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Authors

Patel, Tushar N

Chaise, Aaron J

Hanna, John J

et al.

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Structure and Funding of Clinical Informatics Fellowships: A National Survey of Program Directors

Tushar N. Patel[1] Aaron J. Chaise[1] John J. Hanna[2] Kunal P. Patel[1] Karl M. Kochendorfer[1] Richard J. Medford[2] Dara E. Mize[3] Edward R. Melnick[4,5] Jonathan D. Hron[6,7] Kenneth Youens[8] Deepti Pandita[9] Michael G. Leu[10,11,12] Gregory A. Ator[13] Feliciano Yu[14] Nicholas Genes[15] Carrie K. Baker[16] Douglas S. Bell[17] Joshua M. Pevnick[18] Steven A. Conrad[19] Aarti R. Chandawarkar[20,21] Kendall M. Rogers[22] David C. Kaelber[23] Ila R. Singh[24] Bruce P. Levy[25] John T. Finnell[26] Joseph Kannry[27] Natalie M. Pageler[28] Vishnu Mohan[29] Christoph U. Lehmann[2]

[1] Department of Pathology, University of Illinois Chicago, Chicago, Illinois, United States
[2] Clinical Informatics Center, University of Texas Southwestern, Dallas, Texas, United States
[3] Departments of Biomedical Informatics and Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, United States
[4] Department of Emergency Medicine, Yale School of Medicine, New Haven, Connecticut, United States
[5] Department of Biostatistics (Health Informatics), Yale School of Public Health, New Haven, Connecticut, United States
[6] Division of General Pediatrics, Boston Children's Hospital, Boston, Massachusetts, United States
[7] Department of Pediatrics, Harvard Medical School, Boston, Massachusetts, United States
[8] Department of Pathology, Baylor Scott & White Health, Temple, Texas, United States
[9] Department of Internal Medicine, University of California, Irvine, California, United States
[10] Departments of Pediatrics and Biomedical Informatics and Medical Education, University of Washington, Seattle, Washington, United States
[11] Information Technology Services, UW Medicine, Seattle, WA, United States
[12] Information Technology Department, Seattle Children's Hospital, Seattle, WA, United States
[13] Department of Otolaryngology-Head and Neck Surgery and Clinical Informatics, University of Kansas Medical Center, Kansas City, Kansas, United States
[14] Department of Pediatrics, University of Arkansas for Medical Sciences, Little Rock, Arkansas, United States
[15] Ronald O. Perelman Department of Emergency Medicine, NYU Grossman School of Medicine, New York, New York, United States
[16] Department of Family Medicine, Kettering Health, Indu and Raj Soin Medical Center, Dayton, Ohio, United States
[17] Department of Medicine, David Geffen School of Medicine at University of California, Los Angeles, Los Angeles, California, United States
[18] Department of Medicine, Cedars-Sinai Health System, Los Angeles, California, United States
[19] Division of Clinical Informatics, Department of Medicine, LSU Health Shreveport, Shreveport, Louisiana, United States
[20] Division of Clinical Informatics, Nationwide Children's Hospital and The Ohio State, Columbus, Ohio, United States
[21] Department of Pediatrics, The Ohio State University College of Medicine, Columbus, Ohio, United States
[22] Division of Hospital Medicine, University of New Mexico Health Sciences Center, Albuquerque, New Mexico, United States
[23] Center for Clinical Informatics Research and Education, The MetroHealth System, and the Departments of Internal Medicine, Pediatrics, and Population and Quantitative Health Sciences, Case Western Reserve University, Cleveland, Ohio, United States
[24] Department of Pathology and Immunology, Baylor College of Medicine and Texas Children's Hospital, Houston, Texas, United States
[25] Division of Informatics, Geisinger Health System, Danville, Pennsylvania, United States
[26] Department of Emergency Medicine, Indiana University School of Medicine, Indianapolis, Indiana, United States
[27] Division of General Internal Medicine, Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, New York, United States
[28] Division of Clinical Informatics, Department of Pediatrics, Stanford University School of Medicine, Palo Alto, California, United States
[29] Department of Medical Informatics & Clinical Epidemiology, Oregon Health & Science University, Portland, Oregon, United States

Address for correspondence Tushar N. Patel, MD, Department of Pathology, University of Illinois at Chicago, 840 S Wood St, 130 CSN. Chicago, IL 60612, United States (e-mail: tpatel78@uic.edu).

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Abstract

Background In 2011, the American Board of Medical Specialties established clinical informatics (CI) as a subspecialty in medicine, jointly administered by the American Board of Pathology and the American Board of Preventive Medicine. Subsequently, many institutions created CI fellowship training programs to meet the growing need for

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- clinical informatics
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Georg Thieme Verlag KG,
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informaticists. Although many programs share similar features, there is considerable variation in program funding and administrative structures.

Objectives The aim of our study was to characterize CI fellowship program features, including governance structures, funding sources, and expenses.

Methods We created a cross-sectional online REDCap survey with 44 items requesting information on program administration, fellows, administrative support, funding sources, and expenses. We surveyed program directors of programs accredited by the Accreditation Council for Graduate Medical Education between 2014 and 2021.

Results We invited 54 program directors, of which 41 (76%) completed the survey. The average administrative support received was $27,732/year. Most programs (85.4%) were accredited to have two or more fellows per year. Programs were administratively housed under six departments: Internal Medicine (17; 41.5%), Pediatrics (7; 17.1%), Pathology (6; 14.6%), Family Medicine (6; 14.6%), Emergency Medicine (4; 9.8%), and Anesthesiology (1; 2.4%). Funding sources for CI fellowship program directors included: hospital or health systems (28.3%), clinical departments (28.3%), graduate medical education office (13.2%), biomedical informatics department (9.4%), hospital information technology (9.4%), research and grants (7.5%), and other sources (3.8%) that included philanthropy and external entities.

Conclusion CI fellowships have been established in leading academic and community health care systems across the country. Due to their unique training requirements, these programs require significant resources for education, administration, and recruitment. There continues to be considerable heterogeneity in funding models between programs. Our survey findings reinforce the need for reformed federal funding models for informatics practice and training.

- workforce
- ACGME
- fellowships and scholarships
- internships and residency
- medical informatics

Background and Significance

There is little doubt that clinical informatics (CI) brings tremendous value to the medical management of patients. By implementing design efficiencies and workflow improvements, informaticians can help streamline pre- and postclinical processes including chart review and completion, coding, and billing. These activities are essential for improved patient care and provider satisfaction, regulatory compliance, medicolegal risk mitigation, and reimbursement from payors. These benefits combined with the exponential growth in volume and complexity of medical knowledge and the resulting need to manage health care data and information through informatics have been recognized as drivers for health care organizations to train and recruit CI experts.[1] Despite these gains, training institutions are hesitant to allocate funding and structural support to these programs. The American Medical Informatics Association (AMIA) has worked closely with accrediting bodies to help meet the growing demand.[2] In 2011, the American Board of Medical Specialties announced the creation of CI as a subspecialty leading to board certification, available to physicians who hold, or are eligible, for primary specialty certification.[3] The first board examination in CI was administered in 2013 and the Accreditation Council for Graduate Medical Education (ACGME) accredited the first training programs in 2014.[4] As of 2020, approximately 2,018 physicians achieved board certification in CI through the practice pathway or fellowship certification.[5] The certification pathways are jointly administered by the American Board of Pathology (ABP) and the American Board of Preventive Medicine (ABPM). From an original cohort of four fellowship programs in CI, there were 59 accredited programs at the time of submitting this manuscript.

CI fellows engage in many activities throughout their training, including operational health care delivery (e.g., as a "builder" or "architect," serving on committees including governance, leading and participating on innovative projects), education of clinicians and learners, and on quality improvement and research projects. Despite the growth of fellowship programs, the funding of CI fellowship programs has been challenging. Obstacles to achieving more unified funding models include lack of awareness of CI practice and value, absence of reimbursable billing codes, and a paucity of data on revenue from services provided.[6] Despite calls to action for viable financial models to sustain CI fellowship programs, progress has been slow. Many programs establish CI fellowship programs by piecing together funding from a variety of sources, including hospital/health care system, university, industry, or charitable sources. This has led to significant heterogeneity in the funding frameworks upon which CI fellowship programs are built.

Objectives

To better characterize the governance and funding frameworks upon which CI fellowship programs rely, we created a national survey of ACGME-accredited CI fellowship programs. Survey results offer a cross-sectional assessment of the organizational and administrative structures, personnel resources, and income and expenses related to establishing and maintaining a fellowship program. Insight gathered from this analysis is intended to inform advocacy for reforming federal funding models for informatics training and practice. The analysis also provides valuable insight into the resources required to establish and maintain an ACGME-accredited CI fellowship program.

Methods

Participants

The target population for our survey were program directors of ACGME-accredited CI fellowship programs in the United States. We solicited program directors from all programs (at the time of the survey) that were accredited between 2014 and 2021. We identified potential participants from several sources, including the member list of the AMIA Academic Forum and programs listed in the ACGME Accreditation Data System. We excluded programs that were not ACGME accredited, or in the process of accreditation, to maintain a comparable cohort of programs that were bound by identical program requirements.

Program directors were contacted by email, asked to complete the survey, and were offered to participate in the development and publication of the resulting manuscript. One of the authors (C.U.L.) sent up to three reminder emails for completion of the survey.

Study Design, Survey Items, and Data Collection

The survey was a cross-sectional, online, English language survey accessible via a personalized and/or a public hyperlink. The survey included 24 general program information items followed by 4 items related to recruitment expenses, 9 administrative expense items, 6 items related to fellow expenses, and 1 open ended question allowing respondents to describe and/or clarify their program and expenses. The survey was designed to require 15 to 20 minutes to complete. All survey questions are provided in ►**Supplementary Appendix A** (available in online version). All expenditures were reported as annual expenditures in United States dollars. Expenses incurred over multiple years were asked to be reported after amortization. Study data were collected and managed using REDCap (Research Electronic Data Capture) tools hosted at the University of Texas Southwestern Medical Campus. REDCap is a secure, web-based software platform designed to support research data collection, providing (1) an intuitive interface for validated data capture; (2) audit trails for tracking data manipulation and export procedures; (3) automated export procedures for seamless data downloads to common statistical packages; and (4) procedures for data integration and interoperability with external sources.[7,8]

Results

Program Framework

We invited 54 eligible programs to participate. After three rounds of email reminders, 41 programs responded for a response rate of 75.9%. Programs that responded had been accredited between 2014 and 2021. Many programs had been accredited in 2015 or 2016 (16, 39%), with the first four receiving accreditation in 2014. Most programs (85.4%) were accredited for two or more fellows per year. There were six (14.6%) programs accredited for only one fellow per year, and four (9.7%) programs accredited for five or more fellows per year. On average, there were 5.2 accredited fellowship positions per program, and 2.9 fellows enrolled per program. Out of 210 accredited fellow positions available at the time of survey completion, 119 (56.7%) positions were filled, with 62 first-year fellows and 57 second-year fellows. At the time of survey completion, 16 (39%) programs filled their allotted number of first-year fellows, while three programs (7.3%), all of which were newly accredited in 2021, had not yet recruited any fellows. Twelve programs (29.3%) employed their full allotment of second-year fellows, while 11 (26.8%) had no second-year fellow. One program accredited for two second-year fellows, enrolled three (temporary increase). Another program enrolled five first-year fellows as a temporary increase from four regularly accredited positions.

CI fellowship programs can be administratively housed within different clinical departments. Programs were administratively housed under six clinical departments: Internal Medicine (17; 41.5%), Pediatrics (7; 17.1%), Pathology (6; 14.6%), Family Medicine (6; 14.6%), Emergency Medicine (4; 9.8%), and Anesthesiology (1; 2.4%; ►**Fig. 1**). The administrative clinical department matched the program director's primary specialty certification in most programs (30, 73.2%).

Program Directors

The percent effort assigned to program directors ranged from 10 to 80% with an average of 22.7% and a median of 20%. The most common (20, 48.8%) time allotment for program director percent effort was 20%, which is the ACGME-required minimum.[9] There were seven programs (17.1%) that allotted 10% effort for program directors. Three programs (7%) allotted 40% or more effort for the program director. Program director effort by ACGME approved complement varied substantially. For the 38 programs who had fellows at the time of the survey, the program director's effort per employed fellow ranged between 1.4 and 25% with a mean of 8.8%.

Most program directors held an academic rank of professor (18, 46.2%). Thirteen (33.3%) were associate professors, seven (17.9%) were assistant professors, and one (2.6%) was an instructor. Two programs from nonacademic organizations did not report the academic rank of the program director.

Internal Medicine physicians accounted for 14 (34.1%) program directors, whereas 11 (26.8%) were pediatricians. Emergency medicine physicians and pathologists were program directors for seven (17.1%) programs each. One program

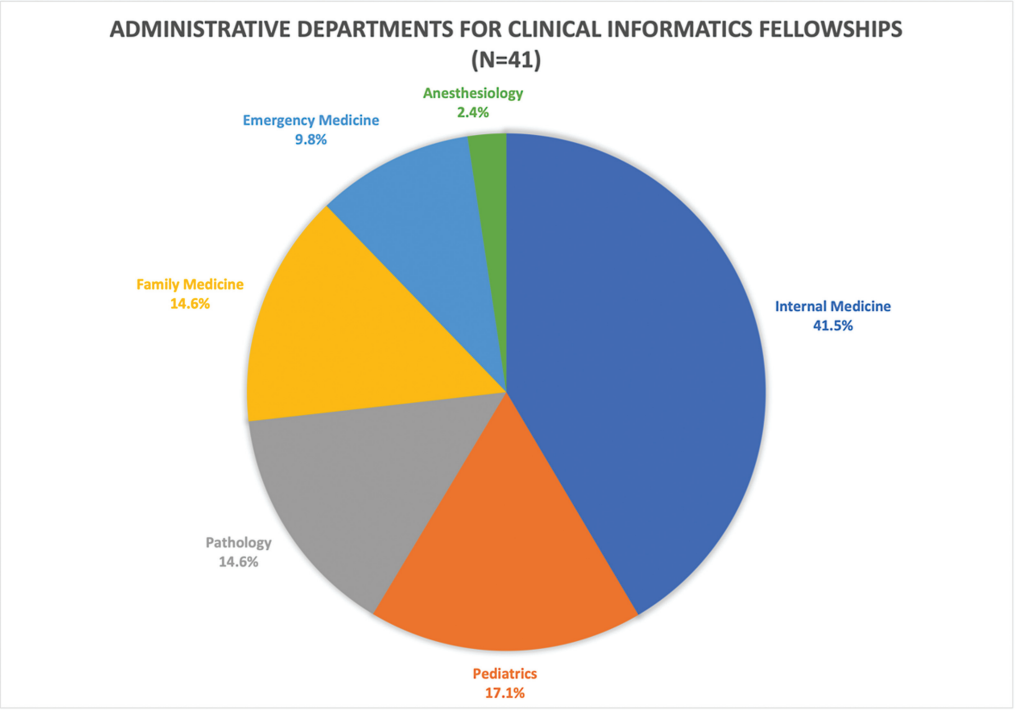

Fig. 1 Administrative Departments for Clinical Informatics fellowships.

director was an otolaryngologist and one a family medicine physician.

Program director salary is a significant expenditure for programs. Sources of funding for program director salary were heterogeneous, suggesting need for multiple institutional stakeholders. Funding sources for CI fellowship program directors included: hospital or health systems (28.3%), clinical departments (28.3%), graduate medical education (GME) office (13.2%), biomedical informatics department (9.4%), hospital information technology (IT; 9.4%), research and grants (7.5%), and other sources (3.8%) that included philanthropy and external entities (►Fig. 2).

Associate Program Directors

Thirty-two programs (78%) had at least one associate program director. Four programs (9.8%) had three associate program directors, 9 (22%) had two associate program directors, and 19 programs (46.3%) had one associate program director adding up to a total of 49 associate program directors for 41 programs (1.2 associate program directors per program). Associate program directors varied in seniority: 3 (6.1%) associate program directors had no academic title provided, 2 (4.1%) associate program directors were instructors, 19 (38.8%) were assistant professors, 14 (28.6%) were associate professors, and 11 (22.4%) were professors. The percentage effort allocated to associate program directors ranged from 0 to 25%, with a mean of 6.2%. For associate program directors with nonzero percent effort allocated, the average was 7.2%. Our survey did not specifically separate or request data on assistant program directors, and we recognize that they play an important role in programs.

Program Coordinators

The amount of effort allocated for program coordinators ranged from 0 to 100% with a mean of 35.9% and a median of 33%. Most commonly (12, 29.2%), programs dedicated 50% of the coordinator's time toward program administration. The ACGME required minimum for program coordinator support is 30%, with additional aggregate effort increasing as the number of approved fellow positions increases (up to 80% minimum effort for >12 fellows).[9]

Clinical Informatics Fellows

Three programs (7.3%) did not require fellows to work clinically in their primary medical specialty. Of these three programs that did not have a clinical practice requirement, two programs allowed fellows to moonlight and add the associated compensation to their salaries. Among the 38 programs with a clinical practice requirement in the primary specialty, 26 programs (68.4%) allowed their fellows to bill for clinical practice in their primary specialty. This significant proportion reflects the need for programs to sustain viability through reimbursement income and not just institutional support. Fellow salaries are one of the largest expenses for most programs and careful consideration needs to be given to program sustainability. As different subspecialties have different levels of reimbursement, some fellows may not adequately subsidize their salaries at the current 20% independent clinical effort cap by ACGME.

Programs utilized a variety of tools and resources to recruit fellows. Twenty-four (58.5%) programs used online media or a Web site, 13 (31.7%) used a flyer, 11 (26.8%) programs used a booth at the AMIA or another conference, 8 (19.5%) used advertisement on X (formerly Twitter), 2 (4.9%)

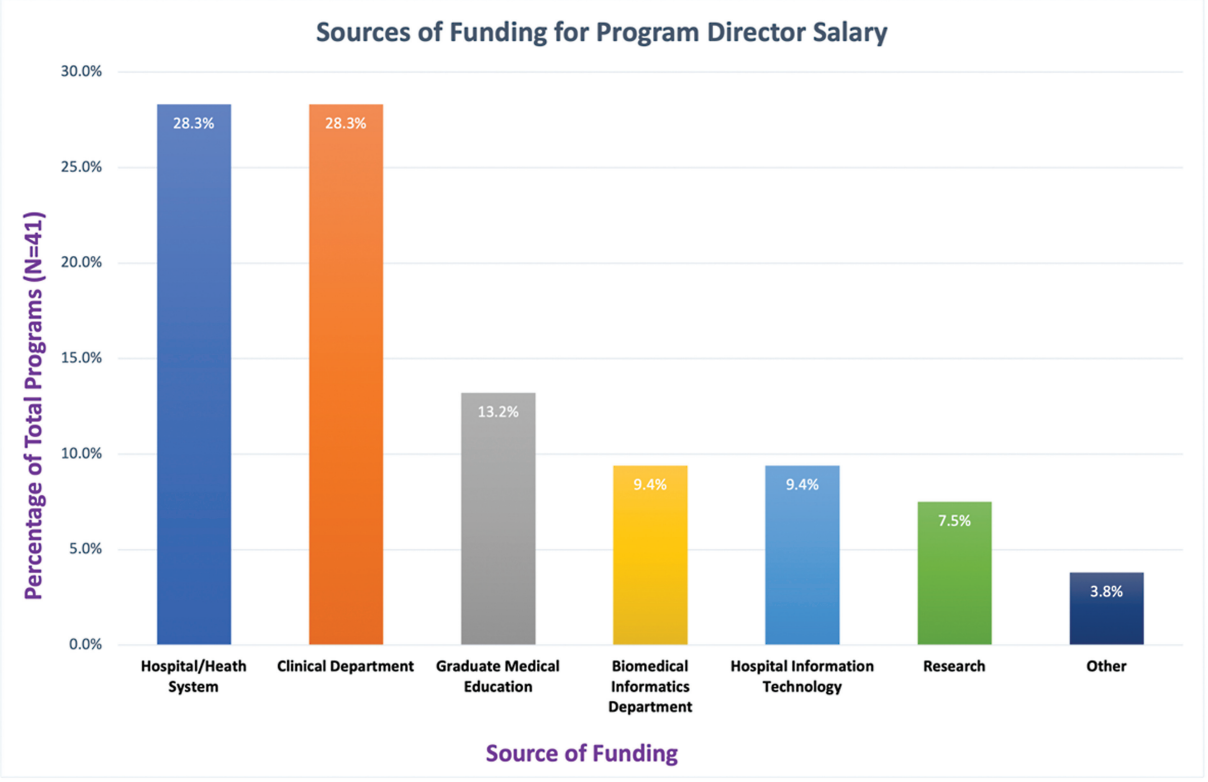

Fig. 2 Sources of funding for CI program director salary.

used advertisement on Facebook, 2 (4.9%) used advertisement in print media, 2 (4.9%) used giveaways, 1 (2.4%) used advertisement on Instagram, 8 (19.5%) reported other approaches. Other approaches included: local/regional outreach efforts, resident-specific informatics rotations, collaborations with other departments to create "combined fellowship" offerings, outreach via graduates of the program, advertisement in the resident IT committee, panel presentation at a national meeting (American Academy of Pediatrics), webinars, email announcements, posting on the AMIA Web site, and word of mouth.

Of the responding programs, 38 (95%) reported that they followed the GME salary range based on the postgraduate year (PGY) level. One program did not respond, and two indicated that they were not following the recommended salary range. For PGY4 fellows, the salaries ranged from $60,616 to $85,821 with a mean of $70,153. For PGY5 fellows the salaries ranged from $62,457 to $91,208 with a mean of $73,091.

Administrative Support

Of 41 responding programs, five provided no answer to the question of how much financial support the program received from other departments, centers, divisions, or dean's offices outside of their home department, for program administration. The average support for the remaining 36 programs was $28,732 (ranging from $0 to $150,000), and the median was $3,250. Seventeen (41%) programs indicated receiving no financial support from outside of their clinical home department. At least one program supported a subset of their fellow's Master's degree program through a National Library of Medicine T15 training grant.

Annual Program Expenditures

Annual program expenditures are displayed in ►Table 1 and vary considerably in amount and type across programs. Certain expenditures are relatively unique to the inherent structure of CI fellowships, in contrast to traditional clinical fellowships. These include membership to the AMIA Academic Forum, attending vendor-sponsored electronic health record (EHR) training events, and provisioning of graduate-level coursework for the fellows. Educational programs, including graduate programs, were reported to have considerable annual expense, ranging from $400 to $112,000 and averaging $25,070. We did not collect data on the number of programs offering a Master's degree as part of the fellowship. AMIA Academic Forum membership ($3,000), which is needed for participation in the CI fellowship match, was reported by only 31 programs. Conference travel was also an important and significant component of fellowship program annual expenditures, ranging from $1,000 to $44,384. One program incurred $9,000/year for "data access services" related to their program, which further highlights the unique costs associated with CI fellowship programs.

Discussion

Our findings on the current landscape of ACGME-accredited CI fellowship programs reflect data from 76% of programs. Early experiences by the initial cohort of four ACGME-

Table 1 Annual programs expenditures

CI fellowship expense	Programs with no expenditure (%)	Programs with expenditure (%)	Minimum expenditure	Maximum expenditure	Average expenditure for programs with expenditure
Fellow relocation	36 (87.8%)	5 (12.2%)	$1,000	$17,400	$6,480
Team-building events including dinners or lunches	7 (17.1%)	34 (82.9%)	$300	$9,600	$1,903
Graduation (gifts and food)	32 (78%)	9 (22%)	$150	$2,000	$1,089
New program director office space	40 (97.6%)	1 (2.4%)	$15,000	$15,000	$15,000
Office supplies	25 (61%)	16 (39%)	$50	$3,600	$694
New computers for Program Director, Associate Program Director, and Program Coordinator	33 (80.5%)	8 (19.5%)	$250	$3,000	$1,659
New computers for fellows	8 (19.5%)	33 (80.5%)	$500	$9,500	$3,386
Certification fees (e.g., state licensure, maintenance of certification, DEA licensure)	23 (56.1%)	18 (43.9%)	$500	$8,000	$2,469
AMIA's Academic Forum membership	10 (24.4%)	31 (75.6%)	$200	$3,000	$1,782
External speakers	33 (80.5%)	8 (19.5%)	$100	$12,000	$5,263
Board preparation for fellows	18 (43.9%)	23 (56.1%)	$500	$6,350	$2,115
Electronic health record training (e.g., attending vendor events)	14 (34.1%)	27 (65.9%)	$500	$10,000	$2,973
Educational programs (e.g., MS)	13 (31.7%)	28 (68.3%)	$400	$112,000	$25,070
Educational conferences (including travel)	3 (7.3%)	38 (92.7%)	$1,000	$44,384	$6,400
Books, journals, open access fees	17 (41.5%)	24 (58.5%)	$100	$3,000	$900
Professional society memberships	17 (41.5%)	24 (58.5%)	$50	$18,960	$1,224
Office space for fellows	40 (97.6%)	1 (2.4%)	$500	$500	$500

accredited CI fellowship programs foretold funding challenges, which were also found in the present survey.[4] Palma et al described the early experiences of combined fellowship training in CI, which also found funding sources to be "quite varied."[10] Other authors have characterized the applicant pool to CI fellowships, or graduating fellows, neither of which our study addressed.[11,12] Our study also found wide variability between responding programs. Programs were supported by multiple sources including: hospitals and health care system administration (non-IT), clinical departments, GME office, biomedical informatics department, health IT departments, research funding or grants, and other sources such as philanthropic or external organizations. In addition, most (68.4%) programs continue to rely on revenue from billing for clinical services provided by CI fellows in their primary specialty. The minority of programs that do not bill for fellows' services may potentially be concerned about Centers for Medicare and Medicaid Services (CMS) penalties, demonstrating a need for CMS to issue guidance on this practice.[6] Our findings suggest that funding challenges reported in the past have not been rectified, jeopardizing the long-term sustainability for CI training programs.[13] These persistent challenges include heterogeneous and often unstable funding sources, and lack reimbursement mechanisms for informatics services by payors. In part, the heterogeneity of funding sources reflects the various domains in which CI fellows work within, and the stakeholders that are invested in their training. Managing a CI Fellowship program with many stakeholders and funding sources can be very challenging. Identifying a few key and consistent sources of funding may help with the administration and long-term sustainability of the programs.

Although CI fellowship programs are accredited by one organization and adhere to one set of requirements, their funding and organizational structures vary considerably. Funding sources and expenses vary in type and size dramatically across programs, making the CI training ground uneven and presenting challenges for fellowship candidates to choose the best program for their needs. This has led to a greater focus on recruitment, with programs devoting considerable resources to securing interest from a limited pool of potential applicants.

The survey results suggest a large percentage of CI program positions (43.3%) remained unfilled. Programs must actively recruit fellows, even though a significant CI workforce is needed.[14,15] Some authors have suggested that the ABPM and the ABP's repeated extension of the "practice pathway" to board certification may have contributed to this development.[16] There

are likely other factors at play as well. Although AMIA and other professional societies have made strong progress on highlighting CI as a subspecialty, residents may still under recognize the field as a career option. Interested practicing physicians may also find it difficult to pursue a 2-year fellowship due to significant opportunity cost. Finally, some programs may intentionally underfill positions due to temporary funding constraints or lack of educational or faculty resources for a given recruitment cycle.

Program directors on average had more senior positions than associate program directors—generally holding Associate or full Professor positions (79%), likely reflecting the degree of experience required to establish, build, or maintain a comprehensive curriculum, and recruit and mentor fellows. Nearly 75% of programs had a program director from the clinical department that was administering the program, suggesting that internal support for this position is important to home departments. Effort for program directors varied greatly from 10 to 80% effort. A possible factor for this wide range is the variance in effort needed to build a new program, versus maintain a stable one—the former naturally requiring more time. This heterogeneity may also decrease with clearer guidance from the ACGME on minimum effort requirements for program directors (associate program directors and other core faculty) that went into effect in 2022.[9] It is also important to keep in mind that listed percent effort may be different than actual percent effort expended, due to differing accounting practices at institutions.

Program coordinators also play an important role in managing the complexities inherent to CI fellowships. Our survey indicates that most programs (85%) secured between 20 and 50% FTE for program coordinators, with ranges from 15 to 100%. Programs are frequently required to establish intramural and extramural learning experiences for fellows, which may require considerable cost and administrative effort. In addition, and particularly important to CI fellowships, program coordinators help manage the procurement and maintenance of diverse funding sources. The importance of a strong administrative leadership team for fellowship program management cannot be overstated.

Despite these challenges, the number of CI fellowship programs continues to increase and these programs continue to develop their training programs for physicians interested in leading digitally enabled health care. Programs continue to innovate their training models, in response to applicant needs. An example includes the rise of combined/integrated training experiences that incorporate concurrent training with other medical fellowships.[10] In 2016, the ABP approved allowing "a trainee to complete the 24 months of ACGME-required training in CI concurrently with another 12-month fellowship in a pathology discipline, completed over the same 24 months."[17] This change reduces overall training time, making additional CI training more attractive for pathologists. In the disciplines certified by the ABPM, concurrent training proposals are reviewed on a case-by-case basis and available to a narrow set of specialties. CI training may be more attractive to these subspecialists if combined fellowship pathways were preapproved as in pathology. Alternative models of CI fellowship training have also been proposed, including hybrid training pathways that embrace remote learning with supervised local experiences, and models that would include CI fellows paying for their own training.[18]

More recently, the AMIA-sponsored Community of CI Program Directors (CIPD) created a national match algorithm and platform that facilitated more seamless and impartial placement of CI fellows into the growing number of programs. To help mitigate limited resources and faculty expertise within many institutions, the CIPD community and AMIA have also created a shared, online didactic series. The pathology informatics community created a similar shared education model through the Pathology Informatics Education Resource.[19]

These developments in CI education represent the hard work and commitment from a collaborative community of fellowship programs, with strong professional society sponsorship. With a growing number of programs hoping to meet the need for training future leaders within health care, it is imperative for governmental, academic, and health care institutions to work together to identify sustainable funding models for CI fellowship programs. Our analysis demonstrates the continued challenges from both established and new programs in piecing together and consistently maintaining adequate funding for their programs. Stable funding is a necessity in an environment where the value of physician informaticians is not yet fully recognized.[20,21] Exceptionally trained physician informaticians have a distinct and important role to play with our allied health professional informatics colleagues. As health care institutions move toward value-based care and away from fee-for-service, our findings reflect a commensurate need for physician informaticians, which could manifest as changes to reimbursement models.

Limitations

There are several study limitations that require discussion. The study was conducted via an online survey, which may be subject to response bias, although it is likely representative given the response rate of 76%. Constructing clear questions that elicit accurate and precise answers from respondents is also challenging when using online surveys. We attempted to mitigate this by having the questions reviewed by multiple authors for clarity. Nonetheless, in reviewing the survey responses, it is apparent that some of the questions might have been ambiguous given answer variability. Funding and expenses can be fluid and dynamic, and our survey may not capture all the categories. In addition, this study represents a cross-section of current CI fellowship frameworks. Many programs evolve and adapt their frameworks to meet changing institutional resources; these progressive changes cannot be captured with a static survey. Finally, we included a question that allowed for narrative response to describe or clarify their program frameworks if not adequately captured by the questions. While this benefited data collection, there is a risk of transforming the qualitative data into discrete categories that are open to subjectivity.

Conclusion

CI fellowship programs continue to grow in an increasingly digital and multidisciplinary practice environment that is focused on improving patient experience, patient outcomes, clinician well-being, health equity, and decreasing costs.[22] Programs have been established across the country in leading academic and community health care systems. Both new and growing programs require considerable resources, including committed leadership and administration, qualified faculty, and stable funding. The need for stable funding arises from the inherent uniqueness of CI training, which often incorporate graduate studies, technical resources (e.g., laptops, offices, etc.), professional society membership, EHR training courses that often require travel, and travel to conferences. These training costs are not fully offset by revenue streams from the 20% allowable practice component or in reimbursable care available in primary medical specialties. Individual CI fellowship programs continue to work toward more uniform and sustainable funding models. These efforts would be aided by increased health care system recognition of the value provided by informaticians and mechanisms to bill for informatics service work by governmental and private payors.[6]

Clinical Relevance Statement

CI represents a growing subspecialty poised to address the challenges of training physicians prepared for the evolving landscape in health care, which has increasing informatics needs and opportunities. ACGME-accredited CI fellowship programs serve as the gold standard training pathway for board-certified clinical informaticians. Our findings show that the continued success of these programs requires significant resources and coordinated advocacy for sustainable funding models.

Protection of Human and Animal Subjects

The study was performed in compliance with the World Medical Association Declaration of Helsinki on Ethical Principles for Medical Research Involving Human Subjects and was reviewed by University of Illinois at Chicago Institutional Review Board (#STUDY2023-1465).

Multiple-Choice Questions

1. The most common clinical department/specialty under which CI fellowship programs are administratively housed is:
   a. Pathology
   b. Emergency Medicine
   c. Pediatrics
   d. Internal Medicine

   Correct Answer: The correct answer is option d. Internal medicine departments serve as the administrative clinical department for 41.5% of CI fellowships.

2. Which of the following program curricular components represents the largest average expenditure for CI fellowship programs?
   a. External speakers
   b. Board preparation course
   c. Educational programs
   d. Books

   Correct Answer: The correct answer is option c. Educational programs represent one of the largest expenditures for programs that integrate them into the curriculum. This includes graduate courses, including a full Master's degree.

3. Which of the following represents a significant source of funding for the CI fellowship program director salary?
   a. Clinical departments
   b. Centers for Medicare and Medicaid Services
   c. AMIA
   d. Health care startups

   Correct Answer: The correct answer is option a. Clinical departments represent a significant funding source for program director salary. In addition, the hospital/health care system, GME office, biomedical informatics department, hospital IT department, and research and grants served as significant sources of funding.

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Conflict of Interest
None declared.

References

1 Kannry J, Sengstack P, Thyvalikakath TP, et al. The Chief Clinical Informatics Officer (CCIO): AMIA Task Force report on CCIO knowledge, education, and skillset requirements. Appl Clin Inform 2016;7(01):143–176
2 Safran C, Shabot MM, Munger BS, et al; AMIA Board of Directors. Program requirements for fellowship education in the subspecialty of clinical informatics. J Am Med Inform Assoc 2009;16(02):158–166
3 Lehmann CU, Gundlapalli AV, Williamson JJ, et al. Five Years of Clinical Informatics Board Certification for Physicians in the United States of America. Yearb Med Inform 2018;27(01):237–242
4 Longhurst CA, Pageler NM, Palma JP, et al. Early experiences of accredited clinical informatics fellowships. J Am Med Inform Assoc 2016;23(04):829–834
5 Desai S, Mostaghimi A, Nambudiri VE. Clinical informatics subspecialists: characterizing a novel evolving workforce. J Am Med Inform Assoc 2020;27(11):1711–1715
6 Lehmann CU, Longhurst CA, Hersh W, et al. Clinical Informatics Fellowship Programs: In search of a viable financial model: an open letter to the Centers for Medicare and Medicaid Services. Appl Clin Inform 2015;6(02):267–270

7 Harris PA, Taylor R, Minor BL, et al; REDCap Consortium. The REDCap consortium: building an international community of software platform partners. J Biomed Inform 2019;95:103208
8 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42(02):377–381
9 ACGME Program Requirements for Graduate Medical Education in Clinical Informatics. Accessed November 01, 2023 at: https://www.acgme.org/globalassets/pfassets/programrequirements/381_clinicalinformatics_2023.pdf
10 Palma JP, Hron JD, Luberti AA. Early experiences with combined fellowship training in clinical informatics. J Am Med Inform Assoc 2020;27(05):788–792
11 Bell DS, Baldwin K, Bell EJ, et al. Characteristics of the National Applicant Pool for Clinical Informatics Fellowships (2016–2017). AMIA Annu Symp Proc 2018;2018:225–231
12 Kim E, Van Cain M, Hron J. Survey of clinical informatics fellows graduating 2016-2024: experiences before and during fellowship. J Am Med Inform Assoc 2023;30(10):1608–1613
13 Kannry J, Smith J, Mohan V, Levy B, Finnell J, Lehmann CUClinical Informatics Program Directors Group-AMIA. Policy statement on clinical informatics fellowships and the future of informatics-driven medicine. Appl Clin Inform 2020;11(05):710–713
14 Bichel-Findlay J, Koch S, Mantas J, et al. Recommendations of the international medical informatics association (IMIA) on education in biomedical and health informatics: second revision. Int J Med Inform 2023;170:104908
15 Fridsma DB. Developing the health informatics workforce of the future: academic and industry partners. J Am Med Inform Assoc 2017;24(03):677–678
16 Turer RW, Levy BP, Hron JD, et al. An open letter arguing for closure of the practice pathway for clinical informatics medical subspecialty certification. Appl Clin Inform 2022;13(01):301–303
17 Johnson R. The American Board of Pathology examiner. 2016 Accessed January 25, 2024 at: https://abpath.org/wp-content/uploads/2023/11/2016_ABPExaminer.pdf/
18 Hersh WR. The clinical informatics practice pathway should be maintained for now but transformed into an alternative to in-place fellowships. Appl Clin Inform 2022;13(02):398–399
19 Henricks WH, Karcher DS, Harrison JH Jr, et al. Pathology informatics essentials for residents: a flexible informatics curriculum linked to Accreditation Council for Graduate Medical Education milestones. Arch Pathol Lab Med 2017;141(01):113–124
20 Payne TH. The value of medical informatics expertise to health care organizations. Ann Saudi Med 1995;15(03):203–204
21 Zhao J, Forsythe R, Langerman A, Melton GB, Schneider DF, Jackson GP. The value of the surgeon informatician. J Surg Res 2020;252:264–271
22 Nundy S, Cooper LA, Mate KS. The quintuple aim for health care improvement: a new imperative to advance health equity. JAMA 2022;327(06):521–522