BMIN5070: Human Factors in Biomedical Informatics (Part 1)
08/27/2025 to 10/15/2025. Wednesdays, 3:30PM-6:30PM RCH B102AB

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Description: The course will cover four main topic areas:
1. Sociotechnical and human-centered design in biomedical informatics;
2. Evaluation and measurement of usability;
3. Implementation and optimization—including tensions among existing vs revised workflows, new software vs legacy systems, vendor software vs need for new builds, customization, retrofits, dongles, etc;
4. Ethics, policy, cybersecurity, and advocacy.

   Each topic area will incorporate principles, methods, and applications. In the principles section for each topic, the course will seek to clearly and define terminology related to the topic area, review how key concepts relate to each other, and examine the relevance of the topic's role to applied clinical informatics. The course will cover qualitative, quantitative, and computational methods used for the design, implementation, and evaluation of health information technology, especially Electronic Health Records (EHRs). The applications section for each topic will use relevant case studies that examine the real-world application of principles and methods.

Course materials: Primary course material will be selected readings from the medical informatics literature appropriate for each class session. **All readings are available on canvas without cost.**
- Articles from, JAMIA, ACI, JAMA, etc; plus selections from the following:
- Harold Thimbleby "Fix IT: See and solve the problems of digital healthcare." (2022) Oxford Univ Press.
- Jonathan Leviss "H.I.T or Miss: Lessons Learned from Health Information Technology Projects." (2019) Third edition. CRC Press.
    o Note: we may substitute items as new articles become available; or we find something better; or if we run behind because of a "visiting" author. We'll provided advance notice of any changes and all needed documents.

Objectives for the course:
1. Introduction to the field of human factors as applied to healthcare information technology (HIT) and HIT devices in healthcare.
2. The history and current landscape of HIT in healthcare
3. The role of HIT in medical workflow
4. Understanding sociotechnical Design in Biomedical Informatics
5. Understanding and implementing Human Centered Design in building HIT and integrating HIT into medical workflow
6. Understanding the reality of vendor-provider relationships
7. Understanding the role of regulations and regulators in the use of medical technology
8. Understanding the process of implementation and optimization of HIT
9. Methods of evaluation of HIT
10. Review of the ethics, advocacy, and policies of HIT in practice
11. Understanding issues of cybersecurity with HIT

Class format: While there are basic issues we want to cover in each session (reflected in the assigned readings), we are able to accommodate each student's interests with individual projects and readings. That means much less lecturing and more individualized learning, more small-group discussion--including individual project planning, with hands-on case study analyses, and time for each student to discuss a journal article from recent publications. We don't have a journal club because we shall discuss the selected articles as part of our class. The goal is to give everyone a chance to experience the medical informatics literature firsthand, and to develop skill both in critical appraisal of this literature and in presenting the information. If students wish to suggest a reading, I'm delighted to consider it.

Please remember the following phrase: "There's a special place in hell for people who read their slides to literate audiences." That is, one of the goals is to improve your ability to present a powerpoint without reading your slides. Use graphs, images or just bullet point on which you expand orally. Of course, you should have notes for yourself, and learn to use PPT presentation mode, that allows you alone to see your notes. Others just think you've got a great memory.

Some of material may be pre-recorded for your viewing in advance. You are expected to view these in advance. Thus, the course sessions will hopefully be shorter than 2.5 hours. To ensure you are really participating, there will be discussion of the material and we may use some of classroom software to ascertain your understanding of the material.

1. We shall seek to have visiting lectures—hopefully live—where students can interact with world leading scholars via Zoom or whatever. We did this in the previous years; it was great.
2. We can use the technology to display articles, graphics, etc. As noted, this is a good time to improve your presentation skills and integrating other media. But please remember my caution about reading text to literate groups. Of course, it's fine to present an article we have all read and to mark it up for our attention.
3. A lot of the readings were authored or coauthored by your instructor. This is somewhat awkward and embarrassing for me, and also not as interesting for me compared to discussing others' writings. However, many of these are seminal works and it would be foolish to avoid them. Also, in addition to free access, at least you get to discuss them with the author one-on-one. I try to give personal stories you may find of interest, i.e., about how the articles emerged from negotiations with editors or struggles to obtain data.
4. We reserve the right (and need?) to change the readings. New articles of great import are published, new controversies emerge, etc. For example, right now, medical informaticists are deeply involved with questions about bias in artificial intelligence (AI) and Machine Learning (ML), telemedicine, personal digital medical devices (including their accuracy and their myriad cybersecurity risk), and assigning non-dire patients to home monitoring. Also, in addition to concerns about biases in AI and ML, the profession is profoundly concerned about even conventional programs for selecting treatment pathways, to predict outcomes, and to assign resources to hospitals and to services.

Course Evaluation: The grade for the course will be based on written responses to in-class case study exercises and assignments (20%), a final project (35%), and participation in class (45%). It's a *seminar*, not a lecture format. Participation in class will be evaluated on preparedness for the readings and participation in discussions. Please note the high percentage linked to class participation.

I. Case Study Exercises. Each week, students will be asked to discuss a real case study of a Health Information Technology project. Students will have access to (the very short) case write-ups from *H.I.T. or Miss*, 3rd ed. You will read the material before class and will address a series of questions. The answers to these questions must be typed up in a half-page-ish document. The key questions to be answered of each case study are:
   A. Identify the key vulnerabilities that contributed to the failure of the case.
   B. Make 1 to 3 suggestions about how future practice should change based on your analysis of the case. I want to emphasize that this summary is a very small part of the class. A half page is often sufficient to reflect your case. Honest.

II. Present a reading to the class.   Each week we'll select in advance a few students to briefly present a reading. This is intended to help you in your careers and make the class a real seminar…and interactive. Students can volunteer reading of special interest to them, and they can be assigned so that all students have opportunities to present. When you lead discussion of a paper you may use a PPT. But it's not required. Also, via screen share we can all see the document if needed.

III. Weekly write up of one of the readings. About one page. It can be the reading you are presenting in class if that works out in terms of the rotation of articles to present to the class. That is, because each week, students will be presenting one of the readings to the class you can pick your presentation reading to also be your one page write up. To repeat: If it's your turn, you can use the reading you are presenting for your one page write up. A two-for.

IV. Final project.   There are three options for the final project:
1. **Option 1A.** A short (8-10 page) paper with a 10-15 minute presentation in class on the last day of classes. The paper and presentation will investigate a specific informatics issue or problem in an actual health or healthcare setting and/or each student's related topic of concern to him/her. To a large degree each student gets to pick his/her topic (with approval by the instructor). Such issues include the implementation of an electronic health record system, the effects of systems on patient safety, adoption of technology in specific clinical settings, or the challenges of health record linkage, and costs and benefits of the technology or workflow change. These are only suggestions. There are many other domains that could be investigated.
2. **Option 1B.**   Also a paper but less preferred than Option 1A. A short (8-10 page) paper with a 10-15 minute presentation in class on the last day of classes. A paper and presentation that demonstrates the student's ability to synthesize the current literature on at least one specific topic area in biomedical informatics, much as one would do for a literature review. The project should dive deeply into a given topic that the student helps select, more than is done in the lecture or the paper(s) covered in class. Note: I much prefer option 1A, but recognize there is little time to conduct research. On the other hand, if you wish to piggy back another study with this class, I'm very open to working with you on that.
3. **Option 2**.   A professor in this department has a project that enables us to make voice and audio recordings of actual outpatient sessions. (Both the doctors and patient have signed consent agreements.) Also recorded are the physician's progress notes and surveys by both doctor and patients about their evaluation of the sessions. Students may opt to make this their final project. They would observe and to provide informed discussion of the interactions. Examples include: How did the doctor use the EHR in the session? How was the EHR a help and/or a barrier to a good clinical visit (Yes, it can well be both). What do you think would make the sessions better? Can include different room arrangements, different approaches to using information, handling missing information, different ways of interviewing patients and maybe relatives, etc. Your 8-10 page write-up should reflect your readings during the course, eg, how usable was the EHR in the session, was needed information available to the doctor when it was needed, how did the technology integrate with the workflow of the clinical effort, etc.

Final project outline: Week 3: Present a two-page prospectus consisting of an outline of the proposed project and/or paper; why you find this of interest and relevant to the class. We shall discuss your paper/project in class. Of course, this can be discussed in class earlier and/or with the professor in advance. I'm happy to guide you if so desired—both with topic selection and with sources.

Final project update: Week 5: Present a 1-2 page update of the progress on your proposed project and paper. We shall discuss the updates in class.

Class Schedule

Wk	Date	Topic	Assignment (due before class)
1	08/27	Introduction, History and Current Landscape. Discussion of Syllabus and Final project.	Review syllabus.
2	09/03	Sociotechnical Design in Biomedical Informatics	Sign up for student presentations. Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
3	09/10	Human Centered Design and Workflow	Write up a 2-page project proposal. Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
4	09/17	Human Centered Design, continued. Vendor-provider relationships.	Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
5	09/24	Implementation and Optimization. Discussion of final project updates	Write up a 1 to 2 page update to your final project. Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
6	10/01	Evaluation of HIT	Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
7	10/08	Ethics, Policy, Cybersecurity and Advocacy	Write up a 1-page review of one of the readings. Write up a ½-page review of HIT or Miss Chapter.
8	10/15	Project presentations	Submit 8-10 page final project summary. Submit project presentation slides.

Readings *(highlighted articles are available for presentation)*

Week 1. Introduction and History of Current Landscape
- Koppel R. Foreword in *H.I.T. or Miss: Lessons Learned from Health Information Technology Projects* (ed Leviss J) 2019. Third Edition, CRC Press
- Ancker JS, et al. Do you want to promote recall, perceptions, or behavior? The best data visualization depends on the communication goal. *Journal of the American Medical Informatics Association* 31, no. 2 (2024): 525-530.
- Saw, J. J., & Gatzke, L. P. (2024). Designing visual hierarchies for the communication of health data. Journal of the American Medical Informatics Association, 31(11), 2722-2729.
- Thimbleby H. Fix IT: Chapters 1-3 (We don't know what we don't know; Cat thinking; Dogs dancing)
- H.I.T. or Miss: Chapter 5

Week 2. Sociotechnical Design in Biomedical Informatics
- Thimbleby H. Presentation on EHR usability issues: *https://www.youtube.com/watch?v=XOXKj8uUAio*
- Smith SW, Koppel R. Healthcare information technology's relativity problems: a typology of how patients' physical reality, clinicians' mental models, and healthcare information technology differ. *J Am Med Inform Assoc*. 2014 Jan-Feb;21(1):117-31.
- Koppel R, Metlay JP, et al. Role of computerized physician order entry systems in facilitating medication errors. *JAMA*. 2005 Mar 9;293(10):1197-203.
- Karsh, B. T., Weinger, M. B., Abbott, P. A., & Wears, R. L. (2010). Health information technology: fallacies and sober realities. *Journal of the American medical informatics Association*, *17*(6), 617-623.
- Thimbleby H. Fix IT: Chapter 19 (Human Factors)
- H.I.T. or Miss: Chapter 8

Week 2 additional readings:
- Arleo, A., Chen, A. T., Gotz, D., Kandaswamy, S., & Bernard, J. (2024). Reflections on interactive visualization of electronic health records: past, present, future. Journal of the American Medical Informatics Association, 31(11), 2423-2428.
- Martin, C. L., Bakker, C. J., Sarkar, S., Kang, R. M., Reid, N. F., Chih, M. Y., ... & Payne, V. L. (2025). Consumer Involvement in the Co-Design of Diabetes Self-Management Smartphone Apps: A Scoping Review. Applied Clinical Informatics, 16(03), 698-707.

Week 3. Human Centered Design
- Kutney-Lee A, et al. Electronic Health Record Adoption and Nurse Reports of Usability and Quality of Care: The Role of Work Environment   ACI 2019 10:129-139
- Tutty MA, Carlasare LE, Lloyd S, Sinsky CA. The complex case of EHRs: examining the factors impacting the EHR user experience. *J Am Med Inform Assoc*. 2019 Jul 1;26(7):673-677.
- Madandola OO, et al. The relationship between electronic health records user interface features and data quality of patient clinical information: an integrative review. *J Am Med Inform Assoc*. 31.1 (2023): 240-255.
- Thimbleby H. Fix IT: Chapter 24 (User Centred Design)
- H.I.T. or Miss: Chapter 10

Week 3 additional readings:
- Jambor, H. K., Ketges, J., Otto, A. L., von Bonin, M., Trautmann-Grill, K., Teipel, R., ... & Bornhäuser, M. (2025). Communicating cancer treatment with pictogram-based timeline visualizations. Journal of the American Medical Informatics Association, ocae319.

Week 4: Human Centered Design continued, Vendor-Provider Relationships
- Amato MG, et al. Computerized prescriber order entry-related patient safety reports: analysis of 2522 medication errors. *J Am Med Inform Assoc*. 2017 Mar 1;24(2):316-322.
- Koppel R, Wetterneck T, Telles JL, Karsh BT. Workarounds to barcode medication administration systems: their occurrences, causes, and threats to patient safety. *J Am Med Inform Assoc*. 2008 Jul-Aug;15(4):408-23. (I'll be presenting this to class. The other readings are available to claim by students)
- Ching JM, Williams BL, Idemoto LM, Blackmore CC. Using lean "automation with a human touch" to improve medication safety: a step closer to the "perfect dose". *Jt Comm J Qual Patient Saf.* 2014 Aug;40(8):341-50. [with editorial] Koppel R. Bar-coded medication administration brings trade-offs even with humane automation and lean approaches. *Jt Comm J Qual Patient Saf*. 2014 Aug;40(8):339-40.
- Thimbleby H. Fix IT: Chapter 18 (Interoperability)
- H.I.T. or Miss: Chapter 12

Week 4 additional readings:
- Poon, E. G., Lemak, C. H., Rojas, J. C., Guptill, J., & Classen, D. (2025). Adoption of artificial intelligence in healthcare: survey of health system priorities, successes, and challenges. Journal of the American Medical Informatics Association, 32(7), 1093-1100.
- Scholich, T., Raj, S., Lee, J., & Newman, M. W. (2024). Augmenting clinicians' analytical workflow through task-based integration of data visualizations and algorithmic insights: a user-centered design study. Journal of the American Medical Informatics Association, 31(11), 2455-2473.
- Kaur, A., Budko, A., Liu, K., Eaton, E., Steitz, B. D., & Johnson, K. B. (2025). Automating Responses to Patient Portal Messages Using Generative AI. Applied Clinical Informatics, 16(03), 718-731.

Week 5: Implementation and Optimization

- Cresswell KM, Bates DW, Sheikh A. Ten key considerations for the successful optimization of large-scale health information technology. *J Am Med Inform Assoc*. 2017 Jan;24(1):182-187.
- Carayon P. Human Factors in Health(care) Informatics: Toward Continuous Sociotechnical System Design. *Stud Health Technol Inform*. 2019 Aug 9;265:22-27.
- Lyell, D., Wang, Y., Coiera, E., & Magrabi, F. (2023). More than algorithms: an analysis of safety events involving ML-enabled medical devices reported to the FDA. *Journal of the American Medical Informatics Association*, *30*(7), 1227-1236.
- Kuziemsky CE, Schwartz DG, Airan-Javia S, Koppel R. Context and Meaning in EHR Displays. *Stud Health Technol Inform*. 2019 Aug 9;265:69-73.
- Thimbleby H. Fix IT: Chapter 11 (Safety Two), Chapter 13 (Risky Computations)
- H.I.T or Miss: Chapter 9

Week 5 additional readings:
- Croxford, E., Gao, Y., Pellegrino, N., Wong, K., Wills, G., First, E., ... & Afshar, M. (2025). Development and validation of the provider documentation summarization quality instrument for large language models. Journal of the American Medical Informatics Association, 32(6), 1050-1060.
- Ray, P. P. (2025). Is ChatGPT worthy enough for provisioning clinical decision support?. Journal of the American Medical Informatics Association, 32(1), 258-259.
- Sahin, O., Zhao, A., Applegate, R. J., Johnson, T. R., & Bernstam, E. V. (2025). Epidemiology of Patient Record Duplication. Applied Clinical Informatics, 16(01), 024-030.

Week 6: Evaluation of HIT

- McPeek E. Presentation on: Using EHR Audit Log Metrics to Decipher Contributions of EHR and Local Work Culture to Clinician Burnout. UCSF 10/15/2021.
- Koppel R. Great Promises of Healthcare Information Technology Deliver Less. Chapter 6 in *Healthcare Information Management Systems* (eds Weaver CA, Ball MJ, Kim GR, Kiel JM) 2016 Springer International Publishing.
- Koppel R, Lehmann CU. Implications of an emerging EHR monoculture for hospitals and healthcare systems. *J Am Med Inform Assoc*. 2015 Mar;22(2):465-71.
- Singh H, Sittig DF. Measuring and improving patient safety through health information technology: The Health IT Safety Framework. *BMJ Qual Saf*. 2016 Apr;25(4):226-32.
- Koppel R. The health information technology safety framework: building great structures on vast voids. *BMJ Qual Saf*. 2016 Apr;25(4):218-20.
- Reese, T. J., Liu, S., Steitz, B., McCoy, A., Russo, E., Koh, B., ... & Wright, A. (2022). Conceptualizing clinical decision support as complex interventions: a meta-analysis of comparative effectiveness trials. *Journal of the American Medical Informatics Association*, *29*(10), 1744-1756.
- Huang, C., Koppel, R., McGreevey III, J. D., Craven, C. K., & Schreiber, R. (2020). Transitions from one electronic health record to another: challenges, pitfalls, and recommendations. *Applied clinical informatics*, *11*(05), 742-754.
- HIT or Miss: Chapter 24

Week 6 additional readings:
- Khera, R., Sawano, M., Warner, F., Coppi, A., Pedroso, A. F., Spatz, E. S., ... & Venkatesh, A. (2025). Assessment of health conditions from patient electronic health record portals vs self-reported questionnaires: an analysis of the INSPIRE study. Journal of the American Medical Informatics Association, 32(5), 784-794.
- Shah, S. J., Devon-Sand, A., Ma, S. P., Jeong, Y., Crowell, T., Smith, M., ... & Garcia, P. (2025). Ambient artificial intelligence scribes: physician burnout and perspectives on usability and documentation burden. Journal of the American Medical Informatics Association, 32(2), 375-380.
- Raban, M. Z., Fitzpatrick, E., Merchant, A., Rahman, B., Badgery-Parker, T., Li, L., ... & Westbrook, J. I. (2025). Longitudinal study of the manifestations and mechanisms of technology-related prescribing errors in pediatrics. Journal of the American Medical Informatics Association, 32(1), 105-112.

Week 7: and Ethics, Policy, Cybersecurity and Advocacy

- Bernstam EV, et al. Quantitating and assessing interoperability between electronic health records. *Journal of the American Medical Informatics Association* 29, no. 5 (2022): 753-760.
- McGreevey, Hanson and Koppel, Chatbots: Clinical, Legal, and Ethical Aspects of Artificial Intelligence–Assisted Conversational Agents in Health Care. JAMA, August 11, 2020
- Walker J, Koppel R. For Healthcare Cybersecurity the Whole is Weaker Than the Sum of the Parts. *The Health Care Blog*. Sept 23, 2016. (https://thehealthcareblog.com/blog/2016/09/23/for-healthcare-cybersecurity-the-whole-is-weaker-than-the-sum-of-the-parts/)
- Gordon S. & Koppel R. "First, Do Less Harm" (2012) Conclusion: Twenty-seven paradoxes, ironies, and Challenges of Patient Safety. Cornell University Press.
- Thimbleby H. Fix IT: Chapter 15 (Regulations Need Tightening)
- HIT or Miss: Chapter 25

Week 7 additional readings:
- Payne, P. R., Johnson, K. B., Maddox, T. M., Embi, P. J., Mandl, K. D., McGraw, D., ... & Adams, L. (2025). Toward an artificial intelligence code of conduct for health and healthcare: implications for the biomedical informatics community. Journal of the American Medical Informatics Association, 32(2), 408-412.
- Thayer, J. G., Franklin, A., Miller, J. M., Grundmeier, R. W., Rogith, D., & Wright, A. (2024). A scoping review of rule-based clinical decision support malfunctions. Journal of the American Medical Informatics Association, 31(10), 2405-2413.
- Kramer DB, et al. Threats to Patient Safety From Cybersecurity Flaws-A New Never Event. *JAMA.* 2025 Jul 7. doi: 10.1001/jama.2025.10104. Epub ahead of print. PMID: 40622734.

Week 8: Student Presentations and Wrap-Up