Application of Adult Learning Theory in Teaching Evidence Based Medicine to Residents

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Abstract

Background and Purpose: Adequate evidence based medicine (EBM) knowledge and skills are required to provide up-to-date, high quality medical care to patients. Unfortunately, achieving these skills and knowledge requires a prolonged learning process and constant exposure to EBM concepts. The adult learning theory holds the assumption that adults learn better in a problem based and collaborative environment, with more equality in between the teacher and the learner. We aimed to evaluate EBM learning outcomes one year after the implementation of a longitudinal EBM curriculum into an internal medicine residency program.
Methods: An EBM curriculum based on the adult learning theory was developed. It included five specific components that addressed all five steps of the EBM cycle (ask, acquire, appraise, apply and assess). A voluntary, anonymous, 27-question survey was distributed to all residents prior to and at the end of the one year of EBM training to self-assess competencies in EBM.
Results: Of the 60 eligible residents, 10 pre-course and 13 post-course completed the survey with a response rate of 17% and 22%, respectively. Self-reported conceptual understanding improved for: relative risk 14%, odds ratio 14%, confidence intervals 27%, and number needed to treat 12%. Comfort with meta-analysis appraisal improved, from 30% to 38%. Routine appraisal sheet use increased by 31%. A 17% increase in satisfaction with the EBM curriculum was reported.
Conclusions: Our intervention successfully increased residents' comfort with EBM concepts and self-reported application of EBM skills and knowledge about patient care. The results of the implementation of the EBM curriculum were promising and suggested valuable implications for EBM faculty to further collaborate with residents in continuous improvement of the EBM learning experiences for advancing the quality of patient care.
Keywords: EVIDENCE BASED MEDICINE, ADULT LEARNING THEORY, RESIDENTS, CURRICULUM

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Introduction

Evidence Based Medicine (EBM) is "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of the individual patient. It means integrating individual clinical expertise with the best available external clinical evidence from systematic research" (1). Practicing EBM requires unique skills of the physician including the abilities to articulate a focused clinical question, efficiently search the literature, apply rules of evidence to clinical studies, and interpret the results for an individual patient (2).

The Accreditation Council for Graduate Medical Education (ACGME) requires any residency program to integrate Practice-based Learning and Improvement into their curriculum: "Residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care based on constant self-evaluation and lifelong learning" (3).

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Unfortunately, residents that graduate from residency training programs do not feel comfortable in appraising the medical literature due to their lack of standardized EBM training.

Learning and applying EBM skills requires a very comprehensive and long process. A systematic review reported a 25% improvement in the EBM critical appraisal knowledge after six hours of journal club time (4). There are previous studies reporting short interventions that had some impact on residents' EBM skills and knowledge (5-7), but they suffer from incomplete description, insufficient evaluation, or unproven effectiveness. All of these studies indicate that integrating EBM teaching with clinical practice is vital in improving learners' attitudes, skills and behaviors (8).

The adult learning theory holds the assumption that adults learn better in a problem based and collaborative environment, with more equality between the teacher and learner (9-10), when they are exposed to concepts that are relevant, meaningful and hold a relationship with past experiences (11). Adult learning is based on four principles (12): 1. Adults need to be involved in the planning and evaluation of their instruction, 2. Experience (including mistakes) provides the basis for learning activities, 3. Adults are most interested in learning subjects that have immediate relevance to their job or personal life, and 4. Adult learning is problem-centered rather than content-oriented.

To motivate residents' learning and facilitate transfer of their acquired EBM skills and knowledge to a patient care setting, we drew on the adult learning theory as a framework for developing a longitudinal learner-centered EBM curriculum. For adult learners, they have differences in learner characteristics that affect their learning process and outcomes. Adult learners are motivated to learn as they experience needs and interests that learning will satisfy; they desire to be self-directed in their learning process; they possess a greater volume of personal experience which represents a rich source of learning; and their orientation to learning is life-centered (10). Previous studies reported that an EBM curriculum based on adult learning theory improves residents' EBM skills and certain EBM behaviors (2). In July 2013 we implemented a yearlong longitudinal EBM curriculum into the internal medicine residency program at Beaumont Health System, Royal Oak, Michigan. We hypothesized that our EBM curriculum would have a positive impact on the residents' perception of the curriculum effectiveness in teaching EBM skills and knowledge. We are reporting a full description of the curriculum in this manuscript because to our knowledge our curriculum is the most comprehensive, longitudinal EBM curriculum reported so far that was constructed on the adult learning theory.

Currently, there is no well-established standardized EBM curriculum reported in the literature and widely adopted by any residency program. Prior to developing and implementing the reported EBM curriculum, our institution had no formal EBM training program. There was no formal assessment of the residency program needs regarding EBM knowledge and skills. The need for an EBM curriculum emerged from the strict ACGME requirements regarding residency-training programs.

Methods

Study design: To assess the perception of the curriculum effectiveness in teaching EBM skills and knowledge, we designed a cross-sectional study. We administered a questionnaire survey twice, prior to and one year following the EBM curriculum implementation in the internal medicine residency program.

Setting: The study was conducted in the Internal Medicine residency program at Beaumont Health System, Royal Oak, Michigan.

Participants: Eligible participants for this study included all internal medicine residents

in training from July 2013 to June 2014. The survey was sent electronically and it was developed to assess the residents' reaction to EBM concepts, pre and post the EBM curriculum implementation. Institutional Review Board approval was obtained. Participation in the survey was voluntary and anonymous.

Outcomes: As a primary outcome we assessed the residents' comfort level with basic statistics, literature search and EBM concepts. As a secondary outcome, we evaluated the residents' satisfaction with the EBM curriculum, one year after the curriculum implementation.

Development of Educational Intervention: In developing our EBM curriculum, we began by assessing the baseline educational and comfort level of residents with the EBM concepts. A de-novo longitudinal EBM curriculum based on adult learning theory was developed.

The EBM curriculum was developed to encompass several components that considered learner characteristics and applied instructional strategies to promote the active learner role and learning process through resident-led teaching sessions and small group discussion surrounding patient care problems that arose in patient encounters. In addition, immediate and regular feedback provided by peers and EBM faculty aimed at informing residents of their learning progress and performance and showing residents how to improve their EBM skills. The curriculum integrated five specific interventions that aimed at covering all five steps of the EBM cycle (ask, acquire, appraise, apply and assess) (see Figure 1): 1) Formal teaching done by EBM faculty regarding EBM fundamentals, 2) Hands-on EBM resources search sessions led by librarians, 3) Standardized critical appraisal process during monthly journal club, 4) Standardized EBM format for residents' senior morning report presentations, 5) Formal and interactive teaching provided by residents for other residents under EBM faculty supervision, regarding all the critical appraisal aspects of different study designs. All of the EBM educational interventions started and finished with a patient case.

Taking into account previous, already tested teaching methods, we incorporated into our curriculum different EBM facilitating techniques: resident-directed teaching, small-group sessions, open discussion sessions and direct one-on-one teaching of EBM concepts. All of these educational sessions had the purpose to develop the skills needed in the adult learning process: autonomous learning skills, self-directed learning skills, communication skills, and skills regarding interaction with peers (7). Overall, the EBM teaching sessions comprised over 10 hours of EBM training each month, for 12 months. (Table 1)

The first intervention implemented consisted of two formal didactic lectures, given by EBM Faculty, regarding fundamentals of EBM and their application to patient care. The goal of these two sessions were to get to residents comfortable with the real meaning of practicing EBM and to familiarize them with basic EBM concepts such as study designs and simple statistics and their interpretation in patient care. The second intervention comprised of 30-minute hands-on learning sessions on using and searching EBM resources. These small group, (10-15 residents), interactive, patient case based activities were led by an inter-professional team formed by a librarian and an EBM faculty member. The goal for the sessions were for residents to learn the hierarchy of evidence and to gain searching skills in finding the best evidence to inform decision making for patient care. The third intervention consisted of a month long team-based learning experience to conduct journal club, with the goal of improving the resident's skills in critical appraisal of any study design. The Journal Club at our institution takes place every month. Five residents are assigned each month to develop the Journal Club, under the direct supervision of an EBM Faculty member. The Journal Club process starts with a case scenario

brought on by the residents and then is followed by the development of a well-formed foreground question. During the month, the residents learn and apply the entire EBM process and at the end of the month, during Journal Club, they are able to guide and teach their peers in small groups (see Appendix). The fourth component is based on stimulating the self-directed learning and communication skills. A group of 10-15 residents each month present critical appraisal of a study that would answer their clinical question and receive direct peer to peer and EBM faculty feedback regarding threats to validity or study design concepts not well understood. Our fifth component was based on EBM teaching done by residents to other residents, mediated by EBM faculty. The concepts taught in these sessions were basic study design and statistical analysis interpretation of therapy studies, diagnosis studies, harm studies and systematic reviews and meta-analysis.

Implementation: The curriculum was implemented starting in July 2013 and lasted for the entire academic year, until June 2014. The five interventions were structured and scheduled to take place throughout the academic year, with a goal that each resident would have had the same opportunities to be exposed to these interventions throughout the year.

Educational Setting: We implemented our EBM curriculum in various educational settings. The first intervention took place during noon conference, when the entire internal medicine residency program is supposed to attend. The second intervention took place during the ambulatory rotation and was repeated for four months in a row until all the residents had the chance to be exposed to the literature search sessions. The third intervention also took place during the ambulatory month and it was repeated every month, until all the residents participated once in the development of Journal Club. The fourth intervention took place every week for two - three residents rotating on the floor months. The fifth intervention was scheduled during the ambulatory months and was repeated monthly until all the residents have been exposed to the EBM concepts taught during the resident led lectures.

During the entire year, each resident was exposed to the first intervention (2 hours), second intervention once (30 minutes), third intervention (4 hours once and then one hour for the rest of 11 months), fourth intervention (4 hours every month) and fifth intervention (1.5 hours each month for 3 months). Overall, the entire EBM curriculum possible exposure time per resident was 69.8 hours over a year (Table 1).

Evaluation of the Educational Intervention: We developed a self-administered questionnaire for the survey which included 27 items collecting demographic information (e.g., level of training of the participants, their medical degree, the current residency program, prior EBM training) and soliciting their opinion and perceptions of the usefulness and the importance of EBM training, their EBM practice patterns and barriers to practice EBM. The survey was administered during an outpatient clinic rotation lecture. Monthly, there are different rotators through the outpatient setting. We excluded the responders that didn't identify their residency program as being internal medicine because they were not exposed to all of the EBM curriculum components as the internal medicine residents. The pre-surveys were administered at the beginning of the academic year, in July 2013 and the post-surveys were administered at the end of the academic year, in June 2014.

The data collected through the surveys reflected: year in training, medical degree, any previous EBM formal training, and overall assessment of residents' perception about EBM training: EBM importance and helpfulness, resources access, comfort with asking a question, acquiring, appraising, applying and assessing the evidence and comfort with different statistical concepts, like relative risk, odds ratio, confidence intervals, statistical power, number needed to

treat, satisfaction with the EBM teaching offered in our internal medicine residency program and personal and system barriers to practice evidence based medicine.

Faculty Training: Our core EBM faculty group received training at the Evidence-Based Care Practice workshop at McMaster University in Hamilton, Canada. Five internal medicine outpatient faculty constituted the core EBM faculty.

Role of Faculty: Faculty fulfilled different roles throughout the EBM curriculum. Their involvement was designed to meet the residents' needs at the time of EBM curriculum delivery. Faculty directly taught EBM concepts during the first intervention, facilitated and guided the literature search intervention, provided one to one teaching and guidance for developing the journal club, gave direct feedback during residents' critical appraisal presentations and facilitated the explanation and understanding of the EBM concepts during the resident-led sessions.

Study size: We included all the sixty internal medicine residents actively enrolled in the academic year of 2013-2014. There was no sample size calculation as this was a pilot study. Also, we had no control group, as the EBM curriculum was mandatory for all the training years of internal medicine residents.

Statistical methods: We use descriptive statistics to characterize the study population. We reported percentages of correct versus incorrect answers for each question. Tests for statistical significance were not reported, as the data was not paired.

Results

Participants: Of the 60 eligible residents, 10 and 13 residents completed the pre and post surveys respectively.

Descriptive data: The post-graduate training level of residents that answered the pre-course questionnaire was: 50% postgraduate

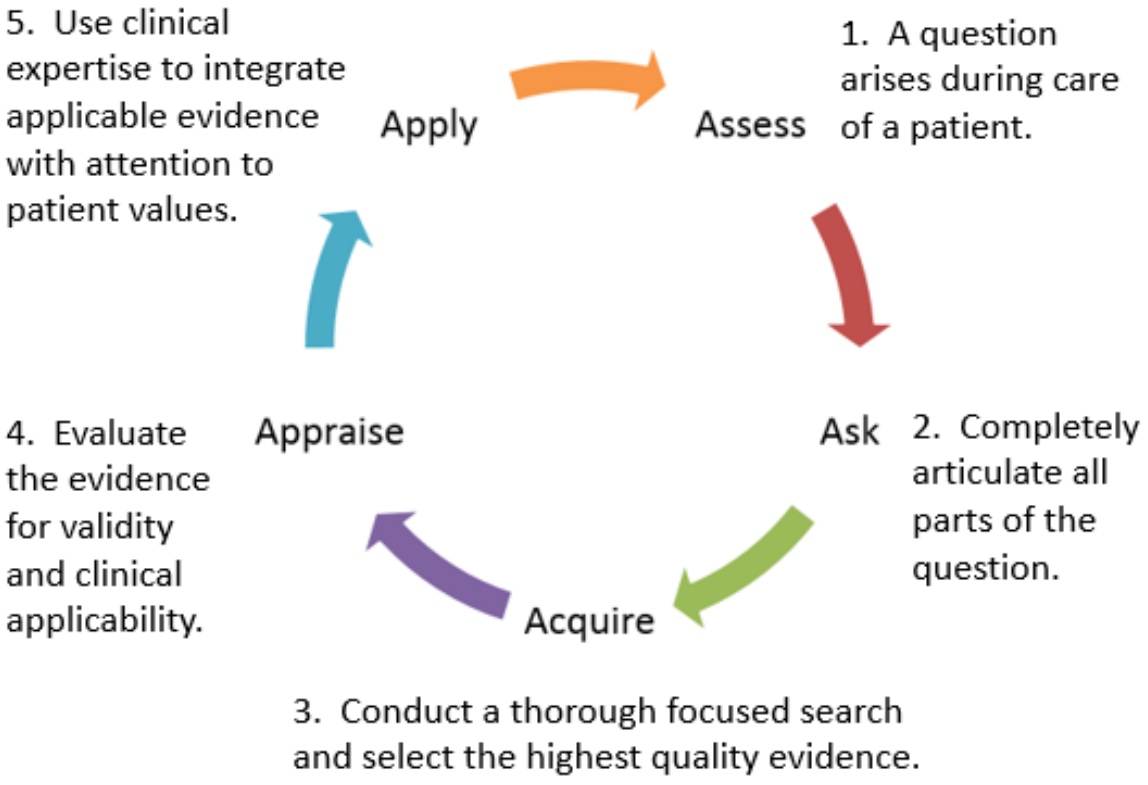

Figure 1. EBM steps.

Table 1. Interventions goals and allocated time

Study Intervention	Goal EBM steps	Allocated time
Intervention 1 Formal EBM teaching	Ask, Acquire, Appraise, Apply, Assess	2 hours / year
Intervention 2 EBM resources search	Acquire	30 minutes monthly
Intervention 3 Journal Club	Ask, Acquire, Appraise, Apply, Assess	4 hours monthly
Intervention 4 Senior Morning Report	Ask, Acquire, Appraise, Apply, Assess	4 hours monthly
Intervention 5 Resident to Resident lectures	Appraise	1.5 hours monthly

year one, 20% postgraduate year two, 30% postgraduate year three, and for the post-course questionnaire was: 30% postgraduate year one, 62% postgraduate year two and 8% postgraduate year three.

Primary outcomes: Before the curriculum implementation, 77% (n=10) of responders reported very little to no previous EBM training. 30% of them were comfortable with medical statistics and 50% reported being comfortable with literature search. 80% of internal medicine residents were using Up-to-date as a source of most medical knowledge. Only 10% of the residents often used medical journals as evidence based resource. The comfort level with medical statistics varied based on the topic: 40% of residents felt comfortable interpreting relative risk and odds ratio; 50% felt comfortable explaining confidence intervals and type 1 versus type 2 error; 80% of residents were comfortable interpreting number needed to treat and reported being previously exposed to critical appraisal of study designs but none of them routinely used critical appraisal sheets. 60% of residents thought that they were comfortable appraising a randomized controlled trial, while only 30% felt comfortable with critical appraisal of meta-analysis. 60% of resident felt that they were comfortable applying the evidence to patient care.

At the end of the yearlong curriculum, residents reported increased comfort with medical statistics (46%) (n=13), literature search (69%), interpretation of relative risk (54%), odds ratio (54%), number needed to treat (92%), and confidence intervals (77%). The residents also reported more exposure (92%) and more use of standardized critical appraisal sheets (31%). Comfort level with critical appraisal increased for a meta-analysis (38%), but not for a randomized controlled trial (54%). Comfort level with application of study results to patient care improved (62%). (Table 2)

Secondary outcomes: Overall satisfaction with the EBM curriculum was 77% (n=13) (Table 2). The residents cited lack of time and lack of understanding of EBM concepts as the most common barriers to EBM training.

Discussion

Our intervention successfully increased residents' comfort with EBM concepts and self-reported application of EBM skills and knowledge to patient care.

The curriculum was structured with different components that embraced residents' characteristics as adult learners. Our findings

Table 2. Pre and post course outcomes

Variable	Pre-course	Post-course
Medical Statistics	3/10 (30%)	6/13 (46%)
Comfort with literature search	5/10 (50%)	9/13 (69%)
Source of most medical knowledge		
1) Clinical exp.	2/10 (20%)	4/13 (31%)
2) Textbook	0/10(0)	2/13 (15%)
3) Formal lecture	0/10 (4%)	2/13 (15%)
4) UptoDate	8/10 (80%)	5/13 (38%)
Reported as often used resources		
1) textbook	2/10 (20%)	1/13 (8%)
2) UptoDate	9/10 (90%)	13/13 (100%)
3) Cochrane	0/10 (0)	0/13 (0)
4) medical journal	1/10 (10%)	3/13 (23%)
5) pubmed/medline	3/10 (30%)	3/13 (23%)
Composing clinical question	7/10 (70%)	8/13 (62%)
Relative Risk	4/10 (40%)	7/13 (54%)
Odds Ratio	4/10 (40%)	7/13 (54%)
Confidence Intervals	5/10 (50%)	10/13 (77%)
Number needed to treat	8/10 (80%)	12/13 (92%)
Type 1 vs. Type 2 error	5/10 (50%)	6/13 (46%)
Exposure to appraisal	8/10 (80%)	12/13 (92%)
Routine appraisal sheet use	0/10 (0%)	4/13 (31%)
Appraisal RCT	6/10 (60%)	7/13 (54%)
Appraisal meta-analysis	3/10 (30%)	5/13 (38%)
Application to patient care	6/10 (60%)	8/13 (62%)
Overall satisfaction	6/10 (60%)	10/13 (77%)
Consider EBM Helpful	9/10 (90%)	12/13 (92%)
Consider EBM Important	9/10 (90%)	11/13 (85%)

were similar to previous evidence that showed that EBM curriculum based on adult learning theory improved residents' EBM skills and certain EBM behaviors (2). Clinical patient care scenarios used in interactive

small-group discussions and critical appraisal of patient-oriented research studies to answer residents' own clinical questions through residents' driven journal club created a context that was relevant to residents' patient care responsibilities and enhanced their motivation to learn and adopt EBM. It also created conditions necessary for residents to reach three types of learning outcomes (11): affective learning (changed attitude), behavioral learning (enhanced competence in practicing EBM for quality patient care), and cognitive learning (EBM knowledge gain). Furthermore, residents' led-teaching sessions met their needs to be self-directed and task-focused (or life-centered) in the learning process and learning outcomes; meanwhile, these sessions took advantage of their existing fund of knowledge, experiences, and learning interests as adult learners (7,8).

We were surprised to discover that before curriculum implementation, the residents were not using textbooks as a knowledge source and only 10% of them were using medical journals as a source of medical knowledge. At the end of the year, 100% of responders were using Up-to-date for patient care decisions, which might imply that the "Acquire" part of the EBM cycle was very well implemented and taught throughout the curriculum. After our EBM curriculum implementation, 15% of residents that responded compared with 4% of residents before, thought that their source of most medical knowledge is formal lectures, which might be related to the quality of our EBM faculty-taught lectures. Also, despite the fact the 80% of residents reported that they were exposed to critical appraisal before the curriculum implementation, none of them actually was using routine critical appraisal sheets. This finding strongly suggests that there is a definite need for a structured EBM curriculum that will routinely expose the residents to the usage of critical appraisal sheets.

Limitations: There are several limitations to our study, including its single-site nature and small sample size. We had a small response rate of 22%, which could imply some risk of self-selection bias, as the survey was voluntary and anonymous. Therefore, data collected may not adequately represent those who chose not to participate. Reporting bias could be another source of bias in our study as our survey assessed self-reported answers that could have been under or over-estimated by the residents. There is a potential for observer bias as one observer collected the data. There is also potential for recall bias as the second survey was administered a year later. Also, the pre and post survey responses were not paired, limiting interpretation of the data.

Strengths and Generalizability: Our study strengths are mainly related to the innovative curriculum structure based on adult learning theory and its potential wide generalizability. Our EBM curriculum was easily integrated into our residency program, as the main components were already part of the residency program, such as senior morning report, journal club and resident lectures. We only had to change each component's structure to be based on EBM. These components are already part of many residency programs; therefore the structural change based on EBM can be easily generalizable.

Similar longitudinal integration of EBM curriculum to ensure constant exposure with the EBM concepts has been previously reported as statistically significantly improving the comfort with evidence based practice (13). We believe that this is a significant strength of our EBM curriculum because it was able to provide longitudinal exposure of EBM concepts for 69.8 hours per year for each internal medicine resident. To our knowledge, our EBM curriculum is the most comprehensive curriculum that has been reported in the literature, addressing all the five steps of the EBM process and providing a substantial amount of exposure to the EBM concepts.

Our study results tremendously helped our EBM Faculty to gauge future training based

on the identified EBM curriculum teaching gaps and learners needs.

Conclusion

As the EBM process is very complex, the learning efficacy is enhanced when it is based on the adult learning theory and when constant, longitudinal exposure pertains over time to the EBM concepts. It still remains unknown the necessary time and the adequate structure needed to learn all the EBM skills and knowledge necessary to provide high-quality patient care.

Conflict of Interest

The author declares no conflict of interest.

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