Mapping the literature of radiologic technology

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While analysis of the literature of radiology has been conducted in the discipline, none of the studies have focused on identifying the core journals. The bibliometric method was used to conduct research to identify the core journals in the radiologic technology field and determine the extent of indexing of those journals. This study was a part of Medical Library Association (MLA) Nursing and Allied Health Resource Section's project to map the literature of allied health. Findings indicate that there is a small core of literature with a heavy reliance on the journal literature. Books are used to a lesser extent. The majority of the citations analyzed were published during the fourteen years between 1980 and 1993. MEDLINE and EMBASE provided the best indexing coverage of the radiologic technology literature; minimal coverage was provided by the Cumulative Index to Nursing and Allied Health Literature and HEALTH.

INTRODUCTION

Radiologic technologists are responsible for the technical aspects of x-ray diagnosis and therapy. The discipline includes several speciality areas—radiography, radiation therapy, and nuclear medicine [1].

In 1995, radiology celebrated the 100th anniversary of Roentgen's discovery of the x ray. The first radiologic technologists, who were photographers, secretaries, engineers, chemists, physicists, and nurses, were called x-ray photographers or operators, and the technology was often used for entertainment, not medical purposes. In the early 1900s, the physician most often operated the x-ray equipment, with assistance from a receptionist or secretary. Throughout the 1920s most radiologic technicians were nurses, and most were female. Men began to enter the profession after World War I [2].

Because the radiologist needed a "helper," the discipline of radiologic technician was developed. The certification agency for radiologic technologists is the American Registry of Radiologic Technologists. The first certificate was issued in 1923 by the American Registry of Radiologic Technicians. The registry was interested in developing educational programs for radiology technology [3]. X-ray technology was recognized as a health profession by the American Medical Association in 1944, and the oversight of educational programs began. At that time, x ray was limited to diagnosis, and there was very little radiation therapy. Radiation therapy was recognized as a separate discipline in 1964 [4].

In the 1960s many educational programs for radiologic technology were directed by hospitals rather than academic institutions, and included a great deal of on-the-job training [5]. Today, however, many programs are based in junior colleges or in four-year colleges or universities.

Only a few bibliometric studies have been conducted in the field of radiology, and none of these have focused on identifying core journals. Elster and Chen analyzed articles published in the *American Journal of Roentgenology* to determine changes in the number of foreign articles published [6]. Multiple authorship in the field of radiation oncology was the subject of the research by Halperin et al. [7]. Stiles and Belt analyzed the radiology literature to identify socioeconomic and political issues addressed in articles from two separate time periods [8]. Beam et al. focused on magnetic resonance research reported in the literature [9]. Holman conducted a bibliometric study to determine the nature of radiologic research, as reflected in the literature [10]. A study analyzing the Cumulative Index to Nursing and Allied Health Literature (CINAHL) and MED-

Table 1
Cited format types and frequency of citations

Cited format type	Total no. citations	Frequency of citations (%)
Journal articles	4,289	81.4
Books	738	14.0
Miscellaneous	242	4.6
Total	5,269	100.0

LINE CD-ROMs for four areas of allied health identified the top journals for radiology and nuclear medicine by using a faculty survey [11].

The purpose of this study is to identify the core journals in the discipline of radiologic technology and to determine the extent of indexing coverage for these journal titles. In addition to providing information for producers of databases and indexes, the results of this study can be useful to collection development librarians and radiologic technology clinicians.

METHODOLOGY

A common methodology was used, as described previously in the overview of the Mapping the Literature of Allied Health project. Three radiologic technology source journals were selected from the "Selected List of Books and Journals in Allied Health" by Brandon and Hill [12]: *Applied Radiology, Canadian Journal of Medical Radiology,* and *Radiologic Technology.* The list of references at the end of each article was analyzed, and each title from 1991 through 1993 was recorded on index cards. Hash marks were used for multiple references for a single title. Letters to the editor, editorials, and similar items were not used.

Citations were first identified as belonging to one of three formats: book (those listing publisher, place of publication, and publication date), journal (those listing volume, issue, and page numbers), and miscellaneous (conference proceedings, government documents, and other material not identified as a book or journal).

Cited items were also categorized by year of publication as follows: 1990 to 1993 (including those documents in press), 1980 to 1989, 1970 to 1979, 1960 to 1969, prior to 1960, and unknown. The 1980 to 1989 segment was further divided into 1980 to 1984 and 1985 to 1989.

The list of journals cited was arranged in rank order according to the number of citations, and divided into three zones, according to Bradford's Law of Scattering. This bibliometric principle states that journals in the top zone are cited most often, those in the second zone are cited frequently, but not as frequently as Zone 1 titles, and those titles in the third zone are cited least.

Table 2
Cited format types by publication year periods

Publication year	Journal articles		Books		Miscellaneous		Total citations	
	No.	%	No.	%	No.	%	No.	%
1990–93*	967	22.5	137	18.6	113	46.7	1,217	23.1
1980–89	2,642	61.6	452	61.2	87	35.9	3,181	60.4
1985–1989	1,849							
1980–1984	793							
1970–79	454	10.6	95	12.9	20	8.1	569	10.8
1960–69	123	2.9	29	4.0	9	3.8	161	3.1
Pre-1960	102	2.4	21	2.8	1	0.4	124	2.3
Not available	1	<0.1	4	0.5	12	5.1	17	0.3

* Includes materials in press.

If a journal had changed titles, the various titles were combined under the most recent title.

Finally, the journals listed in Zone 1 and Zone 2 were checked for indexing coverage with the established method described previously. Four major indexing tools were consulted: MEDLINE, CINAHL, EMBASE, and HEALTH. The journal titles that were included in Zone 1 and Zone 2 were searched in each of these databases to determine whether the titles were indexed and to what extent. Indexing coverage was rated for each journal title and each database on a scale of 0 to 5 (low to high): 5 (95%–100%), 4 (75%–94%), 3 (50%–74%), 2 (25%–49%), 1 (1%–24%), 0 (<1%). A total indexing coverage score was determined by adding the individual scores for each journal in each database.

RESULTS

In *Applied Radiology,* there were 219 source articles with 3,817 cited items; in *Canadian Journal of Medical Radiology,* there were 29 source articles with 402 cited items; and in *Radiologic Technology,* there were 89 source articles with 1,050 cited items. The total for all journals was 337 source articles with 5,269 cited items.

As shown in Table 1, analysis by citation format revealed that journal articles were responsible for 81.4% of the citations. However, books were also cited frequently (14.0%) with miscellaneous formats cited to a lesser extent (4.6%).

As indicated in Table 2, citations were also analyzed according to a publication year. The majority of the journal and book citations were published in the 1980 to 1989 time span. When those journal citations published in the 1980s were further analyzed, it was found that most were published between 1985 and 1989. The majority of the miscellaneous citations were published between 1990 and 1993. More than 80% of the citations in all formats were published during the fourteen-year period between 1980 and 1993.

A total of 659 journals were cited, as shown in Table

Table 3
Distribution by zone of cited journals and references

Zone	Cited journals		Cited journal references		Cumulative total	
	No.	%	No.	%	No.	%
Zone 1	4	0.6	1,473	34.3	1,473	34.3
Zone 2	51	7.7	1,394	32.5	2,867	66.8
Zone 3	604	91.7	1,422	33.2	4,289	100.0
Total	659	100.0	4,289	100.0		

3. However, only four journals (0.6%) accounted for 34.3% of the citations (1,473) and fifty-one journals (7.7%) accounted for another 32.5% of the citations (1,394). The remaining 33.2% of the citations (1,422) were provided by 604 journals (91.7%). Only one reference was cited in 376 of the journals.

The four journals that account for 34.3% of the articles are *Radiology, American Journal of Radiology (AJR), Journal of Nuclear Medicine,* and *Journal of Computer Assisted Tomography.* These journals and the fifty-one titles in the second zone of cited journals appear in Table 4 in descending order of number of citations.

Table 4 indicates the indexing sources for the Zone 1 journals and Zone 2 journals (those accounting for an additional 32.5% of the citations). MEDLINE provided extensive indexing coverage of all Zone 1 (>94%), and EMBASE provided full indexing coverage (>74%). HEALTH provided minor coverage. CINAHL, which purports to cover the nursing and allied health literature, including radiologic technology, provided no coverage of the four Zone 1 titles.

For Zone 2 titles, MEDLINE provided full or partial indexing coverage for all but two titles (which it did not index at all) and EMBASE provided full coverage for all but seven titles (>74%). CINAHL provided extensive coverage (>94%) for only two of the titles, including one for which MEDLINE provided no coverage. Again, HEALTH's coverage was minor for most titles (<75%). However, HEALTH provided better coverage than CINAHL for all but three titles.

DISCUSSION

This analysis of the radiologic technology literature shows a heavy reliance on journals (81.4% of the citations), with a lesser but important use of books (14.0% of the citations). This is consistent with other disciplines in the health sciences. More than 80% of the publications cited were published between 1980 and 1993, indicating a reliance on recent literature. There was a core of the literature, as four titles included 34.3% of the citations and 66.8% of the citations were published in 7.7% of the journal titles.

In general, MEDLINE and EMBASE provided adequate indexing coverage for most of the titles included

Table 4
Distribution and indexing coverage of cited journals in Zones 1 and 2

Cited journal	No. of citations	CINAHL	EMBASE	HEALTH	MEDLINE
Zone 1					
1. Radiology	803	0	4	1	5
2. AJR: American Journal of Roentgenol	428	0	4	1	5
3. J Nucl Med	143	0	5	1	5
4. J Comput Assist Tomogr	99	0	5	1	5
Zone 2					
5. AJNR: Am J Neuroradiol	88	0	4	1	5
6. Radiol Technol	79	5	0	2	4
7. Cancer	74	0	5	2	5
8. N Engl J Med	68	1	3	1	5
9. Int J Radiat Oncol Biol Phys	63	0	5	1	5
10. J Bone Joint Surg	49	0	4	2	5
11. Radiol Clin North Am	44	0	5	1	4
12. Clin Nucl Med	43	0	4	1	5
13. JAMA	42	1	4	2	5
14. J Ultrasound Med	37	0	4	1	5
15. Br J Radiol	36	0	5	1	5
16. Pediatr Radiol	36	0	4	1	5
17. Semin Nucl Med	35	0	0	1	5
18. J Urol	32	0	0	1	5
19. Lancet	31	1	5	1	5
20. Radiographics	30	0	0	1	5
21. Skeletal Radiol	27	0	5	1	4
22. Am J Cardiol	27	1	4	2	5
23. Invest Radiol	27	0	5	1	5
24. Appl Radiol	26	5	0	0	0
25. Chest	23	0	4	1	5
26. BMJ	22	1	5	2	5
27. Semin Roentgenol	22	0	5	1	4
28. Circulation	21	0	4	1	5
29. Clin Radiol	21	0	4	1	5
30. Clin Orthop	20	1	4	1	5
31. J Neurosurg	20	0	4	1	5
32. Arch Surg	18	0	4	3	5
33. Obstet Gynecol	18	0	5	2	5
34. Ann Surg	17	0	4	3	5
35. Gastroenterology	17	0	4	1	5
36. Stroke*	17	1	4	1	5
37. Abdom Imaging/Gastrointest Radiol	16	0	4	1	5
38. Semin Ultrasound CT MR	16	0	5	1	4
39. Spine	16	2	5	2	5
40. Surgery	16	0	4	1	5
41. Am J Surg	15	0	4	3	5
42. Am J Sports Med	15	3	5	2	5
43. Adm Radiol/Adm Radiol J	14	0	0	†	0
44. Ann Neurol	14	0	5	1	5
45. Neurosurgery	14	0	4	1	5
46. Urol Clin North Am	14	0	5	1	5
47. Ann Intern Med	13	1	5	2	5
48. J Thorac Imaging	13	0	5	1	5
49. J Pediatr Surg	13	0	4	1	5
50. J Clin Ultrasound	13	0	4	1	5
51. Mayo Clin Proc	13	0	4	1	5
52. J Am Coll Surgeons/Surg Gynecol Obstet	13	0	4	2	5
53. Am J Obstet Gynecol	12	1	4	1	5
54. Am J Med	12	0	5	2	5
55. Am J Gastroenterol	12	0	4	1	1
Total indexing coverage score		24	215	71	256

Indexing coverage scale: 5 (95%–100%); 4 (75%–94%); 3 (50%–74%); 2 (25%–49%); 1 (1%–24%); 0 (<1%).
* Stroke was indexed in CINAHL 1995 and after.
† *Administrative Radiology/Administrative Radiology Journal* was indexed selectively in HEALTH; the complete number of articles published in 1994 was unavailable.

in Zones 1 and 2. All titles in Zone 1 were covered at more than 75% by both databases. EMBASE provided coverage for all but seven titles in Zone 2 at more than 75%, while MEDLINE covered all but two titles at more than 75%. One title was not covered by either MEDLINE or EMBASE, but was covered extensively by CINAHL (>94%). HEALTH provided minimal coverage (<49%) for most titles in Zones 1 and 2, but radiologic technology is not the main focus of this database. CINAHL's indexing coverage proved inadequate, with only two titles in the top two zones covered completely (>94%) and only two others with limited coverage (<24%). Fifty titles were indexed minimally or not at all in CINAHL (<49%). However, many of the cited titles were clinical medicine titles, and it can be argued that the focus of CINAHL is not the clinical medical literature. One title, *Administrative Radiology/Administrative Radiology Journal,* was not covered by any database examined and is, in fact, not indexed by any indexing service. The total indexing coverage score, as shown in Table 4, indicates the relative indexing coverage for the databases.

CONCLUSION

There is a small core of literature in the radiologic technology field. There is a heavy reliance on the journal literature, but books are used to some extent. More than 80% of the literature referenced had been published between 1980 and 1993. Journals listed in Zones 1 and 2 included general medicine and non-radiology titles. MEDLINE and EMBASE provided full to extensive indexing coverage for most titles, while HEALTH and CINAHL provided only minimal coverage. However, many of the titles were clinical medicine titles, not an area of concentration in either HEALTH or CINAHL. Results of this study can be used by collection development librarians at institutions that provide degrees in radiologic technology. The list of core journals identified in this study is important to database producers, so that the radiologic technology literature can have better indexing coverage by databases other than MEDLINE. While different database producers have different missions, improved indexing coverage of the disciplines included in the database's focus is desirable.

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