

# Digital Transformation of Healthcare

## Course Overview

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Michael Snow, MD PhD, Glen Ferguson, PhD

Center for Health Data Innovations

# Digital Transformation of Healthcare

- Healthcare Informatics
  - The management and use of patient healthcare information driven by insights gained using health information technology
  - The goal is to provide higher quality care (lower cost, greater availability, new healthcare opportunities) to our patients
- Course Objectives
  - Design healthcare informatics projects
  - Develop questions answerable by current systems
  - Estimate the value of a project prior to its implementation
  - Evaluate results from research, economic, and institutional stakeholder perspectives

# Course Overview

- Lecture format
  - Each class will focus on a specific part of the pipeline
  - Explore theoretical constructs through discussion and small group work
  - Compare with practical implementations
- Final Project
  - Teams of X students will present an informatics project to the class at the last lecture
- Grading
  - Class is Pass/Fail
  - Grade is based on participation and final project
- Course Leaders
  - Michael Snow - [msnow1@montefiore.org](mailto:msnow1@montefiore.org)
  - Glen Ferguson - [glfergus@montefiore.org](mailto:glfergus@montefiore.org)

# Lecture Schedule

1. Overview and Introduction to pipeline
2. Clinical Decision Support
3. Machine Learning Models
4. Evaluating Predictions
5. Mobile Health/IOT
6. Cohort Selection
7. Healthcare Economics
8. Administrative Healthcare Databases
9. Ethics of Healthcare Informatics
10. Exploratory Analysis
11. (A Gentle) Deeper Dive into Neural Networks
12. Presentations

# Any Questions

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# Objectives

After this lecture students will be able to

- Describe the different phases of a healthcare informatics project
- Diagram an informatics project as a pipeline

# Metastatic Epidural Spinal Cord Compression

- Overview
  - Occurs in 2% to 5% of all cancer patients
  - Cord compression is the first manifestation in about 20% of patients
  - Survival is generally less than 6 months
  - Prognosis negatively correlates with severity of presenting symptoms
- Diagnosis
  - Clinical Findings + Imaging (MRI or CT)
- Treatment
  - Surgery
  - Radiation therapy

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Let's build our own pipeline for spinal cord compression



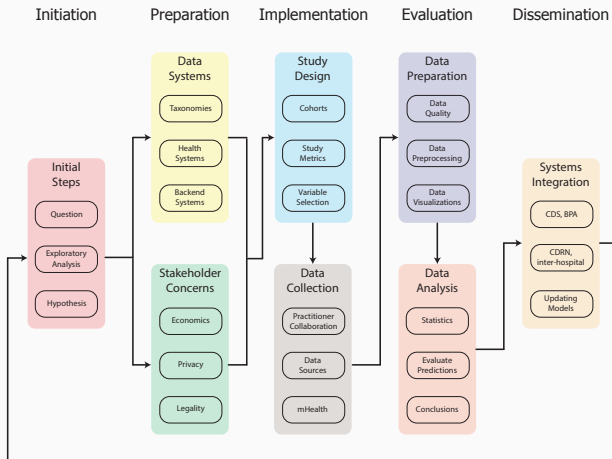
## └ Metastatic Epidural Spinal Cord Compression

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Let's build our own pipeline for spinal cord compression

1. First let's talk about the 4 to 5 basic steps in our pipeline, and then we'll break each step down into 1 to 3 sub-steps, and then discuss the components of the individual sub-steps. The first two parts we'll do together as a group and the last part you will work on in teams

# Healthcare Informatics Pipeline



# Metastatic Epidural Spinal Cord Compression

## Initial Steps

- Question
  - Question
  - Cord Compression is the first manifestation in about 20% of patients
  - Survival is generally less than 6 months
  - Prognosis negatively correlates with severity of presenting symptoms
- Exploratory Analysis
  - Clinical Findings
  - Imaging (MRI or CT)

# Digital Transformation of Healthcare

- What kind of questions can I answer using automatically collected data?
- What kind of data is collected by the hospital and how can I access the data?
- How much will it cost/save the hospital to implement the study as well as act on its results?
- What do I need to consider when designing a study using patient data?
- How can I integrate automatic systems with collaborators to collect the desired data?
- How do I transform the data from its collected format to a format useful for analysis?
- How can I integrate the results of my study within the hospital system?

# Medication Reconciliation

- Medication reconciliation (Med Rec) is the process of
  - Comparing a patient's medication orders to all of the medications they have been taking
  - Understanding why they're taking each medication
  - Comparing that list against new orders
- The goal of Med Rec is to provide correct medications to the patient at all transition points within the hospital.

- According to The Institute of Safe Medication Practice, Med Rec has the potential to eliminate
  - 50% of medication errors
  - 20% of adverse medical events
- Care providers in Montefiore write
  - About 4 million prescriptions a year (averages out to more than 10,000 a day)
  - Prescriptions to over 400,000 different patients
  - Prescriptions for more than 11,000 different medications

## Med Rec Case Study - Definitions

Roses hospital wants to develop a pilot Med Rec system in their Pediatrics department. You are working with a team of institutional stakeholders tasked with comparing the pre- and post-implementation effects of this system. You meet with the healthcare informatics core to discuss the data collection for the study. As the domain knowledge expert, they ask you following questions:

- What qualifies as an adverse drug event (ADE)?
- What qualifies as a medication error?
- How would you sub-classify each and where do they overlap?

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## └ Med Rec Case Study - Definitions

1. an ADE is an injury due to a medication, e.g., cough due to ACE-I in pt w/o hx of cough, nausea after tamiflu, anaphylaxis due to allergy
2. A medication error is any mistake along the path of ordering, transcribing, dispensing, administrating, and monitoring, e.g., docusate given 2 hours late (harmless), critical abx never given (harmful), wrong medication given (anywhere from harmless to fatal), ...
3. Medication errors range from minor, which have little or no harm potential (late docusate) and are not ADEs, to possible, which could have caused injury but did not, either because they were caught in time or the pt did not have a negative rxn (even if they should have) and these are termed potential ADEs, to fatal which are ADEs
4. ADEs are split into potential ADEs, which are always medication errors but were either intercepted or non-injurious, preventable ADEs which are the result of medication errors and non-preventable ADEs, which are not the result of medication errors, such as allergic rxn in a heretofore non-allergic pt



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- How do you identify and retrace a medication error? An ADE?

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1. Prescription writing (autocomplete, autofill, patient charts, dosing, allergies), filling prescription (wrong medication, medication interactions, allergies), prescription handoff, administration (route, dosing, delay), patient ingestion (misinterpret instructions, ignore instructions)
2. self reported, pt surveys, cross-reference medication interactions, lab results, deviations in dosing, e.g., 5mg jumps to 5g, ICD codes, e.g., urticaria (ppv of only about 2%)
3. look for any irregularity in the patient's condition such as change in mental status, sudden drop in blood pressure, sudden drop in oxygen saturation, new rash, or new diarrhea, and then to consider whether it might be related to a medication

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- At what points along the pathway from prescription to ingestion can medication errors occur?
- How do you identify and retrace a medication error? An ADE?
- What is the goal of Med Rec with respect to medication errors? ADEs?

## Med Rec Case Study - Error Metrics

Roses hospital wants to develop a pilot Med Rec system in their Pediatrics department. You are working with a team of institutional stakeholders tasked with comparing the pre- and post-implementation effects of this system. The healthcare informatics core has assembled all the data as per your earlier discussions. Before the statisticians can analyze the results they would like you to help narrow down the scope of their analyses.

- Which type(s) of ADEs and/or medication errors do you want to report?
- How do you want to quantify the different aspects of incidents?
- How do you want to break down the errors, e.g., per hour, per provider, ...?

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1. severity, preventability, the level of disability, the stage in the medication use process at which the error occurred, and the category of healthcare personnel responsible for the error can be classified
2. medication class, hour of day, per day of week, age of patient, number of concurrent medications, inpatient vs outpatient

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- How do you want to quantify the different aspects of incidents?
- How do you want to break down the errors, e.g., per hour, per provider, ...?
- How do you want to quantify the cost/benefit of implementing a Med Rec system?

- Objective
  -
- Setting
  -
- Phases and Participants
  -
- Outcome Measures
  -

# Effect of Computerized Physician Order Entry and a Team Intervention on Prevention of Serious Medication Errors

Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Teich, J. M., ... & Vander Vliet, M. (1998). Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *Jama*, 280(15), 1311-1316.



# Study Parameters

- Objective
  -
- Setting
  -
- Phases and Participants
  -
- Outcome Measures
  -

# Study Parameters

- Objective
  - To evaluate the efficacy of 2 interventions for preventing nonintercepted serious medication errors
- Setting
  - Large tertiary care hospital
- Phases and Participants
  - Phase 1 - conducted prior to the implementation of POE
    - All patients admitted to a stratified random sample of 6 medical and surgical units over a 6-month period
  - Phase 2 - conducted after the implementation of POE
    - All patients admitted to the same units and 2 randomly selected additional units over a subsequent 9-month period
- Outcome Measures
  - Nonintercepted serious medication errors.

# Overall Reductions

	Phase 1	Phase 2	% Difference	<i>P</i>
Nonintercepted serious medication errors	10.7	4.86	-55	0.01
Preventable ADEs	4.69	3.88	-17	0.37
Life Threatening	0.65	0.65		
Serious	0.98	1.96		
Significant	2.86	1.55		
Nonintercepted potential ADEs	5.99	0.98	-84	0.002
Life Threatening	0.82	0.04		
Serious	2.37	0.69		
Significant	2.70	0.6		
All ADEs	16.0	15.2	-5	0.77
Nonpreventable ADEs	11.3	11.3	0	0.99
Life Threatening	1.07	0.69		
Serious	2.37	2.89		
Significant	7.78	9.37		
All potential ADEs	11.7	3.38	-71	0.02
Intercepted potential ADEs	5.67	2.40	-58	0.15

Mean rates (events per 1000 patient days) of incidents in Phase 1 and Phase 2. Paired comparisons were made using *t*-tests

# Reductions by Error Type

	Phase 1	Phase 2	% Difference	<i>P</i>
Mistake in Ordering	4.1	3.3	-19	0.03
Mistake in Transcription	1.3	0.20	-84	< 0.001
Mistake in Dispensing	0.90	0.29	-66	0.001
Mistake in Administration	4.1	1.7	-59	< 0.001
Wrong Doses	0.96	1.51	-23	0.02
Wrong Choices	1.39	0.77	-44	0.07
Wrong Techniques	0.98	0.24	-75	< 0.001
Delays	0.90	0.20	-77	0.01
Known Allergies	0.65	0.29	-56	0.009
Missed Doses	0.57	0.12	-79	0.07
Wrong Drugs	0.49	0.04	-92	0.05
Drug-Drug Interactions	0.41	0.24	-40	0.89
Wrong Frequencies	0.33	0.33	0	0.93
Wrong Routes	0.16	0.04	-75	0.21
Failures to Act on Monitoring	0.16	0.29	74	0.21
Others	2.37	1.38	-43	0.05

Unpaired comparison of mean rates (events per 1000 patient days), controlling for level of care and service, using generalized estimating approaches to control for correlation between phases

## Reductions by Drug Type

	Phase 1	Phase 2	% Difference	<i>P</i>
Analgesics	2.05	1.14	-44	0.01
Antibiotics	1.72	0.86	-50	0.04
Sedatives	0.49	0.98	+99	0.38
Antineoplastics	0.49	0.24	-50	0.34
Cardiovascular Drugs	0.25	0.08	-67	0.08
Anticoagulants	0.98	0.24	-75	0.01
Antipsychotics	0.41	0.16	-60	0.15
Diabetic Drugs	0.49	0.24	-50	0.49
Electrolytes	0.90	0.20	-77	< 0.001
Others	2.62	1.59	-39	0.007

Unpaired comparison of mean rates (events per 1000 patient days), controlling for level of care and service, using generalized estimating approaches to control for correlation between phases

# Economic Savings

- Estimated annual costs of preventable ADEs of \$2.8 million.
- If the observed 17% decrease in the preventable ADE were the hospital-wide decrease, the annual savings would be \$0.48 million.
  - This does not include the costs of injuries borne by patients, of admissions due to drug errors, of malpractice suits, or of the extra work generated by the nonserious medication errors.
- The costs of developing and implementing POE have been estimated to be \$1.9 million, with maintenance costs of \$0.5 million per year
- The net savings have been estimated to be between \$5 to \$10 million per year.

# Thank You

This was a pilot lecture for a course to be given in the fall so any feedback is very much appreciated.

[msnow1@montefiore.org](mailto:msnow1@montefiore.org)