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RESEARCH

A Progress Report on the State of Pharmacy Informatics Education in US Pharmacy Schools and Colleges

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Objective. To characterize informatics education opportunities in US colleges and schools of pharmacy curricula.

Methods. Informatics curricular information online was catalogued via publicly available websites. Website content was searched via domain-specific keywords. Online course descriptions were reviewed. Website searches were also conducted for informatics-related opportunities.

Results. Of 132 pharmacy curricula found online, 47 (36%) included an informatics course. Of those, 64% (n=30) were required while 47% (n=22) were elective courses. Additionally, 20% (n=26) provided informatics advanced and/or introductory pharmacy practice experiences, 20% (n=27) offered an informatics residency, and 17% (n=22) listed certificate and/or graduate degree programs in informatics.

Conclusion. Over the past 10 years, little observable progress has been made in pharmacy school curricula in response to the increasing importance of informatics to the profession. Pharmacy programs can address this educational gap by internal (eg, course development) and external (eg, open source curriculum) solutions.

Keywords: pharmacy informatics, curriculum, education, informatics, technology

INTRODUCTION

Pressing professional need and guidance from the Accreditation Council on Pharmacy Education (ACPE) have raised questions for pharmacy educators about how best to teach pharmacy informatics knowledge and skills to their students. However, the increased need for informatics skills and knowledge within the pharmacy profession is not widely reflected in pharmacy education.[1,2] This disconnect is best conveyed through the lens of the initial 2005 portrait of the state of informatics education in pharmacy.[1] This 2005 study quantified the extent of pharmacy informatics course offerings in pharmacy schools and colleges in the United States (US) through pharmacy school websites. Prior to 2005, indicators of need for informatics-related education in pharmacy included the American Association of Colleges of Pharmacy's (AACP) Center for the Advancement of Pharmaceutical Education (CAPE) outcomes as a target for evolving the content of pharmacy's professional curricula.[3,4] Despite the indicators of need for informatics curricula from AACP, Flynn found that only 33% (n=24) of the 73 schools with online curriculum published listed a discrete course on pharmacy informatics, and only 16% (n=12) required studies in pharmacy informatics.[1] Another notable finding from this 2005 study pointed to confusion over the definition of "informatics." At that time, informatics courses at 24 pharmacy schools had 23 different course titles. That confusion surrounding informatics-related terminology and the lack of consensus are issues that still persist today.[5,6] Most recently, pharmacy informatics has been described as being "centered on the effective management and delivery of medication-related data, information, and knowledge across systems that support the medication-use process."[6]

Since publication of that snapshot of the pharmacy informatics educational arena, several key developments in health care have served to underline the need for

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informatics education for student pharmacists. These include, but are not limited to, the federal mandate in the US to implement an electronic health record (EHR) system, the accompanying widespread use of technologies like computerized physician order entry, e-prescribing, clinical decision support systems, barcode medication administration, lessons learned from disaster response with Hurricane Katrina, Superstorm Sandy, and a devastating tornado in Joplin, Missouri, the growing consumerization and personalization of health care, and emerging opportunities for pharmacy in data analytics and big data as outlined in the Argus Commission Report.[7-14] Similarly, the Accreditation Council for Pharmacy Education (ACPE) released its first explicit informatics guidance in the Standards and Guidelines in 2006.[15] Since that time, ACPE has published a revision followed by a new Accreditation Standards document and Guidelines.[16-18] The profession of pharmacy also identified the need for informatics training when the American Society of Health-System Pharmacists published its 2007 Statement on the Pharmacist's Role in Informatics and the 2015 update, Pharmacist's Role in Clinical Informatics.[6,19]

Also during that time, Fox and colleagues conducted a systematic examination of pharmacy informatics course syllabi with an eye toward the recently released (ie, 2007) ACPE pharmacy informatics competencies.[2] The authors used a survey methodology to solicit didactic and experiential pharmacy informatics syllabi from 89 pharmacy schools, which yielded 27 didactic and nine experiential syllabi sourced from 25 of the 32 schools that responded (28% adjusted response rate). From a review of those syllabi, Fox and colleagues concluded that modest progress had been made, but that "existing informatics courses may not comply fully with curricular guidelines" for pharmacy informatics.[2,15] Reflecting an ongoing challenge in differentiating sub-disciplines and in the terminology surrounding pharmacy informatics, 44% of the syllabi received (16/36) fit the study definition of drug information rather than pharmacy informatics. That highlighted lack of distinction between drug information and informatics helped reveal potential misconceptions regarding what informatics is and is not that still persist today. Other notable findings from the 32 responding schools in this study included: informatics was not yet being taught (n=4) or that it was being taught in an integrated approach rather than as a discrete course (n=3).

Pharmacy educators dedicate their careers to producing practice-ready pharmacy graduates. Pharmacy informatics knowledge and skills are becoming increasingly vital for practicing pharmacists across all settings. It is important to address how well this element of contemporary practice is being incorporated into pharmacy curricula. The objective of this study is provide an update on the current status of pharmacy informatics education in US colleges and schools of pharmacy by characterizing the presence, absence and extent of pharmacy informatics course content and courses available in their published online curricula.

METHODS

A similar methodological approach to the original "Current State of Pharmacy Informatics Education" methods was used to generate the list of professional pharmacy programs in the US leading to the doctor of pharmacy (PharmD) degree.[1] Whenever possible, methods for the current study were followed to replicate the approach for the original study, which was completed approximately 10 years prior. The chief inclusion criteria for a pharmacy program in the current study was either confirmed full or candidate accreditation status granted by ACPE.[20] Each pharmacy college or school included also had to be recognized as a regular institutional member of AACP.[21]

A multi-step process was used to identify, extract, and catalogue pharmacy informatics online curricular information. The first step was to determine the presence or absence of online curricular information for each pharmacy college or school examined via its official, publicly available website. Curricular content housed on any college's own internal intranet was not included in this study. For public-facing online curriculum, a keyword search was conducted with the terms: "health information technology," "health IT," "HIT," "informatics," and "health care technology" as a proxy for identifying informatics-related content. In the next step, course names and descriptions containing these key words were then reviewed to ensure the course was related to pharmacy informatics. To be classified as a pharmacy informatics course, a course description was required to indicate inclusion of informatics-related content (eg, vs drug information mislabeled as informatics); however, course content did not have to be exclusively dedicated to pharmacy informatics topics. As many college websites had a separate listing for electives, an additional open-ended search not constrained by keywords was conducted to identify available electives. Course titles and descriptions, when available, were reviewed for listed electives to determine whether these courses included informatics content. Finally, an evaluation using a key word search of "informatics" was conducted site-wide via online search tool within each publicly accessible college website. This allowed for determination if a pharmacy college or school offered any experiential opportunities, certificate programs, graduate programs, and/or residencies in the field of informatics. Entries for each pharmacy program were

entered into a Microsoft Excel (Redmond, WA) spreadsheet for cataloguing pharmacy informatics curricular content along with a variety of institution-specific information (eg, Uniform Resource Locator for college website, contact information, etc.). An online mapping program (www.easymapmaker.com) was used to map the main campus of each pharmacy school and determine the number of pharmacy schools within a 100-mile radius. This was done, in part, to explore if informatics offerings might serve as a responsiveness proxy for competitiveness when proximity was considered.

Each pharmacy college website was assessed and pharmacy informatics content confirmed by two sets of reviewers serially. Both sets of reviewers were comprised of student pharmacists to best replicate the primary search stakeholder that would ostensibly search for, and benefit from, this online curricular information of interest. To be consistent across all programs, this study did not include any pharmacy informatics curriculum that was not explicitly described on the public website, even in the rare cases where the presence of pharmacy informatics curriculum was known to the reviewers or authors. Student pharmacist reviewers completing this work were in their fourth year (P4) and had also previously completed an introductory health informatics course within a pharmacy curriculum.

Descriptive statistics were used to summarize pharmacy school characteristics. The Chi-square test, including Bonferroni correction for multiple comparisons, was used to compare curricular offerings in pharmacy informatics. Fisher's exact test was used when one or more cells had an expected frequency of five or less. Significance level was determined using $\alpha = .05$. Data analyses were performed using IBM SPSS Statistics, Version 23.0 (Chicago, IL).

RESULTS

A total of 132 colleges or schools of pharmacy met the inclusion criteria for review. Of those 132 public websites for pharmacy program examined, all had curriculum information available online. The data collection process began in January 2015 and all schools had been reviewed, with any categorization discrepancies resolved by April 2015.

Study results outlining informatics education opportunities at pharmacy colleges or schools are summarized in Table 1. Of the 132 curricula examined, 47 (36%) included a course in pharmacy informatics. Among those schools or colleges with a pharmacy informatics course (n=47), 64% (n=30) required the course while 47% (n=22) provided pharmacy informatics as an elective. Five pharmacy programs offered both required and elective courses in informatics. Across all schools, 20% (n=26) provided pharmacy informatics advanced pharmacy practice experiences (APPEs) and/or introductory pharmacy practice experience (IPPE) opportunities, 20% (n=27) offered at least one pharmacy informatics residency, and 17% (n=22) had certificate and/or graduate degree programs in informatics available to pharmacy students. Only four programs offered the full range of opportunities assessed in pharmacy informatics, which included a course (required or elective), experiential opportunities, and a residency; notably, three of these four programs were located in Tennessee.

Table 1 also includes the summarized results for several key subgroups: the 43 schools that were accredited after the 2005 study and not part of that original analysis; the 74 schools with two or more geographically relevant competitor pharmacy schools (ie, located within a 100-mile radius of their main campus); the top 15 American professional pharmacy programs, according to the U.S.

Table 1. Informatics Education Opportunities Offered at US Pharmacy Colleges (January -April 2015)

Informatics Education Opportunity Offered	All schools N=132 (%)	Newer schools[a] N=43 (%)	Multiple schools nearby[b] N=74 (%)	Top USNWR schools[22] N=15 (%)	Top NAPLEX schools[23] N=5 (%)	Top MPJE[24] schools N=9 (%)
Any course	36	42	43[c]	33	40	44
Required course	23	33	30[c]	7	0	11
Elective course	17	16	19	27	40	44[c]
APPE and/or IPPE	20	21	26	13	0	33
Residency	20	9	24	33	60	22
Certificate and/or graduate degree	17	19	19	27	20	44[c]

Abbreviations: USNWR=US News and World Report, NAPLEX=North American Pharmacist Licensure Examination, MPJE=Multistate Jurisprudence Examination, APPE=advanced pharmacy practice experience, IPPE=introductory pharmacy practice experience

[a]Newer schools are defined as those that have secured accreditation since 2005, the year of the original Flynn analysis.[1]

[b]Defined as two or more schools/colleges of pharmacy within 100 miles

[c]Indicates significance, defined as a p value $<.05$ using Chi-square with Bonferroni correction for multiple comparisons

News & World Report (USNWR) 2016 survey of the academic deans of colleges of pharmacy;[22] the five schools with a passing rate on the 2015 North American Pharmacist Licensure Examination (NAPLEX) of 100% or 99%;[23] and the nine schools with a passing rate on the Multistate Pharmacy Jurisprudence Examination (MPJE) of 100%.[24]

When compared with more established programs, the 43 schools accredited since the previous curricular review had a greater percentage of schools offering pharmacy informatics coursework (42% vs 33%; $p=.30$) and requiring informatics as part of required coursework (33% vs 23%; $p=.06$), but were significantly less likely to offer a residency in informatics (9% vs 20%; $p=.03$). Among the top-ranked pharmacy programs, there was no significant difference in whether the curriculum contained a pharmacy informatics course, although the sample sizes for these analyses are very small.

A proximity comparison was also performed for pharmacy colleges to identify and compare those colleges with two or more additional pharmacy colleges located within a 100-mile radius of the focal college's main campus to those with only one other nearby college (n=29) or no other nearby colleges (n=29). The 74 colleges with two or more competitor colleges in close proximity to their campus had a significantly higher percentage of schools with both an informatics course (42% vs 26%; $p=.04$) and a required informatics course (30% vs 14%; $p=.03$).

Finally, among the 47 schools offering formal pharmacy informatics education, it is notable that the pharmacy informatics course titles varied widely and showed very little overlap across curricula. Twenty-eight different course titles were represented among the 30 required courses identified, with only "drug information and informatics" and "health informatics" documented at two separate pharmacy schools. Elective course titles were less disparate, with 17 different course titles listed among the 22 elective courses identified and "pharmacy informatics" appearing at five pharmacy schools. As shown in Table 2, the most common key words across both required and electives were "informatics," "health" or "health care," and "information."

Table 2. Most Frequent Keywords in Titles of Informatics Courses at US Pharmacy Colleges (in 2015)

Required Courses	N=30	Elective Courses	N=22
Informatics	83	Informatics	77
Information	30	Health or Health Care	41
Drug	30	Pharmacy	32
Health or Health Care	30	Information	14
Pharmacy	17	Applications	14

DISCUSSION

While it is encouraging that the total number pharmacy schools and colleges offering pharmacy informatics content via their curricula to PharmD students in the US has increased in the last 10 years (ie, from 24/73 to 47/132), this parallels the increase in the total number of pharmacy schools and colleges during that time. On a percentage basis, there has only been modest increases in pharmacy informatics courses in 2015 (36%) compared with similar offerings identified in 2005 (33%). This is unfortunately consistent with findings of both the original Flynn analysis of pharmacy school curricula on websites and the later survey of informatics syllabi conducted by Fox and colleagues.[1,2] While both of the previous studies and the current one likely used different data collection methods that resulted in incomplete information, the findings were consistent across time and collection method in terms of the dearth of informatics educational offerings and the lack of progress over time. For legacy pharmacy programs (ie, those pharmacy programs that were accredited at the time of the original 2005 Flynn analysis) in the current study, the inclusion was essentially flat at 33% (ie, the same percentage observed in 2005). The overall growth to 36% observed in the current study is attributable to the increase in informatics curricula offered at newer schools (ie, those that have secured accreditation since 2005) (42%). This result is surprising considering there have been several significant changes in related accreditation requirements and in the information infrastructures supporting practice delivery over the past 10 years.

In reference to accreditation standards, ACPE described the informatics requirements for schools offering PharmD education in the 2007, 2011 and now 2016 standards.[15-17] In addition to overtly describing the requirement that didactic elements in informatics be included in the curriculum, the ACPE 2016 standards reference the 2003 Institute of Medicine Report and their five competencies that all health care providers should attain during their education. One of the five core competencies includes the ability to "utilize informatics."[17] This informatics competency was also adopted across all disciplines in a white paper published in 2011 by educational associations representing six health professions, including AACP.[25]

Professionally, the American Recovery and Reinvestment Act of 2009 and Health Information Technology for Economic and Clinical Health Act specifically require the use of an EHR in health systems.[7] Financial incentives in this legislation coupled with requirements from the Centers for Medicare and Medicaid Services (CMS) have led to widespread implementation of EHRs across health systems.[26,27] As a result, the use of informatics

elements in pharmacy practice has expanded dramatically and the effective utilization of information technology has become an essential component of the profession. This growth is also reflected by the rapid increase in the membership of informatics-related professional associations, including the American Medical Informatics Association (AMIA) and the Health Information Management Systems Society (HIMSS), attendance at informatics conferences (eg, increased from "recording breaking" 28,400 attendees in 2008 to over 40,000 in 2017 at the HIMSS Annual Conference) and an expansion of employment opportunities in informatics (eg, Office of National Coordinator investment of $84 million in funding for the health IT workforce development, AMIA 10x10 program to train 10,000 "health care professionals to serve as informatics leaders," etc).[28-33] While accreditation standards would traditionally drive changes in the curriculum, opportunity growth in the profession could also influence the development of educational content. However, it appears that neither accreditation standards nor changes in the profession have significantly affected the development of informatics curriculum in US pharmacy colleges, as reflected by online curricular listings seen in the current study.

Several factors may explain the lack of observed growth in the area of informatics curriculum over the last 10 years. An ongoing challenge has been that the meager number of trained faculty to teach the curriculum may hinder the ability to teach the material across all schools. Because there are very few informatics residencies (n=27) or certificate programs (n=22) offered by pharmacy colleges, there may be limited post-graduate opportunities to develop faculty. In addition, the rapid growth of job opportunities in informatics in the private sector may be diluting the faculty experts who have the knowledge and expertise to teach.[33] As a greater percentage of newer pharmacy colleges had informatics curriculum and required that the course be part of the core curriculum, newer colleges are either more likely to publish their content online or can more easily incorporate informatics into their curriculum. Newer colleges may also have a "clean slate" when building a program, which enables more programmatic flexibility. It is also possible that circumstances may dictate or legacy programs may choose to incorporate informatics content across several courses rather than establish a discrete informatics course. Finally, it may be that schools are still developing content in preparation for the 2016 standards. Because the data was collected until April 2015, it may not reflect planned efforts to satisfy informatics requirements for 2016. Regardless of those factors, findings from this study, particularly when considered in the context of previous efforts in this line of research, reinforce the need to add informatics education in pharmacy school curricula to help produce practice-ready pharmacists who are prepared for an increasingly system-supported and semi-automated work environment.

Future studies evaluating core and elective curricula would strengthen the described methods by contacting representatives of the school directly rather than relying on the school website to evaluate curricular offerings. Alternately, for pharmacy programs, updating their curriculum online and optimizing website design and navigation are procedural solutions worth exploring. This is highlighted by recent reports that college-bound and adult prospective students and parents prioritize college websites as helping inform their choice of college; college websites were the single most powerful recruitment influence by subgroups including parents.[34,35] It is interesting to note that evidence of informatics curriculum was not readily available on the public domain for most of the USNWR top-ranked pharmacy colleges. While there is debate as to the merits of these rankings, it appears that these rankings may not reflect colleges with consistent course offerings in informatics. In the current study, only 7% (1/15) of "highly regarded PharmD programs" (ie, the top 15 colleges of pharmacy as ranked in a *US News & World Report* survey) mandated studies in pharmacy informatics as a graduation requirement.[22] This reflects the broader lack of progress seen since the 2005 study, in which 17% (2/12) of the USNWR top-ranked pharmacy schools had a required informatics course.[1] Mirroring this lack of progress, but potentially confounded by changes over time in the list of USNWR top-ranked schools, only 33% (5/15) in the current study contained any course listings compared to 42% (5/12) in the previous study.

If pharmacy colleges are to meet the ACPE 2016 standards, there are several potential solutions. Colleges can add a course to their existing curriculum on their own developed by their faculty (internal) or they can use an established curriculum available for use (external). Examples of external curriculum may include a certificate program, open source curriculum such as Partners in E or the Association of Faculties of Pharmacy of Canada (AFPC) curriculum.[36,37] Schools may also elect to work with experts from partner institutions that have informatics trained professionals (eg, volunteer faculty). In some cases, the college may choose to leverage existing resources via other units within their institution (eg, medicine, nursing, public health, etc.) to teach informatics, while simultaneously satisfying requirements for interprofessional education by integrating students from those units or vice versa. Regardless of the solution, there are accreditation-related and professional needs for pharmacy colleges and

schools to introduce and enhance informatics training and educational offerings for pharmacy students.

This study is not without limitations. Reported curricular offerings in informatics could be underestimated due to any or all of the following: curricular revision at colleges that have added adequate informatics content to satisfy standards and guidance but cannot be surfaced at course title or description level (as several respondents in the Fox and colleagues study indicated);[2] failure by programs to update college-level course descriptions secondary to prioritized university course catalogs, the contents of which were not included in this analysis; websites that prevented location of informatics content by the end-users (ie, prospective or current students) for which they are intended; and use of manual human search instead of an automated website crawling or scraping service. Complicating the type of assessment described herein, some informatics curricular content may not be available on the school's website but may still be taught at an institution. This would be particularly difficult to identify if an open source informatics curriculum (eg, Partners in E, AFPC) has been selected but is not reported as part of the curriculum. Hence, it would not be identified by website assessment. While the investigators made every attempt to identify appropriate informatics curricular content online, it is possible that pharmacy colleges underreport their educational content online or do not keep their website curriculum description up-to-date; this may be particularly true regarding elective course offerings. As mentioned previously, there are a few instances where the authors are aware that informatics courses are being internally taught or coordinated via an external curriculum, but cannot be observed by assessment of an online curricula listing. As such, those instances could not be included in the current study. Additionally, a defined criterion for establishing proximal competitor distance for pharmacy colleges was not identified, so an estimate reflecting related distances traveled for higher education was used. Similarly, inclusion of informatics educational content on websites was used as a potential proxy for marketability among proximal competitors due to research demonstrating how college websites strongly affect prospective student perceptions, the role of distance as a determinant in college selection, as well as increased messaging that technology in health care and informatics are foundational to all pharmacy practice paths and an emerging career path for informatics specialists.[19,34,38-40]

CONCLUSION

Informatics is an increasingly important domain in producing practice-ready pharmacy graduates, from both accreditation and market perspectives. Observable listings of informatics content in online curriculum do not greatly reflect acknowledgement of this change over the last 10 years by US colleges and schools of pharmacy. Pharmacy programs have several options to address this educational gap including internal (eg, course development) and external (eg, open source curriculum) solutions.

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REFERENCES

1. Flynn AJ. The current state of pharmacy informatics education in professional programs at US colleges of pharmacy. *Am J Pharm Educ*. 2005;69(4):Article 66.
2. Fox BI, Karcher RB, Flynn A, Mitchell S. Pharmacy informatics syllabi in doctor of pharmacy programs in the US. *Am J Pharm Educ*. 2008;72(4):Article 89.
3. Center for the Advancement of Pharmacy Education. Educational Outcomes 1998.
4. Center for the Advancement of Pharmacy Education. Educational Outcomes 2004.
5. Hersh W. Who are the informaticians? What we know and should know. *J Am Med Inform Assoc*. 2006;13(2):166-170.
6. American Society of Health-System Pharmacists. ASHP statement on the pharmacists role in clinical informatics. *Am J Health Syst Pharm*. 2016;73(6):410-413.
7. *Public Law 111-5 - American Recovery and Reinvestment Act*; 2009. https://www.gpo.gov/fdsys/pkg/BILLS-111hr1enr/pdf/BILLS-111hr1enr.pdf. Accessed August 1, 2016.
8. Colligan L, Potts HW, Finn CT, Sinkin RA. Cognitive workload changes for nurses transitioning from a legacy system with paper documentation to a commercial electronic health record. *Int J Med Inform*. 2015;84(7):469-476.
9. Bala H, Venkatesh V, Venkatraman S, Bates J. If the worst happens: Five strategies for developing and leveraging information technology-enabled disaster response in healthcare. *IEEE J Biomed Health Inform*. 2016;20(6):1545-1551.
10. Horahan K, Morchel H, Raheem M, Stevens L. Electronic health records access during a disaster. *Online J Public Health Inform*. 2014;5(3):232.
11. Shin P, Jacobs F. An HIT solution for clinical care and disaster planning: how one health center in Joplin, MO, survived a tornado and avoided a health information disaster. *Online J Public Health Inform*. 2012;4(1):3818.
12. Timmermans S, Oh H. The continued social transformation of the medical profession. *J Health Soc Behav*. 2010;51(1 Suppl):S94-106.
13. Marken PA. Personalized medicine: are we preparing our students for the knowledge revolution? *Am J Pharm Educ*. 2011; 75(3):Article 48.
14. Baldwin JN, Bootman JL, Carter RA, et al. Pharmacy practice, education, and research in the era of big data: 2014-15 Argus Commission Report. *Am J Pharm Educ*. 2015;79(10):Article S26.
15. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional degree program in pharmacy leading to the doctor of pharmacy

degree. 2006. https://pharmacy.wisc.edu/wp-content/uploads/2016/05/final_s2007guidelines2_0.pdf. Accessed September 13, 2018.
16. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional degree program in pharmacy leading to the doctor of pharmacy degree. 2011. https://www.acpe-accredit.org/pdf/FinalS2007Guidelines2.0.pdf. Accessed September 13, 2018.
17. Accreditation Council for Pharmacy Education. Accreditation standards and guidelines for the professional degree program in pharmacy leading to the doctor of pharmacy degree. Standards 2016. https://acpe-accredit.org/pdf/Standards2016FINAL.pdf. Accessed September 13, 2018.
18. Accreditation Council for Pharmacy Education. Guidance for the accreditation standards and key elements for the professional program in pharmacy leading to the doctor of pharmacy degree. https://acpe-accredit.org/pdf/GuidanceforStandards2016FINAL.pdf. Accessed September 13, 2018.
19. American Society of Health-System Pharmacists. ASHP statement on the pharmacist's role in informatics. *Am J Health Syst Pharm*. 2007;64(2):200-203.
20. Accreditation Council for Pharmacy Education. Preaccredited and accredited professional programs of colleges and schools of pharmacy. https://www.acpe-accredit.org/accredited-programs-by-status/. Accessed September 13, 2018.
21. American Association of Colleges of Pharmacy. AACP institutional members. 2015. https://www.aacp.org/article/aacp-institutional-membership. Accessed September 13, 2018.
22. US News & World Report. America's best graduate schools, 2016 edition. http://grad-schools.usnews.rankingsandreviews.com/best-graduate-schools/top-health-schools/pharmacy-rankings. Accessed March 28, 2016.
23. Ross M. Top 5 pharmacy schools with best NAPLEX passing rates. Pharm Times. 2016. http://www.pharmacytimes.com/careers-news/top-5-pharmacy-schools-with-best-naplex-passing-rates. Accessed August 1, 2016.
24. Ross M. Top 9 pharmacy schools with best MPJE passing rates. Pharm Times. 2016. http://www.pharmacytimes.com/careers-news/top-9-pharmacy-schools-with-best-mpje-passing-rates. Accessed August 1, 2016.
25. Interprofessional Education Collaborative Expert Panel. Core competencies for interprofessional collaborative practice: report of an expert panel. Washington, DC; 2011.
26. Centers for Medicare and Medicaid Services. Medicare and Medicaid EHR incentive program basics 2015. http://www.cms.gov/Regulations-and-Guidance/Legislation/EHRIncentivePrograms/Basics.html. Accessed January 7, 2016.
27. Office of the National Coordinator for Health Information Technology. Hospitals participating in the CMS EHR incentive programs, Health IT Quick-Stat #45. http://dashboard.healthit.gov/quickstats/pages/FIG-Hospitals-EHR-Incentive-Programs.php. Accessed January 7, 2016.
28. HIMSS. Record-breaking HIMSS conference & exhibition reflects success, growth of healthcare IT industry. 2008. http://www.himss.org/news/record-breaking-himss-conference-exhibition-reflects-success-growth-healthcare-it-industry. Accessed August 17, 2017.
29. Binder L. Six observations about the healthcare market from HIMSS 2017. Forbes. 2017. https://www.forbes.com/sites/leahbinder/2017/02/24/six-observations-about-the-health-care-market-from-himss-2017/#1a373be32759. Accessed August 17, 2017.
30. HIMSS. Education & workforce development. http://www.himss.org/education-workforce-development. Accessed August 17, 2017.
31. AMIA. AMIA 10x10 courses: training health care professionals to serve as informatics leaders. 2017. https://www.amia.org/education/10x10-courses. Accessed August 17, 2017.
32. International Medical Informatics Association. American Medical Informatics Association membership information. http://www.imia-medinfo.org/new2/node/264. Accessed January 1, 2016.
33. Burning Glass. Missed opportunities: the labor market in health informatics, 2014. https://www.burning-glass.com/research-project/health-informatics-2014/. Accessed September 13, 2018.
34. Ruffalo Noel Levitz. 2014 E-expectations report: the online preferences of college-bound high school seniors and their parents. 2014. https://www.ruffalonl.com/documents/shared/Papers_and_Research/2014/2014_E-Expectations_Report.pdf. Accessed September 13, 2018.
35. Ruffalo Noel Levitz. Study of adult prospective students. 2016. http://learn.ruffalonl.com/rs/395-EOG-977/images/2016_Adult_eExpectations_Report.pdf. Accessed September 13, 2018.
36. Healthcare Information and Management Systems Society (HIMSS). Partners in E. 2015. http://www.himss.org/library/pharmacy-informatics/partners-in-e. Accessed August 18, 2016.
37. Association of Faculties of Pharmacy of Canada (AFPC) and Canada Infoway. Informatics for pharmacy students. E-resource. 2015. http://afpc-education.info/moodle/index.php. Accessed August 18, 2016.
38. Fox BI, Flynn A, Clauson KA, Seaton TL, Breeden E. An approach for all in pharmacy informatics education. *Am J Pharm Educ*. 2017;81(2):Article 38.
39. Fox BI, Flynn AJ, Fortier CR, Clauson KA. Knowledge, skills, and resources for pharmacy informatics education. *Am J Pharm Educ*. 2011;75(5):Article 93.
40. Thirwani A. Anuj Thirwani on career pathways in pharmacy informatics. ASHP Connect. 2015. http://connect.ashp.org/blogs/anuj-thirwani/2015/06/01/anuj-thirwani-on-career-pathways-in-pharmacy-informatics?ssopc=1. Accessed January 1, 2016.