

Bench to Bedside: Detailing the Catalytic Roles of Fully Integrated Information Scientists

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Abstract

Timely access to information in a streamlined, synthesized, and comprehensive format is critical to the success of the transformative programs and learning health systems that characterize Vanderbilt University Medical Center (VUMC). To meet this need, highly-trained information professionals created an infrastructure support framework, based on years of successful evidence interventions, that helps move discoveries from bench to bedside. As clinical programs and practices are regularly evaluated at the institutional level, a team of information experts, each participating actively in projects throughout the medical center, helps document institutional decisions and supports them with both internal and external research data. An archival system supports the maintenance and scalability of this effort through intelligent reminders and, when feasible, work assignments.

With the drive to achieve precision medicine-based care, defined by the National Institutes of Health as an approach accounting for individual genetic, environmental, and lifestyle factors, information professionals need to continually enhance their cadre of skills and competencies. At VUMC, information scientists are engaged in efforts to advance healthcare research; these efforts span from drug repurposing projects that require applying advanced, ever-changing subject knowledge to mine data from genetic, protein, and structural resources, to population health initiatives that necessitate understanding of public health, epidemiology, social determinants of health, and healthcare disparities. The institution's commitment to discovery is coupled with the need to contain costs while improving care. Information scientists ensure resources are properly channeled to current effective care practices by regularly appending and substantiating evidence to decisions undergoing process review. Data is collected on an ongoing basis for formal and informal evaluations, both for purposes of process refinement and for effective communication to leadership on return on investment.

Background

Information scientists at the Center for Knowledge Management (CKM) have become increasingly integrated into the bench to bedside cycle at Vanderbilt University Medical Center (VUMC). A history of successful and meaningful contributions has enhanced and proven the value of our skills and established our reputation as valuable members of multidisciplinary teams. Through leadership from Dr. Nunzia B. Giuse, Vice President for Knowledge Management and tenured Professor of Biomedical Informatics, CKM has gained unique opportunities to link the group's skills to a variety of medical center research efforts.

The center's projects are strategically planned through purposeful mapping of information scientists' skills to specific institutional priorities (Giuse et al. 2013) defined by VUMC's status as a learning health system (Friedman et al. 2015), which the Institute of Medicine (2013) described as a system with "real-time access to knowledge" that "continuously and reliably captures, curates, and delivers the best available evidence to guide, support, tailor, and improve clinical decision making and care safety and quality." Each information scientist undergoes intensive training upon joining the team and must demonstrate through formal internal and third-party verification that necessary skills have been attained before entering into complex evidence projects. To meet the needs of this dynamic environment, information scientists must possess:

- intentionally-developed and continually-refined biomedical content knowledge;
- expert literature searching, appraisal, and synthesis skills;
- understanding of research methods, study design, and reporting standards;
- deep and broad familiarity with the peer reviewed and grey biomedical literature;
- knowledge of how to evaluate bias, assess conflict of interest, and verify/corroborate claims;
- the ability to keep abreast of new evidence as it emerges and understand when it is sufficiently mature to impact practice; and
- aptitude in incorporating evidence, policy, and practice into concise categorized synthesis appropriately targeted to the user.

These skills have been deliberately honed over time through a range of effective and increasingly scalable evidence interventions. With the establishment of the Clinical Informatics Consult Service (CICS), VUMC was at the forefront of bringing information professionals directly into the critical care setting as integrated members of the rounding team, affording them the details of patient cases from which complex clinical questions arise, as well as gaining an understanding of the urgency and complexity of these questions (Jerome et al. 2001; Giuse et al. 2005; Rosenbloom et al. 2005; Mulvaney et al. 2008). The success of this program led to scaling of the effort through the Evidence-Based Medicine Literature Request Information Basket, through which clinicians could request evidence to address a patient-specific clinical question directly via VUMC's secure electronic health record, enabling information scientists to access the patient records and reducing the need to round in person (Giuse et al. 2005; Jerome et al. 2008; PwC Health Research Institute 2012). Based on experience with rounding teams, information scientists already possessed the necessary understanding and commitment to strict adherence to confidentiality standards and Health Insurance Portability and Accountability Act

compliance requirements (HIPAA 1996). In addition to responding to patient-specific requests, information scientists have been involved since 2005 with evidence provision to support the development of ordersets, which provide institution-customized protocols for in-and out-patient care plans (Giuse, Williams, and Giuse 2010).

Deidentified versions of evidence summaries produced through these programs have been consistently stored for ongoing access, both for future use and to facilitate knowledge sharing and reuse by all VUMC clinicians, beyond the initial requestor. More recently, the team developed the Clinical Systems Knowledge Acquisition and Archival Tool (CS-KAAT), which was initially created for system-agnostic documentation of legacy clinical decision support (CDS) rules alongside their supporting evidence (DesAutels et al. 2017; Fox et al. 2017) and has now been extended to other clinical knowledge artifacts (DesAutels et al. 2018). CS-KAAT facilitates the application of rich metadata to each component represented in the tool, assignment and reuse of evidence summaries and citations to all relevant artifacts, and linkage of related decision support elements and orderables extracted from different areas of the clinical enterprise. Through this work, CKM has created a central repository in which evolving institutional care policies and the evidence used to substantiate them can be committed to the institutional memory, while also providing the functionality to enable the evidence to be revisited and updated over time.

As the result of this history, CKM has formed a solid infrastructure to support the institution's complex evidence needs. Information scientists have become integrated members of established teams involved in both the production and consumption of research within and beyond the medical center, as well as often-requested partners for new initiatives that require access to reliable and current evidence in an expertly-filtered and quickly ingestible format. In the fast-paced world of healthcare in which knowledge is constantly evolving based on both population-level and individual patient-focused insights, this infrastructure bolsters the institution against the winds of change and provides a central and reliable source for producing and documenting the evidence that catalyzes the medical center's various components of research and practice.

Impacting Healthcare through Evidence and Data Management

Information scientists continue to leverage and build upon the expertise and knowledgebase generated through previous experience to engage in projects aimed at ensuring resources are properly channeled to current effective care practices and efforts to advance healthcare research by partnering with both local and cross-institutional teams. As our involvement has grown, CKM leadership has strategically focused on: 1) scalable projects in which generated evidence is used to impact decision-making at the population or institutional level; 2) complex, patient-specific questions that require precise searching and extraction of information relevant to an individual's unique clinical condition and comorbidities and therefore could not be answered by existing commercial synthesized evidence products. The information scientist's role in these efforts is not to prescribe one form of action over another but to fully represent all strains of evidence, characterizing the state of the literature including elements such as study design and sample characteristics that may affect the applicability of results, to fully and

quickly inform and enable decision-making; all delivered evidence syntheses are designed to be as comprehensive as possible and include a disclaimer that they do not substitute for clinical judgment. The following examples of more recent projects illustrate the dynamic and multifaceted ways in which information scientists can organize, produce, and deliver knowledge to teams working to advance institutional goals. Below we outline the two main categories of our current projects: 1) evidence provision and data collection; 2) research collaborations.

Evidence Provision and Data Collection

Studies have shown that efforts to improve and standardize patient care, such as implementation of evidence-based ordersets and laboratory test utilization management, can reduce inappropriate ordering and save healthcare costs for institutions and patients (Mathias et al. 2016; Elnenaie et al. 2015; Dayal et al, 2015; Zeidan et al. 2013; O'Connor et al. 2009). As part of the institution's mandate to align care with the best available evidence, CKM continues to provide support for developing and updating VUMC's inpatient and outpatient ordersets. As integrated members of the ordersets development team, CKM evaluates the different facets (e.g., diagnoses, lab tests, medications) of clinical ordersets and prepares review summaries for each facet, ensuring all viewpoints in the literature are represented. Sustained engagement with the ordersets development team and purposeful archiving of evidence summaries from previous updates allows CKM to leverage search strategies and other captured tacit knowledge (such as the databases and grey literature sources that are most useful to consult for a particular topic), enabling a streamlined process in which past efforts are not duplicated.

In 2017, CKM paired with diagnostic laboratory teams to provide evidence to help inform decision-making around institutional test offerings. VUMC established a Laboratory Formulary Committee in 2014 that has since been engaged in efforts to improve care value through reductions in unnecessary or inappropriate testing (Zutter, Field, and Bernard 2017; Butcher 2018). As part of this effort, information scientists assist by providing evidence syntheses regarding the clinical utility of a laboratory test in general or for a specific indication for which there is a question of appropriate use. Based on the scope of the request, information scientists develop broad or focused evidence syntheses incorporating both official recommendations, when available, as well as the supporting primary studies. Information scientists capture all identified viewpoints in the literature, and summaries developed for approved indications are further focused to highlight the evidence supporting the specific indication of interest. The overall findings for each question are summarized into "evidence briefs" that quickly distill the content in the packet for quick review by the members of the diagnostic laboratory team.

To support and manage these projects, the team leverages the functionalities of the Clinical Systems Knowledge Acquisition and Archival Tool (CS-KAAT) (DesAutels et al. 2018). Evidence syntheses for ordersets and laboratory tests are stored in CS-KAAT, which provides the ability through descriptive data to link, for example, diagnostic test records with ordersets in which those tests appear, thereby also linking the associated evidence. The tool also enables distribution of completed summaries, as appropriate, to clinical teams through tailored access. For example, laboratory evidence syntheses are made available through a custom

interface to provide ongoing access to a restricted set of users from the laboratory team. The interface allows for quick review of the “evidence briefs,” as well as access to the full summary, search strategies, and related citations alongside key metadata about the laboratory test itself. To facilitate ongoing review and updates of the content, each summary in CS-KAAT is also assigned a maintenance level based on the currency and stability of the evidence on the topic, prompting automated alerts on a predefined schedule.

In addition to helping impact practice at an institutional level, CKM information scientists have also been approached to partner in the development of systematic reviews and guidelines to standardize practice on a broad scale for specific diseases or interventions (Patel et al. 2018; Deppen et al. 2016; Morandi et al. 2012). Based on our professional expertise and past experience partnering with the former Vanderbilt Evidence-based Practice Center in the development of Agency for Healthcare Research and Quality (AHRQ) comparative effectiveness reviews, the team is equipped to guide VUMC community members through the entire systematic review process, including protocol development, conducting expert literature retrieval, study selection and screening, assessing strength of evidence and risk of bias, data extraction, and finally, writing for publication. CKM devised a stepped-approach list of levels of systematic review elements which allows researchers to customize the level of assistance needed. Currently, a CKM information scientist is working with a team of clinical experts to assist in the development of a set of clinical guidelines for a pediatric condition for which no definitive guidelines are currently available.

With the business of healthcare demanding an evidence-based approach to all facets of decision-making, we now see our skills also being heavily requested by information technology teams. Electronic health records (EHRs) are becoming more and more integral as they aid in the collection and management of data needed for comprehensive healthcare. Informatics and health information technology teams are charged with optimizing both system performance and data utilization. For a recent upgrade of the medical record system at VUMC, CKM developed a model for extracting, evaluating, and organizing best practice implementation data from published and grey literature sources (e.g., user forums, conference proceedings, EHR documentation, technical white papers) which are notably difficult to find (DesAutels 2019). Given the knowledge gap in the EHR implementation literature, CKM was charged with providing and organizing an evidence-based framework to best inform informatics/HealthIT implementation decisions.

Research Collaborations

Center for Knowledge Management information scientists have developed experience with patient recruitment and study design through the conduct of original research to develop and evaluate best practices for patient communication and professional education informed by health literacy and learning styles (Giuse et al. 2012; Koonce et al. 2013; Koonce et al. 2015; Giuse et al. 2016; Kusnoor et al. 2016; Micheel et al. 2017). The team is actively sought as valued partners for collaborative research projects, while continuing to lead independent research initiatives originated by CKM. These efforts span the full range of precision/personalized medicine, including investigation of drugs targeted to specific genetic mutations; evaluation of

questionnaires to standardize collection of data across clinical settings on the social and behavioral factors that affect health; and substantiating content for a research project aimed at educating clinical trial recruiters on best practices for enrollment of underrepresented populations (Frakes 2019). Information scientists' intimate knowledge of the biomedical literature and ability to organize information extracted from various sources into packaged, consumable, and sharable knowledge products are also recognized by our research partners as key catalysts for discovery.

Accelerating Drug Development and Repurposing Incubator

Given the increasing time and cost of new drug development, a multidisciplinary team of experts known as the VUMC Accelerating Drug Development and Repurposing Incubator (ADDRI) is working to identify and evaluate existing drugs with potential for repurposing. They seek new drug indications that target proteins of interest using gene-disease associations from phenome-wide association studies (PheWAS) (Naylor et al. 2018; Pulley et al. 2017). Composed of researchers from the basic and clinical sciences, legal experts, and other stakeholders, the team requires an information scientist with expertise in biochemistry and knowledge of relationships between genes, proteins, pathways, and disease. In response to requests for evidence reviews to validate identified relationships between genetic mutation and phenotype, the CKM information scientist locates and compiles data from multiple databases and resources, in addition to peer reviewed and preprint literature. This work requires an understanding of protein expression, structure, and function to correctly interpret collective evidence and prediction algorithms to answer the original question and support decision-making with regard to advancing the drug for further investigation. ADDRI's approach reduces the projected average time required to initiate and validate a drug discovery project from years to months and has already resulted in several projects reaching Phase II clinical trials, targeted to conditions across the clinical spectrum (Naylor et al. 2018).

Social and Behavioral Determinants Research

The CKM team has also partnered in a series of studies to understand social, behavioral, and economic factors that impact individuals' health, which are collectively referred to as social determinants of health. The first study evaluated a set of measures recommended by the Institute of Medicine (now called the National Academy of Medicine) Committee on Recommended Social and Behavioral Measures for Electronic Health Records (Giuse et al. 2017). For this project, information scientists collaborated with the two Committee co-chairs, which included VUMC's Chief Strategy Officer, as well as colleagues from the University of California, San Francisco. Because the questions identified by the Committee were obtained from multiple instruments, the team initially worked to harmonize them into a single questionnaire. Using an online patient sample, the study evaluated the feasibility of administering the combined question panel, assessed the effect of question order, determined completion time rates, and investigated unanswered question response patterns. The second study replicated the feasibility findings and additionally found an association between the measures with self-reported health (Prather et al. 2017).

After completing these projects, CKM initiated further research on assessment of social determinants of health specifically in the community clinic setting, where social and behavioral determinants are highly likely to play a role in health (Koonce et al. 2017; Kusnoor et al. 2018). This study used questions from the Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences (PRAPARE), an instrument that had been developed specifically for the community clinic population (National Association of Community Health Centers 2016). In addition, the team included questions from the National Academy Medicine questionnaire (Adler and Stead 2015) that had not been addressed by PRAPARE and also added two questions from the Federal Reserve Board's Survey of Household Economics and Decisionmaking to better understand financial strain (Board of Governors of the Federal Reserve Board 2017). The study results demonstrated the feasibility of using this combined, more holistic questionnaire to evaluate social determinants of health in the community clinic setting.

As a next step of this research, CKM began to explore how to connect patients to local services after identifying social needs with the evaluated instruments. Using skills in metadata and knowledge management, information scientists created a database of community resources in the Nashville area to help address needs identified through the social determinants of health questionnaire administered to community clinic patients. The database is freely available to others through our Center for Knowledge Management website.

All of Us Research Program

All of Us (AoU) is a federally-funded research study seeking to enroll a diverse sample of 1 million participants across the United States to investigate how individual genetic, lifestyle, behavioral, and environmental factors impact health (Collins and Varmus 2015). As part of the preparatory/pilot phase of this initiative, CKM information scientists contributed to the development of participant survey instruments by locating and extracting information from published validation studies for survey questions of interest, including details on the study design and characteristics of the validation population. Leveraging expertise in literacy, social determinants of health, study design/appraisal, and information retrieval, information scientists have also provided advice on versioning tools, conducted pilot interviews of potential participants, and provided quality control of survey question provenance. CKM continues to be actively involved in this important national collaborative project. Recent contributions include the collection and compilation of validation studies of social determinants of health measures for use in the continuing development of AoU online patient surveys; collaboration on the design and structure of an AoU survey question portal designed for researcher access; and conducting a competitive landscape analysis of large-scale high quality longitudinal cohort studies in support of the design of a "Research Hub" for access to AoU data by researchers and citizen scientists.

Evaluation

Given the breadth and depth of the range of programs in which CKM is integrated, ongoing evaluation of these efforts is critical for process refinement and communication of the team's effectiveness and impact to medical center leadership. As part of VUMC's annual

evaluation process, CKM solicits feedback from collaborators using a survey that asks respondents to rate outcomes resulting from the provided information, such as “knowledge gained” and “improved patient care,” on a Likert scale from 1 (low) to 7 (high). Information scientists’ evidence products are also evaluated by their peers, using similar items, to assess their efficacy from the perspective of other highly-trained information professionals. Past evaluations have yielded positive results, with all CKM team member evaluations receiving high scores from external collaborators. Collecting this data has allowed CKM to track outcomes over time to ensure consistency of quality as personnel and projects change. Qualitative user feedback is also tracked throughout the year and compiled and reported to leadership to supplement the findings from the formal survey. Internally, all individuals on the team are annually evaluated by their peers through a 360° performance review process, as many of the projects include both internal and external collaborators. As a result, CKM staff become very aware of their peers’ skillsets and in turn remain invested in contributing their highest quality product to VUMC. Thus, the 360° review provides the team with a highly personalized understanding of both the caliber of their skills and opportunities for quality improvement. Additionally, formal evaluations of the Clinical Informatics Consult Service (Mulvaney et al. 2008), as well as subsequent systematic reviews of evidence services delivered by biomedical information scientists in general, have found that these services can inform clinicians’ decision-making, save time, and impact patient care (Perrier et al. 2014; Brettle et al. 2010).

Conclusions

Vanderbilt University Medical Center’s healthcare advancements in education, patient care, and research created the perfect opportunity for CKM to develop into the type of special information scientist group capable of fully participating as partners in the multitude of projects and collaborations described in this paper. Through years of development and refinement of a robust infrastructure support framework, CKM’s information professionals have been able to combine their expertise in information science with rapidly-acquired, in-depth content knowledge and contribute a uniqueness of skills while understanding the roles and processes of all partners. By focusing the team effort on scalable projects and establishing mechanisms for documenting, accessing, and building upon existing knowledge, CKM ensures the impact of our work is not only on the individual team or clinician who receives an evidence summary or research product, but also on the organization as a whole. The knowledge gained feeds into VUMC’s learning health system and aids in guiding both the practice and advancement of healthcare.

References

- Adler, Nancy E. and William W. Stead. 2015. "Patients in Context--EHR Capture of Social and Behavioral Determinants of Health." *New England Journal of Medicine* 372 (8): 698-701. <https://doi.org/10.1056/NEJMp1413945>.
- Board of Governors of the Federal Reserve Board. 2017. "Report on the Economic Well-being of U.S. Households in 2016." Accessed February 2, 2019. <https://www.federalreserve.gov/publications/2017-economic-well-being-of-us-households-in-2016-economic-preparedness.htm>.
- Brettle, Alison, Michelle Maden-Jenkins, Lucy Anderson, Rosalind McNally, Tracey Pratchett, Jenny Tancock, Debra Thornton, and Anne Webb. 2011. "Evaluating Clinical Librarian Services: A Systematic Review." *Health Information and Libraries Journal* 28 (1): 3-22. <https://doi.org/10.1111/j.1471-1842.2010.00925.x>.
- Butcher, Lola. 2018. "Using a Lab Formulary to Improve Value." *HFMA Leadership*, December 18, 2018. Accessed February 2, 2019. https://www.hfma.org/Leadership/E-Bulletins/2018/December/Using_a_Lab_Formulary_to_Improve_Value/
- Collins, Francis S. and Harold Varmus. 2015. "A New Initiative on Precision Medicine." *New England Journal of Medicine* 372: 793-5. <https://doi.org/10.1056/NEJMp1500523>.
- Dayal, Anuradha and Francisco Alvarez. 2015. "The Effect of Implementation of Standardized, Evidence-Based Order Sets on Efficiency and Quality Measures for Pediatric Respiratory Illnesses in a Community Hospital." *Hospital Pediatrics* 5 (12): 624-9. <https://doi.org/10.1542/hpeds.2015-0140>.
- Deppen, Stephen A., Jeffrey Blume, Adam J. Bobbey, Chirayu Shah, Michael M. Graham, Patricia Lee, Dominique Delbeke, and Ronald C. Walker. 2016. "68Ga-DOTATATE Compared with 111In-DTPA-Octreotide and Conventional Imaging for Pulmonary and Gastroenteropancreatic Neuroendocrine Tumors: A Systematic Review and Meta-Analysis." *Journal of Nuclear Medicine* 57 (6): 872-8. <https://doi.org/10.2967/jnumed.115.165803>.
- DesAutels, Spencer J., Dario A. Giuse, Annette M. Williams, Zachary E. Fox, Mallory N. Blasingame, and Nunzia B. Giuse. 2019. "EHR Implementation: Quantifying a Costly Communication and Knowledge Gap." Presented at American Medical Informatics Association Clinical Informatics, Atlanta, GA, May 2019.
- DesAutels, Spencer J., Mary M. Zutter, Annette M. Williams, Dario A. Giuse, Zachary E. Fox, Megan Youngblood, William W. Stead, and Nunzia B. Giuse. 2018. "Integrating Evidence to Inform Lab Test Selection into a Knowledge Management Framework."

Presented at American Medical Informatics Association Clinical Informatics, Scottsdale, AZ, May 2018.

DesAutels, Spencer J., Zachary E. Fox, Dario A. Giuse, Annette M. Williams, Qinghua H. Kou, Asli Weitkamp, Neal R. Patel, and Nunzia B. Giuse. 2017. "Using Best Practices to Extract, Organize, and Reuse Embedded Decision Support Content Knowledge Rules from Mature Clinical Systems." *AMIA Annual Symposium Proceedings* 2016: 504-13. <https://www.ncbi.nlm.nih.gov/pubmed/28269846>.

Elnenaie, Manal O., Samuel G. Campbell, Andrea J. Thoni, Amy Lou, Bryan D. Crocker, and Bassam A. Nassar. 2016. "An Effective Utilization Management Strategy by Dual Approach of Influencing Physician Ordering and Gate Keeping." *Clinical Biochemistry* 49 (3): 208-12. <https://doi.org/10.1016/j.clinbiochem.2015.11.005>.

Fox, Zachary E., Elizabeth T. Frakes, Jing Su, Mallory N. Blasingame, Marcia Epelbaum, Spencer J. DesAutels, Qinghua Kou, Annette M. Williams, and Nunzia B. Giuse. "Applying Knowledge Management Best-Practices to Capture, Support, and Archive Systems-Embedded Clinical Decision Support Evidence." Presented at the Medical Library Association Annual Meeting, Seattle, WA, May 2017.

Frakes, Elizabeth T., Sheila V. Kusnoor, Taneya Y. Koonce, Mallory N. Blasingame, Maria Victoria Villalta Gil, Consuelo H. Wilkins, and Nunzia B. Giuse. 2019. "Faster Together: Facilitating the Recruitment of Minorities in Clinical Trials through Modular, Evidence-based Training Using Coursera." Poster presented at the Medical Library Association Annual Meeting, Chicago, IL, May 2019.

Friedman, Charles, Joshua Rubin, Jeffrey Brown, Melinda Buntin, Milton Corn, Lynn Etheredge, Carl Gunter, et al. 2015. "Toward a Science of Learning Systems: A Research Agenda for the High-Functioning Learning Health System." *Journal of the American Medical Informatics Association: JAMIA* 22 (1): 43-50. <https://doi.org/10.1136/amiajnl-2014-002977>.

Giuse, Nunzia B., Taneya Y. Koonce, Sheila V. Kusnoor, Aric A. Prather, Laura M. Gottlieb, Li-Ching Huang, Sharon E. Phillips, Yu Shyr, Nancy E. Adler, and William W. Stead. 2017. "Institute of Medicine Measures of Social and Behavioral Determinants of Health: A Feasibility Study." *American Journal of Preventive Medicine* 52 (2): 199-206. <https://doi.org/10.1016/j.amepre.2016.07.033>.

Giuse, Nunzia B., Sheila V. Kusnoor, Taneya Y. Koonce, Helen M. Naylor, Sheau-Chiann Chen, Mallory Blasingame, Ingrid A. Anderson, et al. 2016. "Guiding Oncology Patients through the Maze of Precision Medicine." *Journal of Health Communication* 21 (Suppl 1): 5-17. <https://doi.org/10.1080/10810730.2015.1131772>.

Giuse, Nunzia B., Sheila V. Kusnoor, Taneya Y. Koonce, Christopher R. Ryland, Rachel R. Walden, Helen M. Naylor, Annette M. Williams, and Rebecca N. Jerome. 2013. "Strategically Aligning a Mandala of Competencies to Advance a Transformative

- Vision.” *Journal of the Medical Library Association* 101 (4): 261-7.
<https://doi.org/10.3163/1536-5050.101.4.007>.
- Giuse, Nunzia B., Taneya Y. Koonce, Alan B. Storrow, Sheila V. Kusnoor, and Fei Ye. 2012. “Using Health Literacy and Learning Style Preferences to Optimize the Delivery of Health Information.” *Journal of Health Communication* 17 (Suppl 3): 122-40.
<https://doi.org/10.1080/10810730.2012.712610>.
- Giuse, Nunzia B., Annette M. Williams, and Dario A. Giuse. 2010. “Integrating Best Evidence into Patient Care: A Process Facilitated by a Seamless Integration with Informatics Tools.” *Journal of the Medical Library Association* 98 (3): 220-2.
<https://doi.org/10.3163/1536-5050.98.3.009>.
- Giuse, Nunzia B., Taneya Y. Koonce, Rebecca N. Jerome, Molynda Cahall, Nila A. Sathe, and Annette Williams. 2005. “Evolution of a Mature Clinical Informationist Model.” *Journal of the American Medical Informatics Association* 12 (3): 249-55.
<https://www.ncbi.nlm.nih.gov/pubmed/15684125/>.
- Health Insurance Portability and Accountability Act of 1996 (HIPAA). Pub. L. No. 104-191 (1996).
- Institute of Medicine. 2013. “Best Care at Lower Cost: The Path to Continuously Learning Health Care in America.” Washington, DC: The National Academies Press.
<https://doi.org/10.17226/13444>.
- Jerome, Rebecca N., Nunzia B. Giuse, S. Trent Rosenbloom, and Patrick G. Arbogast. 2008. “Exploring Clinician Adoption of a Novel Evidence Request Feature in an Electronic Medical Record System.” *Journal of the Medical Library Association* 96 (1): 34-41.
<https://doi.org/10.3163/1536-5050.96.1.34>.
- Jerome, Rebecca N., Nunzia B. Giuse, Kimbra W. Gish, Nila A. Sathe, and Mary S. Dietrich. 2001. “Information Needs of Clinical Teams: Analysis of Questions Received by the Clinical Informatics Consult Service.” *Bulletin of the Medical Library Association* 89 (2): 177-84. <https://www.ncbi.nlm.nih.gov/pubmed/11337949>.
- Koonce, Taneya Y., Sheila V. Kusnoor, Suzanne T. Hurley, Kalonji M. McClellan, and Nunzia B. Giuse. 2017. “Combining Social and Behavioral Determinants of Health Questionnaires to Inform Precision Medicine in a Community Health Center Clinic.” Poster presented at the American Medical Informatics Association Fall Symposium, Washington, D.C., November 7, 2017.
<https://amia2017.zerista.com/event/member/389702>.
- Koonce, Taneya Y., Sheila V. Kusnoor, Nunzia B. Giuse, Suzanne Hurley, and Fei Ye. 2015. “A Personalized Approach to Deliver Health Care Information to Diabetic Patients in Community Care Clinics.” *Journal of the Medical Library Association* 103 (3): 123-30.
<https://doi.org/10.3163/1536-5050.103.3.004>.

- Koonce, Taneya Y., Nunzia B. Giuse, Songphan Choemprayong, Suzanne Hurley, Sandra L. Martin, Marcia Epelbaum, and Sheila V. Kusnoor. 2013. "Using Personalized Education Delivery to Improve Community Clinic Patient's Knowledge of Hypertension." Special Libraries Association Annual Meeting, San Diego, CA, June 2013.
http://dbiosla.org/events/past_sla_conference/San%20Diego/Personalized%20Education%20Delivery_Final%20Paper_2013.pdf
- Kusnoor, Sheila V., Taneya Y. Koonce, Suzanne T. Hurley, Kalonji M. McClellan, Mallory N. Blasingame, Elizabeth T. Frakes, Li-Ching Huang, Marcia I. Epelbaum, and Nunzia B. Giuse. 2018. "Collection of Social Determinants of Health in the Community Clinic Setting: A Cross-Sectional Study." *BMC Public Health* 18 (1): 550.
<https://doi.org/10.1186/s12889-018-5453-2>.
- Kusnoor, Sheila V., Taneya Y. Koonce, Mia A. Levy, Christine M. Lovly, Helen M. Naylor, Ingrid A. Anderson, Christine M. Micheel, Sheau-Chiann Chen, Fei Ye, and Nunzia B. Giuse. 2016. "My Cancer Genome: Evaluating an Educational Intervention Model to Introduce Patients and Caregivers to Precision Medicine." *AMIA Joint Summits Translational Science Proceedings* 2016: 112-21.
<https://www.ncbi.nlm.nih.gov/pubmed/27570660>.
- Mathias, Patrick C., Jessie H. Conta, Eric Q. Konnick, Darci L. Sternen, Shannon M. Stasi, Bonnie L. Cole, Michael L. Astion, and Jane A. Dickerson. 2016. "Preventing Genetic Testing Order Errors with a Laboratory Utilization Management Program." *American Journal of Clinical Pathology* 146 (2): 221-6. <https://doi.org/10.1093/ajcp/aqw105>.
- Micheel, Christine M., Ingrid A. Anderson, Patricia Lee, Sheau-Chiann Chen, Katy Justiss, Nunzia B. Giuse, Fei Ye, Sheila V. Kusnoor, and Mia A. Levy. 2017. "Internet-Based Assessment of Oncology Health Care Professional Learning Style and Optimization of Materials for Web-Based Learning: Controlled Trial With Concealed Allocation." *Journal of Medical Internet Research* 19 (7): e265. <https://doi.org/10.2196/jmir.7506>.
- Morandi, Alessandro, Jessica McCurley, Eduard E. Vasilevskis, Donna M. Fick, Giuseppe Bellelli, Patricia Lee, James C. Jackson, et al. 2012. "Tools to Detect Delirium Superimposed on Dementia: A Systematic Review." *Journal of the American Geriatrics Society* 60 (11): 2005-13. <https://doi.org/10.1111/j.1532-5415.2012.04199.x>.
- Mulvaney, Shelagh A., Leonard Bickman, Nunzia B. Giuse, E. Warren Lambert, Nila A. Sathe, and Rebecca N. Jerome. 2008. "A Randomized Effectiveness Trial of a Clinical Informatics Consult Service: Impact on Evidence-based Decision-making and Knowledge Implementation." *Journal of the American Medical Informatics Association* 15 (2): 203-11. <https://www.ncbi.nlm.nih.gov/pubmed/18096918>

- National Association of Community Health Centers. 2016. "PRAPARE." Version dated September 2, 2016. Accessed February 2, 2019. <http://www.nachc.org/research-and-data/prapare/>.
- Naylor, Helen M., Jana K. Shirey-Rice, Nicole M. Zaleski, Rebecca N. Jerome, Robert R. Lavieri, Andrea J. Pruijssers, Somsundaram N. Chettiar, Jill M. Pulley, and Nunzia B. Giuse. "Vanderbilt University Medical Center's Drug Repurposing Program: Using Human Genetic Information to Find Effective and Affordable Therapies." Presented at the American Medical Informatics Association Informatics Summit, San Francisco, CA, March 11-15, 2018.
- O'Connor, Chris, Neill K.J. Adhikari, Katharine DeCaire, and Jan O. Friedrich. 2009. "Medical Admission Order Sets to Improve Deep Vein Thrombosis Prophylaxis Rates and Other Outcomes." *Journal of Hospital Medicine* 4 (2): 81-9. <https://doi.org/10.1002/jhm.399>.
- Patel, Mayur B., Josef Bednarik, Patricia Lee, Yahya Shehabi, Jorge I. Salluh, Arjen J. Slooter, Kate E. Klein, et al. 2018. "Delirium Monitoring in Neurocritically Ill Patients: A Systematic Review." *Critical Care Medicine* 46 (11): 1832-1841. doi: <https://doi.org/10.1097/CCM.0000000000003349>.
- Perrier, Laure, Ann Farrell, A. Patricia Ayala, David Lightfoot, Tim Kenny, Ellen Aaronson, Nancy Allee, et al. 2014. "Effects of Librarian-provided Services in Healthcare Settings: A Systematic Review." *Journal of the American Medical Informatics Association* 21 (6): 1118-24. <https://doi.org/10.1136/amiajnl-2014-002825>.
- Prather, Aric A., Laura M. Gottlieb, Nunzia B. Giuse, Taneya Y. Koonce, Sheila V. Kusnoor, William W. Stead, and Nancy E. Adler. 2017. "National Academy of Medicine Social and Behavioral Measures: Associations with Self-Reported Health." *American Journal of Preventive Medicine* 53 (4): 449-56. <https://doi.org/10.1016/j.amepre.2017.02.010>.
- Pulley, Jill M., Rebecca N. Jerome, Jana K. Shirey-Rice, Nicole M. Zaleski, Helen M. Naylor, Andrea J. Pruijssers, James C. Jackson, Gordon J. Bernard, and Kenneth J. Holroyd. 2018. "Advocating for Mutually Beneficial Access to Shelved Compounds." *Future Medicinal Chemistry* 10 (12): 1395-8. <https://doi.org/10.4155/fmc-2018-0090>.
- Pulley, Jill M., Rebecca N. Jerome, Nicole M. Zaleski, Jana K. Shirey-Rice, Andrea J. Pruijssers, Robert R. Lavieri, Somsundaram N. Chettiar, Helen M. Naylor, et al. 2017. "When Enough Is Enough: Decision Criteria for Moving a Known Drug into Clinical Testing for a New Indication in the Absence of Preclinical Efficacy Data." *Assay and Drug Development Technologies* 15 (8): 354-61. <https://doi.org/10.1089/adt.2017.821>.
- Pulley, Jill M., Jana K. Shirey-Rice, Robert R. Lavieri, Rebecca N. Jerome, Nicole M. Zaleski, David M. Aronoff, Lisa Bastarache, et al. 2017. "Accelerating Precision Drug Development and Drug Repurposing by Leveraging Human Genetics." *Assay and Drug Development Technologies* 15 (3): 113-19. <https://doi.org/10.1089/adt.2016.772>.

PwC Health Research Institute. 2012. "Investing in a Knowledge Organization: Vanderbilt's Knowledge Management Team." In: *Needles in a Haystack: Seeking Knowledge with Clinical Informatics*, 38–9. Pricewaterhouse Coopers.

Rosenbloom, S. Trent, Nunzia B. Giuse, Rebecca N. Jerome, and Jennifer U. Blackford. 2005. "Providing Evidence-based Answers to Complex Clinical Questions: Evaluating the Consistency of Article Selection." *Academic Medicine* 80 (1): 109-14. <https://www.ncbi.nlm.nih.gov/pubmed/15618105>.

Zeidan, Amer M., Michael B. Streiff, Brandyn D. Lau, Syed-Rafay Ahmed, Peggy S. Kraus, Deborah B. Hobson, et al. 2013. "Impact of a Venous Thromboembolism Prophylaxis 'smart order set': Improved Compliance, Fewer Events." *American Journal of Hematology* 88 (7): 545-9. <https://doi.org/10.1002/ajh.23450>.

Zutter, Mary, Julie Field, and Gordon Bernard. 2017. "Improving Care and Cutting Costs: Implementation of a Laboratory Formulary to Facilitate Better Laboratory Ordering Practices." *NEJM Catalyst*, September 20, 2017. <https://catalyst.nejm.org/laboratory-formulary-facilitate-ordering-practices/>