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One leg at a time: medical librarians and fake news

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While there has been recent media attention to the issue of "fake news," misinformation and disinformation has been a lasting part of human history. This Janet Doe Lecture presents the history of fake news, how it is spread and accepted, its impact on medical and health information, and medical librarian roles in limiting its spread and promoting correct health information.

INTRODUCTION

There is a saying, "A lie gets halfway around the world before the truth has a chance to get its pants on." Jonathan Swift, Mark Twain, Winston Churchill, Terry Pratchett, and several famous people in history have been attributed to making this statement. It is difficult to determine who the originator of this statement was because it has been printed and reprinted many different times throughout history. However, historians agree that it is highly unlikely Churchill made such a statement which is a bit ironic given that it about the spread of a falsehood [1].

Fake news has been around probably since humans could write. Many people think fake news in politics is a recent issue but it has been used throughout history [2]. In 1769, John Adams wrote in his diary about spending the evening "Cooking up paragraphs, articles, occurrences, - working the political engine," planting false and exaggerated stories to support the American revolution while undermining British rule [3]. In order to keep Germany in the dark about the Allies' new technology, RADAR, which enabled them to intercept and shoot down enemy bombers at night, the British government issued press releases stating that British pilots ate a lot of carrots to give them exceptional night vision. The disinformation campaign intended to fool Germans, but the British public seemed to believe the press releases as well leading to citizen gardens and 100,000-ton surplus of carrots in the country [2].

Not exclusive to governments and politics, there are many types of lies used for many types of reasons by many different people and groups. In her book, Killer Underwear Invasion! Elise Gravel reasons that fake news can be used to make money, be famous, spread beliefs or ideas, gain power, or share information often via social media [3]. Often times motives for spreading fake news is layered and involves several reasons at the same time.

Just as there are various types of fake news and reasons for it, there are several reasons why people are susceptible to fake news. A person's self-image, environment, and emotions all play a part in whether they believe and spread fake news.

When there aren't major clues about the fakeness of news items people will check its validity with other bits of knowledge to assess its compatibility. Information is more likely to be accepted as true by people when it is consistent with what they perceive or assume is true. If a message doesn't jive with one's own personal knowledge or beliefs, the message then gets stuck while trying to be processed, which causes resistance to the acceptance of the information without further investigation. In short, people endorse or support information that matches their preexisting beliefs or comes from an ideologically aligned source. It is easier to believe incorrect information than it is for a person to question their belief system.

People tend to associate and socialize with those who are familiar and have similar interests and social situations or environment. For example, people with children (the situation) might share information on the best vacation spots for kids, kid-friendly events, etc. By sharing this information with others in the same situation, they are sharing information that is familiar. These situations create bubbles that people live within further reinforcing our self-image and view within the bubble, which is their worldview. I use the term bubble to represent this type of worldview because a person's view within bubble is different than what it is when they are looking at something outside through the curvature and sheen of the bubble. The information within the bubbles remains within, bouncing around, reinforcing our beliefs internally and within the bubble.

Media fractionalization, the splitting of information among multiple media outlets through the creation and growth of cable TV, blogs, radio, internet, and social media have made it easier for people to find and select media information that already supports their existing worldview, reinforcing their self-image and bubble. People's online social activity would be considered cyber

bubbles. Natalie Jomini Stroud in the Journal of Communication identified these cyber-bubbles as one reason for the increasing polarization of political discourse [4].

Recent studies have linked the relationship between emotions and susceptibility to fake news. Both positive and negative emotions appeared to selectively affect fake news judgement, while it had no impact on the belief in real news [5]. Skepticism was the only "emotion" not to affect people's judgement of the news. Interestingly, there was no meaningful correlation between emotions and political affiliation regarding believing fake news, emotions trumped the influence of the political party social bubble. The more people relied on emotion over reason, the more they perceived fake news to be accurate.

All of these things: self-image, environment, and emotions factor into our susceptibility to fake news. Stopping the spread of fake news is difficult, yet it is important. Nicole Cook states fake news is a "serious threat to information ecosystems, as truth is no longer related to authority, expertise, or real facts, but to interpretation, perception, emotions, and sentiments" [6]. Moreover, fake news is a symptom of greater problems as it politicizes and weaponizes information. The weaponization of information is against everything that librarians stand for. As librarians, we must find a way to stop the spread of fake news while promoting legitimate news. Stopping the spread is difficult, yet important. There are three ways to help stop the spread of fake news: debunking, debiasing, prebunking.

Debunking is not easy because it relies on changing a person's mind once they have already received the misinformation. In some situations, this can be effective and to have the best chance one must retract the misinformation with facts, repeat the correct information, and use credible sources. Despite doing these things, it can be extremely difficult because presenting the correct information that is contrary to the accepted fake news causes people to question a part of their sense of self, community, and their being. We see this very strongly with the anti-vax movement. They are a whole community where their world view includes the dangers of vaccines. Authors studying misinformation and its correction backfiring, determined when people opposed to vaccines were confronted with their benefits it increased their resistance to legitimate information on vaccines even more. The authors determined that exposure to belief-threatening evidence lead people to discount the entire scientific method. People would rather believe the issue cannot be solved scientifically rather than discounting information that goes against their beliefs [7].

Debiasing is talking to people and getting people to reject the fake news by changing their biases. It is similar to conversational debunking and has been likened to a dance where the fake news believer does much of the leading.

The person trying to do the debiasing must find the believer's worldview, use phrases that don't criticize their worldview but supports the factual parts of it, asks questions, and finds supportive peers within the fake news believer's worldview who trust the real news [7]. Debiasing typically does not happen in one conversation or with those who haven't built up a relationship. However, debiasing skills may be something that doctors, nurses, and other primary care providers who have more personal and continued relationships with patients can develop this type of communication method more.

Prebunking is the process of debunking the fake news and its sources before it happens. The idea behind prebunking is also called inoculation theory. A small amount of the virus, in this case fake news, can help people's minds ward off future exposure. A Cambridge research team created the "Bad News" game where the player's goal was to become a "disinformation and fake news tycoon" [8]. It was determined people playing the "Bad News" game were better at recognizing fake news than a control group playing a different game. Laura Garcia and Tommy Shane created a primer on the First Draft News website on prebunking tools, games, and recommendations [9].

Just like the intricate web of how people fall for fake news, the methods by which to expose misinformation and change people's belief in fake news is just as intricate and requires patience as well as tenacity.

Inspired by Mark Funk's Doe Lecture, where he analyzed word usage in *JMLA*-published articles to explore changes and trends within the profession, I looked to see how many times fake news, disinformation, and misinformation were used within JMLA [10]. The term fake news only showed up once. Elaine Martin's Doe Lecture discussed social justice and the role that medical librarians can play in a democratic society [11]. The term disinformation was in one article on the library's role countering infodemics regarding COVID-19 [12]. Misinformation retrieved twelve times, with it being used most often in article on MLA's InSight Initiative Summit. The audience discussed the absence of experts in public conversations of health-related topics and the responsibility of publishers and librarians to counter misinformation. The InSight Initiative Summit in 2018, stated "the growth of casual comment on social media on topics such as vaccination and lay people debating medical evidence is a huge concern," and advocated for publishers and librarians to be more active in this area [13].

Jerry Perry in his Doe Lecture spoke about improving the quality of life through accurate health information. In 2019, he argued that each of us (medical librarians) are activists and need to own that role [14]. The problem with fake news is not that people fall for it but that it erodes trust in legitimate information. It can deepen ideological divides, disenfranchise people of their rights, and

encourage violence. Fake news often impacts marginalized communities, people of color, and different ethnicities and religions. Since fake news impacts health, librarians combatting the spread of fake news through accurate health information are improving quality of life for others. Library collections, online tools, and collaborative educational opportunities are some ways for librarians to promote accurate health information and combat fake news.

Medical librarians must take ownership of their collections and purchase only scientifically valid resources. They must remove old or outdated materials as the science may be outdated For example, there are older books that refer to gender incongruence as a mental disorder. However, simply removing older editions is not enough, they must be aware of the fake medical information market and work to prevent those materials from infiltrating their collection. According OCLC World Cat and NLM Locator, books from Kevin Trudeau, an author who is a felon convicted of fraud for making misleading health claims in his books, can be found in medical libraries across the country, including the National Library of Medicine [15]. As champions of health information we need to be constantly aware and involved in our purchases, ask questions about the content and whether it promotes or obscures accurate health information.

There is more to the collection than books; librarians must also be aware of the thorny landscape of predatory journals. We can help prevent the spread of fake news through continued awareness and education on the complicated nature of predatory publishing. While the articles in predatory journals are not necessarily fake or wrong, it can be difficult to determine what is real given the lack of proper vetting of information in these journals.

Preprint articles, while helpful in breaking the barriers to getting important research out to the public to help speed up the treatments, can be fraught with inaccuracies that can cause more harm than good. A study in PLOS One found that nearly half of the preprint articles on COVID-19 found on medRxiv and later published in peer reviewed journals contained differences in data, title, and even conclusions. Those articles where the title changed made it difficult to track the article to verify the changes in information from the preprint version to the published peer review version [16].

In order to combat all this possible fake news, librarians should create, collect, and promote online tools on identifying and countering fake news to the people we serve. Library web pages listing tools like "Bad News" game or First Draft News can be helpful to students and medical professionals. In October 2022, the president of the American Medical Association discussed hearing from frustrated physicians working with patients whom they have seen for years and who have trusted their care, and

these patients now make decisions against their medical advice based on fake news [17].

More medical librarians can reach out to other librarians to help prevent the spread of fake news. Public librarians have the experience of communicating and providing information to communities, and medical librarians have the experience of working with medical information. A public librarian and medical librarian team makes an effective consumer health information partnership. Academic medical librarians can partner with university departments already challenged by fake news. Journalism schools and schools of public health are two examples of natural partners to fight against fake news.

Artificial intelligence (AI) has added another complication and layer to the proliferation of fake news. AI is a tool. It is neither good nor bad; it is how people use AI and whether they use it properly as to how it impacts information. The answers that AI provides is related to the data available for it to use. Bad data coming in can equal bad answers going out. Since many AI programs use a variety of data available on the Internet, the data can be correct or questionable. The questionable data can be fraught with bias, misinformation, and outright lies, leading to potential ethical issues regarding the data and results. Librarians should be more engaged in the understanding of the data behind the AI to help ensure factual health information is provided.

Librarians can't be everything at all times, but we can use our strengths to address fake news within our libraries, institutions, and the profession as a whole. Librarians must get involved; simply relying on facts to do the work for us is not a solution. History has shown us there will always be fake news and there will always be new mediums and technologies by which it is spread. My favorite thing about being a medical librarian is finding information and sharing it with people, but we can't do that if fake news keeps getting in the way and muddying the message.

A lie may get halfway around the world before the truth has a chance to get its pants on. But we don't have to stand there and watch. Let's take it one leg at a time and get our pants on to help prevent it from spreading to the other half of the world.

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The impact of libraries and informationists on patient and population care: a mixed-methods study

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Objective: While several studies have examined the effectiveness of librarian interactions with clinicians and impact of librarians on patient care, no studies have explored a library's effects on population care. The goal of this study was to investigate the library's impact on both patient and population care.

Methods: Using a sequential exploratory mixed-methods design, we first interviewed a small set of clinicians and researchers active in patient and population care. Based on the themes that we discovered through coding the interviews, we created a survey that was sent to faculty in the health sciences and the health system.

Results: We collected data from a representative sample of our population. We discovered that all respondents value the library and informationists, using our services most for teaching, publishing, presenting, and professional development.

Conclusion: We now have data to support our value to our population and to show where we can do more work to improve the use of our services. Our study shows the value of doing a mixed-methods sequential exploration in which themes that are important to our user community were identified prior to launching a large-scale survey.

Keywords: Assessment; population health; mixed methods; patient care; libraries; librarians.

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INTRODUCTION

At the Taubman Health Sciences Library (THL) at the University of Michigan, informationists work closely with researchers, faculty, staff, clinicians, and students who focus on the health of patients and populations in the schools of dentistry, medicine, nursing, pharmacy, and public health, as well as the health system (Michigan Medicine). We partner with our users in a variety of ways: collaborating with teams that create local practice guidelines for the health system; supporting health systems researchers; providing instruction in evidence-based practice; and participating in evidence syntheses research projects. However, because we are not clinical librarians who work on the wards, we rarely get the opportunity to directly observe the impact of our library on patient care. While we have long had anecdotal evidence that our community strongly values our expertise and knowledge, we sought to measure and understand the library's impact in both patient and population care, to make meaningful decisions on resources both human and financial.

The THL Assessment Working Group was convened to conduct the project. We began with a review of the literature in 2017 (updated in 2021) to find studies that examined the value of librarians working in an academic setting similar to our own, that focused on patient and population care, and included data (qualitative or quantitative). We found a number of studies that examined the information needs of clinicians [1, 2]; other studies looked at the usefulness of clinical librarians [3–6] or explored the impact measure of libraries [7, 8]. The study that was closest to the work that we wanted to do was Marshall [9], a replication of the 1992 Rochester study [10]. In this study, both quantitative (a critical incident survey of physicians and residents) and qualitative methods (follow-up telephone interviews) were used to determine the impact of library services on patient care. We found no articles that look at the impact of informationists and librarians on population care. Because no one has looked at population care, we do not know how or if information needs of those who work in population care are the same or different from those who work in patient care, and so it was important to include this group of researchers in our study.

We used the following definition of population care in our study and provided it to all who completed either an interview or the survey.

Population care can be defined as health care for broader populations rather than individuals and can include concepts such as clinical guidelines, protocols and legal policy. Specifically, for the purposes of this study, we define population care as "the health care needs of a specific population and making health care decisions for the population as a whole rather than for individual" [11].

In light of this information gap that we discovered through our literature review, we designed a mixed-methods study to understand our impact on both patient and population care. Our use of the word "impact" follows a common usage in the literature that, for example, investigates factors as variables in health or information literacy. Information is but one element in the long process of patient care or the implementation of policy and never directly touches the patient or the population, making it extremely difficult to measure.

METHODS

Figure 1 Mixed-methods sequential exploratory study design
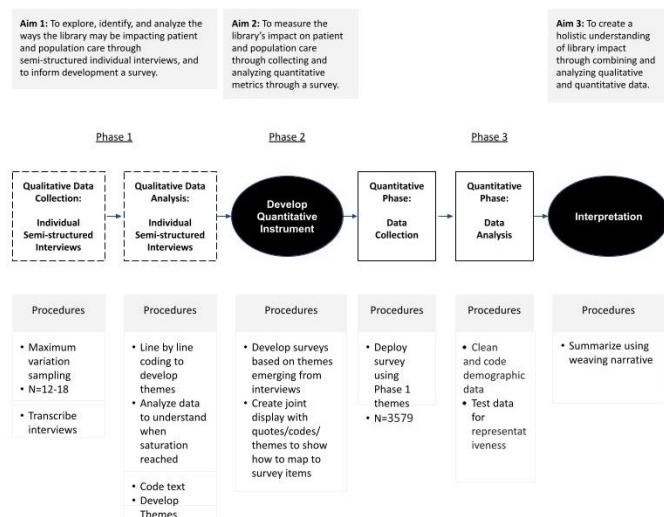
Phase 1

We selected a mixed-methods approach for this project, so that we could utilize the strengths of both qualitative and quantitative data: the data we collected would create a holistic understanding of our impact on patient and population care in a way that could not be achieved by using one type of data alone. The exploratory sequential study design, which includes a qualitative phase followed by a quantitative phase that is informed by the qualitative

phase, was the best fit for our study. Figure 1 summarizes our exploratory sequential design [12].

The University of Michigan Health Sciences and Behavioral Sciences IRB reviewed the project and determined that the "study does not fit the definition of human subjects research" and would not need to be regulated [HUM00131285].

The goal of Phase 1 was to use individual, semi-structured interviews to inform our survey instrument, which was based on Marshall [9], but also would be influenced by our two pilot in-person interviews. In these interviews we had two objectives: 1) to broadly explore themes so that we could better understand ways in which the library may be impacting patient and population care and 2) to inform the creation of the quantitative survey. We created an interviewer handbook, protocol, and list of codes that informed the development of our tools, also modeled on Marshall [9]. The codes that we used were divided into categories such as Roles, Resources, and Informationist Integration, which were further defined by subheadings, including Point of care, Research, and Authorship.

The questions for the qualitative portion of the study included asking interviewees to describe their work (either patient or population care or both), their own use of resources, their experiences of working with an informationist, and how the informationist contributed to their work.

The target population consisted of University of Michigan health care providers and researchers across the health sciences who use the library and either provide patient care or conduct work that explicitly attempts to have an impact on population care, such as health policy or clinical guidelines. Students (including resident physicians) were excluded from the study because they do not have final responsibility for patient care.

To identify potential stakeholders to interview, we conducted a survey of THL informationists to collect names of faculty members to participate in these initial interviews. The recommending informationist then reached out to the faculty member to ensure a better uptake of the interview invitations.

We drafted the Phase 1 questionnaire using probes from Creswell [13], such as "Tell me more;" "What is an example of that?;" and "Could you explain your response more?" We piloted the questionnaire during interviews with two faculty members. We then revised it for use in the 11 formal interviews. The questionnaire is available in the material found under the Data Availability Statement. We included definitions for "population care," "informationist," and "institution," terms that we felt might not be familiar to or defined in the same way by everyone.

Two team members individually conducted the interviews, which were scheduled for 40 minutes. The pilot interviews were used only to test the survey instrument, and we did not retain the data from them for analysis. All interviews were recorded and transcribed using Scribie [14]. They were coded independently by two of the report authors. Coding, using a combination of codes from Marshall [9] and codes that emerged from the interviews, was conducted at the phrase and sentence level. The team members then compared their coding to resolve differences in how the codes were understood and applied and to address the emergence of new codes and incorporate them both retroactively and prospectively. Coding was done manually (on paper, using highlighting) by one team member and in Dedoose [15] by the other team member. Dedoose was also used to perform quantitative analyses.

Phase 2

The COVID-19 pandemic had an extraordinary impact on health and healthcare, as well as the general population. It began while the Phase 2 questionnaire was being developed and approximately six months before that questionnaire was to be released. Because we wondered how this crisis might affect our study population, we added new questions to the survey to understand what effects, if any, the COVID-19 pandemic had on library resource use and access, and on patient and population care.

Gathering the Quantitative Data

Survey invitations were sent to 3,579 people identified through the University's data warehouse as having an affiliation with the schools/colleges of dentistry, medicine, nursing, pharmacy, public health, the hospital system, and also have a faculty appointment. The survey contained multiple-choice, Likert-scale, and open-response questions. It was administered online, using QualtricsXM software [16], over a three-week period in August 2020. Data were queried using IBM's SPSS Statistics [17].

We included demographic questions to understand who THL serves and to discover any gaps in how services were provided at the various schools, at the department level, at specific locations, by gender, and by race or ethnicity. We cleaned and coded the demographic data so that the sample could be tested for representativeness. We asked survey participants about their use of library services and collections in three theme areas, as well as library support during the COVID-19 pandemic.

RESULTS

A strength of mixed-methods methodology is the intentional integration of the qualitative and quantitative data to create a holistic view of the data. Three overarching themes, with subthemes that we investigated in some detail, emerged from the qualitative data and were further explored in the quantitative survey.

1. Access to information resources (which can be further delineated as resource access, resource types, and resource use).

"I feel that everything is literally at my fingertips. I can't tell you the last time I tried to pull an article from a journal that I couldn't access. So I think that that speaks to the depth and breadth of what the library has to offer, 'cause in my kind of work life, the things that I may look into are... Could be very diverse, and I've never had an issue getting an article, old, new, in an obscure journal versus a very mainstream journal. So I think that from a patient care perspective, if I'm about to do a procedure or I know I have a procedure coming up in the coming days and I wanna look up some stuff on it, it's very easy" (Participant #8, patient care provider).

2. Informationist integration and value (which can be itemized as awareness and connection, instruction, expert searching, and statements of informationist value).

"Because this is a relatively new mandate, we've done a lot of benchmarking, a lot of lit reviews of how hospitals have approached this or how other institutions, Public Health, other groups, have approached this work. So library resources have been critical in just understanding what has been done to date in order to guide our feet in determining the best strategy for us. So just to get a lay of the land, to understand what the most fruitful direction to take should be, being at such a resource-rich place like U of M and having the help and support of informationists as well, the Public Health core has been just wonderful" (Participant #1, population care researcher).

"And so whereas, like I said, there's not a specific patient encounter where I've called an informationist, I think that they've clearly shaped the care I deliver as a result of the education I've gotten over the last number of years being a part of this institution" (Participant #7, patient care provider).

3. Information seeking behaviors.

"But I was at another institution for a few years before this that did not have this kind of support. And it really makes a difference in terms of your ability to stay up to date with things" (Participant #3, population care researcher).

The themes from Phase 1 informed the creation of questions for the Phase 2 survey and each theme is mapped to at least one survey question. Table 1 provides a selection of the themes from this phase, illustrative quotes from the interviews, and mapping to survey questions and results in Phase 2.

In Phase 1, the three roles (clinical, population, or clinical and population) were roughly equally represented among the interviewees (four, four, and three,

Table 1 Joint display of themes identified in Phase 1 qualitative interviews, examined in Phase 2 quantitative survey

Phase 1 Themes	Interview Quotations	Phase 2 Questionnaire
Access to information resources	"For guidelines, I'm tracking down guideline articles...for educational instruction, I'm often going back looking for articles in Academic Medicine and other places that have been cited to get the fuller reference and access to them." (Participant #4, patient care provider)	Please select up to three types of information resources that are most important to your professional work. Journals (n=368), Evidence-based information resources (n=225), and Guidelines (n=197) were the top choices.
Informationist integration and value	"We have a bunch of clinicians trying to write grants when most of what they do is see patients, it doesn't come out so well without the help of the informationist I would say." (Participant #9, patient care provider) " [W]ithout the informationist we don't have the good background and we can't support our argument that a service is needed. If we can't support the argument that the service is needed then the service isn't there, and then the patients don't benefit from it…] (Participant #9, patient care provider)	How would you characterize the contribution of the informationist(s) to your information-seeking efforts? Of those who had an interaction with an informationist, 98% (n=128) found the interaction to be "very beneficial" or "somewhat beneficial"
Information Seeking Behavior	"...based on my role…I stay abreast with current evidence that's coming out in the scholarly journals to make sure that I'm treating my patients with the most up to date care and recommendations. Making the recommendations based off of evidence and not just based off of my experience, for example." (Participant #3, population care researcher)	How do the resources you selected [as the most important to your professional work] impact your work? Teaching (n=345) Publishing and presenting (n=339) Professional development (n=321)

Table 2 How do the information resources you selected impact your work?

Type of Impact	Frequency
Teaching	345
Publishing and presenting	339
Professional development	321
Decision making	316
Data work	227
Grants	208

respectively); however, how the participants answered questions varied significantly in relation to their role. We theorized that, with the expansion in the number of participants in Phase 2, we would see an even greater variation in the ways that respondents from each role used library resources and in the library's impact on patient and population care. We also were interested in finding any significant gaps in the provision of service or instances of high impact based on affiliations, locations, race or ethnic identity, and gender identity.

Due to attrition or bad contact information, 13 invitations failed to reach their intended recipient, leaving 3,566 active invitations. At the close of the survey, there were 506 completed questionnaires, for a response rate of 14.2%. Of the completions, 385 people selected a category describing their work as patient care (n=220), population care (n=54), or both patient and population care (n=111). We also collected data from participants who answered neither (n=121), as it provided useful information on the library's service provision; however, it is not the focus of this current study.

We tested data from the 385 eligible participants for representation against the population to which the survey was sent for school/college affiliation, gender, race or ethnicity, and appointment track (clinical, research, tenure, lecturer). In all areas except for gender there was a p-value of less than 0.05, indicating that there was no statistically significant difference between the eligible participants and the population invited to participate.

Access to Information Resources

Phase 1 interviews provided an understanding of the range of library resources that clinicians and population care researchers find important to their work. Using their responses to populate a categorical list of resources and a free text "other" option, survey respondents in Phase 2 provided insights into which resources were used most often and how they were being used for patient care and population care research. In this study, respondents were asked to select up to three types of resources that were most important to their work. They selected journals (n=368), evidence-based resources (n=225), and guidelines (n=197) as their top choices. Reports (n=65) and statistical resources (n=65) ranked at the bottom of the list. Asked how the three chosen resources collectively impact their work, respondents indicated a range of activities whose relative ranks revealed a critical focus on instruction. Table 2 demonstrates how respondents most frequently used the top three resources ranked as important to their work.

Informationist Integration and Value/Information Seeking

In Phase 1, we gathered rich qualitative data on how informationists impact the work of known library users. In Phase 2, we were able to quantify this impact among survey respondents who had a positive interaction with an informationist (categorized as "very beneficial" or "somewhat beneficial") within the past three years (n=114). In terms of their impact, respondents noted that informationists improve efficiency, information seeking, and completion of work (Table 3).

Table 3 How do informationists help impact your work?

Type of Impact	Frequency	Percent
Improved my ability to find and use information	101	89
Contributed to the production and/or completion of my work	85	75
Helped me be more efficient with my time	73	64
Helped with my teaching and/or instruction needs	54	47
Informed my evidence-based decision-making process	31	27

Use of Library Resources During COVID-19

Many libraries have been guided by their own understanding of their patrons' needs, by anecdotal evidence, and by usage statistics of the effects of the COVID-19 pandemic on their patrons' use of library resources [18, 19]. Survey respondents were asked if they were involved in work directly related to the pandemic, including online teaching, coronavirus research, or patient or population care (or both). Of those answering "yes" (n=274, 75%), 22% stated that their use of the library changed during the pandemic. We asked these respondents to briefly describe how their use of the library changed. Respondents wrote about the lack of access to the library's physical spaces: "Used to go to the physical library, but now no longer accessible—more dependent on internet resources" (Participant ID: R_2wF9UJQBvdZ5qme) and "Usually I use the great space for writing grants and papers, but that was not available during shutdown" (Participant ID: R_1CIohFnom8dZgyK).

Some decreases in the use of library resources due to the pandemic are beyond the library's control, such as: "[l]ess time to use library resources due to increase in clinical load," (Participant ID: R_12PuETPGTEJYeXh) and "I would often interact online when I was in my office. During the pandemic I just didn't come to office [sic]" (Participant ID: R_8kddCh7AEFraQi5).

One respondent wrote about increased costs from being unable to access parts of the library collection: "Regret having limited access to textbooks; this required me to purchase them out of pocket" (Participant ID: R_1PTVRIoVysKpSSq).

The closure of physical spaces during the pandemic highlighted the ways that patrons, who use health sciences libraries and already interacting primarily with electronic collections before, continued to engage with library resources—some increasing their use—during the pandemic. The following quotes from the survey demonstrate the range of responses:

"[T]he online library resources were invaluable to not only patient care but also the ability to learn about and expand our understanding of COVID" (Participant ID: R_skjlOtQCAB0wNq1).

"More actively looking for peer reviewed data and clinical guidelines" (Participant ID: R_3ni421mjTKCfOfv).

"Increased use to write COVID-related grants" (Participant ID: R_1CBKg7YHn02Q2aE).

"Accessed more from home" (Participant ID: R_1fdOdJd1a7N13hr).

"Increased use of resources including library information lead to review and write articles around COVID-19 management" (Participant ID: R_1g6eKzuhPLqxOSc).

"I worked on a publication and accessed online library resources more during the pandemic" (Participant ID: R_1cZE1I6AcA7d5Q7).

DISCUSSION

In the literature on surveys as a research methodology, females, including academic women, are more likely to respond to surveys [20] and, therefore, our respondent sample is like the population from which it was drawn across the major characteristics of this population. While the data demonstrated an appropriate representativeness, it should not be seen as characteristic of researchers and providers of patient and population care nationally. Rather, this data and the insights drawn from it provide a new understanding of the information behaviors and needs of this population and may be used to understand how libraries can approach engaging with their researchers and providers at similar large universities and affiliated healthcare systems.

The themes investigated in this study provide new insights into access to information resources, the integration and value of information professionals, and information-seeking behaviors that other health sciences libraries can use to support and deepen their engagement with researchers and providers of patient and population care. Additionally, the findings related to the use of library resources during the pandemic provide new information that health sciences librarians can use to understand how the use of resources was affected during COVID-19 and to plan for future extreme circumstances. At the moment, library literature describes how libraries addressed the challenges of continuing to provide services to their patrons providing patient care [21-23], the role of academic librarians in supporting the information needs of medical staff and researchers, and collaborations with physicians to provide critical and timely resources and intelligence reports [24, 25]. While this literature adds to what is known about how libraries responded to this emerging crisis, our study provides information about how providers of patient and population care used library resources during the pandemic and what they perceived as vital to their work.

Summative evaluations of informationists' work, such as when participants were asked about all the ways that informationist's help impacted their work, provide insight into areas of strongest impact. Using the SWOT analysis framework that considers areas of strength, weakness, opportunities, and threats, data from Phase 2 suggests that seeking additional opportunities to inform evidence-based decision-making through highlighting and providing instruction on the many evidence-based resources available through the library could enhance

informationists' impact in this area. The data provide a guide to where future efforts to collaborate on patient and population care could see the largest increase in our engagement with this user group. While providers of patient and population care in this study did not perceive libraries and informationists as having as significant of an impact on informing their evidence-based decision-making processes, this could be due to 1) greater emphasis being placed on work we do to help them find and use information, 2) a lack of familiarity with our expertise in finding and synthesizing evidence, or 3) a researcher's previous negative experiences working with a librarian, whether at the University of Michigan or elsewhere.

This study offers insights into specific needs and concerns reported by providers of patient and population care during an emerging healthcare crisis that can be used to understand and plan for these needs ahead of the next interruption in regular service provision. Health sciences libraries can expect their patrons to be consumed by patient care responsibilities and the overall management of the population care crises while being simultaneously in need of library resources during the next emerging healthcare crisis. Creating tools that support efficient access to information, such as curated information portals guiding users to the most up-to-date research and implementing strategies for disseminating this information to patient and population care users during the next similar crisis are among the highest priorities information specialists can engage with. The closure of physical spaces to combat the spread of infectious disease reinforces the importance of access to online library resources, including access to informationist expertise. From instruction to research consultation to resource provision, each aspect of the library and informationists' work needs to function as seamlessly in the virtual environment as it does in person in order to best serve providers of patient and population care.

LIMITATIONS

Respondents to the qualitative and quantitative components of the study may have been already favorably predisposed to the library, which may have resulted in disproportionately positive data. With the COVID-19 pandemic beginning about six months before the Phase 2 survey was released, there was probably an adverse effect on the number of survey responses that we received, since a willingness to take the survey would require time and energy on the part of providers and researchers, many of whom took on added burdens of research or patient care at that time. Thus, the study likely did not gather data from those most impacted by COVID-19 patient and population care responsibilities.

While the study sample was representative of the population from which it was drawn, it is not a representative sample of patient and population care

providers and researchers nationally. Insights drawn from this sample may shed light on the information behaviors and needs of similar users at other large academic institutions with associated healthcare systems but are not meant to be generalizable.

CONCLUSION

The impact of information resources on teaching highlighted in this study likely points to their importance at an academic institution where an emphasis on training health sciences professionals is part of the institution's mission. This has implications for the licensing of resources for both the academic and clinical environments and for considerations of cost and cost-sharing of resources between the library, health sciences schools, and clinical departments. Respondents in this study confirmed the importance of journal access for instruction, publishing and presenting, and professional development but seemed less aware of how working with informationists could inform their instruction or their evidence-based decision-making process. These latter two domains—with an emphasis on librarians' expertise in instruction on finding and using information, particularly for the evidence-based decision-making process—point to areas for increasing our impact on patient and population care.

Additionally, these data may be used to understand how to best support the work of patient and population care providers in a number of ways, including proactively looking for information competencies embedded within the health sciences schools' curricula and advocating for integration points for library instruction; working with departments to provide sessions on research dissemination, particularly in open access journals, which libraries have led the way in promoting; and sharing methods for creating alerts that help raise current awareness on topics key to ongoing professional development. Finally, using a mixed-methods research design allowed us to gather rich, multifaceted data. We had previous studies to look to for guidance, and some even used both qualitative and quantitative methods but not in a mixed-methods design. Using an explicit mixed-methods approach, in our case, the sequential exploratory mixed-methods design, meant that we could make informed decisions (based on the qualitative interviews) about the questions we would ask in our quantitative survey, rather than guessing or depending completely on the work of others. The mixed-methods approach is very useful for librarians, as it is flexible, providing multiple ways to gather both qualitative and quantitative data and a framework to integrate both types.

DATA AVAILABILITY STATEMENT

Data associated with this article cannot be made publicly available because they contain personally identifiable information. Access to the data can be requested from the corresponding author and may be subject to IRB restrictions.

AUTHOR CONTRIBUTIONS STATEMENT

Jacqueline Freeman: data curation, formal analysis, project administration, writing - original draft, writing - editing & revision; Mark MacEachern: conceptualization; Gurpreet Rana: conceptualization, data curation, formal analysis; Carol Shannon: conceptualization, investigation, writing - original draft, writing - editing & revision; Craig Smith: conceptualization, data curation, formal analysis, investigation; Judy Smith: conceptualization, formal analysis, funding acquisition, investigation, methodology, project administration, writing - editing & revision; Jean Song: conceptualization, data curation, formal analysis.

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SUPPLEMENTAL FILES

- **Appendices**: The interview instrument and survey questionnaire are available at https://dx.doi.org/10.7302/7636.

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Straight to the point: evaluation of a Point of Care Information (POCI) resource in answering disease-related questions

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Objective: To evaluate the ability of DynaMedex, an evidence-based drug and disease Point of Care Information (POCI) resource, in answering clinical queries using keyword searches.

Methods: Real-world disease-related questions compiled from clinicians at an academic medical center, DynaMedex search query data, and medical board review resources were categorized into five clinical categories (complications & prognosis, diagnosis & clinical presentation, epidemiology, prevention & screening/monitoring, and treatment) and six specialties (cardiology, endocrinology, hematology-oncology, infectious disease, internal medicine, and neurology). A total of 265 disease-related questions were evaluated by pharmacist reviewers based on if an answer was found (yes, no), whether the answer was relevant (yes, no), difficulty in finding the answer (easy, not easy), cited best evidence available (yes, no), clinical practice guidelines included (yes, no), and level of detail provided (detailed, limited details).

Results: An answer was found for 259/265 questions (98%). Both reviewers found an answer for 241 questions (91%), neither found the answer for 6 questions (2%), and only one reviewer found an answer for 18 questions (7%). Both reviewers found a relevant answer 97% of the time when an answer was found. Of all relevant answers found, 68% were easy to find, 97% cited best quality of evidence available, 72% included clinical guidelines, and 95% were detailed. Recommendations for areas of resource improvement were identified.

Conclusions: The resource enabled reviewers to answer most questions easily with the best quality of evidence available, providing detailed answers and clinical guidelines, with a high level of replication of results across users.

Keywords: Evidence-based information; Clinical Decision Support Systems; point of care resources; Information Retrieval

EC   See end of article for supplemental content.

INTRODUCTION

Access to evidence-based drug and disease information is essential for health care professionals to optimize patient care [1]. Electronic information resources, accompanying conventional practices of textbook use and colleague consults, have become a standard approach used to guide clinical care decisions [2-3]. The clinical decision support system of Point-of-Care Information (POCI) resources supports health care providers in answering clinical questions in a timely manner with curated evidenced-based information [4-6].

Although several published research studies are available regarding satisfaction when using clinical information resources, few studies have sufficiently evaluated the ability of POCI resources to answer real-world clinical questions [7-10]. For example, in Nickum et al, three POCI resources of Nursing Reference Center Plus, ClinicalKey for Nursing, and UpToDate were evaluated by nursing staff to answer three clinical questions and then rate their experience based on currency, relevancy, layout, navigation, labeling, and use of filters [10]. In Bradley-Ridout et al, medical residents each answered four clinical questions and compared the accuracy, time to answer, user confidence, and user satisfaction between two POCI resources of UpToDate and DynaMed [8]. However, these studies were limited either by the small number of questions searched or use of questions from medical board review study guides or textbooks rather than questions asked in a direct patient care setting.

DynaMed and Micromedex with Watson, also known as DynaMedex (Merative and EBSCO), is an evidence-

based drug and disease information resource intended to help inform clinical decisions at the point of care (POC) [11-13]. DynaMed is a peer-reviewed clinical content resource with information on disease topics, health conditions, abnormal findings, disease evaluation, differential diagnosis, and disease management [11]. Micromedex is a comprehensive medication information resource with detailed drug monographs, information on drug-drug interactions, and management of drug reactions [12]. The merging of DynaMed and Micromedex into a combined tool, DynaMedex, brought drug and disease information into a single resource to help health care providers in making informed clinical decisions [11-13]. We previously evaluated the application's ability to answer clinical questions in 11 categories (adverse drug reaction/toxicity, alternative medicine, disease, therapeutics and pharmacology, dosing/pharmacokinetics, drug administration, interactions, monitoring/laboratory tests, pregnancy/lactation/breastfeeding, product availability and drug identification, stability/compatibility) and nine specialties (cardiology, critical care, endocrinology, hematology-oncology, infectious disease, neurology, internal medicine, pharmacy, and nursing) [14]. DynaMedex was found to be a useful resource in answering questions in that study, however, the questions were mostly focused on drug therapy, with only a limited number of disease-related clinical questions [14]. The objective of this study was to evaluate the ability of the DynaMedex POCI resource to answer real-world disease-related clinical queries using keyword searches.

METHODS

The study team reviewers included three research pharmacists with a background in clinical pharmacy and informatics. Two pharmacists had prior experience using DynaMedex. The other pharmacist had experience using DynaMed and Micromedex as separate information resources. The study was conducted from May 2022 to April 2023 and the study team was provided access to DynaMedex during that timeframe. This research project was reviewed and approved by the Mass General Brigham institutional review board (2022P002066).

Developing and Searching Clinical Disease-related Questions

The study team compiled a list of 265 real-world disease-related questions using multiple resources. Some questions were submitted by or compiled during interviews with specialty clinicians at our academic medical center to identify questions that occurred in their practices. Other questions were created by the research pharmacists using DynaMedex's data of search terms which were anonymized to the research team, and other questions were based on content from medical board review resources [15-17]. All compiled questions were reviewed by physician specialists to confirm clinical relevance and accuracy. The questions were categorized into five clinical categories (complications & prognosis, diagnosis & clinical presentation, epidemiology, prevention & screening/monitoring, and treatment) and targeted six specialties (cardiology, endocrinology, hematology-oncology, infectious disease, internal medicine, and neurology). The number of questions based on clinical category and specialty are summarized in Table 1.

The real-world disease-related questions were randomly divided among the three pharmacists for review. Each question was independently reviewed by two of the three between December 2022 to February 2023. Reviewers searched for answers to the questions by entering free text into the search field of the POCI resource and then selected the most appropriate monograph from the options that were returned.

Data Collection Categories

After conducting a literature review of studies evaluating drug information resources, the following categories were created to evaluate the availability, relevance, difficulty of

Table 1 Overall count of question categories by specialty

Targeted Specialty	Total Questions n (%)	Complications & Prognosis n (%)	Diagnosis n (%)	Epidemiology n (%)	Prevention & Screening/ Monitoring n (%)	Treatment n (%)
Total Questions	265	38	61	48	50	68
Cardiology	42 (16)	7 (18)	8 (13)	7 (15)	10 (20)	10 (15)
Endocrinology	34 (13)	6 (16)	7 (11)	6 (13)	6 (12)	9 (13)
Hematology-Oncology	34 (13)	6 (16)	6 (10)	5 (10)	7 (14)	10 (15)
Infectious Disease	47 (18)	6 (16)	9 (15)	12 (25)	6 (12)	14 (21)
Internal Medicine	62 (23)	6 (16)	18 (30)	8 (17)	14 (28)	16 (24)
Neurology	46 (17)	7 (18)	13 (21)	10 (21)	7 (14)	9 (13)

answer retrieval, quality of answers, whether clinical guidelines were included, and level of detail of answers provided [18-22]. Search results were independently evaluated by pharmacists based on if the answer was found (yes, no), whether the answer was relevant to the question (yes, no), difficulty in finding an answer (easy, not easy), cited best evidence available (yes, no), clinical practice guidelines included (yes, no), and level of detail of the evidence provided (detailed, limited details). Study methods are summarized in Figure 1.

Figure 1 Study methods
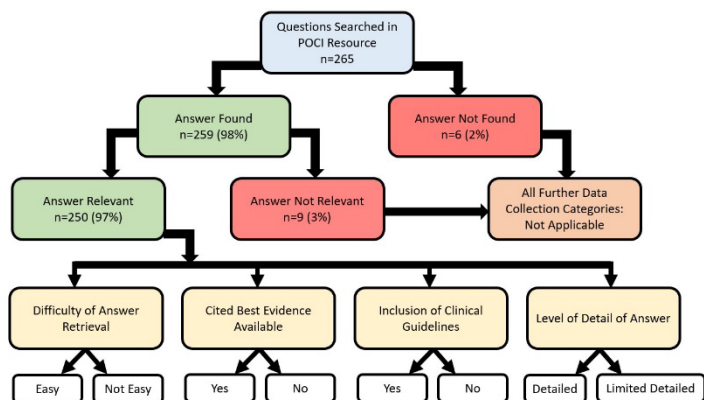
*Note: Comments of reviewers were also recorded for every question.

1) *Availability of answer*: Each pharmacist documented which search terms were used and the monograph where the answer was found for each question. The pharmacist evaluated if an answer was found or not. If both reviewers did not find an answer, then the further data collection categories were considered not applicable (n/a).

2) *Relevance of the information found*: The pharmacists evaluated relevance of answers if found. If the answer was relevant (yes), the answer fully addressed the question, or if the answer was not relevant (no), some parts of the question were unanswered or did not fully answer the question. If both reviewers found an answer was not relevant, then the further data collection categories were considered not applicable (n/a).

3) *Difficulty of answer retrieval*: The difficulty of answer retrieval was categorized as easy or not easy. Those rated not easy required more than a few minutes of searching, entering multiple search terms, and/or looking at multiple monographs to find the answer.

4) *Cited best evidence available*: Best available evidence in general was considered to be randomized clinical trials or systematic reviews. However, for certain situations where it may not have been possible due to ethical concerns (e.g., pregnancy, lactation),

observational studies or case reports may have been considered best available evidence.

5) *Inclusion of clinical guidelines*: Each reviewer assessed if clinical guidelines were available or not available.

6) *Level of detail of answer*: The level of detail of an answer was identified based on if the answer was detailed or not detailed. Detailed answers provided a large amount of information to answer the question such as details on research done to support the answer. Limited detailed answers provided scant information to answer the question such as a single sentence.

7) *Reviewer's comments*: Overall insights and recommendations for improvement were captured about each question searched.

Once all questions were searched, the data was consolidated and analyzed among the three reviewer pharmacists. Differences assessing whether an answer was found were adjudicated through discussion among all three pharmacists until an agreement was reached. Descriptive statistics were calculated to summarize the data.

RESULTS

All Questions Regardless of Specialty or Category

The overall results for all questions regardless of specialty or category are summarized in Table 2. An answer was found for 259 of the total 265 questions (98%) in DynaMedex. Both reviewers found the answer for 241 questions (91%), both did not find the answer for 6 questions (2%), and 18 questions were found by one reviewer but not the second reviewer (7%). The difference in finding an answer between reviewers was due to the search terms used in the POCI resource. Select question and answer examples from the data collection categories are summarized in Table 3. Both reviewers found a relevant answer 97% of the time when an answer was found. Of the 250 relevant answers found, 68% were easy to find, 97% cited best quality of evidence available, 72% provided clinical guidelines, and 95% were detailed.

Reviewer comments were generally positive regarding the application's ability in finding answers. For example, reviewers found the direct website links for disease related monographs to be beneficial. Experience with the product did not affect the ability to find an answer as the number of answers not found were distributed among the searches of the research team. A few recommendations for areas of improvement of the resource were identified: (1) providing direct website links for all studies including within the drug monographs, (2) documenting the date when the monograph was last updated, and (3) enhancing search term recognition when search terms were slightly misspelled or had dashed punctuation as often no search results would appear.

Table 2 Overall count of questions regardless of specialty or category

If an answer was found (n=265)	n (%)
Yes	241 (91)
No	6 (2)
Yes and No = where one reviewer found the answer, but the other reviewer did not	18 (7)
Relevance of the information for answers found (n=259)	
Yes	250 (97)
No	9 (3)
Difficulty in finding a relevant answer (n=250)	
Easy	170 (68)
Not Easy	22 (9)
Mixed = where one reviewer rated the answer as easy, but the other reviewer rated the answer as not easy	58 (23)
Cited best available evidence for relevant answers found (n=250)	
Yes	243 (97)
No	7 (3)
Inclusion of clinical practice guidelines for relevant answers found (n=250)	
Yes	180 (72)
No	70 (28)
Level of detail provided for relevant answers found (n=250)	
Detailed	237 (95)
Limited Details	13 (5)

Results by Clinical Categories

Questions were further analyzed within five clinical categories (complications & prognosis, diagnosis & clinical presentation, epidemiology, prevention & screening/monitoring, and treatment). The results by clinical category are summarized in Table 4. An answer was found by both reviewers in treatment (97%; n=66), complications & prognosis (92%; n=35), prevention & screening/monitoring (92%; n=46), epidemiology (88%; n=48), and diagnosis & clinical presentation (85%; n=52).

For treatment category questions, an answer was found for all 68 questions (100%) by at least one reviewer, and these were all considered relevant answers by the reviewers. For 2 of the 68 questions, an answer was found by one reviewer but not the second reviewer (3%). Difference in finding an answer between reviewers was

due to the search terms used including misspellings. For example, one reviewer found the answer with the correctly spelled search term, "lomentospora proliFICANS," but the other reviewer did not find an answer with the misspelled search term "lomentospora proliFERICAN." When search terms were misspelled, DynaMedex did not show any results. Additional examples are summarized in Table 3.

When one reviewer found an answer easily and the other reviewer did not find the answer easily, this was recorded as mixed in Table 4. Difference in finding an answer between reviewers was due to the reviewer's search terms. An answer was more likely to be classified as easily found and detailed in the prevention & screening/monitoring, treatment, and complications & prognosis categories. In contrast, those not easily found or with mixed level of difficulty between users were more likely to be in the diagnosis & clinical presentation and epidemiology categories. When an answer had the best quality of evidence available, the answer tended to also provide clinical guidelines, such as in the complications & prognosis and diagnosis & clinical presentation categories. For epidemiology, all questions were answered by the best quality of evidence available, often observational studies, and clinical guidelines were also available for about half of the epidemiological questions.

Results by Specialty Area

Questions were also analyzed in each of the six targeted specialties (cardiology, endocrinology, hematology-oncology, infectious disease, internal medicine, and neurology). The results by specialty are summarized in Table 5. An answer was found by both reviewers in infectious disease (89%; n=42), cardiology (90%; n=38), endocrinology (91%; n=31), hematology-oncology (91%; n=31), neurology (91%; n=42) and internal medicine (92%; n=57).

The reviewers were able to find the answers in each specialty area easily with a range of 61-76%, with the answers easiest to find in endocrinology. There were mixed levels of difficulty between users to find the answers in cardiology (34%). The cardiology, hematology-oncology, and internal medicine specialties provided detailed answers over 97% of the time, while the infectious disease and endocrinology specialties provided limited detailed answers about 10% of the time. All specialties presented the best quality of evidence available, with hematology-oncology having the best quality of evidence available (100%) and the lowest specialty being endocrinology (94%). Clinical guidelines were widely available in cardiology (95%), endocrinology (91%), hematology-oncology (78%), infectious disease (67%), internal medicine (69%), and not as often available in neurology (42%), which likely reflects available published clinical guidelines within these specialties.

Table 3 Select examples from the data collection categories

Availability of answer		
Example:	**Question:**	**Explanation:**
A question where neither reviewer found an answer	"After receiving COVID-19 vaccine how long should patients wait before having a mammogram for preventive screening for breast cancer?"	The Society of Breast Imaging released updated guidelines in February 2022 with a new recommendation of no delay between vaccine and a screening mammograph, which was not found in DynaMedex.
A question where one reviewer found an answer, but the second reviewer did not	"What is the number of patients needed to treat to see a benefit of spironolactone in Heart Failure for Reduced Ejection Fraction?"	One reviewer did not find an answer when searching "spironolactone for heart failure," but the other reviewer found the answer using the search term "aldosterone antagonists for heart failure," where a summary of a randomized trial with spironolactone was listed in the monograph. Difference in finding an answer between reviewers was due to reviewer's search terms.

Relevance of the information found		
Example:	**Question:**	**Explanation:**
A question where the answer was rated as not relevant	"When should a Coronary Artery Calcium (CAC) assessment in an intermediate risk individual be repeated if the initial score is zero?"	The Dynamedex monograph cited The American College of Cardiology/American Heart Association 2019 guidelines on primary prevention of cardiovascular disease and cited an answer of 5-10 years. However, this answer differed from the cardiology specialist answer of 3-5 years. Additional searching through other resources found that the answer of 3-5 years matched another POCI resource citing a Multiethnic Study of Atherosclerosis.

Difficulty of answer retrieval		
Example:	**Question:**	**Explanation:**
A question that was rated as not easy by both reviewers	"All of the following viruses can cause latent infections EXCEPT," and answer choices listed various infections such as Hepatitis A, B, or C.	This took a considerable amount of time and effort as both reviewers needed to search each of the individual choices to find a virus that did not cause for latent infections.
A question where the answer was rated as not easy to find for one reviewer and easy for the other	"A patient has upper quadrant abdominal pain, chills, vomiting and confusion. An abdomen ultrasound was done showing multiple stones in the gallbladder. Which is the most likely diagnosis?" Answers included acute cholecystitis, hepatitis, liver abscess, etc.	One reviewer had to look up each answer choice in the monographs and read through clinical and diagnostic findings for each, many of which overlapped between the conditions. However, this question was easy for the second reviewer using the search terms "stones in the gallbladder" from the question and that directed the reviewer to the Choledocholithiasis monograph which answered the question. Therefore, the rating for the question was different due to the reviewer's search terms used in DynaMedex.

Cited best evidence available		
Example:	**Question:**	**Explanation:**
A question with an answer that cited best evidence available	"Which of the following is the most common cardiac complication in children born to mothers with Systemic Lupus Erythematosus?"	DynaMedex lists observational studies and case reports for level of evidence, which is the highest that can be achieved in pregnancy outcomes.
A question with an answer that did not cite the best evidence available	"A patient is started on Riluzole for Amyotrophic Lateral Sclerosis. How often and what labs should be monitored while on this medication?"	The answer cited only the manufacturer's package insert. In this case, the product information is not the best available evidence. Best evidence available would have been inclusion of randomized trials used for the drug to be approved or systematic review articles.

Inclusion of clinical guidelines		
Example:	**Question:**	**Explanation:**
A question with an answer that included clinical guidelines	"Which is the most appropriate first test to confirm the diagnosis of patients with diabetes mellitus?" Answer choices included random plasma glucose level and Hemoglobin A1c."	DynaMedex listed guideline recommendations from the American Diabetes Association (ADA) for diagnostic criteria of diabetes mellitus.

Level of detail of answer		
Example:	**Question:**	**Explanation:**
A question with an answer that was detailed	"What is the most validated test to screen and monitor for severity of cognitive impairment in patients with dementia?"	DynaMedex listed comparisons of validated cognitive screening tests for dementia including the Mini-Mental State Exam (MMSE) which is the most widely used cognitive screening test in primary care. Numerous studies were listed alongside

| | | various guidelines (EFNS-ENS, Canadian Task Force on preventative health care, and NINCDS-ADRDA practical guidelines). |
| A question with an answer that was not detailed | "A mutation in which of the following genes is responsible for CADASIL (Cerebral autosomal dominant arteriopathy with subcortical infarcts and leukoencephalopathy) disorder?" | DynaMedex provided an answer of a sequence alternation in NOTCH3 gene. While it may have answered the question, this question was rated as not detailed since it was limited in the information provided as no other information about the gene was included. |

Table 4 Questions results by clinical category when a relevant answer was found

Clinical Categories	Total Questions n (%)	Relevant answers found n (%)	Easy to find answer n (%)	Not Easy to find answer n (%)	Mixed where one reviewer found the answer easily and the other did not n (%)	Cited Best Available Evidence n (%)	Did Not Cite Best Available Evidence n (%)	Guidelines Available n (%)	Guidelines Not Available n (%)	Detailed n (%)	Limited Details n (%)
Complications & Prognosis	38 (14)	35 (92)	24 (69)	1 (3)	10 (29)	34 (97)	1 (3)	25 (71)	10 (29)	34 (97)	1 (3)
Diagnosis & Clinical Presentation	61 (23)	58 (95)	31 (53)	13 (22)	14 (24)	58 (100)	0	41 (71)	17 (29)	52 (90)	6 (10)
Epidemiology	48 (18)	43 (90)	26 (60)	6 (14)	11 (26)	43 (100)	0	20 (47)	23 (53)	39 (91)	4 (9)
Prevention & Screening/ Monitoring	50 (19)	46 (92)	36 (78)	0	10 (22)	44 (96)	2 (4)	39 (85)	7 (15)	44 (96)	2 (4)
Treatment	68 (26)	68 (100)	53 (78)	2 (3)	13 (19)	64 (94)	4 (6)	55 (81)	13 (19)	68 (100)	0

Table 5 Questions results by specialty area when a relevant answer was found

Targeted Specialty	Total Questions n (%)	Relevant answers found n (%)	Easy to find answer n (%)	Not Easy to find answer n (%)	Mixed where one reviewer found the answer easily and the other did not n (%)	Cited Best Available Evidence n (%)	Did Not Cite Best Available Evidence n (%)	Guidelines Available n (%)	Guidelines Not Available n (%)	Detailed n (%)	Limited Details n (%)
Cardiology	42 (16)	38 (90)	23 (61)	2 (5)	13 (34)	37 (97)	1 (3)	36 (95)	2 (5)	38 (100)	0
Endocrinology	34 (13)	33 (97)	25 (76)	1 (3)	7 (21)	31 (94)	2 (6)	30 (91)	3 (9)	30 (91)	3 (9)
Hematology-Oncology	34 (13)	32 (94)	21 (66)	5 (16)	6 (19)	32 (100)	0	25 (78)	7 (22)	32 (100)	0

Infectious Disease	47 (18)	45 (96)	31 (69)	4 (9)	10 (22)	44 (98)	1 (2)	30 (67)	15 (33)	40 (89)	5 (11)
Internal Medicine	62 (23)	59 (95)	39 (66)	6 (10)	14 (24)	57 (97)	2 (3)	41 (69)	18 (31)	57 (97)	2 (3)
Neurology	46 (17)	43 (93)	31 (72)	4 (9)	8 (19)	42 (98)	1 (2)	18 (42)	25 (58)	40 (93)	3 (7)

A Selection of Results by Clinical Category and Specialty Area

We analyzed questions by clinical categories and targeted specialties. An answer was not found by either reviewer for six questions with a breakdown of cardiology epidemiology questions (n=2), neurology complications and prognosis questions (n=2), a hematology-oncology prevention and screening/monitoring question (n=1), and an infectious disease epidemiology question (n=1).

The best quality of evidence was not available mainly in the treatment sections, for example with 22% endocrinology treatment questions (n=2), 10% cardiology treatment (n=1), and 7% infectious disease treatment (n=1). Limited details were given for endocrinology diagnosis & clinical presentation (43%; n=3), infectious disease diagnosis & clinical presentation (38%; n=3), neurology epidemiology (20%; n=2), infectious disease complications & prognosis (17%; n=1), internal medicine epidemiology (14%; n=1), neurology prevention & screening/monitoring, infectious disease epidemiology (9%; n=1), and internal medicine prevention & screening/monitoring (8%; n=1).

DISCUSSION

We evaluated a commercial POCI application with a focus on real-world disease-related clinical questions and found that it generally performed well, although we also identified opportunities for improvement. Overall, the reviewers were able to answer real-world disease-related queries using keyword searches in the application with ease, and much of the time it provided the best evidence available, included detailed answers, and offered access to clinical guidelines. Such resources are likely to become increasingly important in care delivery going forward.

Previous studies have compared POCI resources to one another or evaluated the satisfaction of using a certain POCI product. For example, Bradley-Ridout et al and Baxter SL et al, evaluated the ability of two POCI resources to answer questions developed using Medical Knowledge Self-Assessment Program (MKSAP), a resource for medical education. They also evaluated ease of finding answers and quality of evidence available [4,8]. Although we used similar resources as a base for developing some questions, we attempted to make our

questions more real-world and clinically relevant by consulting clinical specialist physicians. Other studies looked at features included by POCI resources but did not evaluate the ability of the resource to answer questions [2, 23].

Strengths

This study has several strengths. Overall, there was a high level of consistent agreement among the reviewers for questions regardless of specialty or clinical category, such as in answer found, relevant answer, cited best quality available, and if an answer was detailed. Differences in finding an answer between reviewers were due to the reviewer's search terms used. Over 250 clinically relevant questions were generated from multiple sources including clinical specialists and covered a wide variety of categories and specialties. Results of this study should be of interest to readers of this journal who may be considering this resource in their library collections. The resource provided drug and disease related support in one integrated tool which can be used to support clinical decisions at the point of care. Libraries should consider the information from our study along with comparisons for subscriptions for the service at their institution to costs for comparable products. Finally, the study participants were able to easily find answers supported by high quality evidence to most of their queries.

Limitations

The study was conducted at a single academic medical center using local staff (consultants and researchers) to develop the questions, so the types of questions included may differ from other health care settings. A small sample of questions were used for each specialty and category, which may not be representative of all queries searched in the POCI resource. There may not have been enough numbers of questions for some specialties to get a representative sample to assess the tool and we did not adjust for the differences in the number of questions by specialty or category in the analysis. The complexity of the questions was not evaluated, which may have affected the availability of the answers. While answers to disease-related questions were found, validation of the application's use in the clinical setting as a POCI reference should be further studied. Although pharmacists were searching the questions for this study, this resource has been used by other health professions for usability testing

[9]. Further evaluation should be confirmed in real time direct patient care settings.

We evaluated a commercial POCI application which provided evidence about drugs and diseases and found across a range of categories and specialties it enabled reviewers to answer most disease-related questions easily with the best quality of evidence available, providing detailed answers and clinical guidelines. We also identified opportunities for improvement including recognition of misspelled search terms, documenting the date of monograph updates, and providing direct website links for studies mentioned for all references.

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DECLARATION OF COMPETING INTEREST

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DATA AVAILABILITY STATEMENT

Data for this study is in the attached appendices. Exact text of the questions used could not be provided due to proprietary nature of the content.

AUTHOR CONTRIBUTIONS

All authors contributed to the study conception; design; and acquisition, analysis, or interpretation of the data. DLS, MGA, AR, PMG, MM, AS, LAV, and DWB were responsible for study conception or design. DLS, MGA, ZC, AM, AR, PMG, and MM were responsible for obtaining the list of questions used. DLS and MGA developed the data collection form. RLW, DLS, and MGA did the question review, data cleanup, and analysis, and were responsible for the first draft of the manuscript with all authors reviewing the draft and providing critical feedback. All authors contributed to and approved the final manuscript.

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EC SUPPLEMENTAL FILES

- **Appendix A:** Dynamex Results Deidentified

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Meeting a need: development and validation of PubMed search filters for immigrant populations

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Objective: There is a need for additional comprehensive and validated filters to find relevant references more efficiently in the growing body of research on immigrant populations. Our goal was to create reliable search filters that direct librarians and researchers to pertinent studies indexed in PubMed about health topics specific to immigrant populations.

Methods: We applied a systematic and multi-step process that combined information from expert input, authoritative sources, automation, and manual review of sources. We established a focused scope and eligibility criteria, which we used to create the development and validation sets. We formed a term ranking system that resulted in the creation of two filters: an immigrant-specific and an immigrant-sensitive search filter.

Results: When tested against the validation set, the specific filter sensitivity was 88.09%, specificity 97.26%, precision 97.88%, and the NNR 1.02. The sensitive filter sensitivity was 97.76% when tested against the development set. The sensitive filter had a sensitivity of 97.14%, specificity of 82.05%, precision of 88.59%, accuracy of 90.94%, and NNR [See Table 1] of 1.13 when tested against the validation set.

Conclusion: We accomplished our goal of developing PubMed search filters to help researchers retrieve studies about immigrants. The specific and sensitive PubMed search filters give information professionals and researchers options to maximize the specificity and precision or increase the sensitivity of their search for relevant studies in PubMed. Both search filters generated strong performance measurements and can be used as-is, to capture a subset of immigrant-related literature, or adapted and revised to fit the unique research needs of specific project teams (e.g. remove US-centric language, add location-specific terminology, or expand the search strategy to include terms for the topic/s being investigated in the immigrant population identified by the filter). There is also a potential for teams to employ the search filter development process described here for their own topics and use.

Keywords: Filter; filters; immigrant health; search strategy; filter development; hedge; hedges

EC See end of article for supplemental content.

INTRODUCTION

Immigrants are individuals who, for various reasons, left their country of birth and reside or resided in a different country. The worldwide increase in immigration and individuals identified as immigrants corresponds to a rise in studies on immigrant health. As of November 2022, over 450 systematic reviews had been published in PubMed in the preceding five years on immigrant health. The topics included social determinants of health in immigrant populations, public health interventions for immigrants, health trajectories of immigrants, and the impact of migration on health status disparities [1-4]. As librarians and information professionals, we have experienced many challenges in searching for studies about immigrants. Existing filters including the "Immigrant Health Disparities" filter, which our project team developed in 2018 and 2019, vary in comprehensiveness and many have limited information on the methods used to generate the terms and the overall performance of these filters [5-10]. We launched the development and validation of PubMed search filters to meet our identified information needs, and those of our patrons, for retrieval of peer-reviewed literature on immigrant populations. Subsequently, our team embarked on a multi-year, multifaceted filter development process which allowed us to address a wide range of concepts and challenges.

To start, it was challenging but essential to define the population covered by our project scope due to the complexity of immigrant populations and how immigrants are studied and described in scholarly research. For example, immigrants and immigration may

be key subjects in studies on language, culture, race, and ethnicity; however, these studies may never use immigrant-explicit terminology. Loetscher et al explore the influence of immigration on pregnancy outcomes in Switzerland [11]. The study conveys immigrant status using the phrase "mothers from" in conjunction with a foreign country. The record in PubMed uses no other explicit terms such as "immigrants" and "migrants" to describe the population. We also recognized that immigrant and immigration are evolving and sensitive topics, with nuances that influence term selection, the introduction or disuse of terms (e.g., "illegal immigrants"), and the overrepresentation of US-based research.

Perceptions of immigrants present their own set of challenges. Some groups identify "immigrants" as being residents from a different country [5]. However, the perception of foreignness is more nuanced due to internal migration as well as geopolitical and historical events. For example, "diaspora" can be associated with established populations such as Black Americans in the United States or more recent diasporic events such as Syrians immigrating to European countries. In response to these challenges, we dedicated substantial time and effort to defining immigrants during the project's scope and eligibility criteria phase.

Our examination of various term-generating strategies employed by teams developing comprehensive search filters revealed diverse strategies. Many teams generated terms using word frequency analysis and text analysis software such as PubReminer, Wordstat, Simstat, Concordance, and VOSViewer [12-20]. This approach often requires a manual review of the terms. A growing number of teams relied solely on automated processes, including data visualization tools and frequency analysis, to analyze user data with statistical modeling [17, 21]. Other teams relied on clinician, librarian, and expert opinions or recommendations to generate relevant terms [13, 20, 22]. Several teams undertook manual assessment or other unspecified approaches in reviewing relevant records and identifying relevant titles, abstracts, or controlled vocabulary terms [22-28]. Some teams combined manual review with automated processes, such as frequency analysis or applying an existing filter as a starting point to identify relevant articles [29, 30].
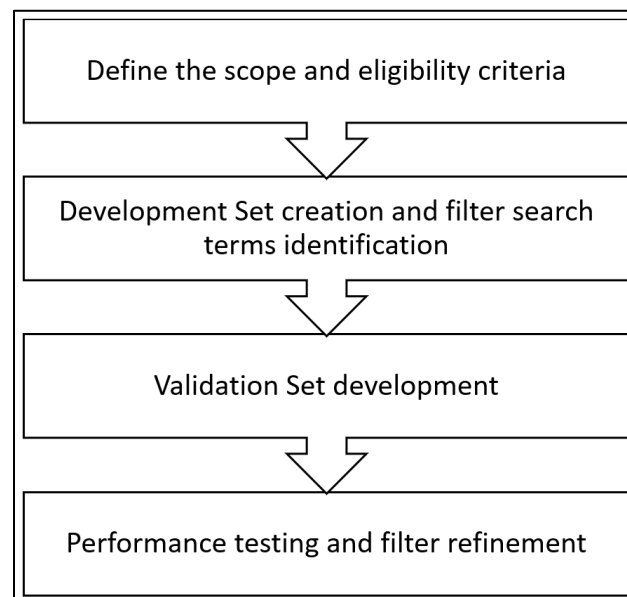
While we examined and used existing filter development processes as a foundation, the complexity of the topic led us to adapt our methodology. We initially aimed for a single filter for research on immigrants in PubMed, however, we realized the two-filter approach would give researchers the option to pull immigrant-related studies that use language and culture words to describe immigrants. Overall, the resulting sensitive and specific filters complement existing filters while providing reproducible methods and performance outcomes that are comparable with other comprehensive filters.

METHODS

Our methodologic approach relied primarily on the following four key phases (also illustrated in Figure 1):

1. Established a clear scope and eligibility criteria. This meant defining the population, establishing the inclusion and exclusion criteria for both studies and search terms, as well as compiling a list of known immigrant search terms from authoritative sources.
2. Created a development set or "gold standard" set comprised of references that meet the inclusion criteria, which the team reviewed, then extracted the immigrant-related term or terms to create the immigrant search filters for PubMed.
3. Created a validation set of references. These were separate sets of references that meet the inclusion criteria and were used to test the filters.
4. Conducted performance tests and revised the search filters as needed. We tested the filters against the validation set references and revised filters to optimize performance.

Figure 1 Filter Development Phases

Define the scope and eligibility criteria

Development Set creation and filter search terms identification

Validation Set development

Performance testing and filter refinement

We compiled search terms for both filters by combining terms derived from authoritative sources (subject experts as well as academic and government publications), the development (gold standard) set references, and references identified from the validation set reference after we conducted the performance tests. As other filter development teams did, we applied manual review and automation to generate the filter terms.

We reviewed different approaches to validating or testing the filters. External validation is described by the UK InterTasc Information Specialists' Sub-Group (ISSG) as testing the filters against a set of records distinct from those used in the filter development [31]. We found that most filter development teams used external validation [13, 15-18, 21, 24, 26, 29, 30, 32-39]. Fewer teams opted for internal validation and tested the filter against the development set of records used to generate the filter [19, 27, 28, 40, 41]. We employed external validation by testing the specific and sensitive filters against the validation set. We selected external validation because we believed testing the final filter or filters against a separate set of references added a layer of objectivity because they were tested against a unique, yet relevant set of references.

We expand on our methodology in the subsequent text and highlight key methodological terms in Table 1.

Table 1 Glossary of project methodological terms

Term	Definition
Development set references	References that meet the inclusion criteria and are assessed to create the filter search terms. Also called the gold standard set.
Eligibility criteria	A predefined set of criteria applied to articles and terms during the screening process to determine whether they will be included or excluded for use in the search filter.
Exclusion criteria	A predefined set of criteria that disqualifies prospective articles or terms from the filter.
Inclusion criteria	A predefined set of criteria that must be present to be included in the search filter.
Indicator	Qualifier or companion word or words, usually non-immigrant specific, that must be combined with another term to indicate immigrant population and retrieve the relevant reference.
Sensitive filter	Search filter with the specific, language and culture terms.
Snowball set references	Studies from the reference lists of relevant systematic reviews identified from the initial topic search in PubMed. These references were randomly divided into two sets, one for the development set and the other for the validation set.
Specific filter	Search filter with specific terms that do not require an indicator.
Validation set references	References known to meet the inclusion criteria and used to test the performance of the search filter.

Defining the Scope and Eligibility Criteria

During the development of the "Immigrant Health Disparities" search filter in 2019, we queried experts with research focused on immigrant health for recommendations on terms and definitions for immigrants. The experts' input guided us toward the definition by Diaz et. al, which describes immigrants as "persons who are moving or have moved across an international border away from their habitual place of residence, regardless of the causes for the movement or the voluntariness of their decision" [8]. This definition informed our discovery process and served as an essential point of reference in defining our scope. The eligibility criteria were applied during all phases of the project.

As part of our inclusion criteria, we included any study that used immigrant-explicit terminology such as "immigrant" or "refugee." This includes individuals of foreign origin regardless of their immigration status (e.g., nonimmigrant workers). We included relevant studies regardless of geography. For example, studies about immigrants living in Sweden or China met the inclusion criteria. Language presented a unique challenge because many non-immigrants may speak a second language or multiple languages. Although individuals who do not identify as immigrants may speak a language different from the general population, many researchers use language phrases and concepts to communicate immigrant status. Consequently, we elected to include records with linguistic-related terms that conveyed a foreign or perceived non-native population such as "non-English speaking" or "language barriers." We encountered a similar challenge with culture as many medical research studies equate cultural differences and acculturation with immigration. We marked references that used culturally specific terms and specific populations for inclusion in our filter and analysis.

Exclusion Criteria: Our exclusion criteria included studies that presented individuals and national, demographic, or administrative geographical units, without conveying international movement. We excluded studies that solely examined individuals' health based on race and ethnicity without taking into account their immigration status, as there are already comprehensive filters for race and ethnicity [42]. We did not restrict studies based on language or place of publication, but in the case of non-English references, relied on the translated title and English language abstract in PubMed.

Development Set (Gold Standard) References

The development set encompasses known references that meet the inclusion criteria [25]. To form the development set reference list, we ran a topic search in PubMed MEDLINE for systematic reviews on preventive health or pregnancy, both search topics were commonly requested by our patrons. This search resulted in 14,095 records,

which we divided into two screening sets for two reviewer teams who then independently screened the titles and abstracts of their assigned set in Rayyan, the screening platform we used for the project. We resolved conflicts through discussion between all four reviewers, which resulted in 135 references meeting the inclusion criteria. From the reference lists of these systematic reviews, we then identified 4,531 unique records indexed in PubMed MEDLINE. This created the snowball set of references as highlighted in Table 1. The snowball set of references helped us populate the development and validation sets with potentially relevant references. We randomly selected half (2,266) of the references in the snowball set and assigned them to the development set for screening using the inclusion criteria. We set aside the other half of the snowball set references (2,265 records) to build the validation set references.

After screening titles and abstracts, we identified 894 of the 2,266 studies to include in the development set. We transferred the titles and available abstracts for each record in the development set to a spreadsheet. We separated those records into four groups, one for each team member to extract terms and phrases that met the inclusion criteria. The relevant terms or phrases were extracted and ranked based on the three-tiered system outlined in Table 2. Team members independently reviewed each term according to the inclusion criteria. We addressed conflicting rankings through discussion and consensus. We ensured that all included terms and phrases were in the PubMed Index [43].

Table 2 Ranking system

Rank	Description
1	Terms met inclusion criteria without the need for an indicator or indicators.
2	Terms met the inclusion criteria when paired with a single indicator.
3	Terms required multiple indicators to meet the inclusion criteria.

Rank 1 terms met the inclusion criteria without the need for an additional indicator or indicators to describe immigrants or immigration. We combined Rank 1 terms with the words derived from the expert consensus and authoritative sources to produce the specific filter. As is the nature of certain terms, there are instances where Rank 1 terms, specific terms (e.g., migration, migrated), are commonly used in the literature to describe biomedical processes. Terms were considered and tested before inclusion. When the terms were tested alone against the validation set, the exclusion of "migrated" resulted in a 1% loss rate while the exclusion of "migration" resulted in an 12% loss rate. Further, when we tested the terms

exclusion from the search filter when applied our validation set, the exclusion of "migrated" resulted in no change to the filter's recall, while the exclusion of "migration" resulted in a loss of recall. The term "migration," therefore, was included in the final filter, while "migrated" was not included.

If a term needed a single indicator, we moved it to Rank 2. We placed terms requiring multiple indicators to communicate immigrant or immigration under Rank 3. The variability in Rank 3 words' indicators made it unfeasible to incorporate those words. As Rank 2 terms required clarification through the inclusion of an indicator, we tested each Rank 2 term or phrase against the specific search string. We assessed the number of unique results identified by that term and not by the specific search filter. We reviewed those unique records for relevant publications and determined inclusion if the term generated relevant records.

Indicators for Rank 2 terms fell under race and ethnicity, culture, language, and geographical location. Several records with Rank 2 terms had indicators from multiple categories. Given the complexity of immigrants and immigration and the use of language and culture to describe immigrants, we felt it necessary to incorporate both concepts by creating a sensitive search filter. The sensitive filter combines all the immigrant terms as well as terminology for language and culture terms. This produced a second filter with greater sensitivity or ability to retrieve all relevant studies because it is a broader search. The language and culture terms came from our term-extraction process and existing search strings [6, 7, 44-64].

To generate the Medical Subject Headings (MeSH) terms, we input the existing immigrant terms and PMIDs of the development set into the PubReminer software [65]. We also input terms into the MeSH browser for additional words [66]. We manually reviewed the results from the PubReminer and MeSH Browser queries for relevancy and inclusion. In 2022, we reran the search in PubReminer and scanned the MeSH browser for changes and new related headings. The specific and sensitive PubMed search filters are available in Appendix A.

Validation Set References

The validation set references are relevant studies the immigrant population filters should find in PubMed. We created the validation set by combining the 2,266 references from the snowball set with the 1,270 unique PubMed records from the Journal of Immigrant and Minority Health, a prominent peer-reviewed journal in the field, as well as its predecessor, the Journal of Immigrant Health. We performed the journal search on May 20, 2020, and an updated search on June 9, 2022, which produced 1,266 records. In all, we screened 4,802 unique records to determine inclusion in the validation set. We divided the

Figure 2 Flowchart for the creation of the validation set
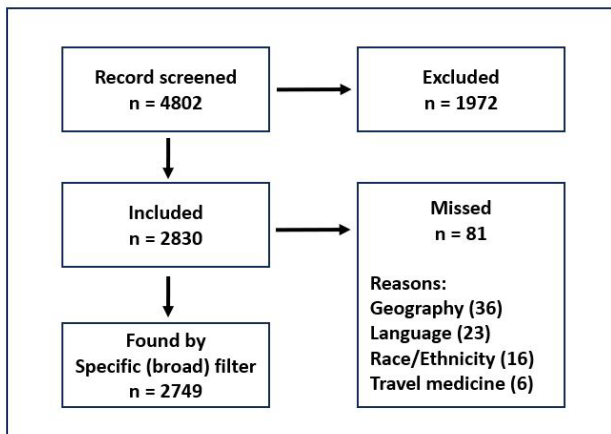
Table 3 Definitions of and formulas for performance measures

Performance measure	Definition/Formula
Correct Inclusion	Relevant records retrieved by the filter, true positives.
Incorrect Inclusion	Irrelevant records retrieved, false positives.
Correct Exclusion	Irrelevant records not retrieved, true negatives.
Incorrect Exclusion	Relevant records not retrieved, false negatives.
Sensitivity	The number of relevant records retrieved determined by (correct inclusion) / the total number of relevant records (relevant records).
Specificity	The proportion of irrelevant records not retrieved calculated by (correct exclusion) / (irrelevant records).
Precision	The proportion of retrieved records that are relevant calculated by (correct inclusion) / (total records retrieved).
Accuracy	The proportion of all records correctly included or correctly excluded determined by (correct inclusion + correct exclusion) / (all records screened).
Number Needed to Read (NNR)	The number of records that need to be read in order to identify a single relevant result calculated by 1 / (precision).

records into two sets for an independent title and abstract screening by two pairs of team members. A total of 2,830 records met criteria for inclusion in the validation set after resolving conflicting decisions through discussion and

consensus. Once completed, the validation set acted as a sample for testing both the full search filter and individual terms to determine various performance measures of the filter as a whole (e.g. how many of our validation set records were captured by our two filters) and individual terms (e.g. testing the recall of a specific term to determine inclusion).

RESULTS

We tested the performance of the specific and sensitive filters in PubMed on September 22, 2022.

The sensitive filter generated 1,674,705 results and captured 874 of the 894 references in the development set. This filter missed 20 relevant studies. Two missed studies used relevant phrases (e.g., "foreign in-home workers" and "born in a country with") that were not in the PubMed Phrase Index. One study required the use of "generation" and variants of the terms. Nine records required a specific country or geographical name, five required a specific language, and two references had specific languages with specific ethnicities. The sensitivity of the sensitive filter was 97.76% when tested against the development set.

The sensitive filter correctly captured 2,749 references (correct inclusion) from the validation set and missed 81 references (incorrect exclusion) that met the inclusion criteria. This contributed to a sensitivity of 97.14%. Records were missed because they used terms for geographic locations (e.g., "born in Mexico"), specific language terms (e.g., "Spanish"), specific race and ethnicity terms (e.g., "Korean American"), or terms related to travel medicine. The number of records missed for each reason is shown in Figure 2.

The sensitive filter pulled 354 references that did not meet the inclusion criteria (incorrect inclusion), and it correctly excluded 1,618 irrelevant references (correct exclusion) contributing to a specificity of 82.05%. The sensitive filter performed with a precision of 88.59%, accuracy of 90.94%, and NNR of 1.13.

The specific filter yielded a total of 460,584 results. When tested against the 894 references in the development set, the specific filter correctly identified (correct inclusion) 779 of the 894 references. It excluded 115 relevant references (incorrect exclusion). Overall, the sensitivity of the specific filter when tested against the development set was 87.14%.

When tested against the validation set, the specific filter correctly found 2,493 references of the 2,830 references in the validation set (correct inclusion). It failed to include 337 references that met the inclusion criteria (incorrect exclusion). This resulted in a sensitivity of 88.09%. The filter incorrectly included 54 references that did not meet the inclusion criteria (incorrect inclusion). It correctly excluded 1,918 references that did not meet the inclusion criteria (correct exclusion), which resulted in a specificity

Table 4 Performance of the search filters

Filter	Correct Inclusion	Incorrect Inclusion	Correct Exclusion	Incorrect Exclusion	Sensitivity (%)	Specificity (%)	Precision (%)	Accuracy (%)	NNR
Sensitive (broad) vs Validation Set	2749	354	1618	81	97.14	82.05	88.59	90.94	1.13
Specific (focused) vs Validation Set	2493	54	1918	337	88.09	97.26	97.88	91.86	1.02

of 97.26%. In all, the specific filter produced a precision of 97.88%and an accuracy of 91.86%. Accuracy was determined by the records correctly included or correctly excluded. The number needed to read (NNR) was 1.02.

While we did not have a baseline or separate comprehensive immigrant population filter to compare performance measurements against, the sensitivity and specificity of the Immigrant Population filters closely resemble numbers generated by the Clinical Study Categories search filters to identify therapy studies and randomized controlled trials in PubMed [22]. PubMed's Therapy filter optimized for sensitive/broad search has a sensitivity of 99% compared to our sensitive filter sensitivity of 97%. The specificity for the sensitive filter was 70% for PubMed and 82% for the sensitive filter. The Haynes team's' Therapy filter optimized for specific/focused or narrower searching resulted in a sensitivity of 93% and specificity of 97%. The specific filter produced a sensitivity of 88% and specificity of 97%. We believe we found a balance between sensitivity and specificity because higher sensitivity indicates less likelihood of missing relevant literature. Higher specificity means less likelihood of retrieving irrelevant records and is inversely related to sensitivity.

DISCUSSION

A comprehensive filter to find studies related to immigrant populations is essential for both healthcare providers working with immigrant and refugee populations, and for researchers seeking to learn more about the topic [67]. Initially, we set out to address the lack of comprehensive search filters for immigrant populations in a health-related database by developing a robust search filter. However, the complexity of the topic lead us to create two filters to allow for a stronger capture of immigrant-related articles [68]. This approach provides searchers with the option to apply a desired level of specificity, precision, and sensitivity to their search. Searchers can select the specific filter, which maximizes specificity and precision, or increase sensitivity by

adopting the sensitive filter. As with any comprehensive filter, our filters pulled many irrelevant studies or "noise" because of the inclusion of terms like "migration" which meets our inclusion criteria but also is used in non-immigrant related research.

Screening for the development set revealed that we could optimize sensitivity by adding language and cultural terms, which we opted to include as a sensitive filter. The need for supplemental filters further shows searching for studies on immigrant populations requires a multifaceted approach. Searchers must strategically build their search with filters such as the Immigrant Health search filters, the MEDLINE®/PubMed® Health Disparities and Minority Health Search Strategy while including other terms and concepts unique to their research questions [69]. In the future, we hope to see more systematic approaches to developing language and culture filters to enhance the sensitive filter to further optimize performance and improve search results.

As with any topic related to health, immigrant populations in health-related research are a nuanced subject leaving considerable room for subjectivity in the selection and relevance ranking of terms. We mitigated this as much as possible by creating clear eligibility criteria and a system for term identification and ranking. The exclusion of Rank 3 terms because they require multiple indicators means our filters missed relevant studies. Likewise, the filters did not find references with long phrases, such as "time living in the United States" that have countless iterations and are not recognized by PubMed's phrase index. Additional enhancements to PubMed, particularly the introduction of proximity searching, may make it more feasible to find records that use more complex word-phase combinations [43].

We also recognize a bias towards United States immigration in our selected terminology because of the heavy representation of U.S.-based researchers and publications in PubMed. To reduce the impact of geography bias, future development and review should incorporate collaborators from outside the U.S. to bring more global perspectives. Our commitment to the

methodology and sourcing terms from pre-determined sources and building our reference and validation sets from topics based on local requests may have introduced selection bias and led to the omission of relevant word variants and terms. We hope to address this limitation in future versions of the filters by broadening the scope of authoritative sources and actively seeking input from researchers and fellow librarians. Likewise, publication of the filters paves the way for enhancements and refinements guided by input from peers, which will help rectify possible limitations stemming from the absence of peer review.

There is a need for collective consensus on reproducible search methodologies that can best help researchers to retrieve relevant literature about immigrants. Community search consortia in library professional groups, especially in countries that have national health systems, may also provide models for centralization and more international collaboration for the development, validation, and sharing of search filters, including those for immigrant populations. We await further developments in this area that will address not only the centralization aspects, but also the additional challenges of ensuring that search filter options can be discoverable not only by librarians but by researchers as well.

Developing the immigrant population filters was a three-year process. During that time, no other similarly focused search filters came to the forefront. The challenges we encountered, from trying to reduce bias and identify all relevant terms, to accommodating more nuanced concepts like language and culture, made us realize why comprehensive filters for immigrant populations have either not been developed or have not been widely shared. These factors motivated us to complete the project. Based on validation in two topic areas, we accomplished our goal to develop comprehensive search filters for immigrant populations to help find subsets of evidence in PubMed. Since the completion of the project, there have been notable advancements in Generative Artificial Intelligence and its associated tools with implications for search filter developments [70]. Further discussion on this subject exceeds the scope of this paper, as the report focuses on tools and approaches under consideration during the development and testing of the immigrant search filters. Nevertheless, we acknowledge the potential of generative AI for future iterations of the search filters. We look forward to future use, external testing, the possible expansion to other databases, and revisions using tools such as generative AI that would build upon our work and continue to improve the performance measurements thus making the specific and sensitive filters even more valuable to librarians and researchers.

AUTHOR CONTRIBUTIONS STATEMENT:

Q. Eileen Wafford: conceptualization; data curation; formal analysis; investigation; methodology; project administration; supervision; validation; visualization; writing – original draft; writing – review & editing. Ramune K. Kubilius: data curation; formal analysis; investigation; methodology; validation; visualization; writing – original draft; writing – review & editing. Corinne H. Miller: data curation; formal analysis; investigation; methodology; validation; visualization; writing – original draft; writing – review & editing. Annie B. Wescott: data curation; formal analysis; investigation; methodology; validation; visualization; writing – original draft; writing – review & editing.

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EC SUPPLEMENTAL FILES

- **Appendix A:** Immigrant Populations PubMed Search Filters

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Validation of an interprofessional education search strategy in PubMed to optimize IPE literature searching

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Objective: With exponential growth in the publication of interprofessional education (IPE) research studies, it has become more difficult to find relevant literature and stay abreast of the latest research. To address this gap, we developed, evaluated, and validated search strategies for IPE studies in PubMed, to improve future access to and synthesis of IPE research. These search strategies, or search hedges, provide comprehensive, validated sets of search terms for IPE publications.

Methods: The search strategies were created for PubMed using relative recall methodology. The research methods followed the guidance of previous search hedge and search filter validation studies in creating a gold standard set of relevant references using systematic reviews, having expert searchers identify and test search terms, and using relative recall calculations to validate the searches' performance against the gold standard set.

Results: The three recommended search hedges for IPE studies presented had recall of 71.5%, 82.7%, and 95.1%; the first more focused for efficient literature searching, the last with high recall for comprehensive literature searching, and the remaining hedge as a middle ground between the other two options.

Conclusion: These validated search hedges can be used in PubMed to expedite finding relevant scholarships, staying up to date with IPE research, and conducting literature reviews and evidence syntheses.

Keywords: Interprofessional education; search hedge validation; relative recall; systematic reviews as topic

INTRODUCTION

For more than a half century, interprofessional education (IPE) has continued to gain traction across clinical practice settings, health-related and adjacent professions, educational institutions, professional organizations, accrediting bodies, and health systems broadly [1]. Defined by the World Health Organization (WHO), IPE occurs "when students from one or more professions learn about, from, and with each other to enable effective collaboration and improve health outcomes" [2]. Because IPE influences collaborative practice (IPECP) and affects many different disciplines, the literature base in the field has grown considerably, yet gaps persist in analyzing and assessing this literature [3,4]. For example, between 1970 and 2010, the number of IPE related research publications increased by more than 2,290% [5,6]. In 2013, the Institute of Medicine (IOM) held a Global Forum on Innovation in Health Professional Education that included two workshops on IPE. A core theme from these meetings centered on IPE and IPECP research and metrics. Specifically, forum conveners and participants asked: "What data and metrics are needed to evaluate the impact

of IPE on individual, population, and systems outcomes?" [7] However, answering this question is near impossible without first understanding how to systematically search and optimize the vast amount of literature currently available.

Scholarship on IPE and IPECP is useful to share evidence on the efficacy of specific IPE activities and how these activities can be replicated or revised [4]. However, the IPE literature is multifaceted not just in content but also in terms of methodology, outcomes, and the literature databases in which it can be found. Common challenges when searching the IPE literature include changes in IPE terminology, the growing number of professions contributing to IPE literature, the intermingling of education and collaboration literature, and various outcome measures (i.e., learner skills, provider attitudes, population health outcomes), and varied methodological approaches [4,8,9]. As Kim and Lee [10] note, "existing literature analysis method requires a considerable labor force, and there are time, effort, and accuracy limitations when analyzing the breadth of IPE literature." As the field of IPE continues to develop, considerations on how best to

search for relevant literature and establish effective search strategies are necessary.

Given the growth of literature in IPE, it is increasingly difficult for researchers to maintain a comprehensive understanding of the most up-to-date evidence. One solution to this is the use of validated search hedges, or search strategies, created by librarians or other expert searchers. Search strategies subject to an objective assessment of search performance can improve consistency and reproducibility of literature searching [11,12]. Search hedges are defined as a set of predetermined search terms which have been tested for their effectiveness in retrieving a specific type of evidence or literature from bibliographic databases [11,12]. They are developed to improve ease and efficiency in finding literature [13]. Rather than individual researchers having to create ad hoc sets of search terms each time they need to find literature, using a pre-created search strategy can be more time effective. However, to ensure that these search hedges are high quality, it is necessary to formally test their performance through the validation process. Validated search hedges are frequently designed to find certain study types or methodologies [12,14] and have also been developed for topic areas such as evidence-based practice [15], health equity [16], and geographic locations [11,17].

There are several methods for designing and evaluating search hedges [12]. Generally, though, these methods follow four steps: "(1) search term selection; (2) identification of a 'gold standard'; (3) evaluation of the search filter; (4) validation" [12]. The so-called "gold standard" is a list of relevant references which are used to test the effectiveness of the search hedge. The identification of a gold standard can be through hand searching, a combination of hand searching and database searching, the use of an existing definitive collection, or the use of a composite collection. Relying on hand searching in whole or part is labor-intensive, so where an authoritative collection of relevant articles does not yet exist, the creation of a composite collection can be an efficient way to manage the process. This methodology, called the relative recall method for search hedge validation, was pioneered in 2006 [14] and has since been used by many other scholars [16–22].

Since there is no current, definitive collection of IPE literature to use as a gold standard set, the authors of this study chose to follow the relative recall method of creating a composite set of literature to use as the gold standard for the validation process. While this methodology is not new, it had not yet been applied to IPE scholarship and, to the best of the authors' knowledge, this is the first IPE search hedge validation study published. This paper will provide the first set of formally validated and recommended terms for finding IPE scholarship which may make future identification of IPE research more efficient.

METHODS

Creation of Gold Standard Set

To create the gold standard set of references against which the completed search hedge would be measured, the authors searched PubMed using the keywords "interprofessional OR interdisciplinary OR IPE", limited to the title field, and including the database publication type filter for systematic reviews. This method of sourcing systematic reviews was designed to find reviews across all dates and disciplines to prevent creating a gold standard set biased toward any one discipline or time period (given the changes in IPE terminology over the years). The titles of the 152 retrieved results were screened by one author (RC) and 18 that were obviously irrelevant (e.g., animal studies) based on their titles were excluded. The remaining 134 results were imported into Covidence and two authors (RC and SN) independently screened titles and abstracts and then full text articles against pre-set eligibility criteria, to create an unbiased pool of reviews [16,19,23]. Screening conflicts were resolved via discussion and consensus.

The eligibility criteria for systematic reviews included in the development of the gold standard reference set was twofold; to be selected, the papers needed to focus on IPE and to be high quality systematic reviews. High quality systematic reviews were defined as those that followed the PRISMA reporting guidelines and included a comprehensive literature search. To meet the inclusion criteria, the reviews needed to focus on IPE specifically and exclusively. This was defined as study populations that included two or more professions, an educational intervention or outcome and based on the WHO widely accepted definition of IPE. To be high quality, reviews needed PRISMA-compliant reporting of systematic review search methodology [24] in the methods section. Given the abundance of low-quality systematic reviews in the literature [25,26], the authors applied the criteria as generously as possible. Reviews lacking one or more of these inclusion criteria were excluded, including reviews partially but not exclusively focused on IPE. Also, if there were review updates published and the latest review included all citations from the previously published reviews, only the most recent review was considered for inclusion.

Development of Search Strategies

The search hedges were developed in an iterative fashion by two literature searching experts. Keywords and subject headings were identified and tested from a range of sources: terms used in landmark IPE papers and other literature [2,4,5,7], search strategies used by Cochrane IPE reviews in the 2000s and early 2010s [27–29], and terms recommended by members of the research team. The first list of search terms for IPE was sent to an expert (in literature searching and IPE) not otherwise involved in

any stage of the project. They peer reviewed the search terms using the PRESS guidelines and their recommendations were incorporated into the search design [30]. Other IPE experts on the research team also completed informal reviews of the search terms and gave input on search term inclusion.

The updated list of search terms was tested term by term for relevance and performance in PubMed. The authors reviewed search results when adding and removing search terms to identify their use in the literature and the number of papers added to the results and thus to determine which versions of the search should move forward to relative recall testing. Terms that did not add any unique results were excluded, to streamline the search hedges, and terms that did not add any results relevant to IPE were also excluded, to remove irrelevant citations. Different versions of the search strategy were created to test the performance of a phrase-based approach to the search versus individual keywords, the importance of a broad versus narrow interpretation of education terminology, and the best-suited PubMed field tags (e.g. [ti], [tiab], [tw]). Ultimately, each search term was tested multiple times to see the types of studies it returned before being included in the final search hedges and undergoing validation. The frequency of occurrence for each included IPE term was calculated using an internal tool [31]. The tool runs Python code to search for a list of keywords or phrases in a set of titles and abstracts. Results are output in Excel and include a count of how many times each term appears in the text corpus. Using this tool allows for greater efficiency when calculating term frequency for a large set of keywords and is the same methodology as could be carried out manually [31]. Occurrence data allowed authors to analyze changes in terminology over time (e.g., is early terminology for IPE such as "interdisciplinary education" still essential to use as a keyword in more recent publications). If the terms used in older publications were significantly different from the terms used in current publications, the authors intended to provide separate versions of the search; however, the older terms were determined to be still relevant for finding current publications and so were included in the final, formally tested search strategies.

Recall and Relative Recall

Recall is the measurement of the proportion of available, relevant results in a database that a search hedge retrieves [13] and equals the number of relevant records retrieved by the search divided by the total number of relevant records [32]. The resulting number can be multiplied by 100 to then be expressed as a percentage. Relative recall is a measure of recall used in search hedge validation that measures the total number of articles retrieved by the search from the gold standard set [14,23]. Since researchers cannot know the total number of relevant records in a database without screening them all, they use

relative recall to estimate the recall of the search hedge. Relative recall as a percentage is used to show the proportion of relevant articles retrieved by the search out of all the relevant articles available [12,14].

Relative Recall
$$= \frac{number\ of\ relevant\ articles\ retrieved\ from\ Gold\ Standard\ set}{number\ of\ articles\ in\ Gold\ Standard\ Set} \times 100$$

As such, this study used relative recall methodology to design and evaluate a search hedge for IPE literature.

Relative Recall Validation Process

The relative recall calculations measured each search hedge against the gold standard set that was created from the IPE systematic reviews. Using the PubMed advanced search page, the team combined each search hedge with the gold standard set of articles and used the number of gold standard articles that appeared in each set of search results as the measurement of relative recall. These measurements were used to determine which search hedges performed the best, would be most useful, and should be included in the results.

A PRISMA flow diagram (Fig. 1) shows the development process of the gold standard set and search hedges.

RESULTS

Gold Standard Set

After screening, there were 13 included systematic reviews published from 2008-2021 that covered various professions, levels of trainees, educational topics, and interventions across health sciences education. The 13 reviews contained 296 unique papers, 267 of which had PubMed identification numbers (PMIDs). Because this search was going to be validated in PubMed, only the papers with PMIDs (or papers indexed in PubMed) were included in the gold standard set so the relative recall measurements would be accurate. These 267 papers, published from 1981-2021, well exceed the minimum recommended number of 100 original papers for a search hedge validation set following relative recall methods [14] and cover a broad range of years up to current scholarship. This set of 267 papers became the gold standard set used for search strategy validation [33].

Search Strategies

The sets of search terms presented here performed the best out of the 12 search strategies developed and tested, as they had high relative recall and can meet a range of research aims. Also, recommendations are provided for individual IPE search terms that have the highest frequency in the results and the best recall, to give

Figure 1 PRISMA flow diagram [24]
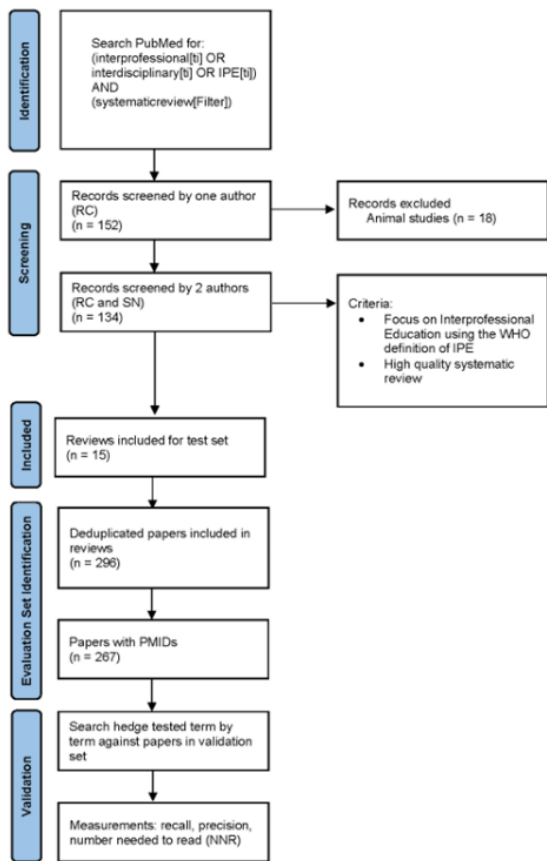

PRISMA 2020 Flow Diagram for IPE search hedges
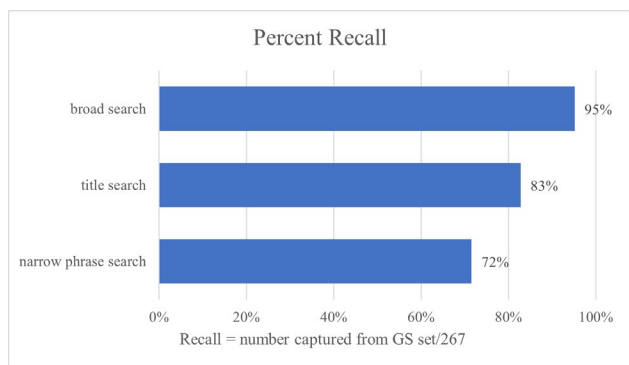
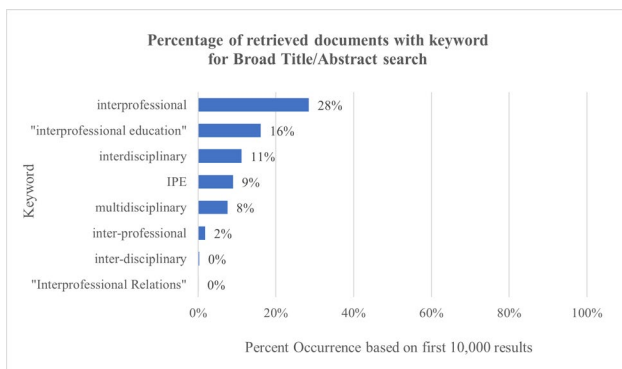**Figure 2** Search hedges and recall

Table 1

Search Hedges with Percent Recall and Total Results

| Number	Search Title	Percent Recall	Total Results*
#1	Narrow Phrase Search: (IPE[tiab] OR "interprofessional education"[Mesh] OR "interprofessional education"[tw] OR "inter-professional education"[tw] OR "interdisciplinary education"[tw] OR "inter-disciplinary education"[tw] OR "multiprofessional education"[tw] OR "multidisciplinary education"[tw] OR "multi-professional education"[tw] OR "multi-disciplinary education"[tw])	71.5%	5,200
#2	Narrow Title Search: (interprofessional*[ti] OR inter-professional*[ti] OR multiprofessional*[ti] OR multi-professional*[ti] OR interdisciplinary[ti] OR inter-disciplinary[ti] OR multidisciplinary[ti] OR multi-disciplinary[ti] OR multioccupational[ti] OR interoccupational[ti] OR inter-occupational[ti]) AND (student*[ti] OR educat*[ti] OR learn*[ti] OR train*[ti] OR teach*[ti] OR curricul*[ti] OR simulat*[ti] OR school*[ti] OR course*[ti])	82.7%	6,555
#3	Broader Keyword Search: (IPE[tiab] OR "interprofessional education"[Mesh]) OR ((interprofessional*[tiab] OR inter-professional*[tiab] OR interdisciplinary[tiab] OR inter-disciplinary[tiab] OR multidisciplinary[tiab] OR "Interprofessional Relations" [Mesh]) AND (student[tiab] OR students[tiab] OR educate[tiab] OR educating[tiab] OR educator[tiab] OR	95.13%	55,791

educators[tiab] OR
education[tiab] OR
instructor[tiab] OR
instructors[tiab] OR
instruction[tiab] OR
teaching[tiab] OR
training[tiab] OR
trainee[tiab] OR
trainees[tiab] OR
curriculum[tiab] OR
curricula[tiab] OR
simulation[tiab] OR
simulations[tiab] OR
shadowing[tiab] OR
"clinical
practicum*"[tiab] OR
"clinical
placement*"[tiab] OR
"experiential
learning"[tiab] OR
teamwork[tiab] OR
"Education,
Professional"[Mesh] OR
"Clinical Competence"
[Mesh]))

*Result numbers as of August 26, 2022

Figure 3 Frequency of individual terms

Figure 4 Recall of individual terms
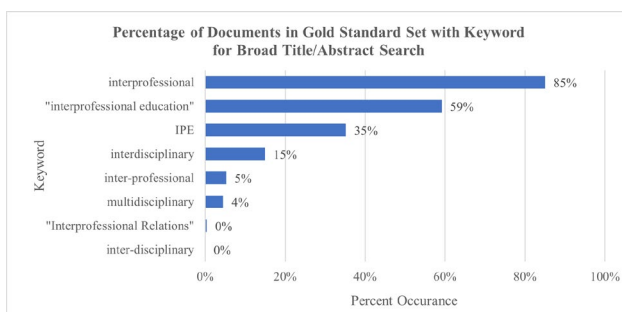
additional search options beyond the full search hedges. These various PubMed search options will give IPE scholars objective data to choose the set of search terms that matches their aims and search for IPE literature in the way that best suits their needs. The searches as presented in Table 1 are intended to be copied and pasted directly into PubMed or included within a larger search strategy for ease of application.

There were three best performing hedges: a broad search strategy recommended for reviews and two narrow searches for efficient article discovery. The two narrower searches have 71.5% and 82.7% recall and 5,200 and 6,555 results in PubMed, respectively. The broader search has 95.1% recall while retrieving 55,791 results. Since the number of results returned by narrower searches was lower while still capturing most of the gold standard articles, these searches are more specific and focused than the other, broader keyword search. The broader keyword search achieved the best recall, however the number of results increased significantly, so it is at risk of also including more irrelevant articles. Therefore, the two narrower searches are recommended for quick retrieval of relevant papers while the broader keyword search is recommended for comprehensive literature reviews. These strategies, especially the broader keyword search, can be used in combination with additional search terms (e.g., terms for specific educational interventions) or other search filters to make the strategy more specific depending on research topics and literature searching needs.

While none of the search hedges reached 100% recall, the team determined that it was not possible to capture the missing studies even with the most sensitive version of the search, which captured 254 of 267 papers. Of the remaining papers, some lacked abstracts and so did not contain enough text to be captured through the keyword-based search approach and others did not contain any potential IPE terms in the title or abstract. While these papers were included in systematic reviews as relevant to IPE topics, this project did not follow the full-text screening process of a systematic review and so could not capture all papers that may include IPE terms in the full manuscripts. High quality systematic reviews, such as those used to source the gold standard set, employ other methods of searching (e.g., citation chaining, hand searching, grey literature searching, etc.), which cannot be replicated in a search hedge validation study limited to the PubMed search interface. While achieving 100% recall was the goal, other studies have also run into this issue [23] and the 95% recall achieved here is higher than in some other published validation papers.

A frequency analysis of the individual terms for IPE in published scholarship, showed that while Interprofessional Education is the established, modern term, there is variation on the terms used by authors in current scholarship and papers are still using outdated

terms such as interdisciplinary or multidisciplinary to refer to interprofessional education. For example, in the first 10,000 search results from using the broad search hedge, interdisciplinary appears in 11.15% of retrieved documents, and multidisciplinary appears in 7.55%. The chart of search terms here can be chosen from in these use cases to find IPE papers.

DISCUSSION

As there is exponential growth in the publication of IPE research, it has become more difficult to efficiently find relevant literature and stay abreast of all the latest research. This is an especially crucial issue for systematic reviews, which attempt to synthesize all of the available evidence with the purpose of informing clinical practice and future research [24,34]. To address this ongoing growth in research across disciplines, journals, and search databases, the results of this formal search hedge validation study provide recommended search terms for IPE studies, to improve future access to and synthesis of IPE research.

A complication in the search for IPE literature is how IPE search terms have changed over time. As societies change, so too, do terms and definitions [35], particularly in changing healthcare environments and contexts. Different terms such as interprofessional, interdisciplinary, multidisciplinary, and transdisciplinary may vary by professional type and field (e.g. social sciences versus medicine or nursing) [35]. These nuances are reflected in the literature. Even though the preferred term for IPE, interprofessional education, shows up in much of the literature, the authors' search-term level analysis of term frequency found that this phrase does not appear in all IPE scholarship even now. Furthermore, other, and older terms still need to be used to see all the scholarship and get to the level of recall needed for systematic reviews. Also, many articles do not use any recognizable phrase for IPE in the title, abstract, or author supplied keywords, meaning that researchers must rely on database indexing, context clues (e.g., the mention of more than one discipline in the abstract), or other searching methods (e.g., forward and backward citation searching) in order to find these papers.

Database indexing is an issue for IPE specifically, due to a lack of a specific, focused Medical Subject Heading (MeSH) term in PubMed until very recently. MeSH terms are used to index articles which refer to the same concepts but use slightly different terminology [15]. The phrase "Interprofessional Education" was not added as a subject heading in the MeSH database until 2021 [36]. Prior to this addition, relevant literature might have been categorized under the subject headings of "Education, Professional," "Interprofessional Relations," or "Interdisciplinary Communication," none of which adequately and specifically describe IPE. These terms are all broad and

conflate IPE with interprofessional collaboration or communication. While literature that is published from 2021 forward will have the IPE-specific MeSH term applied to their index terms, older literature is not retroactively re-indexed using the appropriate term. Therefore, it is important to combine keyword terms with MeSH to capture literature which uses a variety of terminology.

By contrast, researchers who do not need to run a comprehensive search for all IPE literature related to a population or intervention of interest, can use this identification of the frequency of terms for IPE in the literature to choose the best term or terms for their focused search. Researchers can select terms that are used most frequently by other scholars to find IPE papers and omit terms that are used less often, streamlining their search process. Overall, these results allow for recommendations to be made for an entire search hedge and for individual search terms for scholars who do not need an entire search hedge on IPE or who need a search with higher precision to find relevant papers.

Formally validating a search hedge, whether through relative recall or other methodologies, gives the research community an assessment of the performance of a search, so they can make an informed decision about if or how to use it to find relevant studies [12]. Using a formally validated search hedge allows researchers to save time in creating and testing their own search hedges. A past study on the time spent on systematic review tasks found that it took expert searchers an average of 8.4 hours to create and test a comprehensive literature search [37]. It can be assumed that it would take inexperienced searchers even longer to complete the process. Research on the quality of systematic reviews and meta-analyses has consistently found that many published reviews are lacking a rigorous search strategy, whether due to the volume of existing scholarship, a lack of expertise with the literature search process, a reluctance to take the time required for a comprehensive literature search, or all of the above [26]. Having a reliable, comprehensive search hedge already created and ready to use could save research teams a significant amount of time while helping ensure they do not miss important papers.

As Reeves and colleagues [38] note in their 2010 assessment of the evidence of IPE outcomes, "the evidence for the effects of IPE continues to rest on a variety of different IPE programs (e.g., in terms of learning activities, duration, and professional mix) and evaluation/research methods (experimental studies, mixed methods, qualitative studies) of variable quality." Continued interest and investment in IPE has increased dramatically, and synthesis of this literature continues to be updated and expanded by international and national scholars [39]. One recommendation to lower the risk of overlooking relevant studies in reviewing IPE literature is increased awareness and use of reporting guidelines and exhaustive

literature searches [39], such as the search hedge validation conducted within this study.

One limitation of this analysis is that it was completed prior to the National Library of Medicine's update to PubMed at the end of November 2022 which introduced proximity operators as an advanced search feature in the database. This search option was not available when the study was designed and carried out, so the search strategies tested and recommended in this paper do not include the use of proximity operators. While the addition of proximity operators would not change the relative recall of the broader, keyword search hedge, they may change the precision of the search and so should be tested in the future. Additionally, while the searches use terminology current as of the time of search testing, as IPE scholarship continues to grow in future years, the terminology used by researchers may change and require an update of this gold standard set and these search hedges.

Another limitation to be considered is this study, as in all bibliometric research, includes publication bias, the publication of only positive or significant results. The authors could only include published papers in the gold standard set used for the relative recall calculations, so nontraditional scholarship may not be accounted for. Also, the results of the search hedge validation depend on the original reviews' search strategies, since studies not included in the reviews which provided the gold standard set could not be used to test the search hedges. While reviews with low-quality methods were excluded in the screening phase, this is a general weakness of the relative recall methodology. The authors attempted to compensate for this known issue by creating a larger-than-normal gold standard set; validating the search strategy against more articles decreases the importance of any single, hypothetical, missing study [14].

Additionally, another potential limitation of the gold standard set is the ability for better-resourced scholars (be it financial or with increased research institutional support) to contribute more to IPE literature and their terminology choices to overinform the results here. This is not a problem specific to IPE scholarship, but a reflection of existing biases in academic publishing that are carried from primary research into secondary research [40,41].

Finally, while the authors present one search hedge with 95% relative recall, no search hedge in testing was able to achieve 100% recall. This is similar in resulting recall to past search hedge validation studies and comparable to Prady and colleagues [16] (92% recall), Ayiku et al. [11] (96%), and Golder et al. [23] (96%). In the end, the 95% recall achieved by the broad search hedge is still a high threshold and makes this search hedge suitable for systematic reviews. None of the three search hedges are a perfect research tool, but they will still be valuable to researchers.

In summary, this is the first study of its kind for IPE. It provides researchers with data on IPE search terms and search strategies through a relative recall validation of search strategies. These validated sets of search terms will make it easier and more efficient for scholars to find relevant IPE research in PubMed in the future. Next, the authors plan to translate these search hedges to the syntax of other MEDLINE platforms (e.g. Embase via OVID and Elsevier) and test the validation there, as other relative recall validation studies have achieved higher recall in Embase than in PubMed [20]. To remain current, it will also be important to continue to evaluate these search hedges over time, as IPE terminology and database indexing continue to evolve. Also, additional work in this area should test the precision, or sensitivity, of the IPE search hedges as relative recall methodology does not provide this measurement. For the present, these search hedges provide researchers with a range of customizable options for locating IPE scholarship in PubMed.

DATA AVAILABILITY STATEMENT

The complete citation information for the gold standard set of references used for relative recall calculations, and the list of systematic reviews from which the gold standard set was derived is available in the Carolina Institutional Repository at https://cdr.lib.unc.edu/concern/data_sets/0c483v131. The tables and figures presented in this paper, including a document with the complete search hedges, are also available in the Carolina Institutional Repository at https://cdr.lib.unc.edu/concern/multimeds/ht24ww38q.

AUTHOR CONTRIBUTIONS

Rebecca Carlson: methodology; investigation; data analysis; writing—original draft; writing—revisions. Sophie Nachman: methodology; investigation; data analysis; visualization; writing—original draft; writing—revisions. Lisa Zerden: methodology; writing—original draft; Nandita Mani: conceptualization; writing—review and editing.

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Searches as data: archiving and sharing search strategies using an institutional data repository

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Background: By defining search strategies and related database exports as code/scripts and data, librarians and information professionals can expand the mandate of research data management (RDM) infrastructure to include this work. This new initiative aimed to create a space in McGill University's institutional data repository for our librarians to deposit and share their search strategies for knowledge syntheses (KS).

Case Presentation: The authors, a health sciences librarian and an RDM specialist, created a repository collection of librarian-authored knowledge synthesis (KS) searches in McGill University's Borealis Dataverse collection. We developed and hosted a half-day "Dataverse-a-thon" where we worked with a team of health sciences librarians to develop a standardized KS data management plan (DMP), search reporting documentation, Dataverse software training, and how-to guidance for the repository.

Conclusion: In addition to better documentation and tracking of KS searches at our institution, the KS Dataverse collection enables sharing of searches among colleagues with discoverable metadata fields for searching within deposited searches. While the initial creation of the DMP and documentation took about six hours, the subsequent deposit of search strategies into the institutional data repository requires minimal effort (e.g., 5-10 minutes on average per deposit). The Dataverse collection also empowers librarians to retain intellectual ownership over search strategies as valuable stand-alone research outputs and raise the visibility of their labor. Overall, institutional data repositories provide specific benefits in facilitating compliance both with PRISMA-S guidance and with RDM best practices.

Keywords: Research Data Management; Data Deposit; Data Repository; Knowledge Synthesis; Expert Searching; Research Reproducibility; Systematic Review Methodology

BACKGROUND

Prior to the development of public data repository infrastructure, researchers commonly relied on publishers to archive any data underlying their publications [1]. Despite the development of data repositories, researchers continue to share data in the attached appendices or supplemental materials of related journal articles [2, 3]. When data are shared as supplemental materials it is typically the publishers who retain full intellectual ownership (i.e., copyright) [4]. Alternatively, researchers may have opted to indicate within their publication(s) that they would share the data upon request. However, generally, researchers subsequently fail to facilitate data transfers or ensure data are preserved long-term for this purpose. The inaccessibility of research data contributed to the reproducibility crisis in many fields [5-7], including knowledge synthesis [8].

Over the past 10 years, researchers have been facing increasing pressures and incentives to openly share, via distinct preservation-oriented repository platforms, any data that underlies published research findings, articles, or other scholarly works [9, 10]. Indeed, major public funders

(e.g., the US National Institutes of Health (NIH), the National Science Foundation, the Canadian Tri-Agency, etc.) are requiring, or phasing in requirements, for research data underlying publicly funded studies to be FAIR (i.e., that data underlying research publications should be findable, accessible, interoperable, and reusable) [11-13]. The NIH's 2020 Data Management and Sharing Policy, effective since January 2023, requires grant recipients to "plan and budget for the managing and sharing of data" [12]. The Canadian Tri-Agency harmonized Research Data Management Policy is phasing in a requirement for grant recipients "to deposit into a digital repository all digital research data, metadata and code that directly support the research conclusions in journal publications and pre-prints that arise from agency-supported research" [13].

In addition, journal publishers are requiring data availability statements or commitments from authors that data underlying publications will be deposited [3]. The International Committee of Medical Journal Editors (ICMJE) requires that researchers submitting manuscripts to ICMJE journals must provide a data sharing statement indicating whether the data will be available, where the

data will be deposited, and which components or versions of the data will be shared [14]. A recent study by Ngyuen et al. concludes that "journal policies on data sharing might encourage sharing of review materials" [15].

In this way, the research community increasingly view data as important research outputs separate from any related publications [16]. In addition, the FAIR principles for research data are accepted as the best practice across many scholarly disciplines, funding bodies, and journals/publishers [11]. Although the FAIR principles are not completely synonymous with the open science or open data movements, they are highly related in terms of prioritizing the reproducibility of research findings based on empirical evidence as the cornerstone of research transparency and integrity.

In general, the current best practice among research data management (RDM) professionals is to define research data as all the information that is required to reproduce the findings of a study or to verify the findings of a study [17-19]. In this way, a dataset may include computational scripts or code, a codebook or data dictionary, metadata, and other related documentation. For example, in order to replicate the findings of a study, it may be necessary to understand the process by which data were transformed from their original raw state into a clean version, who collected the data, what is the source of the data, who owns the data, and whether there are any limitations regarding the data collection. Thus, a dataset may be composed of many interrelated components including all iterations of the dataset as well as the final version.

With this conceptualization of datasets, a search strategy created for a knowledge synthesis (KS) project can be seen as the code used to retrieve data (the list of relevant abstracts or citations) from a database. This framework suggests that search strategies and related output files are functionally equivalent to research datasets. Librarians who collaborate on KS projects by developing search strategies and exporting records from abstracting and indexing databases are creating intellectual work that contains inherent value as a research output separate from any related publications [20-22].

In addition, according to PRISMA-S guidance, "authors should upload complete documentation to a data repository, an institutional repository, or other secure and permanent online archive instead of relying on journal publication" [23]. Thus, expanding the mandate of RDM infrastructure to include search strategies allows librarians and information professionals who work on KS projects to take advantage of the features of these infrastructure systems to make KS searches compliant with reporting procedures (e.g., PRISMA-S) and professional best practices [24]. This case study presents a new initiative of health sciences librarians and the RDM specialist at McGill University to identify the appropriate repository, create documentation, and populate the repository in order to comply with PRISMA-S guidance for archiving search strategies and curate, preserve, and raise visibility of a collection of librarian-authored KS work [25].

CASE PRESENTATION

McGill University in Montréal, Québec, Canada is a large, publicly funded research institution with a team of seven health sciences librarians collaborating on KS projects across all health sciences disciplines. The team needed a way to better document and share their searches among colleagues and for publication. The health sciences librarian author approached the RDM specialist author to discuss the possibility of using the institutional data repository for these purposes. Before settling on the institutional repository, the authors discussed the needs of the librarians for their KS deposits and examined all feasible repository options. We wanted to ensure that our choice followed the FAIR principles, including increased discoverability, accessibility, interoperability, and reusability, through features such as the minting of persistent identifiers (e.g., DOIs) for each unique object, indexing across major search engines or databases, allowing for the deposit of preservation file types (i.e., open formats instead of proprietary file formats), and allowing for the assignment of an appropriate digital and legally binding license (e.g., a Creative Commons license).

We examined several existing platforms that may be used to archive or publish searches to weigh their benefits and disadvantages. Open Science Framework (OSF) is commonly used for preserving data, documents, and KS work [26]. Launched in late 2021, there is also a domain-specific pre-print style repository, SearchRxiv, that incorporates curation into the workflows for publishing search strategies [27]. Finally, there are institutional repositories that are oriented towards building collections of research outputs by affiliates of a given institution. For example, the University of Michigan is using their institutional data repository, Deep Blue Data, to store and preserve KS work produced by their institutionally affiliated librarians [28].

Following a review of relevant repositories and archives, we decided to focus on institutional options for this initiative for several reasons. First, one key goal of our initiative was to create and maintain a collection produced by McGill University librarians in order to demonstrate the impact of our individual and collective KS work. Oftentimes, the intellectual work of the librarians on these KS projects was unrecognized, particularly when KS projects stalled and never got published.

In our perspective, work by a KS researcher at one institution is likely to be more relevant to other KS researchers at the same institution. Also, if all McGill University librarian search strategies are organized and preserved in one place, it is easier to share our work with each other, demonstrate the quantity of work produced by

our group of librarians, and easily collect evidence of reuse. Second, our librarians aimed to maintain at least some degree of curatorial control over their deposited search strategies. Finally, our institutional platforms are free to use, are built on open-source software, and have stable long-term funding and contingency plans.

We decided not to use our institutional repository (IR), as it is designed primarily for completed documents, including theses, post-prints, and other types of manuscripts. In this way, the IR is not equipped with the robust metadata needed for archiving search strategy documentation as well as the ability to have several versions of the same record (for when a search is changed upon update, for example). In addition, our IR does not have the capability to issue DOIs, nor does it accept a wide variety of file types, but rather is restricted to document file types (e.g., .pdf, .docx, etc.).

We instead chose to use the institutional data repository, which uses the Dataverse software, an open-source repository platform originally developed by the Institute for Quantitative Social Science (IQSS) at Harvard University [29]. Since the Borealis Dataverse installation represents a Canada-wide shared infrastructure service, each institutional Dataverse collection (e.g., McGill University Dataverse) are nested hierarchically under a top-level Borealis Dataverse collection [30]. The Dataverse software allows for each repository collection to contain sub-collections which all may contain one or more datasets. Datasets may contain files, documentation, and metadata.

Borealis Dataverse issues DOIs, incorporates extensive discoverable metadata fields, and allows for the deposit of all types of files and documentation. In addition, the Borealis Dataverse platform is fully bilingual and can be operated in both English and French, which is an important feature for Canadian institutions. Finally, the institutional Dataverse allows for restricted access or access control on individual files. In this way, health sciences librarians can deposit export files from proprietary databases and mediate access to institutional affiliates, thus avoiding a violation of vendor terms while maintaining replicability and reusability.

Once we chose the platform, we created a sub-collection in the McGill collection of Borealis named "McGill Librarian Knowledge Synthesis Search Repository," to make clear that it contains only the work of librarians. Our deposits are strictly the searches, and the metadata links to the resulting publication (when relevant).

The authors then organized a three-hour "Dataverse-a-thon" with the intention of co-creating guidance and documentation to standardize KS deposits and to begin depositing KS search strategies. In January 2022, the authors led a three-hour session, which was held virtually due to COVID-19 restrictions in place at that time. During the "Dataverse-a-thon," the McGill University health

sciences librarians worked with the RDM specialist to develop a draft data management plan (DMP) and README document outlining standardized file formats, file naming conventions, licenses/copyright issues, and a template for inputting metadata fields [31, 32]. DMPs are "living documents" and are updated as new situations for their application arise. Given the novelty of our approach, we anticipate regular updates to our documentation. The most recent version of the DMP/README file and the search reporting template can be found at https://doi.org/10.5683/SP3/FNRHJ2. In the same session, we conducted a training on how to upload and publish data to the institutional Dataverse, co-created sub-collections within the institutional Dataverse for each liaison area (e.g., psychiatry, rehabilitation, dentistry, nursing, etc.), and provided administrative permissions to each corresponding liaison librarian over their own sub-collection. Co-creating the documentation, including a standardized README document and DMP, took almost the entire duration of the initial three-hour "Dataverse-a-thon" session. However, this process allowed all the participating librarians to talk through how they would be using the Dataverse and ensured that the file naming conventions and metadata entries for the data deposits were applicable to different types of KS work.

To build on the momentum from the initial session, we held a second 2-hour session in the spring of 2023 that was focused primarily on helping librarians deposit and publish KS searches. At that time, we also decided to combine the DMP and README files into one document, so it could serve as a quick reference when librarians are depositing datasets. Currently, there are 6 published subject sub-collections within the McGill University librarian KS collection and 23 published datasets. Overall, there were 233 file downloads across these 23 datasets as of July 2023, and the dataset containing our DMP/README documentation has been downloaded 114 times. The full McGill University librarian KS collection can be found at https://borealisdata.ca/dataverse/mcgill_librarian_ks_search_repository.

DISCUSSION

While the initial creation of the DMP and README took some time, the subsequent deposit of search strategies into the institutional data repository has been low effort and quite successful. We are now able to deposit the complete documentation from each KS project, with a typical deposit consisting of a PRISMA-S compliant document with all complete search strategies from all databases in one file, the RIS files or other database output files, and other documentation related to a project. All data are stored according to industry standards for cybersecurity (e.g., encrypted at rest), on servers located at Canadian academic institutions in Ontario, and users aiming to deposit data must authenticate through institutional

affiliations [33]. Metadata are searchable across our KS sub-collection and harvestable by search engines and other repositories [33]. This functionality facilitates discoverability and provides a low barrier for finding our own work in the future, either for our own reuse or to share with colleagues.

Depositing search strategies in an institutional data repository takes 5-10 minutes, on average, per deposit, once a workflow is established, while also potentially reducing the mental load of how to name, store, and find existing searches. For institutions or librarians interested in launching a similar initiative, we recommend launching the projects with two 2-hour sessions, with one session dedicated to training and documentation co-creation, and one session where librarians should be prepared to deposit at least one KS search strategy. Our practice of depositing our searches has been accepted by our research teams, especially when we explain that KS searches translate their research questions into a script that retrieves data according to a set of parameters that the researchers require in making claims for evidence-based studies. We recognize, however, that not all researchers will necessarily be so quick to accept this practice, and it is a question we hope to explore in future research.

In general, institutional data repositories, or institutional Borealis Dataverse collections in the Canadian context, provide specific benefits in facilitating compliance both with PRISMA-S guidance and with RDM best practices. Librarians can deposit the complete search strategy document in RTF format (the preservation standard format), as well as all the direct database downloads, for full transparent reporting of the data retrieval. Database downloads are often RIS files, which are proprietary, and they may be deposited in Borealis Dataverse collections using a feature that allows for restricting file access (i.e., access control). The Dataverse software also allows for versioning of records, meaning that librarians can update the search strategy over time and maintain a record of changes. In addition, the Dataverse software allows for the application of a license or terms of use. In practice, this means that the author(s) of a search strategy can determine to what extent, and in what contexts, their search(es) can be reused for other research projects. If the author(s) of a search strategy license(s) their work openly, Dataverse generates a citation that makes it easy for others to cite their work when it is reused in other projects, which can provide evidence of the broader impact of their intellectual work. Finally, there should be no need to duplicate efforts if a search strategy already exists that can answer or contribute toward answering a new research question, which parallels the notion that there should not be a need to collect the same dataset multiple times.

Since presenting this project at the Canadian Health Libraries Association's 2021 annual conference, three other institutions in Canada have launched their own librarian KS sub-collections in their institutional Borealis Dataverse

collections modeled on our work [25, 34-36]. We are collaborating with these librarians to survey health sciences librarians across Canada on sharing their KS data to inform our work with other institutions across Canada to build standardized collections of deposited searches.

This initiative illuminates the distinct benefits of using an institutional data repository to archive KS search strategies. Librarians can retain intellectual ownership over search strategies as stand-alone research outputs and prevent errors that often can be introduced during the journal publication process. The search strategies will no longer be buried in supplemental files or behind journal paywalls. We hope that deposits in a data repository will help to answer Ross-White's question "What does it mean when we replace the vocabulary of librarianship (search) with the more male-dominated language of computer science (algorithm)?" [20]. By considering our searching as coding, and depositing it as such, we endeavor to make the invisible visible, since librarian work continues to be poorly documented in published reviews [20, 37]. While a KS manuscript may reduce the librarian's work to just a few sentences, the search strategy document in a deposit allows a librarian to fully describe and record every decision made in their search. A librarian can then deliver their documentation to the research team through a link to their work, and this link makes it easier for the research team to include the complete search documentation in a manuscript. Even if a librarian is not given authorship or an acknowledgement by the authors, the link will lead anyone who looks at the search strategy to the librarian. While this is not a perfect solution, it can be a step in making librarian labor more visible. These dataset citations can also be used to demonstrate the amount of labor and impact a librarian has to supervisors and administrators and is not dependant on the publication by a research team. In this way, an institutional data collection of librarian-authored search strategies provides a comprehensive resource, via a single URL, to illustrate the breadth of librarian contributions. Overall, based on our experience, maintaining a librarian collection of search strategies as datasets may increase the broader visibility of the distinct value added by librarian contributions to KS projects.

CONFLICT OF INTEREST DISCLOSURE

DATA AVAILABILITY STATEMENT

Data associated with this article are available in the McGill University Dataverse at https://doi.org/10.5683/SP3/T7ITRM.

AUTHOR CONTRIBUTIONS STATEMENT

Alisa B. Rod: conceptualization; methodology; writing – original draft; writing – review & editing. Jill Boruff: conceptualization; methodology; writing – original draft; writing – review & editing.

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Developing and conducting a language inclusivity assessment on a health science library's website, LibGuides, and signage

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Background: A Diversity, Equity, and Inclusion (DEI) Team at a university health science library created a checklist for inclusive language and conducted an assessment of their library's website, LibGuides, and physical and digital signage. Inclusive language was defined as "language that is free from words, phrases or tones that reflect prejudiced, stereotyped or discriminatory views of particular people or groups".

Case Presentation: The 32-item checklist facilitated the identification of gendered language, stereotypes, ableist language, racist language, stigmatizing language, slang, acronyms, and out-of-date terminology regarding physical and mental health conditions. From the library's website, 20 instances were noted for which improvements were necessary. Out of the 130 LibGuides reviewed, 23 LibGuides had no changes needed and 107 had changes identified relating to language inclusivity (14 strongly recommended changes and 116 suggested changes). Regarding the signage, one flyer was removed for reprinting.

Conclusion: The checklist enabled the team to implement a number of improvements to the library's website and LibGuides. The checklist has been shared with Library Technology Services and the wider campus libraries' Usability Committee for future use, and has also been added to the DEI Team's LibGuide for use by others outside of the university.

Keywords: Diversity, equity, inclusion; Inclusive language; Website; LibGuides; Signage; Academic Health Sciences Libraries

EC See end of article for supplemental content.

BACKGROUND

While academe has been attending to the need for diversity, equity, and inclusion (DEI) work in higher education for years, specific attention to divisive or discriminatory language on websites is more recent. The Black Lives Matter movement ignited a renewed effort to examine the impact of racism in all areas of life, including academic institutions [1, 2, 3]. Problematic language that is ableist, gendered, racist, or otherwise discriminatory or non-inclusive is an issue in health science libraries, as there are historical terms that are derogatory in both medicine and librarianship [4, 5]. These concerns are being addressed in part through efforts such as the National Library of Medicine's review of Medical Subject Headings (MeSH) terms and the National Institutes of Health's UNITE initiative to address structural racism [6, 7].

Scientific language is also rife with racist terms, as Jones points out particularly racially harmful terms that persist

in STEM include the use of words like "master, slave, whitelist, blacklist, etc." [8]. In STEM scholarly publications, emphasizing conscious language by focusing on writing that is free from bias has several benefits; in addition to making writing more respectful, it has the potential to improve the accuracy of writing and increase readership/audience by not excluding people with stereotypical or harmful descriptions or terminology [9].

Assessments of library websites and LibGuides typically focus on accessibility [10, 11, 12, 13], which, while important, should be expanded to include a broader review for non-inclusive language. While a handful of papers report evaluations of libraries' disability webpages (specifically, the existence of a disability page and information on that page), none were found in the published literature that conducted a thorough assessment of the library website or LibGuides across multiple dimensions of inclusion, including language. While

librarians at the University of South Florida's Nelson Poynter Memorial Library undertook a similar assessment to ours, they focused on usability and accessibility [14].

The importance of avoiding outdated terminology and instead using welcoming and inclusive language on the website is reported by Brunskill [10], who interviewed students to learn what they wish to see on an accessibility page and how lack of that information impacts use of the library. Literature on evaluating the inclusivity of library signage is scarce, with articles focusing on signage amount, formatting, and location [15]. Although the importance of creating meaningful digital and physical signage is addressed by Polger and Stempler [16], they evaluate language inclusivity based on user-friendliness instead of DEI elements. Based on the research above regarding the importance of usability and accessibility in library physical and digital spaces as well as the impact of non-inclusive or discriminatory language, this website assessment project is essential to evaluate the state of language on library websites and suggest changes to increase usage of bias-free language. To ignore any of these issues could potentially impact usage, by situating the library as an unwelcoming organization that does not evaluate whether it is creating a safe physical and digital environment.

In order to fill this need for a holistic language inclusivity review, the University of Florida's Health Science Center Libraries (HSCL) created an extensive checklist for language inclusivity based on existing resources and implemented that list by reviewing all pages on their website, the library's LibGuides, and their digital and physical signage. The project's objectives were therefore to 1) create a checklist for inclusive language, 2) review the library's website, LibGuides, and signage using the checklist, 3) update these resources accordingly via language edits or additions, and 4) circulate the checklist to the university's other six libraries for potential use. The time it took to develop this thorough checklist benefits not only this library, but because the assessment tool is easily generalizable, it can also be a useful resource for other university libraries as well as libraries in other settings.

CASE PRESENTATION

The HSCL serves six colleges; Dentistry, Medicine, Nursing, Pharmacy, Public Health and Health Professions, and Veterinary Medicine. To assess and improve the climate for DEI in the library, a team comprised of faculty and staff was created in 2018. This DEI team quickly began work establishing short and long-term goals and planning a variety of activities to assess and support a diverse and inclusive library climate [17]. Over the years since its formation, the DEI team has participated in numerous relevant training opportunities to provide team members with knowledge and skills in the areas needed to work on diversity and equity-related- projects [17].

Additionally, prior to starting many projects the team (or sub team) read related literature to get up to speed on any knowledge gaps. After completing survey-based climate assessments [18], the team moved on to a language assessment project as a subset of this larger goal.

Between 2020 and 2022, the DEI Team conducted a language inclusivity assessment of the HSCL's website [19], LibGuides [20], and physical and digital signage. The team defined inclusive language as "language that is free from words, phrases or tones that reflect prejudiced, stereotyped or discriminatory views of particular people or groups. It is also language that does not deliberately or inadvertently exclude people from feeling accepted" [21].

In March 2020, the team searched for existing literature relating to best practices for language inclusivity employed in library, health, or university settings. Nineteen useful resources were located through a general Google search and through the databases Library and Information Science Abstracts (ProQuest), Library, Information Science and Technology Abstracts (EBSCOHost), PubMed, and Web of Science [21, 22-39]. The team members individually reviewed assessments presented in these resources and each developed at least two questions for a draft checklist. A final version of the checklist was compiled after discussion, through which similar questions were removed and the remaining questions were grouped into identity-based themes (Appendix A). The final 32-item checklist covers topics including demographic information collected in webforms, identification of gendered language, stereotypes, ableist language, racist language, stigmatizing language, slang, acronyms, and out-of-date terminology regarding physical and mental health conditions. The checklist also includes an item addressing whether images on the website are reflective of the communities the library serves; while not strictly language-related, the team felt this significantly impacts inclusivity of communication through the website.

Using the checklist, the team began reviewing the 33 webpages of the library's website in June 2020, not including links to external webpages or HSCL's LibGuides at this stage of the project. Each webpage was assessed by one of five team members, who used a spreadsheet pre-populated with the checklist to record any language that needed to be changed [40]. Team members were asked to "Answer Yes, No, or N/A for each checklist question". When changes needed to be made to a webpage, the reviewers were prompted to "note which page and quote the sentence that needs to be changed and why." The team members also recorded any words or sentences that they were unsure of for discussion and made a note of DEI-related content that could potentially be added based on the language inclusivity literature consulted before beginning the assessment. Once each website page had been reviewed and data entered into the spreadsheet, the team met in late August 2020 to reach a consensus on

corrections and potential additions. The library's website manager then implemented changes to the website in October 2020.

After reviewing the whole website, 20 instances were noted for which improvements needed to be made. One improvement involved adding pronouns for employees who opted in via response to an email invitation to contribute to a culture where gender identity is not assumed but instead affirmed. We also altered the website to refer to services for invisible disabilities, such as assistive technology available for converting text to voice, and added a section for sensory-friendly spaces on our "patrons with disabilities" page with information about nap pods and individual study rooms (sensory-friendly refers to consideration of environmental factors like light, sound, or smell that may contribute to sensory overload). Other changes included using student first language instead of faculty first to reduce implications of hierarchy or preferential treatment (for example, "the library provides research support for students and faculty"); spelling out acronyms; and removing outdated language with negative connotations such as "earmarked," as this term has been associated with enslavement [41]. The team's recommendations for website content additions included creating a DEI statement for the library; developing a code of conduct for the library's online and physical spaces; and adding information about parking, assistive technologies, and emergency evacuation procedures to our "patrons with disabilities" page. There was one instance of a change being discussed but discarded due to concerns about historical accuracy, this was the word "chairman" which was found in an archives-related webpage.

In March 2021, the checklist was repurposed for reviewing HSCL's 130 LibGuides. As with the website review, each LibGuide was independently reviewed by one of five team members using a version of the checklist in Excel. While the checklist did not include items related to link-checking or general accessibility concerns, when team members found broken links or inaccessible formatting, this information was included among the recommendations for the guide author. Through group discussion, it was determined that 107 of the LibGuides had changes relating to language inclusivity (14 with "strongly recommended changes" and 116 with "suggested changes") and that 23 LibGuides had "no changes needed." Across all LibGuides, 186 different recommendations were made, in some cases with multiple recommendations made on a single guide. The project lead reached out to each LibGuide's primary editor to request that the "strongly recommended" changes be swiftly implemented, and that "suggested changes" be implemented if the editor agreed (see example email in Appendix B). Strongly recommended changes, defined as language that is harmful or offensive, included: altering

Table 1 Most common recommended changes for HSCL's website and LibGuides

Recommendation	# times noted on website	# times noted in LibGuides
Consider adding personal pronouns	1	65
Consider using student first language	7	46
Spell out all abbreviations and acronyms	4	20
Update or remove broken links	0	24
Change specific words or phrases (e.g., earmarked, victim)	3	14
General accessibility concerns (e.g., font size, color contrast, screen-reader capability)	0	8
Improve gender-inclusive language	0	9
Other	5	10
Total number of recommendations	**20**	**186**

the word "victim" to the more empowering term "survivor" in the description of a resource for intimate partner violence; capitalizing "Black" and "Indigenous Peoples," as well as other names of nationalities, peoples, and cultures; changing an outdated National Library of Medicine classification of "Mental Retardation" to "Intellectual Disability;" adjusting the term "vulnerable populations" to "marginalized populations" as this more proactively calls attention to the role of social structures in the creation of health disparities; using "congenital anomalies" in place of "birth defects" due to negative terminology connotations identified by some populations; changing the word "slaves" to "enslaved people" in relation to a LibGuide on a past historical exhibit; and adding a disclaimer to another LibGuide to reflect that "women's health" is the terminology commonly used in medicine, but that the library recognizes that use of the word "women" in this context should be inclusive of all people with uteruses regardless of gender identity. Many suggested changes mirrored those identified during the website assessment such as spelling out abbreviations, adding pronouns in LibGuide profile boxes, and using

student first instead of faculty first language. Suggested changes exclusively found in the LibGuides were altering "elderly" to "older adults," adding quotation marks around gendered language used in the description associated with an external exhibition hosted by HSCL, and editing images of nuclear families to represent different types of families.

An assessment of signage and non-digital flyers and forms occurred via a walkthrough of the physical library by three team members in January 2022. One flyer on liaison services was pulled for reprinting, so that the language could be altered to student first instead of faculty first. The website manager then looked at files that were available for display on digital library signage but did not see any content that required modification for inclusive language.

DISCUSSION

This article fills a gap in the literature by providing a concrete example of how to conduct an inclusive language review of a library website. The team found that using the checklist was an effective method for identifying potential improvements to our website and LibGuides. Members of the project group included HSCL's Chair and the library's website manager; this was an advantage because the team did not face any management-level barriers to implementing the website or LibGuide changes. After implementing the website changes, the team shared the checklist with Library Technology Services and the wider libraries' Usability Committee for future use, thus fulfilling the fourth project objective. The checklist was also added to the DEI Team LibGuide [42]. The team believes this process is generalizable outside of the University of Florida and make the checklist available here (Appendix A) so that it can be found and used beyond this specific context.

The larger changes to the website included creating a Code of Conduct, applicable to our physical and online spaces [43]; adding information on sensory-friendly spaces to our Patrons with Disabilities page [44]; and updating our floor maps with clearer information about stairs, elevators, gender-neutral restrooms, and our lactation pod [45]. A number of the recommendations for LibGuide authors mirrored findings from the website, with the most common being suggestions to add personal pronouns, use student first language, and spell out all abbreviations and acronyms (see Table 1 for additional details).

While the team was empowered to make immediate changes to the website upon identifying areas for improvement, potential changes to LibGuides were sent to guide authors without further intervention from the team. Guide authors were largely appreciative of the review process and specific suggestions for their guides, though there was pushback from some individuals who were uninterested in sharing their own pronouns or using non-gendered language in their LibGuides content. On

reflection, the team became aware of media conversations that emphasize how sharing pronouns should not be mandatory in a workplace, in case some individuals do not feel comfortable or ready to share their gender identities [46]. The process of requesting changes to LibGuide language could be considered in the context of academic freedom; however, none of the guide authors explicitly mentioned this concern, the recommendations were made by a team of peers, and no consequences were imposed for noncompliance. This study had two limitations. While the checklist was developed collaboratively, it was not normed prior to use. Also, only one researcher evaluated each webpage and Libguide, which introduced the possibility of reviewer fatigue and confirmation bias.

Going forward, the team needs to determine how often an inclusive language review of LibGuides should be repeated, the process for reviewing newly-created guides, and how to follow-up with guide authors if changes are not made, particularly those that were strongly recommended. Other institutions may benefit from incorporating inclusive language recommendations into LibGuide creation standards or guidelines; however, the University of Florida's decentralized and largely un-mediated LibGuide administration does not make this feasible at our institution at this time. To improve understanding across the library about the inclusive language review process and increase buy-in, the team is considering providing a brief internal training on the checklist and offering badges for LibGuides that meet inclusive language standards. The usability of the checklist could be improved somewhat by further grouping like items together (e.g., all those related to gender inclusivity) and framing all items positively (so that a positive response to each would indicate a positive indicator of language inclusivity). The checklist will also need to be updated periodically as language continues to change and additional strategies are developed for inclusivity. Additionally, the team may engage with others across the University of Florida, who are beginning to consider broader LibGuides review in the model of the California State University Libraries' LibGuides Open Review Discussion Sessions (LORDS) Project, which goes beyond language and accessibility to address expanding race awareness and librarian positionality in LibGuides [47, 48].

Another remaining action item from the initial website review was to create a DEI statement to be posted on the HSCL website. In the past year, another subset of the HSCL DEI Team drafted an HSCL Vision and Values Statement, which was then reviewed, edited, and adopted by the HSCL staff as a whole. While the statement speaks broadly of the work done in our library, diversity, equity, and inclusion permeate the statement. The DEI Team has thus determined that, for the time being, a separate DEI statement is not needed [49].

Overall, the team found that using the checklist generated multiple improvements to HSCL's website and LibGuides. We therefore highly recommend that other libraries consider performing an inclusive language audit, with our checklist available as a starting point. Ideally, as in our organization, website managers will be aware of the importance of both accessibility and language inclusivity. In institutions where this is not the case, libraries should strive to raise awareness of language inclusivity as a DEI issue, not only for website managers but also amongst all library employees who are creating content for websites, LibGuides, and signage.

DATA AVAILABILITY STATEMENT

Data associated with this article are available in the Open Science Framework at https://osf.io/f27wc/.

AUTHOR CONTRIBUTIONS

Jane Morgan-Daniel: conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing – original draft, writing – review & editing. Hannah F. Norton: data curation, formal analysis, investigation, methodology, writing – original draft, writing – review & editing. Mary E. Edwards: data curation, formal analysis, investigation, methodology, writing – original draft, writing – review & editing. Matthew Daley: data curation, formal analysis, investigation, methodology, software, writing – original draft, writing – review & editing.

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ⓔⓒ SUPPLEMENTAL FILES

- **Appendix A:** 32-item Inclusive Language Checklist
- **Appendix B:** LibGuide Changes

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Alexander Fleming: a second look

Danielle Gerberi

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In 1928, Alexander Fleming (1881-1955) identified penicillin, the world's first antibiotic. It was a chance discovery that could have easily been missed had Fleming not taken a second look at a contaminated Petri dish. The discovery of penicillin marked a profound turning point in history as it was the first time deadly infections such as bacterial pneumonia, sepsis, diphtheria, meningitis, and puerperal fever after childbirth could be cured, and it paved the way for the development of additional antibiotics. The Alexander Fleming Laboratory Museum, one of several London Museums of Health and Medicine, is a reconstruction of Fleming's laboratory in its original location at St. Mary's Hospital. As if stepping back in time, visitors gain a glimpse into the man, his bacteriology work, and the events surrounding this important finding. For those unable to travel to London, this article provides a brief narrative of the fascinating story.

INTRODUCTION

On a recent vacation in London, I happened upon the Alexander Fleming Laboratory Museum while checking Google Maps for points of interest near Paddington Station. For as much planning as I had done. reading multiple travel guidebooks and gathering recommendations on places to visit, I was completely unaware of this point of interest. Intrigued by the information I came across about Fleming through a quick online search, as well as the positive ratings on TripAdvisor.com, I readjusted my plans to include a stop at the museum located within Saint Mary's Hospital. While relatively small, it left a big impression and I highly recommend the museum to those visiting London who are interested in the history of medicine.

The Alexander Fleming Laboratory Museum is part of the collective London Museums of Health and Medicine which are sure to appeal to medical and health sciences archivists and librarians as well as to others seeking a little inspiration or perspective by looking to the past. Additional sites in this network include the Anaesthesia Heritage Centre, Barts Pathology Museum, British Dental Association Museum, Bethlem Museum of the Mind, British Red Cross Museum, Chelsea Physic Garden, College of Optometrists, Florence Nightingale Museum, Foundling Museum, Freud Museum, Hunterian Museum of the Royal College of Surgeons, Landon Down Museum, Museum of the Order of St. John, Old Operating Theatre and Herb Garret, Kew Royal Botanic Gardens, Royal College of Midwives, Royal College of Nursing Library and Heritage Centre, Royal College of Obstetricians and Gynaecologists, Royal College of Physicians Museum, Royal London Hospital Museum, Royal Pharmaceutical Society Museum, Royal Society of Medicine, Science Museum, St. Bartholomew's Hospital Museum, and St. George's Museum and Archives [1]. An entire trip to London could be spent visiting just a few of these gems!

An English Heritage blue plaque, one of almost a thousand across the city, marks the outside of the building at Saint Mary's Hospital as the location of the serendipitous discovery of penicillin in 1928. Opened in 1993 in the exact spot of the original lab and directed by archivist and Fleming biographer, Kevin Brown, the museum brings Fleming's paramount discovery to life.

Figure 1 Alexander Fleming blue plaque by burge5k is licensed under CC BY 2.0

Alexander Fleming, known as Alec to his family, grew up on a farm south of Glasgow, Scotland. The second youngest of eight children, he cultivated the skill of keen observation when hunting and fishing as a boy roaming the countryside. After his father passed away at age seven, the family eventually moved to London. Advised as a teenager to pursue medicine as a rewarding profession by an older brother who went into

ophthalmology, Fleming entered St. Mary's Medical School, the newest of the London teaching schools, in 1901. It is thought he arbitrarily applied to St. Mary's over other equidistant medical programs as he was aware of the comradeship of the water polo team; ironically, it was the rifle club in which he would become a valued teammate [2,11]. Fleming was a top student who also worked part-time as a research assistant in the Inoculation Department under the direction of Sir Almroth Wright, a pioneer of vaccine therapy who also became an influential mentor. Although Fleming planned on pursuing surgery and passed the Fellowship of the Royal College of Surgeons exam, he ultimately chose the specialty of laboratory medicine and would go on to spend his entire professional career practicing as a bacteriologist at St. Mary's Hospital.

Figure 2 Picture of Alexander Fleming "File:Alexander Fleming 3.jpg" by Calibuon at English Wikibooks, cropped by User:AlanM1 is marked with CC0 1.0.
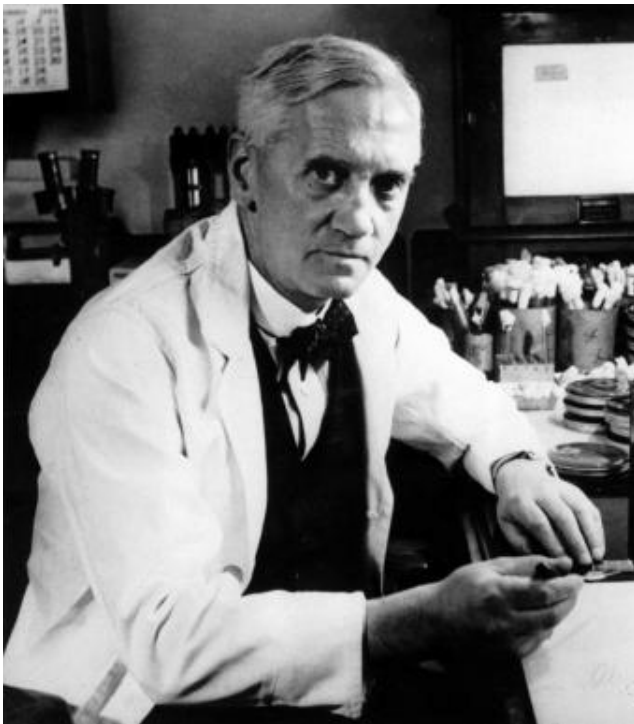
At the onset of World War I, Wright was tasked with establishing a field laboratory at a base hospital in Boulogne, France to study projectile wound infections. Fleming accompanied Wright serving as a captain in the Royal Army Medical Corps. It soon became evident that explosive weaponry led to sepsis, gangrene, and tetanus causing large losses of life and limb. Fleming's research published in the Lancet in 1915 was the first extensive study of war wound infections. The team also demonstrated that the normative use of antiseptics, such

as carbolic acid and sodium hypochlorite, damaged the body's protective leukocytes doing more harm than good. In both war and times of peace, Fleming strove to find a natural nontoxic bactericidal agent to treat infection [2].

In the winter of 1921, Fleming identified a substance in mucus and bodily fluids capable of fighting off bacteria and providing a level of natural immunity. He used a bad cold to his advantage to test his suspicions that nasal secretions are capable of lysis or cellular breakdown. After adding mucus to a culture plate and incubating for several weeks, the plate showed evidence of bacterial inhibition around the mucus. Further experiments using various samples from colleagues and animals resulted in consistent findings showing the trait was inherent and not due to a common cold infection. Wright proposed naming the active substance lysozyme since it acted similarly to an enzyme. When tested on pathogenic bacteria, lysozyme was ineffective and therefore unsuitable for practical therapeutic use, however, its discovery represented an advancement in the field of immunology [2, 6].

In 1928, Fleming was studying Staphylococcus in preparation to write a chapter on the topic for a bacteriology textbook. Before departing for vacation at the end of the summer, a mold spore, likely carried on clothing or through the air from the downstairs mycology lab, contaminated a Petri dish Fleming had cultured with Staphylococcus aureus. The culture plate was one of several left on the workbench for about a month to assess the effects of extended exposure to room temperature on the morphology and virulence of the bacterial colonies [2]. Upon returning to work, Fleming took a second look at a random culture plate that he intended to discard due to the mold contamination. Like his experience with lysozyme, he observed a clear, bacteria-free zone surrounding the mold growth. Under improbable environmental conditions of an unusually cool period of days followed by a heat wave during his vacation, "the contaminating mold had time to develop and the antibacterial agent it produced reached the colonies just at the right age and physiological state when they were still capable of dividing and, therefore, were susceptible to lysis under the influence of penicillin" [3]. Fleming realized the mold had secreted an antibacterial substance which he later named penicillin after the fungal genus Penicillium.

Fleming cultured the mold to evaluate its potency, bactericidal activity, interaction with leukocytes, as well as safety in animals. He found it to be nontoxic and effective against different Gram-positive bacteria such as streptococcus, pneumococcus, gonococcus, and meningococcus. He also conducted numerous experiments using different strains of Penicillium mold and other molds gathered from common sources. Remarkably, only one of the Penicillium strains obtained from the mycology lab exhibited the same effect [4]. Fleming published his landmark article, "On the bacterial

action of cultures of a penicillium, with special reference to their use in the isolation of B. influenzae," in the June 1929 issue of the British Journal of Experimental Pathology. Nonetheless, he and his assistants were challenged by the unstable nature of penicillin which made it difficult to extract and test in patients without a chemistry lab on hand. Fleming generously distributed mold samples around the world to other bacteriologists and mycologists for increased laboratory study but, despite working with penicillin throughout the 1930s as attested by his notebooks, no further breakthrough occurred until a decade later [2, 4, 5].

In 1939, biochemist Ernst Chain, a German-Jewish refugee, rediscovered Fleming's penicillin article while reviewing the literature on natural antibacterial substances. He had recently joined an interdisciplinary team at the Sir William Dunn School of Pathology at Oxford University directed by Australian pathologist Howard Florey. The Oxford team was interested in microbial antagonism since very little was known about the chemical or biological disposition of natural substances capable of inhibitory action on bacteria. Florey developed an interest in antibiosis after having read about Fleming's report on lysozyme in 1929 [2, 13]. The team decided to reexamine substances from past research including taking a fresh look at the antibiotic potential of penicillin. Coincidentally, a transfer from Fleming's preserved penicillin subculture was used. Chain exclaimed, "I was astounded at my luck in finding the very same mold about which I had been reading – here, and in the same building, right under our noses" [5].

Bolstered by chemistry expertise and equipment, the Oxford team developed a successful technique for isolating and purifying penicillin, however, it could only be generated in small quantities. After a controlled study in mice in 1940 showed promising therapeutic results, the notion of using penicillin as a life-saving drug in World War II became a driving force for accelerated human study. Early clinical use met with generally positive outcomes but was limited by the pressing need for a greater supply of penicillin [2, 17].

Interestingly, around this time, Fleming approached Florey to learn how the Oxford team was making penicillin and to ask for a purified dose for a critically ill patient at St. Mary's Hospital with streptococcal meningitis. Florey provided the medicine but asked Fleming to delay administering until he had tested as an intrathecal injection in an animal. Fleming ignored the request as the patient's condition was dire and there was little to lose. The next morning, Florey called Fleming to let him know the animal had died. Fleming revealed the patient's condition had vastly improved and the patient made a full recovery with continued treatment over the following weeks. The miraculous incident at St. Mary's Hospital and Fleming's name quickly spread through London media reports leading to celebrity status [2, 6].

Meanwhile, Florey sought a way to overcome the problem of inadequate penicillin supply using the existing surface culture method available in the lab. Pharmaceutical companies in the United Kingdom were stretched for resources supporting the war effort so Florey headed across the Atlantic to seek outlets for industrial production. Once in the United States, a referral was made to the US Department of Agriculture's Northern Regional Research Laboratory in Peoria, Illinois, which operated a newly developed fermentation facility in the heart of the corn belt. Submerged fermentation, involving aeration of a liquid byproduct from corn in large stainless-steel tanks, proved to be a much more efficient method for growing mold. Combined with a fluke finding of an extra productive strain of mold on a locally grown cantaloupe melon, an exponential yield could be achieved [2, 4].

Coinciding with the American entry into World War II, two federal government agencies, the Office of Scientific Research and Development and the War Production Board, effectively mobilized resources driven by the urgent medical defense needs of the armed forces. A major aim was to generate a sufficient supply of penicillin in preparation for the D-Day invasion on June 6, 1944, since the ability to ward off infection might mean the difference between triumph and defeat. A monumental cooperative effort ensued involving the government, academic institutions, research foundations, and over twenty pharmaceutical companies. Unprecedented free exchange of technical information rapidly accelerated manufacturing. Across the pond, Fleming and Florey advocated scaled-up production in the UK which was hampered by shortages of workers and raw materials, not to mention air raids. Progress was eventually achieved to adequately treat wounded allied troops on multiple war fronts [2, 14, 15].

With more penicillin on hand, Florey was able to move ahead with clinical trials at home as well as on the front lines in North Africa which met with great success. In a trial initiated at St. Mary's Hospital, Fleming was insistent that patients first be tested for diagnostic sensitivity to penicillin before administering the drug since he knew penicillin was not a cure-all. Trials in the US began in 1943 on wounded soldiers at hospitals in Utah and New York with conclusively positive results [2].

Pharmaceutical advertisements displayed slogans such as, "Thanks to Penicillin…He Will Come Home!" serving as some reassurance to families on the home front [8]. Word spread on the life-saving power of penicillin and, for a time, "it became the most sought-after commodity in the world" [9]. Demand escalated for the precious drug for acutely ill civilian cases but penicillin was initially strictly reserved for military use. By 1946, the so-called 'wonder drug' was finally available for the public. As production increased, the price dropped from nearly priceless in 1940, to $20 per dose in July 1943, to $0.55 per dose three years later [10].

Figure 3 Example of one of Fleming's 'mold medallions' from Science Museum London / Science and Society Picture Library; licensed under CC BY-SA 2.0.
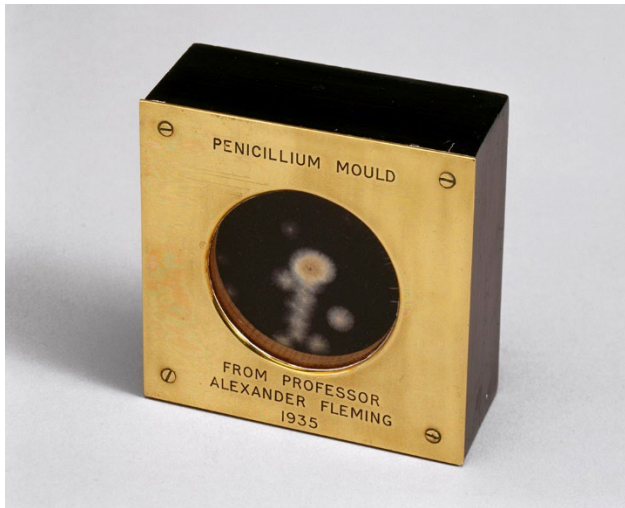
Outside of North America and the UK, global demand arose for penicillin despite countries such as France, the Netherlands, China, Japan, and Germany attempting to manufacture it independently during the war. Reportedly, Hitler was treated with penicillin after the July 1944 inside failed assassination attempt, yet Germany was slow to realize mass production of penicillin. "Although some German scientists and administrators did recognize the importance of penicillin, their efforts were frustrated by infighting, greed and poor organization" in contrast to the coordinated program in the U.S. [17, 18]. The United Nations, World Health Organization and U.S. and Canadian governments assisted with the post-war reconstruction efforts to supply Penicillium cultures, equipment, funding, and training to European and Asian countries such as Italy, Poland, India, and Japan [2, 16].

For their critical involvement in the discovery of penicillin, Fleming, Florey, and Chain were jointly awarded the Nobel Prize in 1945. Dorothy Crowfoot Hodgkin, a chemist at Oxford, determined the molecular structure of penicillin through x-ray crystallography that same year and she was later awarded the Nobel Prize for chemistry in 1964. Chemist John Sheehan successfully created synthetic penicillin in 1957 after nine years of research at the Massachusetts Institute of Technology, though researchers were quick to develop new antibiotics for bacterial infections unresponsive to penicillin.

Fleming was knighted for his service to humanity and granted numerous honors. Somewhat at odds with his unassuming personality, Fleming traveled extensively overseas in a public ambassador role to worldwide acclaim. He presented handcrafted 'mold medallions' as gifts which he made by sealing mold grown on blotting paper between spare eyeglass lenses from his brother's ophthalmology practice. Notable recipients of the mold

medallions included the Queen of England, "Churchill and Roosevelt, friends, colleagues, and many of the people he met on his numerous travels. These insignificant-looking artifacts soon took on the status of holy relics" [2].

Although the discovery of penicillin has been called a fortuitous accident by some, Fleming's acumen certainly played a role. Louis Pasteur's statement, "chance only favors the mind which is prepared," from an 1854 opening address has been evoked in describing Fleming's reaction on the fateful day he encountered the contaminated Petri dish and gave it a second look [2, 6, 7]. Unquestionably, Fleming succeeded in his quest to find a safe substance capable of destroying lethal bacteria which consequently saved countless lives.

Lesser known interesting facts about Fleming include he was called "Flem" by his colleagues, he almost always wore a colorful bow tie, he had an artistic bent which extended to the lab where he created miniature detailed paintings and gardens with pigment-producing microbes, he was an exceptional glass blower who custom-made laboratory apparatus for his own experiments, he conducted the first documented systematic study of nosocomial infection, he introduced a black staining dye for bacteria known as nigrosin, he was fortunate to be unharmed when his London home was hit by bombs in 1941, he perceptively expressed concerns about penicillin overuse leading to antibiotic resistance, his ashes are interred at St Paul's Cathedral alongside tombs and memorials of national British heroes such as Admiral Lord Nelson, the Duke of Wellington and Florence Nightingale, his notebooks are held by the British Library, and his original penicillium mold plate resides at the British Museum [6, 9,11].

Fleming's apprehension about antibiotic resistance proved all too true. Tragically, as the one-hundredth anniversary of the discovery of penicillin draws near, the efficacy of the once remarkable "wonder drug" and successive antibiotics has greatly diminished with the rise of antimicrobial resistance from widespread indiscriminate use. According to the World Health Organization, antimicrobial resistance is one of the top 10 global public health threats facing humanity [19]. Combating this serious threat requires collaborative committed action from intergovernmental bodies, the healthcare and agriculture sectors, academia as well as the public. Emerging alternative antimicrobial approaches, such as nanoparticles and phagotherapy, along with drug repurposing guided by artificial intelligence, are a few strategies offering some hope in a post-antibiotic era [20].

Visiting the Alexander Fleming Laboratory Museum prompted several reflections. Publication and literature searching, so important to our professional work, were influential at multiple stages in the turn of events. The saying, "there is always more to the story" could not be more fitting as many unnamed contributions were made

along the way. "An interdisciplinary approach was needed for the development of penicillin. No single investigator, or small group of investigators, could have accomplished this task" [10]. Even Illinois farms were acknowledged in an online reference I came across which caused me to wonder if my maternal grandmother's family from a farm in central Illinois could have played a tiny part supporting the fermentation process at the Northern Regional Research Laboratory in Peoria [12]. The momentum of World War II facilitated exceptional public-private partnerships to make penicillin a timely reality, changing the course of history. My paternal grandfather, Michael Gerberi, who survived landing on Omaha Beach in the invasion of Normandy on D-Day but was later injured in the Battle of the Bulge and developed pneumonia, may have owed his life in part to penicillin. Perhaps a practical key takeaway is that we can do ourselves and others a service by making a point to take a second look.

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Naomi Cordero Broering (1929-2023)

Alan Carr, AHIP; Michelle Kraft, AHIP, FMLA

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After a long and illustrious career in librarianship, Naomi Cordero Broering, MA, MLS, AHIP, FMLA, died on January 11, 2023. Born in New York City to Puerto Rican parents, Naomi served as MLA's first Hispanic/Latinx president in 1996/97, and in 2003, she received MLA's Marcia C. Noyes Award, MLA's highest professional distinction.

The arc of Naomi's career spanned several years, culminating as dean of libraries at Pacific College of Oriental Medicine (PCOM) in San Diego, where she retired in 2018. While at PCOM, she received numerous outreach funding awards from the National Network Libraries of Medicine (NNLM), Pacific Southwest Region (PSR). According to Alan Carr, retired, associate director, NNLM, PSR, Naomi's outreach was highly impactful and encompassed diverse locations and populations including Hispanics, African Americans, Native Americans, Pacific Islanders, and individuals living in areas with a high incidence of HIV. Her fluency in Spanish enhanced her outreach efforts.

Naomi's husband, Lieutenant Commander Gregory Chauncey, U.S. Navy, retired, often joined her in the exhibit hall at MLA meetings to discuss outreach projects. In 2015, they established and endowed the MLA Naomi C. Broering Hispanic Heritage Grant (now Latinx Heritage Grant) with Naomi being the first recipient. The grant commemorates Naomi's more than four decades of contributions to the profession and is awarded annually to a person of Latinx ethnicity or a person who has an interest in Latinx community information services.

Prior to Naomi's tenure at PCOM, she was the executive director at the Houston Academy of Medicine-Texas Medical Center (HAM/TMC) Library and director, NNLM South Central Region, from 1996-1999. Serving 10 medical schools and an extensive network of hospitals at the time, HAM/TMC Library ranked close to the top due to the size of their budget, personnel, and building, as well as the number of print and electronic resources.

Before coming to HAM/TMC, Naomi left an indelible mark while serving as director, Biomedical Information Resources Center and medical center librarian, Georgetown University Medical Center, Dahlgren Memorial Library from 1975-1996. Under her leadership, the Georgetown University Library Information System (LIS) [1] was among the first integrated online systems developed to automate typical library functions such as acquisitions, catalog, serials, circulation, and bibliographic management (including the mini–MEDLINE System) [2]. LIS and mini-MEDLINE were marketed and sold to libraries across the country.

In addition to serving as MLA President and member of the Board of Directors, Naomi was a Distinguished Member of the Academy of Health Information Professionals, a Fellow of MLA and the American College of Medical Informatics, and editor of the Bulletin of the Medical Library Association (BMLA). Naomi was a founding member and served as secretary of the Friends of the National Library of Medicine. She was also active in several other national associations including the American Society for Information Sciences, American Library Association, American Medical Informatics Association, and the Special Library Association (SLA). She received numerous honors including the SLA Winifred Sewell Award, SLA Professional Award, and the MLA Frank B. Rogers Information Advancement Award.

Leading up to her presidential address in 1996, Naomi presided at all the events of the annual meeting due to the absence of Jana Bradley, who was president at that time. Naomi's presidential address began with a challenge, "Today, I want to ask you to think about what you will be doing in the twenty-first century - in the year 2000 and beyond." She challenged the audience to say "I will serve a larger user base … I will be transmitting health care information to every member of the family … much of my work will be outside the library … it will be a virtual library …" Naomi's words from 1996 resonate with contemporary themes such as health informatics, the NNLM All of Us Program Center, library liaisons, participation in campus/hospital committees, and the development of virtual libraries for native populations.

In the July 1996 BMLA presidential profile of Naomi, Susan Crawford stated, "She was one of the pioneers in implementing the integrated academic (now advanced) information management system (IAMS). Other technical accomplishments include an electronic textbook in human physiology and BIOSYNTHESIS that integrates multiple databases for access through a single gateway. The MAClinical Workstation is a project to develop computer workstations for medical students to prepare them to use computers in their future medical practice."

Naomi was a prolific author, successful grant writer, and ardent supporter of the NLM. She authored over 200 articles and was awarded numerous grants and contracts from the NLM across three NNLM regions. According to the NIH Reporter, Naomi received $5,690,638 in funding from 1985-1995 which was significant for Dahlgren Memorial Library. She leaves a legacy within the academy as a collaborator, visionary, advocate, trailblazer, prolific writer, successful grantee, and supporter of the goals and aspirations of MLA and the NLM. In the July 1992 editorial in BMLA, Susan Crawford introduced Naomi as the new editor with these words, "Vision, creativity, and a great sense of timing."

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Clegg, Margaret. **Human Remains: Curation, Reburial and Repatriation.** Cambridge, UK: Cambridge University Press; 2020. (Cambridge Texts in Human Bioarchaeology and Osteoarchaeology) 176 p. ISBN: 9781107485433. ∞

Libraries share many institutional characteristics with museums. Library special collections and archives departments often contain items that would be on display or stored in a museum. Health sciences libraries with collections that include anatomical items may face similar challenges as museums that include human remains in their holdings, and documentation of provenance as well as the ethics of organizing exhibits. As the level of professional awareness of the ethical and cultural issues in the management of human remains increases, health sciences librarians and archivists may need resources to help make informed professional decisions.[1]

Margaret Clegg's, *Human Remains: curation, reburial and repatriation* is a comprehensive overview of the issues involved in the archival management of human anatomical material. Clegg, formerly of the Natural History Museum in London, is steeped in the complexities involved in this topic and shares her experience in a comprehensive examination of its many facets. While most of the examples are drawn from the institutional, legal, and historical context of the United Kingdom, the United States milieu is also included.

Clegg discusses the way museums have acquired human remains for their collections. In the past, human remains were often taken during military campaigns or exploratory endeavors without respect for the concept of consent. Subsequent decades of decolonization as well as cultural and intellectual change have altered the relationship between the remains, their institutional custodians, and the communities from which they were taken.

Clegg takes up in detail the legal framework governing human remains with a predominant focus on UK law. For comparative purposes, the details of the UK's 2004 Human Tissue Act will be of interest to those familiar only with US laws like the Native American Graves Protection and Repatriation Act of 1990.

The chapter on ethical issues provides important context to the management of research involving human remains on display. The author defines the concept of ethics, offers approaches to distinguishing qualitative categories of remains based on date of death, and discusses professionally accepted museum curatorial values that can serve as a guide to other professions in managing research and display of remains.

Drawn from experience with remains from Tasmania and the Torres Strait Islands, the author shares some of the most interesting material in the book; the issue of repatriation of remains to their original communities. Clegg openly describes the positives and negatives of the two cases, including a successful effort to develop relations with representatives of the Torres Strait Islanders to make the repatriation process an inclusive one.

Content review questions are provided at the end of each chapter, making the book appropriate for inclusion in relevant course curricula. While the variety and complexity of human remains faced by library special collections departments is far less likely than natural history museums, this book has relevance for the library world. The historical and professional context provided by Clegg will benefit librarians and archivists and will support anthropology, biomedical ethics, and forensics curricula.

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Bate, Jason. **Photography in the Great War: The Ethics of Emerging Medical Collections for the Great War.** New York, NY: Bloomsbury Publishing Plc; 2022. 222 p. $137.00 ISBN 978-1-350-1224-8.∞

Photography in the Great War: The Ethics of Emerging Medical Collections for the Great War gives a brief history on photography and how it was used in partnership with surgeons and photographers to provide aid for disfigured servicemen who served in World War I. Focused mainly overseas during World War I, the book reflects how progress was made in the art of photography as technology changed, and how photography may have benefited the treatment of wounded soldiers.

The book is divided into five chapters. Chapter one describes the early history of facial injury photography. This chapter sets the groundwork for the proceeding chapters explaining how photography was used to document disfigurements and treatments.

The second chapter describes the technological advances such as electricity, along with the role photography played in documenting surgical cases of facially disfigured servicemen. The chapter also explains how photographs were published in scientific journal articles to illustrate treatments used during wartime for facial disfigurement surgeries that could be replicated throughout the world.

Alternate health care is the focus of chapter three. Photography was used in performing alternate health care therapies, especially in Italy where healthcare was different from other countries due to lack of funding. Nurses also played a role in photographing disfigured soldiers.

The psychological impact of the soldier's homecoming is detailed in chapter four. In this chapter, photography is used to influence and provide opportunities for the injured soldiers. This chapter discusses how men had to re-establish themselves in society, and how photography benefited their recovery as a means of therapy. Photography offered a reprieve for the soldiers coming home as a way of forgetting the trauma of war.

Medical and dental photographs of facial disfigurations are highlighted in the last chapter. The photographs that make up these collections tell of the social activity and provide an opportunity for surviving relatives to view them. This process was made easier with the digitization of some of these important wartime photographic collections.

Bate's monograph gives an excellent account of service men returning from war, wounded, disfigured and alienated. He cites family and public support determine how well veterans reintegrate into society. Bates draws attention to the ethical guidelines in using these photographs such as privacy and anonymity. He is also a strong advocate for preserving medical photographs, and proponent of protecting the private lives of the patients captured in these medical photographic collections. I would recommend Photograph in the Great War: The Ethics of Emerging Medical Collections for the Great War for those that are interested in the history of photography, and medical history.

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