

# Career Paths of Pathology Informatics Fellowship Alumni

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## Abstract

**Background:** The alumni of today's Pathology Informatics and Clinical Informatics fellowships fill diverse roles in academia, large health systems, and industry. The evolving training tracks and curriculum of Pathology Informatics fellowships have been well documented. However, less attention has been given to the posttraining experiences of graduates from informatics training programs. Here, we examine the career paths of subspecialty fellowship-trained pathologists. **Methods:** Alumni from four Pathology Informatics fellowship training programs were contacted for their voluntary participation in the study. We analyzed various components of training, and the subsequent career paths of Pathology Informatics fellowship alumni using data extracted from alumni provided curriculum vitae. **Results:** Twenty-three out of twenty-seven alumni contacted contributed to the study. A majority had completed undergraduate study in science, technology, engineering, and math fields and combined track training in anatomic and clinical pathology. Approximately 30% (7/23) completed residency in a program with an in-house Pathology Informatics fellowship. Most completed additional fellowships (15/23) and many also completed advanced degrees (10/23). Common primary posttraining appointments included chief medical informatics officer (3/23), director of Pathology Informatics (10/23), informatics program director (2/23), and various roles in industry (3/23). Many alumni also provide clinical care in addition to their informatics roles (14/23). Pathology Informatics alumni serve on a variety of institutional committees, participate in national informatics organizations, contribute widely to scientific literature, and more than half (13/23) have obtained subspecialty certification in Clinical Informatics to date. **Conclusions:** Our analysis highlights several interesting phenomena related to the training and career trajectory of Pathology Informatics fellowship alumni. We note the long training track alumni complete in preparation for their careers. We believe flexible training pathways combining informatics and clinical training may help to alleviate the burden. We highlight the importance of in-house Pathology Informatics fellowships in promoting interest in informatics among residents. We also observe the many important leadership roles in academia, large community health systems, and industry available to early career alumni and believe this reflects a strong market for formally trained informaticians. We hope this analysis will be useful as we continue to develop the informatics fellowships to meet the future needs of our trainees and discipline.

**Keywords:** Clinical Informatics, informatics career trajectories, informatics curriculum, Pathology Informatics fellowship

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## INTRODUCTION

Fellowships in medical informatics have existed going back to the early 1970s with the creation of the National Library of Medicine (NLM)-funded programs.<sup>[1]</sup> Pathology Informatics fellowships are a more recent outgrowth of this legacy and driven by the increasing data volume and computational complexity of clinical laboratories. The training model continues to evolve with the establishment of the newly created Clinical Informatics fellowships, which often include Pathology Informatics components.

The training needs of medical informatics trainees have been dictated by the roles they will fill, and these roles are constantly changing. Early NLM-funded program needs were focused on creating academic medical informaticians to establish informatics departments and train students.<sup>[1]</sup> Today's Pathology Informatics and Clinical Informatics trainees go on to fill a number of diverse roles including academia, operational roles in large health systems, and development roles in industry.

We have previously written about the evolving training tracks and curriculum of Pathology Informatics fellowships.<sup>[2-9]</sup> Analogously, our nonpathology clinical colleagues are writing about the core curriculum and experiences with their Clinical Informatics fellowships.<sup>[10-14]</sup>

Relatively less attention has been given to the posttraining experiences of graduates from informatics training programs. From 1990 to 1991, several authors examined the career paths of the early NLM graduates.<sup>[1,15-17]</sup> These studies found a growing need for medical informatics academicians that outstripped the training pipeline.<sup>[15,16]</sup> About half of these trainees sought and secured an academic role, many with a blend of informatics-related research and clinical activities.<sup>[1,16,17]</sup> Several alumni did not anticipate needing to maintain clinical skills though many jobs required some clinical activity.<sup>[17]</sup> A more recent study looked at graduates of imaging informatics fellowships and similarly found that about 50% assumed academic informatics roles.<sup>[18]</sup> Other data on informatics alumni have been scarce.

There is a similar paucity of literature for Pathology Informatics graduates. To date, we have not formally looked at the career paths of our alumni. Through discussions with our alumni, we feel that the fellowship training is meeting the needs of our trainees; however, we have not previously formally examined the career trajectories of these pathologists who were trained in Pathology Informatics fellowships. In the absence of such data, we are unable to objectively comment on the contribution of our Pathology Informatics fellowships to the careers of our graduates. We are especially concerned with the fellowship's ability to enable the success of our trainees in their initial years of practice, as it has been our understanding that alumni of Pathology Informatics fellowships tend to receive leadership positions almost immediately upon graduation.

Between 2007 and 2016, there were four Pathology Informatics fellowship programs in the United States that graduated the great majority of fellowship-trained pathology informaticians: The Henry Ford Hospital Healthcare System in Detroit, the

Partners HealthCare System in Boston, the University of Michigan Medical Center at Ann Arbor, and the University of Pittsburgh Medical Center in Pittsburgh. Together these programs produced 27 alumni who practiced their entire postfellowship career in the United States. While there was no registry of Pathology Informatics fellows from 2007 to 2016, we are confident that these four programs graduated the great majority, far more than half, of fellowship-trained pathology informaticians during that period.

To examine the career paths of subspecialty fellowship-trained pathology informaticians, the program directors, alumni, and current fellows from the aforementioned programs formed the Pathology Informatics Alumni Group that undertook a review of the career paths of Pathology Informatics fellowship alumni using data extracted from alumni-provided curriculum vitae (CVs). Our goal was to document and understand the relationship between components of training (undergraduate, graduate, and medical) and the early career paths of pathology informaticians. We also sought to identify recommendations to improve our training programs based on these data and that also may be useful for other training programs.

## METHODS

### Data collection

Four Pathology Informatics fellowship training programs (Henry Ford Health System, Partners HealthCare System, University of Michigan, and University of Pittsburgh Medical Center) participated in the study. In conjunction with the author JWR, the fellowship program directors (authors LP, JMT, JRG, and UGB) assembled a list of alumni from 2008 to 2016 that had been practicing in the United States since graduation. Using this list, we generated an E-mail requesting the participation of fellowship alumni in an analysis of informatics career paths. Participation in the analysis was voluntary and alumni could elect not to participate. A reminder E-mail was sent to nonresponders. Alumni were asked to provide a current copy of their CV as a primary data source for the analysis. We aggregated CVs of participants in a central network drive for analysis. The limitations of CVs as a data acquisition mechanism are examined in the discussion section.

### Data analysis

Based on an initial review of the CVs (authors JWR and JRG), we developed a scoring rubric to standardize data collection from the CVs. The rubric included multiple domains encompassing training, employment, scholarship, and teaching. Individual CVs were then scored by author JWR.

We discovered some data elements (e.g., those regarding teaching) were not well standardized in their inclusion and presentation in alumni CVs. Accordingly, we excluded these elements from the final data set. We identified one rubric item (Informatics Appointment) where an alumnus could occupy more than one category. In this case, we applied only one designation per alumnus in the following preference (Chief Medical Informatics

Officer [CMIO] > Director of Informatics > Informatics Fellowship Program Director > Industry > Unspecified).

We used data elements present on the CV to make calculations and summarize data (number of positions since graduation fellowship, number of fellowships, number of years in practice, etc.). We also developed a calculated publication index (articles attributable to an alumnus on PubMed divided by the number of years since informatics fellowship graduation) as a measure of academic productivity. We included all authorship positions and areas of publication irrespective of whether the publication was principally informatics focused. We could not calculate a publication index for two alumni due to name similarities to other authors in the PubMed database making attribution of authorship not possible. Accordingly, we excluded these alumni from this subset of the analysis.

We tallied summative data by fellowship program and generated tables in Microsoft Excel (Microsoft Corporation, Redmond, WA, USA).

**Table 1: Training characteristics of informatics fellowship alumni including undergraduate, medical, and postgraduate training**

Training	HFHS	PHS	UMI	UPMC	Total
Undergraduate study					
STEM	2	10	2	4	18
Other (e.g. humanities)		1			1
Not reported	1	1		2	4
Residency					
AP/CP	3	7	1	6	17
AP		2	1		3
CP		3			3
Residency at institution with PI fellowship					
Yes	1	5	0	1	7
No	2	7	2	5	16
Other residency					
Yes		1		2	3
No	3	11	2	4	20
Informatics fellowship					
1 year		8		5	13
2 years	3	4	2	1	10
Other fellowship (number)					
0	1	4	1	2	8
1	1	6	1	2	10
2	1	2		1	4
3				1	1
Advanced degree					
Yes		9	1		10
Not reported	3	3	1	6	13

STEM: Science, technology, engineering, mathematics, PI: Pathology Informatics, AP: Anatomic pathology, CP: Clinical pathology, HFHS: Henry Ford Health System, PHS: Partners HealthCare System, UMI: University of Michigan, UPMC: University of Pittsburgh Medical Center

American Board of Pathology (ABP) Clinical Informatics diplomate status was sourced from publicly available data as published on the American Medical Informatics Association website.<sup>[19]</sup> Available records spanned the first four classes of diplomates (2013–2016).

## RESULTS

### Response

The majority of alumni contacted (23/27) responded to our request for participation in the study (response rate of 85%). We were unable to obtain CVs for four alumni (two alumni from the Partners HealthCare System, one alumnus from the University of Michigan, and one alumnus from the University of Pittsburgh Medical Center).

### Training

Data regarding alumni training as undergraduate and graduate students are presented in Table 1.

The majority of alumni (18/23) reported completing undergraduate studies in a science, technology, engineering, and mathematics field. Commonly listed disciplines included biology, biochemistry, biology-related engineering, and molecular biology.

Most alumni (17/23) completed combined track training in pathology (clinical pathology/anatomic pathology [AP/CP]) with a minority completing either AP alone (3/23) or CP alone (3/23). Approximately 30% (7/23) of alumni completed their residency training in a program with an in-house Pathology Informatics fellowship program.

Some alumni (3/23) completed some amount of nonpathology residency training (urology, nuclear medicine, and general surgery internship). The majority (15/23) completed at least one additional pathology fellowship and of those five alumni completed more than one additional fellowship. The most commonly reported additional fellowships included molecular genetic pathology (6), a variety of research fellowships (5), and cytology (3). Other reported fellowships included general surgical pathology (2), hematopathology (2), transfusion medicine (1), forensic pathology (1), and genitourinary pathology (1).

Roughly half (10/23) of fellowship alumni reported advanced degrees (MA, MS, and PhD) in their CVs. Advanced degrees were diverse but heavily weighted toward the biologic sciences including genetics/molecular biology, biophysics, physiology, and pathology. One alumnus reported holding an advanced degree in informatics (MS in Medical Informatics).

Slightly more than one-half of alumni elected to complete a 1-year informatics fellowship (13/23) compared to a 2-year fellowship (10/23).

### Employment

Data regarding posttraining employment are presented in Table 2.

**Table 2: Employment characteristics of informatics fellowship alumni including job setting, informatics role, and institutional service**

Employment	HFHS	PHS	UMI	UPMC	Total
Setting					
Academic Health System	3	12	1	3	19
Community Health System				1	1
Industry			1	2	3
Positions since leaving training					
1	3	11	1	3	18
2		1		3	4
≥3			1		1
Clinical care					
Yes	3	9		2	14
Not reported		3	2	4	9
Informatics appointment					
CMIO (or associate)		2		1	3
Director of informatics (or associate)	2	6		2	10
Informatics fellowship PD (or associate)		2			2
Industry appointment			1	2	3
Not reported	1	2	1	1	5
Institutional Committee Service					
Yes	1	6		4	11
Not reported	2	6	2	2	12

CMIO: Chief medical informatics officer, PD: Program director, HFHS: Henry Ford Health System, PHS: Partners HealthCare System, UMI: University of Michigan, UPMC: University of Pittsburgh Medical Center

Most alumni are currently practicing in academic health systems with a few alumni principally employed in industry work and only one alumnus employed by a community health system (as an Associate CMIO). The majority of alumni remain in their first position after fellowship (18/23). Multiple changes in appointments were seen most often in those principally employed in industry.

Slightly more than half of alumni (14/23) list clinical care outside of informatics as a component of their practices. Commonly listed clinical care activities included molecular pathology (4), general surgical pathology (3), and cytology (3). Other clinical service work included immunology, hemoglobin sign out, transfusion medicine, laboratory directorship, and autopsy.

Fellowship alumni also reported a variety of informatics-related institutional committee service including decision support, variation and utilization, reporting, data architecture, operations, hospital information system implementation, biorepository, quality improvement, and clinical competency.

Most alumni (15/23) report at least one formal informatics appointment at the enterprise or departmental level. As described in the methods, we assigned alumni to one

informatics appointment category in the following order: CMIO > Director of Informatics > Informatics Fellowship Program Director > Industry > Unspecified. Assignment was inclusive of associate directorships. According to this assignment, the most common appointment was Director of Informatics (10) followed by CMIO (3) and industry (3), then Informatics Fellowship Director (2). Five alumni did not report a specific informatics leadership appointment. These alumni reported principal activities in molecular genetic pathology (2), enterprise laboratory directorship (1), informatics research (1), and anatomic pathology (1).

The roles of those principally employed in the industry included Head of Pathology, Clinical Informatics/Pathology Informatics Consultant, and Vice President of Computational Pathology in organizations ranging from startups to large, established companies. In addition to these three alumni, four additional alumni reported past or current industry involvement. In all cases, the nature of this work was reported as either an advisory or consultant role.

### Scholarship

Aggregated scholarship data are presented in Table 3.

Most alumni have academic appointments of assistant professor (15/23) with a minority having been promoted to associate professor (3/23). Those remaining were in industry (3/23) or did not report an academic rank (2/23). Alumni publication indexes (number of publications/years since informatics fellowship graduation) vary though the vast majority have and continue to contribute to the academic literature in informatics and/or their clinical specialties.

Most alumni also report informatics professional society involvement (18/23). Commonly listed societies included the Association for Pathology Informatics followed by the American Medical Informatics Association, the Digital Pathology Association, and Healthcare Information and Management Systems Society. Within these societies, alumni report a variety of activities including editorial work, article review, committee involvement (membership, training, and publishing), and standards workgroup involvement.

More than half of alumni have achieved subspecialty certification in Clinical Informatics, having successfully completed the Clinical Informatics Board Examination (2013–2016).

### DISCUSSION

Our analysis highlights a number of interesting phenomena as it relates to the training and career trajectory of Pathology Informatics fellowship alumni.

#### Length and structure of training

We believe it is important to note the varied and long training tracks that our trainees pursue to prepare for a career in informatics. In addition to traditional training in undergraduate,



**Table 3: Scholarship characteristics of informatics fellowship alumni including academic rank, publication index (number of PubMed indexed articles divided by years since fellowship graduation), and informatics professional society involvement**

Scholarship	HFHS	PHS	UMI	UPMC	Total
Academic rank					
Assistant	3	9		3	15
Associate		2		1	3
Not applicable/not reported		1	2	2	5
Publication index (PubMed/years since training)					
0-3	3	3	1	2	9
>3-6		3		1	4
>6		6	1	1	8
Unable to calculate				2	2
Society involvement					
Yes	3	9	1	5	18
Not reported		3	1	1	5
ABP CI diplomate					
Yes	2	6	1	4	13
No	1	6	1	2	10

HFHS: Henry Ford Health System, PHS: Partners HealthCare System, UMI: University of Michigan, UPMC: University of Pittsburgh Medical Center, ABP: American Board of Pathology, CI: Clinical Informatics

medical school, and pathology residency studies, our trainees frequently spend time in additional training roles. These include time pursuing advanced degrees (10/23) as well as completing other (noninformatics) fellowships (15/23), and sometimes even additional residencies (3/23).

As medical knowledge continues to expand and the practice of pathology favors subspecialization, the opportunities for selective training in pathology continue to grow.<sup>[20]</sup> Given our observation that most informatics trainees go on to engage in traditional clinical work in addition to their informatics responsibilities, we feel the obligation to complete additional fellowships alongside an informatics fellowship will continue to increase. An early study of NLM fellows suggested that the prevailing alumni attitude was that maintaining clinical skills would not be required in their work.<sup>[17]</sup> This does not seem to be the case in the current landscape as most of our alumni are engaged in clinical work.

We believe that a 2-year requirement for informatics training adds to the burden of an already long training trajectory. At a certain point, we suspect the length of the training may discourage interested trainees from pursuing formal training in informatics given the additional training expectations in other disciplines. A recent survey of graduates of imaging informatics fellowships revealed that most of their alumni do not support a 2-year training requirement.<sup>[18]</sup>

We have previously written about the need for flexible training tracks to accommodate training in the discipline of informatics and another pathology subspecialty, the so-called “1 + 1” track.<sup>[4,8]</sup>

This training pathway has been popular with our trainees in the past, and we believe that it presents a viable model for future training. The ABP has recently approved a similar approach termed the “blended fellowship.” This pathway allows the trainee to do a 2-year Accreditation Council for Graduate Medical Education (ACGME) approved Clinical Informatics fellowship and in the same 2-year window, a 1-year fellowship in another pathology subspecialty. The 1-year fellowship must include an informatics focus and projects in coordination with the Clinical Informatics fellowship. At the end of the 2-year window, the trainee would be board eligible in both Clinical Informatics and the other subspecialty if ABP certification is available.<sup>[21]</sup> It is our sincere hope trainees, and fellowships take advantage of this pathway and that a similar pathway will be extended to the rest of the Clinical Informatics fellowship community.

### The presence of fellowships promotes interest in informatics

Our data highlight the importance of an informatics fellowship as a means for promoting interest among pathology residency trainees. Of the 23 alumni participating in the analysis, approximately 30% (7/23) were graduates of residency programs with a Pathology Informatics fellowship in-house. This is a sizable fraction as such training programs reported by our alumni represent <4% (4/119) of the total pathology training programs in the United States. We suspect that this may be related to increased awareness of informatics as a viable career path among residents training in programs with informatics fellowships. We have previously written about the importance of longitudinal engagement, including the presence of an in-house fellowship program, in fostering interest in informatics.<sup>[7,9]</sup> We believe the observation that residency programs with in-house Pathology Informatics fellowship are enriched with trainees pursuing informatics fellowship training further supports the concept that the existence of an informatics training program in an institution can help to generate interest in the field among pathology residents.

For programs interested in developing and recruiting informatics talent, we find that a fellowship is an effective means for supporting this initiative. The presence of a fellowship provides residents with exposure to informatics and facilitates early engagement and recruitment to the program. While increasing the number of slots in existing programs will help to satisfy some of the demand for pathology informaticians, we expect that it will also be necessary to establish new programs to foster awareness of informatics among trainees.

### Early leadership positions suggest a strong employment market

It is exciting to note that nearly all of our alumni are practicing informatics in their careers and that the majority are securing leadership roles in informatics early in their careers [Table 2]. Of those not reporting formal informatics positions (5/23), informal conversations reveal that at least four members of this cohort are engaged in significant informatics work through their

other reported activities. Thus, there is virtually no attrition in informatics practice among the alumni in this study. We believe that the early leadership and lack of attrition are highly important observations and reflect the appetite in the market for formally trained informaticians.

Others have projected the increasing need for medical informaticians going back almost 30 years and noted the lack of supply of formally trained informaticians relative to the demand.<sup>[15]</sup> More recently, others have described the explosion in demand for CMIOs.<sup>[22]</sup> This has likely only widened the supply-demand gap. We also note that it is encouraging to see alumni securing appointments as CMIOs. We believe this is an indication that the market views pathologists as qualified candidates for these roles and we expect to see more opportunities for pathologists in this area in the coming years.

While the emergence of ACGME approved Clinical Informatics fellowships in recent years will certainly add to the pool of available informaticians, we anticipate that the market will not saturate quickly as our informal observations indicate that the creation of positions still far exceeds the available talent. Furthermore, given that most of the alumni are engaged specifically in the practice of Clinical Informatics in pathology, we do not anticipate competition for these positions with nonpathology trained fellows except in the circumstances of cross-departmental positions (e.g., Organization-level CMIO). Aronow *et al.* noted in 1991 review of NLM-funded fellows that the impact of the fellows will depend on the creation of faculty positions for them.<sup>[17]</sup> If the current landscape is any indication, the future of our fellows will be very bright.

The large number of alumni securing leadership roles early in their careers puts pressure on the informatics fellowships to ensure that alumni are prepared to handle these positions immediately upon fellowship graduation. We have discussed this, and mechanisms to enhance the fellowships' ability to prepare trainees for leadership roles.<sup>[5]</sup>

We anticipate that informatics alumni will also continue to advance in their academic appointments as well. Our data reveal that alumni have started to advance from assistant to associate professor appointments. Although no alumnus had secured a full professor appointment at the time of our data collection, we believe these advancements will begin within the coming years. The most senior alumni have been in practice for 8 years, so full professor level appointments would not yet be expected. We are informally aware of one alumnus who has advanced to full professor since the time of this study.

### Careers in industry

While the vast majority of our alumni have elected to pursue careers in academia, some report industry affiliation separate from their primary appointment (4/23), and a small but significant subset (4/23) are choosing careers with prominent roles in industry or large community health systems. Greenes *et al.* predicted the emergence of such an industry-focused group in the early 1990s.<sup>[15]</sup>

The NLM fellowship was designed to produce academicians who would then train other academicians.<sup>[1]</sup> Given the potential bias toward training academic informaticians that has existed in medical informatics training programs extending back to the early days of training, it is unclear whether we are adequately meeting the needs of this emerging, industry-centered, subset of trainees. In the current funding environment, academic medical departments are awakening to the importance of partnering with industry and engaging in co-development. In addition, companies with focuses in machine learning and data management ranging from small startups to large established technology companies are actively seeking informaticians to advise and lead their groups. We strive to provide adequate exposure toward working in industry for our trainees. However, whether we are successfully meeting the need is unknown. This is clearly an important area for the future study.

### Implications for Pathology Informatics training programs

One of the goals of our study was to identify areas in which we can improve our fellowships for both fellows and for alumni. In some areas, the study has reinforced issues, of which we were aware and had previously published on including the need for skills in leadership,<sup>[5]</sup> using the fellowship to engage residents in informatics,<sup>[7]</sup> integration of diagnostic pathology fellowships with informatics,<sup>[8]</sup> and the need to mitigate the long pathology training tracks.<sup>[4]</sup>

However, there were issues that we had not carefully considered to date. Reviewing alumni CVs, we observe the way the evolution of informatics technologies build on each other over time (for example LIS Implementation → Enterprise Infrastructure → Laboratory Analytics → Machine Learning Applications). This raises the question of whether the fellowships can help alumni keep ahead of these curves. We see that there is a wide range of “academic productivity” between alumni in different institutions and we suspect there are ways that a fellowship program can collaborate better with its alumni. We can also clearly see the rising importance of careers in industry, consulting, and industrial collaborations.

### Applicability to the broader Clinical Informatics community

Despite our cohort consisting only of pathology-trained informaticians, we believe the early career experiences of our trainees can likely be extrapolated to other disciplines. In particular, our experience may serve as a primer for graduates of the newly formed Clinical Informatics fellowships for what to anticipate in their early careers. Specifically, they can expect to practice a mix of clinical work in their specialty along with informatics-specific responsibilities either in their clinical department or at the level of the enterprise. They will most likely find work in an academic setting though other opportunities are increasingly available. They can expect to assume leadership roles in informatics quickly and will likely find many opportunities for informatics committee service both at the level of the institution and in national societies.

It is also evident that there is an interest and need for training informaticians worldwide. While our study is focused on alumni

trained and practicing in the United States, we believe that our experience may be applicable to trainees and programs in other countries. The four programs in this study have a limited experience in training faculty for practice outside the United States. While programs in this paper have 2 alumni practicing abroad (Canada and India), we are unable to comment extensively on training and workforce needs in other countries. Others have written about the need for informatics training pathways worldwide, both the need for a skilled workforce practicing at the intersection of health-care and information technology and the necessity of assessing capacity and defining appropriate training with local stakeholders.<sup>[23]</sup> The International Medical Informatics Association has been engaged in this topic.<sup>[23]</sup> We believe this area of informatics is poised for additional future innovation and study.

### Limitations

This work exhibits a couple of notable limitations. First, CVs are an informative but imperfect means of data acquisition, as formats are not standardized between institutions. The absence of an item on a CV may mean it is nonexistent or simply that it was not reported. The methods employed in this paper do not allow us to distinguish between the two. We attempted to identify relevant and consistently reported CV data elements for analysis in our study, but it is possible that we are missing data due to the above. The study would have been stronger with a questionnaire as a means of data collection, though we decided early on that this approach may not yield an adequate response rate. A second limitation relates to calculated values, especially our proposed publication index. This index may not be an accurate representation of an individual's productivity as not all applicable publications are indexed in the PubMed database, and misattribution of authorship for returned publications by the queries is also possible. The index may also favor early career trainees whose ratio of publications to years following training may be enhanced due to publications during training. Overall, we believe the publication index is suitable as a general marker of academic productivity for the purposes of this study.

### CONCLUSIONS

We believe our work provides a unique and previously unquantified look at the career paths of informatics fellowship alumni. Our data suggest a strong demand for formally trained informaticians and ready opportunities for leadership in both academics and industry. We hope this analysis will be useful as we continue to develop the informatics fellowships to meet the future needs of our trainees and discipline.

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### Conflicts of interest

There are no conflicts of interest.

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