RESIDENT & FELLOW SECTION

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Education Research: The challenge of incorporating formal research methodology training in a neurology residency

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ABSTRACT

Background: Physicians often do not have good understanding of research methodology. Unfortunately, the mechanism to achieve this important competency in a busy neurology residency program remains unclear. We tested the value and degree of acceptance by neurology residents of a multimodal educational intervention that consisted of biweekly teaching sessions in place of an existing journal club, as a way to provide formal training in research and statistical techniques.

Methods: We used a pre- and post-test design with an educational intervention in between using neurology residents at the University of Iowa as subjects. Each test had 40 questions of research methodology. The educational intervention consisted of a biweekly, structured, topic-centered, research methodology-oriented elective seminar following a year-long predefined curriculum. An exit survey was offered to gather resident's perceptions about the course.

Results: While a majority of residents agreed that the intervention enhanced their knowledge of research methodology, only 23% attended more than 40% of the sessions. There was no difference between pretest and post-test scores ($p = 0.40$).

Conclusions: Our experience suggests that, in order to accomplish the Accreditation Council for Graduate Medical Education goals regarding increasing competency of residents in knowledge about research methodology, a major restructuring in the neurology residency curriculum with more intense formal training would be necessary. *Neurology*® 2008;70:e79–e84

An understanding of research methodology is deemed crucial for both a successful research career[1] and for critically judging publications relevant to practice.[2] In fact, the Accreditation Council for Graduate Medical Education has established as part of the practice-based learning and improvement competency that residents "must demonstrate an ability to a) locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems, b) obtain and use information about their own population of patients and the larger population from which their patients are drawn, and c) apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on diagnostic and therapeutic effectiveness."[3] Unfortunately, the mechanism to achieve these important skills in a neurology residency program remains unclear. The already busy and strict neurology residency curriculum is a challenging environment for formally teaching research methodology. We proposed a targeted multimodal educational intervention using the time allocation of a biweekly journal club to provide training while avoiding a major intrusive modification in the other components of the curriculum. We evaluated the utility of the educational program by assessing its acceptance by neurology residents, and testing for an increase in knowledge of research methodology.

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Table 1	Topics covered in 1-year biweekly structured journal club
Diagnostic tests: sensitivity, specificity, receiver operating characteristic curves	
Biases	
Measure of risk: OR and risk ratio	
Chi-square and Fisher exact test	
Tests trend: Cochran-Mantel-Haenszel test	
Confounding and interaction	
Rates: crude and standardization	
Follow-up data: Kaplan-Meier	
Interobserver agreement: Kappa	
Linear regression	
Logistic regression	
Cross-sectional studies	
Retrospective cohorts	
Prospective cohorts	
Case-control studies	
Randomized clinical trials	
Quasi-randomized trials	
Community intervention trials	

METHODS We used a pre- and post-test design to test knowledge on research methodology in conjunction with an educational intervention. Neurology residents and fellows at the University of Iowa were invited to participate in this voluntary program that took place during one academic year (July 2006–June 2007). In July 2006, the subjects were asked to complete a 40-question pretest on a selected list of topics of research methodology. The actual questionnaire is shown in the appendix. Faculty members of the Department of Neurology were invited to take the pretest for validation purposes.

The educational intervention consisted of an elective biweekly, structured, topic-centered, research methodology-oriented seminar. Each session was centered around a specific topic in research methodology. This curriculum is outlined in table 1. This program encouraged active resident participation with faculty supervision. Each research methodology topic was assigned in advance to one resident. Her or his role included to prepare a short Powerpoint presentation about the topic, to select an article that would illustrate that particular topic, and to generate questions in advance to illustrate important learning points from that article. The residents discussed the Powerpoint presentation, article, and questions with the supervising faculty member (E.C.L.) in order to obtain feedback prior to the presentation. The article and questions were given to all residents before the presentation. The sessions meant to encourage active participation and discussion through case-based learning.

At the end of the series of seminars the participants were asked to complete a 40-question post-test consisting of the same questions as the pretest but administered in a shuffled order. Following the post-test, residents were asked to complete an anonymous survey to gather their perceptions regarding the newly implemented educational intervention. We were particularly interested in perceived benefits for their career, subjective learning, and suggestions for future improvement. Both tests and exit survey were administered through WebSurveyor (WebSurveyor Corporation), a password-protected Web-based computer system, and scores were kept confidential. Comparisons between the number of correct responses in different tests were done using a Wilcoxon rank sum test. Significance was established at the 5% level. Descriptive statistics were used to analyze the responses to the survey. All statistical analyses were performed using SAS version 9.1 (SAS Institute Inc., Cary, NC). This study was previously approved by the University of Iowa Institutional Review Board.

RESULTS Eighteen of 23 neurology residents completed the pretest, and 10/23 residents completed the post-test. The mean number of correct answers in the pretest was 24.17 (SD = 5.77). The mean number of correct answers in the post-test was 25.58 (SD = 4.56) (p = 0.40). Using a paired *t* test for mean difference approximation, we retrospectively calculated that we had a power of 10% to detect a significant difference. The majority of the residents attended fewer than 40% of the educational sessions. A total of 10 faculty members of the Department of Neurology anonymously completed the pretest. The mean number of correct answers in the faculty pretest was 27 (SD = 4.59). Comparison between the resident's and faculty pretest scores showed no differences ($p = 0.16$).

Nine neurology residents completed the exit survey. The results are shown in table 2. Two thirds of respondents agreed that the educational intervention enhanced their knowledge about research methodology. The majority did not perceive a benefit in regards to patient care. Residents were also asked to volunteer anonymous comments about the program. The residents were not enthusiastic about the seminar's emphasis on statistical techniques.

DISCUSSION We tried to address the widespread problem of deficient (or nonexistent) formal research methodology training in neurology residencies by proposing a simple intervention that would not further stretch the current busy schedule of a neurology training program.

The tested multimodal educational intervention did not improve knowledge about research methodology, although we recognize the limitation of our small sample size, which limits the power to detect a significant difference.

Equally disappointing was the moderate to low enthusiasm for this new modality of training, judging by the resident's responses and attendance. Unfortunately, knowledge of research methodology is not a focus of the resident in-training examination administered by the Ameri-

Table 2 Results of the exit survey on neurology residents

This format of journal club has enhanced my understanding of research methodology	Totally agree (0%); Somewhat agree (67%); Do not agree or disagree (11%); Somewhat disagree (22%); Totally disagree (0%)
This format of journal club has enhanced my ability to understand manuscripts	Totally agree (22%); Somewhat agree (44%); Do not agree or disagree (11%); Somewhat disagree (22%); Totally disagree (0%)
This format of journal club has motivated me to read more manuscripts	Totally agree (0%); Somewhat agree (33%); Do not agree or disagree (33%); Somewhat disagree (22%); Totally disagree (11%)
This format of journal club has increased my interest in clinical research	Totally agree (11%); Somewhat agree (33%); Do not agree or disagree (33%); Somewhat disagree (11%); Totally disagree (11%)
This format of journal club has increased my interest in evidence-based medicine	Totally agree (11%); Somewhat agree (44%); Do not agree or disagree (33%); Somewhat disagree (0%); Totally disagree (11%)
This format of journal club has increased my interest in pursuing a research academic career in Neurology	Totally agree (0%); Somewhat agree (44%); Do not agree or disagree (33%); Somewhat disagree (11%); Totally disagree (11%)
This format of journal club has improved the way I explained the evidence facts to my patients	Totally agree (0%); Somewhat agree (22%); Do not agree or disagree (33%); Somewhat disagree (11%); Totally disagree (33%)
How many journal club sessions did you approximately attend?	80-100% of the sessions (11%); 60-79% of the sessions (0%); 40-59% of the sessions (11%); 20-39% of the sessions (44%); 19% or less of the sessions (33%)
What percentage of time did you read the article in advance?	80-100% of the sessions (0%); 60-79% of the sessions (11%); 40-59% of the sessions (22%); 20-39% of the sessions (33%); 19% or less of the sessions (33%)
What is your overall impression of the format of journal club?	Very informative (11%); Somewhat informative (33%); Neutral (44%); Not very informative (0%); Not informative at all (11%)

Values are percentages.

can Academy of Neurology, a standardized measure of resident's performance, or a major focus of the American Board Psychiatry and Neurology certification examination, which might be a disincentive to study this field.

These negative objective and subjective results make us skeptical of the future acceptance of more complex and sustained interventions to enhance understanding of research methodology. Protected time for formal teaching of biostatistics and epidemiology is not easy to achieve in a currently highly regulated residency curriculum.[4] While the NIH provides K grants with required protected time to potential clinician-scientists so they obtain the necessary formal training in research methodology, such assistance is very limited and usually not available during residency.[1] Residency programs that successfully train academic physicians need to include a period of mentored research, or facilitate participation in courses to enhance methodologic expertise.

A Canadian residency program has incorporated an evidence-based medicine (EBM) teaching program in their curriculum.[5] These sessions are topic-centered, so the trainee is taught EBM in the process of critically appraising and reviewing the available literature regarding the particular clinical question. While these topic-centered EBM seminars are likely to be more accepted by residents, and the skills taught crucial for clinical-decision making, one can argue that they should be based on a solid foundation in research methodology. There are other important limitations. First, summaries of EBM only include a handful of conditions,[2] and most of the perceived "landmark" articles in neurology therapeutics will be randomized clinical trials (RCT). Therefore, that approach to learning will likely result in a biased curriculum in which RCT are overemphasized to the detriment of other type of studies, such as prospective cohorts, case-control, or community intervention trials. In fact, a comprehensive assessment of biostatistical knowledge among internal medicine residents has shown disappointing results.[2] Beyond the implications of potentially learning a biased curriculum, such an approach could also aggravate the current national crisis in electing a clinical research career.[1] It is unlikely for a young investigator to start his or her career organizing a RCT, which are among the most costly and complex research experiments. On the other hand, an earlier exposure to other more "affordable" and feasible modalities for research, including retrospective cohorts and case-control studies, might inspire neurologists in

training to pursue similar studies early in their careers. Potential solutions include Web-based courses, perhaps developed by the AAN, and a gradual exposure starting with more appealing topics such as EBM and clinical research design. We also suggest that restructuring the neurology residency curriculum[6] to allow for formal teaching electives in research methodology[7] would be necessary in order to fully achieve the Accreditation Council for Graduate Medical Education competency goals. In particular, an improved understanding of clinical trial methodology and research is important for the core competency of lifelong learning. In addition, knowledge of research methodology is an important component of self-improvement, which also is a core component of maintenance of certification.

APPENDIX

Pre-Test for Journal Club 2006–2007

By E. Leira

This is the table of results for a new test to diagnose CJD:

	Disease Status	
Test Results	+CJC	−CJD
Positive	80	10
Negative	20	90
	100	100

1) Which statement is correct?
   a) **Sensitivity of the test is 80%, specificity is 90%**
   b) Sensitivity of the test is 90%, specificity is 80%
   c) Sensitivity of the test is 20%, specificity is 10%
   d) Sensitivity of the test is 10%, specificity is 20%
   e) This test has equal sensitivity and specificity

2) All of these are components of the Hill criteria to make a case for causal inference except:
   a) Time sequence
   b) Strength of the association
   c) **Results different than previous studies**
   d) Plausibility
   e) Dose response or biological gradient

3) A case-control study is designed to see if there is an association between trauma in the previous months and carotid dissection. There is a concern that subjects with carotid dissection might tend to report previous trauma better than the controls, and therefore bias the results. This would be an example of:
   a) Measurement error
   b) **Recall bias**
   c) Interviewer bias
   d) Selection bias
   e) Confounding bias

4) This is a study assessing the risk of brain tumors in patients exposed to previous radiation. What is the odds ratio of developing a brain tumor for those exposed to radiation?

	Brain Tumor	
Exposed Radiation	Yes	No
Yes	10	5
No	5	5

   a) OR = 1
   b) **OR = 2**
   c) OR = 3
   d) OR = 4
   e) OR = 5

5) Regarding the chi-square test, all is true except
   a) Is based in comparing the expected and observed frequencies
   b) Is a general test to find an association between exposure and outcome
   c) The higher the chi-square statistic value, the stronger the association
   d) **chi-square can be only used with 4 × 4 cells**
   e) Results are expressed with a chi-square value and *p* value

6) The Cochran-Mantel Test is:
   a) A test to determine if a variable is homogeneous
   b) A test to reduce the chance for selection biases
   c) **A test to determine if there a dose-response effect across different levels**
   d) A test to adjust for multiple comparisons
   e) A test to compare the agreement between two observers

7) Everything is true about the Kaplan-Meier estimator except
   a) Is a non-parametric test
   b) Estimates risk over time
   c) Typically used with survival analysis
   e) **Cannot be used if subjects drop out of the study for other reasons**
   f) Yields an estimate of risk at any point in time

8) Everything is true about logistic regression, except:
   a) **The response variable is usually continuous**
   b) The predictor variables can be of various types
   c) The purpose is to determine how one or more independent variables are related to the rate of occurrence of the binary outcome
   d) Can calculate the probability of an outcome for a particular set of values of the predictor variables
   e) Can calculate odd ratios of the outcome for two different values of a predictor

9) For which of these applications would a logistic regression analysis be most useful?
   a) Clinical trial comparing the effect of treatment/placebo on stroke volume on MRI
   b) **A prospective cohort assessing the usefulness and weight of different predictive variables in predicting the development of Alzheimer disease**
   c) A case-control study testing an association of AED exposure with birth control defects
   d) A survey among neurology residents about their knowledge n research methodology
   e) A comparison study of identification of signs of early ischemia on CT between radiology residents and neurology residents

10) When a meaningfully different interpretation of the relationship of interest occurs if an extraneous variable is ignored or included in the analysis, we call that concept
   a) Interaction
   b) **Confounding**
   c) Interference
   d) Effect modifier
   e) Bias

11) All about the kappa statistic is true except:
   a) Is a measure of reliability
   b) Measures agreement between two observers
   c) Compares two categorical measures
   d) Compares the observed agreement with the expected agreement by mere chance
   e) **A Kappa of 0.35 is considered excellent**

12) Regarding rates, all is true except:
   a) Crude rates estimate the actual disease frequency for a population
   b) Crude rates can be used to provide public health planning
   c) Crude rates can be misleading if compared over time or across populations
   d) Adjusted rates represent actual disease frequency in the population studies
   e) Adjusted rates account for differences in population characteristics

13) Everything is true about simple linear regression, except:
   a) The response variable is continuous
   b) Tries to find the straight line that best fit the data
   c) The purpose is to determine the relationship between the independent variables and the predictor variable
   d) Can predict the value of the response variable for any value of the predictor
   e) Can calculate odds ratios of the outcome of interest

14) For which of these applications would a linear regression analysis be most useful?
   a) Clinical trial comparing the effect of treatment/placebo on stroke volume on MRI
   b) A prospective cohort assessing the usefulness and weight of different predictive variables in predicting the development of Alzheimer disease
   c) A case-control study testing an association of AED exposure with birth control defects
   d) A study establishing relationship between blood pressure on admission and volume of the intracranial hemorrhage
   e) A comparison study of identification of signs of early ischemia on CT between radiology residents and neurology residents

15) Which of these is an example of a cross-sectional study?
   a) Clinical trial
   b) Case-control
   c) Survey
   d) Prospective cohort
   e) Retrospective cohort

16) What do all observational studies have in common?
   a) Prospective in nature
   b) Retrospective reviews
   c) Absence of intervention
   d) Time of observation
   e) Require informed consent

17) All of these are functions of an Institutional Review Board except
   a) Protect patient safety
   b) Assure that the research methodology is adequate
   c) Assure that informed consent is obtained
   d) Assure that subjects are compensated for research
   e) Protect vulnerable populations

18) A study wants to determine whether commercial ads on TV about stroke increase the number of patients presenting to hospitals with stroke symptoms. The best method to test this would be:
   a) Community survey
   b) Community intervention trial
   c) Retrospective cohort
   d) Quasi-randomized trial
   e) Randomized clinical trial

19) Patients admitted to a VA hospital with an even social security number are admitted to Medicine and those with an odd social security number are admitted to Neurology. One investigator is interested to know if those admitted to a neurology service is associated with better outcome than those in medicine. This would be an example of a:
   a) Survey
   b) Community intervention trial
   c) Quasi-randomized trial
   d) Randomized clinical trial
   e) Prospective cohort

20) Investigators want to find if there is a relationship between smoking and developing pseudoseizures. They review all the records to the video-EEG unit from 2006–1996 and review for each chart the diagnosis of the spells (epileptic vs pseudo) and whether there is a history of smoking. This study would be best characterized as a:
   a) Survey
   b) Case-control
   c) Retrospective review
   d) Prospective review
   e) Ecological

(NOTE: this question is linked to previous)

21) All of these would be potential limitations to the study except:
   a) Uncertain temporal sequence events
   b) Misrandomizations
   c) Misclassification bias
   d) Selection bias
   e) Incomplete information

Match the following concepts and definitions

22) Number of existing cases in a population (**a**)
23) Proportion of unaffected individuals who on average will contract the disease of interest over a specified period of time (**c**)
24) Rapidity with which newly diagnosed disease develops (**b**)
   a) Prevalence
   b) Incidence rate
   c) Risk

In a clinical trial, match the following concepts:

25) The two interventions are truly different, but the trial gives negative results (**b**)
26) The two interventions are truly not different but the trial shows positive results (**a**)
27) The power of the trial (**e**)
28) The likelihood of Type I error (**c**)
29) The likelihood of Type II error (**d**)
   a) Type I error
   b) Type II error
   c) Alpha level
   d) Beta level
   e) 1-Beta level

30) All these are true regarding randomization procedures in a clinical trial except:
   a) Achieves equality in the baseline characteristics of treatment groups
   b) Allows for a fair comparison of a treatment effect
   c) Avoids selection bias
   d) Prevents imbalanced treatment assignment
   e) Increases power study

31) All of these are advantages of prospective cohorts over retrospective cohorts, except:
   a) Shorter completion time
   b) More complete and accurate
   c) Clear temporal relationship exposure-disease
   d) Better for rare exposures
   e) Minimizes biases

32) All of these are advantages of case-control studies, except
   a) Good for rare diseases
   b) Less expensive
   c) Rapid completion
   d) Good for chronic diseases
   e) Minimizes selection bias

33) A review of the red wine drinking habits and rate stroke in French and US men reveals that French men drink more red wine and have lower rate of stroke than US men. If based on that

study we conclude that red wine drinking reduces the risk of stroke, this could be an example of:

a) Selection bias
b) Ecological fallacy
c) Generalization
d) Recall bias
e) Chauvinism

Match these concepts

34) Selection bias (**b**)
35) Information bias (**c**)
36) Confounding (**a**)
    a) An extraneous variable that accounts for the observed result rather than the risk factor of interest
    b) Sample distorted by the selection process
    c) Misclassification of the variables

37) All of these are advantages of randomized clinical trials except
    a) Balanced groups through randomization
    b) Detailed baseline data
    c) Blinding permits objective outcomes
    d) A small number of participants is usually required
    e) Treatment doses are pre-determined by investigator

38) All of these are important ethical issues that clinical trials should meet except:
    a) There should be equipoity between treatments tested
    b) The research question should be meaningful
    c) The study should include underrepresented groups
    d) Interim analysis of efficacy and safety should be conducted
    e) The study should assure a benefit to the participant

Match the following:

39) Clinical trials of clinical efficacy (**c**)
40) Dose-drug level trials in healthy individuals (**a**)
    a) Phase I
    b) Phase II
    c) Phase III
    d) Phase IV

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