

Research and Applications

Survey of clinical informatics fellows graduating 2016–2024: experiences before and during fellowship

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ABSTRACT

Objective: To describe experiences and activities of Clinical Informatics (CI) fellows since the first fellowships were accredited in 2014.

Materials and Methods: We performed a voluntary and anonymous survey of 394 alumni and current clinical informatics fellows from the graduating classes of 2016–2024 in the summer of 2022.

Results: We received 198 responses; 2% declined to participate. Most were male (62%), White (39%), 31–40 years old (72%), from primary care specialties (54%) and nonprocedural specialties (95%), and without prior informatics experience or any careers before medicine. Most fellows (87–94%) participated significantly in operations, research, coursework, quality improvement, and clinical care activities during fellowship.

Discussion: Women, underrepresented racial and ethnic minorities, and procedural physicians were underrepresented. Many incoming CI fellows did not have an informatics background. During CI fellowship, trainees earned Master's degrees and certificates, were exposed to many different types of CI activities, and were able to spend most of their time pursuing projects that supported their personal career goals.

Conclusion: These findings represent the most comprehensive report to date of CI fellows and alumni. Physicians without prior informatics experience who are interested in CI should be encouraged to apply because CI fellowship provides a strong foundation of informatics knowledge while supporting fellows' personal career goals. There remains a lack of women and underrepresented minorities in CI fellowship programs; efforts to expand the pipeline are needed.

Key words: clinical informatics, medical education, graduate medical education, academic training

BACKGROUND

In 2009 the medical subspecialty of Clinical Informatics (CI) was defined¹ along with the core content² and program requirements for fellowship training.³ The first CI fellowships were accredited by the Accreditation Council for Graduate Medical Education in 2014⁴ and since then the number of fellowships has grown to nearly 60.⁵

Previous estimates demonstrate a relatively strong interest among medical students in topics related to CI, however less than a third were aware of training opportunities, including fellowship.⁶ There are limited data available on CI fellowship applicants,^{7,8} and training experience.^{4,9} A prior survey of CI fellows and program directors examined the process and success in searching for jobs.¹⁰ However more data are needed to help attract medical undergraduate and graduate trainees to the field. This is especially true given the ongoing shortfall and uneven distribution of physician informatics specialists. Based on the most recent published data from the American Board of Preventive Medicine there are 2313 board certified CI physicians.¹¹ This is still well below previous workforce estimates, including the American Medical Informatics

Association 10×10 goal of 1 physician and nurse informaticist for every hospital in the United States.^{11,12}

OBJECTIVE

In this study we survey the current and past CI fellows in order to describe the population and their training experiences.

MATERIALS AND METHODS

During July through September 2022, with Mass General Brigham institutional review board (IRB) exemption, we sent an anonymous, voluntary survey to clinical informatics fellows and alumni known to the AMIA Clinical Informatics Fellows (ACIF) and Clinical Informatics Program Directors (CIPD). Study data were collected using the secure, web-based software platform Redcap (Research Electronic Data Capture)¹³ electronic data capture tools hosted at Mass General Brigham. Data were anonymized and exported to RStudio 2022.12.0/R v3.6.3¹⁴ for analysis.

Except for the first question for electronic consent to voluntarily participate, all questions on the survey were optional. We minimized combining answers from multiple questions in order to protect respondents' anonymity. Questions were mostly single-select multiple choice, with some free text short answer, multi-select multiple choice, and ranking, including: 10 questions on background (demographics, clinical specialty, career goals) and 14 questions on experiences during fellowship. Categorical results were reported as counts and percentages. Unanswered questions were included as "Did not respond". Free text responses (eg, specific certificates or degrees completed during fellowship, career goals) were categorized and reviewed by the first and last authors. Multi-select multiple choice questions summarized each choice as a count and percentage. Questions asking for ranking multiple activities from most to least time, leaving unselected activities not performed, were summarized in 2 ways: any ranked activity was considered as performed and shown as a count and percentage; and the activity ranked as the most time was shown as a count and percentage.

RESULTS

We sent the survey to 394 people during July through September 2022, including 242 alumni and 152 current fellows, and received 198 responses (50.3%). Of the 198 responses, 4 (2%) did not consent to voluntarily participate. [Table 1](#) shows demographics of the 194 respondents who consented. Participants mostly had male gender, white or Asian race, not Hispanic/Latinx, and 31–40 years old (at the time of answering the survey).

[Table 2](#) shows the background of the 194 participants. More than half (53.6%) of participants had a clinical specialty of internal medicine, pediatrics, or family medicine; only 5.2% had procedural specialties (eg, general surgery, urology, anesthesiology, radiation oncology). About 9% were completing additional clinical training (residency or fellowship) concurrently. A minority of participants had a career prior to medicine (21.6%). Nearly half (43.8%) had some informatics experience prior to CI fellowship (43.8%). Many participants recalled starting CI fellowship with career goals of becoming a chief medical informatics officer (CMIO) or hospital administrator, hybrid clinical care and informatics, and an academic or research career (48.9%).

[Table 3](#) shows fellowship experiences of the 106 respondents who, at the time of the survey, reported having a job finalized for the following year; nearly all were alumni though some current fellows were also included. Most of these participants completed at least one type of structured coursework during CI fellowship (87%). About two-thirds of these participants completed a Master's degree (most commonly a Masters in Biomedical Informatics or similar) and two-thirds completed a Certificate program; note, some of these participants completed both a degree and a certificate. The majority of participants noted exposure to the electronic health records (EHR) Epic (92.5%) and Cerner (56.6%) at some point (including careers before medicine, medical training, other clinical activities [moonlighting], or research). Nearly all fellows participated in many different types of activities during CI fellowship; 92.5% participated in 5–8 out of 8 activity categories (operations, research, coursework, quality improvement, clinical care, consulting/industry, teaching, other). Nearly all of the participants spent some time on research,

Table 1. Demographics

Category	Choices	N (%)
Gender	Male	121 (62.4%)
	Female	42 (21.6%)
	Did not respond	29 (14.9%)
	Other	2 (1.0%)
Race	White	76 (39.2%)
	Asian	60 (30.9%)
	Did not respond	31 (16.0%)
	Black	19 (9.8%)
	Other	8 (4.1%)
Hispanic/Latinx	No	159 (82.0%)
	Did not respond	31 (16.0%)
	Yes	4 (2.1%)
Age range	26–30	6 (3.1%)
	31–35	88 (45.4%)
	36–40	52 (26.8%)
	41–45	13 (6.7%)
	46+	7 (3.6%)
	Did not respond	28 (14.4%)
	Total	

clinical care, teaching, operations, coursework, and quality improvement. They spent the most time on operations ($n = 38$, 35.8%), research ($n = 16$, 15.1%), coursework ($n = 15$, 14.2%), and quality improvement ($n = 12$, 11.3%). These participants commonly led or significantly participated in the following types of projects during CI fellowship: data extraction from an EHR or building information technology (IT) systems, and EHR transition or Go Live of a digital product.

DISCUSSION

More than half of the 394 CI fellows and alumni responded to our voluntary and anonymous survey during the summer of 2022. This represents the most comprehensive study to date of CI fellows and alumni, though there is likely overlap in respondents from prior studies.^{7,8,13} This creates an assessment of the current state of CI fellowships and a baseline for future comparisons.

Our survey results demonstrate that although many fellows entered training with some experience, almost a third had minimal or no informatics background. This should serve as encouragement to medical students and residents who are curious about CI but do not see themselves as viable candidates for the specialty. Between the structured coursework available to nearly all fellows, and the broad set of activities and projects, the training can provide all one needs to launch an informatics career.

We also redemonstrate the underrepresentation of women and minorities in the field. While not dissimilar from other medical specialties, the need is perhaps more critical in CI. As we increasingly seek to use artificial intelligence to inform clinical care, a diverse workforce will only help to avoid the propagation of biased data and ensure responsible implementation of these tools.

Table 2. Background

Category	Choices	N (%)
Clinical specialty	Internal medicine	58 (29.9%)
	Pediatrics	31 (16.0%)
	Did not respond	30 (15.5%)
	Pathology	16 (8.2%)
	Family medicine	15 (7.7%)
	Emergency medicine	12 (6.2%)
	Other	10 (5.2%)
	Procedural specialties	10 (5.2%)
	Preventive medicine	8 (4.1%)
	Psychiatry	4 (2.1%)
Any careers before medicine?	No	97 (50.0%)
	Did not respond	55 (28.4%)
	Yes	42 (21.6%)
Any informatics experience before clinical informatics fellowship?	Yes	85 (43.8%)
	No or minimal	60 (30.9%)
	Did not respond	49 (25.3%)
Career goals at the beginning of clinical informatics fellowship?	Did not respond	62 (32.0%)
	CMIO or hospital administration	38 (19.6%)
	Hybrid clinical care and informatics	29 (14.9%)
	Academic or research	28 (14.4%)
	Industry, nonprofit, or nonclinical	14 (7.2%)
	Clinical care	11 (5.7%)
	Unsure	10 (5.2%)
	Other	2 (1.0%)
Total		194 (100%)

Informatics activities

Few fellows had careers before medicine, but nearly half reported some experience with informatics prior to CI training. This may be similar to the 44% of Bell et al's survey respondents who reported informatics-related experience prior to CI fellowship,⁷ with the same limitations of comparison mentioned above. The fact that a substantial proportion of CI fellows had no prior informatics experience should encourage people without informatics experience who are interested and considering applying to CI fellowship programs.

The most common aspirations at the beginning of CI fellowship were to take on the role of CMIO or a similar administrative leader, and to take on the dual roles of clinician and clinical informatician in academic or research careers. This aligns very well with the types of activities that fellows participated in during fellowship (operations, research, coursework, and quality improvement). It is encouraging that fellows were able to pursue activities during CI fellowship that directly supported their career goals. At the same time, nearly all CI fellows participated in many different types of informatics activities and had opportunities for both structured coursework and experiential learning through projects.^{15,16} It is essential that CI fellowships provide fellows with a broad-based informatics foundation and well-rounded educational experiences, regardless of career goals.^{2,3,17} Clinical informaticians do not all need to be experts at writing code to extract data from an EHR, or at building clinical decision support (CDS) tools in an EHR; but they do need to understand the process and potential strengths, weaknesses, and limitations

of different approaches, and to be able to fluently communicate with colleagues who know more or less about these processes.² Our results provide reassurance that CI fellowships seem to be fulfilling these missions. For example, although only 7% started CI fellowship with ambitions for a career in industry, a majority of fellows (76%) participated in some consulting or industry activities during fellowship and anecdotally, fellows' most common request to ACIF was for more exposure to industry. Fellows were not only exposed to a variety of projects, but they led or were significantly involved in many different types of projects. Less than 10% of participants led or were significantly involved in projects related to cybersecurity or information security, though it is unclear whether this was due to a lack of opportunities or fellows' interest. This is an area of need given the growing threat of cybercrime in the US healthcare industry and in hospitals in particular.¹⁸

Diversity

We found that the majority of CI fellows were males in their 30s and either white or of Asian descent. These findings are in keeping with Van Cain's prior survey of fellowship graduates¹⁰ as well as with publicly available data on CI applicants from the Electronic Residency Application System (ERAS)¹⁹ and prior studies by Bell et al.^{7,8}

Our racial distribution is similar to that of United States (US) allopathic medical school applicants and matriculants.²⁰ However, the gender distribution is different from all US medical students, with considerably fewer women in CI fellowships. One study has suggested women have more stable

Table 3. Fellowship experiences

Category	Choices	N (%)
Concurrent clinical training (residency or other fellowship)	No	96 (90.6%)
	Yes	9 (8.5%)
	Did not respond	1 (0.9%)
Structured coursework, including Master's degree, certificate, or other	Yes	94 (88.7%)
	No	12 (11.3%)
Master's degree	No	64 (60.4%)
	Yes	42 (39.6%)
Certificate	No	73 (68.9%)
	Yes	33 (31.1%)
Electronic health record (EHR) exposure	Epic	98 (92.0%)
	Cerner	60 (56.6%)
	CPRS	30 (28.3%)
	All Scripts	18 (17.0%)
	Meditech	17 (16.0%)
	Other	14 (13.2%)
Number of activity types (out of 8 categories: Operations, Research, Coursework, Quality improvement, Clinical care, Consulting/Industry, Teaching, Other)	8	22 (20.8%)
	7	43 (40.6%)
	6	21 (19.8%)
	5	12 (11.3%)
	4	3 (2.8%)
	3	2 (1.9%)
	2	2 (1.9%)
	1	0 (0.0%)
	0	1 (0.9%)
Activity	Research	100 (94.3%)
	Clinical care	97 (91.5%)
	Teaching	96 (90.6%)
	Operations	95 (89.6%)
	Coursework	92 (86.8%)
	Quality improvement	95 (89.6%)
	Consulting or industry	80 (75.5%)
	Other	30 (28.3%)
Project types	Data extraction from an EHR or building information technology (IT) systems	77 (72.6%)
	Implementing a CDS tool in an EHR	68 (64.2%)
	EHR transition or Go Live of a digital product	66 (62.3%)
	Resident or medical student education	48 (45.3%)
	Developing ML models	39 (36.8%)
	Developing an app or software	36 (34.0%)
	Health informatics policy or advocacy	29 (27.4%)
	Consulting or industry	25 (23.6%)
	Cybersecurity or information security	9 (8.5%)
	Other	8 (7.5%)
	Total	

preferences regarding planned medical specialties,²¹ which may indicate this gender disparity originates prior to medical school matriculation.

The CI community must continue to try to increase the diversity in CI. The National Academy of Medicine concluded that increasing the racial and ethnic diversity of healthcare professionals is associated with more equitable access to healthcare.²² This is even more important for CI because clinical informaticians can impact healthcare at the systems and population levels, magnifying both positive and negative

effects and can even cause unintended consequences.²³ The current Accreditation Council for Graduate Medical Education (ACGME) Common Program Requirements note the need to recruit and retain a diverse workforce of residents/fellows, faculty, and staff.²⁴ CI could consider trying to adapt strategies to close the gender gap in related fields, such as surgical specialties,²⁵ science, technology, engineering, and math (STEM)²⁶ and data science.²⁷

Internal medicine and pediatrics were the most well-represented specialties (45.9%) and very few were

proceduralists (5.2%). This may be more diverse than the previously mentioned results of Bell et al⁷ (54.5% internal medicine or pediatrics) and Van Cain and Hron¹⁰ (64.3%), but it is challenging to draw a meaningful conclusion with such small samples, different methods, and partially shared cohorts among these 3 studies. These specialties are dramatically over-represented in CI when compared to the 19.0% of total active US physicians in internal medicine and pediatrics according to the American Medical Association's 2021 Physician Masterfile. This may be related to the differential impact of the EHR on clinical work (less time spent using the EHR while in an operating room); time devoted in clinical training to gain and maintain procedural skills; and differences in physician specialty salaries. Training programs with significant time for research or quality improvement (QI) lend themselves well to incorporating informatics.

Limitations

Our study is limited by our overall response rate as well as the number of respondents who chose not to answer specific questions, especially with respect to gender, race and ethnicity. Still, our findings are comparable to previously published data on CI applicants and fellows. Unfortunately, because publicly available ERAS data are reported based on the residency review committee under which CI programs are accredited (eg, internal medicine-based programs separate from pediatrics-based programs), it is impossible to discern the demographics of the full applicant pool. Moreover, ERAS data represent applicants to CI programs and not those that matriculated successfully, further limiting our ability to compare the groups.

CONCLUSION

Our findings help establish a baseline of CI fellowship experiences and fellow diversity that can be used to measure change in the future. Physicians without prior informatics experience who are interested in CI should not feel discouraged from applying. CI fellowships provide a strong foundation of informatics knowledge while supporting each fellow's personal career goals. The CI community needs innovative strategies to recruit diverse applicants to the field in order to expand representation of women and underrepresented minorities in the workforce.

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AUTHOR CONTRIBUTIONS

All of the authors have had substantial contributions to the conception and design of the work; acquisition, analysis, or interpretation of data for the work; drafting and revising the manuscript for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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CONFLICT OF INTEREST STATEMENT

The authors do not have any competing interests to declare.

DATA AVAILABILITY

In order to preserve respondents' privacy, these data are only available to the study authors.

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