

APPENDIX B

This Appendix presents the *Clinical Informatics Subspecialty Delineation of Practice* developed during the 2018 clinical informatics subspecialty practice analysis that was conducted by AMIA and is described in Silverman HD, Steen EB, Carpenito JC et al. Domains, tasks, and knowledge for clinical informatics subspecialty practice: results of a practice analysis. *J Am Med Inform Assoc* 2019, ocz051, <https://doi.org/10.1093/jamia/ocz051>.

Clinical Informatics Subspecialty Delineation of Practice (CIS DoP)

Domains of Practice

Domain 1: Fundamental Knowledge and Skills

Fundamental knowledge and skills which provide clinical informaticians with a common vocabulary, basic knowledge across all Clinical Informatics domains, and understanding of the environment in which they function.

Domain 2: Improving Care Delivery and Outcomes

Develop, implement, evaluate, monitor, and maintain clinical decision support; analyze existing health processes and identify ways that health data and Health Information Systems can enable improved outcomes; support innovation in the health system through informatics tools and processes.

Domain 3: Enterprise Information Systems

Develop and deploy health information systems that are integrated with existing information technology systems across the continuum of care, including clinical, consumer, and public health domains. Develop, curate, and maintain institutional knowledge repositories while addressing security, privacy, and safety considerations.

Domain 4: Data Governance and Data Analytics

Establish and maintain data governance structures, policies, and processes. Incorporate information from emerging data sources; acquire, manage, and analyze health-related data to ensure its quality and meaning across settings, and to derive insights to optimize clinical and business decision making.

Domain 5: Leadership and Professionalism

Build support and create alignment for informatics best practices; lead health informatics initiatives and innovation through collaboration and stakeholder engagement across organizations and systems.

Tasks and Knowledge & Skills

Domain 1: Fundamental Knowledge and Skills (no Tasks are associated with this Domain that is focused on fundamental knowledge and skills)

Clinical Informatics

- K001. The discipline of informatics (e.g., definitions, history, careers, professional organizations)
- K002. Fundamental informatics concepts, models, and theories
- K003. Core clinical informatics literature (e.g., foundational literature, principle journals, critical analysis of literature, use of evidence to inform practice)
- K004. Descriptive and inferential statistics
- K005. Health Information Technology (HIT) principles and science
- K006. Computer programming fundamentals and computational thinking
- K007. Basic systems and network architectures
- K008. Basic database structure, data retrieval and analytics techniques and tools
- K009. Development and use of interoperability/exchange standards (e.g., Fast Health Interoperability Resources [FHIR], Digital Imaging and Communications in Medicine [DICOM])
- K010. Development and use of transaction standards (e.g., American National Standards Institute X12)
- K011. Development and use of messaging standards (e.g., Health Level Seven [HL7] v2)
- K012. Development and use of ancillary data standards (e.g., imaging and Laboratory Information System[LIS])
- K013. Development and use of data model standards
- K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine -- Clinical Terms [SNOMED-CT], RxNorm, International Classification Of Diseases [ICD], Current Procedural Terminology [CPT])
- K015. Data taxonomies and ontologies
- K016. Security, privacy, and confidentiality requirements and practices
- K017. Legal and regulatory issues related to clinical data and information sharing
- K018. Technical and non-technical approaches and barriers to interoperability
- K019. Ethics and professionalism

The Health System

- K020. Primary domains of health, organizational structures, cultures, and processes (e.g., health care delivery, public health, personal health, population health, education of health professionals, clinical research)
- K021. Determinants of individual and population health

- K022. Forces shaping health care delivery and considerations regarding health care access
- K023. Health economics and financing
- K024. Policy and regulatory frameworks related to the healthcare system
- K025. The flow of data, information, and knowledge within the health system

Domain 2: Improving Care Delivery and Outcomes

Tasks

- 2.01. Develop, implement, evaluate, monitor, and maintain clinical decision support (CDS), in alignment with the Five Rights of CDS (information, person, intervention formats, channel, and point/time in workflow).
- 2.02. Analyze and identify necessary system and process changes to optimize clinical and related workflows.
- 2.03. Assess/evaluate and improve usability of user-facing technology for clinicians using formal methodologies (e.g., usability testing, creating personas, creating use cases)
- 2.04. Identify, execute, interpret, and disseminate measures and/or predictive analytics (e.g., clinical and financial benchmark data, quality performance, regulatory, pay for performance, public health surveillance, patient safety) to provide actionable feedback to improve individual and organizational performance.
- 2.05. Integrate knowledge of patient-specific attributes (e.g., social determinants, genetic data, patient-reported outcomes and preferences, utilization) to determine optimal management and treatment for the individual and populations
- 2.06. Support the development and successful execution of new care delivery models using health information technology (e.g., IT-enabled communication, collaborative workspaces, population health tools).
- 2.07. Ensure continuity of communication and information across transitions of care using health information technology tools and processes.

Knowledge & Skills

- K026. Decision science (e.g., Bayes theorem, decision analysis, probability theory, utility and preference assessment, test characteristics)
- K027. Clinical decision support standards and processes for development, implementation, evaluation, and maintenance
- K028. Five Rights of clinical decision support (i.e., information, person, intervention formats, channel, and point/time in workflow)
- K029. Legal, regulatory, and ethical issues regarding clinical decision support
- K030. Methods of workflow analysis
- K031. Principles of workflow re-engineering
- K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)

- K033. User-centered design principles (e.g., iterative design process)
- K034. Usability testing
- K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)
- K036. Measure development and evaluation processes and criteria
- K037. Key performance indicators (KPIs)
- K038. Claims analytics and benchmarks
- K039. Predictive analytic techniques, indications, and limitations
- K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)
- K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])
- K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])
- K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [CQL], Fast Health Interoperability Resources [FHIR] Clinical Reasoning)
- K044. Reporting requirements
- K045. Methods to measure and report organizational performance
- K046. Adoption metrics (e.g., Electronic Medical Records Adoption Model [EMRAM], Adoption Model for Analytics Maturity [AMAM])
- K047. Social determinants of health
- K048. Use of patient-generated data
- K049. Prediction models
- K050. Risk stratification and adjustment
- K051. Concepts and tools for care coordination
- K052. Care delivery and payment models

Domain 3: Enterprise Information Systems

Tasks

- 3.01. Maintain awareness of healthcare and information technology (IT) landscapes including available products, innovation strategies, emerging technologies, and legal and regulatory requirements to design technical solutions to enterprise challenges.

- 3.02. Develop, evaluate, implement, and participate in a comprehensive system testing plan using functional testing (e.g., unit testing, integration testing, user acceptance testing, regression testing).
- 3.03. Develop, implement, and participate in the Health Information Technology (HIT) upgrade cycle.
- 3.04. Develop, implement, and participate in downtime activities, including recovery.
- 3.05. Determine and specify functional requirements for Electronic Health Records (EHR) and applied Health Information Technology (HIT) systems (e.g., Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS], vendor-neutral archive, pharmacy, revenue cycle), perform vendor evaluation, and select product(s).
- 3.06. Implement, integrate, monitor, evaluate, and maintain Electronic Health Records (EHR) and applied Health Information Technology (HIT) systems, in collaboration with IT staff, based on clinical expertise and best practice to support optimum clinical workflow.
- 3.07. Develop, implement, evaluate and/or integrate portals and other consumer-facing health informatics applications (e.g., disease management, patient education, behavior modification)
- 3.08. Reconcile requirements for clinical integration of data with technical constraints in order to maintain connectivity, interfacing, and validity of content between systems and clinical areas.
- 3.09. Balance user roles and requirements with security, privacy, and safety considerations to determine appropriate system access.
- 3.10. Inventory, evaluate, monitor, and optimize use of various channels used for internal and external messaging to ensure effective and secure communication.
- 3.11. Participate in ongoing security threat assessments, development of clinician facing security policy, and reinforce security training and policies with clinical staff.
- 3.12. Develop, curate, and maintain institutional knowledge repositories to ensure continuity of information systems knowledge across staff transitions and care settings.
- 3.13. Integrate, monitor, evaluate, and maintain connections to external data sources (e.g., registries, exchanges).
- 3.14. Provide clinical input into defining data matching strategies and maintaining master patient index to ensure integrity of patient data sourced across multiple systems.
- 3.15. Assess and prioritize the integration of data from medical devices (e.g., pumps, telemetry monitors, consumer devices) into information systems.
- 3.16. Design and implement strategy for effective use of telehealth (e.g., clinical use cases, software, hardware, staff).

Knowledge & Skills

- K053. Health information technology landscape (e.g., innovation strategies, emerging technologies)
- K054. Institutional governance of clinical information systems
- K055. Information system maintenance requirements
- K056. Information needs analysis and information system selection
- K057. Information system implementation procedures
- K058. Information system evaluation techniques and methods
- K059. Information system and integration testing techniques and methodologies
- K060. Enterprise architecture (databases, storage, application, interface engine)
- K061. Methods of communication between various software components
- K062. Network communications infrastructure and protocols between information systems (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], switches, routers)
- K063. Types of settings (e.g., labs, ambulatory, radiology, home) where various systems are used
- K064. Clinical system functional requirements
- K065. Models and theories of human-computer (machine) interaction (HCI)
- K066. HCI evaluation, usability engineering and testing, study design and methods
- K067. HCI design standards and design principles
- K068. Functionalities of clinical information systems (e.g., Electronic Health Records [EHR], Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS] vendor-neutral archive, pharmacy, revenue cycle)
- K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)
- K070. User types and roles, institutional policy and access control
- K071. Clinical communication channels and best practices for use (e.g., secure messaging, closed loop communication)
- K072. Security threat assessment methods and mitigation strategies
- K073. Security standards and safeguards
- K074. Clinical impact of scheduled and unscheduled system downtimes
- K075. Information system failure modes and downtime mitigation strategies (e.g., replicated data centers, log shipping)
- K076. Approaches to knowledge repositories and their implementation and maintenance
- K077. Data storage options and their implications
- K078. Clinical registries
- K079. Health information exchanges
- K080. Patient matching strategies

- K081. Master patient index
- K082. Data reconciliation
- K083. Regulated medical devices (e.g., pumps, telemetry monitors) that may be integrated into information systems
- K084. Non-regulated medical devices (e.g., consumer devices)
- K085. Telehealth workflows and resources (e.g., software, hardware, staff)

Domain 4: Data Governance and Data Analytics

Tasks

- 4.01. Collaborate in the establishment and maintenance of data governance structures, policies, and processes that encompass data quality, integrity, security, access, data domain management, definition of clinical and business cohorts, oversight and application of data standards, data provenance/lineage, metadata, and data dictionaries/definitions.
- 4.02. Develop, implement, and/or leverage data lifecycle processes for defining sources, and acquiring, storing, cleaning, and ensuring integrity of data to safeguard the availability of relevant and valid data to meet clinical, quality, research, business, and strategic objectives.
- 4.03. Advance/foster semantic interoperability by utilizing data taxonomies to digest, harmonize, and transform data from disparate health information systems to allow computable data availability for clinical care and analytics.
- 4.04. Apply data management techniques (e.g., concept mapping, extract, transform, load [ETL], and validation) to maintain meaning (concept and semantic integrity).
- 4.05. Access and incorporate information from emerging data sources (e.g., imaging, bioinformatics, internet of things (IoT), patient-generated, social determinants) to augment the practice of precision medicine.
- 4.06. Create, enhance, and/or leverage information architecture to efficiently store, query, and retrieve data from large data sets.
- 4.07. Interpret information and apply knowledge gained from data sets using descriptive, diagnostic, predictive, and prescriptive analytic approaches to derive actionable insights.
- 4.08. Employ and deploy advanced and emerging data mining and analytic techniques (including but not limited to data visualization, artificial intelligence, natural language processing, machine learning) to optimize clinical and business decision-making.
- 4.09. Plan and promote longevity and persistence of institutional data infrastructure by developing strategies for the accumulation, curation, and documentation of data sources and metadata.
- 4.10. Participate in regional data sharing through health information exchanges, public health reporting, or other mechanisms.

Knowledge & Skills

- K086. Stewardship of data
- K087. Regulations, organizations, and best practice related to data access and sharing agreements, data use, privacy, security, and portability
- K088. Metadata and data dictionaries
- K089. Data life cycle
- K090. Transactional and reporting/research databases
- K091. Techniques for the storage of disparate data types
- K092. Techniques to extract, transform, and load data
- K093. Data associated with workflow processes and clinical context
- K094. Data management and validation techniques
- K095. Standards related to storage and retrieval from specialized and emerging data sources
- K096. Types and uses of specialized and emerging data sources (e.g., imaging, bioinformatics, internet of things (IoT), patient-generated, social determinants)
- K097. Issues related to integrating emerging data sources into business and clinical decision making
- K098. Information architecture
- K099. Query tools and techniques
- K100. Flat files, relational and non-relational/NoSQL database structures, distributed file systems
- K101. Definitions and appropriate use of descriptive, diagnostic, predictive, and prescriptive analytics
- K102. Analytic tools and techniques (e.g., Boolean, Bayesian, statistical/mathematical modeling)
- K103. Advanced modeling and algorithms
- K104. Artificial intelligence
- K105. Machine learning (e.g., neural networks, support vector machines, Bayesian network)
- K106. Data visualization (e.g., graphical, geospatial, 3D modeling, dashboards, heat maps)
- K107. Natural language processing
- K108. Precision medicine (customized treatment plans based on patient-specific data)
- K109. Knowledge management and archiving science
- K110. Methods for knowledge persistence and sharing
- K111. Methods and standards for data sharing across systems (e.g., health information exchanges, public health reporting)

Domain 5: Leadership and Professionalism

Tasks

- 5.01. Identify informatics trends, best practices, and new technologies and utilize governance processes to position the organization for future opportunities.
- 5.02. Establish and/or participate in Health Information Technology (HIT) governance to support strategic and financial planning, including formulation, implementation, and evaluation.
- 5.03. Participate in the development of organizational health informatics goals, strategies and tactics in alignment with the mission and vision of the organization.
- 5.04. Improve care delivery and outcomes and advance the mission of the organization through effective communication, negotiation, and conflict management.
- 5.05. Build support and create alignment for informatics best practices to ensure all stakeholders are active, visible sponsors of informatics within their respective roles.
- 5.06. Leverage the processes and principles of project management to drive the successful completion of projects on time, within scope, and within budget.
- 5.07. Lead and manage planned and unplanned changes associated with implementing and optimizing clinical information systems to promote adoption by health professionals.
- 5.08. Engage, educate, supervise, and/or mentor clinicians and other healthcare team members in their use of clinical informatics tools, systems, and processes.
- 5.09. Manage and advance collaboration with healthcare team members, patients, members of the care community, external organizations, and vendors.

Knowledge & Skills

- K112. Environmental scanning and assessment methods and techniques
- K113. Consensus building, collaboration, and conflict management
- K114. Business plan development for informatics projects and activities (e.g., return on investment, business case analysis, pro forma projections)
- K115. Basic revenue cycle
- K116. Basic managerial/cost accounting principles and concepts
- K117. Capital and operating budgeting
- K118. Strategy formulation and evaluation
- K119. Approaches to establishing Health Information Technology (HIT) mission and objectives
- K120. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication
- K121. Effective communication programs to support and sustain systems implementation
- K122. Writing effectively for various audiences and goals

- K123. Negotiation strategies, methods, and techniques
- K124. Conflict management strategies, methods, and techniques
- K125. Change management principles, models, and methods
- K126. Assessment of organizational culture and behavior change theories
- K127. Theory and methods for promoting the adoption and effective use of clinical information systems
- K128. Motivational strategies, methods, and techniques
- K129. Basic principles and practices of project management
- K130. Project management tools and techniques
- K131. Leadership principles, models, and methods
- K132. Intergenerational communication techniques
- K133. Coaching, mentoring, championing and cheerleading methods
- K134. Adult learning theories, methods, and techniques
- K135. Teaching modalities for individuals and groups
- K136. Methods to assess the effectiveness of training and competency development
- K137. Principles, models, and methods for building and managing effective interdisciplinary teams
- K138. Team productivity and effectiveness (e.g., articulating team goals, defining rules of operation, clarifying individual roles, team management, identifying and addressing challenges)
- K139. Group management processes (e.g., nominal group, consensus mapping, Delphi method)