RECORD, Volume 31, No. 2*

2005 New Orleans Health/Pension Spring Meeting
June 15-17, 2005

Session 55 TS
Introduction to Research Methods

Tracks: Education & Research, Health

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Panelists: Henry Dove†
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Summary: Relatively little health-care actuarial research is published in the actuarial literature. However, performing, reading and understanding research is critical to the future of the health actuarial profession. This session examines the importance of health actuarial research, how/what to do when conducting actuarial research, researching the literature, statistical tests of significance, writing a research report and how to get published.

Participants have the opportunity to examine published studies with the instructors. These studies are circulated to participants who sign up ahead of the session. The practical application covers applications of the theory to actual research studies and how to interpret a research report: methodology, key assumptions and practical significance.

MR. IAN G. DUNCAN: This session is jointly sponsored by the Education and Research and the Health Care Sections. I'm on the Education and Research Council, as well as being a health-care actuary who happens to do some research on the side. I'll talk for a couple of minutes about the importance of research in the profession.

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Note: The charts referred to in the text can be downloaded at:
http://handouts.soa.org/conted/cearchive/neworleans-june05/055_combined.pdf

We have two speakers today. Marjorie Rosenberg is an actuary and also an academic. She's on the staff of the University of Wisconsin in Madison. We also have Henry Dove, who is not an actuary, but a health-care researcher from Yale University. They'll tell you more about their backgrounds when they speak. We'll talk about the importance of health actuarial research, and then we'll go through a case study of a particular research paper.

Why is research important? Why should people do research? Here are some suggestions. Obviously, for academics it's a requirement of the job. It's an opportunity to share your work with others and expand your practice area. It's very important as a way of expanding and enhancing the visibility of the actuarial profession. Research is one of the positive things we can do to show the outside world the importance of the work that we do. For too long, actuaries have communicated internally on risk and actuarial subjects rather than distributing their work externally. It's a real opportunity for us to engage with the larger outside audience and establish personal reputations, as well as the reputation of the profession as a whole. It's obviously an opportunity to collaborate, meet health-care researchers and share ideas.

As I look around, I see other professions, such as law and medicine, having much more of a tradition of practitioners doing and publishing research. I think that Henry said in a session yesterday that there are something like 3,500 medical journals out there. Imagine that! Some are published monthly, some quarterly and some annually, and all of them publish 20 to 30 articles. How many articles is the medical profession publishing annually? We publish the *North American Actuarial Journal* (*NAAJ*) four times a year. How many articles are there in it? Think about that.

The Morris Commission in the United Kingdom criticized actuaries for their lack of continuing education and the failure of individual actuaries to keep up with new techniques. I'm just as guilty of this as anybody. I finished my last exam in 1982, and I've generally tended to avoid any sort of formal education since then. That's what we're being criticized for by the public. Of course, you might actually learn something along the way.

Health research is woefully underrepresented at the Society of Actuaries. There are about 17,000 members of the Society. About 25 percent of these have health-benefit systems in their affiliation. I, with Margie, did a little search through the *North American Actuarial Journal*, which I think has been going for about eight years. Two hundred fifty-five total articles have been published there. Of these—I think Margie was generous—43 are health-related. She counted some articles that had words in the title such as "genetics," which I think had more to do with life underwriting than with health. But let's be generous and say that there were 43 articles. That's about 15 percent of the total articles in the *NAAJ* for a group of us who are about 25 percent of the total profession. That's pitiful.
There are other good journals out there. One that the Pension Section publishes is called the *Pension Forum*, and it has some fairly scholarly and decent articles. It

comes out sporadically, but a couple of times a year. On health we don't have anything like that, so we have to move. That's what this session is about.

The Health Section also has sponsored some research and, generally, this is available on the Society's Web site. For those of you who are not familiar with it, I suggest you take a look. It's under "Research" on the Health page. The Health Section does have a mission to foster research and makes available funding for those of you who have ideas for research projects. John Cookson is the chairman of the Research Section Council.

Steve Siegel, who's one of the health research actuaries of the Society, just said that a request for proposals has just been sent out and is available on the Web site. We looked at articles that had been published in the *North American Actuarial Journal*; there's also some publication occurring in health services journals that are not actuarial. Dave Axene has published. John Bertko has published. Henry Dove and I have published. Margie also has published in a number of health services research publications. So there is some publication in outside journals directed at the health services research audience, as well as a limited amount in the *North American Actuarial Journal*. But we have to improve our publication record, and that's what this session is about.

MS. MARJORIE A. ROSENBERG: I started my career as a life actuary in industry. When I was in college, I thought about going back to school to get a Ph.D. in teaching, but my professor had never mentioned it, so I didn't think I'd be smart enough to do it. I went to work as an actuary. Then I got the bug and, in 1988, I went back to Michigan, which is where I did my schooling, and I got my Ph.D. in business, with a specialty in statistics. My goal was to teach actuarial science, and I took a job at the University of Wisconsin in Madison. I've been there since then.

It would have been advantageous for me to continue in life, because my industry background was that. But I became interested in health care when I went back to school, so now I'm a health-care person. While I was at Wisconsin, I ended up with a joint appointment in the business school at Wisconsin and in the medical school. My appointment is in biostatistics, which I know nothing about, but the idea is that I do health policy research. This afternoon, I'll be presenting with my co-author, Phil Farrell, the dean of the medical school at Wisconsin, on work that we're doing on cystic fibrosis. So I've come a long way from individual product development and pricing.

The purpose of this session is to introduce research and give a flavor of what a research article looks like, but to do it in a context. We thought we'd first introduce a structure and then take a real article that has been published and is, hopefully, of some interest to you. It is applicable to things that health-care actuaries would do. Hopefully you'll find this educational, if not entertaining.

The research project is something that you want to take some time to define. The

project needs to be manageable. Usually we all have great ideas. An example is the Health-Care Crisis Task Force. This is something that has been going on for two years or maybe a little longer. It started at a meeting like this, when people got together and said, "We should do something about trying to solve the health-care crisis. Actuaries have a perspective, and this is something that we should look into." This was the big project.

It's a huge project. Everybody has been talking about it for years, and it's something for which no one has had an answer. Over that two-year time period that we've been working, we've narrowed the scope of this project to something that's smaller and more manageable. A paper will be submitted for publication that gives the background of this crisis, and then we anticipate working on another paper that will be a case study.

We've taken a very big project and carved it into something that's manageable, so that we can work on it in components. When something is too big, you get lost. It's something that you can't focus and communicate. It could be a subset of a bigger project. Usually you work in increments and do that kind of thing.

Then you want to talk about a contribution to the literature. What are you adding to what has already been out there? It's not that you want to tweak something a little bit. You want to get a message out to a lot of people. The advantage of publishing is that, one, it ties into the image campaign, but two, it also communicates thoughts of actuaries. We learn about what other health services researchers are doing, and then we broaden the field. The whole idea is to expand everybody's education.

What does an article look like? There's an abstract. In business, you might call it an executive summary. It's usually short. It could as little as 100, 150 or 200 words, and it summarizes the whole paper. It gives a background. It gives the data, the methods, the results and the impact. It's very short and concise. The rest of the paper expands on that. You have an introduction and background, where you talk about the purpose of the paper, you give a little background and then you do what's known as a literature review.

I would guess that most actuaries have not done a literature review. It's something that you need to learn. It's looking at what other people have done. It ties back to my previous comment about what your contribution is to the literature. You need to know what other people have done. It's not just in the actuarial literature. You need to look at the medical and the health services research and the health policy literature to see what you're doing that's different from what other people have done.

You summarize the data. You provide a detailed summary of the methods that you're using. You summarize the results. You have a conclusion, and then you have a bibliography for all the literature that you've cited. You want to make sure that

you give a proper citation when you cite literature or you make a statement that seems profound, if someone else has done it.

I mentioned that some journals have particular formats in which they want you to write. Most of the time, you need to go to their Web site and look at the guidelines to authors to see the different restrictions and constraints that they impose on authors. They want you to line things up a certain way and write within a certain length, and they're very picky about that. I had one article that had been accepted that was returned because, when I sent in the final revision, I put the whole paper together. They said, "No, the paper needs to be separate from the figures, and each figure needs to be in a separate file, so you need to do this again." They wouldn't separate out the figures themselves. I had to do that myself. It was annoying, but some things have to be done. Then you want to have a concise summary of the article, from the purpose to the introduction to the conclusions (you usually leave out the literature search).

In the introduction, you want to introduce the purpose of the paper within the first couple of paragraphs. You want the reader to know where you're going. It's not like you want to have a logical argument that, at the end of that introduction, lets the reader knows where you're headed. You want to hit them right at the beginning so that they know what the paper is about. Then, reinforce it. Give support throughout the introduction. Then at the end, remind them of where you're going. The background provides the overall area of concern and where the paper fits in. It addresses what the literature search talks about and what is your contribution. Then you want to describe what is to come in this paper.

You need to describe your data source. What does your data have, and where does it come from? You want to give some background on the details of the data. You want to include figures and tables. At the same time, you want to describe in the body of the paper what the reader should take from those figures and tables. So you shouldn't say, "See Table 2 for the data." What do you want the reader to take from that table? What do you want the reader to take from the figure so that they don't have to think? You should be able to guide them in terms of what they should be doing.

You want to provide background as necessary for actuaries to understand the methods, and you want to provide other studies and sources to give the reader more background. You want to be precise in terms of the methods and models that you're using. In the results section, you summarize the results. Again, if you include tables and figures, you fully describe them.

The conclusion is where you pull the paper together. You want to summarize the results, but then you probably take it one step further in terms of explaining the impact of the research. What is the contribution, and what are the things that the reader should take from it? Usually, you describe the limitations of the study, whether it's in the data—that the data is from a specific source, for example—or whether it's in the methods in terms of the assumptions that you had to make.

Then usually, you put in what the future work is. As I mentioned, this work is usually a beginning of something. Research spawns research. You summarize where you think this research might be headed. Then you include the references for things that you've cited. You don't just load up the bibliography with anything. Anything that's in the bibliography should be cited in the paper itself, and this also is dictated in terms of what the journal has to say.

Henry will take over and discuss how you might summarize the literature. Then we'll follow up with this article. We'll walk through the article, and then you can see all these different sections come to life in a context that hopefully will be of interest to you.

MR. HENRY DOVE: I had gotten my doctorate in a field called operations research. Most of the people who were in my program, those who graduated, went on to become professors. As Ian said, to succeed in academia, you have to publish. So most of them published and continue to publish very arcane articles in mathematical algorithms. I knew as a graduate student that I didn't want to do that. I wanted to do something more applied. That's what brought me to the field of health services research. I've had an unorthodox career. I headed up an applied research program at the Veterans Administration for five years. I was involved with a start-up company in the health information field for five years. Then I've been in consulting for about 10 years, and I also have been a lecturer at Yale University for 25 years and have enjoyed teaching. I have published, but not as much as a full-time academician.

One message that I want to bring to this audience is that I know, as a professor reading students' term projects or reading other kinds of essays, how horrible the writing skills of our students are today. Some of my classmates when I was a graduate student came from an engineering background, and they were terrible writers. One of the points I want to make, as you think in terms of publishing, is that you don't have to write 10 articles per year. If you write just one article per year, I think that would be a great accomplishment.

Part of the problem is that the incentive structure is perhaps not there for actuaries as it is in academia. But I think that there are many opportunities in the consulting field, when you work on a project and you've written a final report, that you could say, "We're proud of what we've done. Why don't we try to publish this?" It's very difficult sometimes to find the time to do that, but I encourage you to attempt to do that because it's worth the effort for yourself and for your firm, as well as for the actuarial field.

Margie went over the general structure of an article. In any article, you have references. As she pointed out, you want to acknowledge the other people who have done research before you. If you write an article and try to submit it for publication and there are no references, then you know that it won't be accepted,

because nobody can come up with a completely unique idea. You know that you'll have some references in any report that you do or any article that you submit for publication.

One of the things that has changed over my career is that there are such powerful tools now to help you do this. I'm from the era when we had to type our own papers. Before that, some people didn't type, so they would handwrite them and then turn them over to someone else who would type them. Now we have word processors and spell-checkers, and we have a wonderful tool for references. It's a tool called Reference Manager. As Margie said, different journals have different styles. It was always a pain in the neck if you wrote an article and submitted it to one journal, and it was rejected. Then, to submit it to journal number two, you would have to take a lot of time to change the format and change the way the references were done. A tool like Reference Manager does this automatically for you, and that saves you an enormous amount of time.

Searching the literature is something else that is much easier in 2005 than it was five or 10 years ago. I talked yesterday a little about this tool called PubMed. I urge people to take a look at this. It's available for free—just Google "PubMed." It has a wonderful tutorial, and it gives you incredible access. In fact, from many journals, you can get the full text version of the articles. It's a wonderful tool.

How do we find articles in PubMed? There are a variety of tools that you can use. When you've written an article, probably you will have found other articles that influenced your thinking. If you look at the references to those articles, maybe you only read three or four articles that were relevant to the research that you did. You would check the references of those articles as a starting point. That is a good way to credit other people for work that they have done that influenced your thinking and that you want to quote.

Another thing that you will find is that certain journals are especially important, so you can do searches in PubMed by just certain journals. Sometimes you will think, "I read this article. It was four years ago, and this article appeared in the journal *Medical Care*. I don't remember who the author was." You can do a search on the journal to track down articles that are important to you.

Very commonly, there are important authors who have done work before. You may find a certain article that was written by a professor or some other leader. In PubMed, you can simply click on authors to find all of the articles that they have written. In fact, there was one professor at Yale who I just couldn't believe had done as much work as he had. I put his name in and I said, "I want to see what this guy has done." Since 2001, I think he has published more than 200 articles. With PubMed, you can say, "I know this guy has done some great thinking, and I want to see what other work he has done." In five minutes, you can find all the articles that someone has written.

The subject headings are also very important. That's "MeSH." All of this has been organized by the National Library of Medicine. They come up with these various headings and revise them from year to year. A term like "predictive modeling" probably was not in there five years ago. Of course, "predictive modeling" is a subject heading now in the National Library of Medicine's PubMed. Another technique that you can use is to search for exact words. If you search by certain words that are not subject headings, it will find any articles that have those exact words in them. So it's a very powerful tool, and I give the National Library of Medicine a lot of credit for the work that they've done in this.

What would be an example of a search? To give a preview of the article that we'll review, which is involved with intensive care units (ICUs) and economic analysis of ICUs, suppose we want to find articles on the cost of care of ICUs and payment systems used by private insurance companies. Possible MeSH terms include "economic analysis," "intensive care units," "insurance reimbursement" or "payment methods." Where did I come up with these terms? It's kind of like when you do a Google search. You think of different general areas, and then you fiddle around for a while. There's not one precise way to find the articles for which you're looking. It's a little hit or miss, but you can do it so quickly that you have a large margin of error.

In PubMed you can use various combinations, unions or intersections or other tools to be more or less restrictive in your search. For example, you could say, "I'm only interested in articles that were published after 1999. I'm only interested in articles that were published in English. I'm only interested in articles that involved humans and that didn't involve animals. I'm only interested in review articles versus original research." The different resources that you have are quite amazing to me.

When I first just searched on "insurance/reimbursement" and a certain time period, it came up with 25,351 "hits," or articles. If you wanted to print out the abstracts of all those articles or the journals in which all those appeared or the citations for all of those, you could do that, but obviously, 25,000 is too many. You would kill too many trees if you did that.

Then I did a search on the MeSH heading "economic analysis," and there were 7,425 articles. Once again, you can fiddle around in these MeSH headings. It gives you a way of going up, which will give you more generality, or you can go down, which makes it more specific. You might search for "economic analysis for hospitals" or "economic analysis for manpower." A lot of this, to repeat, is somewhat hit or miss. The other MeSH heading that I used was "intensive care units," and there were 32,988 articles.

Then I did an intersection of all three of those ("insurance/reimbursement," "economic analysis" and "intensive care units"), and I came up with six articles. You could look up these articles and see the references for those articles and so forth. This all can be done in about five minutes, so you can hone in very quickly on the

articles that are relevant.

Now I want to get started on a brief overview of the article. The article that we're talking about is entitled, "Explaining Variability of Cost Using a Severity-of-Illness Measure for ICU Patients," which appeared in *Medical Care* in April 1990. We purposely chose an article that was not current, because the purpose of this presentation is not to pick apart this article. We want to illustrate some of the things that Margie and I talked about. We also wanted to talk a little about some of the statistical aspects of this article, because we figured that would be of interest to actuaries, and it's an important part of any research article.

The goal of this project was to better understand the determinants of ICU resource use and to evaluate the effects of any reimbursement system, which in this case was a hospital payment system. The key underlying issue here was severity of illness and resource use, and this is certainly something that is of interest to actuaries. The underlying financial question in this article was that the authors were questioning whether diagnosis-related groups (DRGs) may lead to inequities in reimbursement.

Let me just say a little about DRGs, because I have done a lot of consulting about this. It's a patient classification system that is used to pay hospitals for Medicare patients. It began in 1983, and this article was written in 1990. There are 507 DRGs. The DRG a Medicare patient is in determines how much the hospital is paid. What motivated this article was that the authors felt that when a patient was admitted to an ICU, the hospital was not being adequately reimbursed for the ICU resources. That was what led them to this research and to this article.

ICU usage does not increase payment under the DRG system. But the basic idea of this article was that this hospital said, "We have these patients in ICU. We want to understand more about the utilization. We want to understand more about what resources these ICU patients are taking, and we're questioning whether we're being adequately reimbursed under the DRG system for these ICU patients."

To address the issue of severity of illness and resource utilization, the authors had various mortality assessment systems. Now this is an interesting part of this project because on the one hand, they're talking about estimating the risk of death, and on the other hand, they're interested in resource utilization. This is a common problem that exists when we talk about risk. Are we talking about risk of death? Are we talking about risk of utilizing a high number of resources? They point here to four different mortality assessment systems. One is called Acute Physiology & Chronic Health Evaluation (APACHE). Another is called Therapeutic Intervention Scoring System (TISS). Another is called Simplified Acute Physiology Score (SAPS). The one that they used, which was developed by the authors in previous research, was the Mortality Prediction Model (MPM), which estimates the probability of mortality based on 11 different variables.

The basic study design was that they studied 2,749 patients that were admitted into an ICU of the Baystate Medical Center in Springfield, Massachusetts, from February 1, 1983, to January 20, 1985. In practically any article like this that you read, they always exclude certain patients. These authors excluded burn patients, cardiac surgery patients, coronary care units and patients less than 14 years old. Where did they get the independent variables? They got them from the medical record or from the hospital billing system.

The main independent variables included the DRG. It turns out that they only studied four different DRGs. They looked at the length of stay in the ICU, the length of stay in the hospital and the vital status at the discharge from the ICU—that is, was the patient alive or dead when he left the ICU They also looked at whether the patient was alive or dead when he was discharged from the hospital; the age of the patient; the service at admission; whether it was a medical or a surgical patient; whether the patient had been admitted to the ICU in the previous six months; the TISS score, which is a mortality prediction score; and the MPM probability, which is what the authors had developed.

The main dependent variable was interesting in this project. They were trying to get a measure of the resource utilization as a dependent variable. What we would like to have is actual cost for these patients that were admitted to an ICU. In 1983, they didn't have good enough cost accounting systems to enable them to do that, so the authors developed their own dependent variable or cost surrogate, which was weighted hospital days. Every non-ICU day was one unit. The surgical ICU day one was given a weight of four units. For a surgical patient, surgical ICU day two, three, four and so forth were given three units. For the medical ICU, the first day was given three units, and subsequent days were given two units. You could see how they could tally up for each of these 2,000 patients the total number of weighted hospital days as a dependent variable, and they wanted to use those independent variables to try to predict or understand the utilization of the dependent variable.

They thought basically that if you were a surgical ICU patient, you were using more resources than if you were in medical intensive care. If you were not in intensive care, as all patients get discharged from intensive care to nonintensive care, then those were only worth one unit.

Now I'll turn this back over to Margie, who will talk a little more about the calculations that they did in the statistical aspects of this.

MS. ROSENBERG: We're getting toward the results now, but just to take a step back, the data, if you recall, was from 1983 to 1985. This is right after the introduction of the DRG system. So one of the complaints—that's not the right word, but we'll use it because I can't think of the other one—about the DRG system was that it didn't account for severity of illness. These researchers said, "We have this mortality prediction model that we'll use as a variable for severity to show that these DRGs are not sufficient. They're heterogeneous, so that if you just give one

dollar amount for everybody, you're not adequately reimbursing hospitals for resource utilization." How many people have used other kinds of classification systems, such as ambulatory groups? Do you use DRGs? Do you use them for risk adjustment or predictive modeling? How many people have done that? Just a few. The idea of this paper was that maybe you're not interested in DRGs, but perhaps in your own work, or if you use other classification systems, these are things that you can think about while you're doing your own work.

Table 1 (page 11, slide 2) is lifted directly from the paper. So in Table 1, we have the list of variables. What the authors did was separate out—this may sound familiar for those who do predictive modeling—the top 10 percent of the patients based on ICU length of stay. Those who are in the ICU longer are probably sicker people and then versus everybody else. What's the rule of thumb? It's 10 percent of the people do 80 percent of the cost or something. They're using that rule of thumb, so each of the variables then is compared in this group of patients that are in the hospital the longest versus the patients that are not in the hospital the longest.

Does anybody know what a P-value is? Does anybody remember at one point learning about a P-value? In using P-values you compare two groups, and you want to know if these numbers are different from one another. If we take the first one, it says ICU length of stay mean, and then standard deviation is in parentheses. For the top 10 percent, 16.9 is the mean with 277 people. So you're always clearly showing your sample size. The standard deviation is 13.5. It says that there's a lot of variation in that number, even though there are 277 people. That's a lot of people. But for the other group (2,472 patients), the mean is 1.8 with a standard deviation of 1.4. Without knowing anything about P-values, do you think 16.9 is different from 1.8? Of course it is. The 1.4 says it varies around 1.8, but not too far. It's still big relative to 1.8, but it doesn't move real far from 1.8, relative to 16.9. But 16.9 moves 13, but it doesn't get quite as close to 1.8 because of the standard deviations. So this P-value is less than 0.001. That says these two numbers are not the same statistically. When the P-values are small, that's good if you're trying to show that things are different. It's bad if you want them to be the same. When you look down the column, you can see that these are all significantly different from zero, meaning that the two means are different.

Again looking at Table 1, the advantage of doing P-values is here, for age. The age is 61.0 versus 58.8. Are those different? You'd say, "I don't know. That's pretty close." The standard deviation is 19.3 versus 19.4, so you'd say, "I really don't know." They seem different, but they could be pretty close because of standard deviations. If you look at the P-value, it's at 8.2 percent. In medical studies, 5 percent is like magic. If it's less than 5 percent, it's significantly different. If it's greater, it's not. So if you get a P-value of 0.051, what do you say? You say that it's not, if you just report whether something is significant. The nice thing about reporting P-values is that you show that it's bigger than 5 percent, but maybe it's not that much bigger. Different disciplines have different magic numbers. In social

sciences, 10 or 20 percent might be your P-value. I don't remember the history; I've been curious about it. Why 5 percent? It's a nice number, but 10 and 20 are nice numbers, too. Why aren't those magic? But 5 percent is the magic number.

FROM THE FLOOR: Is there an actuarial magic number?

MS. ROSENBERG: How many articles in the *North American Actuarial Journal* do you think contain P-values?

FROM THE FLOOR: I'm not sure that I've ever seen one.

MS. ROSENBERG: That's my point. There is no actuarial magic number, and actuaries usually don't think about this. Now should they? I think it's reasonable, even though I don't do P-values myself. It does give you some kind of statistical measure to show that there are differences, instead of just saying that there's a big gap between the two. Is this hard to do? Any computer now will generally do it. You all are experts in Excel, which can do this with no problem. You, too, can do P-values if you choose. Essentially, you include variables in this table so that you can describe them—the mean, the standard deviation—and describe how you're trying to analyze the data. Here, they wanted to point out that there are some differences between these two groups and that maybe there's something to this.

They like tables, very detailed tables. Rather than looking at these groups from a number of days in the hospital, Table 2 (page 11, slide 3) looks at those who lived and those who died. Let's separate out these ICU people into two groups. The two groups are: did you survive the experience, or did you die? We know that if you go into an ICU, you're a sick person. This table just looked at their mortality prediction model by different percentages—so zero to 0.5, the probability of dying while in the hospital or in the ICU—and they measured this model.

The nice thing about this method is that it's measured at the time of admission to ICU, so it doesn't need measurements after you're in the ICU. I know that the APACHE does that, and some of the other scoring systems probably take measurements while you're in the ICU as well, and then they update it. This procedure gives hospitals an indicator of whether you'll be dying in the hospital. You have these different probabilities, from zero up to one.

The number of patients dwindles. As you would expect in predicting the probability of dying, you'll have smaller numbers that you're saying will probably die. Then they give a mean and a standard deviation for those who lived and those who died. These are the length of stay in ICU for those who lived versus those who died, and there's a big difference. Those who died were in longer—these are the weighted hospital days—than those who lived. So the severity is a little different.

Table 3 (page 12, slide 1) shows the descriptive statistics for the DRGs. Does anybody know what DRG 1 is?

MR. DOVE: It's craniotomy without trauma.

MS. ROSENBERG: Craniotomy without trauma. DRG 75 is major chest procedures and DRG 110 is major reconstructive vascular procedures without a pump for age 69 and are comorbid conditions.

What we want to do is look at these descriptive percentages of all hospital admissions in this DRG that spent time in the ICU. We said that the DRGs are heterogeneous, so some are in the ICU and some aren't. The chart looks at the weighted hospital days with their standard deviation, the hospital length of stay (just the straight hospital length of stay that's not weighted), ICU length of stay, this mortality prediction model again, then the TISS score and then the number of people. The point in the paper is that the standard deviation, again, is large compared to the mean, but we saw that on the previous table as well.

The strategy is to investigate the ability of the mortality prediction model. Usually researchers develop something and say, "Let's use it." They had previous papers that described this mortality prediction model. If you're interested in it, you can go through PubMed and get the original articles.

Method A was just to use dummy variables. A dummy variable is one that addresses, for example, you are in DRG 5 or you're not in DRG 5. It's a binary variable, so a one or a zero. A one says that you're in that DRG, and zero says that you're not. So here's the test. I have four DRGs in a model. Do I need four dummy variables? We need three dummy variables because if we have zero, zero, zero, for example, then DRG 5 is the one left out. If we have zero, zero, zero for the other three, then that says that it's DRG 5. You need one less than the number of variables. For instance, sex is a common variable that we use. You can declare male as one or female as one, and whichever one is not one is zero. You could have several age categories: 18 to 30, 30 to 40 and so on. Sometimes there's some reasoning. Maybe you do a reference group, and so that would be the zero, zero, zero, and then everything else would be compared to that reference group.

Method A uses as dummy variables relative weights of each DRG. We mentioned with DRGs that the original Medicare assignment was that they give this relative weight, and so that's built into the DRG system. Then they use the geometric mean for the length of stay. Then they tested another method, method B, in which they took the same thing as with method A, but then added this mortality prediction model, whatever the model predicted between zero and one, and then squared it and added that as well. They thought that perhaps there was a quadratic relationship. We'll see some graphs that will give some idea of that.

Method C is method B, but it eliminated one outlier. My personal bias is that data is data. If you have an outlier, you want to be careful about removing it. You want to make sure that it's not information that might be of use for you. Some methods

say, "That number throws my results off, so I'm going to throw it out." You might want to rethink that.

Again, regarding the methods, we compared the 10 percent with the highest ICU days versus the others. The relationship between the resource and severity was examined by stratifying the patients according to their mortality prediction model probability and computing the mean value of weighted hospital days for each of those stratum. We used the four DRGs. The results are that the long-stay ICU patients, when compared to the non-long-stay ICU patients, have higher weighted days, have higher TISS scores, have higher MPM scores, were older and were more likely to have had previous ICU care in the last six months, and all were statistically significant against age. That is the verbal description of Table 1 that we reviewed.

They did regression, for those who are curious. DRGs explained about 5 to 6 percent of the variation in weighted hospital days. Adding the mortality prediction model variable doubled the R-squared. Usually in your statistics courses, when all of your examples showed 80 to 90 percent R-squared, you said, "I feel good about that." For this study, the R-squareds are around 5 percent. I remember that there's a current version in which they were excited because they got up to 20 percent. Is there a magic number for R-squared? Obviously there is not if when things are published, they're excited about 5 percent. Now the argument is, is it better to have at least 5 percent of the explained error rather than not explaining anything? If you could explain 20 percent of the variation in expenditures rather than not, that's a lot of money. So that's how people justify the use of an R-squared that's not 90 percent.

Multiple admissions to an ICU are associated with high weighted days, and large amounts of hospital resources are consumed by patients who die, which is what you would expect. Some of the variation in weighted hospital days within the DRGs can be explained by the severity of illness, as measured by this mortality prediction model. We show that that helped the R-squared, and that ranged from 6 to 25 percent. The mortality prediction model added to the model as a variable helped raise this R-squared and explained the variation. A rise in the mortality prediction model led to a large increase in weighted hospital days, but at a higher rate, the rate of increase diminished. We'll see some graphs that talk about this. At high levels of the mortality prediction model, it fell. Resources fell with the severity, reflecting that many of these patients died quickly and cheaply.

Figure 1 and Figure 2 (page 14, slides 1 and 2) are the graphs that they've included in the paper. The Y-axis is the weighted days, so that's our dependent variable, and the X-axis is the mortality prediction model. They drew a line, and they did a regression that is weighted days as you have an intercept and a slope, and the X is the mortality prediction model. So what does this tell us?

FROM THE FLOOR: There are a lot of outliers.

MS. ROSENBERG: There are a lot of outliers, so you don't like these, right? I don't, either. There are a lot of people here. These outliers really don't pull things up. You don't have a line that goes like that. That would be a lot worse. But then there are a lot of them, and there are a lot out here that keep the line that way. So if you have a line that goes like this, what does that tell you?

FROM THE FLOOR: I think it's hard to look at a big glob like that and say that there even is a line.

MS. ROSENBERG: Well, let's pretend that we can see a line. Let's pretend that all you can see is this line. What does the line tell you then? Let's suppose that this is the true relationship. The positive slope says that for lower mortality prediction, we have lower weighted days. For higher, we have higher weighted days. It's a nice way of summarizing. If you want to have the predicted value from the model, you would just stick in this mortality prediction that you get right when the person comes into the hospital, and you're predicting the number of weighted days that the person will be in the hospital. That's what this kind of figure is saying.

Let's look at Figure 2. Again, here are these outliers. This is a real test now. Does this line look like it's going up or down? It looks like it's down to me, and here's the test. I think there's a mistake. I'd look at the caption myself. I think that slope should be a negative number. You have to proofread these papers yourself when you get them back. As an author, you get tired of seeing these things again and again, and you don't look at the captions. These are for the nonsurvivors, so these are the people who died. This line goes down, so weighted days that are small will have a lower mortality prediction level. This doesn't make sense in a way, right? I'm having trouble interpreting this. So for the deaths, this is a little harder. You want to look at things. Even though we said the model was significant, they said that there were differences between those who lived and those who died.

FROM THE FLOOR: I thought it was somewhat logical, because the higher your probability of dying, the shorter your length of stay. You die more quickly because you have a high probability of dying.

MS. ROSENBERG: That's correct. Thank you for reminding us of that. Those who have a high probability won't stay in the hospital very long.

FROM THE FLOOR: The dependent variable there was not how long they stayed in the hospital; it was the number of weighted days.

MS. ROSENBERG: That's right, but that's still a function of the length of stay. Table 4 (page 14, slide 3) summarizes the data and the R-squareds. Here are more P-values, if you care to look at those by DRG. What they always do is put in the parameters of the model. You summarize the R-squared. You put in their standard deviation of these parameter estimates, and then this is the P-value again. This would say that for DRG 1, if you put in a constant, plus the mortality prediction

model, plus the mortality prediction model squared, you explain about 5.5 percent of the variation, but it's significant. So it's a significant resolve. The P-value is 0.019.

These others are also significant. You don't say that they're more significant. You just say that they're significant. All four DRGs came up with significant models by using the constant and the mortality prediction model. If we combine all the DRGs, we also come up with a significant resolve.

Figure 3 (page 15, slide 1) is the justification for having a quadratic. If you recall, a quadratic is a parabola. It goes up; it goes down. Because of the coefficients, the curve was like this. That curvature in the data is the justification visually of why using the mortality prediction model constant, plus a square term, is useful.

Henry will now finish the paper.

MR. DOVE: I really don't want to talk about the implications of this article, and I don't want to talk about the limitations of the article. I would rather spend about five minutes talking about the process of turning a research project or a report that you did into a published article. It has been my experience as a consultant and working with people in large, managed-care organizations and hospitals that they often do a lot of good work. I urge them to get credit for the work that they've done and to add a little bit to the literature. The challenge is finding the time to do it and not to be discouraged when you submit an article and it is rejected.

I also try to encourage people to submit to a peer-reviewed journal versus a non-peer-reviewed journal. The term that I use for a non-peer-reviewed journal is a "throwaway journal." These will not be in PubMed. These are not recognized as serious journals, so I urge you to submit your work to a peer-reviewed journal. There are various tiers, and you probably know about this. It must be very difficult to get an article accepted by some journals, such as the *North American Actuarial Journal*. If you were to submit an article to *The New England Journal of Medicine*, it would be very, very difficult to get accepted into that. I urge you to think about the journal before you submit it, so that you don't shoot too high or too low.

It's also a good idea to talk to some of your colleagues or to people in academia who could review your article, find some fault in it and maybe suggest a journal for you to submit it to. I have listed some of the journals that I have published in that are well known in the health services research literature (page 18, slide 2). Margie talked about the P-value for actuaries. I urge you to think of 0.05 because I urge you to publish in nonactuarial kinds of journals. That would enhance the profession more than if you published in a lesser-known journal that fewer people read.

I wanted to give some time for questions; that's why I didn't want to make any more comments about this article. Can we open this up to any questions that people have?

FROM THE FLOOR: I work at an insurance company, but I came from consulting. We used to do a lot of research papers in consulting because you can get clients to release data, or you can conglomerate data from different sources. But what would you suggest when you work in an insurance organization? They aren't real happy for you to be sharing things that you come across when you're working or things about the members. What do you suggest? It's a big issue.

MR. DOVE: This is a problem for large organizations. It's also, obviously, a problem for consultants, because you can't just take work that you did as a consultant and try to publish it without permission. But it has been my experience that the problem is one of just getting clearance in the organization. Most organizations don't want to give away any proprietary information, but usually there are ways that you can write an article and protect the proprietary part. Normally you can get these kinds of articles cleared within your organization. A reviewer might say, "We want more information about how you did this calculation," or, "We want to see what the coefficients are for this in this table," and then you could explain. Then you can go through the process. "This is proprietary information." You're not trying to hide anything. You didn't just make up this number, but you can't release everything. Those sorts of problems can usually be worked out.

It has been my experience that most insurance companies like the publicity that they get because it shows that people in the organization are thinking and doing important work, yet they will not give away the farm. But I think most organizations are proud of the work that's done, so it's worth the effort. It's unrealistic to expect that you'll publish five different papers. If you just do one good paper per year, I think that that is a good goal for people to set.

MR. DUNCAN: I used to work for Aetna. My experience is that if you can find and attach yourself to the business driver, there's an opportunity for you. Aetna, back in the 1980s, wanted to prove that pre-authorization saved money. They were quite happy to share the data because they wanted to get it out that pre-authorization saved money.

We see the same thing in the managed care industry today in areas in which I work, such as disease management. It's being challenged so much commercially as to whether, in fact, there are savings there that companies are scrambling to try to get their results into the peer-reviewed literature. As Margie said at the beginning, you're not solving world hunger here. You have to focus the study on something that is manageable and publishable within a reasonable period of time. Then I think you can get support from a commercial organization to do that.

MR. ELI DONKAR: I'm with the Social Security Administration. For practitioners who haven't been actively engaged in research, a very important point that you make is that if your goal is to get this published, it's important to identify what it is that you're contributing in the context of the existing literature. You've given a lot

of helpful ideas, and there certainly are a lot of tools. I'm not a health actuary, so I wasn't familiar with things in the health area, but there are lots of great tools to find these articles. But for people who are not familiar with the literature, in evaluating the literature, it's very difficult to figure out if what you're doing—not whether it's new, because you can read the papers you come up with in your search and find that nobody said anything about this before—is significant. That's an important thing. It's not just that here's something new, but here's something new that will be a useful contribution. So the question is, do you have any suggestions for people about how to make that determination? That was the first question.

I have a suggestion, as an associate editor, regarding picking a place to submit an article. A lot of journals have favorite topics. In doing your literature search, an important thing to do is to recognize that the thing you're working in seems to have been published a lot in this journal. I think that it's probably a good idea to submit things to that journal. That would be my observation, but I would welcome comments on that, too.

MR. DOVE: The first piece of advice I would have is that when you get a seed of an idea or a seed for a paper, instead of writing out the article and submitting it someplace, it's always a good idea to talk to somebody about this. The best kind of person to talk to would be someone in academia. This gets at the issue of continuing relationships with people in academic institutions. This doesn't mean that you have to pay them. It could just be a telephone call to say, "Professor X, I was thinking about this work that I'm doing, and this is an outline of what I'm doing." I think you'd be surprised that a lot of people in academic institutions would be willing to give a little time to say, "This could be important."

Remember, you have to think about the outliers. You have to remember what your bottom-line idea is that you're trying to work on. That will save you an incredible amount of time and frustration. Even if you don't have a university nearby, with the Internet you can exchange ideas, and you can also talk to people in your field who have been through this before. The worst thing that you can do is to try to do it all by yourself in a vacuum, because you'll just end up getting frustrated. If you can talk to somebody else, ask that person to suggest other journals that you could review. Increasingly, these journals are available online, which means that you don't have to go to a medical school library to find good articles. Don't try to do it by yourself.

MS. ROSENBERG: Henry kind of read my mind in terms of my answer, but I'd like to go one step further. If you're interested in doing research, I'm happy to talk to you, or you can e-mail me about your ideas. I'll put my name out there as a personal academic if you'd like to talk to someone.

With regard to the second question, it's really helpful before you write the article to understand that you do want to write with a target audience in mind. The target audience would be those who read a particular journal. I echo Henry's idea. You

want to look at the journal articles and ask, "Are these articles along the same lines as the paper that I'm thinking about?" Or, it could actually structure a paper for you if it's a little fuzzy. But that way, you see the structure and how people write the articles for these particular journals, so it gives you a better idea.

There are journals, such as *Health Affairs*, that people probably have heard about. I submitted an article to them, and within two weeks they told me, "Thanks, but we don't take this kind of article." Some of them get back to you and reject pretty quickly. It just wasn't appropriate. They have limited space, and they pretty much used up all their journals for about four years in terms of the space. You do want to look at the journals and target yours most effectively.

MR. SIEGEL: Do you normally have your articles peer-reviewed by friends or colleagues before you submit to a peer-reviewed journal, just so that you can have some idea of, if there are any objections, what those might be? I know that sometimes in the review process in a peer-reviewed journal, it can take a while just to recruit a set of reviewers. To expedite that, do you normally do that, or do you have some other strategies for expediting that process?

MR. DOVE: I normally don't do that, but I think that varies a lot from person to person. I have a pretty good idea when I send an article away. I don't want to waste my time if my subjective probability is that the chance that it will be accepted is 0.01. It's not worth the postage for me. I will think somewhere in the zone of 0.25 to 0.75.
I try to read the article before I submit it and then ask myself, "Is this written clearly enough?" Often it's very frustrating if you get the reviewers' comments and you can tell that they just didn't understand what you were writing about. Practically all of the articles that I've written have been done with someone else, so you can get a lot of useful suggestions by the interchange with the co-author.

MS. ROSENBERG: I agree. When you have co-authors, they're your natural reviewers, in a way. Some disciplines, such as accounting, do that quite frequently. They'll go to meetings and get their articles reviewed. For this meeting today, I welcome suggestions on our paper. The peer-review process is a painful thing to learn because of the rejections that you get before the final acceptance. But each time someone criticizes your paper, it's to make it better. People read things differently, so you want to try to make things as clear as possible so that you widen the readership. From that standpoint, it is good to have as many people critique your paper as possible, just to get different viewpoints.

MR. DUNCAN: We're coming to the end of our time, so I will wrap this up. But before we all stop, I'll lay out my own personal fantasy of what the Health Section of the Society of Actuaries would be. That would be that we're all so excited about doing research that we share this with each other within some kind of research network, or we have some kind of conference—we tried to do something like this last year with the Applied Actuarial Research Conference—and get people to submit

work. It would not necessarily be completed papers, peer-reviewed or anything like that, but just work so that we could take a look at it and do those kinds of seminars that we used to have in graduate school, where people would put a paper or some research in front of you, and everybody would tear into it. That's my own personal fantasy.

The other thing I want to do before we finish is to say that in the room today we have a number of people from the Research Section of the Society whom you may not know. You've seen Steve Siegel at the microphone. Ronora Stryker is another. John Cookson is the chair of the Health Research part of the Council. These are all people who help us with research. If you don't know them personally, take time and meet them and talk to them about what can be done and what resources exist at the Society to help move research forward.