

Early experiences of accredited clinical informatics fellowships

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Christopher A Longhurst¹, Natalie M Pageler¹, Jonathan P Palma¹, John T Finnell², Bruce P Levy³, Thomas R Yackel⁴, Vishnu Mohan⁴ and William R Hersh⁴



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ABSTRACT

Since the launch of the clinical informatics subspecialty for physicians in 2013, over 1100 physicians have used the practice and education pathways to become board-certified in clinical informatics. Starting in 2018, only physicians who have completed a 2-year clinical informatics fellowship program accredited by the Accreditation Council on Graduate Medical Education will be eligible to take the board exam. The purpose of this viewpoint piece is to describe the collective experience of the first four programs accredited by the Accreditation Council on Graduate Medical Education and to share lessons learned in developing new fellowship programs in this novel medical subspecialty.

INTRODUCTION

In the fall of 2013, the nation's first group of physicians became board-certified in the new subspecialty of clinical informatics, which was recognized by the American Board of Medical Specialties in 2011. These physicians were eligible to take the board exam based on either the practice pathway (3 years of practice with 25% clinical informatics work) or the non-traditional fellowship (approved fellowships) or education (MS or PhD programs) pathway. The board exam tested core content for this new subspecialty,¹ and in 2013, 456 physicians became subspecialty certified by either the American Board of Preventive Medicine (ABPM) (432 diplomates) or the American Board of Pathology (ABP) (24 diplomates).² In 2014, another 331 physicians passed the board exam to become certified (306 by ABPM and 25 by ABP), and in 2015, another 320 physicians passed (303 by ABPM and 17 by ABP), raising the total to 1105 physicians who are clinical informatics subspecialty certified as of January, 2016.

Starting in 2018, physicians will no longer be able to obtain board eligibility for the clinical informatics subspecialty through the practice and education pathways, and only physicians who have completed a 2-year clinical informatics fellowship program accredited by the Accreditation Council on Graduate Medical Education (ACGME) will be eligible to take the board exam to be certified in the subspecialty. Draft recommendations for formal fellowship training requirements were first published in 2009,³ and final requirements were published by the ACGME in early 2014.⁴

The purpose of this viewpoint piece is to describe the collective experience of the only four clinical informatics fellowship programs accredited by the ACGME in 2014 (also the first such programs to be accredited), and to share lessons learned in developing new fellowship programs in this non-traditional subspecialty.

OVERVIEW OF ACCREDITED PROGRAMS

A brief description of each of the four clinical informatics fellowship programs accredited in 2014 follows, and details are summarized in Table 1.

Stanford University

Stanford University has a long tradition of biomedical informatics (BMI) training, dating to National Library of Medicine (NLM)-funded MS and

PhD programs launched in the early 1980s.⁵ More recently, clinical faculty at the Stanford-affiliated Lucile Packard Children's Hospital have contributed substantial scholarship in applied clinical informatics in close partnership with the hospital's Center for Quality and Clinical Effectiveness.^{6–8} The clinical informatics department has hosted elective rotations for residents for the last decade, and faculty members have supervised several clinical fellows from other subspecialties who have informatics-focused scholarship. With funding support from an unrestricted philanthropic grant from Hewlett Packard, three clinical faculty members with formal postgraduate training in medical informatics (C.A.L.), BMI (J.P.P.), and medical education (N.M.P.) received approval from Stanford University's graduate medical education (GME) committee in the fall of 2013 to found the clinical informatics fellowship program. The program launched with two fellows on July 1, 2014, received initial ACGME accreditation from the Pediatrics Residency Review Committee (RRC) 2 weeks later, and accepted another two fellows who started the program on July 1, 2015.

The Stanford University fellowship program is structured to prepare graduates for careers in both healthcare delivery and industry. The fellowship begins with three core rotations of 8 weeks each in the three information technology departments at Stanford Children's Health, Stanford Health Care, and the Stanford University School of Medicine. Following these core rotations, project-based elective opportunities include rotations through other healthcare delivery settings (eg, Sutter Health, Santa Clara Valley Medical Center, Veterans Affairs [VA] Palo Alto) as well as industry experiences (eg, Doximity, HP Labs, and Accenture). Fellows also participate in the NLM-funded BMI training program by attending the annual retreat, participating as facilitators in a clinical informatics seminar course, and engaging in project-based collaborations.

Oregon Health & Science University

The Oregon Health & Science University (OHSU) clinical informatics fellowship program received ACGME accreditation from the Internal Medicine RRC in the fall of 2014, and its first two fellows started in July 2015. The OHSU clinical informatics fellowship is part of the larger family of OHSU BMI educational offerings and was not a replacement for any existing programs. OHSU continues to offer its nearly two decades-old graduate program in BMI (Graduate Certificate, two master's degrees, and a PhD degree) as well as other

Correspondence to Christopher A Longhurst, Department of Biomedical Informatics, University of California, San Diego (formerly at Stanford University). For numbered affiliations see end of article.

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Table 1: Summary of first four accredited clinical informatics fellowship programs

Program	Founding leadership	ACGME accreditation	Launched (first fellows)	No. of fellows/year	Sponsoring residency program
Stanford University	Christopher A Longhurst (PD)	July 2014	2014	2	Pediatrics
	Natalie M Pageler (APD)				
	Jonathan P Palma (APD)				
OHSU	William R Hersh (PD)	September 2014	2015	2–4	Internal medicine
	Vishnu Mohan (APD)				
	Thomas R Yackel (APD)				
UIC	Bruce P Levy (PD)	September 2014	2015	2	Pathology
Regenstrief Institute	John T Finnell (PD)	October 2014	2015	2	Emergency medicine

ACGME, Accreditation Council on Graduate Medical Education; APD, associate program director; OHSU, Oregon Health & Science University; PD, program director; UIC, University of Illinois at Chicago.

See <https://www.amia.org/programs/academic-forum/clinical-informatics-fellowships> for the current list of all ACGME-accredited clinical informatics fellowship programs and links to individual program websites.

research fellowships, including the program funded by NLM since 1992.⁹ OHSU also has a long history of providing BMI education via distance learning, with many physicians using the online Graduate Certificate and master's programs to successfully launch careers in clinical informatics.

The OHSU fellowship is structured as a clinical fellowship, with fellows working through various rotations in different healthcare settings at the OHSU Hospital and Clinics and the Portland VA Medical Center. Fellows also take courses in the OHSU BMI Graduate Program that aim to provide them with the knowledge base of the field and prepare them for the board certification exam at the end of their fellowship. In their second year, fellows undertake research as well as quality improvement projects. Throughout the fellowship, fellows participate in weekly meetings of trainees in all fellowship programs (including NLM) as well as monthly journal clubs.

The Regenstrief Institute

The Regenstrief Institute has a long and distinguished history of research in BMI and healthcare. It has been recognized for its role in improving quality of care, increasing the efficiency of healthcare delivery, preventing medical errors, and enhancing patient safety. Established in 1969 by philanthropist Sam Regenstrief, the Institute is a 501(c)(3) non-profit organization closely associated with the Indiana University School of Medicine and Eskenazi Health (formerly Wishard Memorial Hospital), Indianapolis's public teaching hospital and safety net health system.

The Regenstrief Institute has three training tracks for those interested in a career in BMI. The first track is for those seeking an academic career and has an emphasis on scholarly projects. The second track is a pharmacology-epidemiology program that emphasizes drug safety, medication delivery, and the epidemiology of assessing and enhancing medication compliance using informatics tools. The third track is the clinical informatics fellowship program that was ACGME-accredited in 2014. This new fellowship arose from the existing BMI academic track and is based at two separate and distinct hospital systems: Eskenazi Health, which focuses on the vulnerable urban residents of Marion County, Indiana, and Indiana University Health, which is a large healthcare delivery system, with 19 separate hospitals spread across Indiana. The Regenstrief Institute clinical informatics fellowship program received ACGME accreditation from the

Emergency Medicine RRC in the fall of 2014. Clinical informatics fellows rotate with the Indiana Health Information Exchange, the Marion County Health Department, and the Family and Social Services Administration for the State of Indiana. Fellows complete a certificate in health informatics as part of their required coursework.

The University of Illinois at Chicago

The University of Illinois at Chicago (UIC) has a long history of leadership in BMI education, with the first Commission on Accreditation for Health Informatics and Information Management Education-accredited online graduate program, the first program to focus on the organizational and social issues impacting health informatics, and (now) one of the first ACGME-accredited fellowships in clinical informatics. A group of clinical informaticians from a variety of medical specialties (family medicine, internal medicine, pathology, and pediatrics), collaborating with UIC's Department of Biomedical and Health Information Sciences (BHIS), submitted an application to ACGME in the spring of 2014 and received accreditation through the Pathology RRC in September 2014. The program's first fellows started in 2015.

The UIC fellowship is geared towards physicians looking to practice clinical informatics full-time or in combination with practicing medicine. As such, its primary training focus is on the operations of a clinical informatics department. The fellowship also includes research options, and the fellows have opportunities to work closely with graduate students in the BHIS Department on a variety of projects.

The UIC program currently has three fellows. One is following the standard clinical informatics program track. The other two are pursuing a specially designed 2-year hybrid fellowship in clinical informatics and surgical pathology as a proof-of-concept for blended programs. In September 2015, ABP formally approved concurrent training for fellows to do an ACGME-approved clinical informatics fellowship with another 1-year pathology fellowship, spread out part-time over the same 2 years as the clinical informatics training. These fellows will be eligible for board certification in clinical informatics and a subspecialty of pathology. It should be noted that the capability to create this dual track is unique to ABP as a co-sponsor of the clinical informatics subspecialty. Creating similar concurrent training opportunities in other specialties would require collaboration between ABPM and the appropriate clinical board. At this time, the fellows participating in UIC's

blended clinical informatics/surgical pathology fellowship program are integrating and progressing well in both aspects of the fellowship.

LESSONS LEARNED, 2013–2015

We have divided our lessons learned into five general categories: funding, didactics, experiential rotations, longitudinal experiences and scholarship expectations, alignment with health system leadership, and the ACGME accreditation process.

Funding

A major challenge for all four programs has been to secure the funding necessary to launch a fellowship program. Clearly, educational programs that generate revenue (eg, through tuition from students, clinical revenues, and/or training grants) are more appealing to financially challenged academic medical centers than fellowships funded through health system revenues. For clinical informatics subspecialty fellows, all of whom are board-eligible or board-certified in a primary specialty, this creates a potential opportunity to fund fellowship salaries with their own clinical work, which is the case at the Regenstrief Institute and UIC. Unfortunately, institutional interpretations of Center for Medicare and Medicaid Services (CMS) billing guidelines at Stanford University, OHSU, and many other programs prohibit GME trainees from billing for clinical services. This prevents clinical informatics subspecialty fellows, who are board-eligible or board-certified in a primary specialty, from billing in that specialty without oversight from an attending physician. A clarification from CMS that these subspecialty fellows are approved to submit claims in their primary specialty would help tremendously from a funding standpoint and would carry the additional benefit of allowing these doctors to autonomously deliver healthcare services within the systems they are working to improve. An open letter to CMS requesting this clarification was recently published, and the American Medical Informatics Association is leading advocacy in this area.¹⁰

Although the Stanford University program launched in 2014 with philanthropic funding, it would not have been possible to fund fellows in 2015 without additional support. Fortunately, this became available after several departments, including surgery, emergency medicine, internal medicine, pathology, and neurology committed to either dedicated or shared funding of clinical informatics fellows with primary certification in their respective specialties. Although promising, funding commitments from these departments at this time does not secure the fellowship program's long-term funding, because both departmental financial situations and departmental leadership may change.

Funding support for the fellowship at UIC, similar to Stanford's fellowship, is being supported by clinical departments. It is strongly preferred that the clinical informatics fellows be integrated with both the clinical informatics program and the clinical department in which they practice. As such, each specific clinical department partners with the clinical informatics program in the evaluation, interview, and selection of applicants from their own specialty. The clinical department will provide the funding for the fellow and will have the opportunity to recoup their investment both through the professional billing of the physician and the interest the fellow will have in advancing clinical informatics projects of specific interest to that clinical department. This model is working well, though it does carry the risk that fellows from a funded specialty will be chosen over more qualified fellows from a specialty that has not committed to funding. However, additional clinical departments that do not currently sponsor clinical informatics fellows seem eager to be included for upcoming fellowship classes. At the same time, UIC is pursuing additional funding options, such as a sponsored fellowship through philanthropic donations.

Funding support for one of the fellowship spots at the Regenstrief Institute is being supported by its affiliated healthcare system. Although similar to UIC's and Stanford University's funding models, the healthcare system overall supports the fellow, rather than an individual clinical department. The chief information officer (CIO) considers the role that clinical informatics fellows play within their institution to be invaluable in the learning process and views these fellows as potential future hires as assistant or associate chief medical information officers (CMIOs). The Regenstrief Institute's long-term goal is to arrange similar support for the other three fellowship positions.

Initial funding support for OHSU's clinical informatics fellowship was provided for one slot each from OHSU Hospitals and Clinics and the Portland VA Medical Center. After the program's successful launch, the two entities have agreed to provide funding for one new fellow per year (two steady state) going forward. Other healthcare entities in the Portland, Oregon, area are considering funding further positions, up to the four positions per year (eight steady state) for which the OHSU program is accredited.

Didactics

One of the challenges of launching a new fellowship program is ensuring that fellows receive adequate didactic content for the core knowledge of the subspecialty. For faculty in the program who also serve other roles in the health system, this can entail tremendous commitments of time to prepare and deliver a new curriculum. The OHSU faculty mapped five courses of their clinical informatics certificate program to 95% of the published core content topics of the subspecialty. Although this does not guarantee coverage of all required clinical informatics subcompetencies or of all the content tested on the board exam, it can provide a solid foundation for fellows who take one course per academic quarter, a reasonable class load that can be accomplished during the 2-year fellowship without significantly impacting experiential learning. In contrast, completing a full master's program requires 16 courses, which would require 2 courses per quarter for the entire 2 years of the fellowship. At OHSU, clinical fellows will be required to complete the OHSU Graduate Certificate Program, with an option for pursuing a master's degree for those who are motivated to do so.

The Stanford program leadership felt that this level of commitment would not be consistent with the primary intent of the fellowship, which is to provide experiential learning. It is also unclear that earning a master's degree would confer additional advantage to clinical informatics fellows who become board-eligible after completing the 2-year fellowship program. At Stanford University, the curriculum for first-year fellows was initially supplemented with three courses from the OHSU distance-learning curriculum. This decision was made in collaboration with the local leadership of the Stanford BMI MS/PhD training program, recognizing that the core content of the subspecialty was covered adequately by the existing BMI curriculum. Although this incurred extra expense for the fellowship, it relieved the program leadership of the extensive investment in time that would be required to create this curriculum. As more faculty affiliated with the Stanford University fellowship program become board-certified in clinical informatics, the program transitioned to on-site didactics beginning with its second class of fellows.

The Regenstrief Institute also decided to utilize the didactic curriculum offered by OHSU. They have found the costs of doing so to be roughly equivalent to performing instruction in-house. The course feedback to the program directors about their fellows has been outstanding. Informal feedback from the Regenstrief Institute fellows has rated the OHSU curriculum to be outstanding as well. The Regenstrief

Institute also offers its own didactic program to supplement the fellowship, with a weekly work in progress update and weekly lectures by its faculty.

UIC has chosen to collaborate with its BHIS Department to create a 2-year didactic program for the fellowship. The BHIS Department offers both an online Master of Science in Health Informatics and an online Illinois Board of Higher Education Certificate Program. Similar to Stanford University, UIC believes that experiential learning is the primary intent of its clinical informatics fellowship, and that, therefore, one course per academic quarter provides the correct balance for the training program. In addition to the fellows participating in the five existing BHIS courses, the clinical informatics program and the BHIS Department have created three additional quarters of unique content designed to provide interactive sessions that will bridge online didactic courses and live experiential learning. The launch of the didactic session has proceeded well, and the fellows are successfully interacting with the other students in the online courses.

Another opportunity for didactics is the recent creation of a monthly virtual case conference series specifically for clinical informatics fellows. Fellows from all programs can participate through video conference and collaboration software. One program serves as the host for each session, and presents a common issue in clinical informatics for the participants to discuss. This enhances didactic education by providing either actual or simulated situations faced by clinical informaticians in their daily practice and also facilitates networking between fellows and the programs. This will also include yearly face-to-face fellow retreats in the future. Over 15 programs, both ACGME-accredited and nonaccredited, participated in the first video case conference. The major challenge being addressed at this time is the technical logistics of bringing together such a diverse group in a true collaborative experience, and early experiences of doing so have been positive.

Experiential Rotations

A general metaphor for achieving accreditation of the fellowship programs has been “fitting a square peg into a round hole.”¹¹ The programs’ leadership have felt this most acutely with the concept of “rotations,” which make sense for fellows in clinical subspecialties but are a more elusive concept within clinical informatics. In Stanford University’s clinical informatics fellowship, topical rotations within subjects such as clinical applications, analytics, help desk, and other areas were initially considered, but then discarded. In lieu of defining rotations within a single delivery system, the Stanford program developed partnerships with healthcare delivery organizations (eg, Stanford Children’s Health, Stanford Health Care, VA Palo Alto, Sutter, and Royal Children’s Hospital in Melbourne, Australia), research groups (the Stanford University School of Medicine), and companies (eg, HP Labs, Accenture, and Doximity). Rotations at each of these sites allow fellows to experience the breadth of opportunities available for physician informaticists. The Stanford University sites are considered core rotations and are introduced in the first 6 months of the fellowship to facilitate fellows’ exposure and networking opportunities. The remaining sites are considered elective opportunities, and fellows are expected to function in leadership roles to own and execute longitudinal informatics projects with each elective site chosen.

The Regenstrief Institute meets with the senior leadership of both its primary facilities (Eskenazi Health and Indiana University Health) to outline existing experiences with the core content. As a result of these meetings, rotations have been designed that include but are not limited to: supply chain, help desk, legal and regulatory, data warehouse, research, and clinical decision support teams.

OHSU developed a series of complementary rotations in consultation with informatics leadership at both the OHSU Hospital and the Portland VA Medical Center. These activities are purposively designed to expose fellows to both the technological and cultural differences between the organizations in which they rotate. The rotations include spending blocks of time in the clinical informatics operational units at the OHSU Hospital and the Portland VA Medical Center, along with those in the OHSU information technology, security, and training departments.

UIC has also grouped what might be considered individual rotations into a generic operational rotation in which fellows will experience the full range of activities of a clinical informatician. The day of a physician practicing clinical informatics is a mixture of different projects, problems to be solved, meetings, research efforts, and educational sessions, in addition to some clinical practice. Training programs are supposed to prepare fellows for actual practice in their chosen field. UIC leadership thus felt that the best way to accomplish this goal in clinical informatics is not to create artificial divisions, but to emulate the balancing act that is the reality of clinical informatics practice. The challenge for ACGME-accredited programs is to properly document the activities in which the fellows participate in order to ensure that the fellows have received comprehensive training. Fellows in the UIC program are currently working on several major and minor operational projects and serving on hospital committees, individually and in teams, which have been assigned to them through discussions between the fellows, their faculty mentors, the hospital’s information services and clinical departments, and the program director. They are documenting their work through the use of electronic portfolios, which will allow the program to monitor their progress and to balance their activities to provide them with sufficient breadth and depth of experiences.

Longitudinal Experiences and Scholarship Expectations

The ACGME expects all subspecialty fellowships to include longitudinal experiences. Stanford University’s clinical informatics program leadership defined “longitudinal experiences” to include participation in various standing committees from the core rotations. These include meetings such as the clinical decision support committees at both its affiliated hospitals, the monthly information systems physician advisory group at Stanford Children’s Health, the weekly Medical Informatics Director meeting at Stanford Health Care, and the weekly research review meeting at the Stanford University School of Medicine. Solutions in the OHSU, the Regenstrief Institute, and UIC clinical informatics fellowship programs are nearly identical to those in place in the Stanford University program.

In addition, ACGME requirements outline an expectation that all subspecialty fellows demonstrate evidence of scholarship. In Stanford University’s clinical informatics fellowship, the first class of graduating fellows (2014–2016) presented posters based on their quality improvement projects at multiple informatics and clinical conferences, and both fellows had peer-reviewed publications in press prior to graduation.^{12,13} The other programs have similar expectations of their fellows.

Alignment with Health System Leadership

Most enterprise informatics efforts require support from health system leadership, such as the CIO and CMIO. All four ACGME-accredited clinical informatics fellowship programs consider this a critical component of creating a successful fellowship. In Stanford University’s fellowship, one of the two core health systems’ CMIOs is the program director (C.A.L.), and the other health system’s CMIO and both health system

CIOs are affiliated and actively involved with the fellowship program. In OHSU's fellowship, the Chief Clinical Integration Officer, who oversees the institution's population health and value-based care programs as well as the clinical informatics department and the Chief Health Information Officer, functions as an Associate Program Director (T.R.Y.). In the Regenstrief Institute's fellowship program, fellows are given the title of Assistant CMIO and work closely with the CMIOs at both of the program's associated facilities. In UIC's fellowship program, the affiliated hospital's Chief Health Information Officer and CIO are core faculty members and actively support the program. The UIC program has found that information services directors and managers are eager to teach the fellows and to utilize them to advance initiatives and projects in need of physician and informatician support. Health systems clearly need physician informaticists, and the leadership from all four of the ACGME-accredited clinical informatics fellowships view the training programs as an opportunity to further engage physicians.

ACGME Accreditation Process

All of the clinical informatics fellowship programs described herein generally agreed that the ACGME accreditation application was time-consuming and that the ACGME WebADS application website did not facilitate efficient data entry. In addition, the four programs found that a supportive GME infrastructure made the application process easier. It is worth noting that the clinical informatics specialty-specific application form is only one small part of the entire application package, which can take from 100–300 person-hours to complete. At the Regenstrief Institute, UIC, and OHSU, having program leadership with GME experience (J.T.F. in emergency medicine, B.P.L. in pathology, and V.M. in internal medicine) helped significantly with the application process.

All subspecialty fellowships require a sponsoring residency program, which determines the final residency review committee to approve accreditation. The ACGME has defined nine different residency programs that can sponsor a clinical informatics fellowship program (anesthesiology, diagnostic radiology, emergency medicine, family medicine, internal medicine, medical genetics, pathology, pediatrics, or preventive medicine). The four clinical informatics fellowship programs accredited by ACGME in 2014 have four unique sponsoring residencies (see Table 1). In each case, the sponsoring residency mirrors the clinical specialty of the program director, which in turn reflects the impact that ease of access and existing relationships have on this process (although the sponsoring residency program can, of course, differ from the program director's clinical specialty). The sponsoring residency did not seem to impact the application process itself, which appears to depend more heavily on the clinical informatics prescreening committee than on the final RRC review. Importantly, and unique to the clinical informatics subspecialty, the academic departmental affiliations of the fellowship program may differ significantly from the sponsoring residency program.

FUTURE CHALLENGES

The prospects for accredited clinical informatics fellowship programs are bright, although many unanswered questions remain about the future of training physicians in clinical informatics.^{11,14} In light of our collective experience and the previously identified challenges, we believe that securing sustainable funding remains the primary challenge for existing programs as well as the primary deterrent to the formation of new programs. We collectively believe that the most viable solution for this issue is allowing clinical informatics fellows to bill as attending physicians for their clinical activities and applying that income to fund

fellowship training, as described in the previously published open letter to CMS.¹⁰

A related challenge is the ability of physicians graduating from fellowship training to gain suitable employment. If the funding issue limits the number and capacity of fellowship programs, then programs will be unable to meet the need for the production of certified subspecialists. This may lead potential employers to hire physicians with alternative training, which may decrease the interest of physicians in clinical informatics fellowship training and board certification, further compromising both the recognition and success of the subspecialty.

Other fellowship challenges relate to the intrinsic limitations of the recognition of clinical informatics as a subspecialty rather than a specialty. For example, this model requires that all fellows be board-eligible in a primary specialty before pursuing clinical informatics training, which limits the potential for surgical residents to spend their research time during residency training in clinical informatics. From a pragmatic standpoint, the fellowship training model also seems likely to narrow the fellowship candidate pool to those who are not yet established in their careers.

Another challenge is aligning clinical informatics fellows with their appropriate specialties. At OHSU, not all of the clinical departments have practice opportunities that align with the structure of the clinical informatics fellowship. In addition, some types of fellows are locked out of clinical practice (eg, a pediatrician cannot usually assume a VA position, since most VA hospitals do not have pediatric practices). It is clear that the interview process for fellows must include the involvement of their respective clinical departments, but the clinical departments and the clinical informatics leadership may value different skills in applicants, making recruitment of optimal clinical informatics candidates more challenging.

Related to this is the challenge of including an appropriate blend of fellows from different medical specialties in clinical informatics fellowships. The assumption is that it is preferable to have fellows from a variety of specialties to enhance training, build bridges between the different aspects of clinical informatics and clinical practice, and to better establish clinical informatics as a broad, unified field instead of an association of isolated subspecialties. It will be important to study what impact, if any, the sponsoring residency program of the clinical informatics fellowship has on the applicants for the program and, ultimately, on the mix of clinical disciplines represented by the fellows in the training program. At this time, there appears to be no discernible pattern, but with such few slots currently available for clinical informatics fellows, it is difficult to draw conclusions.

Finally, clinical informatics is inherently an integrative discipline. The American Medical Informatics Association is leading an effort to develop an interprofessional informatics certification, and we hope to see fellowship programs expand to include other applicants from other disciplines. However, the implications of instituting and maintaining an interdisciplinary fellowship with respect to continued ACGME accreditation are unknown, and such an effort will be similarly challenged to secure funding.

CONCLUSIONS

Several conclusions can be drawn from the experiences of the first four clinical informatics fellowships to be accredited by the ACGME. First, all of these programs have found significant interest in fellowship training for clinical informatics among the current generation of medical students and physicians-in-training, and, in part, the fellowships are attractive because they are perceived to provide a structured pathway to a career in the clinical informatics field. Second, there is no single "correct" way to create a clinical informatics fellowship program. Variation reflects different health system infrastructures and

cultures and will undoubtedly generate learning across all programs. Third, although all four programs have achieved initial funding support, it is unclear whether their funding methods will be sustainable. This problem is exacerbated by the inability of fellows to bill for medical practice in their primary specialty, which could serve as a source of revenue to pay fellows' salaries and other expenses. Finally, it is critically important for all the accredited clinical informatics fellowship programs, now numbering 11 and increasing rapidly, to share their experiences and lessons learned, in order to continue to improve training for all clinical informatics fellows.

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C.A.L. conceived of the manuscript, revised all drafts, provided final approval, and agrees to be accountable for all aspects of the work. N.M.P., J.P.P., J.T.F., B.P.L., T.R.Y., V.M., and W.R.H. each provided substantial contributions to the design of the original manuscript and critical revisions, have provided final approval of the version to be published, and agree to be accountable for all aspects of the work.

COMPETING INTERESTS

None.

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AUTHOR AFFILIATIONS

¹Department of Biomedical Informatics, University of California, San Diego (formerly at Stanford University)

²Department of Emergency Medicine, Indiana University

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³Department of Pathology, University of Illinois at Chicago

⁴Department of Medical Informatics & Clinical Epidemiology, Oregon Health & Science University