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Perioperative Research Fellowship: Planning, Implementation, Experience

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Abstract

Perioperative outcomes research has gained widespread interest and is viewed as increasingly important among different specialties, including anesthesiology. Outcome research studies serve to help in the adjustment of risk, allocation of resources, and formulation of hypotheses to guide future research. Pursuing high quality research projects requires familiarity with a wide range of research methodologies, and concepts are ideally learned in a dedicated setting. Skills associated with the use of these methodologies as well as with scientific publishing in general, however, are increasingly challenging to acquire. This article is intended to describe the curriculum and implementation of the Perioperative Medicine and Regional Anesthesia Research Fellowship at the Hospital for Special Surgery. We also propose a methodology to evaluate the success of a research fellowship curriculum.

INTRODUCTION

Perioperative outcomes research has gained widespread interest and is viewed as increasingly important in anesthesiology.^{1, 2} Studies focusing on perioperative outcomes serve to help in the adjustment of risk, allocation of resources, formulation of hypotheses to guide future research, and comparison of institutional practices providing benchmarks for clinical care.³ Further, the introduction of accountable health care has increased pressure on specialties and care teams to determine the impact of interventions on medical and economic outcomes. To pursue such high quality projects, however, researchers must be familiar with a wide range of methodologies not traditionally part of their repertoire, including

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epidemiological and public-health-specific analysis techniques, advanced statistics, and principles of comparative effectiveness research. Skills associated with the use of these methodologies as well as with scientific publishing in general are increasingly challenging to acquire.⁴ Given the importance of perioperative outcomes research to our specialty, stakeholders are striving to formalize and expand the way research is being performed.^{5, 6} It is widely recognized that successful participation in academic processes are an increasingly important hallmark of a physician's career.⁷ Overcoming research complexities will require professional, mentor-driven guidance and formalized training.^{8–10} Several programs in the United States have implemented research fellowships, but opportunities to learn remain rare and information regarding various approaches is limited. Our goal is to describe the curriculum and implementation of the Perioperative Medicine and Regional Anesthesia Research Fellowship at our institution, the Hospital for Special Surgery (HSS). Regional anesthesia is integral to our program, in particular due to increasing evidence of the impact of regional anesthesia on perioperative outcomes. A research fellowship can feasibly be associated with other subspecialties; however, restriction to a certain subspecialty can provide a concise focus and context that can facilitate the converging of an institution's resources, abilities, and the fellow's interest. As we are aware that many other successful programs may exist, our experience presented here should be viewed only as an example. Along with a description of the curriculum and implementation of this program, we seek to propose a methodology to formally evaluate the success of a research fellowship curriculum and present preliminary results attained by the first fellowship graduates.

Implementation of a Perioperative Research Fellowship

a) Theoretical pre-fellowship preparations

Preparing a formalized research fellowship program requires a clear definition of expectations and roles. Duties and responsibilities of the fellow, mentor (s), and administrator (s) should be clearly defined, including a written and unambiguous description of the reporting chain¹¹ (Fig. 1). Defined personal goals of our research fellows are commonly (1) active participation in different types of clinical and epidemiologic research, ultimately leading to publications in peer-reviewed journals, (2) gaining experience and broader knowledge in topics related to research, including a solid understanding of theoretical and applied biostatistics, and (3) practically experiencing the publication and presentation process in a professional surrounding.

A detailed and comprehensive planning budget is an important preliminary step to ensure sufficient availability of resources. Matters of expense to consider include not only funds for the cost of research projects but also a stipend/salary for the fellow to support housing, benefits, and living expenses. Possible financial resources include institutional funding (eg, out of an allocated research budget), institutional or federal research support (eg, grants), internal as well as external scholarships, or individual research allowances awarded to the incoming fellow.

b) Application and candidate selection process

At our institution, candidates interested in a Research Fellowship are asked to submit the following documentation along with the official application:

1. Official copy of medical school transcript and diploma
2. Current curriculum vitae
3. Personal statement (a narrative of approximately 250 words explaining the reasons for the applicant's interest in an anesthesiology research fellowship)
4. Three letters of professional reference, including one from the director of the applicant's current training program
5. Three proposed research projects, including supporting literature for each proposal

Future fellows should have a good clinical understanding of the specialty as well as a clear desire to pursue academics, and generally have at least 1 year of experience in clinical anesthesiology. Research experience is not mandatory but is of benefit and should be considered in the application process.

All applications for Research Fellowships are reviewed by the Department Director, the Medical Director of Education, the Administrative Director of Education, the Medical Director of Research, and the Director and Assistant Director of Training Programs. Selected candidates are then invited to interview with the above-mentioned group.

Candidates with high potential for selection are paired with a mentor to help them with this process, and with the general project proposals. Clinical projects should be tailored to the institution's specific possibilities. It is integral for the proposed mentor to take a significant role in the selection process. Once discussed with the Fellowship Committee Membership, the Medical Director of Research, and other members of the research staff, a recommendation is made that is approved in its final version by the Department Director/Anesthesiologist-in-Chief (Fig. 2).

The planning of a curriculum and its components must reflect reasonable expectations in view of the length of the proposed fellowship. The question of ideal length for a research fellowship is subject to complexity of the proposed projects, time required to achieve certain study milestones (especially those that necessarily require physical presence of the fellow at the investigational site), and time required to analyze data and composition of manuscripts. At our institution, the Research Fellowship must be a minimum of 12 months in duration but may be extended to 24 months.

c) The role of the mentor (s)

Upon candidate acceptance, the mentor will immediately assume an active role in guiding the incoming fellow. First, the mentor should be an academically experienced, senior faculty member who is able to set aside a significant amount of time exclusively for interaction with the fellow. The collaboration is intimate and relies on adequate communication and a high level of mutual reliance.¹² This requires involvement in the selection process of the fellow. Secondly, a faculty member's needs for research help must be balanced with the acquisition

of necessary skills by the mentee. Finally, the mentor should be willing to provide counsel and career planning not only during and after the fellowship.¹³ To facilitate ongoing interaction between the fellowship graduate and mentor, strategies for open, available means of communication (including regular contact via e-mail as well as teleconferences) should be devised at an early stage, ideally before graduation.

c) Pre-fellowship timeline

Within 1 month of accepting the Research Fellowship offer, incoming fellows are asked to become actively involved in planning their academic year. Mentor and fellow are expected to remain in close contact with each other for at least 6 months prior to the start of the fellowship. In this period, study protocols are being compiled, and the fellow receives preparatory information and learning tasks. This includes participation in the crafting of submissions to the Internal Review Board, and completing all required regulatory learning modules including the online Collaborative Institutional Training Initiative (CITI) exam.¹⁴ To minimize time spent on bureaucratic processes, components need to be identified that can feasibly be addressed before the physical start of a fellowship. Such a proactive approach will most certainly increase the efficiency of the program and minimize frustrations when the length of the fellowship is confined to one year.

Foreign Medical Graduates accepted into the program, who are not United States citizens must apply to the Education Commission on Foreign Medical Graduates (ECFMG) for a visa, most likely a J-1 Visa. The ECFMG sponsors visas for physicians in graduate training in advanced research programs as well as clinical training programs.

d) The practical fellowship implementation

The 1-year HSS research fellowship is based on 3 components:

1. Educational component: part-formalized, part-autonomous education in statistics and research methodology
2. Research component: development, execution and analysis of clinical and epidemiological studies
3. Presentation component: immersion experience in the academic presentation and publication process

d.1) Educational component—An institutional cooperation with a biostatistics, epidemiology, and/or public health department is beneficial and can be a major contributor to numerous aspects of the curriculum. Subjects taught include a large variety of different statistical techniques (see Appendix 1, SDC 1).^{17,18,19,20} Furthermore, as much personal interaction as possible between the fellow and biostatisticians involved in the process should be attained. Empirically, this approach greatly improves the mutual understanding of the analysis processes between physicians and statisticians, and reportedly helps develop invaluable skill sets for future use.²¹ In our research fellowship, statistical theory is taught using multiple approaches, including formal coursework and lectures, exemplary homework, and mentored work on own projects.^{15,16} Collaboration with statisticians is encouraged informally, and takes place most frequently while working on the conception as well as the

performance of actual projects. The authors believe that a part-formalized educational component is more instructive compared to sole “ex-cathedra” research methodology teaching, as it contributes to the generation of autonomy amongst the fellows.

d.2) Research component—The fellow should be preferably involved in a large number of different types of research protocols in order to maximize exposure and experience. At our institution, the research fellow regularly participates as a co-investigator in prospective cohort studies, observational studies, interventional studies including randomized controlled trials, retrospective/chart review studies, basic and translational research, systematic literature reviews and meta-analyses. A subset of the studies should be attended to by the fellow from conception to performance of the trial, and up to the final analysis. This will allow the fellow to experience all aspects of research preparation and conduct. This may require collaboration with other departments within and outside the institution. Moreover, a particular emphasis is placed on epidemiological research, utilizing large administrative and quality assurance databases. Emphasis during teaching should include a focus on pitfalls associated with database research in general as well as with advanced statistical methodology required for comparison of very large sample sizes.^{2,19} Finally, the participants of the program should gain insights into various other academic endeavors, including consensus processes, multicenter trials and grant writing.

d.3) Presentation component—For the immersion into different aspects of academic presentation and publication, fellows should be allowed to obtain copious practical experience in the field. Manuscript development, drafting, correction, collation, organization, submission, handling of, and response to, academic peer reviews should be some of the fellow’s important activities, in order for he/she to eventually oversee the process in its entirety.²² However, to allow for a thorough understanding, it is important that the fellows are additionally challenged with the counter-position, by asking them to compose critical reviews of certain articles and discussion of the results,²³ which can in part be achieved by presentations at journal clubs. While individual aptitude for public speaking varies,²⁴ successful presentations are largely technical, modifiable, and readily improved by frequent practice.²⁵ At our institution, the Research Fellow is also required to attend the thrice-weekly morning academic program and to present at these gatherings multiple times. Additionally, participation at national and international conferences with poster presentations and short lectures allows for regular practice and discussion with a critical audience.

Evaluation of Effectiveness

While the success may be gauged by numerical targets (manuscripts published or in review), the true success will only be measureable in the years to come after completion. As the purpose of the fellowship is to produce a high level, independent researcher who impacts their clinical field, becomes a lifelong learner, and utilizes the evidence from published literature in their practice, our evaluation strategy includes the yearly collection of data capturing the Research Fellow’s research productivity. This includes the administration of a survey of a physician’s lifelong learning²⁶ to assess whether graduates maintain research

productivity and high orientation towards continued learning. Productivity data is collected as prescribed by the biostatistical evaluation literature²⁷ and fall in the following categories:

Proposal, grants, and contracts:

- Numbers submitted, resubmitted, and funded
- Amounts requested and awarded
- Funding source and types (intramural or extramural; foundation, industry, or government agency; funding for infrastructure, research, or career development)

Abstracts and presentations

- Number
- Forum for presentation (local, regional, national, or international)

Manuscripts

- Number
- Journal quality and impact metrics

Other means for the dissemination of information:

- Educational activities (eg, lectures, workshops, tutorials)
- Web sites
- Instruction manuals
- Reference books

Orientation towards learning is measured by the Jefferson Scale of Physician Lifelong Learning (JSPLL),²⁸ a psychometrically sound instrument consisting of 14 items (answered on a 4-point scale) measuring 3 factors designated as “learning belief and motivation,” “attention to learning opportunities,” and “skills in seeking information.” A 5-member external advisory board will be assembled every 3 years and summary data from above will be presented to judge the success of the program. Improvements as needed will be made according to their advice.

Experience with the Research Fellowship at Hospital for Special Surgery

At the time of the drafting of this manuscript, 4 fellows have enrolled in the research fellowship as presented here since its inception in 2010. One research fellow per year was trained in the program, with 2 fellows currently enrolled. Fellows work in research exclusively for at least 12 months. Thus far, one fellow has taken the opportunity to extend the nonclinical research fellowship to encompass an additional year of a combined clinical-research fellowship (20% nonclinical). The recruitment process is initiated each year approximately 8 months before the next research fellow begins and is carried out as described above. At the authors' institution, the research fellowship is primarily funded through institutional resources (ie, a dedicated research and education fund, which is supported by clinical revenue).

While long-term success remains to be determined, preliminary measures of success for all fellows enrolled to date are very encouraging. Fellows were intricately involved in 3 to 5 clinical studies each, while participating in more than 5 public health-related epidemiologic projects per year. Fellows submitted between 5 to 12 peer-reviewed manuscripts with the vast majority published in peer-reviewed journals, many with the fellow as first author. More than 10 abstracts per fellow were presented at national and international meetings, of which a number were awarded “best of meeting” abstract prizes, by the American Society of Regional Anesthesia, the American Society of Anesthesiologists and by the European Society of Anaesthesiology. The 3 graduated fellows have returned to their home institutions and have continued to conduct research projects, produce scientific material, and pursue external funding. All are clearly demonstrating a drive of continued productivity and show promise in the pursuit of an academic career.

Conclusions

Perioperative outcomes research is occupying an increasingly important role in the field of anesthesiology. Numerous study groups employ progressively advanced methodologies to study effects invoked by the relatively brief period of perioperative patient management, including (among many others) the Outcomes Research Consortium,²⁹ a large group of individual authors involved with outcomes research, groups at the Cleveland Clinic,³⁰ as well as the authors’ own group. Subjects studied include differential effects of varying anesthetic techniques, effects of perioperative medication administration, impact of certain preexisting comorbidities, postoperative monitoring and adverse events, perioperative inflammation, cancer recurrence, and more.³¹ Electronic health records, quality improvement databases and automatically recorded data in anesthesia information management systems (AIMS) are being increasingly consulted for analysis.³² Moreover, numerous specialties outside of anesthesiology increasingly rely on outcomes research, including internal medicine,³³ cardiology³⁴ and surgery.³⁵ Not least, outcomes research is increasingly identified as an indispensable “source of wisdom” to drive healthcare reforms and to allow healthcare policymakers to reallocate resources. Developing and implementing a curriculum and evaluating its success are major investments toward meeting challenges faced and equipping physicians with the necessary tools to effectively address important questions. While many approaches to organizing such a fellowship are possible, our institutional example presented here may be used as a resource for departments seeking to make this investment.

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Figure 1. displays an administrative diagram outlining roles and responsibilities of various organizational structures and individuals towards the research fellow.

Figure 2.
displays a process diagram outlining the selection process for candidates.

Appendix 1

List of research didactics used within the educational component of the research fellowship

Objectives / Learning targets in statistical education	
Participants should be able...	Exemplary Course Contents
<ul style="list-style-type: none"> - To understand the differences of controlled studies (eg, clinical trial, experiment) vs observational studies, to understand cause vs association/ correlation - To understand the different types of studies 	<ul style="list-style-type: none"> - Randomized studies vs observational studies - Why are observational studies so essential in health research? - Limitations and value of observational studies - Definition of bias and confounding in observational studies - Historic examples - Presentation of study types, including differential assessment and presentation of examples: <ul style="list-style-type: none"> ○ Observational study designs: case-control studies, matched case-control studies, cross-sectional studies, nested case-control studies, cohort studies, case-cohort studies. ○ Interventional study types: randomized, controlled versus pragmatic, blinded, cross-over. ○ Epidemiologic approaches
<ul style="list-style-type: none"> - To understand the technical, organizational and ethical foundations for the implementation of studies - To be able to rigorously design and write an analysis plan for a study 	<ul style="list-style-type: none"> - Familiarization with the department's research division, available resources and potential constraints - Introduction to Research Ethics - The Collaborative Institutional Training Initiative (CITI) program and exam^a
<ul style="list-style-type: none"> - To be able to understand statistical methodology and analyze data using a statistical software program, e.g. Stata, SPSS, SAS 	<ul style="list-style-type: none"> - What is statistics? Working with data: types of data (continuous, discrete, survival), organizing and displaying data (frequency tables, graphs and plots, histograms, scatter plots, frequency and cumulative frequency plots), summary measures (central tendency (mean, median, mode, percentiles)), dispersion and variability (variance, standard deviation, range, coefficient of variation) - Statistical Inference, introduction to estimation, confidence intervals and hypothesis testing, single sample hypothesis testing and interval estimation: null and alternative hypothesis, type I and Type II errors, one tailed versus two tailed tests, relationship between hypothesis testing and confidence intervals (CI), estimating the CI for the mean, testing hypothesis about the mean, test for and two sample means, proportions, testing the differences of two means, Student's t-test, paired t-test, testing the differences of two proportions - Analysis of Variance (ANOVA) and contingency tables - Non-parametric tests (logarithmic transformation of non-normal data, Wilcoxon rank sum test, Wilcoxon sign rank test, Kruskal-Wallis test, Fisher exact test) - Correlation and linear regression: parameter inferences, multiple linear regression, analysis of covariance, logistic regression, diagnostic tests, goodness of fit - Survival analysis Kaplan-Meier estimator, log rank test, Cox proportional hazards model - Statistical Methods for Causal inference: causal diagrams and identification of causal effects, counterfactuals, Introduction to confounding and effect modification, propensity score, inverse-probability weighting, instrumental variables - Special considerations in epidemiology and public health, advanced topics, model diagnostics (adjustment for multiple analyses, c-statistic, concept of multicollinearity, Hosmer-Lemeshow test)

Objectives / Learning targets in statistical education	
Participants should be able...	Exemplary Course Contents
<ul style="list-style-type: none"> - To learn about existing large observational study databases, examples of large interventional studies, examples of large anesthesia-related database studies 	<ul style="list-style-type: none"> - NHANES^b, Framingham heart study^c, ARIC^d, CHS^e, SEER^f, H-CUP^g, Nurses' Health Study^h, Add Healthⁱ - POISE^j, 6S^k, CHEST^l etc. - Rodgers et al 2000^m, Wijeyesundera et al 2008ⁿ, Memtsoudis et al 2014^o
<ul style="list-style-type: none"> - To introduce the concept of meta-analysis for observational studies and their reporting standards 	<ul style="list-style-type: none"> - What is meta-analysis? - Meta-analysis for observational vs. randomized studies - Statistics methods for meta-analysis - The Meta-Analysis of Observational Studies in Epidemiology (MOOSE) statement^p - How to do meta-analysis in Stata
<ul style="list-style-type: none"> - To understand numbers in literature and health news properly 	<ul style="list-style-type: none"> - Observational studies on the news - Problems in current health news reports - Common reporting errors and misunderstanding - How to write statistics and numbers in press release
Suggested Course Materials	
<p>Books</p> <ul style="list-style-type: none"> • Rosner B. <i>Fundamentals of Biostatistics</i>. 2010. Cengage Learning, Stamford, CT. • Kuzma J, Bohnenblus, S. <i>Basic Statistics for the Health Sciences</i>. 2004. McGraw-Hill, New York, NY. • Rothman KJ, Lash TL, Greenland S. <i>Modern Epidemiology</i>. 2012. Lippincott, Williams & Wilkins. Philadelphia, PA. • Elston RC, Johnson W. <i>Basic Biostatistics for Geneticists and Epidemiologists: A Practical Approach</i>. 2008. John Wiley & Sons, Hoboken, NJ. • Jewell NP. <i>Statistics for Epidemiology</i>. 2003. Chapman and Hall, London, United Kingdom. • Aliaga M, Gunderson B. <i>Interactive Statistics</i>. 2005. Pearson PLC, London, United Kingdom. • Bland M. <i>An Introduction to Medical Statistics</i>. 2000. Oxford University Press, Oxford, United Kingdom. <p>Useful websites</p> <p>Altman D, Bland M. Statistics Notes in the British Medical Journal. Available at: http://www-users.york.ac.uk/~mb55/pubs/pbstnote.htm (last accessed March 25, 2014)</p> <p>Institute for Digital Research and Education, University of California, Los Angeles. Resources to help you learn and use Stata. Available at: http://www.ats.ucla.edu/stat/stata/ (last accessed March 25, 2014)</p> <p>Various Authors. Statistical Primer for Cardiovascular Research in the <i>Circulation</i> Journal. Available at: http://circ.ahajournals.org/search?tocsectionid=Statistical+Primer+for+Cardiovascular+Research&sortspec=date&submit=Submit (last accessed March 25, 2014)</p>	

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