a. Hormonal and mechanic changes in the stomach such as a decrease in ghrelin and increase in GLP1, and delayed emptying (3)
    b. Mechanical changes in the stomach causing faster gastric emptying
    c. Changes in the absorption capability of the stomach and gastrointestinal tract
    d. I don’t know

11. Bariatric embolization is performed by:
    a. Delivering micro beads into the left gastric artery (3)
    b. Inserting micro beads into the right gastric artery
    c. Inserting micro beads into the gastric branches of the left gastroepiploic artery
    d. Inserting micro beads into the celiac artery

12. What are possible risks of bariatric embolization?
    a. Future malnutrition due to malabsorption
    b. Increased appetite for food due to hormonal changes
    c. May not be able to undergo bariatric surgery in the future (1)
    d. Gastric ulcerations (3)

13. Circle all “common” side effects of bariatric embolization
    a. Malnutrition in the long term if prescribed vitamins are avoided
    b. Pain (3)
    c. Scar tissue formation (1)
    d. Vomiting (3)
    e. Diarrhea
    f. I don’t know

14. What is the current state of bariatric embolization?
    a. It is a procedure currently being performed in some hospitals
    b. It is a procedure undergoing early clinical trials (3)
    c. It is a randomized controlled trial that is undergoing phase ¾ clinical trials.

16. Please write any other comments you may have about this module.
Recommendations

High

Greatest potential for improving user satisfaction.

• Change the interface so that users have more control over the pace of learning. The audio was appreciated, but the interface confused most users, and some commented that an animation made them feel “nervous”, as if they had to rush to gain all the information. All participants who were shown these two interfaces preferred the interface 2 (this is actually more in line with what was found during needfinding and with thematic coding).

• Make it obvious that once the last subsection of a section (risk, bariatric surgeries, etc) is reached, the user must click one of the sections in the primary navigation at top in order to continue forward. This could be done with animation, or a clear label.

• In the intro screen, the silhouettes of the doctor and patient should be clickable to get to their respective sections (not just the labels “doctor” and “patient”).

• Make it clear in the risk section that the unknown aspect of future bariatric embolization is a real risk. Not future malnutrition due to malabsorption (perhaps should state this).

• Make interactive areas its own unique color so that users know that it can specifically be interacted with.

• Make the instructions that state that an area can be interacted with, much more obvious than they are now. One strategy is to not have an arrow that bends, make the “click to interact” text larger.

• More emphasis on safety of the embolization and assurance about the non-targeted embolization risk. The chances of this risk occurring are very low with all the precautions taken. Emphasize that it is super selective embolization, only targeting the left gastric in the left fundus and that that is what makes the risk so low.

• There should be a title at the top of each subsection just to describe what the topic of that subsection is about.

• Technical issues exist. After the user clicks an interactive button, they have difficulty getting out. May have to add an explanation within the popup that the user can click anywhere to return to the interactive.

• More visual interest should be added with the addition of more nuanced visual design and rendered assets.
• Accuracy is needed. In the embolization explanation, the vessels should be blocked all the way to where it branches off the left gastric.

• The gastric banding surgery illustration may be inaccurate. The stomach pouch that is made may be too small in the current illustration.

• Accuracy is needed. At the end of the procedure, the illustration should be of a patient lying on a stretcher, not on a surgical table.

• Accuracy is needed. A patient MAY be asked to take medications to protect the stomach. There are still some things that are unclear.

• For the doctor portion, procedure section, add information that describes that if there is still significant blood flow remaining to the fundus at this time then the decision might be made to embolize other arteries such as the gastric apoploic, short gastric apoploic.

• Accuracy issue. At the end of the procedure section, mention that most patients will go home the evening of the procedure.

Medium

Greater potential for improving user satisfaction.

• For the physician section, include an explanation on the hormonal changes expected, explaining the general mechanism of how it would lead to weight loss.

• Add information on where the treatments fit in overall. Explain how diet would be tried first (7% weight loss on average), then bariatric embolization (20% weight loss, but more invasive), then bariatric surgery (50% weight loss on average, most invasive). Let the viewer understand the general landscape of weight loss and how bariatric embolization is in the middle.

• More emphasis on how minimally invasive bariatric embolization is. Show a comparison of the scars made from bariatric surgery vs bariatric embolization at the end of section 2. Show how invasive most bariatric embolization is.

• Make the buttons for the different subsections signify to the user that they can be interacted with.

• Add more nuanced animation. In the procedure section, show the catheter entering the thigh.
• In the procedure section make it clear that the doctor is accessing either the groin OR the wrist.

• In the why bariatric embolization section, when hormone production in the fundus is being mentioned, there should be some sort of animation signifying that happening, for more visual interest.

• In the procedure section, when DSA is being explained, the animation should be made so that it feels as if a picture is actually being taken.

• When the user clicks on an interactive element, make the popup box appear close to the word that was clicked since that is what it’s defining for the user. If it covers another part of the interactive it confuse the user because it’s not consistent and is more difficult to associate with what was just interacted with.

• For the doctor portion, at the end of the Why Bariatric Embolization section, ghrelin and GLP-1 should be interacted with. There are many healthcare professionals who are not familiar with those terms.

Low

Potential for improving user satisfaction.

• Change the wording on the intro screen to “care provider” instead of “doctor”. This is because nurses, physician assistants, dieticians, etc, would also be users.

• Label the arteries (radial, femoral, aorta, left gastric, celiac).

• Add arteries to the sections where they are mentioned, but are not seen in the visualization yet.

• List credits at the end.

• The leader lines labeling “bleeding” in the risk section of the interactive looks confusing and the individual areas of bleeding should be labelled individually.

• The dots showing the map of the US in the intro section doesn’t get across how serious the obesity problem is. Visualize it in a different way. Perhaps a bar graph or pie chart.

• Add more nuanced animation. In the primary navigation have some movement that is activated when the user mouses over the section, in order to show the user that it can be interacted with.
• Keep the capitalization in each of the labels consistent.

• In the procedure section, explain a little more what the difference between wrist and thigh access is. Perhaps at the end of the procedure. This is because one of the non-clinician users was still confused about this aspect of the procedure.

• The fonts on the medication bottles should be fixed. They visually look odd and stretched.

• In the bariatric embolization section, the animation of the stomach changing to the gastric band stomach looks odd because the stomach outline changes.

• The “R” in roux-en-y should be capitalized when it is mentioned in the section Bariatric Surgeries.

• The “B” and “E” in Bariatric Embolization should be capitalized within the interactive.

• Grammar error when user can interact with the ghrelin text. It should read “Most of the ghrelin...” etc.

• Grammar issue. Throughout the interactive, when out-patient procedure is mentioned, the hyphen is not necessary.

• In the intro section some rewording is necessary. “Achieve weight loss” sounds more correct than saying “to help in weight loss”.

References

Cited References


Bawudun, Dilmurat, Yan Xing, Wen-Ya Liu, Yu-Jie Huang, Wei-Xin Ren, Mei Ma, Xiao-Dong Xu, and Gao-Jun Teng. “Ghrelin Suppression and Fat Loss following Left Gastric Artery Embolization in Canine Model.” CardioVascular and Interventional Radiology 35.6 2012): 1460-466.
General References


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Vita

Edwin Choi was born in Los Angeles, California on November 28, 1988. He attended Mercer Island High School in Washington before enrolling in the University of Washington. During his undergraduate studies, he pursued both fine arts and biology when he discovered the field of medical illustration from an acquaintance in a sketching club. After discovering that both his passions could be combined, he graduated with a dual degree in General Biology and Painting & Drawing in 2011.

Edwin received classical art training at Gage Academy in Seattle before making a solo backpacking trip around the world. After his travels, he enrolled in the graduate program in Medical and Biological Illustration at The Johns Hopkins University School of Medicine in the fall of 2013.

After developing an interest in user experience (UX), user interface (UI) and interaction design (IxD) during his 2nd year of graduate studies, Edwin pursued an elective course exploring aspects of UX design. He interacted with groups at the University of Baltimore, University of Maryland Baltimore County, University of California Los Angeles, and IDEO. Following his graduation in May of 2015, Edwin plans to combine his training in medical illustration with his experience and interest in UX to design digital tools and applications within the healthcare realm to improve patient and clinician experiences.