

Teaching Lifelong Research Skills in Residency: Implementation and Outcome of a Systematic Review and Meta-Analysis Course

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ABSTRACT

Background There is rising concern that fundamental scientific principles critical to lifelong learning and scientific literacy are not sufficiently addressed during residency.

Objective We describe the development, implementation, and evaluation of a systematic review and meta-analysis course designed to improve residents' research literacy.

Intervention We developed and implemented a novel, interactive, web-enhanced course for third-year psychiatry residents to provide the theoretical and methodological tools for conducting and reporting systematic reviews and meta-analyses. The course is based on Bloom's learning model, and established criteria for reporting systematic reviews and meta-analyses. Eight sequential learning objectives were linked to 8 well-specified assignments, with the objectives designed to build on one another and lead to the creation of a scientific manuscript.

Results From 2010–2014, 54 third-year psychiatry residents (19 unique groups) successfully completed the course as part of a graduation requirement. The majority rated the course as being good or very good, and participants reported a statistically significant increase in their confidence to conduct systematic reviews ($\chi^2 = 23.3$, $P < .05$) and meta-analyses (Fisher exact test, $P < .05$). Estimated total dedicated resident and faculty time over a period of 36 weeks was 36 to 72 hours and 60 hours, respectively. Residents' academic productivity included 11 conference presentations and 4 peer-reviewed published manuscripts, with 2 residents who were awarded honors for their projects.

Conclusions A formal training course in systematic reviews and meta-analyses offers a valuable learning experience, which enhances residents' research skills and academic productivity in a feasible and sustainable approach.

Introduction

Participation in scholarly activity is important to advance residents' critical evaluation of research, ensure care is evidence based, and address the critical shortage of physician researchers.¹ To accomplish these goals, many programs have developed longitudinal research curricula^{2–7} and/or research tracks.^{8–10} Approaches described in the literature vary in the amount of devoted research time, ranging from protected research blocks^{11–13} to a dedicated research year.¹⁴ Yet, programs continue to struggle to successfully integrate practical research experience into residency training.^{15–17} This lack of integration may in part be due to several factors, including increased clinical service demands,^{18,19} limited funding dedicated for residents to conduct research,^{20,21} insufficient faculty mentors, and limited resident^{20,22,23} and faculty time.^{19,23} Although the majority of programs

report having some infrastructure to provide a research training experience, many report low levels of research knowledge (eg, research design, manuscript writing, and grant writing).²⁴ To bridge this gap, it is critical that residency programs provide research training experiences that are educationally meaningful, and sustainable within the existing training framework.

Teaching residents how to conduct systematic reviews and meta-analyses may provide a solution to some of these barriers. Systematic reviews and meta-analyses are efficient means of integrating existing information; they provide data for rational decision making²⁵ and can be taught using established guidelines²⁶ and previously vetted tools.²⁷ These skills are relevant to lifelong learning, quality improvement, and evidence-based practice, as systematic reviews and meta-analyses provide succinct syntheses of critical biomedical information that can inform clinical practice and improve patient care. The benefits of systematic reviews as research activities in graduate medical education have been de-

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scribed,^{25,28} but to our knowledge, this is the first article describing the integration of a systematic review course in a residency program.

Methods

Intervention

The Department of Psychiatry at the University of Maryland School of Medicine developed and successfully implemented a hybrid course utilizing interactive face-to-face and online elements for third-year psychiatry residents that provides the theoretical and methodological tools required to conduct and report the results of systematic reviews and meta-analyses.

Course Development: Theoretical Framework

The course was informed by Benjamin Bloom's mastery for learning model in which residents are helped to master each learning task before moving to a more advanced learning task.²⁹ This model requires well-defined learning objectives that are sequentially organized to fulfill a given learning objective. Eight sequential learning objectives regarding data collection were developed based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, which are an evidence-based minimum set of items for reporting on systematic reviews²⁶ (TABLE). These learning objectives were each linked to 8 well-specified assignments, which were reviewed using a structured instrument to provide constructive feedback. Learning objectives were specifically designed to link to the PRISMA guidelines, and naturally build on one another to lead to the creation of a scientific manuscript.

Consistent with the principles of adult learning (eg, andragogic learning),³⁰ course design focused on problem-based assignments in teams. Each group chose a research question that became the focus of the sequential, problem-based assignments listed above. The course emphasized working in small groups as this is how "science gets done in the real world," and it additionally offered an opportunity for self-directed learning. The instructor served as a facilitator, answering questions, providing information (in the format of a small series of problem-based, informational lectures), and ensuring projects were completed efficiently.

Course Content

The course provided 9 succinct, 30- to 45-minute lectures that occurred over a 9-month period. Lectures emphasized critical learning objectives that

What was known and gap

Research literacy, including the ability to aggregate data from multiple studies, are physician skills not well addressed in residency.

What is new

A required course in conducting and reporting systematic reviews and meta-analyses for psychiatry residents that has been sustained over multiple years.

Limitations

Single specialty, single institution intervention may reduce generalizability.

Bottom line

A formal course in systematic reviews and meta-analyses for residents offered a valuable learning experience, and enhanced their research skills and academic productivity.

were nearly always linked to an assignment (TABLE) and were supplemented by group-based, self-directed learning in the service of completing each assignment.

Web-Enhanced Format

A web-based educational service (Blackboard)³¹ was used to provide the online structure for the course. Blackboard has the ability to post all educational material, remind participants of required readings and due dates, create chat rooms for open discussion and dialogue, and collect course-related projects and outcome data. For the purpose of this course, the site was used to disseminate course specific information (downloading and uploading assignments).

Course Implementation and Time Requirements

Residents: All third-year psychiatry residents participated in the course as a graduation requirement. Residents were expected to complete class assignments, culminating in a scientifically formatted manuscript ready for peer review. Residents were also required to present their work at a departmental research day. Submitting manuscripts or abstracts for publication and conference participation was optional. Class assignments were developed to take each resident approximately 5 hours of outside class time over a period of 36 weeks, and residents estimated spending approximately 1 to 2 hours weekly.

Faculty: One faculty member served as the course instructor. In addition to in-course instruction, the instructor met with each resident group separately for out-of-class consultation for approximately 1 to 2 hours over the length of the course (with an estimated total faculty time of approximately 60 hours).

TABLE

Content of Course Lectures With Learning Objectives Linked to Assignments Based on PRISMA Criteria

Lecture Title	Content	Related Assignment
What is a Systematic Review and Meta-Analysis?	Describes the history and rationale for conducting a systematic review and meta-analysis. Introduces residents to PRISMA guidelines and the Cochrane Handbook.	No
Selecting a Research Topic and Developing a Research Question	Provides information regarding how to create a 1-sentence, informative research question based on the PICO format. Discusses strengths and weaknesses of broad versus narrow questions through examples.	Create a PICO informed research question.
Nuts and Bolts of a Systematic Review Part 1: Eligibility Criteria	Describes the eligibility criteria that will be used to conduct the literature search. Discusses strengths and weaknesses of broad versus narrow usages of eligibility criteria.	Define and describe eligibility criteria.
Nuts and Bolts of a Systematic Review Part 2: Literature Search	Describes how to conduct a reproducible literature search using different databases. Discusses grey literature. Begins discussion of publication bias. Describes how search results interface with PRISMA flow diagram.	Conduct and document the results of literature search using at least 2 databases (eg, PubMed, PsycINFO). Begin to populate PRISMA flow diagram.
Nuts and Bolts of a Systematic Review Part 3: Interrater Reliability	Reviews concept of interrater reliability. Discusses how to calculate κ statistic. Provides examples of how κ statistic can be used to report interrater reliability as it pertains to using eligibility criteria to include or exclude papers in the systematic review.	Report results of κ statistic as it pertains to evaluating whether to include or exclude papers in the systematic review. Finish populating PRISMA flow diagram.
Nuts and Bolts of a Systematic Review Part 4: Assessing Quality	Discusses how to report quality of the papers being reviewed by the systematic review, using "Risk of Bias" instrument developed by Cochrane review.	Create a risk-of-bias table as well as a summary table for all papers included in the systematic review.
Nuts and Bolts of a Meta-Analysis Part 1: Organizing Data, Effect Sizes, and Forest Plots	Describes how to organize data culled from papers included in the systematic review to be used to conduct a meta-analysis. Provides examples and tools to do this. Defines measures of effect size and how to calculate these measures from data collected from the studies included in the meta-analysis.	Collect, organize, and document key data from each study included in the systematic review in order to enable calculation of a weighted effect size.
Nuts and Bolts of a Meta-Analysis Part 2: Publication Bias and Heterogeneity	Discusses and describes publication bias and heterogeneity as it applies to meta-analysis. Provides examples of interpreting results.	Calculate weighted effect size. Present and interpret forest plot and funnel plot.
Manuscript Preparation: How to Write a Scientific Paper	Reviews ethics and key component of paper writing.	Write a scientifically formatted manuscript ready for peer review.

Abbreviations: PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PICO, Population, Intervention, Control Group, and Outcome.

Course Assessment

Residents anonymously completed an evaluation form created by the authors about whether the course met learning objectives. This consisted of 38 questions that used a 5-point Likert scale and evaluated the utility of key course components, and included 3 open-ended questions for feedback about strengths and weaknesses of the course. This retrospective pre-

post method preserves the anonymity of residents' responses and has been shown to be effective in program evaluation.³²

The evaluation was deemed exempt by the University of Maryland School of Medicine Institutional Review Board.

Analysis of course evaluations consisted of univariate distributions for each variable, as well as comparisons of percentages using 2-tailed χ^2 test or Fisher exact test (Stata version 12, StataCorp LP).

Results

From 2010–2014, 54 residents (consisting of 19 unique groups, ranging in size from 2 to 4 members) successfully completed the course. From the results of these evaluations, residents who took the course reported a statistically significant increase in their confidence to conduct a systematic review (79.6% [43 of 54] reported being “confident” or “very confident” postcourse versus 7.4% [4 of 54] before the course; $\chi^2 = 23.3$; $P < .05$) as well as a statistically significant increase in their confidence to conduct a meta-analysis (77.8% [42 of 54] reported being “confident” or “very confident” postcourse versus 5.6% [3 of 54] before the course; Fisher exact test; $P < .05$). The course received an overall evaluation as being “good” to “very good,” and the course was rated as being neither too easy nor too hard. The majority (85%, 46 of 54) reported they agreed or strongly agreed that they had enough time to complete all assignments. Key course components were rated favorably: 90% (49 of 54) reported that meeting with the course instructor was “very helpful” or “helpful,” and 76% (41 of 54) reported that completing the final scientific paper was “very helpful” or “helpful.” In particular, residents noted that the structured, stepwise content of the course was linked to success. We present selected written comments taken from the evaluations to illustrate this point:

“It was very helpful learning how to do a meta-analysis/systematic review. I also feel that it was extremely helpful learning how to assess the quality of research studies. Lastly, I truly appreciated the strict deadlines for each assignment.”

“Stepwise approach to completing, constant guidance through each step, knowledge and confidence gained from completing project.”

Additionally, some residents chose to submit abstracts to conferences or submit their manuscript for publication. For the 19 groups that completed the course, there have been 11 abstracts accepted at national scientific meetings. One poster presentation received the distinction of being the “Best Resident Poster” at 1 meeting. There have also been 4 published peer-reviewed manuscripts. One manuscript received the “Best Resident Paper” award from a state professional society.

Discussion

Our report is on the successful development, implementation, and evaluation of a research training

course that fits well within the context of a residency training experience. Most residents liked the course, felt they had enough time to complete the course, and gained confidence in their ability to conduct a systematic review and meta-analysis. Many residents published peer-reviewed manuscripts, which was infrequent prior to this course implementation.

It is important to consider factors that facilitated the success of the course along with potential barriers to its implementation. The course had support from the chairman and the residency program director, including the provision of faculty time and funding to support course creation and instruction. As the course was significantly different from previous research activities, it was vetted by residents and faculty to garner support and champion the effort. Barriers noted during this process included residents’ concern over the time required to complete course assignments. These concerns were overcome by incorporating 1 hour per week for “protected time” to work on course activities. To help promote the success of the course, we added an award for the best resident project and a formal end-of-the-course oral presentation. Presentations were used to showcase the results of the course and were considered highly successful. After the end of the first year of the course, residents provided feedback that having protected time was not necessary and this component was dropped.

Strengths of this research training course include (1) provision of valuable research experiences without requiring significant programmatic restructuring; (2) emphasis on group-based, self-directed learning; and (3) minimal faculty burden. The time required for residents to complete the course was approximately 36 to 72 hours. It is important to note that Rivera and colleagues²⁰ found that internal medicine residents presenting their work at a conference spent a median of 200 hours on research abstracts, and 50 hours on clinical vignettes.

An important limitation of this project evaluation is the lack of validity evidence for the author-developed survey. Course evaluation could be strengthened by using existing validated tools and/or establishing survey validity by comparing the authors’ survey with other evaluation instruments. In addition, the course was developed and applied in a single institution for residents in a single specialty, limiting generalizability. Finally, a retrospective pre-post method may introduce recall bias, even though it is commonly used in educational program evaluation.

Implementing this type of course in a residency training program requires careful consideration, as adding 1 to 2 hours per week of additional resident work may not be feasible in some programs.

Identifying a faculty member to lead the course also may prove challenging. Faculty who do not have a background in research methodology may not feel prepared to teach a course such as this. However, these challenges are surmountable with guidance and consultation. The authors are currently developing a course guide with all the necessary teaching materials to help facilitate dissemination. This course guide will be available by the authors and supplemented through ongoing consultation, using a train-the-trainer model to facilitate implementation.

Conclusion

Providing the framework, resources, and training necessary to conduct a systematic review and meta-analysis led to the attainment of academically relevant skills that can be applied in lifelong learning. These outcomes suggest that the course is educationally meaningful, sustainable, and impacts both residents' research training and the profession at large.

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