RURAL RADIOLOGY: WHO IS PRODUCING IMAGES AND WHO IS READING THEM?

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EXECUTIVE SUMMARY

This study identifies the advanced imaging technology available to rural hospitals including on-site and mobile technology and assesses access to timely radiological interpretation of plain film and advanced technology images. Data were collected by a survey of hospital administrative personnel in all rural hospitals in an eight state region (Idaho, Iowa, Minnesota, Montana, North Dakota, Oregon, South Dakota, Washington, and Wyoming) of the Northwest. Rural hospitals were defined as all hospitals in the eight states not in a Metropolitan Service Area.

The outcome measures used in the study included the percent of rural hospitals with advanced imaging technology (such as computerized axial tomography, magnetic resonance imaging, dedicated mammography, and ultrasound) locally available, and the frequency of an on-site radiologist to interpret these images as well as plain film images.

The results indicate that local availability of advanced imaging technology varied from 92 percent for dedicated mammography units, 90 percent for ultrasonography, and 73 percent for computerized axial tomography to only 31 percent for magnetic resonance imaging. Radiologists were on site in the rural hospitals some portion of 46 percent of the days each year; 39 of the rural hospitals had on-site radiological services less than once a week.

Rural hospitals clearly provide local access to many types of advanced imaging technology. However, the availability of an on-site radiologist to interpret all types of radiological images is limited. This suggests that non-radiologists are major radiology service providers in rural America. More comprehensive studies of the actual process of image interpretation in the daily care of patients in rural hospitals are needed. In particular, who is interpreting radiology images in rural hospitals and with what accuracy and what effect on the quality of patient care?

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INTRODUCTION

Each day thousands of people in hospitals across rural America require medical images for the assessment and diagnosis of symptoms and diseases. However, the medical literature contains little information about the availability of imaging services and radiologists to rural Americans. Information on the local accessibility of equipment such as dedicated mammography units, ultrasonography machines, Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) equipment has been summarized on a national basis but not specifically for rural areas (AHA, 1991; Mettler, et al., 1993). In addition, no information on when, how and by whom the resulting images are interpreted has been published.

With the possible exception of MR imaging, most of the newer radiologic technologies are considered a part of standard care in primary as well as tertiary care hospitals. Without access to specialized images, providers must refer patients to other sites. Referrals may result in delayed care for patients, lost revenues for hospitals and providers, and outmigration for other services that are available locally (Bronstein and Morrisey, 1990; Bateman, 1991). Diagnostic or treatment delays may adversely affect the quality of patient care while loss of patients and revenues may make the recruitment and retention of rural providers more difficult.

Radiologists perform or interpret the results of most hospital imaging procedures. Some of these procedures are considered urgent and affect patient care

within minutes. These procedures must be completed by physicians available on site. Non-urgent imaging procedures usually affect patient care within hours, rather than minutes, but still need to be interpreted promptly. No information has been published assessing the current availability of radiologists to provide timely interpretation of rural hospital and emergency room x-rays. This information is needed because new rules about ownership of the imaging technology, new certification requirements for mammography providers, and escalation of specialty "boundary" issues regarding the interpretation of images could have a major impact on the future availability of rural imaging services. The purpose of this study is to provide information on the current availability of imaging equipment in rural hospitals, the accessibility of radiologists to patients in rural hospitals and the alternatives utilized when radiologists are not locally available. This information is useful in providing a context and a baseline for assessing the possible impacts of policy changes now under consideration.

METHODS

Primary data for this study were gathered through telephone surveys of rural hospital administrators during June, July and August of 1991. These data were part of a larger study of rural hospitals that addressed issues relating to staffing, technology and financial stability. To be considered rural, a hospital had to be located in a county that was not part of a metropolitan statistical area (MSA) as determined by the U.S. Office of Management and Budget (U.S. Department of Commerce, 1987). All rural hospitals (n = 454) in an eight state area (Washington, Oregon, Idaho,

Montana, North Dakota, South Dakota, Minnesota and Iowa) were contacted with 97 percent (n = 441) responding to the survey.

Telephone interviews were conducted with each hospital administrator by interviewers from the University of Minnesota Institute for Health Services Research Survey Research Center. The interviews provided a complete description of the composition of the hospital's medical staff and an inventory of technologies available at the hospital. Additional data on the number of beds, inpatient admissions, emergency visits, outpatient visits and availability of certain types of services such as orthopedic surgery, outpatient surgery, and obstetric units, at each hospital were obtained from the AHA 1990 annual survey data file. The Medicare case mix index for each hospital was obtained from 1991 Prospective Payment System data.

RESULTS

Characteristics of Hospitals Surveyed

The majority of hospitals surveyed have fewer than 50 beds and are located in small communities more than 60 miles from a city with a population of 50,000. Thirteen percent of the hospitals are Medicare-designated rural referral centers and 41 percent are designated as sole community hospitals. The average bed size of the hospitals in the survey is significantly less ($p < .01$) than that of all rural hospitals nationally (Table 1).

The average number of physicians on the active medical staffs of the surveyed hospitals is 15. Ninety-seven percent of the hospitals have a general or family

Table 1

Characteristics of Study Hospitals

Population Served					Road Miles to City of 50,000 or More					Number MDs on Active Medical Staff						
<10,000	10,000-24,999	25,000-49,000	>=50,000	Mean (SD)	<=30	31-60	61-120	>120	Mean (SD)	0-1	2-4	5-7	8-14	15-40	>40	Mean (SD)
35%	39%	14%	12%	24,836 (37,271)	9%	20%	47%	24%	92 (60)	6%	34%	17%	17%	16%	10%	15 (23)

	Bed Size					
	<24	25-49	50-99	100-199	>=200	Mean
Study Hospitals (n=441)	26%	46%	18%	8%	2%	49 beds
All Rural Hospitals[1] (n=2,460)	8%	31%	33%	21%	7%	84 beds

[1]From 1990 AHA annual survey (Hospital Statistics, 1991).

physician on active staff and 60 percent have a general surgeon. Other specialists are less commonly present on active medical staffs.

Imaging Equipment Accessibility

The local availability of specialized imaging technologies was assessed (Table 2). No information was collected regarding equipment for plain films or contrast studies. Among the survey respondents, only four percent have a fixed MRI unit, but 28 percent use mobile MRI services. On average, hospitals with fixed MRIs have more beds (155 versus 45), larger active medical staffs (87 versus 13), and serve larger populations (116,000 versus 21,000) than other rural hospitals. Those with no local fixed or mobile MRI services have, on average, fewer beds (35), fewer active medical staff members (18), and serve smaller communities (14,000). The average distance from the nearest city of 50,000 is approximately the same for hospitals with fixed, mobile or no MRI services. For those with neither a mobile or fixed MR imaging unit (69 percent), the nearest unit is located an average of 59 miles away.

Seventy-three percent of the hospitals have local access to a CT scanner. Twenty-seven percent have a fixed CT scanner at their hospital or a nearby clinic, while 46 percent use a mobile CT scanner. Like the MRI equipment, fixed CT scanners are, on average, more likely in larger hospitals (92 versus 33 beds) with larger medical staffs (40 versus 6) that serve more populous areas (58,000 versus 12,000). Small hospitals in small communities are the least likely to have CT scanners, mobile or fixed.

Table 2

Imaging Technology in Rural Hospitals (n = 441)

Technology	Installation			Ownership	
	Fixed	Mobile	None	Hospital[1]	Physician[2]
MR Imaging	4%	27%	69%	14%	9%
CT Scan	27%	46%	27%	35%	5%
OB Ultrasound	59%	29%	12%	66%	6%
Abdominal Ultrasound	57%	33%	10%	63%	6%
Doppler Ultrasound	41%	32%	27%	57%	7%
Dedicated Mammography Unit	63%	29%	8%	70%	7%

[1]Hospital either totally or partially owns the technology.
[2]Physician(s) either owns or shares ownership in the technology.

Note: Other ownership arrangements include rent or lease, and ownership by other hospitals.

SOURCE: Adapted from Table 6.1 in Hartley, D., "Mobile Technology in Rural Hospitals: The Case of the CT Scanner," unpublished Ph.D. thesis, University of Minnesota, Minneapolis: 1993.

For hospitals with mobile CT scanners, these units are on site an average of two days per week and include the services of a special radiology technician for 99 percent of the hospitals. Two percent of hospitals using mobile scanners reported that a radiologist accompanies the scanner. Thirty percent of the hospitals using mobile CT reported that the owners of the unit provide the services of a radiologist as a consultant. Hospitals without local CT technology refer patients to a clinic or hospital an average of 51 miles away when CT scans are required.

Over three quarters of the hospitals surveyed have locally available fixed or mobile obstetrical (OB), abdominal and Doppler ultrasound (Table 2). Eighty-eight percent of hospitals that have both OB and abdominal ultrasound capabilities use the same unit for both procedures. Hospitals without ultrasound technology report that a unit is available an average of approximately 45 miles away.

Four hundred eight hospitals, 92 percent of the sample, indicate that they have a dedicated mammography unit; 66 percent have the unit permanently installed in the hospital, 32 percent use a mobile unit and two percent use a dedicated mammography unit that is permanently installed in a clinic near the hospital. Among the 33 hospitals that do not have a dedicated mammography unit, only three use conventional x-ray machines for mammography. The primary reasons given for not acquiring a dedicated mammography unit include the cost of purchase or installation, lack of demand, and the availability of dedicated mammography nearby.

Ownership of all types of imaging equipment varies with the expense required to purchase and install it (Table 2). Local hospital ownership (total or partial)

increased from only 14 percent of hospitals owning all or part of the relatively expensive MRI unit to 70 percent of hospitals owning all or part of a dedicated mammography unit. The number of hospitals reporting physician ownership of equipment varied from five percent of CT scanners to 9 percent of MRI machines (Hartley and Moscovice, 1994). However, the ratio of physician ownership/hospital ownership was much higher for the more expensive MRI and CT equipment than for the ultrasound and mammography equipment.

The availability of imaging technology differs according to a hospital's size and the availability of other services in the area. Table 3 provides a summary of hospital characteristics and availability of different types of technology by Medicare designation of the hospital as a rural referral center, a sole community hospital, both or neither. In general sole community hospitals are smaller and more isolated and rural referral centers are larger and provide a greater diversity of services. As one would expect, all types of technology are significantly more likely ($p < .001$) to be on-site (either fixed or mobile) in rural referral centers.

Image Interpretation

Imaging equipment is of little value without having someone available to interpret the images produced. On average, for the hospitals in the sample, a radiologist is present for at least part of three days per week. However, the presence of a radiologist varies from less than once per week in 39 hospitals to daily in 55 hospitals (Table 4). The number of days per week a radiologist is present in the

Table 3

Characteristics of Hospitals and Availability of Radiologic Services by Type of Hospital

	Type of Hospital			
	Rural Referral Center (RRC) Only (n = 31)	**Both RRC and SCH (n = 24)**	**Neither RRC or SCH (n = 232)**	**Sole Commmunity Hospital (SCH) Only (n = 154)**
Characteristics of Hospitals				
Beds	129 (65)[1]	88 (69)	42 (27)	36 (27)
Population of service area	92,545 (67,582)	53,325 (60,137)	19,709 (23,097)	14,356 (22,846)
Road miles to city of 50,000	87 (47)	87 (40)	77 (48)	116 (72)
Number of active physicians	68.3 (40.4)	30.3 (25.8)	11.0 (13.3)	8.5 (12.9)
Characteristics of Radiology Practice				
Days/week a radiologist is present in hospital	6.0 (1.8)	5.0 (2.2)	3.3 (2.1)	2.4 (2.0)
Proportion of hospitals served by radiology group practice	87%	65%	63%	57%
Proportion of hospitals served by local radiology practice	93%	70%	30%	28%
Radiologist does own billing	93%	78%	78%	76%

Table 3 (continued)

	Type of Hospital			
	Rural Referral Center (RRC) Only (n = 31)	Both RRC and SCH (n = 24)	Neither RRC or SCH (n = 232)	Sole Community Hospital (SCH) Only (n = 154)
Presence of Imaging Technologies				
MRI				
Fixed	36%	8%	.4%	2%
Mobile	45%	38%	28%	22%
None	19%	54%	72%	76%
CT				
Fixed	84%	58%	20%	21%
Mobile	10%	25%	56%	41%
None	7%	17%	24%	38%
OB Ultrasound				
Fixed	90%	75%	56%	53%
Mobile	7%	17%	32%	30%
None	3%	8%	12%	17%
Mammogram				
Fixed	77%	75%	67%	51%
Mobile	7%	8%	27%	42%
None	16%	17%	6%	7%

[1] Numbers are means and numbers in ( ) are standard deviations.

Table 4

Characteristics of Rural Hospitals by Number of Days Per Week Radiology Services are Provided

Characteristics of Rural Hospitals	Number of days per week a radiologist is in the hospital			
	< 1 day/wk (n = 39)	1-3 days/wk (n = 205)	4-5 days/wk (n = 125)	> 5 days/wk (n = 72)
Admissions/week	5.5 (3.0)[1]	10.6 (6.7)	31.2 (23.7)	77.9 (46.5)
Outpatient visits/week[2]	60.0 (38.9)	134.3 (94.7)	354.5 (273.7)	743.0 (467.9)
Surgeries/week	.99 (1.5)	3.9 (4.4)	13.3 (2.4)	16.2 (11.3)
Medicare case mix index	.96 (.09)	1.01 (.09)	1.11 (.11)	1.24 (.13)
Specialty scale[3]	2.7 (2.9)	3.4 (3.5)	8.5 (5.0)	13.8 (3.6)
Road miles to radiology practice[4]	NA	56.8 (57.7)	22.8 (40.2)	7.0 (7.6)

[1]Numbers in ( ) are standard deviations.
[2]Outpatient visits per week include both outpatient and emergency visits.
[3]Specialty scale is a variable constructed using Guttman scaling techniques. It represents the level of specialization on a rural hospital medical staff using a single scale. The scale values range from 0 to 17 with 17 indicating the highest level of specialization. For more information on the development of the scale variable refer to Christianson et al., 1993.
[4]Road miles to radiology practice with local radiologists assigned a value of 5 miles.

hospital is associated with indicators of the volume of services provided by the hospital, the complexity of the services it provides, and the cost to the radiologist of providing the services. Measures of the volume of services include the number of hospital admissions, the number of outpatient and emergency room visits, and the number of surgical procedures done each week. Each of these measures is significantly correlated with the number of days a radiologist is present in the hospital each week. As the volume of services increases, the number of days a radiologist is present increases. Simple correlation analysis also shows a strong positive and statistically significant association amongst these different measures of service volume (Table 5).

The complexity or intensity of services provided by the hospital is assessed using two index measures: the Case Mix Index (CMI) (a scale based on the diagnostic related groups of Medicare patients served in the hospital each year) and the Specialty Scale, an index describing the specialty composition of the hospital medical staff. Increased patient complexity and increased diversity of hospital medical staff are positively and significantly ($p < .001$) correlated with the number of days a radiologist is in the hospital each week.

The distance from the hospital to a radiologist's base practice is one readily available estimate of the cost to the radiologist of providing services. The number of road miles between the hospital and the radiologist's base practice (with "local radiologists" assumed to be five miles away) is negatively correlated with the frequency of radiologist services in the hospital. Local radiologists are more likely to

Table 5

Pearson Correlations Among Hospital Characteristics and Number of Days Per Week Radiology Services are Provided

	Days/Week	Admissions/Week	Outpatient Visits/Week	Surgeries/Week	Case Mix Index	Specialty Scale
Admissions/week	.6751					
Outpatient visits/week	.6529	.8119				
Surgeries/week	.5639	.4940	.4599			
Case mix index	.6661	.6622	.5682	.5050		
Specialty scale	.7097	.7100	.6469	.4533	.6474	
Road miles to the radiologist	-.4318	-.2923	-.2630	-.2472	-.2709	-.3045

All correlations are statistically significant at a p-value $< .001$.

be in the hospital more than three times a week but non-local radiologists are present, on average, less than three times per week.

The various measures of volume, intensity and cost of services not only correlate with the number of days a radiologist is present in a hospital but are also strongly correlated with one another (Table 5). For example, hospitals with large numbers of admissions are likely to have large numbers of emergency room visits and to include diverse specialties on their medical staff. However, investigating only one measure of size, or one of complexity, may ignore special needs for radiology services represented in each of the volume and complexity measures.

Regression analysis was used to control for other effects when assessing the relationship between radiologist availability and each of the measures. Indicator variables for each state were included in the regression equations to control for potential confounding effects related to practice style or availability of unmeasured services across states. Because the inclusion of both admissions and outpatient visits resulted in unstable estimates, due to their very high correlation, only admissions per week was included in the final regression model. Admissions per week was the preferred variable since the frequency and diversity of imaging procedures is likely to be greater in hospitalized patients than in outpatients.

The volume of services, complexity of services and cost to the radiologist of providing the services all remained significantly related to the frequency of radiology services controlling for other correlations through regression analysis. Radiologist

availability in the hospital increases with higher volume and more complex services, as well as shorter travel distances for the radiologist.

What Happens When A Radiologist Is Not Present?

Thirty-nine hospitals do not have a radiologist in their facilities one or more times per week. Twenty-two of these 39 hospitals report that a radiology consultant does the final interpretation of all their x-rays while 16 indicate that a staff physician does the final interpretation. When images are sent to a radiologist, 22 of these hospitals use a courier, seven use the mail and four use both a courier and mail. It takes an average of 28 hours to receive the results when images are sent to a consultant. None of these facilities had teleradiology in 1991, although eight did plan to acquire the technology for transmitting radiology images within the next five years.

Few rural hospitals have an in-house radiologist 24 hours a day. When a radiologist is not present, 60 percent of the 441 hospitals said a radiologist is on call to come to the hospital. Other arrangements for having an image interpreted include using a courier (25%), fax or teleradiology (3%), or mail service (3%) to deliver an image to a radiologist; having one of the non-radiology medical staff read the image (5%); referring the patient to another facility (2%); or, a combination of arrangements. When an image is sent to a consultant it takes an average of 13 hours to receive the results, with little difference in turnaround time for those hospitals served by local or non-local radiologists .

Forty-six (10%) of the surveyed hospitals obtain a radiologist's services at least part of the time through teleradiology. Twenty-eight report they send CT images, nine

send MR images, 16 send ultrasound, five send mammograms and 27 send plain films. These hospitals report that the average time elapsed between sending an image to a radiologist and receiving an interpretation has decreased from approximately 20 hours before teleradiology to three hours with teleradiology. An additional fifty-five hospitals indicate that they are considering the acquisition of teleradiology capability by 1996. Reasons given for not having teleradiology include the frequent availability of a radiologist at the hospital, the high cost of purchase and installation, poor image quality and the lack of a radiologist to read the transmitted images.

Hospital-Radiologist Relationships

Because radiologists are often considered hospital-based physicians, they may have unique relationships with the hospitals in which they work. According to the hospital administrators, 22 percent of hospitals provide billing services to their radiologists. Hospitals provide free billing services to 29 (20%) of the solo radiologists and 10 (4%) of the group practice radiologists. Seven hospitals indicate that they guarantee their radiologist an annual income or dollar volume of business. Six of these seven hospitals provide the guarantee to a local solo radiologist.

DISCUSSION

Most rural hospitals in the eight-state study region have access to radiological services and many to advanced radiologic technology. However, compared to all U.S. hospitals, these rural facilities are less likely to have fixed or full time services. In 1990, 58 percent of all U.S. hospitals, versus only 27 percent of the surveyed

hospitals, had fixed CT scanners (AHA, 1991). However, another 46 percent of the surveyed rural hospitals had mobile CT scanners available locally. The number of magnetic resonance image machines was 0.26 per hospital in the entire U.S. but only 0.04 in the study sample of rural hospitals (Mettler, et al., 1993). An additional 121 (28%) of the rural hospitals had mobile units, narrowing the gap in local hospital availability of the service. While imaging technology is less readily available in rural areas, not including mobile technology in comparisons to urban hospitals falsely exaggerates this difference.

The availability of locally-based radiology equipment decreases with the expense of the equipment and its installation cost. The same trend exists for all technology available to a rural hospital (i.e. locally based and mobile technologies). While 92 percent of the rural hospitals have dedicated mammography machines available locally, only 31 percent have MRI available locally. This gradient from high availability of mammography and ultrasound to limited availability of MRI mirrors the national trend.

Physician ownership of the radiology equipment used by rural hospitals was minimal in 1991. Only five percent to nine percent of MRIs, CT scanners, ultrasound machines and dedicated mammography units had at least partial physician ownership. However, the likelihood of at least partial physician ownership vs. hospital ownership increased with the overall expense of the equipment. The number of imaging units having even partial physician ownership is difficult to assess. The nine percent of hospitals reporting at least partial physician ownership of the MRI equipment may be

reporting on the ownership of only two or three mobile machines used by several of the hospitals surveyed or they could be reporting on many different mobile machines.

Since this survey in 1991, physician ownership of medical equipment has become subject to additional legal and financial penalties (Crane, 1992). New "safe harbor" regulations and the passage of the Stark II law regarding medical equipment impose very stiff financial penalties for physician ownership of any equipment in which physicians could receive financial gain from patient referrals (Hudson, 1993). These regulations have become so complex and cumbersome that groups such as the American Medical Association are recommending that physicians should not consider ownership of medical equipment without intensive legal scrutiny prior to purchase (Council on Ethical and Judicial Affairs, 1992). Therefore it seems unlikely that physician ownership of imaging equipment in rural hospitals will increase from the relatively low level observed in the study sample.

Most of the rural hospitals surveyed appear to meet the minimal standards for mammography by using dedicated machines for mammography screening. Only thirty-three of the surveyed hospitals did not have a dedicated mammography unit and, of these thirty three, only three used conventional x-ray machines for mammograms. A new mammography technology law that became effective on October 1, 1994 may have an impact on the future availability of rural mammography services. The law requires all mammography units to have American College of Radiology accreditation to receive Medicare reimbursement. Many rural hospitals report the accreditation process to be long and arduous, especially for mobile mammography machines

(personal communication, June Hart, Minnesota Department of Health, Radiation Safety Control Section). Because this law increases the administrative cost of acquiring and maintaining a mammography unit, and may prohibit some rural hospitals from receiving Medicare reimbursement, it could decrease the number of rural hospitals that will provide mammography services in the future. Thus, in this case, efforts to assure quality could increase costs and decrease access.

Radiologists expect to perform or interpret the results of most hospital imaging procedures. For emergency radiology procedures or emergency interpretation of radiographs, 60 percent of rural hospitals say they have a radiologist on call. For the other 40 percent, "quick" x-ray interpretation requires an average of 13 hours by courier and mail or three hours for teleradiology. These times are quite long when there is need for an urgent clinical decision.

While hospitals have some special arrangements for emergency radiologist consultations, most x-rays are not emergent but affect the care of the patient on an immediate or daily basis. Radiologists are available an average of three times each week to the 441 respondent hospitals, leaving over 54 percent of the days each year with no radiologists on site. This raises several questions concerning how radiologic services are provided on these days. Who actually reads the urgent and routine images upon which emergent as well as daily patient care decisions are made? What is the accuracy of interpretations made by non-radiologists? Is the rate of accuracy of non-radiologist interpretation different for different types of x-rays? These are issues that need to be considered in scientifically valid ways, and a limited number of

studies have begun to look at these questions (McGinty, 1994). However, radiology groups, including the American College of Radiology, have expressed concern over the usefulness of studies designed to evaluate the frequency and accuracy of non-radiologist interpretation of x-rays (MSR, newsletter of the Minnesota Society of Radiologists, September, 1994). Nevertheless, with over 46 percent of radiology relative value units being completed by non-radiologists in some states, such as North Dakota (Sunshine, Bansal and Evens, 1993), and no radiologist being on site the majority of days in the rural hospitals surveyed, such studies could provide important information about quality of care in rural areas, as it relates to imaging interpretation.

Teleradiology is often suggested as one solution when a radiologist is not present in a rural hospital (Franken, et al., 1993). But teleradiology has a low penetration in these 441 rural hospitals with only ten percent using teleradiology in 1991 and another 13 percent suggesting that they plan to acquire teleradiology by 1996. With the increased availability of federal and state grants for purchase of this equipment, this trend needs to be monitored. The validity of the concerns expressed by the hospitals not planning to purchase teleradiology equipment, and those who have abandoned their teleradiology equipment (e.g. image quality, cost of installation and lack of 24 hour radiologist coverage at teleradiology receiving sites) should also be evaluated.

Currently most of the rural hospitals in this study have on-site radiologists part of the time. The availability of radiologists is associated with indicators of hospital volume of services, diversity of the medical staff, and distance between the hospital

and the radiologist's base practice. However, further evaluation of observed differences across states is necessary, since there are no apparent state rules or laws governing frequency of radiology services or requiring radiologists to read x-ray images.

According to a national survey of radiologists, rural radiologists are more likely to be generalists, solo practitioners and not board certified than their urban counterparts (Deitch, et al., 1993). However, the trend of greater radiology subspecialization, of fewer radiology solo practices, and of younger radiologists practicing in metropolitan areas, could limit the future access to radiologists' services in rural areas. The impact of these trends should be followed.

Unique practice incentives provided to radiologists by rural hospitals appear to be minimal at this time. However, as third party payers, including Medicare, continue re-evaluating and lowering reimbursement rates for some imaging services, the need for rural recruitment incentives may increase and leave smaller hospitals that have fewer discretionary funds less able to recruit or retain on-site radiology services.

This study was not able to provide information on the integration of the radiologists into the medical staff activities of rural hospitals. While the standard definitions of active, courtesy and consulting staff are useful for describing the integration of most specialties into a hospital staff, the terms may have very different implications for radiologists. Being classified as a member of the active staff may require a certain minimal number of admissions to the hospital each year and therefore eliminate the possibility of radiologists ever being eligible for active staff memberships,

for participation on hospital committees, or for holding medical staff office. Therefore, in this article no numerical estimates of the radiologists on individual hospital medical staffs are given. The number of days a week a radiologist comes to a hospital is not affected by the staff membership definition. To clarify the radiologist's role in rural hospitals in future analysis, a standardized definition of active, courtesy and consulting staff membership for radiologists should be developed and followed. Several large groups have attempted to develop standardized definitions but none have succeeded in developing a nationally accepted definition due to the many different purposes for which medical staff size and composition are calculated. For example, hospital administrators prefer to have all physicians on the "active" staff for marketing and certification purposes. Radiologists might prefer not to be members of the active medical staff to avoid required attendance at medical staff meetings or committee appointments.

Finally, it should be noted that the characteristics of hospitals in the study region are not the same as those for all rural hospitals in the U.S. This region has a much higher percentage of small rural hospitals (less than 24 beds) with an average bed capacity of 49, as compared to 84 beds for all rural hospitals (AHA, 1991). The implications of this difference for the generalizability of the study results is not clear.

In conclusion, the assessment of access to rural imaging services requires additional information. Diagnostic imaging is a two part procedure; image production and image interpretation. Without an interpretation the image is of no clinical value. More comprehensive studies of the actual process of image interpretation in the daily

care of patients in rural hospitals are needed. In particular, who is interpreting radiology images in rural hospitals and with what accuracy and what effect on the quality of patient care?

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