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Impact of audio text, visual text and cueing on cognitive load and performance

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IMPACT OF AUDIO TEXT, VISUAL TEXT AND CUEING ON COGNITIVE LOAD AND PERFORMANCE

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DEDICATION

I dedicate this dissertation to my family, and particularly to my father Benedict Arini, who always made everything possible.

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CHAPTER 1

INTRODUCTION

Cognitive load is the amount of mental effort that is expended by a learner when he or she is participating in instruction. Cognitive load theory has its foundations in learning theory, in particular in information processing theory (Sweller, 1999, 2003). Cognitive load theory suggests that working memory is very limited, and only able to hold a small number of items simultaneously. Memory theorists have proposed different limits, the most widely cited of which is Miller's 7 items, + or – 2 (Baddeley, 1992a, 1992b, 1994; Cowan, 2000, Frick, 1984; Lachman, Lachman & Butterfield, 1979; Miller, 1956; Simon, 1974). Long term memory is believed to have a virtually unlimited capacity (Newell & Simon, 1972). While humans have an unlimited capacity to store information, the capacity to actively process information is limited by the capacity of working memory. Cognitive load theory states that working memory capacities must be taken into consideration when designing instruction, because to overload working memory with information or unnecessary processing demands during instruction interferes with learning (Sweller, 1993). If instruction is designed in a way that causes excessive cognitive load, the instruction will not be effective. The significance of Cognitive Load Theory for instruction is well documented in the literature (Sweller, 1999; 2003).

Cognitive load is defined as the amount of mental activity that occurs within working memory. This amount of mental activity is directly related to the number of elements that must be held in working memory at any given time. There are four general principles of cognitive load theory (Cooper, 1998):

1. Working memory is extremely limited.
2. Long term memory is essentially unlimited.

3. The process of learning requires working memory to be actively engaged in the comprehension (and processing) of instructional material to encode to-be-learned information into long term memory.

4. If the resources of working memory are exceeded, then learning will be ineffective.

There are three types of cognitive load: intrinsic cognitive load, germane cognitive load, and extraneous cognitive load (Sweller, 1994; Sweller, van Merrienboer, & Pass, 1998). Intrinsic cognitive load is generated by the subject matter to be learned; it is an integral part of the information to be learned. When performing a learning task, a number of elements must be held in working memory at the same time. The greater number of elements that are needed in working memory to learn something, the higher the intrinsic cognitive load is predicted to be. The concept of element interactivity provides additional refinement to cognitive load theory. When instruction requires the learner to hold several elements in working memory and to apply them to the instruction simultaneously, then the instruction is said to have high element interactivity (Sweller, 1996). Element interactivity has implications for instructional design. When there is high element interactivity, such as when teaching problem solving or complex information, then intrinsic cognitive load is high (Pollock, Chandler & Sweller, 2002). Under these conditions, it is important to design instruction in a way that reduces cognitive load.

In contrast, extraneous cognitive load is the additional cognitive load imposed upon the learner by an inefficient instructional design. Extraneous cognitive load is increased when the instructional design requires that a student hold too many elements in active memory. Extraneous cognitive load also occurs when elaborate search or problem solving processes are included in instructional designs, overwhelming the capabilities of active memory (Sweller, 1991; Sweller, 1993). The goal of effective instructional design is to reduce extraneous cognitive load.

Another goal of effective instructional design is to increase germane cognitive load in relation to extraneous cognitive load. One important way to learn is by developing and extending schemata, thus connecting directly to long term memory capabilities when learning is taking place (Sweller, 1994). Schemata are also important in intellectual performance because although multifaceted, they are recognized in working memory as only one element, rendering complex intellectual tasks easier to accomplish (Kalyuga, Chandler & Sweller, 1999). Germane cognitive load is imposed on the learner by the act of learning itself and is generated when schemata are produced and stored in long term memory. A summary of the three types of cognitive load is presented in Figure 1. Germane cognitive load uses the space in working memory that remains after intrinsic and extraneous load use the available resources. If there is inadequate working memory accommodate germane cognitive load, then it is unlikely the learner will be able to develop new or modify existing schemata. Instructional designs that reduce extraneous cognitive load and direct the attention of the learner to schema formation thus increasing germane cognitive load are thought to be among the most effective designs (van Merrienboer, Schuurman, de Croock, & Paas, 2002; Paas, Renkl & Sweller, 2003; Sweller, van Merrienboer & Pass, 1998.)

Figure 1

Three Types of Cognitive Load

Intrinsic Cognitive Load – ICL	Extraneous Cognitive Load – ECL	Germane Cognitive Load – GCL
ICL + ECL + GCL = Total Cognitive Load		

The automation of knowledge is another important concept in understanding cognitive load. Considerable conscious thought and effort to recall and use information is needed when learning

something new. As a learner moves to an expert level, the use of the information becomes increasingly automatic. An expert will be sufficiently familiar with the information to retrieve and use the information without consciously controlling its retrieval and use (Sweller, 1994). Sweller states that intellectual performance can only reach its full potential when knowledge is automated. Automation and schema formation free up resources for other learning activities and reduce the impact of cognitive load on new learning.

There is a significant body of research on cognitive load theory (Sweller, 1999, 2003; Sweller, van Merrienboer, & Paas, 1998). The implications for instructional design have also been explored, and the recommended techniques have been shown to be more effective than traditional instructional designs (Sweller, 1999, 2003). Three related phenomena, the split-attention effect, the redundancy effect, and the modality effect are the most relevant to the present research.

When instructional materials have both images and accompanying text, learners must split their attention between the image and the text. For example, the learner reads a paragraph, and then is directed to the image with a statement such as "...notice in figure 3..." In such a learning situation, the learner must keep both the related text and the image in working memory as the information from both is processed in an attempt to understand the material, causing overload. This phenomenon is referred to as the split-attention effect. It is not limited to text and graphics, but can also occur when a learner's attention is split between a computer presentation and a printed manual, such as when a learner is working with a new software package (Chandler & Sweller, 1991).

The redundancy effect is an example of "less being more" helpful to the learner. When instructional materials are designed so that the text and the graphics are redundant, containing

exactly the same information, the result is extraneous cognitive load. This divided focus results in less capacity in working memory for learning strategies and high levels of cognitive load (Chandler & Sweller, 1991).

The modality effect suggests that parts of working memory are specific to different sensory modes (Penney, 1989; Baddeley, 1992a, 1992b). While the majority of working memory serves as a general resource, visual and auditory areas of memory are specialized and can assist with complex learning tasks. Instructional designers are able to present visual materials as illustrations and textual material in an auditory form, allowing short term memory to handle the information effectively (Mousavi, Low & Sweller, 1995).

The three effects, split-attention, redundancy, and modality, interact and impact the effectiveness of instruction. When planning instruction the designer may need to plan for the modality effect. For diagrams and other instructional materials that would split attention, designers may present these with auditory text. Care must be taken not to produce the redundancy effect by simultaneously presenting the same information in both auditory and visual text modes. Although the simplest way to eliminate the redundancy effect under split-attention conditions for expert learners is to eliminate the explanatory text and integrate it into the diagram (Sweller, 1999), the question of the impact of learner experience on designing instructional diagrams, and determining when text is truly redundant, is not clear in the literature and requires further study.

For decades the instructional design field has discussed the use of structured text and text with signals to cue the learner to key concepts and relationships between ideas (Armbruster, 1986; Jonassen, 1982, 1985). Providing signals or cues in instructional materials can enable the learner to focus on key concepts (Meyer, 1975; Lorch, 1989), to improve recall of information,

and to improve transfer capabilities for information (Loman & Mayer, 1983; Mautone & Mayer; 2001). Signaling in instructional text has also been shown to improve performance by decreasing cognitive load under certain instructional conditions (Jeung, Chandler & Sweller, 1997; Kalyuga, Chandler & Sweller, 1998).

The focus of this study is to examine the effects of cognitive load theory, particularly the effects of modality and cueing, when learning from text and diagrams. The following review of the literature on cognitive load and cueing is divided into three sections. First, the literature on split-attention and redundancy is examined. Second, studies investigating the modality effect are reviewed. The third section reviews the literature of signaling or cueing related to performance and cognitive load in instructional design. The study sought to confirm existing research on the effects of narration vs. written text on cognitive load, and to extend cognitive load research into the area of signaled text and narration. The findings contributed to the theory and practice surrounding the design and development of instruction; particularly instruction that is designed to be offered via the Internet, or web-based instruction.

CHAPTER 2

REVIEW OF THE LITERATURE

Split-Attention & Redundancy Effects

When presenting diagrams and explanatory text in multimedia instructional programs, it has been shown that managing split-attention and redundancy is important to learning effectiveness. Traditionally, diagrams and explanatory text are presented separately in instructional materials. Cognitive load theory postulates that splitting the learner's attention between the diagram and the explanatory text causes extraneous cognitive load. A way to resolve this situation is to integrate the explanatory text into the diagram. In two studies, Chandler and Sweller (1991, 1992) compared differences in split source instructional materials and those with integrated instructions in both an industrial training setting and in a normal training environment. They found that the integrated instructions groups outperformed the groups that were given instructions in the split source format. Cerpa, Chandler, and Sweller (1996) investigated the split-attention effect in a study comparing two groups of students, one of which used integrated computer-based training software that integrated the manual, and one of which used a conventional print manual and the associated computer software. Performance of the integrated computer-based training group on an achievement test was significantly higher than the manual and software group. Research in this field supports the idea that integrated instructional formats are superior to those that split learner attention and cause increased cognitive load and decrease levels of performance.

In multimedia instructional design, a designer may be tempted to include an image and text, and then provide narration that is a repetition of the information, that is, the narrator reads the text while it is displayed. Unfortunately, this strategy does not work as practice or rehearsal

for the learner as intended, but instead forces the learner to pay attention to more than one source of verbal information, one of which is visual and the other auditory. Including this redundant information in the instruction results in increased cognitive load and allows less capacity in working memory for learning strategies. In a study of the cognitive constraints of multimedia learning, Mayer, Heiser, and Lonn (2001) investigated the redundancy effect when presenting visual text with concurrent audio narration. In this study college students viewed an animation of how lightning is formed, and concurrently listened to a narration explaining the same phenomenon. Study participants, who were provided with instruction that included a visual animation, visual on-screen text, and audio narration of the text, didn't perform as well on retention and transfer tests as participants who received the visual animation and narration, with no on-screen text. The redundancy effect was produced by this instructional design, overloading the visual processing mechanism of short-term memory and causing the participants to split their attention between the two formats. The participants in this study were college students and the materials were presented in a brief instructional format. An important question is whether this result would hold with ecologically valid materials and participants who had a vested interest in learning the content.

Modality Effect

Another way to reduce cognitive load is to utilize the multiple-channel capabilities of working memory, or the modality effect, to present information in a way that avoids redundancy and enhances the processing capacity of working memory. Although it is believed that the majority of working memory serves as a general resource, it is theorized that specific parts of it are dedicated to processing visual information and auditory information (Baddeley, 1992a, 1992b; Paivio, 1990). A number of memory researchers (Allport, Antonis & Reynolds, 1972;

Brooks, 1967; Frick, 1984; Paivio, 1990; Penney, 1989) have demonstrated the effectiveness of processing information in both the visual and auditory channels of working memory. This theory, referred to as the multiple modality or multiple-channel hypothesis, has generated a number of studies which have demonstrated that working memory can be enhanced by using more than one channel to convey instructional information. For example, in a multimedia program where the graphics are presented visually and the textual material is presented in an auditory form, presenting information in two different modes would allow working memory to process these pieces of information separately and avoid the creation of extraneous cognitive load. Tindall-Ford, Chandler, and Sweller (1997) demonstrated the role of visual and audio elements in the presentation of instruction. In a series of experiments in an electrical apprenticeship program, technical engineering drawings used were designed to test this hypothesis. Results showed that presenting a diagram with narration was superior to presenting both diagram and text in visual mode, when measured by performance on and transfer to a practical task. The authors suggest that this modality effect is due to an expansion of working memory that provided increased processing power to the learner. In a second experiment, a table was substituted for the diagram, and was presented to two groups using visual text and narration. Results were similar to the first experiment. The group who received the table and narration was superior to the group that received the table with visual text, both in terms of higher performance and lower measured cognitive load. This second experiment supported the initial findings, and also demonstrated the effectiveness of the modality effect in both diagrams and tables. Mousavi, Low, and Sweller (1995) also suggest that working memory can be expanded by using these multiple channel capabilities. The authors found similar efficacy of the modality effect when presenting geometry worked examples to 8th grade students. The materials consisted of 5

minutes of instruction and included three treatments; a diagram with visual and audio text (simultaneous method), a diagram and visual text (visual-visual method), and a diagram with narration (visual-audio method). The simultaneous group and the visual-audio group performed better than the group that received both the diagram and the text visually. In a study with younger students, Leahy, Chandler and Sweller (2003) investigated the modality effect, and found similar results; that audio and visual presentations were superior to visual only presentations. This study also tested the redundancy effect, presenting a diagram with both written text and redundant audio text, and found that the diagram with written text group out performed the diagram, written text, audio text group. The performance difference was attributed to a redundancy effect caused by the audio narration, which was needed to understand a diagram with integrated written text. It was interesting to note that the redundancy effect was produced with younger learners (age 10-11 years) in this experiment. Conversely, Moreno and Mayer (2002) found in a study of audio presented with concurrent and non-concurrent visual text, that concurrent presentation of a diagram and visual text was less effective that a sequential presentation of first a diagram with spoken text and ten the presentation of visual text. The redundancy effect was not generated because the presentations were sequential. Interestingly, this study added relevant natural sounds to the lesson on lightning formation (thunder, rain sounds), but these sounds had no effect on the amount that the students remembered, nor was there an interaction with redundancy. The findings in these studies are consistent with the hypothesis that the dual modality format enhanced working memory by allowing the instruction to be processed more efficiently, reducing cognitive load, and improving participant performance. A more complex picture of the redundancy effect is also emerging. A potential

question is whether the results could be replicated in other domains of knowledge with older participants in actual training.

Clearly, the redundancy effect can be produced by both split attention and the inappropriate use of dual modalities in instruction. There are also implications regarding redundancy when considering the sequencing of instruction and the expertise of learners. In a study of the effects of learner experience on split-attention and redundancy, Kalyuga, Chandler, and Sweller (2000) presented a diagram with both auditory and visual text to experienced and inexperienced learners. Their findings regarding the modality effect were consistent with those of Mousavi et al. (1995) and Tindall-Ford et al. (1997). In these studies, an interesting difference was found between learners who were experienced with the content of the instruction and inexperienced learners who were not. When presented with a diagram and auditory text, experienced learner's performance was degraded when compared to performance with only the diagram. The authors suggest that since the experienced learners were familiar with the content and could understand the diagram without the text, the redundancy effect was evoked, adversely effecting both cognitive load and performance. It was concluded that presenting a diagram with explanatory text in an auditory format enhances working memory for inexperienced learners, but it causes redundancy for experienced learners.

The findings of these studies indicate that when designing multimedia instruction, a) it is possible to increase the effective size of working memory by presenting text in an auditory rather than visual format, b) in order to avoid the redundancy effect, present unique information in each mode and carefully sequence the instruction, and c) learner experience impacts instructional design choices. Using these techniques decreases cognitive load and increases learner performance in multimedia instruction, but it is not clear how to best design instruction to reduce

cognitive load and improve performance of novice learners in an actual instructional situation in a non-technical knowledge domain.

Instructional Cueing

The use of visual cues such as headings and text structure is an accepted technique in instructional message design, enabling the learner to organize information into the coherent structure needed for learning (Fleming & Levie, 1993). Text cues have been defined (Meyer, 1975) as elements in the text that guide the learner but do not convey information. These cues would include titles and headings that are used to provide a framework in the text guiding the reader to key information (Lorch, 1989; Meyer, 1975, 1985; Armbruster, 1986). It also includes the use of color codes and other types of alerts that are used to draw learner attention to key ideas (Jeung, Chandler & Sweller, 1997; Kalyuga, Chandler & Sweller 1999). A new area for research may be audio text, or narration with cues or signals, and its effect on performance and cognitive load. Use of audio alerts (Lee, 1996), and temporal sound (Mann, 1995) have been discussed in the instructional design literature, and audio alerts have also been discussed in the human factors literature (Shneiderman, 1998), but are indicated as a way to direct attention to important information or as a feedback mechanism. Studies are needed to investigate the impact of cued audio text, or narration, on the effectiveness of instruction.

Loman and Mayer (1983) determined that signaling or cueing improved both recall and the use of learned information for problem solving. Participants read either a signaled or non-signaled expository passage and were given a recall test, and a test to determine their success using the information for solving problems. The signals in this study consisted of a) preview sentences, b) underlined headings, and c) logical connective phrases. Participants with signaled text performed better on the recall of concepts and generated higher quality solutions to

problems. Participants with non-signaled text were better able to recall information from the beginning and end of a text passage and generated low quality solutions to problems. The authors concluded that signaling was effective in modifying students' reading strategies. Although the overall amount of information recalled by the signaled participants was less, signaling was found to improve both recall of concepts and the ability to transfer information to develop high quality solutions to problems. A study by Lorch, Lorch and Inman (1993) examined the effects of text signaling (headings, overviews and summaries) on the recall of expository text. They found that a) signaling improved recall for both the topics of the text and for their organization, and b) participants who received signaled text generated recalls that were organized better than those of participants who read plain text. In several experiments, Mautone and Mayer (2001) determined that cueing and structuring text information in a multimedia presentation improved both recall and transfer capabilities for information presented in a brief training segment. On closer examination of the instructional materials presented to the two groups of participants, it must be noted that the text structure may also have improved the readability of the materials.

In the three studies discussed above, the stimulus materials were relatively brief (3-6) paragraphs of expository text, and the participants were high school or college students. Of interest is the impact of text signaling on both cognitive load and performance to determine if the effects of signaling remain significant in a longer training session.

Other types of text cues include highlighting key words or phrases in the text using color, and for computerized forms of instruction, using animations or highlighting text electronically in some way. In a study that investigated the role of visual signals using both auditory and visual instruction modes, flashing text was tested as a method to reduce cognitive load in instructional

materials requiring high and low visual search techniques needed to coordinate audio and visual information (Jeung, Chandler & Sweller, 1997). For the flashing text treatment, when the audio text was presented, the corresponding visual portion of the text flashed. When participants used instructional materials that required high visual searching techniques, electronic flashing was found to be useful to guide the visual search in a mixed modality instructional format. In a related experiment, no significant benefit was found for flashing text in instructional materials with a low visual search requirement. The findings suggest that for instructional materials where the visual search requirements are high, inclusion of visual indicators (flashing) will direct the learner to the appropriate text. This design was thought to improve the effectiveness of the materials by reducing the cognitive load that results from the visual search processes. Participants in this study were 6th year primary school students, and the instructional materials were of brief duration and were in the area of geometry. Cognitive load was not measured in these experiments, but was suggested as the cause of the differences in performance on the achievement and transfer tests. In a similar experiment, Kalyuga, Chandler and Sweller (1999), used color-coded text in an attempt to reduce cognitive load caused by searching for relevant information on a diagram during instruction. The diagram with text was color coded so that the parts of the diagram, and their associated text were presented in the same color. For example, in describing the function of a circuit, both the area of the diagram with the switch, and the text that discussed the function of the switch in completing the circuit, were color-coded blue. It was predicted that the color-coded presentation would produce less cognitive load for learners than the traditional instructional format, supporting the hypothesis that color-coding reduced split-attention and reduced cognitive load. The findings supported this hypothesis; the color-coded diagram and text group had higher test performance and lower cognitive load than the group that

received conventional instruction. The authors suggested that when instructional text is presented in a written form, the search needed to coordinate diagrammatic and textual material can be simplified, and resulting cognitive load can be reduced by using color-coding or other signals to guide the learner. Participants in this study were students in the first year of a trade apprenticeship program. The instruction and testing was completely computer-based and the whole session took one hour. Of the signaling studies examined here, only this one took place in an actual training setting. Further research is required to test the use of signaling in instructional materials to reduce cognitive load and improve performance.

Although there is extensive research on the effectiveness of cues presented in visual text, there is a gap in the education literature on the effectiveness of signaled audio text. Since signaled visual text has been shown to be effective way to improve instructional effectiveness, signaled audio text that is presented as narration may also be an effective strategy. There is some information in the literature regarding the use of audio alerts in multimedia instruction. Mann (1995) investigated the use of temporal sound, or spoken information in a multimedia program used to present highlights and details of the instruction, and found that temporal sound may help learners focus attention on critical information and improve learning. In an overview of interface design elements for instruction, Lee (1996) suggests that audio feedback be used sparingly because too many audio alerts may confuse or annoy the learner. The human factors literature addresses audio alerts as a way to direct a computer user's attention to important information. In a comprehensive summary of alerts in the human factors literature, Shneiderman (1998) recommends using soft tones for regular positive feedback and harsh sounds for emergency situations. Further research is needed on the effect of sound and narration on learning and cognitive load, particularly with respect to signaled or cued narration.

Evidence Based Medicine

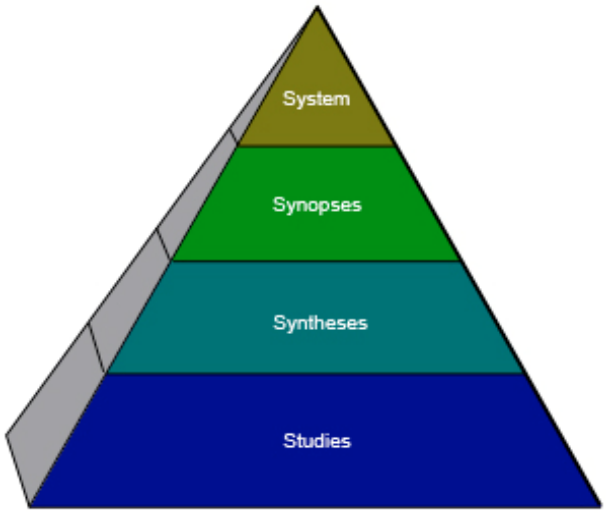
Evidence based medicine (EBM) content material will be used in this study. EBM refers to the use of the best evidence in the medical literature to make medical decisions regarding patient care. One of the many challenges in the practice of medicine is locating current and authoritative information to answer the many questions that occur during the course of caring for patients (Sackett, 2000). Even the most up to date health care provider frequently encounters gaps in professional knowledge that must be filled rapidly by reliable sources. Although the medical literature is an authoritative source, it is voluminous and increases exponentially each year. Empirical studies have shown that medical literature searching is difficult, and searches performed by medical professionals are not always successful (Sutcliffe, Ennis & Watkinson, 2000). EBM is a way to select the best the medical literature based upon judgements of which literature is the most scientifically accurate and relevant for patient care (Grandage, Slawson, & Shaughnessy, 2002). Leadership for EBM teaching and research is located at the Centre for Evidence-Based Medicine at Oxford University and at McMaster University in Hamilton, Ontario. In recent years, the medical community has adopted the EBM Pyramid, proposed to establish a hierarchy of evidence for physicians to use in selecting resources (Haynes, 2001; McKinnell, Elliott, & Frankish, 1999). The four levels of the pyramid are System, Synopsis, Synthesis and Studies (see Figure 2). The top layers of the pyramid are contain the best and most efficient evidence for patient care, and physicians are encouraged to search System resources first before trying to locate Synopses on a topic, and so on down to Syntheses and Studies.

The Accreditation Council for Graduate Medical Education (ACGME) requires that resident physicians demonstrate competency in 6 areas, one of which is Practice-Based Learning

and Improvement. Many hospitals, such as the one where this project will take place, are teaching techniques in EBM literature searching to fulfill this competency. Literature searching is a way to locate specific topical information in computerized databases that are available in libraries. EBM literature searching techniques was the subject matter taught to participants in this study.

Figure 2

The Evidence Based Medicine Pyramid



Problem

This study will extend the current research into the effectiveness of visual text, auditory text, and cueing for both types of text in instructional diagrams. These effects will be examined in an actual training situation, which will advance the research in a field where much of the research has been done with college students in experimental settings using brief instruction. Conducting the research using the library and information science domain of knowledge is also unique in that most of the previous research has been done using subject matter in technical areas such as mathematics and engineering. This study is designed to examine how visual text, audio

text and cueing impact cognitive load and performance of first year resident physicians when they are being trained on EBM literature searching procedures in an actual instructional setting in a medical library. Previous studies examining the impact of visual vs. audio text and cueing on cognitive load and performance have primarily concentrated on short instructional segments and have used students as research participants. The purpose of this study is to investigate the effects of text format and text and audio cueing in an actual instructional setting with professional learners using EBM subject matter for the first time. The following paragraphs describe hypotheses for this study.

Prior research has demonstrated that working memory can be enhanced by employing the modality effect. Studies by Tindall-Ford, et al. (1997) and Mousavi, et al. (1995) concluded that presenting a diagram with accompanying audio text or narration produced lower cognitive load and higher performance in research participants than a diagram with visual text. The following hypothesis will test the theory further, in a new domain of knowledge and in an actual training setting. It is predicted that novice participants using instructional materials with audio text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text.

Signaled or cued text has been found to effectively improve recall, problem solving, and transfer (Lorch & Mayer (1983); Mautone and Mayer (2001). Similarly, Jeung, Chandler and Sweller (1997) found that flashing visual text used to highlight important parts of the accompanying audio text, successfully directed learner attention to important points in the instruction. Kalyuga, Chandler and Sweller (1999) found that text that was color coded to coordinate with an accompanying diagram reduced cognitive load when compared with a non-coded version of the same text. The following hypothesis will add to this body of research by

testing the effects of signaling on cognitive load and transfer in a new domain of knowledge and in an actual training situation. It is hypothesized that novice participants using instructional materials with cued visual text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text without cues.

There is a gap in the education literature concerning the effectiveness of audio text, or narration, with cues. Audio alerts in multimedia instruction were discussed by Mann (1995), who investigated the use of temporal sound and found that it may help focus attention on critical information and improve learning. Lee (1996) suggests that audio feedback be used sparingly because too many audio alerts may confuse or annoy the learner. In the human factors literature, audio alerts are discussed as a way to direct a computer user's attention to important information (Shneiderman, 1998). In order to investigate the possible effectiveness of instructional narration with cues, it is hypothesized that novice participants using instructional materials with cued audio text will experience lower cognitive load, achieve higher recall, and formulate superior EBM literature searches than novice participants using instructional materials with non-cued audio text.

In summary, the hypotheses for this study are listed below, and will be tested in a new domain of knowledge and in an actual training setting, with older participants, actively involved in the medical profession.

1. It is predicted that novice participants using instructional materials with audio text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text.

2. It is hypothesized that novice participants using instructional materials with cued visual text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text without cues.

3. It is hypothesized that novice participants using instructional materials with cued audio text will experience lower cognitive load, achieve higher recall, and formulate superior EBM literature searches than will novice participants using instructional materials with non-cued audio text.

When the presentation format of instruction is changed, the learner's cognitive approach to the material is also changed. If visual text is presented to learners, they must read and process the information. If narration is used the learner must hear and process it. Theories regarding preferred learning styles are fairly detailed, and promote the idea that individuals prefer different ways of learning. But there is no theoretical bridge between learner preferences and cognitive load theory or any literature regarding how a learner's preference for reading or listening effects their performance, recall or cognitive load. The following research questions are designed to gather more information about these interesting concepts.

1. What are learner's attitudes toward the presentation of instructional text? Do they prefer audio text or visual text when learning from diagrams?

2. What are learner's attitudes toward text with cues? Do learners prefer visual text and audio text with cueing or visual text and audio text without cueing when learning from diagrams?

CHAPTER 3

METHOD

Participants and Research Design

The study tested participants' recall, performance, rating of cognitive load, and preferences when taking a web-based instructional course on EBM literature searching concepts and procedures. The Human Investigation Committee at Wayne State University and Henry Ford Hospital Institutional Review Board were consulted and their approval was received for this research. Participants were 78 first-year resident physicians, employed at a major teaching hospital in Detroit, Michigan. The participants were drawn from a pool of 123 first year residents at the institution. Although each of the residents were contacted to participate in the research, multiple times as necessary, there were 45 residents who could not participate due to scheduling difficulties. All residents are required to demonstrate competency in EBM literature searching as part of the residency training curriculum. The participants received a medical degree from a medical school that is accredited by the American Association of Medical Colleges, were computer literate, and were almost equally divided between males and females. Although the plan was for the participants to have no prior training in EBM literature search techniques, selected residents did receive training from a faculty member after the study began. This situation is discussed further below. Participants received a pretest at new resident orientation. Participants would be eliminated from the study if a statistically significant relationship is shown between the pretest and objective test results. The 5 item pretest had completely different questions than the 25 item objective test that was given to participants at the end of the study. The pretest and objective tests were designed this way to preclude any

incidental learning that could have caused inflated results on the objective test. Informed consent was required for this study.

The study was a 2 text (audio text and visual text) X 2 signal (signaled and non-signaled) design. Treatments were delivered via a 60-minute web-based instructional program that comprised actual instruction on EBM literature searching techniques, entitled Finding the Best Evidence (See Appendix F). Group 1 received visual text without signals. Group 2 received visual text with visual signals. Group 3 received audio text without signals. Group 4 received audio text with signals.

Major dependent variables were recall, performance, cognitive load, and learner preferences. These were measured by the following instruments; (a) a knowledge test of EBM concepts, (b) a demonstration of EBM literature searching skills, (c) a rating of cognitive load, (d) and a measure of learner preferences for audio text, visual text, and both of these with and without signals.

Materials

A 60-minute web-based instructional unit was developed on Evidence Based Medicine searching techniques and databases. Included was a definition of the best evidence for patient care, a description of information found in 7 EBM resources, and literature searching techniques to be used for extracting the best information. Interactions for the instruction were built based on Jonassen's generative strategies model (Jonassen, 1988), and included multiple choice questions, matching and listing tasks built into the web-based instruction. These embedded processes provided rehearsal, mnemonics, exemplifying, analysis of key ideas, analogies and synthesis based exercises to aid learners to understand the subject matter. Examples included disease processes and treatments that are familiar to resident physicians in their first year of training.

Since two treatments included narration, a video scriptwriter with 25 years of experience with developing instructional video was consulted regarding the appropriateness of the text for narration, and found that no changes were necessary for the script to be intelligible both as visual and audio text. A trained actor provided the narration for the treatments that required it.

Instruments

The present research seeks detailed information regarding the way presentation methods impact learning and performance. The instruments for the study were also detailed, and measured the effects of cued and non-cued visual and auditory text by; a) evaluating the cognitive load of the participants, b) identifying the format in which they prefer to learn new information, c) testing participants' recall of either cued or non-cued material, and d) determining how well participants can use their new knowledge to complete EBM literature searches.

Cognitive Load Assessment. A web-based mental effort rating scale was administered immediately after the instruction to all participants to gather their subjective assessment of cognitive load. The subjective cognitive load assessment that was used in this study was developed by Paas and VanMerrienboer (1994) and has been used in over 20 studies to measure cognitive load. The reliability of the rating scale was tested in two studies, and the coefficient of reliability (Cronbach alpha) was 0.90 and 0.82 respectively. In a test of sensitivity, the mental effort rating scale was shown to be sensitive to cognitive structures that were generated by different instructional strategies. The reliability and sensitivity of the measure is statistically significant. This rating scale consists of one question that is rated on a 9-point modified Likert scale. It was administered as the first question in the Learner Preferences Test in order to avoid any confounding by the testing.

Learner Preferences. A web-based instrument was used to examine learner preferences for audio text vs. visual text, and for visual text and audio text with and without cues. The participants were shown the diagram and text for all four treatments, and rated the treatments according to their preferences by assigning numbers one to five, five indicating the most preferred treatment.

Objective Test. A web-based objective test was administered to all participants to determine the amount of information they learned. This test was unique and did not contain any of the same questions used on the pretest.

Performance Test. A performance test was administered to determine how well the participants are able to complete a successful EBM literature search after taking the instruction. The performance test consisted of two clinical questions that could be answered by specific resources in the medical literature. The clinical questions were designed to encompass medical problems that typically occur in the practice of first year resident physicians. The literature was searched for test questions that have been used successfully in other EBM instruction, and the questions were selected from this pool by 3 experienced medical librarians and reviewed by a physician who is actively involved in the Internal Medicine Residency program. The two test questions that were developed for the performance test were carefully selected by the medical librarians so that there was only one correct answer for each of the two questions. This work was made easier because the participants were taught to search the EBM literature in the most efficient way, moving from the top to the bottom of the EBM pyramid using only the 7 specific resources that were part of the instruction. The participants applied the information they learned during the web-based instruction and attempted to select the correct resources and to answer the questions. The quality of the information they located was also evaluated. The evaluations

were completed by 3 medical librarians using a rubric. A rubric is a scoring instrument that allows tests to be scored objectively by defining all possible results and relating these to a precise number of points. The rubric was developed by a team, which included a medical librarian, a physician actively involved in the Internal Medicine residency program, and an educational specialist from the department of Internal Medicine. The rubric was constructed to reflect whether the evidence based information resources selected were the correct, and whether the results of the search contained the correct answer to the clinical question. All four treatment groups received the same performance test, which was administered last.

Treatments. Four treatments were designed to test the hypotheses regarding audio text, visual text, with and without signals. The treatments were designed with the assistance of three subject-matter experts; a Master's prepared medical librarian with 8 years experience, a Master's prepared librarian with 28 years experience, and a staff physician actively involved in the Internal Medicine residency program. The subject-matter experts have experience with EBM literature searching techniques and the ACGME competency requirements for resident physicians.

1. Treatment four incorporated three diagrams summarizing an important concept in EBM literature searching, and these were accompanied by narration that included audio cues for the most important concepts in the instruction. To produce these cues, the narrator used his voice to emphasize the material. The participant proceeded to the computer, put on a headset, and started the program. Each treatment took approximately 60 minutes. The treatment was immediately followed by a 30-minute session that included a rating of cognitive load, a measure of learner preferences for audio text, visual text, and for visual and audio

text with and without cues, an objective test of recall, and a performance test to demonstrate EBM literature search skills. These measures were also taken by the remaining 3 treatment groups.

2. Treatment three had the same three diagrams as treatment four, and the diagrams were accompanied by audio text without cues.
3. Treatment two had the same diagrams as the others, and had visual text with cues. These signals were produced by highlighting words in the instructional text on the computer screen.
4. Treatment one had the same diagrams, and had visual text with no cues.

Testing the Materials

Before the study began, the four treatments and the instruments were evaluated by an instructional designer, tested by two trained medical librarians, and field-tested by four volunteer resident physicians who are in their second year of training. Second year residents were chosen to evaluate the materials because they are the group which shares the most characteristics with the research participants without actually using potential research participants to test the materials. Revisions were made to the instructional materials and treatments based on the developmental testing. Minor changes made related to clarifying the instructional procedure for the participants and correcting typographical errors.

Procedure

The pretest was administered to all first year physician residents during new resident orientation. The residency program directors encouraged the residents to participate and complete their required EBM training in a timely way. Resident physicians made an appointment at their convenience to participate in the study. Residents who did not participate in

the study will be able to participate in the EBM instruction after the data are gathered and the instruction is released for general participation.

Data collection occurred during a normal week for medical residents, which is actually a 7-day, 80-hour week. Blocks of time were established during the day and afternoon shifts to accommodate the scheduling needs of the participants. The treatments and research instruments were completed in the study area of the hospital library. Participants were randomly assigned to a treatment group, in the order in which they entered the library for the study.

The participants were seated in a study carrel that contained a computer. The following procedure was used:

1. The research librarian logged the participant into the session
2. She explained the procedure for completing the instruction, including how to print the searching test.
3. The participant went through the instruction, including the following steps:
4. EBM web-based instruction program
5. Learner preferences test, including cognitive load measure
6. Objective test
7. Performance test
8. Logout

Each participant moved through these items at his or her own pace. Each person was logged in using a password and ID that identified the participant and allowed data from their session and their test results to move from the web instruction into a database. The participant completed one of four web-based instruction programs depending upon the treatment group to which he or she was assigned. For example, for treatment four they put on headsets and went through the

instruction. The headset was needed because the stimulus materials consist of three diagrams accompanied by narration, or auditory text. When the participant got to the screens with those diagrams, they rolled their mouse over the diagram to activate the narration. Treatment three participants also use the headphones. In treatments two and one, participants rolled the mouse over the diagrams, and the text appears on the screen to the right of the diagram. No headphones were used. Only three participants took part in the research at any given time, and they were not able to see one another. Their use or non-use of headphones did not affect them. After they completed the treatment, participants then completed the multiple choice learner preferences test with cognitive load measure. Next participants completed multiple choice objective test. Participants' answers were scored and recorded by the program. The final activity was the performance test. The participant read 2 clinical questions, and completed an EBM literature search on each to find answers. They printed out their answers. These answers were scored by 3 professional medical librarians using a rubric. After completing the session the participant was logged out by the research librarian. The elapsed time for each segment of the study was recorded. The average time that was taken by participants to complete the instruction was 89 minutes. Three computers were used to administer the treatments and the instruments. These computers were Dell desktop systems, with 2.40 GHz, 512 MB of memory, a flat panel 17" monitor, running Windows XP, with an integrated Sound Blaster compatible AC97 sound card. The computer will have a Logitech 2-button optical mouse and a Radio Shack head-set.

A summary of the hypotheses, research questions, instruments which were used for the analysis and assessment, and the statistical analyses are summarized in Table 1.

Table 1

Hypotheses, Research Questions, Instruments and Statistical Analyses

Hypotheses and Research Questions	Instruments	Statistics
Hypothesis 1: Novice participants using instructional materials with audio text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text.	Cognitive load measure Objective test Performance test	MANOVA and univariate analysis as needed
Hypothesis 2: Novice participants using instructional materials with cued visual text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text without cues.	Cognitive load measure Objective test Performance test	MANOVA and univariate analysis as needed
Hypothesis 3: Novice participants using instructional materials with cued audio text will experience lower cognitive load, achieve higher recall, and formulate superior EBM literature searches than will novice participants using instructional materials with non-cued audio text.	Cognitive load measure Objective test Performance test	MANOVA and univariate analysis as needed
Research Question 1: What are learner's attitudes toward the presentation of instructional text? Do they prefer audio text or visual text?	Learner preferences test	Paired t-test Wilcoxon rank sum test AVNOVA
Research Question 2: What are learner's attitudes toward cued and non-cued text? Do learners prefer visual text and narration with cues, or visual text and narration without cues?	Learner preferences test	Paired t-test Wilcoxon rank sum test AVNOVA

CHAPTER 4

RESULTS

MANOVA Procedure

Multivariate analysis of variance was performed using the SAS procedure PROC GLM. The outcome vector for the MANOVA considered the three primary measures: cognitive load, recall score and literature search score. An initial analysis used all four groups to test for interaction between text type (audio or visual) and cuing (present or absent). Since the specific research hypothesis dealt with groups two at a time, regardless of the result of the interaction test, MANOVA was also used to test each of the three hypotheses. Finally, MANOVA's adjusting for prior evidence based medicine training, were also performed. An alpha level of .05 was used for all statistical tests.

Univariate Analysis

The primary outcome variables were compared one at a time using Wilcoxon rank sum tests. Cognitive load and searching test results were also categorized as (difficult yes/no) and completely correct or not, respectively, and compared by chi square tests.

The search test score assigned by the three scorers were compared by a Kruskal-Wallis test. (The Kruskal-Wallis test is a generalization of the Wilcoxon rank sum test for more than two groups.)

Preliminary Analysis of Variables Used in MANOVA

Basic summary statistics for the MANOVA analysis variables are shown in Table 2. There were no significant correlations among the primary outcomes. The correlations ranged from 0.042 to -0.138, *p* ranged from 0.229 to 0.716. The pre-test score did not correlate with the main outcomes (r=-0.076 to 0.072), but had a modest correlation with how long into the

residency year a student was (r=0.301, p<.01). The residency time also had modest correlation with how long was spent on the training (r=0.241, p<.01). Finally, the time spent on the training had modest correlations with the objective and searching test scores (r=0.251 and r=235, p<.05), but no correlation with cognitive load (r=0.158, p>.05).

Table 2

Means and Standard Deviations or Percentages for Variables Used in MANOVA Analyses

Variable	Response	Plain Text (N= 20) Mean [SD]	Plain Audio (N= 19) Mean [SD]	Cued Text (N= 20) Mean [SD]	Cued Audio (N= 19) Mean [SD]
Cognitive Load	1-9 (9=Difficult)	4.2 [1.6]	4.6 [1.7]	4.3 [1.6]	3.7 [1.3]
Objective Test Score	25 Maximum (Best) Score	20.3 [2.3]	20.1 [3.3]	19.3 [3.3]	20.2 [3.1]
Searching Test Score	0, 1 or 2 Points	1.3 [0.6]	1.3 [0.5]	1.2 [0.6]	1.6 [0.5]
Searching Test Results	0 of 2 Correct	1 (5%)	0 (0%)	2 (10%)	0 (0%)
	1 of 2 Correct	12 (60%)	13 (68%)	12 (60%)	8 (42%)
	2 of 2 Correct	7 (35%)	6 (32%)	6 (30%)	11 (58%)
Prior EBM Training	No Prior EBM	15 (75%)	11 (58%)	14 (70%)	13 (68%)
	Prior EBM	5 (25%)	8 (42%)	6 (30%)	6 (32%)

MANOVA Results

The MANOVA p-values for interaction, main effects and three pre-specified hypotheses are shown in Table 3. No tests were statistically significant. Results were similar with and without adjustment for prior EBM training. The smallest p-values were observed for hypothesis 3, that cued audio text would give better outcomes than plain audio text but these were not statistically significant, (p>.05).

Table 3

MANOVA Significance Test Results With and Without Adjustment for Prior EBM Training

Effect	Unadjusted df	Unadjusted F	*p* Unadjusted	Adjusted for Prior EBM Training df	Adjusted for Prior EBM Training F	*p* Adjusted for Prior EBM Training
Interaction (text type vs. cuing)	3, 72	1.58	0.201	3, 71	2.02	0.118
Main Effects						
Text Type	3, 73	0.99	0.405	3, 72	0.84	0.479
Cuing	3, 73	0.47	0.702	3, 72	0.45	0.718
Hypothesis 1	3, 35	0.26	0.852	3, 34	0.44	0.723
Hypothesis 2	3, 36	0.61	0.612	3, 35	1.18	0.333
Hypothesis 3	3, 34	1.88	0.151	3, 33	1.85	0.158

All F-statistics are not statistically significant, p>0.05

Univariate Results

The univariable analysis results for the three primary hypotheses are shown in Tables 4A, 4B and 4C. There were no statistically significant differences. For hypothesis 3 (See Table 4C), the cognitive load was not significant (*p*>.05).

Table 4A

Univariable Comparisons for Hypothesis 1: Plain Text vs. Plain Audio

Variable	Response	Plain Text (N= 20) Mean[SD]	Plain Audio (N= 19) Mean[SD]	*p*
Cognitive Load		4.2 [1.6]	4.6 [1.7]	0.451

Variable	Response	Plain Text (N= 20) Mean[SD]	Plain Audio (N= 19) Mean[SD]	*p*
Cognitive Load Difficult	Cog Load <= 4	15 (79%)	14 (74%)	0.703
	Cog Load >= 5	4 (21%)	5 (26%)	
Objective Test Score		20.3 [2.3]	20.1 [3.3]	0.877
Searching Test Score		1.3 [0.6]	1.3 [0.5]	1.000
Searching Score Detail	0	1 (5%)	0 (0%)	0.579
	1	12 (60%)	13 (68%)	
	2	7 (35%)	6 (32%)	
	0 or 1	13 (65%)	13 (68%)	0.821
	2/2 Correct	7 (35%)	6 (32%)	
Total Time in Minutes		85.8 [33.7]	98.3 [35.4]	0.181

Table 4B

Univariable Comparisons for Hypothesis 2: Plain Text vs. Cued Text

Variable	Response	Plain Text (N= 20) Mean[SD]	Cued Text (N= 20) Mean[SD]	*p*
Cognitive Load		4.2 [1.6]	4.3 [1.6]	0.751
Cognitive Load Difficulty	Cog Load <= 4	15 (79%)	15 (79%)	1.000
	Cog Load >= 5	4 (21%)	4 (21%)	
Objective Test Score		20.3 [2.3]	19.3 [3.3]	0.325
Searching Test Score		1.3 [0.6]	1.2 [0.6]	0.631
Searching Score Detail	0	1 (5%)	2 (10%)	0.815
	1	12 (60%)	12 (60%)	

Variable	Response	Plain Text (N= 20) Mean[SD]	Cued Text (N= 20) Mean[SD]	*p*
	2	7 (35%)	6 (30%)	
	0 or 1	13 (65%)	14 (70%)	0.736
	2/2 Correct	7 (35%)	6 (30%)	
Total Time in Minutes		85.8 [33.7]	92.7 [37.8]	0.503

Table 4C

Univariable Comparisons for Hypothesis 3: Plain Audio vs. Cued Audio

Variable	Response	Plain Audio (N= 19) Mean[SD]	Cued Audio (N= 19) Mean[SD]	*p*
Cognitive Load		4.6 [1.7]	3.7 [1.3]	0.100
Cognitive Load Difficulty	Cog Load <= 4	14 (74%)	18 (95%)	0.075
	Cog Load >= 5	5 (26%)	1 (5%)	
Objective Test Score		20.1 [3.3]	20.2 [3.1]	0.965
Searching Test Score		1.3 [0.5]	1.6 [0.5]	0.120
Searching Score Detail	1	13 (68%)	8 (42%)	0.103
	2	6 (32%)	11 (58%)	
	0 or 1	13 (68%)	8 (42%)	0.103
	2/2 Correct	6 (32%)	11 (58%)	
Total Time in Minutes		98.3 [35.4]	99.7 [42.7]	0.977

Learner Preferences

Learner preferences were studied to determine whether:

1) Learners prefer audio text or visual text when learning from diagrams.
2) Learners prefer audio or visual text with or without cueing when learning from diagrams.

Participant preferences of mode of information presentations are shown Table 5. The overall proportions preferring audio text and cueing were 42% and 77%, respectively. The exact 95% confidence intervals for these binomial proportions were 31% to 54% and 66% to 86%, respectively. Since the confidence interval for text includes the 50% proportion, the data did not indicate a significant preference for audio text vs. visual text ($p>.05$). However, since the confidence interval for cueing does not include the 50% proportion, the data indicated a preference for cueing that is statistically significant ($p<.01$). That is, there is evidence that the participants preferred cueing, but no preference with respect to audio or visual text was determined.

Table 5

Preferences For Screen Type Most Liked

Screen Most Liked	N	Percent
Plain Text	9	11.54
Plain Audio	9	11.54
Cued Text	36	46.15
Cued Audio	24	30.77

Preferred Treatment

A summary of participants who did and did not receive the treatments that they preferred is reported in Table 6. For the 20 participants who received the treatment that they stated that they preferred on the Learner Preferences Test, no evidence was found that a preference match influenced cognitive load, recall or performance.

Table 6

Summary of Participants Receiving Preferred or Not Preferred Treatment

Variable	Response	Not Preferred (N= 58) Mean [SD]	Preferred (N= 20) Mean [SD]	*p*
Cognitive Load		4.1 [1.7]	4.5 [1.2]	0.408
Cognitive Load Difficulty	Cog Load <= 4	45 (80%)	17 (85%)	0.646
	Cog Load >= 5	11 (20%)	3 (15%)	
Objective Test Score		20.1 [3.0]	19.5 [3.2]	0.374
Searching Test Score		1.3 [0.5]	1.4 [0.7]	0.458
Total Time in Minutes		91.9 [33.1]	100.1 [47.5]	0.400
Pre-Test Score		2.3 [1.0]	2.2 [0.9]	0.552
Training Month		4.7 [0.8]	5.2 [0.9]	0.052

Test Results

Means of the test scores from the study reflected the expectations that were established when the study materials were pilot tested by the second year residents. The pilot test produced 3 usable sets of test data. One of the 4 residents who participated in the pilot test completed all of the instruction and testing in twenty-five minutes and his results were removed from the pilot because the trial was inadequate. Study test results and presented in Table 7 and the Pilot test

results are presented in Table 8. For not-preferred vs. preferred treatments, the participants mean score was 2.3 and 2.2 on the pre-test, 20.1 and 19.5 on the recall test and 1.3 and 1.4 on the performance test respectively.

Table 7

Summary of Participants Test Scores

Variable	Not Preferred (N= 58) Mean [SD]	Preferred (N= 20) Mean [SD]	*p*
Pre-Test Score	2.3 [1.0]	2.2 [0.9]	0.552
Objective Test Score	20.1 [3.0]	19.5 [3.2]	0.374
Searching Test Score	1.3 [0.5]	1.4 [0.7]	0.458

Similarly, the pilot test residents mean score was 20 on the recall test and 1.3 on the searching test respectively. These data show the expected distribution of scores for participants that scored high and low, and support the proposition that there is no ceiling effect reflected in the data.

Table 8

Summary of Pilot Test Scores

Variable	Pilot Test Scores
Objective Test Score	20.0
Searching Test Score	1.3

Analysis of Scoring

Scores were analyzed according to who among the three scorers scored the searching test, to look for a bias toward harder or easier scoring. The differences among in scores given by the three scorers were not statistically significant ($p>.05$ by Kruskal-Wallis test).

CHAPTER 5

DISCUSSION

Hypotheses

In this study, three hypotheses were investigated to determine whether visual or audio text, with and without cues, were the most effective methods to present instructional text, as measured by cognitive load, recall and performance of the study participants.

1. Novice participants using instructional materials with audio text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text.
2. Novice participants using instructional materials with cued visual text will experience lower cognitive load, achieve higher recall and formulate superior EBM literature searches than will novice participants using instructional materials with visual text without cues.
3. Novice participants using instructional materials with cued audio text will experience lower cognitive load, achieve higher recall, and formulate superior EBM literature searches than will novice participants using instructional materials with non-cued audio text.

The main effects and the three hypotheses were not statistically significant for any of the measures. Hypothesis one, that audio text would produce more positive results than visual text, and hypothesis two, that cued visual text would produce superior results when compared to visual text without cues, were not supported. Although not statistically significant, the largest differences in means or proportions were observed for hypothesis three (see Table 4C), which predicted that cued audio text would give better outcomes than plain audio text. There is strong

evidence in the literature that signaling or cueing is an effective way to direct learner attention to key topics, improve recall, transfer of training, problem solving, and learner organization (Loman & Mayer, 1983; Lorch, Lorch & Inman, 1993; Mautone & Mayer, 2001). The use of audio alerts and temporal sound has also been discussed in the instructional design and human factors literature (Lee, 1996; Mann, 1995; Shneiderman, 1998), but research on narration with cues or signals, and its effect on recall, performance and cognitive load are new with the present research. For the present research, it is noteworthy that the mean for cued audio text was 1.6 compared with the mean for plain audio text which was 1.3. Upon further analysis, it was noted that of the proportion of learners who received a perfect score (2 out of 2 correct) on the searching test, 58% received the cued audio treatment and 32% received the plain audio treatment. This result indicates the data is consistent with practical significance for cued audio text, even though it is not statistically significant. The data suggest a need for further research into this phenomenon.

This research sought to answer the question of whether the widely documented research results on cognitive load and performance could be replicated with ecologically valid materials and participants who had a vested interest in learning the content. The course which carried the stimulus materials was specifically designed for the study population, to fulfill the ACGME competency for Practice Based Learning and Improvement that all residents in the United States are required to accomplish. The hypotheses were not supported, and the results were not replicated as anticipated. Explanations for these results are discussed in detail below.

Expert Reversal and Intelligence

One explanation for the lack of a relationship between the hypothesized variables is a recent addition to cognitive load theory, the expertise reversal effect. Expert reversal occurs

when experts are provided with instruction that is most useful to novices, and the extra information that is not needed by the experts creates a redundancy effect and increases extraneous cognitive load (Kalyuga, Ayres, Chandler, & Sweller, 2003). Another recent addition to cognitive load theory is a deeper understanding of schema formation, and that there are changes in cognitive load as a learners' expertise develops (Paas, Renkl, & Sweller, 2003). Since the data for the pretest did not interact significantly with the other test results in this study, and it is clear that participants were novices with the topic of the instruction, EBM literature searching. Although we are confident of the participants' novice condition, it is conceivable that their existing medical knowledge and their general knowledge of literature searching had actually moved some of the participants forward on the novice to expert continuum and that schema formation was more advanced in some participants. If this is true, expert reversal effect could perhaps be responsible for the lack of statistical significance in the data, having the effect of reversing the performance of some of the participants who were more expert than others.

Another explanation could be the intelligence and learning skills of the participants; perhaps we can refer to them as "expert learners". The study participants were all resident physicians who had successfully completed medical school and had spent 3 -7 months in training at a major metropolitan teaching hospital. In order to achieve their positions, the participants must be highly intelligent, successful students, and knowledgeable in the subject of medicine. Their similarity in terms of high intelligence and their sophisticated study skills may have lead to their being capable of high achievement with any instructional design. The effects of the treatments in relation to cognitive load, recall and performance may not have been measurable because the participants were highly intelligent, outstanding learners who could succeed in any instructional setting. Medical schools entrance criteria are set very high, and most successful

applicants have a higher undergraduate grade point average (GPA) and higher scores on standardized tests than most college students.

Research Questions

The study also sought to determine whether the effectiveness of the presentation methods for visual text is affected by learner preferences for different text designs. Research questions explored whether learners preferred audio text or visual text, and whether learners preferred visual and audio text with or without cueing. The research questions for this study are as follows:

1. What are learner's attitudes toward the presentation of instructional text? Do they prefer audio text or visual text when learning from diagrams?
2. What are learner's attitudes toward text with cues? Do learners prefer visual text and audio text with cueing or visual and audio text without cueing when learning from diagrams?

Data from a detailed learner preferences instrument, determined that the participants preferred cueing, but that no preference with respect to audio as opposed to visual text was determined. The literature is clear about the usefulness of visual cueing or signaling in instructional text. Instructional message design methods include the use of headings and text structure that help the learner develop a framework in the text to guide the learner to key information (Armbruster, 1986; Fleming & Levie, 1993; Lorch, 1989; Meyer, 1975, 1985). Cueing then, is both a method supported by research in the field, and a method that was preferred by the participants in the current research.

Learner Preferences and Learning Style

Another interesting result for this data set is that for participants who received their preferred treatment, no evidence was found that their preference influenced cognitive load, recall, performance or total time in minutes spent on the instruction. These results are summarized in Table 9.

Table 9

Participants Receiving Preferred or Not Preferred Treatment

Variable	Response	Not Preferred (N= 58) Mean [SD]	Preferred (N= 20) Mean [SD]	p-value
Cognitive Load		4.1 [1.7]	4.5 [1.2]	0.408
Recall Test Score		20.1 [3.0]	19.5 [3.2]	0.374
Searching Test Score		1.3 [0.5]	1.4 [0.7]	0.458
Total Time in Minutes		91.9 [33.1]	100.1 [47.5]	0.400

For purposes of this research, the learner's preference for a given treatment was determined in the Learner Preference Test, one question of which showed all four treatment methods and asked which they preferred. The screen from the instruction used in this way was the EBM Pyramid screen, one of three that was used in each of the four treatments to present information differently for each of them. For example, the explanatory text for the EBM Pyramid was presented as plain visual text, cued visual text, plain audio text and cued audio text, depending upon the treatment to which each participant was assigned. The participant was asked which screen they preferred when learning new information. This represents a direct measure of which treatment the learner preferred when learning new material for this particular course.

Previous research has indicated that good measurement tools are available for learning styles and learner preferences (Dunn, 1990; Dunn & Dunn, 1978) and that learning differences based upon preferences can be implemented in the classroom when these preferences are known (Nunney & Hill, 1972). Based upon previous research, some effect of learner preferences may have been anticipated when the learner is assigned to the treatment that most directly matched their preferred learning style. More recent literature speaks to the lack of empirical research regarding the categorization of individuals as auditory learners, visual learners, and even horizontal learners (Jonassen, 1993, Smith & Ragan, 1999) in relation to any particular instructional strategy or instructional design recommendations for groups of learners. This lack of a demonstrated relationship between specific instructional strategies and learner preferences may explain the data summarized above. Other explanations are also possible. As we investigate the depths of human cognition through brain research with sophisticated medical research tools in the next decade, some of these debates will be put to rest. For now, it makes some degree of sense that cognitive load during instruction would not necessarily be effected by a learner's preference if cognition is a feature of human awareness that is more biologically structured than perhaps an opinion or a preference. This is an area for future research.

Prior Training

One unanticipated event during this experiment was the introduction of EBM training by a physician staff member to 28 resident physicians during the study period. This was an informal course that was taught without a set curriculum or outline, and based upon the needs of the resident physicians as perceived by the instructor. The residents were taught in three groups during a three month period, during the data collection period for this study. The residents were also given instruction in EBM during patient rounds, which is a twice daily visiting of patients

by physicians who are responsible for their care. During rounds, when it became apparent that EBM principles were needed to find literature to improve the care of a particular patient, informal instruction was offered to residents. Statistical analysis showed no difference in cognitive load, recall or performance between the resident physicians who took part in this prior training and those who did not, see Table 10. Since there was minimal overlap in the information taught in the informal course and the EBM web-based course upon which this experiment is based, this lack of significance is not surprising.

Table 10

Summary of Significance for Test Results With and Without Adjustment for EBM Training

Effect	*p* Unadjusted	*p* Adjusted for Prior EBM Training
Interaction (text type vs. cuing)	0.201	0.118
Hypothesis 1	0.852	0.723
Hypothesis 2	0.612	0.333
Hypothesis 3	0.151	0.158

Participants and Designs

One of the goals of this research was to replicate previous cognitive load experiments in an actual training situation with adult learners. This study is one of the few cognitive load studies conducted in an actual training setting with participants who are actively working professionals, beyond their college years, in this case resident physicians. Chandler and Sweller (1991, 1992), Cerpa, Chandler, and Sweller (1996), and Mayer, Heiser, and Lonn (2001) investigated split attention and redundancy. Chandler and Sweller (1997), Mousavi, Low and

Sweller (1995), Chandler and Sweller (2000), and Tindall-Ford et al. (1997) investigated the impact of the modality effect when instructional designs are made to take advantage of more than one channel (audio vs. visual) of working memory. Loman and Mayer (1983), Lorch, Lorch and Inman (1993), Mautone and Mayer (2001), and Jeung, Chandler and Sweller, 1997) all investigated the impact of text cueing on recall and performance. In all cases, the stimulus materials were relatively brief and the participants ranged from 7th grade students to college students.

Two studies offer a possible explanation for the results found in the present research. Kalyuga, Chandler and Sweller, (1999), tested the effectiveness of cued written text. The participants were trade apprentices in an actual training situation, and the instruction was 60 minutes long. This study determined that presenting cued text, when color coordinated with an accompanying diagram, simplified the visual search needed to understand the diagram and reduced cognitive load. So this research used longer instruction, cued text and took place in an actual training situation, and demonstrated the effectiveness of cueing in instructional text. It is interesting that in this study, the instruction was system-paced rather than learner-paced.

A study by Tabbers, Martens and Van Merrienboer (2004) investigated the modality effect and cueing by presenting four treatments similar to those used in the present research, audio and visual text, both with and without cues. The study was also similar in that the instruction was one hour in length, followed by a period of testing, and the participants were adults 20 to 25 years old. It was predicted that participants who received the audio treatments would outperform those who received the visual treatments, but this did not prove to be the case. Also, cueing was significant in results for the objective test, but not for the transfer test, and mental effort was equal for all conditions, again similar to the results for the present research.

The authors proposed a modality reversal effect, where the expected results of the research are the reverse of the expected modality effect, and the visual text was the more effective instructional strategy. This modality reversal effect could have been the result of the instruction being learner-paced as opposed to system-paced. When instruction is system paced, the learners in each treatment have the same amount of time to review the material, focus their attention on learning, and move on to take the test. In this scenario, the audio text is more efficient and better uses the dual processing features of working memory.

For both the present research and the Tabbers et al. (2004) study, the pace of the instruction was controlled by the learners. Learner-paced instruction allows the participants in the visual text treatment to skip back and forth in the text and review the visual material more easily than the audio text can allow. The participants with visual text have an advantage in learner-paced instruction that is not as available to those in the audio condition, where the text is more linear in nature and skipping around for review is not accomplished as easily. It should be noted that the Kalyuga, et al (1999) study, with adult learners, longer instruction, and a demonstrated modality effect, was also system-paced. Although the modality reversal effect is speculative and requires additional research, it is a possible explanation for the differences in results between the present research, the Tabbers et al. study, and the larger base of research that demonstrates the modality effect. Demonstrating the modality effect in web-based training is an interesting and challenging undertaking that will require additional research and planning to fully replicate in an actual training situation.

Limitations

The sample size was limited by the number of resident physicians available at the institution during the study period. This is a reality of working with residents in a hospital

setting where they are the primary patient care givers and are working an 80-hour per week schedule. Another limitation is that during the study period, a physician conducted an informal class on EBM with 28 of the study participants. Since these participants were randomized across the study, their participation in the extra training did not have a statistically significant effect on the data. Also, there was a practical limitation on the number of questions that could be included in the searching test. Although it would have been better to have more than two questions on the searching test so that the means would have been more statistically powerful, adding more questions would have extended the time spent on the study beyond what one could expect from the participants. Finally, the measurement of cognitive load in this study was completed by a subjective measurement which has been shown to be statistically significant. It is possible that using the measure multiple times, rather than once as we did in the present study, may have yielded additional significant data. Objective measures of cognitive load are also becoming more accessible to researchers and could be considered for future research.

Implications for Instructional Design

Two important observations have been added to the knowledge base of instructional technology as a result of this experiment.

1. Learners prefer cued text in the instructional designs.
2. Learner preferences did not impact on cognitive load, recall or performance.

Regarding cueing, no determination could be made about whether learners preferred audio or visual text with cues, but overall cued text was found to be preferable to plain text. This is good news for designers of web-based instruction and message designers, whose goal is to present an attractive course that will motivate learners. When participants received the treatment that they preferred, there was no evidence that this affected their cognitive load, recall or performance on

the EBM searching test. Although there is more work to be done in both of these areas, it is safe to say that designing signaled or cued text will assist in the effectiveness of instructional designs, and that learner preferences have yet to be shown effective in the delivery of web-based instruction.

Future Research

Several interesting directions are provided to instructional technology researchers by this study. Overall, the most interesting of the questions is the very different results experienced here when compared to other studies in the cognitive load literature. What caused the lack of statistical significance in the three hypotheses, two of which had been tested many times by other researchers? It is possible that the longer instructional session, the use of adult learners, the learner-paced design, or the fact that very high achieving "expert learners" were used as participants somehow impacted the complex mix of factors and affected the results enough to eliminate statistically significant differences. Future investigations could include the design of a shorter version of this course with the same cohort of participants, or conversely to design a similar course with learners of more average achievement. These research designs may help to determine whether there are conditions under which a particular design for web-based instructional text can be found to be most effective.

The fact that the cued audio treatment approached statistical significance is also intriguing. The practical significance of perfect performance tests for a large percentage of participants who received the cued audio treatment is worthy of additional investigation. This is particularly important because previous research was done by inserting audio alerts, such as beeps, rather than by cueing or emphasizing actual words, the method used here. Since so much

web-based instruction now includes audio text, it would be interesting to further explore the effectiveness of cued narration by word emphasis.

Another important area for future research is the impact of self-pacing on modality choices. The Tabbers et al (2004) study was similar to the present research in that it did not replicate the modality effect, nor demonstrate the superior effectiveness of audio text when compared to visual text. Since other cognitive load researchers have demonstrated the modality effect with instructional designs that included system-paced instruction, research on the pacing of instruction is indicated from these contradictions.

Further exploration into cued text, both visual and audio, and their impact on in the effectiveness of instruction is a rich area for future research.

APPENDIX A - PRE-TEST

Evidence Based Medicine Study - Screening Test

This is a screening test for a research project on Evidence Based Medicine (EBM). It is a screening device for the research. Your scores are not permanently recorded. Answer the questions to the best of your ability. If you are not sure of an answer, please guess.

1. What is Evidence Based Medicine?

   a) A laboratory procedure that measures the effectiveness of medical treatments
   b) A protocol to capture evidence and findings from pharmaceutical research
   c) A system for medical decision-making based on evidence in the literature
   d) An educational program regarding legal evidence and medicine

2. Which type of EBM resource is the most efficient method by which to locate clinical information?

   a) Studies
   b) Systems
   c) Synopses
   d) Syntheses

3. Who designed the EBM Pyramid of Evidence?

   a) Haynes
   b) McMaster
   c) Oxford
   d) Sackett

4. You have been assigned by the chairman to locate the best clinical information for development of a new clinical policy on the use of nasal influenza vaccine in children from 2 years to 4 years of age. For a detailed and comprehensive review of the topic, which resource should you consult?

   a) Cochrane
   b) DARE
   c) MEDLINE
   d) Up To Date

5. What type of information is in the Cochrane Database of Systematic Reviews?

   a) Clinical information summaries selected with rigorous criteria.
   b) Good information for answering Background questions.
   c) Literature searches and references selected by medical librarians.
   d) The world's most authoritative database of medical information.

APPENDIX B - LEARNER PREFERENCES TEST

Evidence Based Medicine Study - Learner Preferences Test

1. On the scale below, please indicate the amount of mental effort you experienced when completing this course. Rate your effort 1 if you found the course very, very easy, and up to 9 if you found it very, very difficult. Please only choose one number, from 1 to 9.

1	2	3	4	5	6	7	8	9
Very, very Easy		Easy		Neither Easy Or Difficult		Difficult		Very, very Difficult

For questions 2-4, please look at the following four screens which represent four different teaching methods. If you have not already done so, please put on the headphones provided for you. Click on the screen shot to see an example of each teaching method. Please take a moment to look at each screen.

Screen 1 Diagram and plain visual text	Screen 2 Diagram and narration
Screen 3 Diagram and cued visual text	Screen 4 Diagram and cued narration

2. Which screen would you <u>most</u> like to use when learning new information? Please indicate your answer below by clicking on your preference.

- ❑ Screen 1
- ❑ Screen 2
- ❑ Screen 3
- ❑ Screen 4

3. Which of the screens would you least like to use when learning new information? Please indicate your answer below by clicking on your preference.

- ❑ Screen 1
- ❑ Screen 2
- ❑ Screen 3
- ❑ Screen 4

4. Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.

_____ Screen 1
_____ Screen 2
_____ Screen 3
_____ Screen 4

For questions 5-9, please indicate your answer on the scale provided. All of these questions refer to an online instructional program like the one you have just completed.

5. When working on an online instructional program, I prefer to read the text instead of listening to narration.

- ❑ Strongly Agree
- ❑ Agree
- ❑ Neither Agree or Disagree
- ❑ Disagree
- ❑ Strongly Disagree

6. When working in an online instructional program, I prefer to listen to a narrator instead of reading written text.

- ❑ Strongly Agree
- ❑ Agree
- ❑ Neither Agree or Disagree
- ❑ Disagree
- ❑ Strongly Disagree

7. When reading text from a computer screen, I find that highlighted words help me remember important concepts in the instruction.

- ❑ Strongly Agree
- ❑ Agree
- ❑ Neither Agree or Disagree
- ❑ Disagree
- ❑ Strongly Disagree

8. When listening to spoken language and the narrator emphasizes certain words, I find it easier to remember these ideas and facts.

- ❑ Strongly Agree
- ❑ Agree
- ❑ Neither Agree or Disagree
- ❑ Disagree
- ❑ Strongly Disagree

9. When studying new material, my preferred learning method is to read the words on the screen and listen to the narration at the same time.

- ❑ Strongly Agree
- ❑ Agree
- ❑ Neither Agree or Disagree
- ❑ Disagree
- ❑ Strongly Disagree

When answering questions 10-15, please think about how you prefer to learn new information when studying or working. First read through the entire list. Please indicate your answer by clicking on your preference. Select only one learning method for each question.

10. When learning about a concept such as differential diagnosis, I prefer to use this method for understanding the information:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online
- ❑ Read a journal article
- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape
- ❑ Other, please specify _____

11. When learning about a disease process or symptom such as cardiac arrhythmia, I learn best by:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online

- ❑ Read a journal article
- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape
- ❑ Other, please specify _____

12. When learning to recognize a dermatology condition such as eczema, I prefer to:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online
- ❑ Read a journal article
- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape

Other, please specify _____

13. When learning to recognize a condition such as jaundice, I prefer to:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online
- ❑ Read a journal article
- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape
- ❑ Other, please specify _____

14. When learning how to take a patient history, I prefer to:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online
- ❑ Read a journal article

- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape
- ❑ Other, please specify _____

15. When learning a procedure such as the steps of a physical exam, I prefer to:

- ❑ Listen to a CD
- ❑ Listen to an audio tape
- ❑ Listen to a lecture in person
- ❑ Listen to a lecture online
- ❑ Participate in a discussion in person
- ❑ Participate in a discussion online
- ❑ Read a journal article
- ❑ Read a book
- ❑ Read new information online
- ❑ Watch a DVD
- ❑ Watch a video tape
- ❑ Other, please specify _____

APPENDIX C - OBJECTIVE TEST

Evidence Based Medicine Study - Objective Test

Please read each question carefully and select the one, best answer.

1. There are three prominent organizations that provide leadership, research, workshops and resources for evidence based medicine programs world-wide. Of the organizations listed below, which is one of these prominent organizations?

   - ❑ Cochrane Collaboration (Correct)
   - ❑ Haynes EBM Institute
   - ❑ McMaster Network
   - ❑ Trout Research Center

2. Rank the following resources in terms of their efficiency for finding clinical information. Rank them 1 – 4, with 1 being the most efficient.

   _____ DARE (Ranking – 2)

   _____ MEDLINE (4)

   _____ Cochrane (3)

   _____ Up To Date (1)

3. If you are searching for information at home, and want to check systems resources first, which EBM resource should you choose?

   - ❑ ACP Journal Club
   - ❑ Clin-***e***guide (Correct)
   - ❑ DARE
   - ❑ Up To Date

4. Which of the following statements indicates to you that the best evidence is being used for patient care?

   - ❑ I prefer a policy of watchful waiting in a case such as Mr. Jones.
   - ❑ The staff said that with cases like this, we should do it his way.
   - ❑ This is the way we did it at the hospital where I did my residency.
   - ❑ We haven't had a case like this lately, let's consult the literature. (Correct)

5. The EBM pyramid is directly available on the web at which two locations?

   - ❑ Care Plus and henryford.com
   - ❑ Care Plus and the NIH

- Sladen site and Care Plus (Correct)
- Sladen site and henry.hfhs.com

6. Of the four categories of Evidence Based Medicine that are represented on the EBM Pyramid, which one requires the most time and effort to locate useful clinical information?

- Studies (Correct)
- Synopses
- Syntheses
- Systems

7. What is one of the characteristics of the Up To Date database?

- Available for remote use at home or while traveling
- Compiled by information company employees
- Search processes and cumbersome and inefficient
- Source of expert topic reviews on clinical conditions (Correct)

8. EBM System resources are a good source of information for which type of information?

- Background questions
- Foreground questions
- Both types of questions (Correct)
- Neither type of question

9. What are background questions about?

- Basic sciences information related to patient care
- General knowledge about how to treat a disorder (Correct)
- Information related to literature searching procedures
- Specific information regarding patient management

10. Which of the statements below is a characteristic of Studies?

- Foreground questions are best answered using Studies
- Include expert appraisal of the evidence available for clinical questions
- Must be consulted for information when all other resources are exhausted (Correct)
- Studies are the most efficient method for locating clinical information

11. You have been assigned by the chairman to locate the best clinical information for development of a new policy on the use of a new ALS medication in adult patients. You have already searched Up To Date, Clin-***e***guide, ACP Journal Club, and DARE, with limited results. What is the next resource you choose to search?

- Cochrane (Correct)
- MEDLINE

- Sum Search
- Up To Date

12. Which of the statements below is a characteristic of System resources?

- Used exclusively to answer Foreground clinical questions
- The most efficient source of information for clinical questions (Correct)
- Unavailable from Care Plus, the HFHS online medical record
- Near the bottom of the Evidence Based Medicine pyramid

For questions 13 - 14, please read the following case and clinical question:

Your patient, Mrs. Johnstone, presents in the ER with right arm clumsiness and garbled speech. Her blood pressure is 154/84 mmHg with a regular heart rate of 72 per minute. Examination of cardiovascular and neurological systems is otherwise entirely normal. Your diagnosis is transient ischemic attack and you prescribe aspirin. You are interested in assessing Mrs. Johnstone's carotid arteries for possible stenosis, but you are not keen on referring her for a risky angiogram, and are not sure about the efficacy of a carotid ultrasound as an alternative.

Clinical Question: In order to confirm carotid stenosis what is the best choice, a carotid ultrasound or an angiogram?

13. In order to perform an efficient search, the first place you should consult for information is:

- ACP Journal Club
- Cochrane
- Sum Search
- Up To Date (Correct)

14. Why choose this resource first?

- It is a resource of studies
- It is a resource of synopses
- It is a resource of syntheses
- It is a systems resource (Correct)

For questions 15- 16, please read the following:

The mother of your patient, a ten-year-old healthy girl, calls to say that her daughter is coming down with a cold and she has heard that Echinacea can be helpful. She wants to know whether you recommend it.

15. System resources are temporarily unavailable. Which resource would you consult next?

- Cochrane
- DARE (Correct)
- MEDLINE
- Up To Date

16. If you needed additional background information on this topic and system resources were still unavailable, where would you look?

- ACP Journal Club
- Cochrane (Correct)
- DARE
- MEDLINE

Please read the following case study and answer question 17:

As the result of a routine physical examination, 18 year-old woman with no previous medical problems is found to have a cholesterol reading of 302. You recommend that she see the dietitian for a cholesterol lowering diet, and schedule a repeat visit for 4 months. In 4 months, her cholesterol is 270, and you decide to start the patient on cholesterol lowering drug treatment. The patient has a family history of high cholesterol and coronary artery disease, and asks you if exercise will assist in lowering her cholesterol. The patient is scheduled to return to your office in two weeks, and you plan to search for the best evidence before the appointment.

Clinical Question: For an 18-year-old woman with high cholesterol, will exercise contribute to lowering cholesterol and preventing coronary artery disease?

17. This is an example of what type of a clinical question?

- Background Question
- Foreground Question (Correct)
- Patient Question
- Study Question

18. Which of the statements below is a characteristic of Synopses?

- Consulted when no System resources are available (Correct)
- Contain lengthy and detailed articles of 10-15 pages
- Provide extensive background information about clinical questions
- The first source of EBM information that should be consulted

19. Which of the following types of studies is the gold standard of best evidence?

- Appraised cohort studies
- Case control studies
- Randomized controlled trials (RCT)
- Systematic reviews of RCT's (Correct)

20. Who developed the pyramid of evidence that categorized the literature into the four S's: system, synopses, syntheses and studies?

- Elliott
- Haynes (Correct)
- McKinnell
- Sackett

21. Which of the following statements is true of the ACP Journal Club?

- Articles are summarized in lengthy documents of 15 pages or more
- Has abstracts of clinically relevant articles with sound methodology (Correct)
- Is available on the Cochrane Collaboration web site at no cost
- Provides an interactive forum on EBM for all interested clinicians

22. Which of the following resources is an EMB search engine?

- Cochrane Database
- DARE
- MEDLINE
- SUMSearch (Correct)

23. At what point in his or her medical career is a physician most likely to have numerous and varied background questions?

- During a fellowship
- Early in their career (Correct)
- Just before retiring
- Late in their career

24. What is a characteristic of synopses?

- Essential clinical information is provided in paragraph format
- Provides extensive, detailed clinical background information
- Outlined, structured abstracts of individual studies and reviews (Correct)
- It is used when there are no relevant studies on a medical topic

25. What is the biggest challenge related to using studies?

- Few articles are usually found and insufficient information exists to make a good clinical decision
- Extensive articles with background information make it hard to find the most relevant information
- Rigorous searches for evidence can leave doubt regarding the effectiveness of clinical interventions
- A lack of expert appraisal leaves clinicians to judge validity and usefulness for clinical care (Correct)

APPENDIX D - SEARCHING TEST

Evidence Based Medicine Study - Searching Test

Three patient situations with clinical questions are described below. Consider each situation and the clinical question. Use the link below to go to the Sladen EBM Pyramid, select the resource you will use, and complete a search for each question. You may stop the search process when you have located an answer to each clinical question. Print your search results for each question.

1. Mrs. Naggan, a 46-year-old woman, has had ulcerative colitis for 7 years now, with extensive involvement of her colon and severe symptoms at times. Her colitis is in remission at present. She would rather not have surgery, but is concerned about the mounting risk for cancer that she has heard of through the newsletter of a patient support group for her condition. Her spouse has convinced her to find out just what the risk might be.

   Clinical Question: In a 46-year-old woman with a 7-year history of extensive ulcerative colitis, what is the risk for developing bowel cancer?

   EBM Pyramid

2. In your role as the physician on a patient safety improvement team, you audit 150 consecutive patient notes from patients in your department to determine the proportion of patients for whom the department has provided appropriate preventative care. You discover that there is an uneven recommendation of preventive interventions. Some patients who are unlikely to be helped have been receiving interventions, and some patients have been missed for whom these interventions are likely to be beneficial. You wonder if computerized reminders will be an effective way to help you and your colleagues carry out preventive care, and other routine tasks.

   Clinical Question: Can computerized reminder systems improve the quality of clinical care?

   EBM Pyramid

APPENDIX E – GRADING RUBRIC

Finding the Best Evidence
Grading Rubric for Searching Test

Participant Name_____ Researcher Name_____

Directions:

Two patient situations with clinical questions are described below. Consider each situation and the clinical question. Use the link below to go to the Sladen EBM Pyramid, select the resource you will use, and complete a search for each question. You may stop the search process when you have located an answer to each clinical question. Print your search results for each question.

Question #1: In a 46-year-old woman with a 7-year history of extensive ulcerative colitis, what is the risk for developing bowel cancer?

Participants must find the information in **UpToDate** or **Clin-*e*guide**.

This is a pass/fail question.

Score_____

Question #2: Clinical Question: Can computerized reminder systems improve the quality of clinical care?

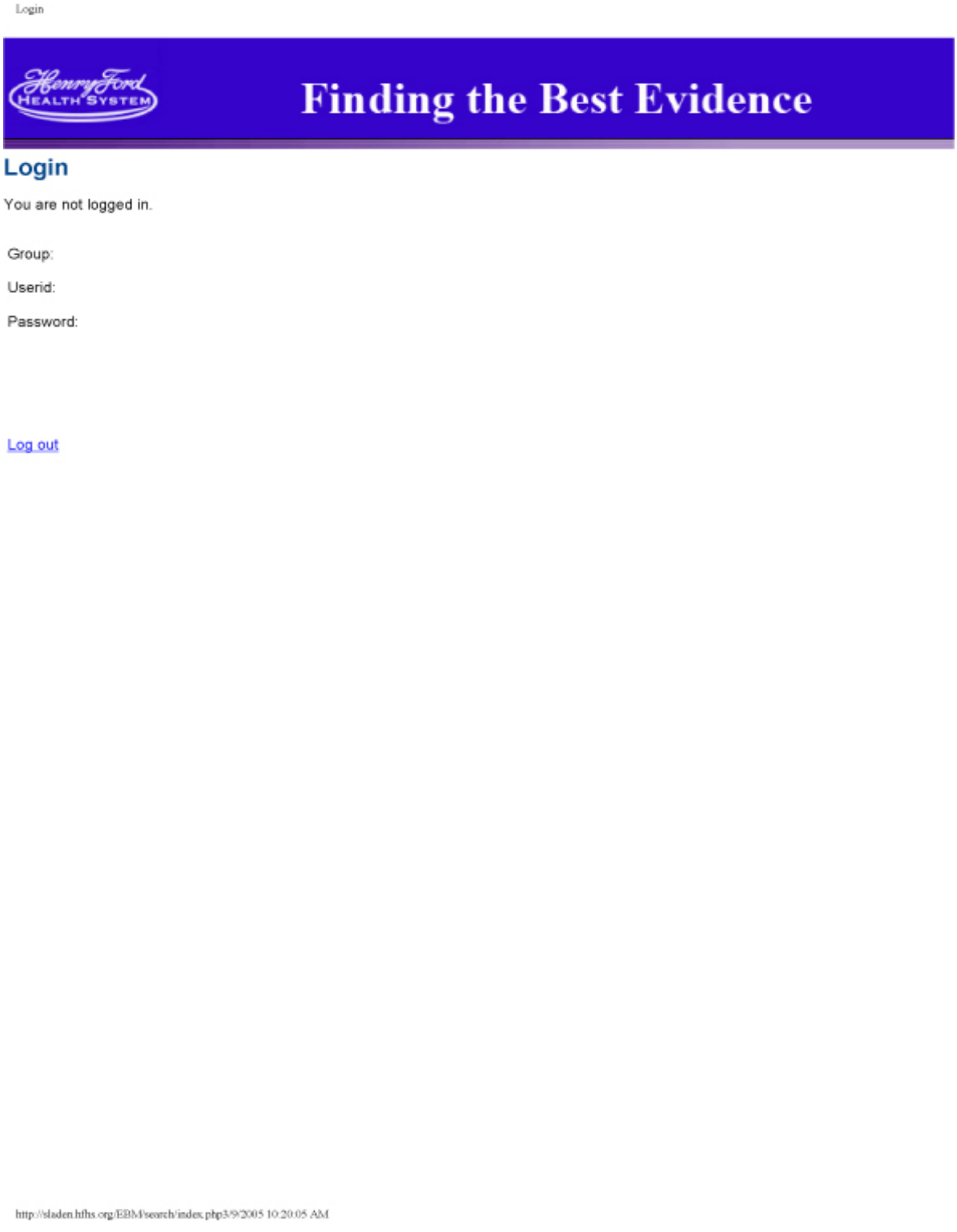
Participants must find the information in **ACP Journal Club** or **DARE**.

This is a pass/fail question.

Score_____

Grading notes: For each question the possible score is 0 for fail and 1 for pass. The total score can be 0, 1 or 2.

APPENDIX F



Login

Login

You are logged in as: test01

Log out

Begin Finding the Best Evidence!

Henry Ford Health System

Finding the Best Evidence

What is EBM?

Evidence based medicine (EBM) is a system for making patient care decisions based on clinically relevant evidence in the medical literature.

> "It is the integration of the best research evidence, clinical expertise and patient values. When these three elements are integrated, clinicians and patients form a diagnostic and therapeutic alliance which optimizes clinical outcomes and quality of life." Sackett, Evidence-Based Medicine: How to practice and teach EMB.

Finding answers to clinical questions fast is a priority for clinicians. The good news is that with the right skills, finding answers based on the best medical evidence available is becoming easier every day.

This program is designed to teach you how to use resources at the Sladen Library web site to locate these answers quickly.

Press Next to get started.

Next >>

Finding the Best Evidence

Why EBM?

Finding the best evidence to support clinical practice is essential for good patient outcomes. Even the most expert physician must improve and update their knowledge base in order to provide the best care. But what is the best way to achieve this goal? Traditionally, physicians have kept up to date by reading journals in their specialty. In today's fast paced hospital setting, physicians must quickly target relevant and authoritative information. Finding information or articles that present clinically excellent studies on a specific topic quickly is what EBM is all about.

This course is designed so that you fulfill the Practice Based Learning and Improvement competency of the Accreditation Council for Graduate Medical Education.

Introduction
--What is EBM?
--Why EBM?
--Founders
--Gold Standard
--Pyramid of Evidence
--Navigating Around

Clinical Questions
EBM Pyramid
EBM Resources
EBM Practice
Conclusion
Assessment

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Finding the Best Evidence

Founders

The Centre for Evidence-Based Medicine at Oxford University in Oxford, England, was established as the first of several centers around the world with the aim of promoting evidence-based health care and providing resources and support to those who want to move EBM forward. The center provides support by providing workshops, and journal and internet resources. David L. Sackett, formerly a professor here, continues his work at the Trout Research and Conference Center in Ontario, Canada. Dr. Sackett is author of Evidence-Based Medicine: How to practice and teach EBM.

The Cochrane Collaboration was founded by the British National Health Service in 1993 and is named after Archie Cochrane, the British epidemiologist. The collaboration is a non-profit, international organization that promotes the search for evidence in the form of clinical trials and other studies.

The collaboration provides educational experiences and leadership for physicians who are interested in and involved with the production of systematic reviews, and produces the Cochrane Database of Systematic Reviews. The collaboration also provides a focal point for research into EBM processes and evaluation of education.

The Canadian Cochrane Network and Centre is located at McMaster University and is associated with 16 academic health sciences centers in Canada and is supported by the Canadian Institutes of Health Research. R. Brian Haynes is the author of the definitive article "Of studies, syntheses, synopses, and systems: the "4S" evolution of services for finding the current best evidence" in the EBM Notebook. He is the creator of the EBM pyramid we use in this course, and is on the staff at McMaster.

These organizations have fostered the development of EBM throughout the world. As a result of their work, health care professionals in many countries participate in teaching evidence based practice and writing systematic reviews for a growing number of EBM publications.

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Henry Ford Health System

Finding the Best Evidence

Gold Standard

EBM organizations have developed a model to grade medical information according to its effectiveness for patient care. This model is called the hierarchy of evidence. Although it is beyond the scope of this instruction to present the whole model, the pyramid of evidence presented in this course is based on the notion that medical evidence in the literature can be characterized as good, better and best.

The gold standard of evidence in the medical literature is systematic reviews of randomized clinical trials. Randomized clinical trials are carefully designed, statistically valid studies that have significant results for medical study. Prestigious EBM organizations such as the Cochrane Collaboration review all of the randomized clinical trials on a topic and write a systematic review that synthesizes the information in all of the reviews. These are published in various sources such as the Cochrane Database of Systematic Reviews, which will be covered later in this course.

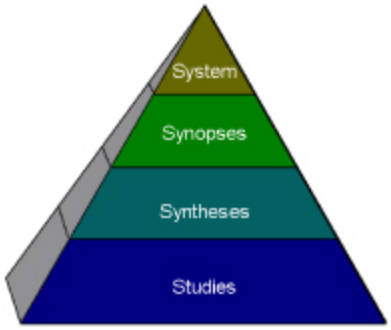
Systematic reviews are not yet available on all medical topics. Efficient ways to search for the best evidence include systematic reviews as well as other excellent and authoritative resources.

<< Back **Next >>**

Finding the Best Evidence

Pyramid of Evidence

The EBM pyramid of evidence was originally developed by McKinnell and Elliott (1997) for the Cochrane Electronic Library. R. Bryan Haynes modified the pyramid of evidence to categorize the EBM resources into the four S's: System, Synopses, Syntheses and Studies, shown below. When searching for resources, always remember that System resources are the most efficient, Synopses are next, and so on down to Studies, which are the least efficient way to locate information. As you search for information, you will want to try the most efficient method first, and go down the pyramid until you find an answer to your question.



While you look at the illustration, think about it as you would a menu, moving from top to bottom when looking for information. The pyramid actually is a navigation device on the Sladen Library web site. You will use it later in the course.

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Finding the Best Evidence

Navigating Around

The best way to move through the course is to hit the Next button on each page.

Also on each page you will find a detailed menu which includes each section and individual page of the course. You always know where you are in the course because the title of the page you are working on is black on the menu.

Continue through the course at you own pace, reviewing as needed. Then you will take three short tests. The whole course and testing will take an hour or less.

This course has multiple choice quizzes and other interactive features designed to help you learn the material. Your answers will not be recorded during the course, until you get to the Assessments Section at the very end. Feel free to browse around and learn more!

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Value of Questions

Concise clinical questions assist medical problem solving by:

- Focusing on evidence that is directly related to both the patient's needs and the physician's knowledge needs.
- Helping to communicate more clearly when talking with other providers about the patient's condition.

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Questions Happen

When do questions arise in the clinical setting? Physicians know when they have a question waiting to be answered. Experienced physicians know that clinical questions occur during these following 10 events of medical care.

Clinical findings	How do I gather and interpret findings from the history and physical examination?
Etiology	What is the cause of this disease or condition?
Clinical manifestations	How do I use my knowledge of the clinical manifestation of the disease to classify my patient's illness?
Differential diagnosis	When I consider all the possible causes of the patient's condition, how do I recognize those that are serious and responsive to treatment?
Diagnostic tests	How do I select and interpret diagnostic tests to refine my understanding of the patient's condition?
Prognosis	What is the patient's clinical course and how do I anticipate complications of the disorder?
Therapy	How do I select treatments that help the patient and are worth the cost and effort of using them?
Prevention	How can I more easily identify risk factors and diagnose diseases earlier?
Experience and understanding	How can I best empathize with my patient's situation and understand what their experience means to them?
Self-improvement	What must I do to keep up to date, improve clinical skills, and develop a better clinical practice?

Adapted from Evidence-Based Medicine: How to practice and teach EBM, by David L. Sackett, et al.

Take a moment to remember a recent clinical question. Think about which of the above factors generated the question. Was it just one factor or more than one? How did you find the answer to your question? If you found an answer, how did it improve the patient care process? Give yourself 2 or 3 minutes to work through this exercise.

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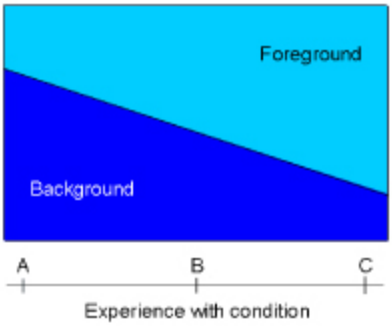
Two Types



Adapted from Evidence-Based Medicine: How to practice and teach EBM, by David L. Sackett, et al.

There are two types of clinical questions, Background questions and Foreground questions.

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Finding the Best Evidence

Background

Background questions ask for general knowledge about a disorder. They have two components:

- A question root like "who, what, when, where, why?"
- A medical condition or disorder

Examples of background questions:

"What causes hypertension?"
"When do complications of cholecystitis usually occur?"

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Foreground

Foreground questions ask for specific knowledge about managing patients with a disorder. A patient is always the focus of a foreground question.

Examples of foreground questions:

"In patients with suspected pneumonia, are any clinical findings sufficient to confirm or exclude pneumonia, or is a chest radiograph necessary for the diagnosis?"

"In middle aged patients with chronic ulcerative colitis, what is the risk that the patient will develop cancerous lesions if they do not have surgery?"

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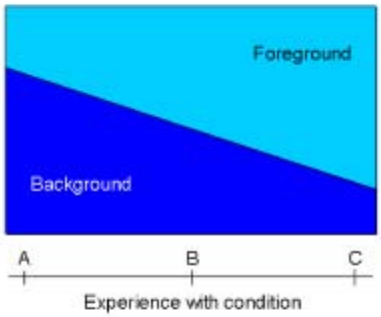
Knowledge



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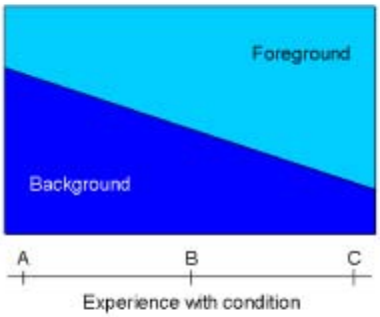

Clinicians have a need for both background and foreground knowledge. This knowledge varies over time, and depends on experience with the condition being treated.

Background

When clinical experience with the condition is limited, at point A, the majority of our questions will be about background knowledge. Students will often fall into this category. As clinician's experience and responsibilites increases, at point B, there is more balance between background and foreground questions.

Foreground

Further experience will place us at point C, where most of the questions will be foreground questions. Note that clinicians will always have background questions when encountering a new medical condition.

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The Right Question

Foreground questions are focused on the patient, their condition, and possible treatment options. They have four components:

- Patient and/or problem
- Intervention
- Comparison intervention – if relevant
- Outcome

You can remember the 4 components of a foreground question by remembering PICO.

When formulating clinical questions, it is important to include all 4 of the components. This will make your question precise and the answer will contain all the information needed.

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PICO

Patient – how old is the patient, are they male or female, what is their problem or condition, what is their overall medical status? This part of the question is factual.

Intervention – what intervention am I recommending for this patient? This part of the question requires some thought and a literature search.

Comparison intervention – what other intervention should be or has been considered? More thought and research is needed if you are considering an alternative intervention.

Outcome – what is the desired outcome of the intervention, or what will be decided if I answer the clinical question? Will the patient have surgery, or will they try a new diet and return in 6 months for more testing?

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Review

Take a moment to think of a clinical question that you encountered in your work. Answer the following questions. Give yourself 2 or 3 minutes to complete this exercise.

- Was it a background question?
- Was it a foreground question?
- If it was a foreground question, think about and write down all four components of the question: Patient/Problem, Intervention, Comparison Intervention, and Outcome.
- You can remember the 4 components of the foreground question by remembering PICO:

P	Patient/Problem
I	Intervention
C	Comparison Intervention
O	Outcome

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The Pyramid

The EBM Pyramid was first developed by R. Brian Haynes to describe the hierarchy of evidence in a graphical way. Dr. Haynes is Professor of Clinical Epidemiology and Medicine at McMaster University in Ontario, Canada. McMaster University as you remember from the Introduction, is a leadership institution for the implementation of evidence based medical practice.

Dr. Haynes' idea provides us with a structure to follow when selecting EBM resources. The Sladen Library staff has modified the pyramid to be both a teaching tool, as in this course, and a navigational device for finding medical evidence, as you will see in a moment.

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Best Evidence

What makes an article or summary good for clinical care? Information that is clear, brief and authoritative is good, but the most important factor is whether the findings are statistically valid. Statistical validity provides evidence that the treatments and procedures presented in the articles is effective in the real world of patient care. Tremendous efforts are under way in the medical profession to identify these articles for clinicians and present them in a way that allows for fast access.

Expert physicians select and review articles according to rigorous statistical and quality standards developed by medical organizations such as the American College of Physicians and the Centre for Evidence-Based Medicine at Oxford University . Then the information is loaded into databases and indexed to make it easily available. The EBM resources presented in this course are among the best available.

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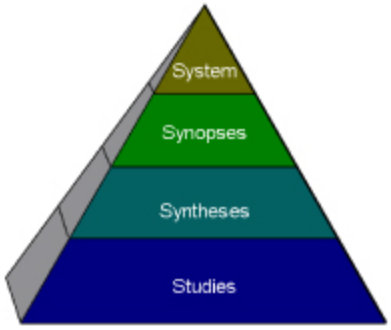
Using the Pyramid

When searching for evidence while at HFHS, the pyramid in this course and on the Sladen web site is your guide. When you have a clinical question, start at the top of the pyramid with System resources, and then move down the pyramid until you locate an answer to your question.



Remember that the most efficient resources are located at the top of the pyramid. In order to use your time wisely, consult the top of the pyramid first and move down only if you cannot find an answer. For example UpToDate is a System resource, and is a very efficient information source.

As you move down the pyramid, finding an answer will take more time. Studies are at the bottom of the pyramid, and MEDLINE is a Studies resource. We know that MEDLINE is a comprehensive and authoritative resource for searching the world's medical literature. However, by definition much of the information in MEDLINE is not evidence based. As a result, you must invest comparatively more time finding and selecting the best evidence from MEDLINE. Do this if it is necessary, but always try resources at the top first.

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Resource Types

There are four types of EBM resources, System, Synopses, Syntheses and Studies. Use the graphic below to learn about them. Go on to the next page when you are finished reviewing all four levels.

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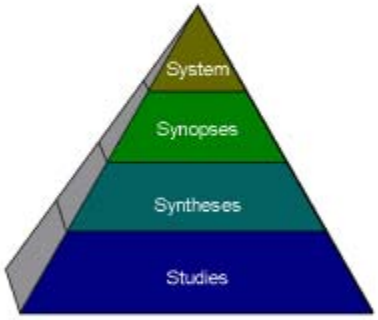

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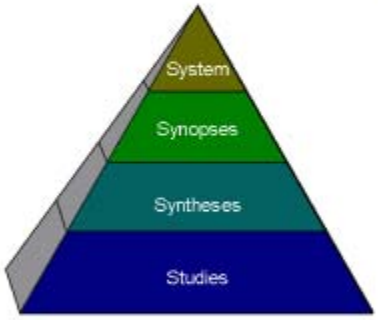

System Resources

EBM system resources are the best source of information about specific clinical problems. In a perfect world, EBM system resources would be fully integrated into the electronic medical record. At this time, two medical electronic textbooks are available to provide EBM system information to clinicians.

These resources consist of summaries of the best medical information about specific conditions, treatments and diagnoses. Physicians who are authorities in the field compile and update the electronic textbooks. The systems are designed to present the information for quick and easy access in a clinical setting.

Use system resources for both background and foreground questions.

Examples of system resources are UpToDate and Clin-eguide.

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Resource Types

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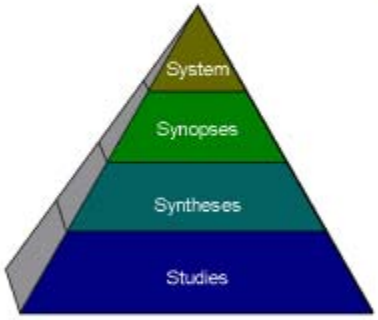

Synopses

When no system resources exist for a clinical problem, then synopses of individual studies and reviews are the next best resource of information. Synopses are structured abstracts of individual studies and reviews. They provide essential information to support medical decisions in a very brief format. The perfect synopsis provides exactly enough information to support a clinical decision.

Use synopses for foreground questions.

Examples of synopses are ACP Journal Club and DARE - Database of Abstracts of Reviews of Effects.

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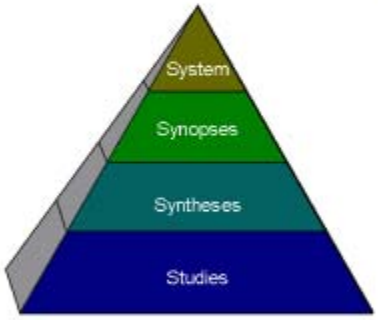
Resource Types

There are four types of EBM resources, System, Synopses, Syntheses and Studies. Use the graphic below to learn about them. Go on to the next page when you are finished reviewing all four levels.



Syntheses

For more detail, or if no system resource or synopsis is available, the databases of systematic reviews are the next best resource. These are summaries based on rigorous searches for evidence, and provide clear data about the effectiveness of a health care intervention. Syntheses are also helpful for the development of institutional clinical policies.

Syntheses are very detailed and are presented in an outline form. Clinicians can go directly to the conclusions to find the implications for treatment.

Use syntheses for background and foreground questions.

An example of a synthesis is the Cochrane Database of Systematic Reviews.

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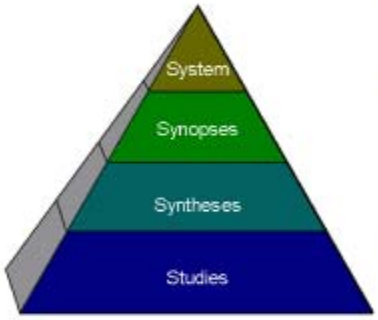
Resource Types

There are four types of EBM resources, System, Synopses, Syntheses and Studies. Use the graphic below to learn about them. Go on to the next page when you are finished reviewing all four levels.



Studies

If no system resource, synopsis, or synthesis is available, a clinician must turn to bibliographic databases to find original studies. When using original studies, remember that there is no expert appraisal of the evidence present in the higher levels of the EBM pyramid. The clinician decides whether the study is valid and if it presents the best evidence for clinical use.

Studies provide information to answer foreground questions.

Search filters and search engines are available to assist in searching for studies based on the best evidence. SUMSearch and MEDLINE with EBM filters are two good sources of original studies.

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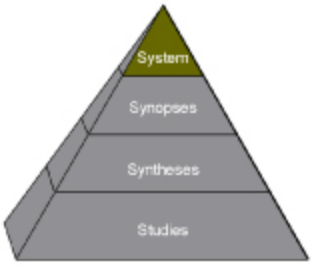
System Review

System resources are the most efficient EBM resources available to the clinician. Located at the top of the pyramid, they are consulted first. If an answer to the clinical question can be found with system resources, there is no need to continue down the pyramid.



Review what you learned about system resources and think about the following questions. You can return to the pyramid to review information there.

Can a system resource be used for answering Background questions, Foreground questions or both?

The resources are comprised of summaries of several articles. Who writes these summaries? Why does this make the resources more useful for patient care?

What are system resources designed to do best?

What are examples of system resources?

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--Synthesis Review
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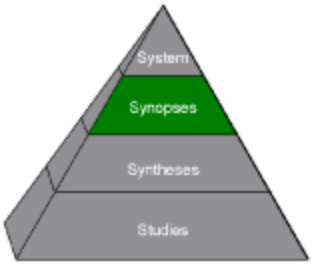
Synopsis Review

Synopses are brief structured abstracts of individual studies and reviews. Where the systems level provides a summary of several articles and reviews, a synopsis summarizes one document and is specifically designed to support medical decisions.



Review what you have learned about synopses and consider the following questions. You may want to return to the pyramid for a review.

Can a synopsis be used for answering Background questions, Foreground questions or both?

Why do you decide to consult synopses as opposed to a system resource?

What are examples of synopses?

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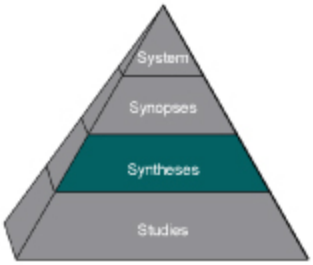
Synthesis Review

Syntheses are very detailed reviews of the medical literature on a topic, presented in an outline form. For quick information, clinicians can go directly to the conclusion paragraph to find treatment information.



Think about what you have learned about syntheses, and answer the following questions. If you would like a quick review, return to the pyramid.

Are syntheses used for Background questions, Foreground questions or both?

In the hierarchy of EBM resources, when are syntheses consulted? Would you ever consult syntheses before the other EBM resources?

What is an example of a synthesis resource?

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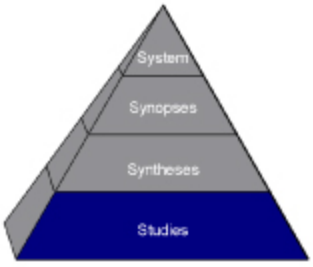
Studies Review

The studies level of the EBM pyramid represents the original studies that are the primary sources for the other resources we have been reviewing. When reading this original material, remember that there is no expert appraisal of the evidence at the studies level.



Remembering what you have learned about the EBM studies resources, consider the following questions. If you would like to review the material, return to the pyramid.

What tools are available to make searches at the studies level more effective at finding the best evidence?

Are studies best for answering background or foreground questions?

When searching in the studies level, who decides whether the study is valid and if it presents the best evidence for clinical use?

When should a physician consult studies when searching for the best evidence?

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Resources

Rich and authoritative EBM resources are available on the Sladen Library web site. As you saw in the previous module, the Sladen EBM pyramid is designed to help you find these resources efficiently. Although there are hundreds of resources and different ways to locate the best evidence for patient care, this course will focus your attention on seven of the best resources available anywhere. These are:

System
- UpToDate
- Clin-eguide

Synopses
- ACP Journal Club
- DARE

Syntheses
- Cochrane Database of Systematic Reviews

Studies
- SUMSearch
- MEDLINE

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Finding the Best Evidence

Specifics

Each resource had unique qualities. Use the graphic below to review the resources that are available to you. Go on to the next page when you are finished reviewing all 7 of the resources.

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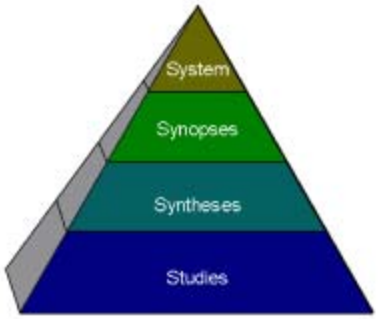

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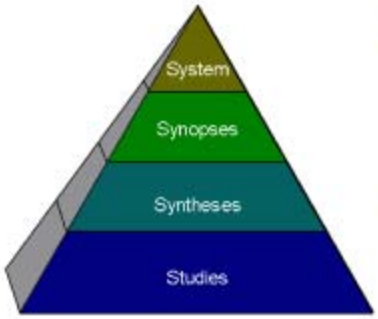

System - UpToDate and Clin-eguide

UpToDate is made up of topic reviews about medical conditions and treatments. Physicians who are authorities in the field write the information, and it is updated often. Search by entering a term into a dialog box. After the search is entered, you will see a list of topic reviews to choose from.

Clin-eguide is also made up of topic reviews, arranged in a menu. The information is written by panels of physicians and is updated often. Enter the search in the dialog box. This resource has a brief outline format that leads you rapidly to clinical information. It is also available for home use via remote access.

Access these resources from the Sladen Library Provider Page or from the Library tab on CarePlus.

Use UpToDate and Clin-eguide for background and foreground questions.

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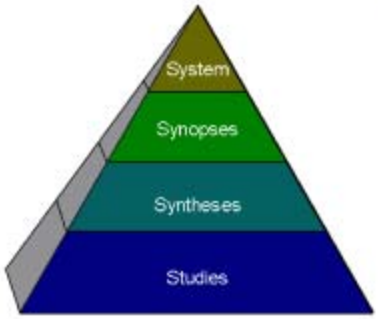

Synopses - ACP Journal Club and DARE

The ACP Journal Club, published by the American College of Physicians, screens the top journals and identifies clinically relevant and methodologically sound studies. Articles are summarized in an abstract. ACP Journal Club is an OVID database, and is searched using this familiar search screen. Enter a search term or keyword into the dialog box, and select Article Review from the results. This database lists results by clinical question, patient, intervention and outcome.

Database of Abstracts of Reviews of Effects (DARE) is produced by the National Health Service of Great Britain. It contains assessments of systematic reviews selected from medical journals. The information is formatted in a very brief outline format. DARE is an OVID database. This database includes the clinical question, patient, intervention and outcome.

Access both of these resources from the Sladen Library Provider Page or from the Library tab on CarePlus.

Use ACP Journal Club and DARE for Foreground questions.

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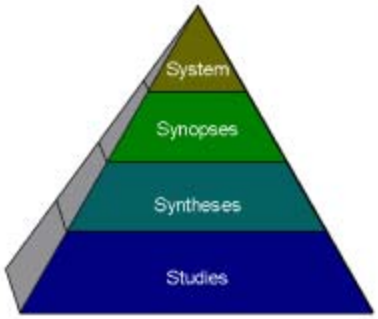

Syntheses - Cochrane Database of Systematic Reviews

The Cochrane Database of Systematic Reviews contains topic reviews of diseases and medical conditions, based on literature searches that have been reviewed by the Cochrane Collaboration. This database is available on OVID. The strength of this database is that it is presented in two very useful formats. Abstracts are available for rapid access. Topic Reviews are available for detailed information and clinical policy development.

Access this resource from the Sladen Library Provider Page or from the Library tab on CarePlus.

Use the Cochrane Database for Background and Foreground questions.

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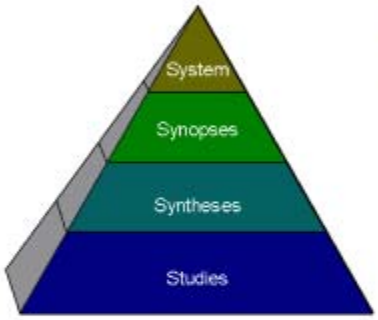

Studies - SUMSearch and MEDLINE with Filters

SUMSearch is a search engine that selects articles based on quality. It simultaneously searches a number of resources, including MEDLINE, DARE, and the National Guideline Clearinghouse. To search, type a topic in the dialog box on the main page. There are easy ways to limit and expand your search. Note that the search results are journal articles and you must do the critical appraisal for clinical use.

EBM filters are available to search MEDLINE. These filters are specialized literature searches designed to select the best evidence from MEDLINE. To search, select MEDLINE with Filters from the resource list. Select Randomized Controlled Trials and Systematic Reviews - Narrow Strategy. The system will take you to OVID MEDLINE and automatically perform the search. Next enter your topic and combine with the filter search results. Options to limit search results are also provided.

Access these resources from the Sladen Library Provider Page or from the Library tab on CarePlus.

Use SUMSearch and MEDLINE with Filters for Foreground questions.

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Focusing Questions

Take a moment to consider the following clinical question. You may want to review the material about formulating clinical questions that was covered earlier under Clinical Questions.

You have a patient who is traveling to Vietnam on business and wants to know if there is anything to prevent acquiring avian flu. You would usually recommend a flu shot, but are not sure whether it will be effective for avian flu. Remembering PICO, patient, intervention, comparison intervention and outcome, you think it through this way:

P	a patient who is traveling to Vietnam wants to avoid avian flu
I	would it be effective to provide this patient with a flu shot?
C	are there other effective prevention strategies?
O	a healthy patient who does not contract avian flu

Think about the most concise and direct way to express the primary topic of interest to the patient in this case. From the list below, select the word or phrase that would best capture the concept to be searched?

- Database design and retrieval.
- Number of references available.
- Quality of the medical literature.
- Search engine functionality.

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Finding the Best Evidence

System

UpToDate and Clin-**e**guide are efficient and easy to search. After you consider the clinical question, use the following procedure. Using the pyramid, go to the UpToDate or Clin-**e**guide web site. To find information, enter a search term in the text box on the screen. Search results include an outline of related diseases and treatments from which you can select the topic that best matches the clinical question at hand.

A key feature that distinguishes UpToDate and Clin-**e**guide from all the others is that they can be used for both background and foreground questions. If, for example, you encounter a disease process or complication and you are not familiar with it or the wider health implications, both UpToDate and Clin-**e**guide provide background information to place the question in perspective. Foreground information is included as well.

A key difference between the two resources is that UpToDate is only available when you are within the Henry Ford Health System computer network. This means that if you are using any computer within the system, UpToDate is accessible. Clin-**e**guide is available both within the system and also at home or when you are traveling.

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System Case

Please consider the following case and clinical question and answer the questions below.

Mrs. Smith is a 50-year-old woman who presents with a 2-month history of bilateral knee pain. She reports occasional swelling, and states that her activities are limited by her knee discomfort. She uses 650 mg of Tylenol daily with minimal relief. She saw a commercial for Celebrex on TV and asks if this medication will give her better pain relief. She works as a housekeeper and has no medical insurance.

On physical exam she has a body mass index of 32. She has bilateral knee crepitus with decreased range of motion and no effusion.

Weight bearing knee x-rays reveal mild degenerative changes bilaterally consistent with osteoarthritis.

P	A patient with bilateral knee osteoarthritis, who has no health insurance
I	She is currently on 650 mg of acetaminophen daily
C	She wants to know if Celebrex would provide more effective pain relief
O	Safe, effective pain relief for the patient

Clinical question:

In patients with knee osteoarthritis, do COX-2 inhibitors (Celebrex) give greater pain relief than acetaminophen?

You find the following information after searching system resources:

- Evidence from several randomized trials indicate that COX – 2 inhibitors have comparable efficacy when compared with acetaminophen, but are contraindicated in patients with renal disease, congestive heart failure and peptic ulcers.
- Recommended that acetaminophen is the first line therapy in non-inflammatory osteoarthritis.

You discuss the following to the patient:

- We inform the patient of the risks and benefits of COX – 2 inhibitors and confirm that acetaminophen as the first line treatment for painful knee osteoarthritis.
- We also recommend exercise and weight loss.

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System Quiz

Please answer the following questions regarding the case. Your answers will not be recorded.

1. You are familiar with the COX–2 inhibitor vs. acetaminophen debate, but need to refresh your knowledge regarding osteoarthritis. What is the most important advantage of using either UpToDate or Clin-eguide to answer this question?

- Both are excellent for answering background and foreground questions.
- Information is presented by both resources in an easy outline format.
- System resources are the most efficient ones available to the clinician.
- UpToDate and Clin-eguide have current and authoritative topic reviews.

2. UpToDate and Clin-eguide contain topic reviews of specific medical conditions and associated treatments. Who writes these topic reviews?

- Editorial boards which consist of physicians and company employees.
- Information company employees who are well-versed in medicine.
- Physicians and panels of physicians who are authorities in the field.
- Topic review boards which are made up of physicians and librarians.

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Synopses

The American College of Physicians (ACP) Journal Club and The Database of Reviews of Clinical Effectiveness (DARE) are accessed via the EBM pyramid. From there you will be guided to OVID, where these resources reside on the web. To find information, enter your search terms in the text box provided on the OVID search screen. Search results for these databases provide brief synopses of the best evidence on the topic.

The key feature of these resources is that the material is presented to you in a brief format. Both databases give you the clinical question and present information in the PICO format, so you can easily identify the patient, intervention and outcome. Both of the resources are used to answer foreground questions. One thing to remember is that these databases are relatively new with a smaller number of entries, and may not contain all the information you are seeking. If the information is there, however, it is the best evidence, presented in a quick and concise format.

A key difference between ACP Journal Club and DARE is that the ACP Journal Club entry summarizes several articles and provides an abstract of the findings, which is called a commentary. DARE includes systematic reviews from key medical journals and presents the information in a brief outline.

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Synopses Case

Please read the following case, clinical question and PICO analysis.

Mr. Jones is a 55-year-old male with hypertension, dyslipidemia, and asthma. He has had a myocardial infarction in the past with resultant mild congestive heart failure. He notes unchanged use of his beta-angonist inhaler once or twice per month, and is not on any inhaled or oral steroids. He is currently symptom free.

His physical exam shows a BP 148/80, pulse 88. The cardiovascular exam shows a regular rhythm, normal S1 and S2, no murmurs or gallops, no JVD. The lungs are clear without wheezes or rales. An examination of the extremities shows trace peripheral edema, no clubbing, and good peripheral pulses.

You know that the patient could benefit from beta-blockers for his mild congestive heart failure, but wonder if beta-blockers will negatively effect the patient's asthma? This concern leads you to search for the best evidence, and you proceed to formulate a clinical question.

P	A patient with asthma and mild congestive heart failure
I	He would benefit from a beta-blocker but you are concerned that it may worsen the asthma
C	The comparison intervention is to continue to monitor Mr. Jones and not to give beta-blockers
O	Improve the patient's cardiovascular disease without aggravating his asthma

Clinical question:

In patients with asthma and an indication for a beta-blocker, does use of a cardioselective beta-blocker increase morbidity from reactive airway disease?

You look for information in the system resources, but still have questions. You move down the pyramid to the synopses and locate the following information:

- Patients with mild-to-moderate obstructive lung disease may tolerate cardioselective beta-blockers, and these drugs should not be withheld in patients who could clinically benefit from them.

Back to the patient:

- Mr. Jones meets the inclusion criteria

It is safe to start Mr. Jones on a cardioselective beta-blocker without worsening his asthma or response to inhaled beta-angonists.

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Synopses Quiz

Please answer the following questions regarding the case. Your answers will not be recorded.

1. What is the most important advantage for using synopses to answer this clinical question?

- ACP Journal Club and DARE are the most authoritative EBM resources available.
- Synopses provide a complete analysis of the disease process and possible drug interactions, with a complete reference list.
- Synopses are reviews of the best literature on a topic, presented in a brief outline format or a commentary that summarizes the findings.
- The question is a background question and synopses are among the best sources for answers to these questions.

2. When considering Mr. Jones' situation, what could motivate you to search for the best evidence to assist you with this medical decision?

- A colleague says, "I prefer a policy of watchful waiting in a case such as Mr. Jones" with no reference to the literature. You decide to search for evidence.
- On rounds, a colleague has stated that "I was trained this way..." In order to verify this treatment, you decide to search for the best evidence.
- You recognize that your professional knowledge base may not be sufficient to make a diagnosis or treatment recommendation.
- You've asked a staff physician on your unit about a patient, and he suggests that you go to the library for more information.

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Syntheses

The Cochrane Database of Systematic Reviews is one of the most authoritative sources of EBM information available. The topic reviews it contains are based on literature searches and selection criteria developed to very precise standards that were developed by the Cochrane Collaboration. The Cochrane Database is unique because it is a synthesis of many review articles that are analyzed and a lengthy, authoritative analysis is compiled. A typical topic review can be 25-75 pages long. Both background and foreground information is included. Access Cochrane from the pyramid, and click on Cochrane next to the Syntheses section of the pyramid. This will take you to OVID, where you enter your search terms in the text box.

A key feature of the Cochrane Database is that it is particularly useful for clinical policy formation. Because of the time that must be invested in each review and the selection criteria, much of the work needed for policy development is already completed. Also, the reviews tend to be on questions that impact many patients.

The Cochrane Database is also useful for patient care. Although the number of topics is limited when compared to other resources, when there is a review available you can be very sure of its quality. When using Cochrane for patient care, go directly to the Conclusion section for a summary of clinical recommendations. If you need background information, go to that paragraph. Also, select records that have [Systematic Review] in the citation. Remember that records in Cochrane are in all stages of review development, and those which have completed the have this notation and most useful for clinical decision making.

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Syntheses Case

Please read the following case, clinical question and PICO analysis.

Since you have had a career long interest in the benefits of smoking cessation, when the call goes out for a committee to develop a clinical policy recommendation regarding smoking cessation and coronary heart disease you decide to volunteer. One of the first questions that comes up is how much and how quickly a smoker with coronary artery disease benefits when they quit smoking. Everyone says that you must have been a librarian in a previous life because you are very adept at searching the medical literature and finding the best evidence. As the committee begins to work, your reputation precedes you and the committee assigns you the task of finding the best evidence for discussion.

You have searched system and synopses resources using the pyramid and have found excellent information that could be used for patient care, but you want a comprehensive review and you need it for today's meeting. You decide to proceed to a synthesis resource.

P	Patients with coronary artery disease who have stopped smoking
I	Smoking cessation
C	None
O	Find information on morbidity and mortality for those who have ceased smoking

Clinical question: What is the magnitude of risk reduction when a patient with coronary heart disease quits smoking?

You search the Cochrane Database of Systematic Reviews and locate a 68-page systematic review on the topic. The review considered the findings of twenty studies and presented the following conclusions:

- Quitting smoking is associated with a substantial risk reduction of 36% in patients with identified coronary heart disease.
- There is strong evidence that quitting smoking is strongly associated with a reduction in total mortality for these patients.
- There was a lack of a clear relationship between length of the follow-up period and risk reduction, so it was not possible to determine how quickly the benefit took effect after smoking ceased.

You present the systematic review from Cochrane to the committee and highlight the recommendation:

- People who stop smoking following the onset of coronary heart disease or revascularization have a substantially lower risk of death. Evidence suggests that intervention to help patients with coronary artery disease stop smoking can be effective.

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Syntheses Quiz

Please answer the following questions regarding the case. Your answers will not be recorded.

1. When selecting a synthesis, you have already exhausted two categories of EBM resources and still need more information. Whether you are looking for patient care or clinical policy information, what makes you confident that the answer may be in the Cochrane Database?

- It contains detailed information of the merits of carefully selected literature on a specific topic and has a conclusion that summarizes the best evidence.
- It has a limited number of records to choose from, and this insures that searching for information is very efficient and effective.
- It includes background information for clinical policy formation and foreground information for use by clinicians in direct patient care.
- There are long systematic reviews that assure we will find the best evidence for any condition, applicable to patient care or to clinical policies.

2. Remembering what you have learned about system, synopses and syntheses so far, what aspect of syntheses resources make them uniquely useful for clinical policy formation?

- As a result of the time that is invested in the development of systematic reviews, and the inclusion of carefully selected literature on a specific topic, syntheses are the best resource for clinical policy formation.
- Synthesis resources have information that is at all levels of review, and sometimes the reviews are in process, making them more useful for the development of clinical policies.
- System and synopses resources are limited for clinical policy development because they only contain foreground information which makes the gathering of information more laborious.
- The length of the summary, ranging from 25 – 75 pages per review, makes synthesis resources uniquely useful for the development of clinical policies, particularly for larger organizations.

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Studies

When you have exhausted all of the previous levels on the EBM pyramid, you must try to locate evidence by reviewing individual studies. But any search in this literature can easily retrieve over 100 articles, not all of which are the best evidence. SUMSearch and MEDLINE with filters are both designed to handle a large number of individual studies. SUMSearch is a search engine that searches PubMed (MEDLINE), DARE and the National Guideline Clearinghouse and selects articles based on the quality of evidence. After locating SUMSearch on the pyramid, type the search terms into the text box on the main page.

The best way to search MEDLINE is with the EBM filters. These filters will generate a list of articles that is more likely to be based on evidence. Select MEDLINE with Filters from the pyramid, the select Randomized Controlled Trials and Systematic Reviews – Narrow Strategy. The system will take you into MEDLINE and perform the search automatically. Then combine your topic with the results from the filter search.

An excellent feature of the PubMed version of MEDLINE is the "Related Articles" button. When you locate an article that is on target, click the "Related Articles" button to find more which are similar.

A key feature that distinguishes SUMSearch and MEDLINE with filters from the other resources is the fact that you are searching and reading individual studies. For both of these resources, the number of references retrieved may be high, so use the options provided to limit your search results. Remember that you are getting prescreened articles, but you will still be responsible for reading them and selecting the best evidence from a number of choices.

A key difference between the two resources is that SUMSearch is a search engine that looks through a number of resources for information. MEDLINE is, as you are aware, one of the premier databases of medical information in the world and one of the largest.

Both studies resources are used for foreground questions.

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Studies Case

Please read the following case, clinical question and PICO analysis.

Mr. Anders, an accountant, is a moderately obese 56-year-old man with type 2 diabetes, first diagnosed 11 years ago. He is trying to quit his smoking habit of 25 years. No diabetes complications have been detected so far. His blood sugars are well controlled on metformin but his blood pressure has been mildly elevated, averaging 158/94 mmHg during his past three visits. You propose to prescribe a medication to lower his BP. He has been unable to lower his weight during the past two years despite your urgings.

He is also not keen to consume additional prescription medication, preferring natural remedies. He is open to persuasion, but would like to see the evidence that lowering blood pressure with drugs does more good than harm for people with diabetes and hypertension, and how much benefit he can expect for the additional medication.

P	A 56-year moderately obese old man with type 2 diabetes mellitus and untreated hypertension
I	Hypertension medication
C	Patient has already tried smoking cessation and weight control unsuccessfully
O	Control blood pressure to reduce morbidity and mortality

Clinical question:

In a 56-year old man with type 2 diabetes mellitus and untreated hypertension, is there evidence that medicating for hypertension reduces subsequent morbidity and mortality?

After looking for information in system, synopsis and syntheses resources with incomplete results, you decide to consult studies. You are hoping that by going to MEDLINE, with its mammoth database, you will be able to find evidence for this difficult question. You search MEDLINE using the EBM filters to provide more relevant results and locate the following information:

- Intensive blood pressure control among moderately hypertensive patients with type 2 diabetes led to a relative risk reduction of 32% in deaths related to diabetes and 44% in strokes.
- Enalapril had similar benefits to atenolol but patients were more likely to continue to take enalapril.

Back to the patient:

You discuss hypertension management with Mr. Anders, indicating that these are important new findings. He agrees to a trial of enalapril.

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Studies Quiz

Please answer the following questions regarding the case. Your answers will not be recorded.

1. Mr. Anders has agreed to try enalapril, but calls you back a week later. His wife is convinced that there is a natural remedy that you have overlooked, and would like more information on that treatment so you can discuss it at his next appointment next month. You decide to look for information on this topic in the following resource:

- ACP Journal Club
- Cochrane
- DARE
- MEDLINE

2. One quality of studies resources is both the biggest advantage and the biggest disadvantage. What is it?

- Database design and retrieval.
- Number of references available.
- Quality of the medical literature.
- Search engine functionality.

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Founders

As we saw in the Introduction, there are a number of significant organizations and physicians who are actively involved in expanding the EBM knowledge base.

The Centre for Evidence-Based Medicine at Oxford University in Oxford, England , the Cochrane Collaboration and the associated Cochrane Database of Systematic Reviews and the Canadian Cochrane Network and Centre McMaster University in Ontario are three of the major EBM centers in the world. These organizations have fostered the development of EBM throughout the world. Health care professionals in many countries, including Australia and the United States, participate in teaching evidence based practice and writing systematic reviews for growing number of EBM publications and web sites.

Who are the key individuals who have played a role in the development of EBM and with which of these institutions are they affiliated? Take a moment to remember these individuals, and type your answers in the box below. After you have typed your answers, point to the sentence below to how well you did. Your answers will not be recorded.

Type your answers below

Point here to see the answers

David L. Sackett was professor at the Centre for Evidence-Based Medicine at Oxford University and author of Evidence-Based Medicine: How to Practice and Teach EBM.

R. Brian Haynes on the staff at McMaster University and author of the article "Of studies, syntheses, synopses and systems: the "4S" evolution of services for finding the current best evidence" in the journal EBM Notebook.

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EBM, Not...

Evidence based medicine is a system for medical decision making based on evidence in the literature. But how can we recognize what EBM is not. What are some clues that a conference or discussion is not being based on evidence?

Some key phrases are as follows:

"At this hospital, we always treat..."
"This is the way the Dr. X prefers..."
"Don't consult the library, I prefer a policy of watchful waiting..."
"Ask the staff physician what to do..."

Practice by thinking about what you could say to respond to these situations. Type your answers in the box below. Then roll over the text on the right for some suggestions. Your answers won't be recorded.

Type your answers below	Point here to see the answers
	"Let's go online to see what it says in the literature."
	"This is a good opportunity to consult the evidence."
	"I heard that the Sladen Library has an EBM pyramid."
	"Let's practice what we learned in that web course."

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Elements

The elements of the EBM pyramid are the 4 S's, systems, synopses, syntheses, and studies. The 4 S's were first arranged in this manner by R. Brian Haynes of McMaster University. Which EBM resources go with these 4 elements?

Take a moment to remember the EBM pyramid, and write the resources that correspond to each. After you have typed your answers, point to the sentence below to how well you remembered the resources. Your answers will not be recorded.

Type your answers here!	Point here to check the answers!
1) System	UpToDate Clin-eguide
2) Synopses	ACP Journal Club DARE
3) Syntheses	Cochrane Database
4) Studies	MEDLINE SUMSearch

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Case Study

You are at home in the evening and begin thinking about a patient on your floor today. She is a 47-year-old who presented in the ER with pain and vomiting and was diagnosed with an occluded bile duct, resulting from gallstones. Although she passed the gallstones and the cholecystectomy was performed successfully, she has developed gallstone pancreatitis. The surgeon mentioned that pseudocyst might be a possible complication. You are not familiar with etiology and treatment for pseudocyst, and would like more background information for your next consultation with the surgeon and discussion with the patient.

Clinical Question: Under what conditions does an obstructed bile duct lead to pancreatitis? What is the likelihood that pseudocyst will follow bile duct obstruction resulting from gallstone pancreatitis? What is the prognosis and treatment if it occurs?

1. Which electronic source will provide the most efficient search?

   - ACP Journal Club
   - Clin-eguide
   - DARE
   - UpToDate

2. If for some reason the systems resources were temporarily unavailable on the web, what is the next resource you would consult for this question?

   - ACP Journal Club
   - Cochrane Database
   - DARE
   - UpToDate

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Application

You have been working through the EBM pyramid in this course, and have learned a great deal about the four types of resources and the information resources that fit into these categories. You have also learned to approach your information needs by selecting resources from the top of the pyramid first, and then moving to the bottom.

There are two instances, however, when you may want to jump right to a specific resource. Please write what these situations may be in the box below. Then roll over the text on the right for some suggestions. Your answers won't be recorded.

Type your answers below

Point here to see the answers

When you are looking for background information, consult UpToDate and then jump down to the Cochrane Database, because it also has background information.

When you are working on clinical policies for a group or institution, go directly to the Cochrane Database. Since you will find systematic reviews that include background information, and this is the best place to start.

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Review

Resource	Description	Use	Source
UpToDate	Medical topic reviews from expert authors	Locate clinical information quickly to support patient care	UpToDate, a privately owned company with direct physician involvement in content development
Clin-e guide	Clinical decision support system in an outline format	Locate clinical information quickly to support patient care	Ovid, an information company with direct physician involvement in content development
ACP Journal Club	Reviews of articles with sound methodology and high clinical relevance	Find clinically relevant studies with sound methodology	American College of Physicians
DARE – Database of Reviews of Effectiveness	Critiques of systematic reviews from a variety of medical journals	Find screened review articles addressing standards of care	National Health Service in Great Britain
Cochrane Database of Systematic Reviews	Systematic literature reviews, broad overviews of medical conditions	Use to develop clinical policies and standards of care	Cochrane Collaboration, the EBM authority world wide
MEDLINE	World's most complete and authoritative medical database	Locate clinical information when better screened sources don't answer the clinical question	National Library of Medicine
SUMSearch	An evidence based medicine search engine	Locate clinical information when better screened sources don't answer the clinical question	University of Texas Health Science Center

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Conclusion

Congratulations! You have completed the EBM training course. We hope that you have learned a lot about evidence based medicine and how it enhances medical practice.

The next page begins the testing sequence. There are three brief tests and the entire series will take 30 minutes or less to complete.

Please continue on to the testing page by clicking Next.

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Assessment

Please complete the testing sequence now. There are three tests:

1) Learner preferences test
2) Objective test
3) Searching test

To navigate from test to test simply click on the Next button. Directions for each test are located at the top of each test page.

If you have questions at any time during the testing, please contact the librarian who assisted you at the beginning of the course. We will be glad to assist you with your understanding of specific questions or questions about the web site functionality.

Please click on Next to continue.

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Learner Preferences Test

1. On the scale below, please indicate the amount of mental effort you experienced when completing this course. Rate your effort 1 if you found the course very, very easy, and up to 9 if you found it very, very difficult. Please only choose one number from 1 to 9.

Very, very easy — Very, very difficult

1 2 3 4 5 6 7 8 9

For questions 2-4, please look at the following four screens which represent four different teaching methods. If you have not already done so, please put on the headphones provided for you. Click on the screenshot to see an example of each teaching method. Please take a moment to look at each screen.

Screen 1

Screen 2

Screen 3

Screen 4

2. Which screen would you most like to use when learning new information? Please indicate your answer below by clicking on your preference.

3. Which of the screens would you least like to use when learning new information? Please indicate your answer below by clicking on your preference.

4. Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.

Learner Preferences Test

Screen 1

Screen 2

Screen 3

Screen 4

	For questions 5-9, please indicate your answer on the scale provided. All of these questions refer to an online instructional program like the one you have just completed.	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
5.	When working on an online instructional program, I prefer to read the text instead of listening to narration.					
6.	When working on an online instructional program, I prefer to listen to a narrator instead of reading written text.					
7.	When reading text from a computer screen, I find that highlighted words help me remember important concepts in the instruction.					
8.	When listening to spoken language, and the narrator emphasizes certain words, I find it easier to remember these ideas and facts.					
9.	When studying new material, my preferred learning method is to read the words on the screen and listen to the narration at the same time.					

When answering questions 10-15, please think about how you prefer to learn new information when studying or working. First read through the entire list. Please indicate your answer by clicking on your preference. Select only one learing method for each question.

10. When learing about a concept such as differential diagnosis, I prefer to use this method for understanding the information:

- Listen to a CD
- Listen to an audio tape
- Listen to a lecture in person
- Listen to a lecture online
- Participate in a discussion in person
- Participate in a discussion online
- Read a journal article
- Read a book
- Read new information online
- Watch a DVD
- Other, please specify:

11. When learning about a disease process or symptom such as cardiac arrhythmia, I learn best by:

- Listen to a CD
- Listen to an audio tape
- Listen to a lecture in person
- Listen to a lecture online
- Participate in a discussion in person
- Participate in a discussion online
- Read a journal article
- Read a book
- Read new information online
- Watch a DVD
- Other, please specify:

12. When learning to recognize a dermatology condition such as eczema, I prefer to:

- [ ] Listen to a CD
- [ ] Listen to an audio tape
- [ ] Listen to a lecture in person
- [ ] Listen to a lecture online
- [ ] Participate in a discussion in person
- [ ] Participate in a discussion online
- [ ] Read a journal article
- [ ] Read a book
- [ ] Read new information online
- [ ] Watch a DVD
- [ ] Other, please specify:

13. When learning to recognize a condition such as jaundice, I prefer to:

- [ ] Listen to a CD
- [ ] Listen to an audio tape
- [ ] Listen to a lecture in person
- [ ] Listen to a lecture online
- [ ] Participate in a discussion in person
- [ ] Participate in a discussion online
- [ ] Read a journal article
- [ ] Read a book
- [ ] Read new information online
- [ ] Watch a DVD
- [ ] Other, please specify:

14. When learning how to take a patient history, I prefer to:

- [ ] Listen to a CD
- [ ] Listen to an audio tape
- [ ] Listen to a lecture in person
- [ ] Listen to a lecture online
- [ ] Participate in a discussion in person
- [ ] Participate in a discussion online
- [ ] Read a journal article
- [ ] Read a book
- [ ] Read new information online
- [ ] Watch a DVD
- [ ] Other, please specify:

15. When learning a procedure such as the steps of a physical exam, I prefer to:

- [ ] Listen to a CD
- [ ] Listen to an audio tape
- [ ] Listen to a lecture in person
- [ ] Listen to a lecture online
- [ ] Participate in a discussion in person
- [ ] Participate in a discussion online

- [ ] Read a journal article
- [ ] Read a book
- [ ] Read new information online
- [ ] Watch a DVD
- [ ] Other, please specify:

Objective Test

Finding the Best Evidence

Evidence Based Medicine Study
Objective Test

Please read each question carefully and select the one, best answer.

1. There are three prominent organizations that provide leadership, research, workshops and resources for evidence based medicine programs world-wide. Of the organizations listed below, which is one of these prominent organizations?

   - Cochrane Collaboration
   - Haynes EBM Institute
   - McMaster Network
   - Trout Research Center

2. Rank the following resources in terms of their efficiency for finding clinical information. Rank them 1-4, with 1 being the most efficient.

   DARE

   MEDLINE

   Cochrane

   UpToDate

3. If you are searching for information at home, and want to check systems resources first, which EBM resource should you choose?

   - ACP Journal Club
   - Clin-eguide
   - DARE
   - UpToDate

4. Which of the following statements indicates to you that the best evidence is being used for patient care?

   - I prefer a policy of watchful waiting in a case such as Mr. Jones.
   - The staff said that with cases like this, we should do it his way.
   - This is the way we did it at the hospital where I did my residency.
   - We haven't had a case like this lately, let's consult the literature.

5. The EBM pyramid is directly available on the web at which two locations?

   - CarePlus and henryford.com
   - CarePlus and the NIH
   - Sladen site and CarePlus
   - Sladen site and henry.hfhs.org

6. Of the four categories of Evidence Based Medicine that are represented on the EBM Pyramid, which one requires the most time and effort to locate useful clinical information?

   - Studies
   - Synopses
   - Syntheses

Systems

7. What is one of the characteristics of the UpToDate database?

   Available for remote use at home or while traveling
   Compiled by information company employees
   Search processes and cumbersome and inefficient
   Source of expert topic reviews on clinical conditions

8. EBM System resources are a good source of information for which type of information?

   Background questions
   Foreground questions
   Both types of questions
   Neither type of question

9. What are background questions about?

   Basic sciences information related to patient care
   General knowledge about how to treat a disorder
   Information related to literature searching procedures
   Specific questions regarding patient management

10. Which of the statements below is a characteristic of Studies?

    Foreground questions are best answered using Studies
    Include expert appraisal of the evidence available for clinical questions
    Must be consulted for information when all other resources are exhausted
    Studies are the most efficient method for locating clinical information

11. You have been assigned by the chairman to locate the best clinical information for development of a new policy on the use of a new ALS medication in adult patients. You have already searched UpToDate, Clin-eguide, ACP Journal Club, and DARE, with limited results. Wha is the next resource you choose to search?

    Cochrane
    MEDLINE
    SUMSearch
    UpToDate

12. Which of the statements below is a characteristic of System resources?

    Used exclusively to answer Foreground clinical questions
    The most efficient source of information for clinical questions
    Unavailable from CarePlus, the HFHS online medical record
    Near the bottom of the Evidence Based Medicine pyramid

For questions 13-14, please read the following case and clinical question:

Your patient, Mrs. Johnstone, presents in the ER with right arm clumsiness and garbled speech. Her blood pressure is 154/84 mmHg with a regular heart rate of 72 per minute. Examination of cardiovascular and neurological systems is otherwise entirely normal. Your diagnosis is transient ischemic attack and you prescribe aspirin. You are interested in assessing Mrs. Johnstone's carotid arteries for possible stenosis, but you are not keen on referring her for a risky angiogram, and are not sure about the efficacy of a carotid ultrasound as an alternative.

Clinical Question: In order to confirm carotid stenosis what is the best choice, a carotid ultrasound or an angiogram?

13. In order to perform an efficient search, the first place you should consult for information is:

- ACP Journal Club
- Cochrane
- SUMSearch
- UpToDate

14. Why choose this resource first?

- It is a resource of studies
- It is a resource of synopses
- It is a resource of syntheses
- It is a systems resource

For questions 15-16, please read the following case and clinical question:

The mother of your patient, a ten-year-old healthy girl, calls to say that her daughter is coming down with a cold and she has heard that Echinacea can be helpful. She wants to know whether you recommend it.

15. System resources are temporarily unavailable. Which resource would you consult next?

- Cochrane
- DARE
- MEDLINE
- UpToDate

16. If you needed additional background information on this topic and system resources were still unavailable, where would you look?

- ACP Journal Club
- Cochrane
- DARE
- MEDLINE

Please read the following case study and answer question 17:

As the result of a routine physical examination, an 18 year-old woman with no previous medical problems is found to have a cholesterol reading of 302. You recommend that she see the dietitian for a cholesterol lowering diet, and schedule a repeat visit for 4 months. In 4 months, her cholesterol is 270, and you decide to start the patient on cholesterol lowering drug treatment. The patient has a family history of high cholesterol and coronary artery disease, and asks you if exercise will assist in lowering her cholesterol. The patient is scheduled to return to your office in two weeks, and you plan to search for the best evidence before the appointment.

Clinical Question: For an 18-year-old woman with high cholesterol, will exercise contribute to lowering cholesterol and preventing coronary artery disease?

17. This is an example of what type of a clinical question?

- Background Question
- Foreground Question
- Patient Question
- Study Question

18. Which of the statements below is a characteristic of Synopses?

- Consulted when no System resources are available

Contain lengthy and detailed articles of 10-15 pages
Provide extensive background information about clinical questions
The first source of EBM information that should be consulted

19. Which of the following types of studies is the gold standard of best evidence?

Appraised cohort studies
Case control studies
Randomized controlled trials (RCT)
Systematic reviews of RCT's

20. Who developed the pyramid of evidence that catergorized the literature into the four S's: system, synopses, syntheses and studies?

Elliott
Haynes
McKinnell
Sackett

21. Which of the following statements is true of the ACP Journal Club?

Articles are summarized in lengthy documents of 15 pages or more
Has abstracts of clinically relevant articles with sound methodology
Is available on the Cochrane Collaboration web site at no cost
Provides an interactive forum on EBM for all interested clinicians

22. Which of the following resources is an EBM search engine?

Cochrane Database
DARE
MEDLINE
SUMSearch

23. At what point in his or her medical career is a physician most likely to have numerous and varied background questions?

During a fellowship
Early in their career
Just before retiring
Late in their career

24. What is a characteristic of synopses?

Essential clinical information is provided in the paragraph format
Provides extensive, detailed clinical background information
Outlined, structured abstracts of individual studies and reviews
Is used when there are no relevant studies on a medical topic

25. What is the biggest challenge related to using studies?

Few articles are usually found and insufficient information exists to make a good clinical decision
Extensive articles with background information make it hard to find the most relevant information
Rigorous searches for evidence can leave doubt regarding the effectiveness of clinical interventions
A lack of expert appraisal leaves clinicians to judge validity and usefulness for clinical care

Finding the Best Evidence

Evidence Based Medicine Study
Searching Test

For this test you will search the EBM resources and **print** your search results. Two cases and clinical questions are described on this page and the next.

Please follow this procedure:

- Consider the case and clinical question
- Use the list below to select the resource
- Use as many resources as you need to answer the question
- Stop searching when you have located an answer
- **Print** your search results
- Return to this page and press Next

Question 1

Mrs. Naggan, a 46-year-old woman, has had ulcerative colitis for 7 years now, with extensive involvement of her colon and severe symptoms at times. Her colitis is in remission at present. She would rather not have surgery, but is concerned about the mounting risk for cancer that she has heard of through the newsletter of a patient support group for her condition. Her spouse has convinced her to find out just what the risk might be.

Clinical Question: In a 46-year-old woman with a 7-year history of extensive ulcerative colitis, what is the risk for developing bowel cancer?

System
UpToDate
Clin-eguide

Synopses
ACP Journal Club
DARE

Syntheses
Cochrane Database

Studies
MEDLINE
SUMSearch

<< Back Next >>

Finding the Best Evidence

Evidence Based Medicine Study
Searching Test

Please follow this procedure:

- Consider the case and clinical question
- Use the list below to select the resource
- Use as many resources as you need to answer the question
- Stop searching when you have located an answer
- **Print** your search results
- Return to this page and press Next

Question 2

In your role as the physician of a patient safety improvement team, you audit 150 consecutive patient notes from patients in your department to determine the proportion of patients for whom the department has provided appropriate preventative care. You discover that there is an uneven recommendation of preventive interventions. Some patients who are unlikely to be helped have been receiving interventions, and some patients have been missed for whom these interventions are likely to be beneficial. You wonder if computerized reminders will be an effective way to help you and your colleagues carry out preventive care, and other routine tasks.

Clinical Question: Can computerized reminder systems improve the quality of clinical care?

System
UpToDate
Clin-eguide

Synopses
ACP Journal Club
DARE

Syntheses
Cochrane Database

Studies
MEDLINE
SUMSearch

<< Back Next >>

APPENDIX G

Learner Preferences Test Results

1	**On the scale below, please indicate the amount of mental effort you experienced when completing this course. Rate your effort 1 if you found the course very, very easy, and up to 9 if you found it very, very difficult. Please only choose one number from 1**	
	1 (Very, very easy)	3
	2	3
	3	24
	4	20
	5 (Neither easy nor difficult)	20
	6	10
	7	4
	8	2
	9 (Very, very difficult)	0
2	**Which screen would you most like to use when learning new information? Please indicate your answer below by clicking on your preference.**	
	Screen 1 (plain text)	10
	Screen 2 (plain audio)	11
	Screen 3 (cued text)	39
	Screen 4 (cued audio)	28
3	**Which of the screens would you least like to use when learning new information? Please indicate your answer below by clicking on your preference.**	
	Screen 1 (plain text)	40
	Screen 2 (plain audio)	26
	Screen 3 (cued text)	4
	Screen 4 (cued audio)	18
4a	**Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.**	
	Screen 1 (1st)	15
	Screen 1 (2nd)	21
	Screen 1 (3rd)	25
	Screen 1 (4th)	27
4b	**Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.**	
	Screen 2 (1st)	26
	Screen 2 (2nd)	19
	Screen 2 (3rd)	23

15	When learning a procedure such as the steps of a physical exam, I prefer to:		
	Listen to a CD	0	
	Listen to an audio tape	0	
	Listen to a lecture in person	11	
	Listen to a lecture online	1	
	Participate in a discussion in person	38	
	Participate in a discussion online	1	
	Read a journal article	0	
	Read a book	7	
	Read new information online	1	
	Watch a DVD	22	
	Other	4	

15a	Other, please specify:		
	Specify	82	
	Specify	1	have a person explain the procedure while performing the procedure
	Specify	1	learn throught bedside didactics
	Specify	1	Multimedia: read, see pictures/videos
	Specify	1	read and practice myself
	Specify	1	view it in person
	Specify	1	watch a person do it

	Screen 2 (4th)	20
4c	**Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.**	
	Screen 3 (1st)	26
	Screen 3 (2nd)	28
	Screen 3 (3rd)	19
	Screen 3 (4th)	15
4d	**Please look at the screens again and rank them 1 through 4, 1 being the one you like the best and 4 being the one you like the least.**	
	Screen 4 (1st)	33
	Screen 4 (2nd)	19
	Screen 4 (3rd)	13
	Screen 4 (4th)	23
5	**When working on an online instructional program, I prefer to read the text instead of listening to narration.**	
	Strongly agree	23
	Agree	21
	Neither agree nor disagree	18
	Disagree	21
	Strongly disagree	4
6	**When working on an online instructional program, I prefer to listen to a narrator instead of reading written text.**	
	Strongly agree	7
	Agree	20
	Neither agree nor disagree	21
	Disagree	24
	Strongly disagree	15
7	**When reading text from a computer screen, I find that highlighted words help me remember important concepts in the instruction.**	
	Strongly agree	38
	Agree	45
	Neither agree nor disagree	3
	Disagree	1
	Strongly disagree	0
8	**When listening to spoken language, and the narrator emphasizes certain words, I find it easier to remember these ideas and facts.**	

Strongly agree	14	
Agree	43	
Neither agree nor disagree	17	
Disagree	8	
Strongly disagree	5	

9 When studying new material, my preferred learing method is to read the words on the screen and listen to the narration at the same time.

Strongly agree	25	
Agree	22	
Neither agree nor disagree	16	
Disagree	19	
Strongly disagree	5	

10 When learning about a concept such as differential diagnosis, I prefer to use this method for understanding the information:

Listen to a CD	0	
Listen to an audio tape	0	
Listen to a lecture in person	14	
Listen to a lecture online	4	
Participate in a discussion in person	27	
Participate in a discussion online	1	
Read a journal article	6	
Read a book	24	
Read new information online	6	
Watch a DVD	3	
Other	2	

10a Other, please specify:

Specify	86	
Specify	1	Multi-media including reading and visuals (online or text or journal)
Specify	1	read and discuss in person

11 When learning about a disease process or symptom such as cardiac arrhythmia, I learn best by:

Listen to a CD	2	
Listen to an audio tape	0	
Listen to a lecture in person	12	
Listen to a lecture online	3	
Participate in a discussion in person	21	
Participate in a discussion online	0	
Read a journal article	2	

Read a book	30	
Read new information online	8	
Watch a DVD	5	
Other	4	

11a Other, please specify:

Specify	84	
Specify	1	Multi-media: Lecture if done well, reading and audio
Specify	1	patient
Specify	1	read and discuss in person
Specify	1	Reading Up-to-Date

12 When learning to recognize a dermatology condition such as eczema, I prefer to:

Listen to a CD	0	
Listen to an audio tape	0	
Listen to a lecture in person	10	
Listen to a lecture online	2	
Participate in a discussion in person	17	
Participate in a discussion online	0	
Read a journal article	1	
Read a book	22	
Read new information online	12	
Watch a DVD	17	
Other	5	

12a Other, please specify:

Specify	81	
Specify	1	Audiovisual
Specify	1	color atlas
Specify	1	Multimedia: read, see pictures/patients
Specify	1	patient
Specify	1	read and review pictures or video
Specify	1	see patients in clinic
Specify	1	uptodate

13 When learning to recognize a condition such as jaundice, I prefer to:

Listen to a CD	0	
Listen to an audio tape	0	
Listen to a lecture in person	12	

Listen to a lecture online	4	
Participate in a discussion in person	26	
Participate in a discussion online	0	
Read a journal article	2	
Read a book	23	
Read new information online	7	
Watch a DVD	8	
Other	5	

13a Other, please specify:

Specify	82	
Specify	1	actual patients
Specify	1	color atlas
Specify	1	Multimedia: read, see pictures/patients
Specify	1	patient
Specify	1	read and listen to lecture with pictures
Specify	1	see patients in clinic

14 When learning how to take a patient history, I prefer to:

Listen to a CD	1	
Listen to an audio tape	2	
Listen to a lecture in person	17	
Listen to a lecture online	2	
Participate in a discussion in person	39	
Participate in a discussion online	0	
Read a journal article	0	
Read a book	8	
Read new information online	0	
Watch a DVD	12	
Other	5	

14a Other, please specify:

Specify	82	
Specify	1	have person explain what is going on while they take the history
Specify	1	Multimedia: read, see a video, visualize
Specify	1	observe others taking history
Specify	1	patient interaction
Specify	1	read about and practice myself
Specify	1	watch a person do it

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ABSTRACT

IMPACT OF AUDIO TEXT, VISUAL TEXT AND CUEING ON COGNITIVE LOAD AND PERFORMANCE

by

NARDINA N. MEIN

May 2005

Co-Advisor: Dr. James L. Moseley

Co-Advisor: Dr. Gary R. Morrison

Major: Instructional Technology

Degree: Doctor of Philosophy

The focus of this study is to examine the effects of cognitive load theory, particularly the effects of redundancy and cueing, when learning from text and diagrams. A review of the literature on cognitive load and cueing is presented in three sections; the literature on split-attention and redundancy, studies investigating the modality effect, and literature of signaling or cueing related to performance and cognitive load in instructional design. In one experiment three hypotheses were tested; that novice participants would have lower cognitive load, higher recall and higher performance with a) cued text vs. plain text, b) audio text vs. visual text, and c) cued audio text vs. plain audio text. The study sought to confirm existing research on the effects of narration vs. written text on cognitive load, and to extend cognitive load research into the area of signaled text and narration. Although the results for the 3 hypotheses were not statistically significant, there was an indication of a practical trend supporting the effectiveness if cued audio text, where higher scores on the performance test were observed for these participants. Also, learner preferences were measured for the different text presentation methods, and a preference

for cueing was strongly indicated, although no preference for audio text vs. visual text was identified. These findings contribute to the theory and practice surrounding the design and development of instruction; particularly instruction that is designed to be offered via the Internet, or web-based instruction. Further exploration into cued audio text, plain audio text, cued visual text and cued audio text, and their impact on cognitive load, recall and performance in instruction is a rich area for future research.

AUTOBIOGRAPHICAL STATEMENT

NARDINA N. MEIN

Ms. Mein is the Director of the Sladen Library & Center for Health Information Resources at Henry Ford Hospital in Detroit, Michigan. During her tenure at Henry Ford, the Sladen Library has developed into a customer driven information service, incorporating excellent customer service with the best information technology. In 1997, Ms. Mein led the team that launched the Henry Ford Health System web site. She serves on the Health Sciences Center Information Technology Steering Committee, which advises corporate leadership on information technology policy and budget for the academic departments of Henry Ford Health System.

Ms. Mein received a BA from Michigan State University in 1972 and a MSLS from Wayne State University in 1976. She is a doctoral candidate in Instructional Technology at Wayne State University, where she began her studies in 1998.

Ms. Mein has served the library community in a number of roles, including:

- Distinguished Member of the Academy of Health Information Professionals of the Medical Library Association.
- Member of the Medical Library Association National Program Committee, 1994.
- Library of Michigan, Library Services and Technology Act Advisory Committee, 1991 – 1995.
- Delegate to the White House Conference on Libraries and Information Services, 1991.
- Chairman, Publicity and Promotions Committee for the Medical Library Association Annual Meeting in Detroit, Michigan, 1990.

Ms. Mein has published several articles, book chapters, and video productions, and has made numerous presentations at professional organization meetings and library schools.