

The Effect of an On-Site Radiology Facility on Radiologic Utilization in Family Practice

Roger Peter Strasser, MB, BS, MCISc, FRACGP, Martin Jack Bass, MD, MSc, FCFP, and Michael Brennan, MD, FCFP
Victoria, Australia, and London, Ontario

Family physicians around the world are increasing their use of diagnostic x-ray examinations at a time of controversy about radiologic overutilization. To explore the role of accessibility in utilization, a study was undertaken testing the hypothesis that on-site radiology facilities are an important determinant of usage. Using a historical cohort design with chart review, rates in selected groups of patients were compared between two teaching family medicine centers, one with an on-site radiology service and one without. After controlling for confounding variables, patients with chest-related diagnoses were 2.4 times more likely ($P < .05$) to have a chest film in the presence of on-site facilities. Rates for the off-site examination, upper gastrointestinal series, in patients with abdominal-related diagnoses were similar (relative risk 1.34, $P > .5$) at both centers. Higher usage brought no short-term clinical benefit. It was also observed that residents overinterpreted one quarter of chest films when compared with radiologists' reports.

The use of diagnostic radiology in primary care is increasing¹⁻⁴ at a time of mounting concern about "overutilization."⁴⁻⁷

Generally diagnostic radiology is used more frequently in North America than in the United Kingdom, with a radiologic examination ordered in nearly 8 percent of American family practice ambulatory encounters⁸ compared with less than 2 percent in Britain.^{9,10} One possible explanation was that the ready availability of diagnostic investigations in North America was a factor encouraging greater utilization. A study was undertaken, therefore, to test the hypothesis that ready access by virtue of an on-site facility was associated with higher radiology usage. At the same time, it was further hypothesized that this higher usage would bring no apparent clinical benefit. The study focused on the most commonly performed examinations: chest film as an on-site examination, and upper gastrointestinal series as the comparison off-site examination.

METHODS

All office patients with a new episode of a chest-related diagnosis (Table 1) seen during a two-month period at two community teaching family medical centers were identified from computerized morbidity records. One center had an on-site radiology service that was visited by a radiologist at the end of the day who read the films of the day. Patients at the other center had to travel 2 km to a radiology facility that would telephone readings immediately on request. There was no financial link in either case between the family physicians and the radiology service. Each center consisted of four independent practices, each headed by a teaching family physician who worked with a first- and second-year family practice resident.

Using systematic sampling with a random start, 162 charts were reviewed at the center with on-site radiology and 153 charts were seen at the other center. As well as recording whether a chest film had been performed, data were collected on three groups of factors considered to be potential confounding variables: patient demographic factors, illness factors, and age, sex, and training status of the physician. The only available evidence of social class was whether the patient was receiving social assistance.

Data were also collected from the chart on the patients' clinical progress following the same illness episode over the subsequent three months. Specific items recorded were

Submitted, revised, February 19, 1987.

From the Family Medicine Program, Gippsland, Victoria, Australia, and the Department of Family Medicine, University of Western Ontario, London, Ontario. At the time this study was undertaken, Dr. Roger Strasser was a Kellogg Fellow, Department of Family Medicine, University of Western Ontario, London, Ontario. Requests for reprints should be addressed to Dr. Martin J. Bass, Department of Family Medicine, University of Western Ontario, London, Ontario, Canada N6A 5C1.

TABLE 1. CHEST-RELATED DIAGNOSES (in which chest radiology may or may not have been used)

General Grouping	Diagnosis	ICHPPC-2 Position Number
Chronic chest diagnoses	Chronic bronchitis	142
	Emphysema/chronic obstructive pulmonary disease	143
	Congestive heart failure	112
Acute chest diagnoses	Acute bronchitis	138
	Pneumonia	140
	Asthma	144
Chest symptom	Whooping cough	6
	Chest pain	262
	Cough	270
	Dyspnea	269
	Hemoptysis	268
	Other respiratory system disease	147

TABLE 2. ABDOMINAL-RELATED DIAGNOSES (in which upper gastrointestinal tract examination may or may not have been used)

General Grouping	Diagnosis	ICHPPC-2 ¹¹ Position Number
Upper gastrointestinal tract diagnoses	Esophageal disease	150
	Duodenal ulcer	151
	Other peptic ulcer	152
	Other stomach and duodenum diseases	153
Lower gastrointestinal tract diagnoses	Hiatus hernia	156
	Irritable bowel syndrome	159
	Chronic enteritis, ulcerative colitis, Crohn's disease	160
Other abdominal-related diagnoses	Other digestive system diseases	167
	Gallbladder and biliary tract diseases	166
	Iron deficiency anemia	58
	Pernicious anemia and other deficiency anemias	59
Abdominal symptom	Other anemias	61
	Heartburn	275
	Abdominal pain	279

number of visits and number of chest films after the initial visit, new or worsening symptoms or clinical signs, change in diagnosis or treatment, specialist referral, hospital admission, and "unsatisfactory progress." Unsatisfactory progress was defined as evidence in the chart indicating misdiagnosis or mismanagement that could adversely affect the clinical outcome. This approach was similar to that described by Mushlin et al, whose study showed that "deficiencies in the process of care" had been correlated with unsatisfactory clinical outcome.¹²

As contrast medium examinations were not performed by the radiology service at the study center, the most commonly performed one, upper gastrointestinal (UGI) series, was included as a comparison to chest examination. All office patients newly presenting with abdominal-related diagnoses (Table 2) during the study period were included in the study. There were 103 subjects in the UGI study group at the center with on-site x-ray facilities and 96 at the other center.

For the subjective item "unsatisfactory progress," validity and reliability were enhanced by independent rating by a second chart reviewer, a certified family physician, who was blinded to the hypotheses of the study. In addition, blinded test-retest reliability on a sample of 20 charts found complete agreement on demographic, provider, and radiologic examination data.

RESULTS

Of the patients with chest-related diagnoses at the center with on-site radiology facilities, 21 percent had a chest film compared with only 7.8 percent at the other center. Patients in both centers were similar in age and sex. During the analysis, two potentially confounding variables were identified that were related at the $P < .10$ level to both centers and having a film taken: the presence of a chronic chest problem and the sex of the attending physician. Patients with an exacerbation of an existing chronic chest problem were less likely to be examined radiologically. Female physicians at the center with the on-site service were more likely to order chest films. A Mantel-Haenszel chi-squared analysis,¹³ which controlled for sex and presence of a chronic chest problem (Table 3), revealed that patients with chest-related diagnoses presenting to the center with on-site facilities were 2.4 times more likely to have a chest film performed than were similar patients at the other center.

Having established that chest film usage was significantly higher at the center with an on-site radiology service, the question of whether patients were clinically better off for having x-ray examinations performed more frequently becomes important. Follow-up experiences at both centers were similar, and none of the differences in

TABLE 3. CHEST RADIOLOGY IN PATIENTS WITH CHEST-RELATED DIAGNOSES CONTROLLING FOR RELATED LONG-TERM PROBLEM AND SEX OF PHYSICIAN

Chronic Chest Problem	Physician's Sex	Family Medical Center					
		With On-site Radiology Service			No Radiology Service		
		No. in Group	No. With Film	Chest X-ray (%)	No. in Group	No. With Film	Chest X-ray (%)
Yes	Male	24	2	8.3	51	3	5.9
No	Male	83	15	18.1	73	7	9.6
Yes	Female	11	2	18.2	15	0	0
No	Female	44	15	34.1	14	2	14.3

Mantel-Haenszel¹³ $\chi_c^2 = 4.89$ (df = 1), $P < .05$; relative odds = 2.4

TABLE 4. SUBSEQUENT CLINICAL PROGRESS OF CHEST-RELATED DIAGNOSIS

	Family Medical Center	
	With On-site Radiology Service Percent of Total (n = 162)	No Radiology Service Percent of Total (n = 153)
Visits, 1 or more	45.7	47.7
Visits, 2 or more	14.2	20.9
Chest film (after initial visit)	4.9	4.6
Symptoms worse	7.4	3.3
Signs worse	6.2	3.9
Diagnosis change	7.4	5.2
Treatment change	6.8	6.5
Referral	1.2	1.3
Hospital admission	0.6	1.3
Unsatisfactory progress	1.9	3.3

Note: All differences are nonsignificant

TABLE 5. UPPER GASTROINTESTINAL (UGI) X-RAY EXAMINATION IN PATIENTS WITH ABDOMINAL-RELATED DIAGNOSES CONTROLLING FOR SOCIAL ASSISTANCE

Social Assistance	Family Medical Center			
	With On-site Radiology Service		No Radiology Service	
	No. in Group	UGI X-ray (%)	No. in Group	UGI X-ray (%)
Yes	3	0	8	0
No	34	2.9	67	4.5
Unknown	66	16.7	21	9.5

Mantel-Haenszel¹³ $\chi_c^2 = 0.027$ (df = 1), $P > .5$; relative odds = 1.35

short-term clinical outcomes was significant (Table 4). For each patient whose care was considered unsatisfactory, the second reviewer was asked to assess whether the patient's subsequent clinical progress might have been improved by the earlier performance of a chest film. In all cases at both centers, the answer was no.

It may be argued that the rates of radiology usage were different between the two centers primarily because of intrinsic differences between the physicians. It is for that reason that an examination off-site to both centers has been included in the study. The data for the UGI series in patients presenting with abdominal complaints are presented in Table 5. The analysis controls for social assistance, which was significantly associated with having a UGI series and with the presence of an on-site facility. Rates of UGI series were similar, with a relative risk of 1.35, which does not differ significantly from unity.

Early in the chart review phase, it was noted that not only were more chest films being ordered at the center with on-site radiology, but also that at times there were disagreements between the resident's initial note about the chest film and the radiologists' report. Such discrepancies were observed in 23.5 percent of patients on whom chest films were obtained. Analysis of these disagreements using the binomial test¹⁴ revealed a statistically significant difference ($P = .035$) in the direction of residents noting abnormalities on the film that were not subsequently reported by radiologists. Thus, it appears that at the center with on-site facilities, there was a tendency for residents not only to order more films but also to overinterpret the chest films.

DISCUSSION

Patients with chest-related diagnoses were found to be 2.4 times more likely to have a chest film in the presence of on-site radiology, whereas there was no significant difference between the two family medical centers in UGI ex-

aminations, which were not available at either center. Follow-up of patient charts for up to three months revealed no evidence that the patients were clinically better off for having had x-ray examinations more frequently. In addition, it was found that residents at the center with on-site radiology facilities showed a tendency to overinterpret chest films when compared with radiologists' reports.

Having established association between on-site radiology facilities and chest film utilization, the question arises as to whether the relationship is causal. A strong argument can be made for a causal association. First, strength of association is present, with patients in the on-site facility 2.4 times as likely to have an x-ray examination. Second, the findings are consistent with evidence from the literature. An evaluation of an on-site radiology service in a Scottish health center¹⁵ included a comment that utilization increased by 14.4 percent in the first 12 months of unrestricted access to the on-site facilities. Findings in this present study that higher usage brought no short-term clinical benefit to patients are consistent with evidence in the literature that greater radiologic utilization does not necessarily translate into better health.^{16,17}

The sample size of 150 for each group gave only a 55 percent power of detecting a 10 percent difference in those visiting two or more times after the index visit, so that a clinically important effect may have been missed.¹⁸ On the other hand, the independent reviewer found that additional films would have had no impact on subsequent clinical progress.

Specificity of the relationship is present in this study. A comparison of "on-site" and "off-site" radiology usage suggests that immediate access to on-site facilities is the specific factor associated with higher usage. It cannot be ruled out that just as physicians have surgical signatures,¹⁹ they may have preferences in the use of diagnostic radiology. By comparing the experience of multiple physicians at both centers with the same department, the possibility of such a bias is diminished.

The study findings are consistent with Hardison's law that "the more available or accessible a test or procedure, the greater the indication to do it."²⁰ One example of this phenomenon stands out in the literature. After a laboratory introduced a new multipurpose request form for both arterial and venous blood, the number of requests for oxygen pressure determinations on venous blood (a probably useless investigation) jumped from 10 to 4,000 per year.²¹ Thus, by the criteria of strength of association, consistency, specificity and coherence of the evidence, and reasoning by analogy, it appears that immediate access to on-site facilities is a cause of higher radiology utilization.

On-site facilities have certain advantages for both patients and physicians in terms of convenience and quicker problem assessment¹⁵; however, this study has identified

an important disadvantage of on-site facilities in family practice. With higher usage bringing no apparent clinical benefit, the findings from this study imply that immediate access to on-site radiology facilities encourages less than cost-effective practice. In addition, although not measured in this study, a review of the literature suggests that with higher radiology utilization, patients may be potentially disadvantaged in terms of risks from increased radiation exposure,^{2,22} greater potential for morbidity associated with false-positive results,^{21,23} and more impersonal, technology-centered care.^{24,25} With miniaturization and automation of technology, immediate access to radiology services is likely to become more common in family practice, so family physicians need to be vigilant to the potential pitfalls of immediate access to these facilities.

In addition to the implications for family practice in general, this study has implications specific to postgraduate family medicine training. Undertaken in two teaching centers of the University of Western Ontario family medicine residency program, findings of this study suggest that in the presence of on-site facilities, residents are learning to be relatively frequent users of radiologic examinations despite educational program objectives aimed at discriminating use of diagnostic investigations.²⁶ In addition, the study suggests that residents are overinterpreting chest films with the potential for overdiagnosis and overtreatment. All the implications for family medicine training apply also to the many residency programs in North America whose family practice teaching units are in hospitals and so in effect have immediate access to on-site facilities. There is a pressing need for specific educational strategies that would include instruction on the appropriate use of diagnostic radiology services in family practice and on film interpretation. The emphasis in rounds and case conferences should be on the need for careful consideration of the potential benefit of each examination before it is ordered.

References

1. Metcalfe DHH: Health services in the United Kingdom: Trends in provision and utilization, 1971-80. *Fam Pract* 1984; 1:140-146
2. Advisory Committee on Radiology: X-ray safety in Ontario. Toronto, Government of Ontario, 1980
3. Freeman GK: Use of tests and x-rays. Update 1983; 26:403-410
4. Lyon WK: The overutilization of x-rays. *Can Fam Physician* 1981; 27:1134-1138
5. Middlemass I: Unnecessary x-rays. *Can Med Assoc J* 1971; 105:807-809, 849
6. Hall FM: Overutilization of radiological examinations. *Radiology* 1976; 120:443-448
7. Abrams HL: The "overutilization" of x-rays. *N Engl J Med* 1979; 300:1213-1216
8. Geyman JP, Rosenblatt RA (eds): The content of family practice: Current status and future trends. *J Fam Pract* 1982; 15:677-737

9. Birmingham Research Unit of the Royal College of General Practitioners: Practice activity analysis: 3. Investigation. *J R Coll Gen Pract* 1978; 28:60-62
10. Mills KA, Reilly PM: Laboratory and radiological investigations in general practice: IV. Results of radiological investigations. *Br Med J* 1983; 287:1265-1268
11. ICHPPC-2: International Classification of health problems in primary care. Second Report of the Classification Committee of the World Organization of National Colleges, Academies and Academic Associations of General Practitioners/Family Physicians. New York, Oxford University Press, 1979
12. Mushlin AJ, Appel FA, Barr DM: Quality assurance in primary care: A strategy based on outcome assessment. *J Community Health* 1979; 3/4:292-305
13. Mantel N, Haenszel W: Statistical aspects of the analysis of data from retrospective studies of disease. *J Natl Cancer Inst* 1959; 22:719-748
14. Siegel S: *Nonparametric Statistics for the Behavioral Sciences*. New York, McGraw-Hill, 1956
15. Howie V: The evaluation of an x-ray unit in a health centre. Edinburgh, Scottish Home and Health Department, 1974
16. Williams SV, Eisenberg JM, Pascale LA, Kitz DS: Physicians' perceptions about unnecessary diagnostic testing. *Inquiry* 1982; 19: 363-370
17. Gershel JC, Goldman HS, Stein REK, et al: The usefulness of chest radiographs in first asthma attacks. *N Engl J Med* 1983; 309:336-339
18. Fleiss JL: *Statistical Methods for Rates and Proportions*. New York, John Wiley, 1973
19. Wennberg J, Gittelsohn A: Variations in medical care among small areas. *Sci Am* 1982; 246(4):120-134
20. Hardison JE: To be complete. *N Engl J Med* 1979; 300:193
21. Rang M: The Ulysses syndrome. *Can Med Assoc J* 1972; 106: 122-123
22. Benson JM: Radiation safety. *J Fam Pract* 1982; 15:435-439
23. Iatrogenesis: Just what the doctor ordered. *J Community Health* 1980; 5:149-157
24. Reiser SJ: *Medicine and the Reign of Technology*. Cambridge, Cambridge University Press, 1978
25. McWhinney IR: Medical knowledge and the rise of technology. *J Med Philos* 1978; 3:293-304
26. Christie R, Morrissy J, Payne W, et al: Post Internship Program: Report of the Working Party on Curriculum. London, Ontario, University of Western Ontario, Department of Family Medicine, 1984