RESEARCH

Evaluation of an Evidence-Based Medicine Curriculum in a PGY1 Pharmacy Residency Program Using the Fresno Test

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Objective. To assess the effectiveness of a longitudinal evidence-based medicine (EBM) curriculum to improve pharmacy resident knowledge and skills in evidence-based practice as measured by the Fresno Test.

Methods. Residency program director and clinical pharmacist preceptors in a community teaching hospital developed a longitudinal EBM curriculum for a postgraduate year one (PGY1) pharmacy practice residency. The program was offered as a yearlong series of 1-hour meetings to train residents in evidence-based practice. A pre/post study design was used to evaluate the program. The full 12-item Fresno Test was used to measure specific EBP skills: Ask, Acquire, Appraise, Apply and Assess. Pre/post composite and item mean scores were compared using Student’s paired t-test.

Results. Forty-three residents completed pre- and post-Fresno Test evaluations between 2008 and 2014 with a mean increase in pre- and post-training scores from 125.9 (SD 32.9) to 138.5 (SD 33.6), p < .02.

Conclusion. A longitudinal training program in EBM in a pharmacy residency demonstrated improvement in core evidence-based practice abilities as measured by the Fresno Test.

Keywords: evidence-based medicine, evidence-based practice, pharmacy residency

INTRODUCTION

Evidence-based practice (EBP) is an integrative approach to patient care requiring specific knowledge skills and abilities to maximize patient benefit by making decisions using the best available, relevant, and valid evidence. Cook and colleagues first described a five-step model for EBP in 1992. The model was further described in a consensus statement developed at the 2003 Conference of Evidence-Based Health Care Teachers and Developers and published as the Sicily statement on evidence-based practice in 2005. The Sicily statement specifies five abilities: formulate an answerable question (Ask), retrieve the best evidence (Acquire), appraise the evidence for validity (Appraise), determine relevance and applicability (Assess), and apply the evidence to a patient and evaluate the impact (Apply). Principles of evidenced-based practice are used in all the steps of the Pharmacists’ Patient Care Process (PPCP) published by The Joint Commission of Pharmacy Practitioners in 2014. The Accreditation Council for Pharmacy Education adopted the PPCP as a key element in the curriculum design, delivery, and oversight standard in 2015. The five evidence-based practice abilities are woven into the Center for the Advancement of Pharmacy Education (CAPE) educational outcomes and pharmacists are expected to enter practice with the ability to use the best evidence to maximize the benefit of medications for their patients. The American Society of Health System Pharmacists incorporated EBP abilities into the criteria for three out of four required PGY1 pharmacy residency competency areas: Patient Care, Advancing Practice and Improving Care and Teaching, Education and Dissemination of Knowledge. Evidence-based practice competes with the anecdotal practice of medicine in busy clinical settings where postgraduate pharmacy training is conducted.

A wide variety of approaches have been studied for the instruction of EBP within health professions and across the educational continuum from undergraduate to postgraduate continuing medical education. Strategies shown to be effective in the postgraduate setting include journal clubs, targeted question training, online instruction,
Objective assessment of EBP skills is necessary to measure instructional effectiveness. Multiple validated measurement instruments exist for EBP. The Fresno Test was developed to assess EBP skill development in family medicine residents and has been extensively validated in postgraduate trainees. The test has been used in studies evaluating EBP in pharmacy students. Composed of 12 items in open-ended, free-text questions, fill-in-the-blank questions and calculations related to two pediatric scenarios, the test is scored out of a total of 212 points. Taken in one 30-minute sitting, the test is scored using a standardized rubric with specific categories (not-evident, minimal and/or limited, strong, excellent) including examples to improve rating on each item. Questions align with the five EBP domains demonstrating high inter rater reliability using multiple graders as well as the ability to discriminate performance between expert and lower competence levels. The test was developed as a pass-fail instrument with the midpoint established as the threshold for each item. However interpretation of competence ultimately relies on expert opinion. Methods to assess attitudes and behaviors toward EBP exist but are less well validated.

EBP practice mastery is a core postgraduate educational objective across health professions and is consistently promoted as a strategy to sustain lifelong learning. In their experience as postgraduate clinical instructors, the study investigators have found that the EBP skills of entering PGY1 pharmacy residents are inconsistent. PGY1 pharmacy practice residents entering EBP skills and abilities have not been described using a validated test of evidence-based medicine. Pharmacy practice residency programs have long included EBP skills as core-learning objectives; however, the effectiveness of these strategies has not been described using a validated test of EBM. Significant barriers to EBP including ever-increasing amounts of medical literature and conflicting evidence and time pressures on practice underscore the importance of delivering effective EBP instruction to pharmacy residents.

The aim of this study was to evaluate the effectiveness of a longitudinal clinically integrated EBP curriculum to improve PGY1 resident performance on the validated Fresno Test of evidence-based medicine.

METHODS

Cone Health is an 869-bed community health system. Its flagship institution, Moses Cone Hospital, has conducted an American Society of Health-System Pharmacy accredited Post Graduate Year 1 (PGY1) residency program since 1968. Instruction in EBP has been incorporated into both required and elective rotations in the form of journal clubs, patient discussions, required topic discussions and case presentations for many years. Residents’ progression through this instruction varies based on rotation schedule. In 2007, the Residency Advisory Committee (RAC) responded to residents’ feedback regarding this lack of organization and began to evaluate the instruction of EBP within the program. Required and elective rotations were surveyed to identify current instructional components. Residents and preceptors identified existing active learning strategies including presentations and journal clubs as effective instructional methods. A literature review was conducted to identify best practices in EBP and its instruction. Guyatt’s Users Guide to the Medical Literature and Slawson and Shaughnessy’s Information Mastery approach to EBP were identified and used to form core instructional content.

One clinical staff pharmacist and the residency program director developed a clinically integrated longitudinal EBM curriculum with interactive classroom components and multiple presentations. Mixed instructional methods was used because of the differing entering competence in EBM knowledge and EBP skills. A clinical staff pharmacist coordinated the program. A clinical coordinator delivered the statistics sessions. Application assignments were mentored and evaluated by pharmacist preceptors considered subject matter experts in the topic chosen by the resident. The required curriculum was first implemented for the 2009 residency class.

The curriculum focused on developing knowledge and skills in the five EBP steps. A series of knowledge-based interactive seminars during orientation launched the program followed by weekly 1-hour meetings throughout the entire residency year. Seminars focused on review of EBM concepts including statistical methods, search strategies, and evidence appraisal. Two follow-up seminars were scheduled later in the year to reinforce skills in assessing validity and relevance in the context of real life practice and delivering continuing education. EBP skills were developed in the context of a series of increasingly complex presentation assignments. In 2010, based on resident feedback, four resident-delivered statistics seminars were added. Table 1 describes the content and timing of each curricular component and the EBP step instructed.

The first skills training was a multistage assignment completed during the first quarter of the residency. In stage one, residents had two weeks to identify a single piece of patient-oriented evidence that matters (POEM) in
<table>
<thead>
<tr>
<th>Session Title (Presenter): Topic Covered</th>
<th>Allocated Time</th>
<th>Timing</th>
<th>EBP Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction to Information Mastery (Preceptor led): Translating EBM to practice including asking good questions using Patient-Intervention-Comparison-Outcome (PICO) format.</td>
<td>1h</td>
<td>July</td>
<td>Ask, Acquire, Appraise</td>
</tr>
<tr>
<td>Statistics Part 1 &amp; 2 (Preceptor led): Study design, and statistical concepts of validity, magnitude, and significance.</td>
<td>2 x 1h</td>
<td>July</td>
<td>Appraise</td>
</tr>
<tr>
<td>Application of Information Mastery (Preceptor led): Focused review on relevance and finding the information that matters to your patients.</td>
<td>1h</td>
<td>July</td>
<td>Appraise</td>
</tr>
<tr>
<td>How to Find the Evidence (Resident self-guided team exercise): Review evidence-based tools available through the local medical library.</td>
<td>1h</td>
<td>July</td>
<td>Ask, Acquire</td>
</tr>
<tr>
<td>POEM Presentation (Resident delivered presentation): Identify and review a single article, includes case application and an active learning strategy.</td>
<td>10 min</td>
<td>Q1</td>
<td>All steps</td>
</tr>
<tr>
<td>Clinical Question for Quality Team (Resident delivered presentation): Question supplied by pharmacy quality team, team assigned based on resident interest.</td>
<td>10 min</td>
<td>Q1</td>
<td>Acquire, Appraise, Apply</td>
</tr>
<tr>
<td>How to Deliver Effective Continuing Education (Preceptor led): Emphasis on active learning strategies/including demonstration of strategies.</td>
<td>1h</td>
<td>Q1</td>
<td>Apply, Assess</td>
</tr>
<tr>
<td>Topic (Resident delivered presentation) evidence-based review on therapeutic topic of resident’s choice.</td>
<td>15 min</td>
<td>Q2</td>
<td>All steps</td>
</tr>
<tr>
<td>“Clinical Jazz” (Preceptor led): Integrating evidence-based medicine, information mastery with practice experiences.</td>
<td>1h</td>
<td>Q2</td>
<td>Apply, Assess</td>
</tr>
<tr>
<td>Case (Resident delivered presentation): Patient case presentation.</td>
<td>15 min</td>
<td>Q3</td>
<td>All steps</td>
</tr>
<tr>
<td>Continuing Education (Resident delivered presentation): Accredited Continuing Education, use of active learning strategies required.</td>
<td>50 min</td>
<td>Q3-4</td>
<td>All steps</td>
</tr>
<tr>
<td>Statistics Case (Resident delivered presentation) practical application of statistical concepts, including the power of the number needed to treat, use of case reports, predictive value and application of the odds ratio.</td>
<td>20 min</td>
<td>Q3</td>
<td>Assess</td>
</tr>
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Abbreviations: EBP = Evidence-based practice; *Q1 = quarter one; Q2 = quarter two; Q3 = quarter three; Q4 = quarter four
a practice area of personal interest. POEM identification immersed residents in the challenge of finding the evidence and the need for good questions. In stage two, the residents had four weeks to appraise the evidence and develop a 10-minute presentation using the patient, intervention, comparison, outcome (PICO) question format as a framework for application of the evidence to a patient case. Residents received formative feedback on this presentation from an assigned mentor with expertise in the topic chosen by the resident. In the final stage, the presentation was delivered to an audience of clinical pharmacists. Formative feedback was given on both presentation content and delivery. This initial assignment set clear expectations for the application of EBM knowledge to practice within the curriculum and to clinical practice. Further skill practice was achieved through three additional presentations of increasing complexity. Residents received formative and summative feedback on quality of the literature chosen, article review, presentation and teaching skills using a standard rubric for all presentation assignments.

To assess the curricular effectiveness, a retrospective cross-sectional before-after study was completed in 2016. Residents completed the Fresno Test in week 1 and during the last month of the residency. Clinical staff pharmacists and residency program directors (six individuals who were involved in curricular instruction) scored the residents’ Fresno Test using the grading rubric developed for the test. Graders were blinded to the test taker identity and did not grade pre- and post-tests from the same resident. Structured interview feedback was obtained annually from the residents and preceptors. Residents completing both pre- and post-evaluations between July 2008 and June 2014 were included and used as their own control. The Cone Health Institute Review Board approved this study.

The effectiveness of the EBM curriculum was measured using difference in total pre- and post-training Fresno Test scores as the primary outcome. Unadjusted comparison of total Fresno Test pre- and post-test scores and subscores by EBP domain was conducted using Student’s paired t-test. Adjusted comparison of the pre- and post-test scores was conducted using a generalized estimating equation regression model. This model adjusted for the within-resident repeated measures of test scores, along with test year and test grader. Additionally, within-resident differences in pre- and post-test scores were compared across pre-test score quartiles using linear regression. No sample size calculation was performed because all residents participated. Stata version 12.1 (StataCorp LLC, College Station, TX) was used for data analysis. An a priori \( p < 0.05 \) was considered significant.

**RESULTS**

Forty-three residents completed pre- and post-training Fresno Test assessment between the years 2009 and 2014. The mean Fresno Test score increased from 125.9 (SD 32.9) pre-training to 138.5 (SD 33.6) post-training, \( p = 0.02 \) in an unadjusted comparison using a paired t-test. The adjusted mean values for pre- and post-training Fresno Test scores were 124.2 and 140.0 respectively, \( p = 0.001 \) in the generalized estimating equation model, which adjusted for repeated-measure, grader, and test year (Table 2). The total possible score on the assessment was 212 points. Numeric improvement was seen in all EBP skills measured by the Fresno Test: forming questions in PICO format (Ask), search strategies (Acquire), validity assessment (Appraise), study design (Apply) and calculations (Assess). Statistically significant improvement was seen in the Assess subscore in both the unadjusted and adjusted comparisons (13.9 [SD 10.4] to 20.4 [SD 10.0], \( p = 0.001 \) and 14.8 to 22.1, \( p < 0.001 \), respectively) (Table 2).

**DISCUSSION**

The impact of a longitudinal EBM curriculum over multiple years in a PGY1 pharmacy residency using the full 12-item Fresno Test was measured. Overall, EBM

| Table 2. Fresno Test Pre-test and Post-test Scores and Subscores as Measured and Adjusted for Covariates of Repeated Measure, Grader, and Year |
|-------------------------------------------------|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Measured Values** | **Values Adjusted for Covariates** | | | | | |
| | Pre-Test | Post-Test | | Pre-Test | Post-Test | |
| | M (SD) | M (SD) | | M (SD) | M (SD) | |
| Total Score | 125.9 (32.9) | 138.5 (33.6) | .02 | 124.2 (37.4) | 140.0 (40.8) | .001 |
| Subscores (Fresno Test Questions) | | | | | | |
| Ask (1) | 15.8 (5.0) | 16.7 (4.2) | .25 | 16.5 (5.4) | 17.8 (5.9) | .10 |
| Acquire (2-4) | 33.5 (10.3) | 35.6 (9.0) | .30 | 30.7 (11.7) | 33.1 (12.9) | .19 |
| Apply (10-12) | 16.9 (5.7) | 19.0 (6.8) | .09 | 17.5 (8.0) | 20.1 (8.7) | .04 |
| Appraise (5-7) | 45.9 (14.7) | 46.7 (16.4) | .78 | 44.2 (19.6) | 46.3 (21.4) | .44 |
| Assess (8-9) | 13.9 (10.4) | 20.4 (10.0) | .001 | 14.8 (11.7) | 22.1 (12.8) | <.001 |

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knowledge and EBP skills as assessed by the Fresno Test increased over the 12-month residency program. When evaluating the unadjusted individual aspects of EBP, significant improvement was seen only in the EBP ability to assess relevance and applicability (Assess) as demonstrated on the Fresno Test by calculating number needed to treat. The multivariate analysis also demonstrated a significant improvement in EBP ability Apply as demonstrated on the Fresno Test by determining which study design was appropriate for specific applications (Table 2). Qualitatively, the presentations delivered over the course of the curriculum improved consistently for all residents from the initial POEM assignment to the final case presentation delivered in the spring. Over the course of this program, resident and preceptor feedback were aligned and positive. Annual structured interview feedback indicated that the program was effective at training EBP skills and was well-received by the residents and mentors. The longitudinal EBM curriculum had a meaningful positive impact on resident satisfaction in the training program.

The Center for the Advancement of Pharmacy Education (CAPE) 2013 Educational Outcomes describes EBM knowledge in its first domain “Foundational Knowledge” and EBP in the third domain “Approach to Patient Care.” Pharmacists are expected to enter practice with the ability to “develop, integrate and apply knowledge from the foundational sciences to evaluate the scientific literature” (CAPE 1.1) and “identify problems; explore and prioritize potential strategies and design, implement, and evaluate a viable solution” (CAPE 3.1). From this foundation, the American Society of Health-Systems Pharmacists (ASHP) Post Graduate Year One (PGY1) Residency Competency Areas, Goals and Objectives (2014) incorporate the concept of “evidenced-based” in the criteria for three out of four required competency areas: Patient Care, Advancing Practice and Improving Care and Teaching, Education and Dissemination of Knowledge. For example, objective R1.1.5 specifies that therapeutic goals should be evidence-based. Multiple reviews have been published on the instruction of EBP in the health professions suggesting that effective instruction of EBP abilities is possible and has an impact on practice. Pharmacy school courses that effectively instruct EBP knowledge and skills have been described. Despite agreement that EBM is a foundational knowledge and skill, the anecdotal practice of medicine still exists in busy clinical settings, putting pressure on the daily application of EBP. To our knowledge, this is the first study to describe the instruction of EBP in the postgraduate pharmacy residency setting.

While EBP instruction has been shown to be effective in postgraduate medical training, studies suggest EBP knowledge and skills deteriorate over time. This study demonstrated improvement in EBP knowledge and skills over a 12-month period. While there is no passing Fresno Test score, the entering cohorts’ scores measured higher than the medical residents tested in validation samples and in more recent studies, suggesting that expectations for postgraduate EBP training in pharmacy are higher than for other health professions. The study investigators saw a spectrum of entering EBP resident competencies confirming their design phase perception of variability in entry EBP skills. This finding confirms the need for introductory knowledge-based EBM seminars in a postgraduate pharmacy EBP curriculum. While the results of this study demonstrate an improvement in overall Fresno Test performance, there is a need for more studies both on how to best optimize the impact of EBP training across the scope of residents entering competency and how to evaluate the impact of EBP training on EBP skills beyond the PGY1 residency year.

This study has several limitations. The pre-post study design’s lack of randomization and a control group leads to questions of the true effectiveness of the intervention to improve EBP skills. The lack of a control group limits the measurement of the intervention in residents especially with variable entering Fresno Test scores. To explore this relationship, pre-training scores were stratified by quartile. Significant improvement in post-training scores was seen for the two lowest pre-test quartiles, by 42.2 and 24.6 points, respectively, $p < .001$ and $p = .005$ by linear regression (Figure 1). For residents with pre-training scores in the upper quartiles, no significant change was noted. The impact of the intervention is further confounded by the fact that while the EBM curriculum is required and session attendance is excellent, pharmacy residents’ training in EBP also occurs during rotation activities, which are variable by design based on resident interest and scheduling. Each resident’s unique training experience was not explored in this analysis. The residency program also includes a required research curriculum not described in this study, which may have further influenced this outcome. The external validity of the results must also be considered due to the selective nature of the PGY1 residency program. Multiple contextual factors have been shown to affect the EBP learning environment, including the role of the learner, accountability, presence of social support, learning culture and resource availability. This study did not control for these factors so the possibility that their presence confounds the effect of the intervention on EBP skills cannot be excluded. Formal assessment of learning environment should be considered as a part of further study of EBP educational interventions especially for efforts targeting programmatic change in EBP curriculum.
Treatment effect was measured using the Fresno Test graded by multiple EBM instructors directly involved with the delivery of the curriculum. By design, graders were blinded to test taker identity and did not grade pre- and post-test pairs. However, the possibility of grader bias is not excluded. The possible influence of confounders in a multivariable analysis considering repeated measures, year and grader, which maintained statistical significance between the pre- and post-test scores was explored. Compared with other tests of EBM, the Fresno Test is the best studied with the strongest tests of validity and high inter-rater reliability.\textsuperscript{15} While the Fresno Test has been used to measure pharmacists’ EBM skills, the test is not validated in a cohort of pharmacists. The short answer essay format makes results dependent on test taker effort, which may have had a disproportionate impact on the post-test score due to the low stakes associated with the final assessment in the resident curriculum. The Fresno Test in its full original form was used with the pediatric clinical cases. Appraise and apply domains of EBP are assessed most extensively by the Fresno Test. However, the practice of pharmacy requires the use of EBP components across all areas especially ask and acquire.\textsuperscript{16} Further study of EBP training for pharmacists may benefit from adapting the Fresno Test case scenarios to include pharmacotherapy specific cases and development of an expanded rubric that more robustly measures skills in the ask and acquire domains.

**CONCLUSION**

A longitudinal EBM curriculum is an effective method to improve the knowledge and application of evidence-based practice in a PGY1 pharmacy practice residency as measured by the Fresno Test. Results suggest that the Fresno Test can be used to assess knowledge and skills in a postgraduate pharmacy cohort. Opportunity exists for further development and validation of assessment tools for EBM knowledge and EBP skills in a cohort of pharmacists who use all EBP domains extensively. EBP instruction is an integral part of postgraduate pharmacy residency training and it bears further investigation with regards to how best to train pharmacists for the lifelong application of these skills.

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