Anesthesiology 2007; 106:826–35

We Are What We Make: Transforming Research in Anesthesiology

The 45th Rovenstine Lecture

*J. G. Reves, M.D.**

THIS lectureship honors Emery Andrew Rovenstine, M.D., who was a distinguished anesthesiologist, Chair of the Department of Anesthesiology, New York University Medical Center and Director of Anesthesia, Bellevue Hospital, a founder and past president of the American Board of Anesthesiology, past president of American Society of Anesthesiologists (ASA), and recipient of the Society's 1957 Distinguished Service Award. The Rovenstine Lecture was established in 1962 and today is the 45th commemorative lecture. I did not know Dr. Rovenstine, but I have read his writings. Let me sum him up as an extraordinary early leader in anesthesiology whose lifetime of service had an enormous impact on our specialty and does to this day. I hope you all understand the privilege it is to give a lecture in his honor.

I realize that I stand between you and lunch—a dangerous place for anyone in front of anesthesiologists since lunch breaks are most unpredictable and always needed. Aware of this, I am reminded of a vignette reported by Alexander Heard, B.A., M.A., Ph.D. (Chancellor Emeritus, Vanderbilt University, Nashville, Tennessee) on the occasion of an annual "Dixie Dinner" in New York hosted by the Southern Society (made up of well-heeled but displaced Southerners in that big city) where "the speaker was introduced exactly at midnight and with great fanfare to give 'his address'—(realizing the lateness of the hour) the honoree arose, gave his house number and street name in Princeton, NJ, and sat down."[1] You are not that fortunate.

We (all who practice anesthesiology) are what we (those anesthesiologists who are in academia) make. Our academic departments have three missions: (1) education, (2) clinical service, and (3) research. We are especially proud of the excellent physicians we educate and the clinical care we provide. We must excel in these two, and we do. However, today I will focus on our research mission, something we do less well, and that needs transformation. In choosing this subject, I am aware of the admonition given by Rhodes in his wonderful book, *The Creation of the Future: The Role of the American University*: "little has changed in the century that has passed since Horace Mann declared that to disperse an angry mob, all that would be necessary would be to announce a lecture on education," and I would add research to this.[2]

There are several reasons to focus on anesthesiology research: First, it is something that I have been committed to since the summer before I began medical school. Second, I think it is an area in which academic anesthesiology can and must do better. Third there has been a flurry of worry expressed in our journal, ANESTHESIOLOGY, and elsewhere of late.[3–11] Finally, I have always been convinced that unless we question what we do and what we know through research, we will never improve by doing things new and better. The General Electric slogan of the 1960s, "Progress is our most important project," has been and always will be my professional credo. It must be the motto of anesthesiology as well.

The remainder of this lecture is in three parts: (1) the present status of research, (2) a root cause analysis of our research performance, and (3) a plan to improve the current state of our research.

This article is accompanied by an Editorial View. Please see: Evers AS, Miller RD: Can we get there if we don't know where we're going? ANESTHESIOLOGY 2007; 106:651–2.

* Professor of Anesthesiology and Pharmacology, Dean, College of Medicine, and Vice-President for Medical Affairs.

Received from the Medical University of South Carolina, Charleston, South Carolina. Submitted for publication November 17, 2006. Accepted for publication January 4, 2007. Support was provided solely from institutional and/or departmental sources. The Emery A. Rovenstine Memorial Lecture was presented at the Annual Meeting of the American Society of Anesthesiologists, Chicago, Illinois, October 16, 2006.

Address correspondence to Dr. Reves: Department of Anesthesiology and Pharmacology, Medical University of South Carolina, 96 Jonathan Lucas Street, Suite 601, Charleston, South Carolina 29425. revesj@musc.edu.

Part 1: The Present Research Status

In the Rovenstine lecture of 1984, Eugene A. Stead, M.D. (Emeritus Professor), the Duke University medical icon, stated, "Your [anesthesiologists'] place in the medical sun is now secure. You have the same needs for informed students, excellent research programs, and sophisticated faculty as do older specialties of medicine and surgery."[12] Just over 20 yr ago, we were making enormous strides, and academicians outside our specialty noticed. A decade later, I complained to Nicholas Greene, M.A., M.D., F.R.C.A., of New Haven, Connecticut (1922–2004), when we were writing our book on academic anesthesiology,[3] about how tough things had

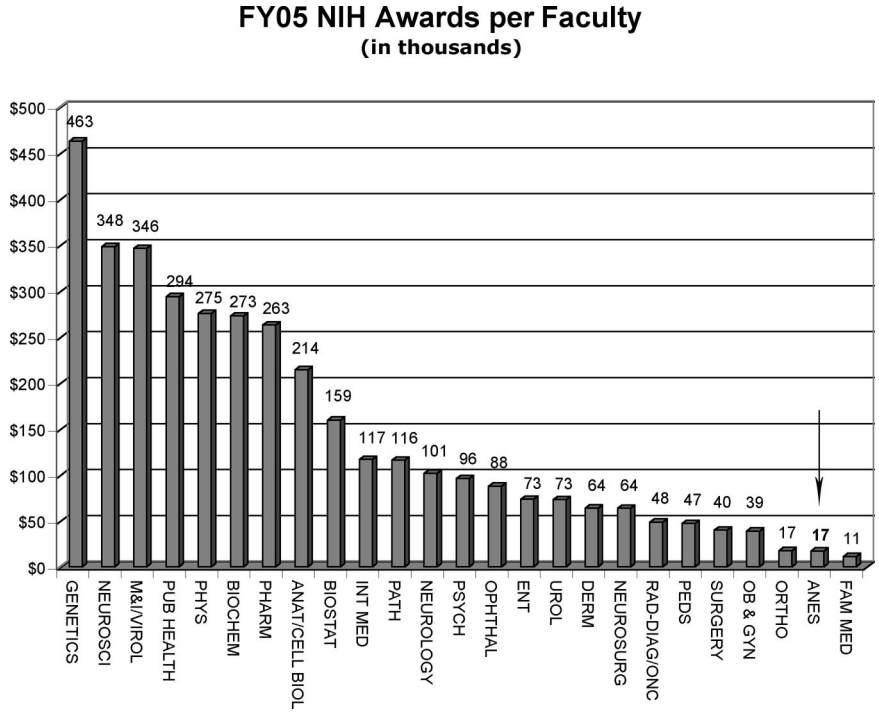

Fig. 1. Research productivity of faculty by specialty in American medical colleges. FY = fiscal year; NIH = National Institutes of Health. See text for details; derived from citations in footnotes† ‡ and Desmarias.[26]

become for academic anesthesiology. Dr. Greene said with compassionate irritation, "Jerry, you have no idea what tough means. Think about the time when anesthesia belonged to the department of surgery or was run by the hospital, and when most of the care, virtually all of it in some of the finest institutions, was given by nurses." And, of course, Dr. Greene was correct; I had no concept of what people like Emery Rovenstine and Dr. Greene himself had overcome as they successfully established a new field complete with research, department by department throughout the land.

So what is the status of our research? Research quality is best reflected by National Institutes of Health (NIH) funding. This exists in only about 40% of the 128 accredited departments.[5,7] About half of the Anesthesiology NIH funding (48%) is found in only 10 departments, 64% in the top 15, and 77% in the leading 20 departments.† In other words, the majority of our academic departments are not participating in the NIH arena; the preponderance is in one quarter of the departments, and in my view, this is a very serious problem for our entire profession.

Academic anesthesiology has a large presence numerically in American Colleges of Medicine. Of the nearly 100,000 clinical department faculty nationwide (97,736 in the academic year 2004–2005), 5,461 (5.6% of all faculty) are in anesthesiology departments.‡ This is a critical mass, slightly lower than another hospital-based specialty, radiology (diagnostic and oncology), which has 6,606 (6.8% of total).

Figure 1 portrays research productivity of all medical school departments. NIH dollars generated per faculty are computed. The data were derived by dividing the total NIH dollars ($92.3M for anesthesiology in fiscal year 2005)† by the number of faculty in anesthesiology (5,461 in 2005)‡ in each specialty. Anesthesiology productivity is the same as orthopedics, and both are only ahead of family medicine at the unenviable bottom of the list of 25 departments. In viewing what we have made here, it brings to mind the quote of the architect Frank Lloyd Wright: "The physician can bury his mistakes, but the architect can only advise his clients to plant vines."[13] We cannot bury or hide these data, for they are published every year by the NIH, and all of academia studies them intently.

Why is research important to a clinical specialty? There is a simple reason. Research is the lifeblood of today's university. It is essential because when the faculty are learning through research and the students are learning from the faculty, we have an exciting intellectual environment where everyone is learning. Our profession and the society we serve are the benefactors.

Our research problem is not so much one of poor *quality* but rather of insufficient *quantity*. We have a number of exceptional investigators who have sustained research careers over lengthy periods. We just don't have enough of them. Anesthesiology has brought the world pain clinics, intensive care units,

† Data are from the NIH Web site. Available at: http://grants1.nih.gov/grants/award/rank/medttl05.htm. Accessed September 15, 2006.

‡ Data are from the AAMC Web site. Available at: https://services.aamc.org/privatesite/index.cfm?path=/data/databook/private/tablec2.pdf. Accessed October 24, 2006.

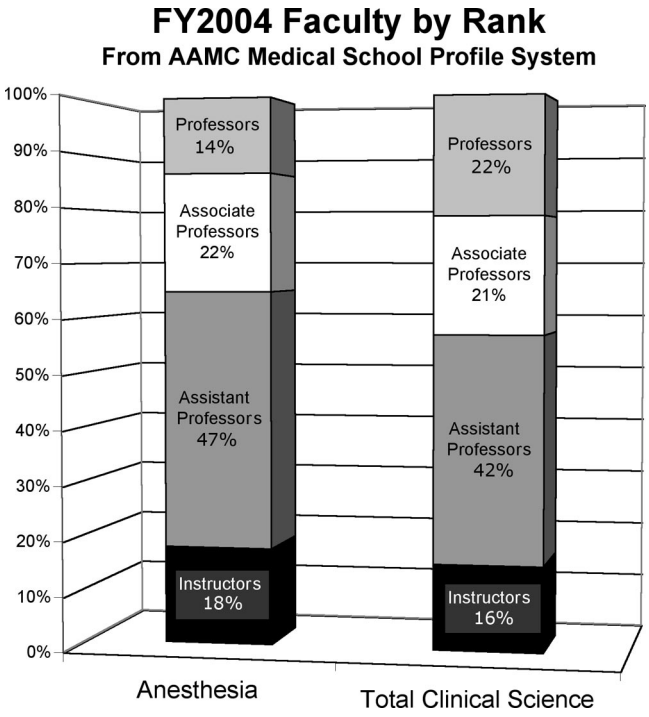

Fig. 2. Academic rank of anesthesiology and all other specialties. The instructor is the lowest rank, and professor is the highest. Note that anesthesiology does not have as many full professors as other fields. AAMC = Association of American Medical Colleges; FY = fiscal year. The percentages were derived from data at http://www.aamc.org/data/msps/start.htm, accessed September 6, 2006.

cardiopulmonary resuscitation, clinical simulation, patient safety research, and many important basic science discoveries.

Figure 2 contrasts the academic rank of anesthesiology faculty compared with faculty of other departments in our medical colleges. Note that anesthesiology differs from the others in the number of assistant professors and most importantly in full professors. It is the disparity between the percent of full professors that is so telling. We are not reaching in sufficient numbers the highest academic rank compared with our peers. This is an indirect reflection of our overall academic standing, and a direct reflection of the research performance of our faculty because promotion is most often based on research accomplishments. It underscores our relative low number of investigators.

Part 2: Root Cause Analysis of Anesthesiology Research Performance

Before presenting a root cause analysis, let me mention the tried but untrue reasons for our performance: (1) too young a field; (2) too late now; (3) conspiracy: "they" won't let us compete; (4) the NIH is biased against us: need our own study section or institute; (5) all of the "anesthesia diseases" problems are solved; (6) all of the toxicology problems of our drugs are solved; (7) no time for research; and (7) no money for research. All of these can be debunked, and most have been. Some have merit, but they all are excuses for not making research a high priority. An example is the no time excuse. We could have more nonclinical (academic) time were we to work different schedules or recruit more faculty (admittedly we would have to reduce compensation to do this). We make choices and live with the consequences that we use as reasons for not pursuing research in earnest.

So, let us leave the excuses behind and go to a root cause analysis[14] of our poor research performance, believing that if we know the causes, a plan to address the causes can be formed and implemented. There are two general questions to consider in the root cause analysis: (1) who enters the field as residents and as faculty, and

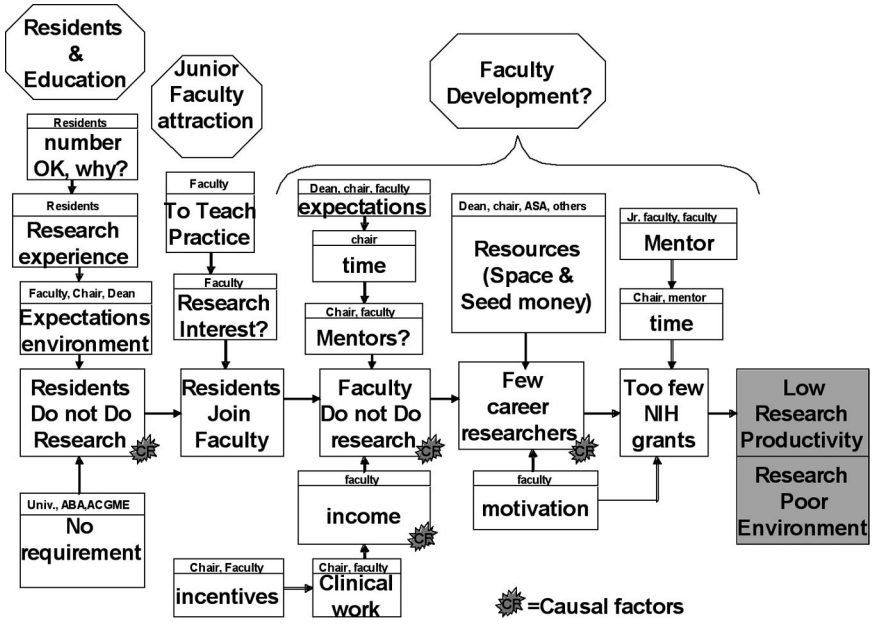

Fig. 3. A root cause analysis[14] of the low performance in anesthesiology research is presented. The *octagonal boxes* contain the career loci of developing individuals in the continuum of research development. *Arrows* indicate the progression of these individuals and forces that impact on the individuals as they move from entry into the profession (*top left*) to the end result of the entire process (*gray boxes* on the *right*). The *upper level of divided boxes* indicates those responsible for influencing the factor of the developing individual. Note that anesthesiology does not educate, support, or recruit sufficient investigators to have high research productivity. Critical factors causing this are identified. ABA = American Board of Anesthesiology; ACGME = Accreditation Council of Graduate Medical Education; NIH = National Institutes of Health; Univ. = universities.

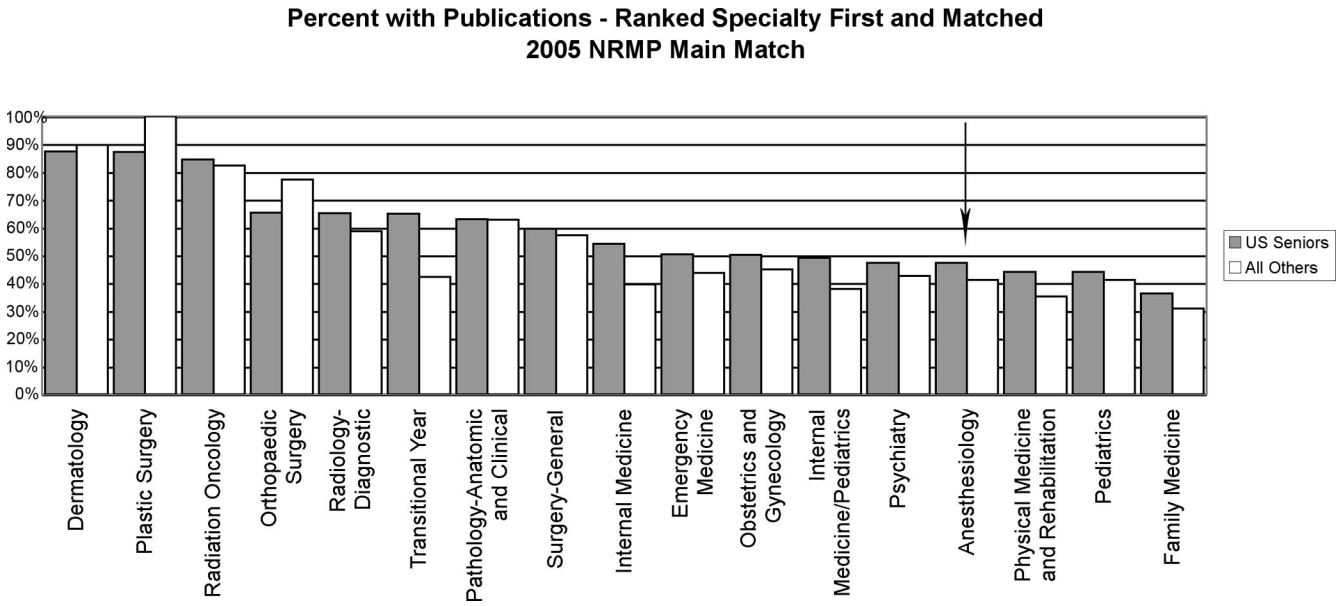

Fig. 4. The number of publications by medical students who chose anesthesiology in the 2006 match compared with all other medical students.‖ NRMP = National Resident Match Program.

(2) how do we develop both groups. Within this general area, I believe there are four specific causal factors and many contributory factors that lead to our low research productivity (fig. 3).

The first questions are, do we have enough physicians entering anesthesiology and why do they enter our specialty? We recruit about 1,500 students per class, and Schubert of Cleveland estimates that this is about the correct number.[15] A more difficult question is, are we attracting residents with the potential to become academicians? This is a murky area and impossible to know with certainty.

There are two articles that have recently explored the question of why residents choose their anesthesiology residency.[16,17] Reasons given in surveys in the United States and in Australia are (1) it is a "hands-on" specialty; (2) it is the practice of physiology and pharmacology; (3) there is ample time off; (4) it provides immediate gratification; (5) it is procedure based; (6) there are controllable hours; and (6) it offers part-time work options.[16,17] Research opportunities in the field are less a reason for going into anesthesiology now than previously, and factors that are not important are income and exposure during medical schools.[17] The Association of American Medical Colleges (AAMC) has more information from their annual survey of all graduating medical students.§ Of the 11,471 graduating medical students in 2006 who completed the survey, 7.5% chose anesthesiology. Overall, 70% of medical students reported that in choosing their specialty, lifestyle was a "moderate" or "strong" influence, whereas salary expectations were "moderate" in 36.5% and "strong" in only 12.3%. The greatest attraction for the entire class of 2006 was mentor/role model; 75.5% reported this as either moderate (32.4%) or strong (43.1%).§ It would seem the degree to which we can provide positive role models will influence our ability to attract the largest group of students, since the perception of lifestyle is an area in which we already do well. However, I am not certain that lifestyle is an advantage in getting those students destined to academic excellence.

Interestingly, more than half of the 2006 medical school graduates expect to be involved in research during their careers (exclusively 0.4%, significant 16.1%, and somewhat 42.7%).§ It can be surmised that anesthesiology is not attracting enough of this half of the medical students who believe they will be doing research in their careers, although this is conjecture on my part.

We also learn from the AAMC student survey that although the specialty attracts a good number (about 80%) who have done some research, this is less than many of the fields,‖ and most tellingly, anesthesiology attracts fewer students with research publications than most of the specialties (fig. 4). Because we attract fewer with publications, I wonder if our residents, even though they have research experience, are as research committed as those who choose other specialties. We need investigator finishers, and we do not seem to be attracting them.

Regardless of research experience or commitment, once recruited, "we set extraordinarily low expectations in regard to the research accomplishments of our finest trainees."[5,7] This reflects my personal experience through the years as a faculty member, as a close ob-

§ Graduation Questionnaire data are from the AAMC Web site. Available at: http://www.aamc.org/data/gq/allschoolreports/2006.pdf, pp 1, 43. Accessed November 7, 2006.

‖ Data are from the AAMC Publications Web site. Available at: https://services.aamc.org/publications (Charting Outcomes in the Match). Accessed November 7, 2006.

server of program directors and who they recruit, as a chair with fellow chairs and watching their priorities in departmental development, and as a dean comparing anesthesiology to other disciplines when listening to students who are deciding on their life's work. Remember, our residencies are capstone postdoctoral education experiences, not apprenticeships. They are a continuation of physician education that begins in medical school. Although about 90% of residents will go to the community, we need to be preparing them to be critical thinkers. The residency must be an educational experience of the highest order; it should be scholarship.

We do expect our residents to be superb clinicians, and that is what they become. This is what we make, and it is good—it is just incomplete. Both the university and the nonuniversity anesthesiologist in practice must have been taught and understand research to be able to sort valid information from invalid. Also increasingly, clinical research is being done in many specialties in nonuniversity settings. We should prepare our graduate medical education students to learn about clinical research so that regardless of whether they stay in academic medicine or fulfill society's need for clinical practice, they are optimally prepared.

Another major contribution to the lack of resident research is that it is not required. The university and the department do not require it, and neither does the American Board of Anesthesiology (ABA), the Anesthesiology Residency Review Committee (RRC), or the Accreditation Council of Graduate Medical Education (ACGME). Were any one of these three entities to require either instruction in the method of research or the actual conduct of it, we would surely have residents knowledgeable about it. One thing we can be sure of, residents do what is required of them, and they master what they are taught.

So we have an educational system that does not recruit residents with demonstrable potential for research, and we do not have the expectations or the requirements and environment to foster it. Therefore, residents do not do research: This is the *first causal factor* in our low research productivity.

Junior faculty are attracted to academics for many reasons; some enjoy teaching and others like the tertiary/quaternary practice. I am not sure how many of the faculty join to pursue research. Some do, and the fundamental question is, how are they developed and how can others be recruited to join them as investigators?

The dean (my colleagues), the chair, and the faculty do not expect the junior anesthesiology faculty to take up investigative careers. Thus, the seniors contribute to the problem of poor junior faculty development, because expectations are a most powerful force in faculty development. It is not just the academic people who do not espouse research. Kearney in Canada, using the Delphi consensus technique to define the characteristics of professionalism in anesthesiology, listed qualities and competencies that define all anesthesiologists.[18] Although the list is complimentary to us, and I think accurate, with traits such as integrity, responsible, trustworthy, vigilant, team worker, communicator, and so forth, notable is the omission of characteristics like intellectual curiosity, investigation, critical thinking, and innovation. I have to ask, "Do we run trade schools or professional ones where all are imbued with, or at least honor, the thirst for new knowledge through true scholarship?"

Faculty need nonclinical time to develop an academic career. It is difficult to think about research questions when one is supervising two first-year residents during difficult cases, especially when that is what one is assigned every single day. In fact, the clinical work burden has squeezed about all the academic time out of the faculty.[3,19] This is the chairs' responsibility to correct. Also, there are not enough mentors for the junior faculty. The existing faculty may not be able, have time, or wish to mentor the junior faculty. The chair then has to find mentors outside the department until the department is self sufficient in this crucial category. Mentorship is critical to successful faculty development.

Let me comment briefly on the role of anesthesiology chair, which is treated in great length elsewhere.[3] I recently told our Board of Trustees when introducing Scott Reeves, M.D., our new anesthesiology chair in Charleston, that "I believe being chair of anesthesiology is one of the most difficult jobs in any medical center today. My hat is off to the chairs of our departments." The chairs have many competing responsibilities that do not allow them to focus exclusively on faculty development.

Incentives are used to reward performance,[20–23] and Lubarsky in Miami recently wrote, ". . . we are paid to work. Our salary is a regular incentive to get up at 5:45 A.M. and drive to work, instead of lounging late in the morning in a warm bed, and heading out even later to a soft white sand beach."[22] And incentives are used mightily in anesthesia. The largest incentive ($97,261 per faculty person) is provided by the hospital to the department.[24] One can be sure the hospital incentives are not given to develop the research careers of the faculty. However, I am particularly troubled about a developing entitlement philosophy of our faculty when those of us in academia expect this subsidy even and demand it. I often hear said, "the hospital or the university owes us . . ."

Thinking this way reminds of a Mark Twain quote: "Don't go around saying the world owes you a living. The world owes you nothing. It was here first."# This is not to say that anesthesiology departments do not have real financial issues, for they do,[24] but there are more

Mark Twain as cited at: http://www.mtwain.com/_quotes.html. Accessed December 20, 2006.

creative ways to make ends meet than demanding subsidies. And we should be clever enough to convince all that we earn what we expect, not expect what we earn.

Most departments also use incentives to accomplish clinical work, hoping that in so doing not only will the clinical work be done, but that the added clinical pay will narrow the gap with nonacademicians in private practice. It is apparent that the gap in financial pay is narrowing between anesthesiologists within academic departments and those in the community. But the gap still is about 30% (the Medical Group Management Association reports that private practice anesthesiologists make $334,000,[25] and the AAMC reports that academic anesthesiologists average $255,000).[26] The irony of the "competitive compensation" strategy is that the more we try to make academic anesthesia *pay* like private practice, the more we actually make academia *like* private practice, and then we risk losing some of our best faculty to private practice since there is little left of academics in academia, but the pay is still less. Why would anyone want to function like a private practitioner but not get paid for it? All this brings me reluctantly to the admittedly very controversial conclusion that income expectations of the faculty is the *second causal factor* in our lack of research productivity.

One of many consequences of anesthesiology compensation is the disparity between what an academic anesthesiologist makes and what the NIH top allowable salary is for investigators. The average income for academic anesthesiologists is about $79,300 above the NIH cap (top pay for an investigator paid by the NIH). The average income for anesthesiologists in all ranks according to the AAMC is $255,000 in fiscal year 2005,[26] and the NIH salary cap is $175,700. Thus, even if fully funded by the NIH to do research, an academic anesthesiologist would make significantly more money doing clinical care. Thus, departments will either have to supplement the salary of the investigator to get the investigator to the average academic anesthesiology income, or the investigator will make a great deal less money than noninvestigators. This means that incentives are in place to discourage faculty from choosing research careers and leads to some tough choices.

The effect of the environment, the expectations, and the incentives combined with the desire to augment personal income mean that too few junior faculty are developed in research. This is the *third causal factor* in our subpar research performance.

Despite the handicaps and the hurdles, some faculty are motivated to have research careers. They make every effort to do so. What now confronts them is a lack of resources. Resources are defined as space, money, time, and training grants. Not enough seed money exists for the start-up of young and committed faculty to pursue their careers. Space is not given by the deans to the departments because the departments have not earned it with NIH and other peer-reviewed funding; this now becomes a downward spiral of lack of space, leading to lack of funding, and then even less space. The deans cannot be faulted here since space is at a premium everywhere and most other disciplines can make more legitimate claims on the space based on extramural support. Finally, anesthesiology departments compared with others do not take advantage of the Veterans Administration programs where faculty are given time and resources to develop research careers.**

The *fourth causal factor* is that there are relatively few career investigators who submit relatively few NIH grants, and we have the problem of low research productivity and a poor research environment in our anesthesiology departments and, therefore, in our field. We are what we make.

Part 3: A Plan to Improve Anesthesiology Research

Orin F. Guidry, M.D. (Past ASA President, Department of Anesthesiology, Ochsner Clinic Foundation, New Orleans, Louisiana), challenged the Association of University Anesthesiologists, an elected group of the most academically active anesthesiologists in this country, at their annual meeting, to develop a plan for research. He seemed as frustrated as everyone else with the current state of research in our field. He posed a question: "What is the plan?"[27] Well, Mr. President, in answer to your question, I have "a plan" that comes from my root cause analysis: I cannot be sure it is "the plan" you requested. My plan begins with a vision statement for our specialty and the departments and training programs that make it: *Anesthesiology attracts, educates, supports, and retains individuals who advance the field and all medical science through scholarly research.* To accomplish this vision, I respectfully offer the following plan.

Causal Factor 1

To eliminate or attenuate the problem of "residents do not do research," there are several action steps to be taken. First, we must recruit medical students who have experience and desire to continue research during their residency. This would include a very concerted effort to recruit M.D.–Ph.D. graduating students. A program to guarantee research support to these students in the form of a scholarship sponsored by the ASA or other interested bodies would be most helpful. This could be done immediately.

** Data are from the US Department of Veteran Affairs Office of Research and Development. Available at: http://www1.va.gov/resdev/funding/professional_dev.cfm. Accessed December 20, 2006.

When the ABA changed the anesthesia training requirements in 1989 to require a third year, we effectively abolished the *elective* postgraduate year (PGY)-4 year-long research track. We went from training 19 residents a year in a year-long research experience to zero within 10 yr.[28] In 1989, we had 19, or 31%, of all elective PGY-4 residents spending an entire year doing research, to none or 0% in 1997. This illustrates the law of unintended consequences, since it is known[29] that the desire of the ABA was not to curtail research training. I believe it is time for another curricular revision in which the ABA specifically includes research as an elective track in the 4-yr continuum. It is not sufficient simply for the ABA to "allow"[29] extended research experiences. The RRC should insist on verifiable research exposure on site visits and find some residents seriously engaged in research. After all, we get what we make.

Residents should be provided with advisors who stimulate them to get involved in research during the first and subsequent years of the residency. It should be possible to have done 30 months of research during a 5-yr (60-month) residency program for those who elect to do so.[6,7] To foster this activity, we should offer master's degree training in clinical research to interested residents during their 4 yr of education. I do not think that performing research should be required of all, but *all residents* must be *exposed* to it, and some should be guided to pursue it in depth. Furthermore, the chair, residency director, and faculty must expect some of the residents to *excel* in research during their residency.

Toward this end, there must be an ample variety of research within the department; this would be mainly clinical research, but for those who wish to immerse themselves for a year in research, the laboratory is an option. Research mentors must be available (in or outside of the department) for serious resident investigators, especially those who elect an additional PGY-5 solely in research. If this additional year is to be combined with an anesthesiology subspecialty fellowship, as it should be for fellows in accredited subspecialties, then the residency is now extended to 6 yr. All anesthesiology fellowships then would be 2 yr in length— one of those years devoted to scientific inquiry.[5,7] Funding for these additional years must be secured. Excellence in research, teaching, and clinical care must be equally valued; there should be no separation of these three missions and no difference in their perceived value by the faculty. We must create and maintain a departmental atmosphere where the joy and excitement of investigation fill the air. In doing so, we must commit to the implementation of recommendations of the AAMC task force on Translational and Clinical Science. Last month, a blue ribbon panel of the AAMC produced a document that explicitly calls for 12 major changes to create more clinician scientists. The first two steps apply to our transformation of anesthesiology education: "Every resident should be taught principles of research and the ACGME should embed research in its core competencies."[30] Imagine if anesthesiology were the first specialty to formulate a plan to produce translational investigators, and if we were the first specialty fully compliant with the AAMC panel recommendations. This would astonish the larger academic community and prepare us for a bright future.

Causal Factor 2

Nobody likes to speak about compensation as a causal factor, and with good reason. Chairs and deans who talk of flat faculty incomes have short tenures. Nevertheless, I am compelled to say that preoccupation with compensation is a problem for anesthesiology and increasingly all of medicine, actually. Remember, our profession is about serving others, not ourselves.

In Henry Rosovsky's delightful book, *The University: An Owner's Manual*, there is a priceless anecdote: "At every Harvard commencement the graduates of the Business School, who have just been awarded the MBA degree, get up and with great joy and defiance wave dollar bills. In turn, they are soundly booed by nearly all the other graduates. This has become a ritual of significance. . .[31] The distinction between business leaders and other professionals, especially medicine, is clear to all.

To address the compensation problem, I propose the following steps. Departmental value systems should be adjusted to reflect university-wide goals of achieving excellence in research and education, rather than focusing solely on clinical care. Incentive plans should be put in place that promote excellence in all three missions. The nonfinancial rewards of academic excellence should be clearly and constantly demonstrated, compared with the mainly financial rewards present in community hospital environments. Nonremunerative rewards should be provided, such as time for scholarly activities. Anesthesia faculty should be encouraged to mix with faculty of all disciplines— especially the other "research-oriented" specialties—and compare pay stubs!

Chairs should make it clear that academic anesthesia is about advancement of careers and furthering the field—not maximizing personal income. When I moved to Duke University from the University of Alabama at Birmingham, a very fine academic environment, but one where the basic sciences were doing more than the clinical sciences in research, I noted what I described as "a major parking lot ecology change"—at Duke, in the clinical faculty parking lot were Fords, Chevrolets, and Hondas, compared with foreign-made sports cars in Birmingham. The clinical faculty income was less in Durham, but clinical science research productivity was

greater. We must create an environment where the greatest gratifications are found in seeing the present generation of academic anesthesiologists advancing the field and seeing the next generation of anesthesiologists succeed by their example.

Causal Factor 3

The next factor of concern is that "faculty do not do research." There are several steps to correct this problem. There must be a clear expectation that promotion and advancement in the department are dependent on the conduct of scholarly activities. We must create a mentoring plan for all junior faculty—mentors may be drawn from outside of the department as indicated. Junior faculty should be assisted with identifying and accessing the resources needed to achieve educational and research goals. We should create individual faculty development plans that are reviewed each year, and implement an incentive plan that rewards in a meaningful way faculty growth and development in research.

We must also provide encouragement to the discouraged. We have entered an NIH phase where only about 10% of first-time NIH RO1 applications are funded.[32] It is easy to give up with the chances for success being only 10%, but persistence pays great dividends, and persistence requires encouragement. Actually, this is a propitious time for us in anesthesiology to enter the NIH arena because many other specialists, used to better days, will be particularly disillusioned. We should applaud publicly all achievements along the road to investigative success. Brag to the entire department when someone has a paper accepted in a superior journal or scores well on an NIH grant! Well-earned praise is a powerful motivator.

Causal Factor 4

The final causal factor in overall poor departmental performance is that there are too few career investigators, whom I define as that group of faculty who spend the majority of their time engaged in fruitful research. It is this group that can compete in the NIH arena over a sustained time. There are several additional steps in the removal of this final barrier to our success. First, we must determine how many career investigators the department can support and then recruit or develop that number. We should set national goals for numbers of investigators. It should be at least double the number we have now. We must provide the resources (time, money, and space) for this vital departmental group to function optimally. We should take advantage of the Veterans Administration system that still encourages academic growth.

We should also get the US Congress or Centers for Medicare & Medicaid Services to revoke the present anesthesiology teaching rule that specifically encumbers academic anesthesiology departments by requiring one anesthesiologist's supervision for two residents but limits the ability to bill for services to only one of the sites. This results in tying up anesthesiologists clinically and not supplying the dollars to pay for their clinical involvement, thus robbing the department of money that could be used to invest in research.

Academic anesthesiology must secure more support for developing investigators from the ASA, International Anesthesia Research Society, subspecialty societies, and other foundations. The support through the years of the ASA Foundation for Anesthesia Education and Research starter grants has assisted junior faculty in developing into career investigators,[33] but more seed money is needed to produce more investigators. The model is good, it is just underfunded. Research seed money will not come from the university or NIH—it must come from the larger anesthesiology community. All of us must invest in our research future. This is not a problem confined to the academic community; it is a problem for all of anesthesiology.

We must demonstrate the great variety and potential for anesthesiology clinician scientists. We attract residents into our field because of their love for pharmacology and physiology; we must capitalize on these interests in sciences. We have the potential to work in all aspects of neuroscience, the exciting areas of pharmacogenetics, pain, and a host of other very important areas. The Global Perioperative Research Organization, under the very able leadership of Mark Newman, M.D. (Professor, Department of Anesthesiology, Duke University Medical Center, Durham, North Carolina), and Lee Fleisher, M.D. (Chair, Department of Anesthesia, University of Pennsylvania Health Systems, Philadelphia, Pennsylvania), is proposing the visionary combination of electronic medical information systems with genetics databases to understand why patients in populations respond the way they do. Who among you has not wondered why some patients are sensitive to our drugs and others resistant? We could predict this by genetic testing; why should we have to guess?

We must participate in interdisciplinary and translational research work. The director of the NIH has vowed that research of the future must involve research teams, and anesthesiologists must join these teams with the unique background we bring to all questions. With our established leadership in patient safety and simulation, shouldn't we use simulation as the airline industry does to perfect and maintain knowledge, skills, and teamwork at high levels and to reduce errors in the hospital? Imagine an anesthesiologist working on awareness and how memory works who discovers a treatment for Alzheimer disease. Or think of one of our investigators who works out the biologic mechanism of addiction—and in so doing discovers a preventive treatment for this disease that

is the scourge of society and our own profession. And, finally, consider anesthesiology scientists engaged in the new field of regenerative medicine—using stem cells to print organs for our surgical colleagues to implant. We must make our mark in important and timely research areas. There are a limitless number of new techniques to apply to the huge array of questions facing society, and we should be in the vanguard of this work.

Summation

So that is my plan to accomplish the vision. What is not provided in this plan are two important details. First is the source of the funding, and second is who will lead the effort. Funding can only come once the commitment is made to integrate research fully into anesthesiology. This commitment has not yet been made. Funding will follow the commitment; that is one definition of commitment.

Who will lead the transformation? To emphasize and incorporate research into academic anesthesiology is a multigroup decision and requires a coordinated action. The rank and file of the ASA, the ASA House of Delegates, the ASA officers, the department program directors, the chairs of the departments, the faculty, the residents, the ABA, the RRC, and the ACGME all must decide that research is an important part of our specialty.

The plan to get anesthesiology productive and competitive with our peer groups requires rethinking and transforming the education of our specialty. If this were easy and if we had the leaders now or in the past to do this, I would not be standing before you talking about this. It is hard work, and to get it done, the various constituents who are independent and have many different priorities must be led. Getting everyone to go in one research direction is the proverbial "cat-herding" problem. There are a lot of groups that are comfortable with the old directions, others have ideas that are polar opposites, and all can be independent actors.

The problem of anesthesiology research productivity has been identified for some time. The question is, who can get everyone who has thoughts about this to act? Ordinarily, what is called for are committees and task forces who further study and detail the problem. The groups most likely to take ownership of the research problem are the Society of Academic Anesthesia Chairs/Association of Anesthesia Program Directors, the Association of University Anesthesiologists, the International Anesthesia Research Society, and subsets of the ASA like the Foundation for Anesthesia Education and Research. To one degree or another, each of these has thought about the problem before. However, when a group studies a problem and makes recommendations, the plan is usually filed somewhere and can't be found in about 6 months. This is because no single individual or organization can be held accountable. *Someone* or some *small group* representing all the constituencies in anesthesiology will have to take this leadership with a timetable agreed upon for implementation of less than 2 yr. This person or persons must be held accountable by all of the interested organizations. Reports to the various groups should be provided semiannually.

I do sense enough concern, now, in all quarters that, if appointed, a leader or leaders could accomplish this transformation plan. It will be a difficult journey, and it is not for the faint of heart. It will take years to see the fruits of the labor. It requires a vision and determination not previously within us.

Are we looking at the dawn of a new day for our specialty? Our lackluster research effort must improve for a field with as many bright people as we have in it. It must improve for a specialty as old and mature as we now are. It must improve if we wish to advance anesthesiology. It must improve if we wish to sit at the table as peers with our academic colleagues in the halls of academe. It is must improve, for if not, I fear a future where anesthesiology will be viewed merely as a necessary, but only a technical specialty, irrelevant to mainstream medicine. And, finally and most importantly, it must improve because a new day beckons with more scientific discovery, more innovation, and more notable improvement to public health than ever before—and for the good of our patients and the society we serve, we need to be explorers in this exciting new world.

So I leave you with a single declarative sentence: In research we have done too little, for too long, but it is not too late.

References

1. Heard A: Speaking of the University: Two Decades at Vanderbilt, 1st edition. Nashville, Vanderbilt University Press, 1995
2. Rhodes FHT: The Creation of the Future: The Role of the American University. Ithaca, Cornell University Press, 2001
3. Reves JG, Greene NM: Anesthesiology and the Academic Medical Center: Place and Promise at the Start of the New Millennium. Philadelphia, Lippincott Williams & Wilkins, 2000
4. Jackson RGM, Stamford JA, Strunin L: Correspondence: The canary is dead. Anaesthesia 2003; 58:911–2
5. Schwinn DA, Balser JR: Anesthesiology physician scientists in academic medicine: A wake-up call. ANESTHESIOLOGY 2006; 104:170–8
6. Knight PR, Warltier DC: Anesthesiology residency programs for physician scientists. ANESTHESIOLOGY 2006; 104:1–4
7. Campagna JA: Academic anesthesia and M.D.–Ph.D.s (letter). ANESTHESIOLOGY 2006; 105:627–30
8. Gelman S: Anesthesiologist scientist: Endangered species (letter). ANESTHESIOLOGY 2006; 105:624–5
9. Pandit JJ: Royal College recommendations to improve academic anesthesia in the United Kingdom: How they compare with United States proposals (letter). ANESTHESIOLOGY 2006; 105:625–6
10. Fleisher LA, Eckenhoff RG: Image not living up to goal (letter). ANESTHESIOLOGY 2006; 105:626–7
11. Andreae MH: Integrate our international anesthesia research potential (letter). ANESTHESIOLOGY 2006; 105:624

12. Stead EA Jr: Anesthesiologists come of age: Their stake in general education, research, residency education, and selection of medical students and faculty. ANESTHESIOLOGY 1985; 62:774–80

13. Wright FL: Frank Lloyd Wright and his art. New York Times Magazine. October 4, 1953:26, 27, 47

14. Rooney JJ, Vanden Heuvel LN: Root cause analysis for beginners. Qual Prog 2004; 37:45–53

15. Schubert A, Eckhout G Jr, Tremper K: An updated view of the national anesthesia personnel shortfall. Anesth Analg 2003; 96:207–14

16. Roberts LJ, Khursandi DCS: Career choice influences in Australian anaesthetists. Anaesth Intensive Care 2002; 30:355–9

17. Wass CT, Long TR, Randle DW, Rose SH, Faust RJ, Decker PA: Recruitment of house staff into anesthesiology: A re-evaluation of factors responsible for house staff selecting anesthesiology as a career and individual training program. J Clin Anesth 2003; 15:289–94

18. Kearney RA: Defining professionalism in anaesthesiology. Med Educ 2005; 39:769–76

19. Warters RD, Katz J, Szmuk P, Luehr SL, Pivalizza EG, Koch SM, Price M, Ezri T: Development criteria for academic leadership in anesthesiology: Have they changed? Anesth Analg 2002; 95:1018–23

20. Abouleish AE, Apfelbaum JL, Prough DS, Williams JP, Roskoph JA, Johnston WE, Whitten CW: The prevalence and characteristics of incentive plans for clinical productivity among academic anesthesiology programs. Anesth Analg 2005; 100:493–501

21. Miller RD: Academic anesthesia faculty salaries: Incentives, availability, and productivity. Anesth Analg 2005; 100:487–9

22. Lubarsky DA: Incentive everything, incentive nothing. Anesth Analg 2005; 100:490–2

23. Miller RD, Cohen NH: The impact of productivity-based incentives on faculty salary-based compensation. Anesth Analg 2005; 101:105–99

24. Tremper KK, Shanks A, Morris M: Trends in the financial status of United States anesthesiology training programs: 2000 to 2004. Anesth Analg 2006; 102:517–23

25. Academic Practice Compensation and Productivity Survey for Faculty and Management, 2005 Report Based on 2005 Data. Denver, Medical Group Management Association, 2005

26. Desmarias W, editor: Report on Medical School Faculty Salaries 2004-2005. Washington, DC, Association of American Medical Colleges, 2006, p 30 (departmental averages calculated)

27. Guidry OR: What is the plan to improve research in anesthesiology? Association of University Anesthesiologists Update, Spring 2006; 1–3

28. Havidich JE, Haynes GR, Reves JG: The effect of lengthening anesthesiology residency on subspecialty education. Anesth Analg 2004; 99:844–56

29. Warner MA, Hall SC: Research training in anesthesiology: Expand it now! ANESTHESIOLOGY 2006; 105:446–8

30. Promoting Translational and Clinical Science: The Critical Role of Medical Schools and Teaching Hospitals, Report of the AAMC Task Force II on Clinical Research. Washington, DC, Association of American Medical Colleges, 2006, p 3

31. Rosovsky H: The University: An Owners Manual, 1st edition. New York, WW Norton, 1990

32. Mandel HG, Vesell ES: Declines in funding of NIH R01 research grants. Science 2006; 313:1387–8

33. King CP, Hug CC: Survey of former recipients of research funding from the American Society of Anesthesiologists and the Foundation for Anesthesia Education and Research. ANESTHESIOLOGY 1998; 88:519–24