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Has the Radiologist Shortage Been Resolved? Recent Findings Using an Improved Survey Based Measurement

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HAS THE RADIOLOGIST SHORTAGE BEEN RESOLVED?
RECENT FINDINGS USING AN IMPROVED SURVEY BASED MEASUREMENT

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We report on a recently-developed, improved measure of shortages or surpluses of physicians - namely, the extent to which they desire less or more work if their income changes by the same percentage as their workload.

Data from the American College of Radiology's (ACR's) 2007 Survey of Radiologists are used. Physicians were contacted via telephone and email by an outside contractor to assure confidentiality. Responses were weighted to be representative of all post-training professionally active radiologists in the U.S. The author analyzed workloads and the desired workload changes for (i) radiologists who wanted less work, (ii) those who wanted more work, and (iii) those who sought no change. Characteristics of physicians in each of these three groups were analyzed. Multivariable regression analysis was employed to identify the probable causal links between characteristics of radiologists and the practices they work in with their desire for a workload change.

The net average workload change sought in 2007 was approximately a 3% increase. By comparison, in 2003, radiologists on average did not desire a statistically significant change in workload. Subgroup analysis for 2007 indicates that, on average, radiologists working in government practices sought 26% more work, while those in multi-specialty private practices sought 4% more work. Those in the Northeast averaged wanting a 7% increase while in the Midwest and West, less than 1% change was desired.

The overall balance between the demand and the supply of radiologists shifted towards a surplus between 2003 and 2007. Based on our measure, we judge there was a balance in 2003 and a 3% surplus in 2007. There were differences in the surplus/shortage situation by type and location of practice.

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Recent Findings Using an Improved Survey Based Measurement

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Krishan Soni

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Abstract

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Data from the American College of Radiology's (ACR's) 2007 Survey of Radiologists are used. Physicians were contacted via telephone and email by an outside contractor to assure confidentiality. Responses were weighted to be representative of all post-training professionally active radiologists in the U.S. The author analyzed workloads and the desired workload changes for (i) radiologists who wanted less work, (ii) those who wanted more work, and (iii) those who sought no change. Characteristics of physicians in each of these three groups were analyzed. Multivariable regression analysis was employed to identify the probable causal links between characteristics of radiologists and the practices they work in with their desire for a workload change.

The net average workload change sought in 2007 was approximately a 3% increase. By comparison, in 2003, radiologists on average did not desire a statistically significant change in workload. Subgroup analysis for 2007 indicates that, on average, radiologists working in government practices sought 26% more work, while those in multi-specialty private practices sought 4% more work. Those in the Northeast averaged wanting a 7% increase while in the Midwest and West, less than 1% change was desired.

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Introduction

The ability of medical professionals to meet the growing healthcare needs of an aging American population has been an important focus of health services research during the previous decade. Physicians, represented by their medical societies, have begun to undertake careful study of the changes in the supply of and demand for physician services. As healthcare providers are increasing their reliance on radiographic imaging, the demand for radiology services has grown significantly [1], leading to a shortage of radiologists at the beginning of this decade [2]. However, numerous studies have shown that it is difficult to accurately predict shortages and surpluses in the market for radiologists [2-4]. The American College of Radiology (ACR), a national medical society representing U.S. based therapeutic and diagnostic radiologists, has taken a leading role in researching and publishing information regarding trends in physician shortages/surpluses, changes in workload, and physician job satisfaction. The ACR uses a variety of survey methodologies to study characteristics of radiologists [5-13], characteristics of radiology practices [14-18], workload and productivity of radiologists [19-22], the supply of radiologists graduating from training programs [23-28], the demand for radiologists by hiring groups [29-35], and the status of the employment market as reflected in help wanted indices and job placement data [36-44]. A summary of ACR studies over the past two decades along with key findings is presented in Appendix I.

The ACR's 1998 Survey of Hiring showed a shortage of approximately 600 radiologists nationwide [35]. Driven by an aging population and an age-adjusted growth in demand for radiology services, it was predicted that the total workload of radiologists

would increase much faster than the number in practice and the shortage would become more severe [2]. By 2000, several other measures further supported the fear of a radiologist shortage. Ratios of job listings to job seekers increased dramatically [39], academic departments had on average over 5 vacancies [41] and job advertisements in major radiology journals increased substantially [38]. Radiologists themselves were beginning to feel over worked; according ACR's 2000 Survey of Radiologists, 51% of radiologists felt that they had too much work [9]. By 2001, the concern of a shortage became so great that the American College of Radiology convened a blue-ribbon task force of top leaders to assess the situation and make recommendations on possible actions to be taken. Throughout that time, the ACR continued to monitor the situation with periodic surveys.

In its 2003 Survey of Radiologists, the ACR found that the shortage of radiologists had "eased considerably" [45]. Using radiologists' individual desire for more work to indicate a surplus and a desire for less work to indicate a shortage, the ACR concluded that there was an overall balance between the supply and demand of radiologists in 2003 [10]. However, the projected demand for radiological services continues to grow faster than the radiology workforce, leaving us to question whether this was a transient balance, a long term steady state, or an inflection point leading to an eventual surplus.

The purpose of this study, therefore, is to use updated data from a 2007 Survey of Radiologists to further investigate the market for radiology services. Like the 2003 survey, we will present findings using weighed data and information of hours worked, analyzing the extent to which radiologists wanted more or less work in 2007; we

continue to assume that the desire for less work indicates a shortage while the desire for more work suggests a surplus. If the labor market for radiologists is indeed efficient, we would expect the market to clear and the average physician would be working his or her desired number of hours each year.

Statement of Purpose

The purpose of this project is threefold:

(1) Using data from the ACR's recent 2007 Survey of Radiologists, we will continue to follow the shortage/surplus situation of radiologists in the U.S. This paper uses one analytical tool that, in comparison with other metrics, can guide our understanding of the current state of the radiology labor market.

(2) We hope to further understand the determinants of physician desired workload by analyzing individual characteristics of physicians and practices, such as gender, age, subspecialty, and practice location, and how those characteristics are related to a desired change in workload.

(3) Finally, we aim to validate an improved methodology using a survey based instrument that captures desired workload changes to follow shortages and surpluses in the physician labor market.

Materials and Methods

Academic Disclosure

This work is based on findings from the American College of Radiology's 2007 survey of radiology members. The survey was constructed and distributed to participants by the ACR and its contractors. Mythreyi Bhargavan (ACR) was responsible for cleaning the data and calculating weighting factors. All statistical analyses were conducted by the author of this paper. Many of the analytic methods used in this project were developed during previous ACR studies. We therefore reference the original sources and recite the methodology below for the reader's convenience.

Survey Design and Sampling

The survey methods were largely developed during the ACR's previous 2003 survey of radiologists and radiation oncologists and have been published in detail elsewhere [10, 11, 22]. The 2007 survey was a twenty question stratified random sample web-based email and telephone quota survey of ACR radiologist members (approximately two-thirds of post-training, professionally active radiologists in the U.S. are ACR members) conducted in May and June of 2007 (May 1 – June 15). A letter with a link to the survey was mailed out to members without email addresses. Radiation oncologists were excluded, as were trainees and retirees. The strata were the states of Arkansas, California, Georgia, Iowa, Louisiana, Michigan, Montana, New Jersey, New York, North Dakota, Texas, West Virginia, and all other states grouped by the four Census regions (Northeast, Midwest, West, and South). For the selected states, the sample included minimums of 30 responses for New York, 42 responses for California, and 20 responses for each of the other states on the list. The remaining states were

treated as four groups by census region, and the minimum sample size required was proportionate to the population of these states in the Census region. For example, the states in the South not listed above had 66% of the population of the South, and the minimum sample size collectively required from these states was 66.

In total, 487 responses were received, and the response rate was 20% (487/(2702 contacted – 282 disconnected phone numbers or wrong number – 36 not qualified). To further assure confidentiality, the survey was conducted by an outside contractor, dmrkynetec (http://www.dmrkynetec.com/), and the data set delivered to the ACR was stripped of all individual identifiers. The survey questions are shown in Appendix II.

Weighting

To make the 2007 data representative of all radiologists in the U.S., a multi-stage weighting process was carried out. First, responses from each state were weighted by (number of ACR members in the state)/(number of responses from the state). Second, the 2003 survey had shown differential response by age. Based on the differential response rates found in 2003, the weight for respondents age below 35 were multiplied by 1.105; for age 35-44, by 1.045; for age 45-54, by 0.974; for age 55-64, by 0.934; for age 65-74, by 0.929; for age 70 and older, by 0.994 and for those of unknown age by 1. Finally, because, in 2003, ACR members were on average in somewhat larger practices than radiologists as a whole, another adjustment was required. To do this, we separated respondents into practice size categories of 1, 2-4, 5-7, 8-10, 11-14, 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50 or more. For respondents in each size category, the previously-derived weight was multiplied by (percent of all radiologists in the U. S. in the size category in 2003)/(percent of ACR members in the size category in 2003).

Definition of Variables

Of greatest interest to this study, the survey asked radiologists how their workload compares with the one they desire. To allow for easy comparability to the 2003 survey data, respondents were presented with the same three answer options in this survey: "about right," "I'd like my work and my income reduced by about __%," and "I'd like my work and my income increased by about __%." By tying workload so overtly to income the survey designers sought to maximize the realism of the answers and the rate of response to this question; >97% of the respondents in the sample answered this question. In this study, overwork and underwork were defined as changes in workload sought if income were to change accordingly.

The survey asked respondents the location of their main practice according to the following six categories: main city of a large metropolitan area (total area population of 1 million or more), suburb of a large metropolitan area, main city of a smaller metropolitan area (total area population of >50,000 but <1 million), suburb of a smaller metropolitan area, nonmetropolitan location (total area population of 50,000 or less or rural location), and "varied locations" (no one location is principal). We report location according to these six categories.

Somewhat similarly, we asked respondents "Which best describes your main practice?" and provided seven answer options: solo practice; locum tenens; primarily academic practice (owned by any agency or variety of agencies); private, multispecialty practice that is not primarily academic; government practice, not primarily academic; private radiology, nuclear medicine, and/or interventional radiology practice, not

primarily academic; or other (specify). We report practice type according to these seven categories.

The survey also asked respondents for their main subspecialty, their weekly hours, their annual vacation weeks, whether they are an owner of their main practice, whether they work full time or part time, and the total number of procedures performed in the practice. While most variables were reported on the 2007 survey, some of the demographic data, including age and location by state, were self-reported to the ACR member database. Consistent with previous analyses, the respondents are classified into five age groups: less than 35, 35–44, 45–54, 55–64, and 65 years old or over. States are grouped into the four census regions—Northeast, Midwest, South, and West—for reporting statistics.

The final five items on the survey probed the effects of the Deficit Reduction Act of 2005 and changes in Medicare payment policies on physician practices. Analysis of these data is not within the scope of this project.

Data Quality Improvement

As has been seen in previous ACR studies[22], every survey has deficient data—missing items, responses not in accordance with directions given in the questionnaire, and responses that are inconsistent with other responses or have other problems. As we were most concerned with the ability to separate physicians into one of three categories based on their preference for workload – that is, those who want more work, those who are happy with their current level of work, and those who desire less work – we designated Question 9 - “how does the number of hours and weeks you work compare with the

amount you would like?" - as a "core-question." 2.5% (12 of 487) of survey respondents omitted this question and were excluded from the data analysis.

Data used in this report were additionally cleaned and edited by MB to further minimize deficiencies. The author of this paper undertook one additional step to improve the quality of the procedure data, which is described as follows:

The number of procedures per FTE radiologist was calculated as the ratio of reported procedures for the practice to the calculated number of FTE radiologists. So that we could avoid distortions of results due to outliers that possibly represented erroneous responses, and so that we could compare results with findings from previous studies, we used a previously employed method of eliminating responses that reported fewer procedures per FTE radiologist than one-third the median value across all responses (i.e., 13,733 [all values are rounded to the nearest whole number]) or more numerous than three times the median value. This eliminated slightly less than 13% of responses with very low reported average numbers of procedures per FTE (ie, less than 4,600 procedures) and slightly less than 1% of responses with very high reported average numbers of procedures per FTE (i.e., more than 40,000 procedures). In ignoring these observations entirely, we implicitly assume that the distribution of the "true number of procedures" underlying these erroneous responses is similar to the distribution of the responses that we do include and that are correct.

Statistical and Data Analysis Methods

All analysis was restricted to post training respondents who reported that they were working full-time or part-time in radiology at the time the survey was conducted.

Thus, all residents, fellows, retirees, or radiologists otherwise temporarily or permanently not working in radiology were excluded from all analysis.

As was the case when the 2003 Survey data was analyzed [22], all information presented is based on weighted data and thus is representative of what responses would have been if all radiologists in the United States had been surveyed and had responded. Reported standard errors of the mean (SEMs), standard errors of regression coefficients, and tests of statistical significance, which were based on SEMs and standard errors of regression coefficients, were calculated by taking into account not only the weighted nature of the data but also the complex survey design—that is, the fact that responses came from distinct strata. The standard errors were calculated with survey-specific SAS software procedures (proc surveymeans and proc surveyreg).

Standard errors are not only used in calculating the statistical significance of differences observed when making comparisons but are also the most common measure of sampling variability. (Sampling variability is the phenomenon that, in general, a statistic—such as a mean—from a sample will differ somewhat from the same statistic for the entire underlying population from which the sample is drawn.) There is a 95% probability that the true value of a statistic for an entire population lies within approximately 2 standard errors of the corresponding statistic for a sample drawn from that population. The difference between two figures is regarded as statistically significant at 5% if the difference equals at least $1.96 \times (a^2 + b^2)^{1/2}$ where a is the standard error of the first figure and b is the standard error of the second figure [14].

The standard deviation is another figure often useful in describing and interpreting data. However, its easy use is largely confined to normally distributed data.

The standard deviation is less informative when data is not normally distributed and therefore is not reported here. It can, however, easily be calculated from the standard error by multiplying the standard error by the square root of the number of cases that underlie the statistic.

For a broad answer to the question of whether radiologists feel overworked, descriptive statistics were analyzed, using the workloads and desired workload changes for all radiologists, by dividing them into three groups: those who wanted less work, those who wanted more work, and those who sought no change in their workload. Weekly and annual hours, the overall desired change in workload in percentage and in hours, the weekly and annual desired workloads, and the percentage of part-time workers in each of the three groups were determined. This is the same methodology used by Meghea and Sunshine in the analysis of the 2003 survey [10].

Annual hours were calculated by multiplying the reported weekly hours by the total number of weeks worked in a year. The measure of weeks worked was calculated by assuming that radiologists worked 52 full weeks less 2 weeks (10 days) for holidays less vacation time as reported on the survey.

For the remaining analyses, which dealt with categories of radiologists, annual rather than weekly hours were used because annual hours capture both the weekly workload and the number of weeks worked annually by the respondents. Data were analyzed for radiologists who do not subspecialize, for radiologists who do subspecialize, for individual subspecialties, by practice size, by practice type, by practice location, by census region, and by gender, so as to provide evidence on shortages or surpluses associated with particular characteristics of the radiologist and the practice.

Multiple linear regression analysis was performed to determine the probable causal links between characteristics of radiologists and the practices they work in and their desire for a change in annual workload. Regression analysis is used to identify the independent effect of each factor considered, such as the radiologist's subspecialty or the practice type, on the desired workload change, statistically controlling for the effects of all other variables included (all other factors being held constant). By controlling for the effects of the other characteristics, we are more likely to identify which factors have a causal effect on differences in desired workload changes.

The dependent variable in the regression analysis is the individual's desired change in annual hours worked. The explanatory variables are age, gender, subspecialty, full- or part-time status and the annual hours worked for those working full time. In addition to individual characteristics, we considered the practice size, the location of the practice in a metropolitan or nonmetropolitan area, the census region, and the type of practice.

To investigate the regression results further, the annual hours worked and the numbers of vacation days of full-time radiologists were tabulated by practice type.

We also reviewed the procedure load in a radiologist’s practice, measured by the average number of procedures performed full time equivalent. We estimated this parameter by dividing the annual procedures performed in the practice by the number of FTEs in the practice, where an FTE is defined as 1* full time radiologists + 0.5* part time radiologists. To understand how procedure loads may vary between practice types, the mean, median, upper and lower quartiles of annual procedures per FTE were calculated for each practice type.

For comparisons of means, statistical tests were conducted to determine whether differences between groups were significant at $P \leq .05$. Regression coefficients were considered significantly different from zero when the P value was .10 or less. Statistical tests at this P value cutoff are the standard in the health economics literature. More restrictive tests at $P \leq .05$ were used because the standard deviations are relatively small in the univariate analyses.

All data analysis was carried out with SAS Version 9.1 (SAS Institute Inc., Cary, NC, USA).

Results

Survey Respondents

Who responded to our survey?

Weighted and unweighted data describing survey respondents are presented in Table 1. In total, 475 people responded (20% of those surveyed) and adequately answered the core question. Unweighted %'s represent actual survey responses while the weighted %'s are adjusted to reflect all professionally active U.S. radiologists. Comparison of the unweighted and weighted data indicates that radiologists participated in this survey in rates roughly equivalent to their overall population sizes.

Eighty one percent of radiologists claimed that they specialized, which was somewhat higher than the 71% found in the 2003 survey. Of the 10 subspecialties, the largest group was interventionalists (15%), followed by neuroradiologists (11%) and breast radiologists (10%). The relative order was unchanged from 2003.

Roughly half of radiologists owned their practices, and 69% of practices were private (51% single specialty and 18% multispecialty.) One third of radiologists practiced in the South while the remaining two thirds were evenly distributed across the rest of the country.

Radiologists were evenly split across age groups from < 35 to 65. Six percent of actively practicing radiologists were over 65 years of age. Roughly 19% of radiologists reported their gender as female, (compared with 17% in 2003 and 16% in 2000).

Supply exceeds Demand

What does data analysis reveal about the balance of supply and demand?

Weighted data of physicians' actual and desired workload, shown in Table 2, indicate that physicians desire a net 3.3% increase in work overall. Only 10% of radiologists wanted less work, while twice as many (20%) radiologists wanted more work. Those who wanted to work less preferred a 20% decrease in workload, on average, while those who wanted more work wished for a 26% increase. Using these percentages to calculate physician hours, the desired changes in weekly hours worked were 11 hours (decrease) and 13 hours (increase). In annual hours, the desired decrease and increase were 463 and 544 hours, respectively. The average desired workload increase and decrease were significantly different ($P \leq .05$) from zero, but were not significantly different from each other.

On average, radiologists desired an increase in work of about 1.5 hours more each week. Given a typical working week of 49 hours, this represents an increase of approximately 3.3%. In annual hours, the overall average change sought is an increase of 65 hours, which is about 3.1% of the typical annual workload of 2,083 hours. The desired changes in hours, both weekly and annually, are significantly different from zero ($P \leq .05$).

Comparison to Previous Data

Has the situation changed since 2000?

Relative to 2000 and 2003, the number of physicians who wanted more work in 2007 increased. In 2000, 51% of physicians wanted less work while only 5% wanted more work [9, 41]. In 2003, the percentages of physicians wanting less and more work were about equal, 17% vs. 16% respectively [10, 41]. By 2007, 20% of radiologists

wanted more work while only 10% wanted less work (Figure 1). It should be noted that on the 2000 survey the question was asked differently. Respondents were given 5 answer categories to choose from (much too little work, somewhat too little work, about right, somewhat too much work and much too much work.) For the purposes of comparison, the "much too little" and "somewhat too little" categories were combined into "want more work" while the "much too much" and "somewhat too much" categories were combined into "want less work."

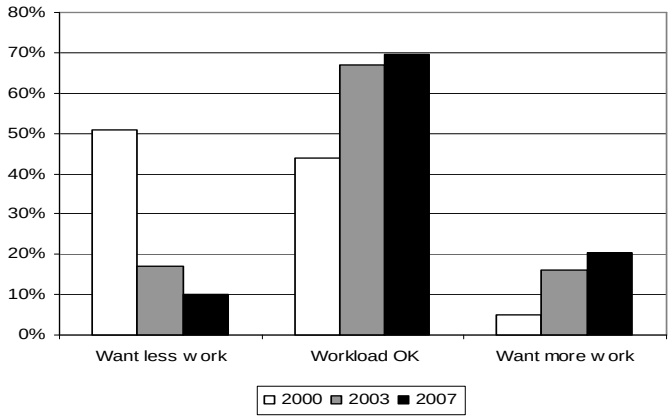

Figure 1: Radiologists' self reported workload burdens
2000 (white bars), 2003 (grey bars), and 2007 (black bars). Source: [9, 10, 41]

Working Hours of Radiologists Seeking Change in Workload

Were there differences in the annual work hours or number of part time workers among those who were seeking more (less) work?

Radiologists seeking less work averaged 54 hours a week, which was significantly more ($P \leq .05$) than the 49 hours worked by those satisfied with their typical working week (Table 2). Those desiring an increased workload averaged 49 hours weekly, which was not significantly different ($P > .05$) from the weekly hours reported by the radiologists who stated that they worked about the right amount. Annually, radiologists seeking less work had worked an average of 2,296 hours, which was a significantly larger

annual workload ($P \leq .05$) than the 2,052 hours averaged by radiologists satisfied with their workload. Those desiring an increased workload averaged 2,083 hours per year, which was not significantly more ($P > .05$) than the workload of radiologists who stated that they worked the right amount.

The average weekly workload desired by radiologists seeking to work less was 43 hours (54 – 11 hours), while those seeking to work more wanted a 61-hour working week (49 + 13 hours). The preferred weekly workloads of the radiologists seeking more and those seeking less work were both significantly different from the "OK workload" of 49 hours ($P \leq .05$). Similarly, the preferred annual workloads of radiologists satisfied with their hours were different among the three categories of radiologists.

Relative to 2003, the weekly hours worked, weekly change sought, and weekly hours desired were not statistically different (Figure 2).

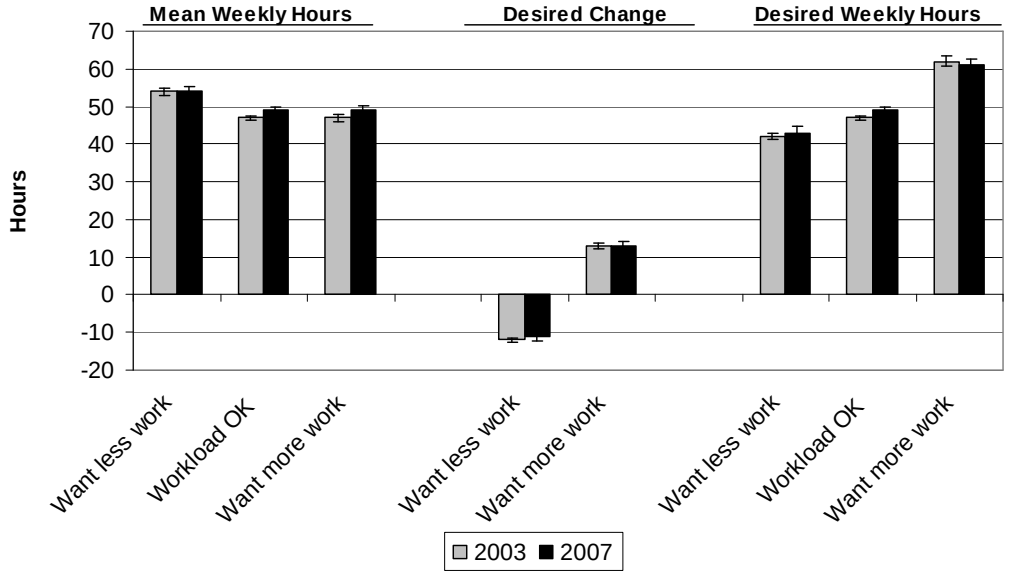

Figure 2: Radiologists mean weekly hours, desired change, and desired weekly hours 2003 vs. 2007. Error bars represent SEMs. Source: [10]

Overall, 16% of respondents were part-time radiologists. Approximately 17% of radiologists seeking less work were employed part time, compared with only 13% of

those desiring more work. Sixteen percent of the radiologists satisfied with their workload were part-time workers.

Characteristics of Radiologists Seeking Change in Workload

What are the characteristics of radiologists who want a decreased (or an increased) workload?

Nearly 20% of radiologists reported that they do not subspecialize. Within this group, 10% wanted less work, while 15% wanted more work (Table 3). Those wanting less work preferred 732 hours less each year, while those wanting more desired 699 more hours. These numbers were not statistically different from each other ($P > .05$). The overall net workload change wanted by nonsubspecialist radiologists was not significantly different from zero or the overall average of 65 hours.

The remaining 81% of radiologists subspecialized at least to some extent. Ten percent of that group wanted a decrease in workload, and 22% wished for an increase. The radiologists who sought a lesser workload were working an average of 2,326 hours a year, while those seeking an increased workload averaged 2,132 hours; the changes in annual hours implied by the percentage of change desired were 411 hours less and 520 hours more per year, respectively, which were not significantly different at standard statistical levels ($P > .05$). The overall workload change sought by all the subspecialists was an increase of 73 hours a year, or 3% of the average workload of 2,127 hours. This was statistically different from zero, but not from the overall average of 65 hours or from the change desired by those who don't subspecialize ($P > .05$).

Among the ten radiology subspecialties included in the survey, there were some differences across fields (Table 3). Fifty one percent of abdominal radiologists wanted

more work while only 5% wanted less work. On average, abdominal radiologists wanted an 11% increase, or 234 more hours per year. Nuclear radiologists showed a similar preference with 31% wanting more work and only 4% wanting less work. The average increase in workload desired was 243 hours representing an 11% increase over the base of 2,116 annual hours. Musculoskeletal and pediatric radiologists showed the opposite preferences. Thirty one percent musculoskeletal radiologists wanted less work and 15% wanted more. On average, musculoskeletal radiologists wanted a decline of 34 hours per year which was neither significantly different from zero nor the overall mean of 65 hours. For pediatric radiologists, 35% wanted less work while none wanted more work. The average change in workload desired was 163 hours, or a decrease of 9% from the base of 1,736 annual hours. Given the small sample sizes – 19 abdominal radiologists, 30 musculoskeletal radiologists, 28 nuclear radiologists and 9 pediatric radiologists, most of these estimates are not significantly different across subspecialties. The sole exception is pediatric radiology which did significantly differ from the other 8 subspecialties ($P<.05$).

The net average desired workload changes for radiologists working in solo, small (2-10 radiologists), large (11-20 radiologists) and very large (21+ radiologists) were not significantly different from the overall average of 65 hours ($P>.05$).

Fifty seven percent of government radiologists wanted an increase in workload while none wanted a decrease. The net average desired workload change was an increase of 496 hours per year, or 26% more than the current 1,870 annual hours. This was both significantly different from the overall average of 65 hours and from all other subspecialties ($P \leq .05$). A similar pattern was seen in 2003 when 31% of government practice base radiologists wanted more work, and none less. At that time, the overall

average workload increase sought was 246 hours a year, 12% of the typical workload. Twenty-two percent of private multi-specialty radiologists wanted more work while only 6% wanted less work. This group desired a total net increase of 83 hours per year ($P \leq .05$), or 4% of the mean annual 2,000 hours. In all other practice types, the sample of radiologists who wanted more work outnumbered those who wanted less.

Data were analyzed according to the location of the practice: large metropolitan area (population, ≥1,000,000), small metropolitan area (population between 50,000 and 1,000,000), or nonmetropolitan area (population, <50,000 or rural). Radiologists working in urban and suburban practices in a large metro area wanted more work. On average 24% and 25% of urban and suburban radiologists, respectively, wanted more work while only 8% and 7% wanted less work. Overall, the net increase in annual work hours desired was 142 (6.4%) ($P \leq .05$) and 72 hours (3.7%) (not significant ($P > .05$)). Radiologists working in the main city of a small urban area were balanced on average wanting no net change in hours.

Analysis by census region indicated that physicians in the Northeast and South wanted more work while those in the Midwest and West were in balance. Among Northeastern radiologists, 10% wanted less work while 29% wanted more work. The net total workload change desired was an increase of 150 hours (7.1% of 2,116 hours) which was statistically significant ($P \leq .05$) both from the overall average of 65 hours and the other census regions. Nine percent of radiologists in the South wanted less work, while 27% wanted more work. However, in this region, the total net change desired of 99 hours was not significantly different from the overall average ($P > .05$). Interestingly, the overall annual change desired in the Midwest and the West was a decrease of only 3

hours and 8 hours respectively (<1%). Both were highly significant when compared to the other census regions (P<.01). For these regions, the number of radiologists wanting an increase in hours was approximately equal to those wanting a decrease.

Eighty one percent of post-training, professionally active radiologists were men. Approximately 10% of male radiologists said they wanted to work less, and 21% reported a desire for a workload increase. Overall, the net average desired workload change was an increase of 78 hours a year, which was 3.8% of the typical workload of 2,067 annual hours and was not significantly different from the overall average ($P > .05$). Thirteen percent of female radiologists wanted to work less, while 20% wished for a workload increase. The overall average workload change sought was an increase of 2 hours a year, which was not significantly different from the overall average of 65 hours ($P > .05$).

Factors That May Explain Imbalances in the Radiology Services Market

What factors are associated with a desire for more/less work and may explain the imbalances in the radiology services market?

Age, gender, subspecialty, practice location, census region, and practice type influenced the desire for a change in workload (Table 4). When other factors were held constant—including hours worked—radiologists older than 65 years of age sought a workload change of 182 hours a year less ($P \leq .05$) than the change sought by 45–54-year-old radiologists, the reference category. This is a significantly larger reduction than the 42 hours reported by radiologists over 65 in the 2003 survey. Other age categories did not have a significant effect on the desired change in hours.

Men wanted to change their workload by 115 hours a year ($P \leq .05$) more than the women did. Comparably in 2003, men wanted approximately 70 hours more work relative to women.

We considered the effects of full/part time status and total number of annual hours worked. In 2003, it was found that full-time respondents working more hours annually wished for a smaller change in workload –every 100 more hours worked a year lowered the desired change in annual workload by 9 hours. This relationship was not demonstrated in the 2007 data.

Four of the 10 subspecialties did exhibit a significant effect on desire for annual workload change. Relative to no subspecialty, the reference category, abdominal radiologists and interventional radiologists wanted 233 and 165 more hours per year respectively ($P \leq .05$). Holding all else equal, nuclear radiologists also wanted 277 more hours than those who don't specialize ($P \leq .05$). Conversely, pediatric radiologists sought 214 fewer hours per year ($P \leq .10$).

Relative to mid-size practices with 11-20 radiologists, very large radiology practices (>21 radiologists) wanted 96 more hours per year ($P \leq .10$).

Working in a large metropolitan area was associated a desire for an increase in workload relative to working in a small urban area (reference category). When all other factors—including subspecialty and census region—were held constant, radiologists in urban and suburban metropolitan practices wanted an increase in annual workload of 166 ($P \leq .01$) and 110 ($P \leq .05$) hours respectively, relative to radiologists working in small cities. In the 2003 survey, it was found that radiologists in non-metropolitan areas

wanted less work compared to those in large metropolitan areas. In the 2007 survey, we saw a non-significant increase of 61 hours desired compared to small urban areas.

There were also significant differences by census region. Compared to the South, the reference and also the largest region, radiologists from the Midwest and West wanted 128 ($P \leq .05$) and 140 ($P \leq .01$) fewer hours, respectively. Those in the Northeast wanted a nonsignificant ($P > .05$) decrease of 32 hours.

When other factors—including region and practice location—were held constant, radiologists working as solo practitioners, in academic practices, in nonacademic multispecialty practices, and in government-owned practices all sought larger increases in annual workload relative to that in the reference category of radiologists in private, nonacademic radiology groups. Given the small sample sizes, the effects for most of the practice types were not significant. However, radiologists working in government practices sought larger annual increases than those in the reference group by 527 hours a year ($P \leq .01$). A similar effect was seen in 2003, when government practices sought larger increases of 384 hours per year.

As a check on the data, we performed a comparison of the observed mean change in annual hours sought and the mean change predicted by our multivariate regression model (Table 5). The weights for each subgroup of radiologists (the fraction of radiologists working in each type of practice) are listed in the right column. In all cases, the differences between the observed and the predicted values were not significant ($P > .05$), indicating that the model coefficients describe physician behavior with a reasonable level of accuracy.

Other Factors Considered: Vacation and Procedure Load

Average annual hours and vacation days of full-time radiologists in various types of practices were investigated (Table 6). Akin to the findings in 2003, the annual hours are quite similar across practice types except that government radiologists report approximately 10% fewer hours worked annually than does the average radiologist. Radiologists in nonacademic private practices and in nonacademic private multispecialty practices report approximately twice as many vacation days as others.

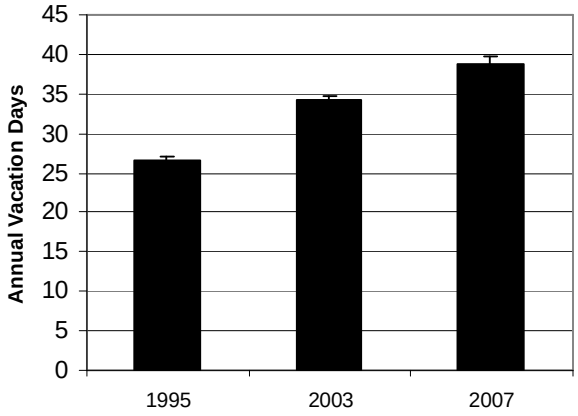

Figure 3: Annual vacation days 1995, 2003, 2007
Bars indicate standard errors. Source: [45]

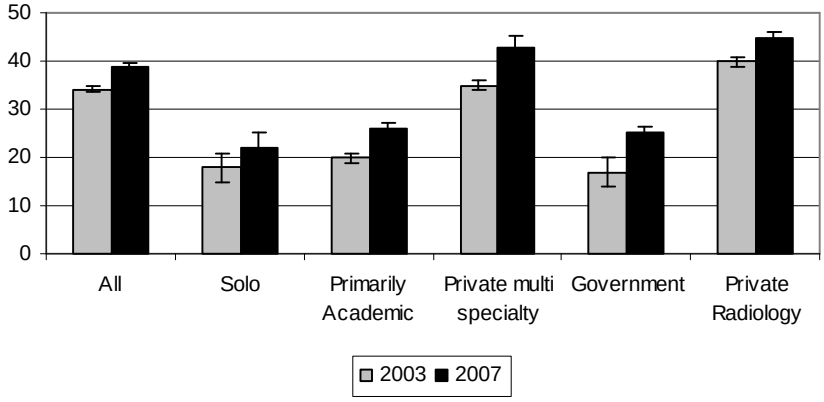

Figure 4: Comparison of annual vacation days across practice types
Bars indicate standard errors. Source: [10]

Over the past decade, the amount of vacation time taken by all radiologists has risen (Figure 3). In 1995, the average annual number of vacation days reported was 26.6,

in 2003 this had risen to 34.2 and in 2007 we find that vacation days average 38.8 across all physicians [45]. This trend has held for all practice types (Figure 4).

Additionally, we considered the effect of work intensity (procedures per FTE per hour) on radiologists' desired change in work hours. While this variable was not found to be significant contributor in the multivariable regression analysis, a related measure, the total number of annual procedures per FTE across practice and over time, was interesting (Table 7, Figure 5). Compared to 2003, there was an average increase of 7% in annual procedures across all radiologists ($P \leq .05$). The mean number of procedures per radiologist rose from 13,900 in 2003 to just fewer than 14,900 in 2007. Significant increases were also found for government and private radiology practices which showed a 30% and a 9% increase in procedure volume, respectively ($P \leq .05$). However, it should be noted that the number of procedures per radiologist varies widely and means should not be taken as norms.

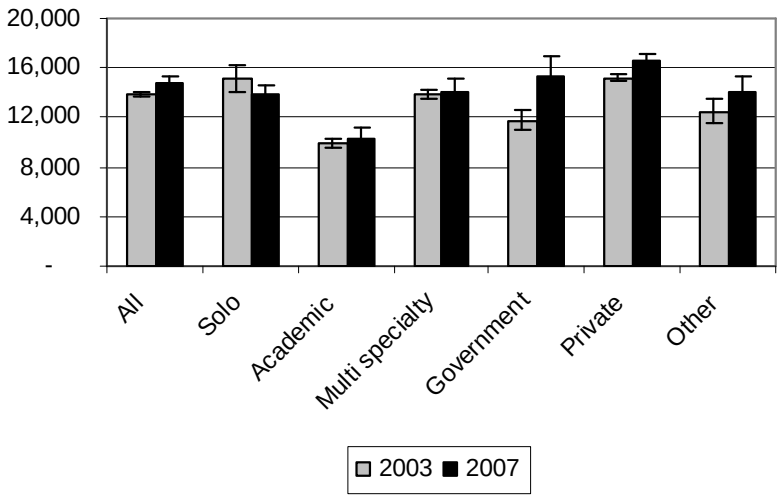

Figure 5: Annual procedures per FTE radiologist by practice type
Bars represent standard errors. Source: [22]

Discussion

Substantive Findings from the 2007 Survey

Overall, this study confirms that radiologists desired a 3.3% net increase in workload in 2007. Physicians who wanted more work outnumbered those who wanted less work by 2:1 (Figure 1). This was a substantive change from 2003 when the overall supply and demand of physicians was found to be in balance. Interestingly, the mean annual hours worked and the total desired annual hours did not change significantly for those who wanted more or less work (Figure 2). Physicians in each of these groups wanted to work just as many total annual hours in 2007 as they said they did in 2003. Accordingly, the bulk of the 3.3% net desired increase in total work can be attributed to a larger number of physicians who describe themselves as wanting "more work." It is somewhat surprising that there is no significant difference in mean annual hours worked between those whose workload is "OK" and those who "want more work," indicating that factors other the total number of hours worked determine a physician's optimal total working hours, a finding of the 2003 survey. This was confirmed in the regression analysis which showed no significant effect of annual hours on determining desired workload.

It appears that the balance that was seen in 2003 has now shifted towards a slight surplus, or oversupply, of radiologists. Larger imbalances were seen in individual subspecialties and practice types. Those who reported that they subspecialize worked significantly more hours than those who did not subspecialize (2,127 vs 1,894 annual hours). However, neither group wanted a change in total hours that was significantly different from all other radiologists. As most subspecialists retain the ability to work as

generalists, they can work both within and outside of their specialty area, tailoring their workload as desired. Tabulations of the 2003 survey data illustrated that very few specialists practice their subspecialty exclusively [10]. Within subspecialties, there were however imbalances. While our ability to identify imbalances in individual subspecialties was limited due to the small sample sizes, four subspecialties did stand out. Most strikingly, univariate analysis revealed that pediatric radiologists wanted to work 163 fewer hours, a significantly larger decrease than all other subspecialties. Similar, but less significant, results were seen in 2003 indicating that there is a shortage of pediatric radiologists, relative to other subspecialists, and that the shortage is becoming more severe. Abdominal, interventional, and nuclear radiologists each demanded more hours relative to all the other groups. It appears that these groups are facing a greater oversupply than other subspecialties. Given that increasing numbers of interventional and nuclear procedures are being done by cardiologists, vascular surgeons, and other practitioners [6], nuclear and interventional radiologists are facing particularly heavy competition for work.

As expected, the percentage of part-time radiologists was slightly smaller in the group that wanted more work (13%) than it was in the group that wanted less work (17%), indicating that part-time radiologists, on average, are able to find positions where they can work at least their minimum number of desired hours.

Univariate analysis by practice type indicated that the 3% of radiologists working in government practices were seeking an additional 26% workload. This was confirmed in the regression analysis. Similar findings had been seen in 2003 and were attributed to the unique attributes of government practices. Government radiologists do work about

10% fewer total annual hours than the average radiologist (1,870 vs. 2,083). This appears to be a combination of ~20% fewer weekly work hours (41.6 vs. 49.3), and fewer average weeks of vacation of each year (5.0 vs. 7.8 for all groups). This would fit with the notion that government jobs tend to require fewer weekly hours, but are not as generous with vacation time. We would question whether the demand for more work among government radiologists represents a true oversupply, or simply a desire to work hours more commiserate with radiologists in all other practices. As had been suggested in 2003, it may be the case that lower incomes in government practices may induce radiologists working in these practices to work longer hours to increase their incomes. There is little empirical evidence to support this hypothesis.

We were surprised to find such significant differences in workload preferences across regions given that no significant regional differences had been seen in 2003. Both univariate and regression analysis confirmed that radiologists in the Midwest and the West wanted significantly fewer hours than those in the Northeast and the South. The net desired change for radiologists in the Midwest and the West (<1%) was not significantly different from zero, indicating a relative balance in these regions. Univariate analysis of showed that radiologists in the Northeast wanted 7% more work, indicating a relative surplus, but this did not appear significant in the regression. Directionally, these findings are consistent with the 2003 data (the 2003 were not significantly different from zero.)

Similarly, radiologists practicing in large urban metropolitan areas demanded significantly more work, indicating a relative oversupply in cities. It would appear that the growth in the demand for radiology services has not kept pace with the net rate at which radiologists are entering practice large cities and in the Northeast. Alternatively,

given higher costs of living in these areas, radiologists in the cities and in the Northeast may be looking to work more hours to supplement their income.

The regression analysis also shows that men seek approximately 5% more work hours than women, holding all else equal. This may result from perceived differences in family responsibilities between men and women. Additionally, older radiologists (>65) wanted to work fewer hours.

Overall, we have seen that vacation days have been on a steady rise over the past ten years, and this trend has been consistent across all practice types. Unfortunately, we have no empiric data to suggest why this may be the case.

In a previous paper, Meghea [11] found that radiologists who work more intensively (completed more procedures per hour) sought, to a very small extent, fewer hours. We used multivariable regression to analyze the effect of work intensity on physicians desired work hours but were unable to find any significant effect. The small sample size, compounded with a high rate of missing responses for this question challenged our ability to tease out any small effects. However, we did see a continuation of the trend towards more annual procedures per FTE. In 2007, the mean number of procedures completed for all radiologists was 14,900, up 7% from 13,900 in 2003. In 1991, radiologists completed 11,100 procedures on average (Figure 6) [22]. However, as Bhargavan points out, the number of procedures does not describe the intensity or difficulty of a radiologists workload. Therefore, the total RVUs per FTE and RVUs per procedure are a better way to monitor changes in physician productivity. While this is the subject of another ACR paper, we mention it here because of its relation to physician work hours.

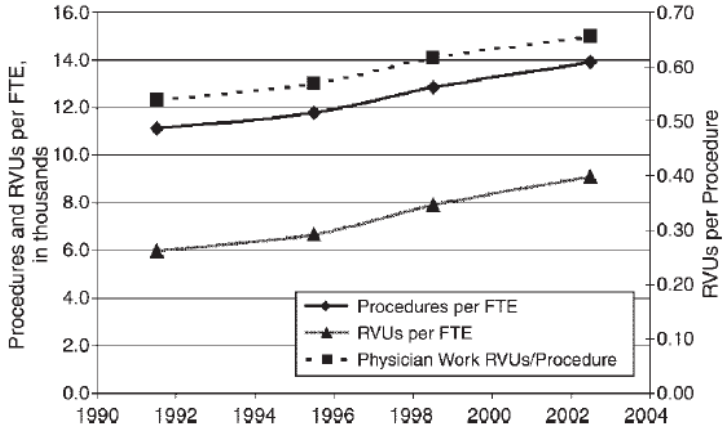

Figure 6: Trends in workload per FTE radiologist
from 1991-1992 to 2002-2003 Source: [22]

As our data has illustrated, the radiologist shortage that was seen in 2000 was in balance by 2003 and now appears to have shifted towards a slight surplus. One of the possible explanations for this shift is that radiologists have become more productive over the past ten years, completing more procedures per given unit of time (Figure 6). Higher productivity results in the need for fewer radiologists and would help ease a shortage or further a surplus.

Supporting Data

The ACR uses a number of methodologies to monitor the state of the employment market for radiologists. In the past 10 years, the College has published reports describing a number of primary tools which it uses for tracking changes in physician surpluses and shortages. These tools include: self-reported workload burden (survey), measured workload in RVUs and procedures (survey), listings at an ad placement service, vacancies in academic radiology departments, and employment advertisements in radiology journals. Self reported workload burden is the subject of this paper and has been described in detail above. Measured workload is also briefly discussed, and updated with the latest results from the 2007 Survey. We will briefly discuss the use of listings,

academic vacancies, and employment advertisements, and how their key findings relate to those of this study.

Since 1990, the ACR has been tracking the ratio of diagnostic radiology job listings to job seekers at the ACR Professional Bureau (the ACR's placement service) [39, 41-44]. Data are collected at the annual meeting of the Radiological Society of North America (RSNA), where the Professional Bureau has an on-site presence. Previously published data have shown this to be a validated and useful relative measure of the overall radiology employment market, including both community and academic positions. This index was most recently updated with 2007 data at the 2006 RSNA meeting [44]. At the height of the radiologist shortage in 2000-2001, the ratio peaked at almost 4 listings per seeker. By 2003, this ratio fell to ~1, indicating a relative balance of those seeking work a positions listed, and remained stable through 2006. In 2007, we saw a substantial downturn to 0.72, consistent with a surplus of radiologists. We have yet to reach the nadir of 1 posting for every 4 applicants that was seen during the mid 1990's. Findings from the job listing index are consistent with the surplus demonstrated from the 2007 survey data. However, this ratio is not a perfect measure of shortages and surpluses, as it tends to magnify true market changes by a factor of 2 or 3 [39].

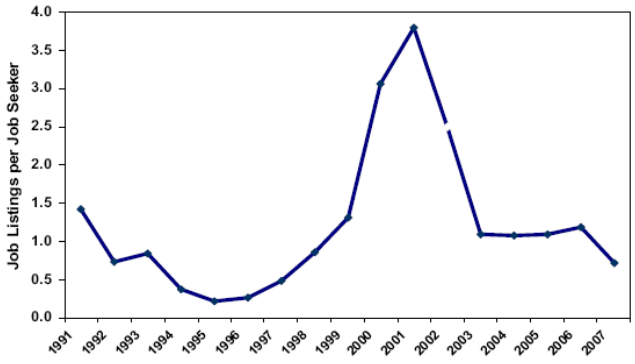

Figure 7: Ratio of job listings per job seeker at the ACR Professional Bureau
Source: [44]

A related method relies on surveys of academic radiology departments to determine vacancy rates [42, 43]. This metric has been found to be well correlated to the ratio of jobs to job seeker. From 2001 through 2003, the number of vacancies was declining, consistent with a decrease in the radiology shortage and a move to overall balance. However, after 2004, we see a rise in average vacancies which would be more consistent with a shortage than a surplus. While it is believed that this metric is well correlated with the overall radiology market, it is direct measurement of the academic market for radiologists and may not accurately reflect changes seen among private radiology groups.

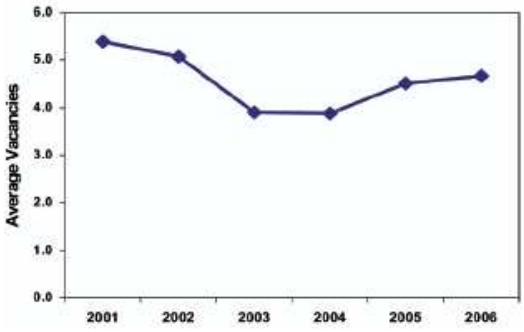

Figure 8: Average vacancies per academic radiology department
Source: [44]

An alternative measure of the radiology employment market is a validated help wanted index for radiology positions [36-38, 40, 43, 46]. This method codes all diagnostic radiology positions advertised in the American Journal of Roentgenology (AJR) and Radiology by practice type, geographic location, and subspecialty. The index contains data beginning in January 1991 and is updated on an annual basis. The most recent data is available through 2005 [43]. Consistent with the Job listing ratio, the help wanted index showed a peak number of advertisements in 2000-2001, indicating a relative shortage of radiologists. Since 2002, it has steadily been declining, signifying

that the shortage has eased and that there may possibly be a surplus. Listings have not yet hit the nadir that was seen in 1995 when there was a severe oversupply of radiologists, as practice hiring slowed significantly in the wake of fears that managed care would significantly reduce the demand and reimbursement for radiology services. With increasing numbers of advertisements being placed online, this tool may no longer accurately reflect changes in the radiology job market and appears to be falling out of favor.

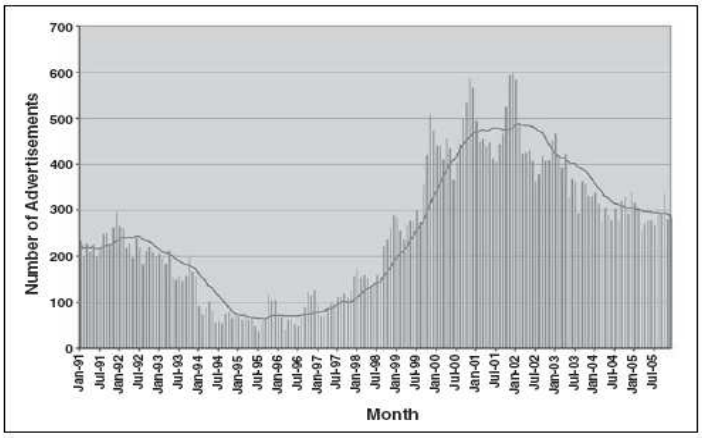

Figure 9: Number of advertisements for radiologist jobs
Source: [45]

Two of the three measures above are consistent with the observed trend towards a surplus of radiologists that we have seen from our analysis of the 2007 Survey data. This leads to the obvious next question – why has the shortage eased, and why might we be facing a surplus?

Reasons for Easing of the Physician Shortage

Surpluses and shortages of radiologists occur when supply and demand are not matched. Accordingly, a shortage can occur when demand increases without an equivalent increase in the supply of radiologists, or when the supply of radiologists drops given a constant demand. A third factor – productivity of radiologists - can modulate the

effective supply, allowing fewer radiologists to meet higher levels of demand. Some of the important drivers of shortages and surpluses are shown in Figure 10.

Category	Favors Shortage	Favors Surplus
Technology	Better imaging modalities CT MRI	Efficiency promoting PACS Teleradiology Automated templates Night hawk
Individual Desires	For lower workload	For higher income
Supply of Radiologists		Women entering the field Decreased training length Increase # of training programs
Demand for Services	Universal insurance Population growth Aging	Physician self-referral Giving up low value procedures

Figure 10: Factors affecting shortages and surpluses
Source: [4, 45]

Technology is an important driver of both productivity (indirectly supply) and demand. New modalities like CT and MR imaging are highly effective and have become important tools in the evaluation of many patients. Additionally, these scans are more complex and require more radiologist time for interpretation. Both of these factors have led to a net increase in the demand for radiologist services, and favor a shortage. On the other hand, efficiency promoting technologies like PACS (Picture Archiving and Communications Systems), teleradiology, automated templates, and night hawk services allow the physician to be more productive, completing more procedures per hour. These technologies favor a surplus.

Individual desires, to the extent that they affect how much an individual wants to work, will affect the net supply of radiologists. Desires for lifestyle (spending time with family) lead individual physicians to work fewer hours and results in the need for more physicians. In contrast, desires to improve income lead physicians to work more hours, decreasing the total number of physicians needed.

The change in the total supply of radiologists is determined by the number of physicians who enter the field each year, less those who leave. If residency programs were to decrease the length of training, or increase the number of training spots, the total supply of radiologists would increase.

Finally, rising demand for services would favor a shortage of physicians. Annual population growth, aging, and the increased age-adjusted use of radiology services all increase demand. On the other hand, physician self referral (imaging procedures being performed by non radiologists) has increased over the past several years, decreasing the number of services requested of radiologists [4, 6]. Similarly, in times of severe shortages, radiologists have the option of giving up low value procedures to other specialists to free up their own time, and help ease a shortage.

Sunshine and Meghea argue that there have been no significant changes in the supply of radiologists, and that the demand has increased, favoring an even greater shortage [45]. They suggest that the resolution of the shortage can be explained almost entirely by increased productivity. In fact, we have seen a significant trend towards increasing numbers of procedures per FTE and RVUs per FTE over the past decade (Figure 6). Between 1995 and 2003, the work done per radiologist each year increased by more than 36% in terms of RVUs and 18% in procedures, while annual work hours increased by only 2% [45]. From 2003 through 2007 we saw an additional 7% increase. This shortage has resolved because physicians are getting a lot more work done, predominantly by being more productive, rather than by working more hours. It is unknown how much of this increase in productivity is due to efficiency promoting technologies.

Implications for Physician Workforce

Why should we invest in understanding surpluses and shortages?

Radiologists are interested in understanding how their workload compares with that of others – this is a frequent query received by the ACR department of research. Given the diversity of subspecialties, practice types, and practice environments, there is no single way to operate a radiology practice. Survey data provides us with descriptions of how practices of different types operate on average. Additionally, physicians want to have a sense for how the future and their practice will be impacted over time. Monitoring trends and changes in the physician workforce and the demand for radiology services allows us to forecast and better respond to macroeconomic issues. Important policy considerations may be impacted by understanding trends in surpluses and shortages. For example, residency programs can adjust the length of training and the number of spots to balance the supply of radiologists. Changes in Medicare payment policy affect physicians' income and may play a large role in the desire to work more or less. Changes in attitudes and preferences also change how physicians view their desired work levels, and will affect the physician labor market over time. By measuring these trends, we can gain a better understanding of the practice of radiology in the U.S.

Strengths and Limitations of this Study

Every study has limitations both in the methodologies it employs an in the data it uses. Regarding the source of our data, the 2007 survey, we had a very low response rate (~20%) compared to previous ACR surveys which received response rates between 63 and 75%. This resulted in a relatively small sample size of just 475 valid responses. Subgroup analysis was difficult given the very small sample sizes.

Another important limitation is the imprecision due to sampling error (which is represented as standard errors for in the tables). Given the natural randomness of sampling, it is possible that some results could appear by chance alone. Additionally, while we tried to account for response bias using weighting, error could have been introduced because our weights did not account for all possible characteristics.

The survey obtained very little data on the hours and desires of part time radiologists. All questions were asked for the typical full time employee in a practice.

Much of our analysis used multivariable regressions which illustrates correlated links, but does not demonstrate causality. This allows the possibility of selection bias – if radiologists with a preference for fewer working hours choose a practice that is known to have fewer working hours, then the association demonstrated between working fewer hours and that practice would reflect a causal link from the radiologist to the practice. Our interpretation of the results assumes that it is the nature of the practice that affects the radiologist.

In this study we use a self-reported workload burden to measure physician surpluses and shortages. While, this is just one indicator of surpluses, we were pleased to see that it correlated well with other markers of shortage/surplus including the help wanted index and the ratio of job listings to seekers.

The 2003 survey depended on the assumption that desired changes in workload were equivalent to desired changes in work hours. If desired changes were significantly affected by the intensity of work, rather than just work hours, the implications of that study's findings would have been different. However, based on both our findings, and

those of Meghea [11], intensity has a small effect or nonsignificant effect on desired work hours.

The strengths of the survey are that is has been well validated and used multiple time within the radiology community. Additionally, the stratified sampling should capture accurate representation of all types of radiologists. Finally, sample weighting should make the data indicative of the results we would have obtained had we collected data from all us radiologists.

Overall Conclusions

In conclusion, we found a net 3.3% surplus among U.S. radiologists, a significant change from the balance that was found in 2003. In 2007, the number of physicians who wanted more work outnumbered those who wanted less work by 2 to 1. We found some imbalances between subspecialties; there is a shortage among pediatric radiologists and a surplus of abdominal, neuro, and interventional radiologists. We also found some imbalances by region. Those in the Northeast wanted 7% more work on average while those in the West and Midwest wanted <1% change in work hours. There was a surplus of radiologists working in urban metro centers. We also found that women want less work than men and over those who are over the age of 65 wanted to work less than younger radiologists.

Overall, our findings of a radiologist surplus were supported by changes other markers of physician shortage and surplus. We believe this survey methodology to be a valid tool for assessing the state of the physician workforce.

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Table 1: 2007 ACR Survey of Radiologists: Responses by Physician Attribute

Characteristic	n	Unweighted %	Weighted %
All Respondents	475	100%	100%
Subspecialize			
Yes	366	77%	81%
No	107	23%	19%
Subspecialty			
No Response	118	25%	23%
Abdominal	19	4%	4%
Body	40	8%	9%
Breast	51	11%	10%
Interventional	71	15%	15%
Magnetic	36	8%	8%
Musculoskeletal	30	6%	7%
Neuroradiology	44	9%	11%
Nuclear	28	6%	6%
Pediatric	9	2%	1%
Ultrasound	16	3%	2%
Other	13	3%	4%
Group Size			
Solo	25	5%	7%
2 to 10	180	38%	38%
11 to 20	124	26%	27%
21+	146	31%	28%
Ownership Stake in Practice			
Yes	207	44%	44%
No	258	54%	55%
Dont Know	7	1%	1%
Practice Type			
Solo	18	4%	5%
Primarily Academic	80	17%	18%
Private multi specialty	95	20%	18%
Government	9	2%	3%
Private Radiology	248	52%	51%
Other	13	3%	2%
Location			
Main city of large metro area	92	19%	24%
Suburb of large metro area	90	19%	19%
Main city of smaller metro area	181	38%	34%
Suburb of smaller metro area	38	8%	11%
Non metro or rural	64	13%	9%
Varied locations	8	2%	2%
Census Region			
Northeast	94	20%	23%
Midwest	129	27%	22%
South	141	30%	33%
West	111	23%	22%
Age (y)			
< 35	105	22%	24%
35-44	116	24%	26%
45-54	131	28%	24%
55-65	90	19%	20%
>65	33	7%	6%
Gender			
Female	71	15%	19%
Male	315	66%	81%

Note: Where indicated, data are weighted to be respresentative of total US radiologists

Table 2: Descriptive Statistics by Preferences about Workload

	Want Less Work		Workload OK		Want More Work		All Respondents	
Descriptive Statistic	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
Number of responses	55		335		85		475	
Percentage of Radiologists	10%		69%		20%		100%	
Percent part time workers within group	17%		16%		13%		16%	
Mean weekly hours	54	1.3	49	0.7	49	1.2	49	0.5
Mean annual hours	2,296	67.2	2,052	29.2	2,083	54.8	2,083	24.4
Mean percentage change sought	-20	2.6	NA	NA	26	2.1	3.3	0.9
Mean weekly change sought (hours)	-11	1.4	NA	NA	13	1.0	1.5	0.4
Mean annual change sought (hours)	-463	56.2	NA	NA	544	44.4	65	18.7
Mean weekly hours desired	43	1.8	49	0.7	61	1.7	51	0.7
Mean annual hours desired	1,833	84.6	2,052	29.2	2,627	78.6	2,148	31.0
Weeks worked	42	0.4	42	0.2	43	0.4	42	0.2
Average # of part time radiologists per group	3.2	0.7	2.7	0.3	2.9	0.7	2.8	0.3
Average # of full time radiologists per group	14.6	2.6	15.2	1.2	16.8	2.5	15.5	1.0

Note - All data, other than number of responses, are weighted

NA = Not Applicable

Table 3: Mean Annual Hours and Mean Change Sought, by Radiologist and Practice Characteristics

Characteristic	n	Want Less Work					Workload OK			Want More Work					All Respondents				
		%	Mean Annual Hours		Mean Change Sought (h)		%	Mean Annual Hours		%	Mean Annual Hours		Mean Change Sought (h)		Mean Annual Hours		Mean Change Sought (h)		
			Mean	SE	Mean	SE		Mean	SE		Mean	SE	Mean	SE	Mean	SE	Mean		SE
All Respondents	475	10%	2,296	68	-463	56	69%	2,052	29	20%	2,083	55	544	45	2,083	25	65		19
Subspecialize																			
No	107	10%	2,177	131	-732	155	76%	1,884	84	15%	1,764	153	699	116	1,894	69	33		61
Yes	366	10%	2,326	78	-411	46	68%	2,097	30	22%	2,132	56	520	44	2,127	26	73		19
Subspecialty													24%						
Abdominal	19	5%	2,590	-	-648	-	44%	2,160	125	51%	1,971	233	526	88	2,086	133	234		97
Body	40	5%	2,436	-	-244	-	73%	2,016	58	22%	2,119	144	558	161	2,058	56	110		57
Breast	51	7%	2,320	119	-636	105	66%	1,959	108	27%	1,879	64	286	53	1,962	77	34		37
Interventional	71	10%	2,496	340	-377	101	65%	2,106	62	25%	2,217	102	628	76	2,173	66	120		52
Magnetic	36	10%	2,149	92	-483	46	68%	2,066	59	22%	2,378	226	385	42	2,144	73	39		47
Musculoskeletal	30	31%	2,375	99	-274	41	54%	2,329	182	15%	2,238	73	313	23	2,329	106	-37		54
Neuroradiology	44	9%	2,297	114	-378	127	73%	2,087	110	18%	2,110	42	438	24	2,110	80	46		47
Nuclear	28	4%	2,000	-	-300	-	65%	2,044	99	31%	2,281	108	818	208	2,116	79	243		104
Other	13	11%	1,932	15	-898	78	89%	2,240	129	0%	.	.	.	.	2,207	121	-94		88
Pediatric	9	35%	2,295	182	-459	36	65%	1,429	546	0%	.	.	.	.	1,736	441	-163	*	105
Ultrasound	16	8%	2,365	52	-349	101	68%	1,645	126	24%	2,081	117	897	29	1,809	121	186		129
Practice Size																			
Solo	25	3%	2,852	170	-499	46	74%	2,045	195	23%	1,879	85	374	146	2,035	151	68		41
2 to 10	180	11%	2,336	124	-468	101	67%	2,015	61	21%	2,018	115	548	67	2,052	51	64		36
11 to 20	124	10%	2,209	94	-529	98	73%	2,104	40	17%	2,119	65	456	34	2,118	32	21		30
21+	146	10%	2,267	100	-382	66	68%	2,053	44	22%	2,198	63	647	91	2,106	35	108		38
Practice Type																			
Solo	18	5%	2,852	170	-499	46	82%	2,301	167	13%	2,052	103	665	197	2,296	141	62		53
Primarily Academic	80	11%	2,655	222	-439	100	74%	2,169	64	15%	2,396	78	815	170	2,256	59	71		49
Private multi specialty	95	6%	2,221	113	-316	56	72%	1,947	59	22%	2,115	133	460	84	2,000	54	83		29
Government	9	0%	.	.	.	.	43%	1,898	83	57%	1,850	43	866	74	1,870	44	495	*	194
Private Radiology	248	13%	2,174	58	-480	75	67%	2,058	42	20%	2,059	77	473	42	2,073	33	34		27
Other	13	2%	2,640	-	-792	-	89%	1,555	356	9%	2,100	-	630	-	1,621	320	42		56
Practice Location																			
Main city of large metro area	92	8%	2,432	277	-352	94	67%	2,197	43	24%	2,209	117	707	102	2,219	46	142	*	45
Suburb of large metro area	90	7%	2,276	70	-451	100	68%	1,924	72	25%	1,968	59	426	48	1,961	52	72		30
Main city of smaller metro area	181	15%	2,251	71	-538	99	66%	2,097	50	19%	2,115	121	422	50	2,123	43	0	*	34
Suburb of smaller metro area	38	4%	2,148	106	-266	25	78%	1,979	119	18%	1,914	64	734	96	1,973	95	125		72
Non metro or rural	64	12%	2,329	112	-424	56	74%	1,926	125	14%	2,029	92	510	137	1,990	97	17		36
Varied locations	8	2%	2,520	-	-252	-	87%	2,053	353	11%	2,100	-	630	-	2,066	307	66		68
Census Region																			
Midwest	129	12%	2,461	189	-399	69	73%	2,062	35	15%	1,813	142	310	38	2,075	45	-3	**	21
Northeast	94	10%	2,291	78	-502	165	61%	2,041	64	29%	2,216	73	694	91	2,116	43	150	*	50
South	141	9%	2,234	107	-515	113	64%	2,132	66	27%	2,127	85	547	69	2,140	49	99		41
West	111	9%	2,174	89	-424	72	83%	1,960	59	8%	1,842	222	394	53	1,971	53	-8	**	19
Gender																			
Female	71	13%	2,581	219	-485	86	66%	2,085	86	20%	1,771	132	328	68	2,088	78	2		34
Male	315	10%	2,276	62	-503	78	68%	2,013	32	21%	2,139	67	597	51	2,067	28	78		27

Note - All data, other than number of responses (n), are weighted

NA = Not Applicable ** Results statistically significant P<.01 * Results statistically significant P<.05

Table 4: Results of Multivariable Regression with Desired Change in Annual Hours as Dependent Variable

Parameter	Coefficient	SE	
Intercept **	-27	85	
Age (y) *			
< 35	70	78	
35-44	-40	60	
45-54	*Reference*	…	
55-65	-91	66	
>65	-182	77	**
Gender (0 if female, 1 if male) **	115	48	**
Subspecialty ***			
Abdominal	233	104	**
Body	62	94	
Breast	96	70	
Interventional	165	81	**
Magnetic	54	117	
Musculoskeletal	-35	89	
Neuroradiology	131	91	
Nuclear	277	139	**
Pediatric	-214	109	*
Ultrasound	143	146	
Other	-154	130	
Respondent works full time	43	112	
Full time indicator x annual hours	0	0	
Practice Size			
1-10 Radiologists	46	56	
11-20 Radiologists	*Reference*	…	
Over 21 Radiologists	96	53	*
Practice Location *			
Main city of large metro area	166	60	***
Suburb of large metro area	110	55	**
Main city of smaller metro area	*Reference*	…	
Suburb of smaller metro area	20	65	
Non metro or rural	61	79	
Varied locations	138	108	
Census Region **			
South	*Reference*	…	
Northeast	-32	86	
Midwest	-128	52	**
West	-140	51	***
Practice Type **			
Solo	98	110	
Primarily Academic	19	66	
Private multi specialty	63	43	
Government	527	163	***
Private Radiology	*Reference*	…	
Other	4	81	

Note

*** Statistically significant P<.01

** Statistically significant P<.05

* Statistically significant P<.10

Table 5: Comparison of Actual Change in Hours Sought and Change Predicted with Multivariate Regression

Parameter	Mean Change Sought (h)	SE	Mean of Predicted Change Sought (h)	SE	Category Weight (%)*
Age (y)					
<35	**92**	39	**176**	99	24%
35-44	**61**	33	**61**	16	26%
45-54	**82**	51	**82**	19	24%
55-64	**34**	36	**34**	25	20%
>65	**6**	32	**6**	21	6%
Gender					
Female	**2**	34	**2**	17	19%
Male	**78**	27	**78**	14	81%
Subspecialty					
Abdominal	**234**	97	**234**	35	6%
Body	**110**	57	**69**	21	11%
Breast	**34**	37	**26**	15	13%
Interventional	**120**	52	**146**	23	19%
Magnetic	**39**	47	**15**	18	10%
Musculoskeletal	**-37**	54	**-101**	27	8%
Neuroradiology	**46**	47	**72**	19	14%
Nuclear	**243**	104	**254**	24	8%
Pediatric	**-163**	105	**-163**	58	2%
Ultrasound	**186**	129	**103**	40	3%
Other	**-94**	88	**-111**	58	5%
Practice Size					
1-10 Radiologists	**65**	31	**68**	21	46%
11-20 Radiologists	**21**	30	**-3**	16	27%
Over 21 Radiologists	**108**	38	**113**	21	28%
Practice Location					
Main city of large metro area	**142**	45	**134**	19	24%
Suburb of large metro area	**72**	30	**58**	18	19%
Main city of smaller metro area	**0**	34	**9**	17	34%
Suburb of smaller metro area	**125**	72	**134**	65	12%
Non metro or rural	**17**	36	**23**	29	9%
Varied locations	**66**	68	**96**	31	2%
Census Region					
Northeast	**150**	50	**130**	26	23%
Midwest	**-3**	21	**-11**	17	22%
South	**99**	41	**111**	25	33%
West	**-8**	19	**-9**	14	22%
Practice Type					
Solo	**62**	53	**79**	43	5%
Primarily Academic	**71**	49	**73**	23	18%
Private multi specialty	**83**	29	**84**	18	19%
Government	**495**	194	**495**	51	3%
Private Radiology	**34**	27	**18**	13	52%
Other	**42**	56	**51**	42	2%

Note: * The weights by category add up to 100%

Table 6: Work Hours and Vacation Weeks of Full-time Radiologists, by Practice Type

		Weekly Hours		Annual Hours		Vacation Weeks		Vacation Days*	
Practice Type	**n**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**	**Mean**	**SE**
All	475	49.3	0.5	2,083	24	7.8	0.2	38.8	1.0
Solo	18	50.3	3.0	2,296	140	4.4	0.7	21.8	3.3
Primarily Academic	80	50.3	1.2	2,256	59	5.2	0.2	25.9	1.2
Private multi specialty	95	48.3	1.2	2,000	54	8.6	0.5	42.8	2.3
Government	9	41.6	0.9	1,870	44	5.0	0.3	25.1	1.4
Private Radiology	248	50.4	0.7	2,073	33	9.0	0.2	44.9	1.2
Other	13	38.4	7.6	1,621	318	6.2	1.8	31.1	9.1

Note - * Assumes 5 working days per week

Table 7: Annual Procedures per FTE Radiologist According to Practice Type

		2007					2003		
Practice Type	**n**	**Mean**	**SE**	**Lower Quartile**	**Median**	**Upper Quartile**	**Mean**	**SE**	**% change**
All	346	14,855	427	11,429	14,326	18,462	13,900	200	7% *
Solo	11	13,951	706	12,000	15,000	15,000	15,100	1,100	-8%
Primarily Academic	47	10,333	753	7,222	9,135	11,765	9,900	400	4%
Private multi specialty	67	14,050	1,014	9,349	13,733	16,800	13,900	300	1%
Government	6	15,309	1,580	13,333	13,333	18,667	11,800	800	30% *
Private Radiology	199	16,558	475	12,138	16,000	21,333	15,200	300	9% *
Other	5	14,044	1,300	10,000	15,000	15,000	12,500	1,000	12%

* Statistically significant P<.05

Appendix I – Summary of Key Findings from Recent ACR Surveys

Relevant ACR Studies 1989-2007 and Key Findings

First Author	Year	Survey	Key Findings
Characteristics of Radiologists			
Deitch	1993	1990 Survey of Radiologists	Changes include more women, subspecialists, and fellowship-trained radiologists in younger age groups
Sunshine, JH	1993	1989 Medicare	Nonradiologists performed 25% of all radiologic work in the United States
Chan	1995	1990 Survey of Radiologists	65% of Radiologists are satisfied with their job
Deitch	1995	1990 Survey of Radiologists	
Deitch	1997	1995 Survey of Radiologists	Few changes from 1990-1995; more women, more specialties, fewer solo practices
Crewson	1999	1995 Survey of Radiologists	Satisfaction has declined due to fear about managed care
Sunshine, JH	2002	2000 Survey of Radiologists	51% of Radiologists want less work. The shortage is increasing
Meghea, C	2005	2003 Survey of Radiologists	Overall balance in work; Govt and acad practices want more work
Meghea, C	2007	2003 Survey of Radiologists	More intensity results in a desire for fewer annual hours
Zafar	2007	2003 Survey of Radiologists	Radiologists have higher satisfaction than other physicians; satisfaction has decreased over time.
Characteristics of Radiology Practices			
Sunshine, JH	1992	1989 Survey of Groups	Supply and demand are in balance
Bansal	1994	1991-92 ACR Census	
Sunshine, JH	1994	1992 Survey of Groups	Workload stable from 86 to 89 and 92
Sunshine, JH	1995	1992 Survey of Groups	Changes since 1989 were small
Cypel, YS	2003	1999 Survey of Practices	
Analysis of Workload and Productivity			
Sunshine, JH	1998	1996 Hiring by Groups	Substantial growth in procedures and RVUs per FTE
Conoley	2000		Workload is increasing due to higher utilization of cross sectional imaging and int. studies
Sunshine, JH	2000		
Levin	2002	Medicare	Cardiologists doing more MPI
Bhargavan, M	2002	1999 Practices	Substantial growth in procedures and RVUs per FTE
Bhargavan, M	2005	2003 Radiologists	Substantial growth in procedures and RVUs per FTE
Bhargavan, M	2005	MEPS	Demand for radiology services (workload) increases 8% annually

Relevant ACR Studies 1989-2007 and Key Findings (Continued)

First Author	Year	Survey	Key Findings
Supply of Radiology Workforce - Ability for Training Graduates to find Employment			
Sunshine, JH	1994	1994 Res. Training Directors	Job market is weakening
Sunshine, JH	1996	1995 Res. Training Directors	Despite high pessimism, unemployment is remarkably low
Burkhardt	1997	1996 Res. Training Directors	Low unemployment, and res directors are cutting spots significantly
Crewson	1998	1997 Res. Training Directors	1997 job market improved over 1996 job market, 13-14% reduction in the annual graduates
Crewson	1999	1998 Res. Training Directors	<1% unemployment
Bushee	2000	1999 Res. Training Directors	Fellows found jobs earlier than in past years. Program reductions are < than reported in 1998
Demand for Radiology Workforce - Studies of Practice Hiring			
Deitch	1992	1991 Hiring Survey	Supply and demand are in balance
Sunshine, JH	1995	1994 Hiring Survey	Employment market is weakening; however, large-scale collapse has not occurred
Deitch	1996	1994 Hiring Survey	Available positions decline sharply, but 400 positions remained vacant at the season end
Mallick	1997	1996 Hiring Survey	The 1991-1995 decline in hiring has ceased and perhaps reversed
Elliot	1999	1997 Hiring Survey	Shortage: 278 excess positions available
Hogan	2001	1998 Hiring Survey	Shortage: 330 excess positions available
Analysis of Help Wanted Indices and Placement Data			
Forman, HP	2000		Introduces HWI as a new indicator for measurement
Covey, A	2000		Demand for radiologists is rising according to HWI
Saketkhoo, D	2002		Shortage of radiologists is stabilizing
Sunshine, JH	2002		Placement service data are reasonably accurate measures of the employment market
Saketkhoo	2003		
Sunshine, JH	2004	2003 Rads, job adv, vacancies, ratio	Shortage has considerably eased
Saketkhoo, D	2005		Substantial decline in demand for diagnostic radiologists
Licurse	2006		Discrepency between 3 indices; demand on the rise.
Sunshine, JH	2007		Fewer job offers. Finding highly desirable jobs is difficult
Commentary on Shortage and Surplus			
Sunshine, JH	1992		Accurate long-term projection of supply and demand is difficult
Janower, M	1996		Describes factors affecting shortage and surplus
Bhargavan, M	2002	2000 Rads	There is a serious shortage which is projected to increase
Sunshine, JH	2006	1995, 2003 Rads	Shortage has eased for a variety of reasons

Appendix II – 2007 ACR Survey of Radiologists

INTRODUCTION
[Read By Telephone Interviewer]

Hello. My name is _____ and I am calling from dmrkynetec on behalf of Dr. Arl Van Moore, Chairman of the Board of the American College of Radiology. Dr. Moore recently e-mailed Dr. _____ to say we would be calling on his behalf. May I speak with Dr. _____?

[IF NOT AVAILABLE, ATTEMPT TO SCHEDULE A SPECIFIC CALL BACK. IF THE DOCTOR WILL NOT BE AVAILABLE WITHIN THE NEXT 3 WEEKS, THANK AND TERMINATE.]

[To doctor]: Good morning/afternoon, Dr. _____. My name is _____ and I am calling from dmrkynetec on behalf of the American College of Radiology.

You should have been notified by e-mail recently by Dr. Arl Van Moore (chair of the ACR Board of Chancellors) about a very important information collection effort the ACR is undertaking with regard to recent Medicare reimbursement cuts for radiology. The ACR has contracted with dmrkynetec to conduct a brief telephone survey on this subject and other important problems radiologists face. I would like to take just a few minutes of your time today to ask some questions. Please be assured that the information will be used only by the ACR and that the confidentiality of your answers will be preserved.

[SCREENER QUESTION:] Are you a diagnostic radiologist, interventional radiologist, or nuclear medicine physician actively practicing in the US?

Yes – **[CONTINUE WITH Q1]**
No – **[SKIP TO THANK YOU AND GOODBYE]**

Q1. Doctor [_____], are you familiar with the radiology payment cuts by Medicare that are part of the Deficit Reduction Act of 2005?

Yes – **[SKIP TO Q2]**
No – **[CONTINUE WITH BACKGROUND]**

Background: The Deficit Reduction Act of 2005 became law early last year. One of the Act's provisions caps the technical component of Medicare payment for physician office imaging to the lesser of the Hospital Outpatient Prospective Payment or Medicare Fee Schedule payment, effective January 1, 2007. This provision, combined with other cuts, reduces payment for numerous, important imaging procedures.

Q2. In order to assess the impact this and other payment cuts have on radiologists, the ACR needs information on the extent to which radiologists and their patients are affected. We have prepared a few questions in that regard. They deal with some

characteristics of your practice and your workload, as well as with practice finances.

How many FULL-TIME radiologists are in your practice? Exclude residents and fellows but include interventionalists and nuclear medicine specialists.

_____ Full-time radiologists
_____ Don't know [If the response is "Don't know," ask for an approximate answer.]

"Full-time" refers to whatever is typical for your practice.

Q3. How many PART-TIME radiologists are in your practice (If none, enter "0"):

_____ Part-time radiologists
_____ Don't know [If the response is "Don't know," ask for an approximate answer.]

"Part-time" refers to physicians who typically work fewer than full-time hours.

Q4. Do you, yourself, work full-time or part-time?

_____ Full time
_____ Part time

Q5. What is the approximate average number of hours a full-time radiologist works per week in your main practice in a regular week—that is, a week with no holidays or other special events?

_____ Hours per week

Q6. How many weeks of vacation a year does a full-time radiologist in your practice get, on average?

_____ Weeks of vacation per year

Q7. Do you subspecialize within radiology, even to a small extent?

_____ Yes
_____ No **[SKIP TO Q9]**

Q8. What is your main subspecialty?

[INTERVIEWER, DON'T READ THE LIST BELOW. JUST CHECK OFF WHATEVER THE RESPONDENT SAYS, AND IF RESPONDENT DOESN'T GIVE ONE OF THESE ANSWERS, CHECK "OTHER" AND

WRITE IN THE RESPONDENT'S ANSWER. REGARD ANSWERS AS CORRESPONDING TO AN ENTRY ON THE LIST REGARDLESS OF WHETHER RESPONDENT ONLY GIVES THE ADJECTIVE, OR GIVES "IMAGING" OR "RADIOLOGY" OR SOMETHING SIMILAR AS A SECOND WORD. FOR EXAMPLE, "ABDOMINAL," "ABDOMINAL IMAGING," AND "ABDOMINAL RADIOLOGY" ALL SHOULD BE RECORDED AS THE FIRST CATEGORY.]

_____ Abdominal imaging
_____ Body imaging
_____ Breast imaging
_____ Interventional
_____ Magnetic resonance imaging (MR or MRI)
_____ Musculoskeletal
_____ Neuroradiology
_____ Nuclear medicine/nuclear radiology
_____ Pediatric radiology
_____ Ultrasound/sonography
_____ Other (write what respondent said)
_____

Q9. Given that income largely depends on the amount of work done, how does the number of hours and weeks you work compare with the amount you would like? Please let me read the three answer options before you answer.

_____ My work and my income are about right
_____ I would like my work and my income reduced by about _____ percent
_____ I would like my work and my income increased by about _____ percent

Q10. Does your main practice use a nighthawk service from outside of the practice? **[Probe: A nighthawk service provides radiologic image interpretations external to the location where the study is performed. The nighthawk service may be in the U.S. (domestic) or outside the U.S. (foreign; offshore)]**

_____ Yes
_____ No

Q11. Which one of the following best describes your main practice? Please allow me to read the full list before you answer.

[Mark only one]

a. Solo practice

b. Locum tenens

c. Primarily an academic practice (regardless of ownership)

d. Government practice, such as military or VA, and not primarily academic. (Note: If private practice on contract, do not use this category)

e. Private, multi-specialty practice, not primarily academic

f. Private radiology, nuclear medicine, and/or interventional radiology practice (or practice involving some of their subspecialties), not primarily academic

g. Other, specify: _____

Q12. Which one of the following best describes where your main practice is located? Again, please allow me to read the full list before you answer. Is your practice mostly in a:

[Mark only one]

a. Main city of a large metropolitan area (total area population 1,000,000 or more).

b. Suburb of a large metropolitan area (total area population 1,000,000 or more).

c. Main city of a smaller metropolitan area (total area population greater than 50,000 but less than 1,000,000).

d. Suburb of a smaller metropolitan area (total area population greater than 50,000 but less than 1,000,000).

e. Non-metropolitan location (total area population 50,000 or less, or rural).

f. Varied locations, no one type is principal.

Many of the following questions ask about business and operational details of your practice. If you find you don't know the answer, could you refer us to someone who does, such as the practice manager**? [IF MULTIPLE "DON'T KNOW'S" START OCCURING, GET NAME AND CONTACT INFORMATION OF SOMEONE MORE LIKELY TO KNOW THE ANSWER**.]

Q13. For the most recent 12 months for which data are conveniently available, what is the total number of procedures performed by your main practice? (If you don't know, please check with your practice head or administrator):

_____ Number of procedures performed

Q14. Do you yourself, or you as part of your group, have an ownership interest or equity partnership in any radiology office or imaging center facility or other entity that owns diagnostic imaging equipment used to perform tests outside the hospital setting? This could be ownership through your practice or through a separate partnership, joint venture, corporation, etc.

_____ Yes
_____ No **[SKIP TO Q15]**
_____ Don't know **[SKIP TO Q15]**

What modalities are owned? I will read several imaging modalities and then check all that apply.

a. Computed tomography or CT

b. Magnetic resonance imaging or MRI

c. Positron emission tomography or PET

d. Other nuclear medicine

e. Mammography

f. Ultrasound

g. Interventional radiology

Q15. Are you **affiliated** in any of the following ways with a diagnostic imaging center that performs diagnostic imaging procedures outside the hospital setting? I will read several types of affiliation and then check all that apply:

a. An equity partner in the imaging center

b. A salaried employee of the imaging center

c. Provide services to the imaging center under contract

d. None of the above

e. Other (explain)

_____

Questions 16 through 20 pertain to the Deficit Reduction Act of 2005 and Medicare Payment Policies. Given their limited relevance to this paper, these questions are not repeated here.

Thank you for your time. Your response is extremely valuable to the profession.