LEARNING OBJECTIVES: EL Clinical Informatics & Data Science

Overarching Goals	**Learning Objectives: By the end of the rotation, students will be expected to:**	**Where/how taught** *(location or learning activity)*	**Taught by** *(attending, fellows, etc.)*	**How student's achievement of objective is assessed** *(assessment method)*	**How feedback is given** *(feedback method)*	**Quantity target** *(target number of patients/ events during rotation)*
2, 3, 5	1. **Information gathering skills:** Gather the important information that is needed for the four case histories provided and complete concept mapping using medical language. a. The student should be able to identify pertinent positive and negative information present in the clinical case as drawn from both history, physical exam, laboratory and imaging investigations b. The student will give a clear, concise oral presentation of the pathophysiological concept mapping performed	Section of Biomedical Informatics and Data Science and Yale New Haven Health System Digital & Technology Solutions	Faculty, fellows, and associated hospital digital & technology solutions staff	The first workshop of the elective will run students through four clinical cases, given the task of concept mapping[1]; linking clinical information via pathophysiological explanation to explicate a set of generated differential diagnoses.	Feedback will be given through a group discussion of the accuracy of the aggregate concept map of all students	4
1, 2, 3, 4, 5	2. **Documentation and translation of physical examination skills:** Using knowledge of the pertinent physical examination for the evaluation of the four case histories provided and complete concept mapping using the structured terminologies/vocabularies learned during the elective. a. Performing this concept mapping with the extension of structured	Section of Biomedical Informatics and Data Science and Yale New Haven Health System Digital &	Faculty, fellows, and associated hospital digital & technology solutions staff	The second workshop of the elective will run students through the four clinical cases in the first workshop, creating concept mapping linking clinical	Feedback will be given through a group discussion of the accuracy of the aggregate concept map of all students	4

[1] See the use of a concept map for physiology education in Engelberg JO. Complex medical case histories as portals to medical practice and integrative, scientific thought. Advances in Physiology Education. 1992 Dec;263(6):S45. For broader discussion of concept maps in UME more broadly, see Fonseca M, Marvão P, Oliveira B, Heleno B, Carreiro-Martins P, Neuparth N, Rendas A. The effectiveness of concept mapping as a tool for developing critical thinking in undergraduate medical education–a BEME systematic review: BEME Guide No. 81. Medical Teacher. 2023 Nov 17:1-4.

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	terminologies/vocabularies will result in the student being able to improve their differential diagnostic performance during a clear, concise oral presentation b. The student should be able to explain each identified piece of clinical information, why it is being performed and what abnormalities are being sought.	Technology Solutions		information via pathophysiological explanation to generate a set of differential diagnoses using the structured terminologies/vocabularies learned during clinical informatics education		
1, 2, 3, 4, 5, 6, 7, 8	3. **Application of knowledge/diagnostic and treatment skills:** Develop an understanding of how clinical informatics is capable of improving care delivery and outcomes. Through a written report and oral presentation of a diagnostic or treatment problem and clinical decision support solution related to their specialty of interest: a. Demonstrate an understanding of the basic principles of decision support (such as the 'five rights') b. Within the Epic EMR instance at YNHH, use SlicerDicer to investigate the clinical problem related to the proposed decision support system c. Within the Epic EMR instance at YNHH, use Reporting Workbench to run real-time	Section of Biomedical Informatics and Data Science and Yale New Haven Health System Digital & Technology Solutions	Faculty, fellows, and associated hospital digital & technology solutions staff	Students will identify a clinical diagnostic or treatment problem amenable to the application of clinical decision support. With guidance students will both propose and implement a decision support system to be deployed within YNHH and defend it to a panel of	A report will be written and orally presented by each student and graded by faculty according to this learning objective	1

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	reports related to the proposed decision support system d. Within the Epic EMR instance at YNHH, use LogicStream to investigate orders or order panels related to the proposed decision support system e. Evaluate and critique examples of Best Practice Alerts previously reviewed by the MIOs f. Implement the clinical decision support system as at minimum a prototype within the YNHH electronic medical record i. Through an evaluation of the technical solution presented, the solution must demonstrate feasibility given the explained clinical context g. Describe how the first line therapy for the clinical problem selected will be altered by the clinical decision support system Identify, execute, interpret, and disseminate measures and/or predictive analytics a. Within the Epic EMR instance at YNHH, use SlicerDicer to investigate a clinical problem related to their specialty of interest b. Within the Epic EMR instance at YNHH, use Reporting Workbench to run real-time reports related to their specialty of interest			faculty at the end of the rotation		

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	c. Within the Epic EMR instance at YNHH, use LogicStream to investigate orders or order panels related to their specialty of interest d. Evaluate and critique prior data requests sent to the Joint Data Analytics Team by IRES/clinical service lines relevant to their specialty of interest As part of the final report describing clinical problems and the design of a clinical decision support system in their specialty of interest a. Analyze and identify necessary system and process changes to optimize clinical and related workflows b. Assess/evaluate and improve usability of user-facing technology for clinicians using formal methodologies (e.g., usability testing, creating personas, creating use cases) a. Within their specialty of interest, use Care Signature pathways to evaluate and critique existing work relative to principles of human factors usability and human computer interaction design					
1,3,4,7,8	4. **Procedural skills:** Develop an understanding of the fundamental knowledge and skills of informatics through lectures and problem sets.	Section of Biomedical Informatics and Data Science and	Faculty, fellows, and associated hospital	Students will be given problem sets and cases to practice the informatics	Problem sets will be marked by faculty and feedback provided	3

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	Use and understand a high-level programming language and the management of basic databases (Python or R): a. Object-oriented programming b. Structured Query Language (SQL) database programming for clinical problems including the use of YNHH data architectures. Develop an understanding of data governance and analytics through the following tasks within a problem set/case: i. Apply data management techniques (e.g., concept mapping, extract, transform, load [ETL], and validation) to maintain meaning (concept and semantic integrity). ii. Interpret information and apply knowledge gained from data sets using descriptive, diagnostic, predictive, and prescriptive analytic approaches to derive actionable insights. iii. 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.	Yale New Haven Health System Digital & Technology Solutions	digital & technology solutions staff	procedural skills, as well as understand their use in clinical context		

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	c. Statistical methods in informatics i. Bayesian and Frequentist principles of decision analysis ii. Basic machine learning techniques (supervised vs. unsupervised techniques) iii. Vanguard topics in artificial intelligence (including but not limited to deep learning, transfer learning, large language models, explainable AI) d. Basic natural language processing (regular expressions, part of speech tagging/parsing, the UMLS) e. Basic data visualization (statistical graphic generation using seaborn/the grammar of graphics depending on programming language) Use and deployment of Application Programming Interfaces (APIs) a. Basic architecture of the web and HTTP protocols Knowledge of vocabularies, terminologies, nomenclatures, data taxonomies and ontologies a. Logical Observation Identifiers Names and Codes [LOINC] b. Systematized Nomenclature of Medicine -- Clinical Terms [SNOMED-CT] c. RxNorm					

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	d. International Classification Of Diseases [ICD] e. Current Procedural Terminology [CPT] f. Observational Medical Outcomes Partnership (OMOP) Common Data Model g. PCORnet Common Data Model Develop and use interoperability/exchange standards a. Fast Health Interoperability Resources [FHIR] b. Digital Imaging and Communications in Medicine [DICOM] Develop and use messaging standards a. Health Level Seven [HL7] v2 b. X12 Healthcare Provider Information Transaction Set (274)					
4, 5, 6	5. **Attitude:** Demonstrate professional responsibility in working as a team member with other members of the clinical informatics service and digital & technology solutions staff within YNHH. a. The student should exhibit honesty, accuracy and integrity in all interactions with all partners within the health system they interact with (e.g. patients, families, colleagues…).	Section of Biomedical Informatics and Data Science and Yale New Haven Health System Digital & Technology Solutions	Faculty, fellows, and associated hospital digital & technology solutions staff	This component will be assessed through participation in rotation activities	Feedback will be provided individually be faculty to students on a weekly basis to reinforce reflective practice	4
5, 6, 8	6. **Career/context:** Know the training/career pathway for clinical informatics. a. Know 3 aspects of career satisfaction in this specialty.	Section of Biomedical Informatics and Data	Faculty, fellows, and associated	This component will be assessed through	Feedback will be given orally during lecture discussion	1

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	b. Know key roles that the specialty plays in the health care system.	Science and Yale New Haven Health System Digital & Technology Solutions	hospital digital & technology solutions staff	participation in lecture discussion		
1,6,7	7. **Enterprise Information Systems:** Understand the development, curation, and maintenance of institutional knowledge repositories to ensure continuity of information systems knowledge across staff transitions and care settings. These include but are not limited to: a. Care Signature b. ServiceNow c. Ellucid d. Epic institutional training documents Participate in the inventory, evaluation, monitoring, and optimization of various channels used for internal and external messaging to ensure effective and secure communication. These include but are not limited to: a. Mobile Heartbeat b. Epic SecureChat c. YNHHS policies and procedures to ensure effective and secure communication	Section of Biomedical Informatics and Data Science and Yale New Haven Health System Digital & Technology Solutions	Faculty, fellows, and associated hospital digital & technology solutions staff	Written report discussing existing knowledge repositories and their ability to solve a given clinical problem. Written report comparing and contrasting options in a given clinical scenario to perform key communication tasks.	Grading of both reports by faculty	2
6,8	8. **Leadership and Professionalism:** Leverage the processes and principles of project management to drive the successful completion of projects on time, within scope, and within budget.	Section of Biomedical Informatics and Data	Faculty, fellows, and associated	Students will be given a business case to solve pertaining to an	Grading of business case by faculty	1

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	a. Basic managerial/cost accounting principles and concepts b. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication c. Effective communication programs to support and sustain systems implementation	Science and Yale New Haven Health System Digital & Technology Solutions	hospital digital & technology solutions staff	existing problem within YNHHS		

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Overarching Goals and Definitions of Elective/Subinternship

Overarching Goals

See Webpage: https://medicine.yale.edu/education/curriculum/Goals%20and%20Principles_268834_284_26474.pdf

The Overarching Goals of the curriculum serve as the foundation for our curriculum and define its content. Emphasis is placed on goals that meet the growing needs of a changing society and medical practice. A strong foundation in science provides special opportunities for students to participate in creative endeavors
that foster the life-long pursuit of scholarship.

1. Health Promotion and Disease Prevention: Students apply scientific knowledge and use clinical skills to promote health and prevent disease in individuals and communities.

2. Mechanisms and Treatment of Disease: Students acquire knowledge at the molecular, cellular, organ-system, whole body, and societal levels, and integrate this knowledge with clinical science and skills to diagnose and treat disease.

3. Clinical Reasoning: Students exercise clinical judgment based on a thorough understanding of the patient, application of sound scientific principles, and knowledge of the health care systems. Clinical reasoning is learned through practice, self-reflection, and feedback

4. Patient Care: Students achieve competency in the care of patients at a level required to excel in residency.

5. Professionalism and Communication: Students demonstrate respectful and ethical behavior in all of their professional interactions and provide compassionate, empathic care to patients and families. Professionalism and communication skills are acquired through practice, self-reflection, and feedback.

6. Responsibility to Society: Students learn to practice medicine with cultural competence and fiscal responsibility in preparation for work in a society characterized by diverse populations and economic constraints.

7. Creation and Dissemination of Knowledge: Students manifest independent and creative thinking fostered by a collaborative graduate school environment. They perform mentored scholarly research culminating in a formal written thesis to promote critical thinking, understand the scientific method, and contribute to medical knowledge.

8. Physician as Scientist: Students learn to approach medicine from a scientifically minded perspective and are educated and mentored by leading scientists. This prepares them for careers in biomedical science and as medical practitioners, and to become the next generation of medical scientists and leaders in academic medicine.

Each goal has been thoroughly reviewed by a task force comprised of content experts, interested parties, and students. These task forces made recommendations for content and pedagogy across the four years that are being used to guide the curriculum rebuild process.

Subinternship and Clinical Elective Definitions

A **Subinternship** is an opportunity for a medical student to engage in a clinical rotation meeting the following criteria:

1) With appropriate supervision, assume patient care responsibility at the highest appropriate level possible within the specialty area, interfacing with the patient, the medical team, the nursing staff, and any other services.
2) Total immersion in day to day activities, tasks, and responsibilities of patient care.
3) A broadened patient case-mix and patient load with case assignment and schedule similar to 1st year resident.
4) An opportunity to solidify advanced clinical knowledge, skills and professionalism.
5) A level of independence appropriate to a 4th year medical student.

A **Clinical Elective** is an opportunity for a medical student to engage in a clinical rotation with the following characteristics:

1) With appropriate supervision, participate in the care of patients as an adjunct to a primary clinician (usually a fellow or resident) on a service. The student may interface with the patient, medical team, nursing staff, and other services.
2) Exposure to and participation in day to day activities, tasks, and responsibilities of patient care on the service.
3) A patient case-mix chosen for interesting learning opportunities.
4) An opportunity for exposure to sub-specialty areas of medicine which will enhance student's knowledge base and experience.

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5) A level of independence appropriate to a 4th year medical student.