Infectious diseases citation patterns: mapping the literature 2008–2010 EC

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Objectives: The research identified the publication types and ages most frequently cited in the infectious diseases literature and the most commonly cited journals.

Methods: From 2008–2010, 5,056 articles in 5 infectious diseases journals cited 166,650 items. Two random samples were drawn: one (n=1,060) from the total set of citations and one (n=1,060) from the citations to journal articles. For each sample citation, publication type and date, age of cited item, and inclusion of uniform resource locator (URL) were collected. For each item in the cited journal articles sample, journal title, publication date, and age of the cited article were collected. Bradford zones were used for further analysis.

Results: Journal articles (91%, n=963) made up the bulk of cited items, followed by miscellaneous items (4.6%, n=49). Dates of publication for cited items ranged from 1933–2010 (mean=2001, mode=2007). Over half (50.2%, n=483) of cited journal articles were published within the previous 5 years. The journal article citations included 358 unique journal titles.

Discussion: The citations to current and older publications in a range of disciplines, heavy citation of journals, and citation of miscellaneous and government documents revealed the depth and breadth of resources needed for the study of infectious diseases.

INTRODUCTION

In October 2001, Robert Stevens, photo editor at American Media, was the first patient in nearly twenty-five years to be diagnosed with inhalational anthrax, in what turned out to be merely the start of a bioterror attack using the mail system. Over the following months, the United States were swept into a panic about the disease. Public health departments, researchers, and clinicians had to immediately brush up on a disease that had been largely forgotten outside of hypothetical bioterrorism exercises, and of course, they had to deal with the outbreak and the mass hysteria it engendered [1]. Questions had to be answered: Should postal workers who might have been exposed be vaccinated? How best could buildings and facilities be decontaminated? How do clinicians diagnose and treat the disease? What was the likelihood of catching anthrax through indirect contact with contaminated mail? To help answer these questions, access to pertinent infectious disease literature and research was required. Other outbreaks and new emerging infectious diseases mean that infectious disease professionals will always need access to information to help answer their questions. This paper's purpose is to help libraries develop collections to support infectious disease professionals' information needs.

One way to identify information needs is through bibliometric analysis. Citation analysis, a form of bibliometric analysis that examines citation patterns in a discipline's primary literature, has long been established as a methodology for identifying core literature for that discipline [2]. This current citation analysis continues in that tradition, investigating which different types and ages of material are cited and in which journals cited articles appeared. Other infectious disease bibliometric studies have identified trends in research in Asia [3]; authorship and per-country productivity in the European Union [4], Latin America [5], and China [6]; contributions of AIDS research collaborations [7]; pharmacotherapy [8]; appearance of cost-utility analyses [9]; international

Highlights

- Literature on infectious diseases is multidisciplinary, encompassing medical specialties, public health, and the medical sciences.
- Infectious disease publications cite journal articles more than 90% of the time. Cited journal articles greatly range in age at citation: more than a quarter were over 10 years old.
- Infectious disease citation patterns resemble clinical medicine citation patterns more than public health citation patterns.

Implications

- Infectious disease professionals need access to general medicine titles as well as infectious disease, immunology, virology, microbiology, and public health literature.
- Librarians serving infectious disease researchers and practitioners should provide access to older materials, especially journal back files, to support the cyclical needs of their patrons.

EC Supplemental Table 4 is available with the online version of this journal.

tuberculosis research [10]; gaps and coverage in European infectious disease literature [11]; and presence of infectious disease research in major medical journals [12], but this study is the first attempt to identify citation patterns. It builds on the work of Rethlefsen and Wallis, who studied citation patterns of the public health literature more broadly [13].

INFECTIOUS DISEASES

Infectious disease professionals working in public health include epidemiologists, public health laboratory workers, researchers, and policy makers. Nevertheless, infectious diseases transcend public health disciplines, requiring infectious disease clinicians, scientists, and public health professionals to look to other disciplines for relevant research and identify new knowledge or uses for diagnostics, vaccines, and therapeutics that protect the public's health. Immunology, public health, medicine, virology, microbiology, veterinary medicine, and others are relevant to infectious diseases, all enabling infectious disease professionals to adequately respond to disease outbreaks.

Disease outbreaks from known pathogens continue to be a major emphasis for infectious disease professionals, but, with the advent of severe acute respiratory syndrome (SARS), the H1N1 and H5N1 influenzas, and other novel and emerging infectious diseases, it is imperative that public health professionals, clinicians, and researchers have broad access to the most current and most relevant information to support surveillance, response, and research. Jones et al. in their retrospective study of global trends in emerging infectious diseases concluded that the incidence of emerging infectious diseases outbreaks has risen considerably since 1940, 60% of which were caused by zoonotic pathogens [14]. Infectious diseases are expected to continue to cross over from wildlife to humans and to reemerge over time, with some resulting in deadly or disruptive human pandemics, further emphasizing the importance of libraries providing public health professionals, infectious disease clinicians, and scientists with access to a strong collection of infectious disease materials. This study, which identifies the types and ages of materials cited in infectious disease journals as well as key journals and subject disciplines referenced therein, can provide librarians an evidence-based guide to developing collections to support infectious disease professionals, particularly those working in public health.

METHODOLOGY

This study used the methodology established by the Mapping the Literature of Public Health group for this citation analysis, as outlined below [15]. This protocol reflects the base protocol developed by MLA's Nursing and Allied Health Resources Section (NAHRS) for their mapping the literature of allied health and nursing projects, with modifications first used by Rethlefsen and Wallis in their citation pattern study of the *American Journal of Public Health* [13, 16].

Due to the broad scope of infectious disease epidemiology and research needed to support public health, the researchers chose to use five journals as the starting point for the citation analysis. Criteria for inclusion depended on a range of factors, particularly a high ranking in the ''Infectious Diseases'' category of the 2010 *Journal Citation Reports (JCR) Science Edition,* inclusion on the Biomedical & Laboratory Practice Essential Core list of the Core Public Health Journals Project version 2.0 [17], publication by a major infectious disease society or organization, and a strong public health focus. Titles with a strong public health focus included those emphasizing epidemiology, prevention and control measures, and novel disease outbreaks. Journals selected were *Clinical Infectious Diseases*, *Emerging Infectious Diseases*, *Epidemiology and Infection*, *Journal of Infectious Diseases*, and *Lancet Infectious Diseases*. *Clinical Infectious Diseases* and *Journal of Infectious Diseases* are official publications of the Infectious Disease Society of America, and each explicitly states a public health component to their publication, including epidemiology [18, 19]. *Emerging Infectious Diseases,* published by the Centers for Disease Control and Prevention, emphasizes its goal to provide information for infectious disease specialists and public health generalists [20]. *Epidemiology and Infection* is the only selected title to focus solely on the epidemiology of all infectious diseases, and *Lancet Infectious Diseases* is the top journal in the *JCR* ''Infectious Diseases'' category. It started as a review journal on all aspects of infectious diseases but, in mid-2010, began including original research as well.

For each journal, citations from all original research articles, original research correspondence, review articles, historical review articles, and major commentaries and editorials from 2008–2010 were identified for inclusion and hand-counted. A total of 5,056 articles produced 166,650 citations, including 151,807 (91.1%) citations to journal articles. Each original citing article, citation, and journal article citation was given a unique identifying number. Two samples were generated, one from the overall pool of 166,650 cited items and one from the pool of 151,807 cited journal articles. The first sample from the overall pool of cited items (Overall Cited Items Sample) was designed to provide information on the most frequently cited types of material, citation of online materials, and age of citations. The second sample, from the smaller pool of cited journal articles (Cited Journal Articles Sample), provided information on which journals were the most frequently cited. The researchers used an online sample size generator to determine a sample size for each group that had a 95% confidence level and a +/−3% confidence interval [21]. From the overall pool of 166,650 items, 1,060 items were needed for the Overall Cited Items Sample; from the pool of 151,807 cited journal articles, 1,060 items were needed for the Cited Journal Articles Sample. An online random number generator was

used to sample 1,060 items from each pool [22]. Because the 2 pools were not exclusive, the same cited journal article could appear in both samples.

For each item in the Overall Cited Items Sample (n=1,060), the researchers recorded the type of cited item (book, government document, journal article, or miscellaneous), inclusion of a uniform resource locator (URL), and the date and age of the cited item. Government documents included technical reports and other major publications only. Government websites, laws, and government-published serials (with the exception of monographic or statistical series such as the National Center for Health Statistics' *Vital and Health Statistics Series*) were included in miscellaneous or journal articles categories. Age was calculated by subtracting the year cited from the year of the citing article's publication. For example, if an article published in 2010 cites a book from 2002, the citation is 8 years old. Cited item age and publication type data from the overall cited items sample were analyzed using JMP 9.0 statistical software for cross-tabulation and the chi square statistic with a *P*-value threshold of 0.05.

For the Cited Journal Articles Sample (n=1,060), the name of the cited journal and the date and age of the cited article were collected. Each journal title was standardized to the current journal title where possible. In a very few instances, a journal split into multiple parts after the cited article was published. In these cases, the old title was used. Cited journals were analyzed using Bradford zones. Bradford zones are based on Bradford's Law of Scattering, which states that a few core journals will contain the majority of citations in any given field [23]. Using Bradford zones is a common methodology that ranks cited journals in descending order, from most to least cited, and divides the list into three zones with equal citation counts. Zone 1 contains the most heavily cited journal titles, those accounting for the top third of the citations, and is always the smallest zone. Zone 2 contains the middle third of the cited journals, and Zone 3 contains the least cited titles [24].

Because a sample was used and the delineations between zones might be suspect, the researchers also examined the overall subject of the journals. Subject categories were assigned based on those in the 2010 *JCR Science Edition,* and subject categories were designated using similarly scoped titles in the *JCR* as a guide for the forty-nine titles that were not included in the *JCR,* only two of which fell in the first two Bradford zones. The total number of journal titles and total citations per subject category were tallied.

RESULTS

Overall Cited Items Sample

As in the total pool of cited items, journal articles made up 91% (n=963) of citations in the Overall Cited Items Sample. Other citation types were rare, the next most popular being miscellaneous items with 4.6% (n=49). Two sampled items were excluded from the final overall cited items sample due to data entry error, leaving the number of cited items at 1,058. Table 1 lists the complete number and percentages of publication types. Only 28 items (2.6%) included an explicit URL.

Table 1
Cited items by frequency of publication type from the Overall Cited Items Sample (n=1,058)

Publication type	n	%
Book	27	2.6
Government document	19	1.8
Journal article	963	91.0
Miscellaneous	49	4.6
Total	1,058	100.0

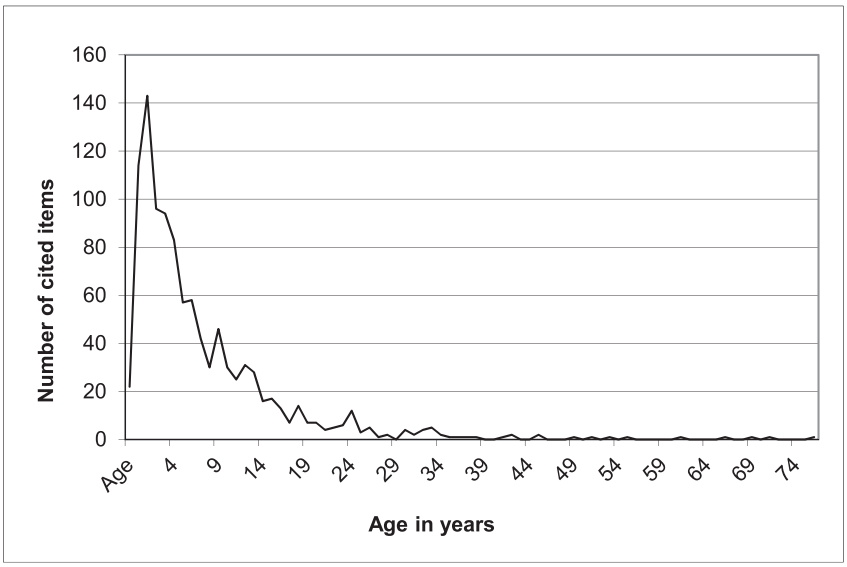
Cited items ranged in publication date from 1933–2010. Five items, all websites in the miscellaneous publication type category, did not have associated dates, and dates could not be located. The median year of cited item publication was 2004, the mean was 2001, and the mode was 2007. Figure 1 shows the long tail distribution of the number of cited items by age. Table 2 displays the age of cited items by the publication type. Journal articles were most likely to be cited within 5 years of publication. Just over half of all cited journal articles were published within the previous 5 years (50.2%, n=483). Nevertheless, authors cited older journal articles relatively frequently. Indeed, 8.0% (77) cited journal articles were 21 or more years old at time of citation. Though the small number of cited items older than 5 years in the books, government documents, and miscellaneous categories make a chi square statistic impossible, clearly, compared to the other publication types, journal articles were far more likely to be older when cited. Miscellaneous items and government documents, on the other hand, were very unlikely to be older than ten years.

Cited Journal Articles Sample

After linking the cited journal titles to their most current versions, 358 unique journal titles were cited in 1,060 citation sample. Twelve journals (3.4%) accounted for approximately the top third of all citations (34.1%, n=361). These twelve titles could be considered Zone 1 titles in a Bradford analysis (Table 3). As this analysis was based on a sample, the researchers opted to count the next approximate third of citations (the next 29.7%), those cited between 4 and 15 times each, as Zone 2 titles (Table 4, online only). Zones 1 and 2, with 63.7% (n=676) of all citations, only included 16.8% of journal titles (n=60).

The Zone 1 titles fell into six subject categories, as defined by the *JCR Science Edition:* ''Infectious Diseases,'' ''Immunology,'' ''Microbiology,'' ''Virology,'' and both ''Medicine, General and Internal'' and ''Medicine, Research and Experimental.'' With the addition of three categories—''Public, Environmental, and Occupational Health''; ''Pharmacology and Pharmacy''; and ''Tropical Medicine''—75% of all citations fell within this small group of subject categories. Table 5 lists the top journal subject categories by number of unique

Figure 1
Number of cited items by age



journal titles cited and by number of total citations to journals in those subject disciplines.

DISCUSSION

Infectious disease prevention and control is one of the key areas of public health, but the infectious disease work of public health professionals and researchers is inextricably linked with many other medical and scientific fields, from the doctors who treat patients in outbreaks to the microbiologists who invent tests to detect new strains of bacteria to the immunologists who develop new vaccines. For instance, in a study of the literature of the SARS outbreak, one of the greatest infectious public health threats of the past decade, Kostoff and Morse created a multi-domain taxonomy to explain the literature. The two main areas of publication were the epidemiology/clinical medicine—including global epidemic control, hospital epidemic control, clinical treatment, and clinical diagnosis subdomains—and the biological domain—comprising genetic, protein structure, and drug treatment subdomains [25]. All these domains were needed to effectively combat the outbreak. It is this synergy between a whole swath of fields and research that may well explain why this mapping study demonstrated citation mapping patterns largely dissimilar to other public health fields but quite similar to medical and scientific fields.

The clearest demonstration of this is the ratio of cited journal articles to other publication types. In previous studies that mapped the literature of public health, journal articles were cited around 60%–75% of the time, with books, government documents, and miscellaneous items cited less often but still relatively frequently [13, 26–29]. The only similar ratio of cited publication types in public health disciplines is in environmental health, where 85.5% of citations were to journal articles [30]. Instead, infectious disease literature's citation patterns closely mimicked general clinical medicine and biomedical research literature, which has been shown to cite 91%–93% journal articles fairly steadily over time [31, 32]. Burdick et al., in 1993, showed that 91% of citations in 10 internal medicine journals were to journal articles [31], and Lariviere et al. reported an increase from 87%–93% of citations to journal articles in health sciences from 1980–2000 [32]. Even a closely related

Table 2
Cited item age by publication type, Overall Cited Items Sample (n=1,058)

	Books		Government documents		Journal articles		Miscellaneous		Total	
Cited item age	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
0–5 years	16	(59.3)	16	(84.2)	483	(50.2)	37	(84.1)	552	(52.4)
6–10 years	3	(11.1)	3	(15.8)	222	(23.1)	5	(11.4)	233	(22.1)
11–15 years	5	(18.5)	0	(—)	124	(12.9)	1	(2.3)	130	(12.4)
16–20 years	1	(3.7)	0	(—)	57	(5.9)	0	(—)	58	(5.5)
21 or more years	2	(7.4)	0	(—)	77	(8.0)	1	(2.3)	80	(7.6)

5 miscellaneous items had no date and are not represented in the table. Percentages are rounded and may not add up to 100%.

Table 3
Zone 1 titles from the Cited Journal Articles Sample (n=1,060)

Journal	Times cited	Percent of total	Cumulative percent
J Infect Dis	57	5.4	5.4
Clin Infect Dis	52	4.9	10.3
N Engl J Med	38	3.6	13.9
J Clin Microbiol	37	3.5	17.4
Lancet	29	2.7	20.1
J Virol	27	2.5	22.6
AIDS	25	2.4	25.0
Infect Immun	23	2.2	27.2
Emerg Infect Dis	21	2.0	29.2
J Immunol	18	1.7	30.8
JAMA	17	1.6	32.5
Vaccine	17	1.6	34.1

discipline, tropical medicine, cited a slightly lower percentage of journal articles (87.9%), as shown by Hua [33]. It should be noted, however, that both Lariviere et al. and Hua calculated the serials to other publication type citation ratios using Science Citation Index, which leaves out laws, websites, and many other miscellaneous items from its statistics [13, 32, 33].

As with other citation analyses in public health disciplines, approximately half of all citations were to items 5 or fewer years old, and three-quarters of citations were 10 or fewer years old [13, 26, 28, 30, 34]. Most interesting here was the sizable number of citations to journal articles that were 15 or more years old, nearly 14%. Indeed, 8.0% of journal article citations were older than 20 years. This is perhaps unsurprising, considering the cyclical nature of disease outbreaks. With each potential influenza pandemic, for example, researchers, epidemiologists, and public health professionals look to the past handling of the 1918 influenza outbreak and the 1976 swine flu outbreak for lessons. Libraries supporting public health researchers and professionals with infectious disease interests and responsibilities should maintain collections of older journals, whether in print or by subscribing to online back file access, to support this cyclical, yet critical need for data.

Also similar to previously published literature mapping studies was the concentration of citations in a small percentage of journal titles. Here, 3.4% of all journals cited contributed 34.1% of the citations, much like previously published studies in epidemiology [35], general public health [13, 28], tropical medicine [33, 36], tuberculosis [10], and occupational health [37]. Sixty-five percent of journal titles (n=233) were cited only once, indicating a wide dispersion of infectious disease literature beyond the small set of core journals in Zones 1 and 2.

Three source journals appeared in Zone 1: *Journal of Infectious Diseases* and *Clinical Infectious Diseases*, which top the list of cited journal titles, and *Emerging Infectious Diseases*. The remaining two source journals appear in Zone 2. No journals classified by the *JCR Science Edition* as ''Public, Environmental, and Occupational Health'' appeared in the Zone 1 journal titles, a surprise considering the importance of infectious disease epidemiology and control to public health. Instead,

Table 5
Cited journal articles by subject discipline, Cited Journal Articles Sample (n=1,060)

	Journal titles		Citations	
Subject discipline	n	(%)	n	(%)
Biochemistry and Molecular Biology	16	(3.0)	32	(1.8)
Biotechnology and Applied Microbiology	8	(1.5)	13	(0.7)
Cell Biology	12	(2.2)	24	(1.4)
Critical Care Medicine	3	(0.6)	18	(1.0)
Gastroenterology and Hepatology	11	(2.0)	32	(1.8)
Genetics and Heredity	10	(1.9)	12	(0.7)
Hematology	10	(1.9)	15	(0.9)
Immunology	44	(8.2)	295	(16.8)
Infectious Diseases	47	(8.7)	293	(16.7)
Medicine, General and Internal	38	(7.1)	147	(8.4)
Medicine, Research and Experimental	12	(2.2)	44	(2.5)
Microbiology	34	(6.3)	234	(13.3)
Multidisciplinary Sciences	5	(0.9)	29	(1.7)
Parasitology	12	(2.2)	19	(1.1)
Pathology	12	(2.2)	13	(0.7)
Pediatrics	11	(2.0)	30	(1.7)
Pharmacology and Pharmacy	21	(3.9)	47	(2.7)
Public, Environmental, and Occupational Health	36	(6.7)	106	(6.0)
Respiratory System	10	(1.9)	27	(1.5)
Tropical Medicine	15	(2.8)	46	(2.6)
Veterinary Sciences	16	(3.0)	25	(1.4)
Virology	24	(4.5)	103	(5.9)

Multiple subject disciplines may be assigned to each unique journal title and citation. Subject disciplines represented are the top 20 for unique journal titles and/or for number of citations.

journals fell into the clinical and biomedical research realms and include three of the top general medical journals, *New England Journal of Medicine* (*NEJM*), *Lancet*, and *JAMA*. General medicine journals have ranked high in many other public health disciplines [13, 26, 29, 34] and other disciplines related to infectious diseases, including epidemiology [35], tropical medicine [33, 36], and SARS [25]. Indeed, a recent study by Fätkenheuer et al. investigated the relative frequency of infectious disease research compared to other disciplines in the same three medical journals as found in Zone 1 here. The study found that, overall, *NEJM*, *Lancet*, and *JAMA* publish more articles in the infectious disease discipline than any other except cardiology. *Lancet*, in fact, publishes more infectious disease–related articles than articles in any other discipline [12]. Researchers have also investigated the journals publishing the most research on SARS [25, 38] and tuberculosis [10]. Xing et al., for instance, found that the top three journals publishing SARS epidemiology research were *Emerging Infectious Diseases*, *Lancet*, and *Radiology* [38], while Kostoff and Morse found that the most SARS literature was published in biological journals, although the most highly cited SARS literature was published in the major medical and multidisciplinary science journals [25].

Xing et al. also noted that during the SARS outbreak, public health bulletins like *Weekly Epidemiological Record* and *Morbidity and Mortality Weekly Report (MMWR)* published the fastest responses to the crisis. The only journals with comparative speed were *NEJM* and *Lancet* [38]. This is notable as no public

health bulletins appeared on the Zone 1 list, although they are the most critical sources in an outbreak. They are not, however, highly cited in the literature. This contrasts with a study of the Minnesota Department of Health's citation patterns, where *MMWR* was the top cited publication, though that study was not limited to infectious disease professionals [28]. Here, only *MMWR* and *Euro Surveillance* appear in the Zone 2 list; *Weekly Epidemiological Record* only appears in Zone 3. Local public health bulletins are also important during an outbreak. Many of these sources are freely available online, and libraries serving public health practitioners in particular should take especial care to collect or at least catalog these bulletins.

Over all three zones, sixty-nine different subject categories of journals are represented. All manner of medical specialties appear, as well as scientific disciplines related to infectious diseases. The spread of citations throughout so many subject disciplines conforms to previous studies. For example, Rosas et al. looked at papers published by members of the National Institute for Allergy and Infectious Diseases (NIAID) HIV/AIDS Clinical Trials Network and found that just for one infectious disease, papers were published across forty-one different subject disciplines. Similar to this study, the top subject disciplines from *JCR Science Edition* for publishing HIV/AIDS research included ''Infectious Diseases''; ''Pharmacology and Pharmacy''; ''Medicine, General and Internal''; ''Virology''; ''Microbiology''; ''Public, Environmental, and Occupational Health''; and ''Immunology'' [39]. Libraries serving specialists in certain infectious diseases—such as hepatitis, human papillomavirus, meningitis, or other non-systemic diseases—will also need to collect journals in the medical disciplines where literature is likely to be concentrated, such as gastroenterology, hepatology, obstetrics and gynecology, and neurology.

The Core Public Health Journals Project Version 2.0 (Core Journals) [17], produced by the Public Health/Health Administration Section of the Medical Library Association, has several categories relevant to public health professionals and researchers working with infectious diseases, namely, Epidemiology, Biomedical & Laboratory Practice (BLP), and the Key Journals for All Public Health (Key Journals). None, however, included one of the Zone 1 journals found in this analysis, *Journal of Virology. Infection and Immunity*, *Journal of Immunology*, and *Vaccine* appear only as Research Core titles in BLP [40]. The other Zone 1 titles are Essential Core in BLP and Key Journals for All Public Health. Many Zone 2 titles do not appear anywhere in the Core Journals, including *Virology*, *Journal of Antimicrobial Chemotherapy*, and *Hepatology*. This study, then, used in conjunction with an expert-reviewed list like the Core Journals can help broaden public health collections.

Indeed, comparison with expert-reviewed lists, local citation analysis, and other means of producing core journals lists is one way to combat some of the limitations of this study's methodology. As noted above, the sampling method used makes it difficult to delineate between Bradford zones with complete accuracy. Though sampling makes this kind of research more manageable, it does mean that a title that may have been identified as a Zone 1 title in an analysis of the complete set of citations might not have appeared in Zone 1 here. Different source journals would likely produce different results as well. Though the authors tried to select a range of important infectious disease titles as the source journals, the emphasis on clinical and biological science titles found in Zone 1 might have much to do with using journals with more than just a public health focus.

CONCLUSION

Infectious disease specialists in public health research and practice work across a range of fields to keep the public safe. They may work in public health departments, clinics and hospitals, or academic institutions. This citation analysis has demonstrated the depth and breadth of the resources that these researchers and practitioners require and use, particularly the need for older journals and collections in many subject disciplines. Libraries supporting infectious disease specialists may wish to focus their collection budgets on providing access to key journal literature, as it is overwhelmingly the most cited material. This is not to say, however, that other types of materials are unimportant. Weekly public health bulletins such as *MMWR* and *Weekly Epidemiological Record* may not be heavily cited, but they are key resources for those responding to and preparing for disease outbreaks, as bulletins tend to be the fastest places to disseminate outbreak research [38]. Though working epidemiologists likely already receive copies of *MMWR* in print or via email and may also subscribe to mailing lists like ProMED-mail [41], which distribute up-to-date information about outbreaks and emerging diseases, libraries may wish to catalog these bulletins to provide enhanced access for students and others interested in infectious diseases. Most are freely available on the web, including *MMWR*, *Euro Surveillance* (now a journal as well as rapidly published bulletins), and the *Weekly Epidemiological Record*.

Major medical journals—such as *Lancet*, *NEJM*, and *JAMA*—are important sources for infectious disease literature as well as for other public health fields. Libraries serving research institutions in particular—but also those serving large public health departments, public health practitioners, or researchers with specific disease emphases—may wish to broaden collections with access to journals in other medical disciplines, such as gastroenterology, hematology, hepatology, obstetrics and gynecology, and neurology. Clinical journals are only part of the picture of infectious disease literature, though. Vaccine development, disease genetics, diagnostics, or other areas of microbiology, virology, or immunology are crucial to infectious disease research, as shown by the prominence of titles like *Vaccine* and *Infection & Immunity* in this study. Libraries working with large

public health departments, public health laboratories, and infectious disease researchers will want to provide access to the journals listed in Zone 1 and perhaps many in Zone 2. Libraries serving only local public health departments without laboratory facilities may not require subscription-based access to the more basic science titles.

Citation analysis is one way to look at a discipline's core literature. Though it can serve as a valuable collection development tool, it should not be used in a vacuum. Local needs analysis, expert opinion, and other methods of collection analysis are also needed to effectively manage collections. This paper, however, can be used as a basis for understanding the more universal citation patterns of infectious disease professionals, both in terms of age and types of citations and the key journals for the discipline.

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