COVID-19 and the MSHS

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The Mount Sinai Health System (MSHS)



The Epicenter of the COVID-19 Pandemic in the United States



BIG DATA IN A TIME OF BIG VIRUSES.

How the World is Using Data & Analytics to Fight COVID-19

Relational databases

Data contained in EHR

NLP Tools Required

DemographicsMedical history

- •Vital signs
- •Diagnoses
- Medications
- Treatment plans
- Immunization historyRadiology imagesLaboratory results

Fake ID	ENTRY_DAT		COD
34068	5/1	3/2001	41.85
37660	8/6	/2002	79.99
140680	8/31/2003		79.99
23315	5/14/2003		112
75000	7/9/2004		117.0
Lab test	s	/2004	117.2
Lab test Fake ID	s TEST	ENTRY_DAT	VALL
Lab test Fake ID 3536	s TEST pO2	ENTRY_DAT 1/23/1996	VALL 314
Lab test Fake ID 3536 72921	s TEST pO2 LDL	ENTRY_DAT 1/23/1996 2/5/1996	VALLL 314 34
Lab test Fake ID 3536 72921 102460	rest pO2 LDL pCO2	ENTRY_DAT 1/23/1996 2/5/1996 1/26/1996	VALU 314 34 45
Lab test Fake ID 3536 72921 102460 135043	rest pO2 LDL pCO2 HDL	ENTRY_DAT 1/23/1996 2/5/1996 1/26/1996 1/25/1996	VALL 314 34 45 35

Problem lists:
Medications known to be
prescribed:
Keppra 750 mg 1/2 tab q am
and pm
Dexilant 60 mg by mouth daily
aspirin 325 mg 1 tablet by
mouth daily
clopidogrel 75 mg tablet 1
tablet by mouth daily
IZ
Known adverse and allergic
drug reactions:
Sulta Drugs
known significant medical
diagnoses:
Seizure disorder
Aneurysm
Heartburn
Known significant
operative and invasive
procedures:
2003 Appendectomy
2005 Stents put in **DATE
[Aug 29 05]

Semi-structured

Clinical notes

EXAM: BILATERAL DIGITAL SCREENING MAMMOGRAM WITH CAD, **DATE[Mar 16 01]: COMPARISON: **DATE[Jul 01 01] TECHNIQUE: Standard CC and MLO views of both breasts were obtained. FINDINGS: The breast parenchyma is heterogeneously dense. The pattern is extremely complex with postsurgical change seen in the right upper outer quadrant and scattered benign-appearing calcification seen bilaterally. A possible asymmetry is seen in the superior aspect of the left breast. The parenchymal pattern otherwise remains stable bilaterally, with no new distortion or suspicious calcifications. IMPRESSION: RIGHT: No interval change. No current evidence of malignancy.. LEFT: Possible developing asymmetry superior aspect left breast for which further evaluation by true lateral and spot compression views recommended. Ultrasound may also be needed., RECOMMENDATION; Left diagnostic mammogram with additional imaging as outlined above., A left breast ultrasound may also be needed, BI-RADS Category 0: Incomplete Assessment - Need additional imaging evaluation. IMPRESSION: RIGHT: No interval change. No current evidence of malignancy....

Unstructured

Wei-Qi, W. & Denny, J.C. Genome Medicine, 2015.

Mount Sinai COVID Informatics Center

Fighting Covid-19 with the Power of Data

Informatics Crisis Response Platform



Infrastructure supported by Microsoft Azure cloud computing services, MSCIC has built and maintains a ground truth harmonized dataset that integrates data streams from MSHS clinical data (e.g. EHR, Imaging, Pathology) along with novel research data sets (e.g. –omics, digital health tracking, immune biomarkers)

RAPID CLINCIAL APPLICATION

Rapid Clinical Intervention Toolkit

facilitates the practice of evidence-based medicine in the MSHS by feeding insights from data science into the daily workflow via the electronic medical record

battle ready in this and in future crises





VM matrix Bach VM is based on a same image we created ad-hoc for the project

ASSOCIATION OF ANTICOAGULATION WITH MORTALITY





Performance at MSH (train + CV)

Model Performance at Training



External and temporal performance (validation)

XGBoost Performance on Validation Sets



What did the model learn?



Interactions between features can further reveal what the model learned



SHAP Interactions: Critical Event at 7 Days

Sulaiman Somani, BS

CORONAVIRUS (COVID-19)

SARS-CoV-2 is Devastating to Numerous Organ Systems



1 Lungs

A cross section shows immune cells crowding an inflamed alveolus, whose walls break down during attack by the virus, diminishing oxygen uptake. Patients cough, fevers rise, and it takes more and more effort to breathe.

2 Liver

Up to half of hospitalized patients have enzyme levels that signal a struggling liver An immune system in overdrive and drugs given to fight the virus may be causing the damage.

3 Kidneys

Kidney damage is common in severe cases and makes death more likely. The virus may attack the kidneys directly, or kidney failure may be part of whole-body events like plummeting blood pressure.

4 Intestines

Patient reports and biopsy data suggest the virus can infect the lower gastrointestinal tract, which is rich in ACE2 receptors. Some 20% or more of patients have diarrhea.

5 Brain

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Windpipe

Bronchii

Bile duct

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2

Some COVID-19 patients have strokes, seizures, mental confusion, and brain inflammation. Doctors are trying to understand which are directly caused by the virus.

6 Eyes

Conjunctivitis, inflammation of the membrane that lines the front of the eye and inner eyelid, is more common in the sickest patients.

7 Nose

Some patients lose their sense of smell. Scientists speculate that the virus may move up the nose's nerve endings and damage cells.



8 Heart and blood vessels The virus (green) enters cells, likely including those lining blood vessels, by binding to ACE2 receptors on the cell surface. Infection can also promote blood

clots, heart attacks, and cardiac

inflammation.

V. ALTOUNIAN/SCIENCE

AKI Stages: Overall and ICU Admissions



Objective: To Evaluate Approaches for predicting the Need for Acute Hemodialysis over a variety of time horizons using data from <24 hours of admission

Study Workflow

A. Facilities



B. Data



C. Timeline



Performance Characteristics of Models over Time Horizons

	Internal Validation		External Validation	
	AUROC	AUPRC	AUROC	AUPRC
Horizon: 1 day				
LASSO	0.85	0.24	0.82	0.17
Logistic Regression	0.88	0.29	0.81	0.13
Random Forest	0.91	0.30	0.89	0.23
XGBoost (imputed)	0.93	0.34	0.91	0.30
XGBoost (not-	0.96	0.55	0.96	0.37
imputed)				
Horizon: 3 days				
LASSO	0.86	0.28	0.84	0.25
Logistic Regression	0.86	0.30	0.82	0.19
Random Forest	0.89	0.39	0.83	0.26
XGBoost (imputed)	0.92	0.42	0.87	0.33
XGBoost (not- imputed)	0.94	0.57	0.89	0.44

Performance Characteristics of Models over Time Horizons

	Internal Validation		External Validation			
	AUROC (95% CI)	AUPRC (95% CI)	AUROC	AUPRC		
Horizon: 5 days						
LASSO	0.86	0.38	0.83	0.26		
Logistic Regression	0.86	0.33	0.81	0.21		
Random Forest	0.87	0.40	0.80	0.26		
XGBoost (imputed)	0.87	0.43	0.86	0.32		
XGBoost (not-	0.89	0.52	0.89	0.46		
imputeaj						
Horizon: 3 days						
LASSO	0.84	0.39	0.84	0.27		
Logistic Regression	0.84	0.35	0.81	0.22		
Random Forest	0.85	0.37	0.81	0.25		
XGBoost (imputed)	0.85	0.40	0.87	0.31		
XGBoost (not- imputed)	0.89	0.54	0.89	0.43		

Model Explainability and Features



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