

This workbook "Medical Conditions Analysis for Electronic Healthcare Records" (DOI: <https://doi.org/10.21949/1528558>) supplements the MITRE document "Integrating Commercial Healthcare Datasets for Aeromedical Risk Analyses" (DOI: <https://doi.org/10.21949/158556>).

This workbook addresses eight different medical conditions that can lead to pilot incapacitation. Each page focuses on one condition and lists information that could be found in a healthcare dataset to help predict the onset of that condition through the use of a machine learning algorithm. The information listed ranges from diagnoses, tests, and vitals that are collected in electronic health records. The MITRE team has included the relevant ICD-9, ICD-10, LOINC, and/or SNOMED codes to help readily identify the information in the data, as well as the normal ranges the data should fall between (where applicable). This document was produced with the objective of aiding machine learning algorithms in medical risk forecasting for these specific conditions. Diabetes has one extra page since it is its complications, rather than the condition itself, that can lead to acute incapacitation. For more information on why these conditions were chosen, consult "Integrating Commercial Healthcare Datasets for Aeromedical Risk

Recommended Clinical Factors for AI/ML features

Myocardial Infarction

ICD-10 code range:

I21.x

Text Description	LOINC	ICD-10	ICD-9	SNOMED	Units	Normal Range		Comments
						Min	Max	
Body Height	8302-2				cm	< 137	> 213	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7				kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5				NA	<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6				mmHG	90	<140	
Diastolic Blood Pressure	8462-4				mmHG	< 60	<90	
Cholesterol_HDL	2095-8				mg/dl	<40	> = 40	
Cholesterol_LDL	13457-7				mg/dl	< 100	130	
Cholesterol_LDL/HDL	11054-4				NA		<=3.5	
C-Reactive Protein_high sensitivity	11039-5				mg/L	< 1	> 3	
Troponin	89575-5				ng/mL		< 0.04	
HemoglobinA1c	4548-4				%	< 5.7	> = 6.5	Normal: HbA1c below 5.7% Pre-diabetes: HbA1c between 5.7% and 6.4% Diabetes: HbA1c of 6.5% or higher
Cotinine Serum	10365-5				ng/mL	<10	> = 10	Nicotine test to help determine smoking status.
CT Calcium Score	36934-5				NA	0	> 0	This is a CT Scan test.
CT Coronary Angiogram	87847-0							
Framingham Risk Score for coronary artery disease	75201-2			315039001	%	<10	>= 10	This is a tool used to estimate a person's 10-year risk of developing coronary artery disease based on several risk factors.
ECG Impression	8601-7							
Left Ventricular Ejection Fraction	10230-1				%	<= 40	>70	Left ventricular ejection fraction (LVEF) is the critical finding to measure heart output via echocardiogram. Heart failure severity comes from this measurement.
Smoking Status	72166-2			365980008				This term is used in various ways in EHR data.
Sedentary lifestyle				415510005				Binary: Will be 0 or 1.
Obesity		E66.9	278.00					Diagnosis
Coronary Artery Disease		I25.10	414.00					Diagnosis
Diabetes Type 2		E11-[next digit]	250.00					Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and control).
Diabetes Type 1		E10-[next digit]	250.01					Diagnosis—Only 10% of diabetics
Hyperlipidemia		E66.x	272.4					Diagnosis
Hypertension		I10	401.9					Diagnosis
History of COVID		Z86.16						Diagnosis
Post COVID-19 condition U09.9		U09.9						Long COVID code

References

[Medscape Medical Knowledgebase](#)

[CDC ICD 10 Search Tool](#)

[ICD 10Data Tool](#)

[Unified Medical Language System® \(UMLS®\) SNOMED Browser](#)

[Unified Medical Language System® \(UMLS®\) RxNorm Browser](#)

[Chen, Zhihao, Jixi Shi, Thibaut Pommier, Yves Cottin, Michel Salomon, Thomas Decourselle, Alain Lalande, and Raphaël Couturier. 2022. "Prediction of Myocardial Infarction From Patient Features With Machine Learning." *Frontiers in Cardiovascular Medicine* 9. <https://www.frontiersin.org/articles/10.3389/fcvm.2022.754609>.](#)

[Greenland, Phillip, Maria Deloria Knoll, Jeremiah Stamler, James D. Neaton, Alan R. Dyer, Daniel B. Garside, and Peter W. Wilson. 2003. "Major Risk Factors as Antecedents of Fatal and Nonfatal Coronary Heart Disease Events." *JAMA* 290 \(7\): 891–97. <https://doi.org/10.1001/jama.290.7.891>.](#)

["Cardiac Risk Calculator and Assessment." n.d. Cleveland Clinic. Accessed February 8, 2023. <https://my.clevelandclinic.org/health/diagnostics/17085-heart-risk-factor-calculators>.](#)

Summary

This provides comprehensive information on diseases, clinical care and issues in healthcare. It is used internationally. Medscape requires a paid subscription.

To determine codes and related diagnoses

To determine codes and the ICD 10 hierarchy

Use the US edition for SNOMED mapping.

National Standard for Medications

This study proposes machine learning-based models to automatically evaluate the severity of myocardial infarction (MI) from physiological, clinical, and paraclinical features. The study of the features' importance also revealed that the troponin value had the strongest correlation to the severity of the MI among the 12 selected features

Antecedent major CHD risk factor exposures were very common among those who developed CHD, emphasizing the importance of considering all major risk factors in determining CHD risk estimation and in attempting to prevent clinical CHD.

This content highlights the risk factors of coronary heart disease and provides risk calculators.

Recommended Clinical Factors for AI/ML features

Cardiac Arrhythmias

ICD-10 code range: see below for specific arrhythmia codes

Text Description	LOINC	ICD-10	ICD-9	SNOMED	Units	Normal Range		Comments
						Min	Max	
Body Height	8302-2				cm	< 137	> 213	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7				kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5				NA	<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6				mmHG	90	<140	
Diastolic Blood Pressure	8462-4				mmHG	< 60	<90	
Family history of heart attack				266897007				
Family history of sudden death				430283008				
Personal History of congenital heart conditions		287.74	V13.6x.					Diagnosis
C-Reactive Protein high sensitivity	11039-5				mg/dL	< 1	> 3	
Serum Potassium	6298-4				mmol/L	< 3.5	> 5	
Serum Magnesium	19123-9				mg/dL	<1.7	> 2.2	
Serum Calcium					mg/dL	< 8.5	>10.2	
Troponin	89575-5				ng/mL		< 0.04	
B-type natriuretic peptide (BNP)	42637-9				pg/mL	< 100	>= 100	
Glomerular Filtration Rate (GFR)	48642-3				mL/min/1.73m	< 90	>= 90	Renal Function that determines severity of chronic kidney disease.
Thyroid Stimulating Hormone	3016-3				mIU/L	< 0.4	>4.0	
HemoglobinA1c	4548-4				%	< 5.7	> = 6.5	Normal: HbA1c below 5.7%. Pre-diabetes: HbA1c between 5.7% and 6.4%. Diabetes: HbA1c of 6.5% or higher.
Left Ventricular Ejection Fraction	10230-1				%	<= 40	>70	Left ventricular ejection fraction (LVEF) is the critical finding to measure heart output via echocardiogram. Heart failure severity comes from this measurement.
Holter Monitor	62356-8			43939100				Holter monitor results are free text description of the cardiologist's interpretation.
Implantable Loop Recorder	not available			179808003				This small device is implanted into the patient for long term monitoring for cardiac arrhythmias. Results may be summarized by specific time periods or by abnormal cardiac rhythms.
Electrophysiology study	not available			252425004				This is an invasive procedure that involves cardiac catheterization to detect arrhythmias. The result is a long free text document with headers for the various measurements.
ECG Impression	8601-7							ECG analysis is the most important feature in prediction and detection of cardiac arrhythmias. Machine learning models implemented into ECG instruments is widely used. Smart watches can also detect certain arrhythmias. EHR data for ECG impression however is often a challenge because it is in a text-based report.
Smoking Status	72166-2			365980008				This term is used in various ways in EHR data.
Sedentary lifestyle				415510005				Binary: Will be 0 or 1.
Atrial Fibrillation		I48.0	427.31					This represents a stable atrial fibrillation without complications
Atrial Fibrillation with rapid ventricular rate		I48.1	427.31					Key Clinical Outcome for incapacitation.
Supraventricular Tachycardia		I47.1	427.0					Diagnosis
Ventricular premature beats		I49.3						Diagnosis
Bradycardia - Sick Sinus Syndrome		I49.5						Diagnosis
Right Bundle Branch Block		I45.1	426.51					Diagnosis
Left Bundle Branch Block		I45.29	426.52					Diagnosis
Other Conduction Disorders		I45.90	426.9					Diagnosis
Hypertrophic Cardiomyopathy (aka IHSS)		I42.1	425.1					Diagnosis
Hyperthyroidism		E05	242					Diagnosis
Syncope		R55	780.2					Diagnosis
Obesity		E66.9	278.00					Diagnosis
Coronary Artery Disease		I25.10	414.00					Diagnosis
Diabetes Type 2		E11-[next digit]	250.00					Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and control).
Diabetes Type 1		E10-[next digit]	250.01					Diagnosis--Only 10% of diabetics
Hyperlipidemia		E66.x	272.4					Diagnosis
Hypertension		I10	401.9					Diagnosis
History of COVID		Z86.16						Diagnosis
Post COVID-19 condition U09.9		U09.9						Long COVID code

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National Standard for Medications.

[Prediction of Atrial Fibrillation using machine learning.](#)
[Machine Learning in Arrhythmia and Electrophysiology](#)
[Performance of an electronic health record-based predictive model to identify patients with atrial fibrillation across countries](#)

This 2021 review paper provides detailed information on various methodologies to predict atrial fibrillation.
This 2021 review paper provides detailed information on various developments in ECG-based ML.
The goal of this study was to assess predictive model for atrial fibrillation in EHR systems.

Recommended Clinical Factors for AI/ML features

Stroke ICD code range: J42.x J43.x J44.x

Text Description	LOINC	ICD-10	ICD-9	SNOMED	Normal Range			Comments
					Units	Min	Max	
Body Height	8302-2				cm	< 137	> 213	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7				kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5				NA	<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6				mmHG	90	<140	
Diastolic Blood Pressure	8462-4				mmHG	< 60	<90	
Cholesterol_HDL	2095-8				mg/dl	<40	> = 40	
Cholesterol_LDL	13457-7				mg/dl	< 100	130	
Cholesterol_LDL/HDL	11054-4				NA		<=3.5	
Contine	10365-5				ng/mL	<10	> = 10	Detects nicotine to determine tobacco
Hemoglobin A1c	4548-4				%	< 5.7	> = 6.5	Normal: HbA1c below 5.7% Pre-diabetes: HbA1c between 5.7% and 6.4% Diabetes: HbA1c of 6.5% or higher
C-Reactive Protein_high sensitivity	11039-5				mg/L	< 1	> 3	
CBC with all components	58410-2							This is a panel with about 10 components.
Red blood cell distribution width	30384-2				fl	< 11.5	> 14.6	fl is femtoliters.
CT Calcium Score	36934-5				NA	0	> 0	
ECG Impression	8601-7							
Carotid Ultrasound	42349-1							
Carotid Angiography	31005-4							
Smoking Status	72166-2			365980008				Binary: Will be 0 or 1
Sedentary lifestyle				415510005				Binary: Will be 0 or 1
Obesity		E66.9	278.00					Diagnosis: See Body Max Index above.
Diabetes Type 2		E11-[next digit]	250.00					Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and control)
Diabetes Type 1		E10-[next digit]	250.01					Diagnosis--Only 10% of diabetics.
Hyperlipidemia		E66.x	272.400					Diagnosis
Hypertension		I10	401.90					Diagnosis
Coronary Artery Disease		I25.10	414.00					Diagnosis
History of COVID		Z86.16						Diagnosis
Post COVID-19 condition U09.9		U09.9						Long COVID code

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[SNOMED Browser](#)

[Unified Medical Language System® \(UMLS®\) RxNorm Browser](#)

[Singh, M. Sheetal, Prakash Choudhary, and Khelchandra Thongam. 2020. "A Comparative Analysis for Various Stroke Prediction Techniques." In Computer Vision and Image Processing, edited by Neeta Nain, Santosh Kumar Vipparthi, and Balasubramanian Raman, 98–106. Communications In Computer and Information Science. Singapore: Springer. \[https://doi.org/10.1007/978-981-15-4018-9_9\]\(https://doi.org/10.1007/978-981-15-4018-9_9\).](#)

[Hunter, Elizabeth, and John D. Kelleher. 2022. "Age Specific Models to Capture the Change in Risk Factor Contribution by Age to Short Term Primary Ischemic Stroke Risk." *Frontiers in Neurology* 13. <https://www.frontiersin.org/articles/10.3389/fneur.2022.803749>.](#)

[Pit chai, R., Bhasker Dapore, P. V. Pramila, M., Vidhyalakshmi, S. Shanthi, Wadi B. Alonzi, Khalid M. A. Almutairi, R. S. Sundaram, and Ipsa Beyene. 2022. "An Artificial Intelligence-Based Bio-Medical Stroke Prediction and Analytical System Using a Machine Learning Approach." *Computational Intelligence and Neuroscience* 2022 \(October\): e5489084. <https://doi.org/10.1155/2022/5489084>.](#)

[Predicting Risk of Stroke From Lab Tests Using Machine Learning Algorithms: Development and Evaluation of Prediction Models](#)

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National Standard for Medications

Quote from the abstract: "If we can predict a stroke in its early stage, then it can be prevented. In this paper, we evaluate five different machine learning techniques to predict stroke on Cardiovascular Health Study (CHS) dataset."

Age is one of the most important risk factors when it comes to stroke risk prediction. However, including age as a risk factor in a stroke prediction model can give rise to a number of difficulties. The age group models from this research show better results when compared to a model for all ages that includes age as a risk factor. The study developed a machine learning algorithm that predicts stroke in real-time using electromyography (EMG) data. The findings suggest that real-time analysis of biosignals using machine learning can improve stroke prediction and help patients receive prompt treatment. The aim of this study was to apply computational methods using machine learning techniques to predict stroke from lab test data. The predictive model, built using data from lab tests, was easy to use and had high accuracy.

Recommended Clinical Factors for AI/ML features

Kidney Stones

ICD code range: J42.x J43.x J44.x

Text Description	LOINC	ICD-10	ICD-9	SNOMED	Units	Normal Range		Comments
						Min	Max	
Body Height	8302-2				cm	< 137	> 213	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7				kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5				NA	<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6				mmHG	90	<140	
Diastolic Blood Pressure	8462-4				mmHG	< 60	<90	
Cholesterol_HDL	2095-8				mg/dl	<40	> 40	
Cholesterol LDL	13457-7				mg/dl	< = 100	130	
Cholesterol/HDL	11054-4				NA		<=3.5	
Cotinine Serum	10365-5				ng/mL	<10	> = 10	Detects nicotine to determine tobacco exposure.
High Sensitivity C-Reactive Protein	11039-5				mg/L	< 1	> 3	
CBC with all components	58410-2							
Smoking Status	72166-2			365980008				
Sedentary Lifestyle					415510005			
Family history of kidney stones				416519002				
Diuretic Medication				722048006				
Urinalysis	24356-8							This is a panel with multiple values of the urinalysis (e.g., glucose and protein).
Serum Creatinine	14682-9				[Mass/Vol]	0.5	1.2	
Glomerular Filtration Rate (GFR)	48642-3				mL/min/1.73m	< 90	>= 90	Renal Function that determines severity of chronic kidney disease.
Blood Urea Nitrogen	3094-0				mg/dL	6	20	
Serum pH	2753-2				pH	7.35	7.45	This is an arterial blood sample.
Urine pH	2756-5				pH	4.5	8	
Serum Calcium	17861-6				mg/dL	8.5	10.2	
Serum Potassium	6298-4				mmol/L	3.5	5	
Serum Uric Acid	3084-1				mg/dL	2.4	6	
Hemoglobin A1c	4548-4				%	< 5.7	> = 6.5	Normal: HbA1c below 5.7%. Pre-diabetes: HbA1c between 5.7% and 6.4%. Diabetes: HbA1c of 6.5% or higher.
Primary Hyperoxaluria		R82.992	791.90					Diagnosis
Cystinuria		E72.04	270.00					Diagnosis
Polycystic Kidney Disease		Q61.3	753.12					Diagnosis
Diabetes Type 2		E11-[next digit]	250.00					Diagnosis--query via E11-[any value]
Diabetes Type 1		E10-[next digit]	250.01					Diagnosis--only 10% of diabetics. Query via E10-[any value]
Hyperlipidemia		E78.5	272.40					Diagnosis
Obesity		E66.9	278.00					Diagnosis
Hyperparathyroidism		E21.0	252.00					Diagnosis
History of COVID		Z86.16						Diagnosis
Post COVID-19 condition U09.9		U09.9						Long COVID code

References

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[DeJohn, Charles A, Alex M Weblink, and Julie G Larcher. n.d. "In-Flight Medical Incapacitation and Impairment of U.S. Airline Pilots: 1993 to 1998."](#)

The FAA gathered information on aircrew in-flight medical events that occurred on U.S. airlines between 1993 and 1998. This study brings insights into conditions that result in in-flight incapacitation.

[Magherini, Roberto, Elisa Mussi, Yary Volpe, Rocco Furferi, Francesco Buonamici, and Michaela Servi. 2022. "Machine Learning for Renal Pathologies: An Updated Survey." *Sensors \(Basel, Switzerland\)* 22 \(13\): 4989. <https://doi.org/10.3390/s22134989>.](#)

[Alghafees, Mohammad A., Saleha Abdul Rab, Abdulaziz S. Aljurayyad, Tariq S. Alotaibi, Belal Nedal Sabbah, Raouf M. Seyam, Lama H. Aldosari, and Mohammad A. Alomar. 2022. "A Retrospective Cohort Study on the Use of Machine Learning to Predict Stone-Free Status Following Percutaneous Nephrolithotomy: An Experience from Saudi Arabia." *Annals of Medicine and Surgery* 84 \(December\): 104957. <https://doi.org/10.1016/j.amsu.2022.104957>.](#)

[Kavoussi, Nicholas L., Chase Floyd, Abin Abraham, Wilson Sui, Cosmin Bejan, John A. Capra, and Ryan Hsi. 2022. "Machine Learning Models to Predict 24 Hour Urinary Abnormalities for Kidney Stone Disease." *Urology* 169 \(November\): 52–57. <https://doi.org/10.1016/j.urology.2022.07.008>.](#)

Machine learning techniques are increasingly being applied in the medical field, including in nephrology, due to the prevalence of renal pathologies in society. The use of machine learning in nephrology shows promise in aiding physicians with accurate and rapid diagnoses. The aim of the study was to use machine learning to predict the stone-free status after surgical removal of a kidney stone. We developed an effective machine learning model to assist physicians in selecting patients with a history of kidney stones requiring surgical care that are at risk for recurrence.

This study aimed to explore the use of machine learning methods in predicting 24-hour urine abnormalities, which can aid in guiding empiric therapy for kidney stone disease. The results show promise but further work is needed.

Diabetes

ICD 10 Codes

E11.x

E10.x

Note: ICD-10 codes E11.x Type 2 Diabetes consist of 90% or cases. E10.x consists of Type 1 insulin-dependent diabetes which make up 10% of cases

Text Description	LOINC	RXNORM	ICD-10	ICD-9	SNOMED	RxNorm	Units	Normal Range		Comments
								Min	Max	
Body Height	8302-2						meters	< 1.3	> 21	Used to calculate Body Mass Index
Body Mass Index Weight	29463-7						kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5		NA					<18.5	>29.9	Overweight between 25 and 29.9 Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Waist Circumference	56115-9				60621009		inches	<=40	>40	Obesity measurement
Systolic Blood Pressure					271649006		mmHg	< 90	>150	
Diastolic Blood Pressure					271650006		mmHg	< 60	>= 90	
Hemoglobin A1c	4548-4						%	< 5.7%	< =6.3%	Normal: HbA1c below 5.7% Pre diabetes: HbA1c between 5.7% and 6.4% Diabetes: HbA1c of 6.5% or higher
Serum Creatinine	2160-0						mg/dL	< 0.59	>1.35	
Glomerular Filtration Rate (GFR)	48642-3						mL/min/1.73m	< 90	>= 90	Renal Function that determines severity of chronic kidney disease.
Pre-diabetes			R73.03	790.29				>= 5.7%	<=6.4%	HgbA1c values determine diagnosis of this intermediate state.
Diabetes			E11.9	250.00					>= 6.5%	HgbA1c values determine diagnosis of diabetes.
Blood glucose level (fasting)	14749-6						mg/dl	<= 70	> 100	Blood glucose level (fasting): Normal range is typically between 70 to 100 mg/dL (3.9 to 5.6 mmol/L).
Serum Glucose (hypoglycemia range)	2345-7						mg/dL	< 60	>140	Hypoglycemia symptoms are experienced when the serum glucose drops under 60 with increasing severity as the level becomes less than 50 mg/dL.
Triglyceride level (fasting)	2571-8				14927-8		mg/dl	< 150	>= 150	Triglyceride level (fasting): Normal range is typically less than 150 mg/dL (1.7 mmol/L).
High density lipoprotein cholesterol (fasting)	2085-9				14646-4		mg/dl	<40	>=40	High density lipoprotein cholesterol (fasting): Normal range is typically greater than 40 mg/dL (1.04 mmol/L) in men and greater than 50 mg/dL (1.3 mmol/L) in women.
Cholesterol_LDL	13457-7						mg/dl	< 100	>= 130	
Cholesterol_LDL/HDL	11054-4						NA		<=3.5	
C-Reactive Protein-High Sensitivity	30522-7							<3	>= 3	Risk factor for heart attacks.
γ-glutamyltransferase level (fasting)	2256-0				25844-3			<30	>=30	γ-glutamyltransferase level (fasting): Normal range is typically less than 30 U/L.
Alanine aminotransferase level (fasting)	1742-6				1742-6		U/L	< 7	> 55	
Aspartate transaminase (AST):	1920-8						U/L	< 8	>48	
Alkaline phosphatase	6768-6						U/L	<20	> 140	
Obesity			E66.x	278	414916001			<30	>= 30	Measured by Body Mass index. Most common diagnosis in adults in US.
Hyperlipidemia			E78.5	272.4						Most common diagnosis in adults.
Hypertension			I10	401.9						45% of adult Americans have this.
Coronary Artery Disease			I20.x through I25.x	414.00						Crucial diagnosis codes to identify this significant co-morbidity which can be incapacitation when a heart attack occurs.
Prediabetes			R73.03	790.29						Programmatically identify this diagnosis using HgA1c values >=5.7 and < 6.4 %.
Hypoglycemia			E16.0							
Metabolic syndrome			E16.1							
Polycystic ovary syndrome			E16.2	251.2	302866003					
Gestational diabetes mellitus (GDM)	730-3		E88.81	277.7	237604001					
Sedentary lifestyle			E28.2	256.4	237439001					
Hemochromatosis carrier state (C282Y mutation)			O24.4	648.8	73211009					
Chronic hepatitis C infection					415510005					
Depression			283.89	275.00	42399005					
Personal history of antineoplastic chemotherapy for cancer			B18.2	70.54	840539006					
Sleep Apnea	74605-2		F32.9	296.2	35489007					
Uric Acid (male): 3.4-7.2 mg/dL	3084-1		292.21	92.21	254815009					
History of COVID			G47.3x	780.57	197235008					
Post COVID-19 condition U09.9							mg/dl	< 2.4	> 7.2	Diagnosis Long COVID code

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[Prediction of progression from pre-diabetes to diabetes: Development and validation of a machine learning model](#) This article describes a Machine Learning approach to assign risk for progression of prediabetes to diabetes.

[Development of Various Diabetes Prediction Models Using Machine Learning Techniques](#) Two sets of variables were used to develop eight DM prediction models. The area under the receiver operating characteristic curve (ROC-AUC) for the 62-variable DM model making 12-month predictions for subjects without diabetes was the largest (0.928) among those of the eight DM prediction models

[Machine learning and deep learning predictive models for type 2 diabetes: a systematic review](#) This is a detailed review of various approaches in machine learning to predict high risk for development of diabetes.

[Predicting the risk of developing diabetic retinopathy using deep learning](#) This presents a deep-learning system that used color fundus photographs to predict the development of mild or worse diabetic retinopathy within 2 years, for patients with diabetes who did not have diabetic retinopathy at the time of screening.

[Prediction of Diabetic Sensorimotor Polyneuropathy Using Machine Learning Techniques](#) Diabetic sensorimotor polyneuropathy (DSPN) is a major complication in patients with diabetes mellitus (DM), and early detection or prediction of DSPN is important for preventing or managing neuropathic pain and foot ulcer. Our aim is to delineate whether machine learning techniques are more useful than traditional statistical methods for predicting DSPN in DM patients.

[Chronic kidney disease prediction based on machine learning algorithms](#) Within the confines of a supervised learning environment, a total of 12 different machine learning-based classifiers have indeed been examined, with the greatest performance indicators being an accuracy of 0.983, a precision of 0.98, a recall of 0.98, and an F1-score of 0.98 for the XgBoost classifier.

Diabetic Complications**Clinical Outcomes for diabetes progression to new condition**

Condition	ICD-10 CM	ICD-9 CM	SNOMED-CT	Comments
Myocardial Infarction and related conditions	I20.x through I25.x	410 through 414	414545008	All of these conditions are key complications of diabetes with poor glucose control. These are used as clinical endpoints/outcomes when predicting progression in diabetes.
Stroke	I63.x	434.91	404684003	
Neuropathy Type 2 diabetes	E11.4x	250.60	368581000119106	
Neuropathy Type 1 diabetes	E10.4x	250.60	78954200	
Nephropathy (kidney disease) Type 2 Diabetes	E11.21	250.40	420279001	
Nephropathy (kidney disease) Type 1 Diabetes	E10.21	250.40	421893009	
Type 2 diabetes mellitus with retinopathy codes	E11.329	250.50	422034002	
	E11.339	250.50	422034002	
	E11.349	250.50	422034002	
	E11.359	250.50	422034002	
Type 1 diabetes mellitus with retinopathy codes	E10.329	250.51	420789003	
	E10.339	250.51	420789003	
	E10.349	250.51	420789003	
	E10.359	250.51	420789003	
			371087003	
Type 2 diabetes with foot ulcer	E11.621	250.8		
Type 1 diabetes with foot ulcer	E10.621	250.8	420789003	
Type 2 diabetes with hypoglycemia	E11.641	250.3	120731000119103	
Type 1 diabetes with hypoglycemia	E10.649	250.81	84371000119108	

Recommended Clinical Factors for AI/ML features

Chronic Obstructive Pulmonary Disease (COPD)

ICD-10 codes

J42.x J43.x J44.x

Text Description	LOINC	ICD-10 codes	ICD-9 codes	SNOMED	RxNorm	Units	Normal Range		Comments
							Min	Max	
Body Height	8302-2					meters	< 1.3	> 2.1	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7					kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5			NA			<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. = weight (kg) / height (m) ² . BM
Systolic Blood Pressure	8480-6					mmHG	90	<140	
Diastolic Blood Pressure	8462-4					mmHG	< 60	<90	
Cholesterol HDL	2095-8					mg/dl	<40	> = 40	
Cholesterol LDL	13457-7					mg/dl	< 100	130	
Cholesterol LDL/HDL	11054-4					NA		<=3.5	
HemoglobinA1c	4548-4					%	< 5.7	> = 5.7	Normal: HbA1c below 5.7%. Pre-diabetes: HbA1c between 5.7% and 6.4%. Diabetes: HbA1c of 6.5% or higher.
Cotinine Serum	10365-5					ng/mL	<10	> = 10	Nicotine test to help determine smoking status.
CT Calcium Score	36934-5					NA	0	> 0	This is a CT Scan test.
Carotid Angiogram	87847-0								
FEV1	20150-9						<30%	>=80%	FEV1 stands for Forced Expiratory Volume in 1 second. It is a measure of lung function that indicates the amount of air that can be forcefully exhaled from the lungs in one second after taking a deep breath. This value determines the stage of COPD.
Serum Potassium	6298-4					mmol/L	3.5	5	
Arterial Blood Gas pH	1863-0						7.35	7.45	No units needed
Arterial Blood Gas Partial pressure of oxygen (PaO2)	2019-8					mmHg	7.35	7.45	
Arterial Blood Gas Partial pressure of carbon dioxide (PaCO2)	2028-9					mmHg	35	45	
Arterial Blood Gas Bicarbonate (HCO3)	2029-7					mmHg	22	28	
Arterial Blood Gas Oxygen Saturation	20564-1					%	95	100	
Pulse Oximetry	59408-5					%	95	100	
Chest x-ray	18782-1								
ECG Impression	8601-7								
Alpha-1 antitrypsin	17781-6					mg/dL	0.9	2	
Pulse Oximetry	59408-5					%	95	100	
N-acetyl-glycoprotein	30098-8								
Serum Glucose	2345-7					mg/dL	70		
Lactate	mg/dL					mg/dL	4.5	19.8	
Distance walked in 6 minutes	62395-2					feet	1312	>=1640	Abbreviation used: 6MWD
Smoking Status	72166-2			365980008					The values are: 1) never smoked 2) quit smoking 3) time in years since quit smoking 4) current smoker EHR systems capture this in various ways which will need to be determined.
Smoking years	11368-8					packyears			
Smoking Amount	443672007					packs day	0	> 0	
Smoking pack years	11368-8						0	> 0	Calculated by multiplying smoking-years to smoking amount.
Secondhand smoke exposure	718-7	Z77.22		16090371000119100					
Occupational exposure to dusts and chemicals	35201-5			16090571000119100					
Exposure to fumes from burning fuel	718-7			16090571000119100					
CT Scan of Chest	71270-1			404684003					The CPT codes are 71250 and 71260.
Albuterol					153941				
Metaproterenol					197313				
Levalbuterol					401980				
Pirbuterol					259515				
Ipratropium					197284				
Tiotropium					784979				
Acclidinium					1159464				
Revefenacin					2096598				
Theophylline					197827				
Fluticasone					1340775				
Budesonide					197267				
Sedentary lifestyle				415510005					Binary: Will be a positive or negative.
Obesity		E66.9	278.00						Diagnosis
Diabetes Type 2		E11- [next digit]	250.00						Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and control).
Diabetes Type 1		E10-[next digit]	250.01						Diagnosis--Only 10% of diabetics
Hyperlipidemia		E66.x	272.4						Diagnosis
Hypertension		I10	401.9						45% of adult Americans have this.
Coronary Artery Disease		I20.x through I25.x	414.00						Crucial diagnosis codes to identify this significant co-morbidity which can be incapacitation when a heart attack occurs.
Asthma		J45.x	493.x						
Chronic Bronchitis		J42.x	491.21						Diagnosis

Pneumonia		J12.x J15.x	486.00					Diagnosis
Lung Cancer		C34.s	162.x					Diagnosis
Personal History of Lung cancer				415082004				
History of COVID		Z86 . 16						Diagnosis
Post COVID-19 condition U09.9		U09.9						Long COVID code

References

[Medscape Medical Knowledgebase](#)

[CDC ICD 10 Search Tool](#)

[ICD 10Data Tool](#)

[Unified Medical Language System* \(UMLS®\) SNOMED Browser](#)

[Unified Medical Language System* \(UMLS®\) RxNorm Browser](#)

<https://academic.oup.com/jamia/article/16/3/371/858120>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2732240/>

<https://onlinelibrary.wiley.com/doi/full/10.1002/jcla.23641>

Summary

This provides comprehensive information on diseases, clinical care and issues in healthcare. It is used internationally. Medscape requires a paid subscription.

To determine codes and related diagnoses

To determine codes and the ICD 10 hierarchy

Use the US edition for SNOMED mapping, National Standard for Medications

A Bayesian network model composed of age, sex, race, smoking history, and 8 comorbidity variables is able to predict COPD in the independent set of patients with an accuracy of 83.3%. The study demonstrates that data extracted from electronic medical records can be used to create predictive models.

This study shows the development of a predictive model of COPD using comorbidities and demographic information extracted from medical records of asthma patients. The results show that it is possible to use data extracted from

medical records to create predictive models.

The study's objective was to identify metabolic biomarkers in serum for diagnosing chronic obstructive pulmonary disease (COPD). This study suggests that artificial intelligence integrated with serum metabolic biomarkers has a great potential for auxiliary diagnosis of COPD.

Obstructive Sleep Apnea

ICD code range: G47.3x

Text Description	LOINC	ICD-10	ICD-9	SNOMED	RxNorm	Units	Normal Range		Comments
							Min	Max	
Body Height	8302-2					meters	< 1.3	> 21	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7					kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5			NA			<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6					mmHG	90	<140	
Diastolic Blood Pressure	8462-4					mmHG	< 60	<90	
Cholesterol	2095-8					mg/dl	<40	> = 40	
Cholesterol LDL	13457-7					mg/dl	< = 100	130	
Cholesterol/HDL	11054-4					NA		<=3.5	
Cotinine Serum	10365-5					ng/mL	<10	> = 10	Detects nicotine to determine tobacco exposure.
Smoking Status	72166-2			365980008					
Sedentary Lifestyle				415510005					
Hemoglobin A1c	4548-4						<5.7	>=6.5	Normal: HbA1c below 5.7% Pre-diabetes: HbA1c between 5.7% and 6.4% Diabetes: HbA1c of 6.5% or higher
Apnea-hypopnea Index	90563-8						< 5	>=5	This is the key measurement for diagnosis and severity. It is the output from a sleep study
Pulse Oximetry	59408-5					%	95	100	CPT code 94760
ECG Impression	8601-7								
Epworth Sleep Scale	72228-4					NA	<=5	>5	
Oxygen Desaturation Index	81898-5						<5	>=5	
Neck circumference	8289-6					inches	<17	>=17	This is for males- females have a slightly different range
Montreal Cognitive Assessment	72133-2 (test) and 72172-0 (test results)						<26	>= 26	Note: This has a range from 0 to 30 with 26 or over showing greater cognition in a number of areas. It is widely used in clinical trials and medical practice. It takes an average of 10 minutes for the patient to complete.
Daytime sleepiness				230490003					No ICD or LOINC code available. The Epworth Sleepiness Scale (see above) is the best clinical approach to assess sleepiness.
Asthma		J45.x	493.x						Diagnosis
Diabetes Type 2		E11-.[next digit]	250.00						Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and control)
Diabetes Type 1		E10-[next digit]	250.01						Diagnosis--Only 10% of diabetics
Hyperlipidemia		E66.x	272.4						Diagnosis
Obesity		E66.9	278.00						Diagnosis
Hypertension		I10	401.9						Diagnosis
Mild Depression		F34.1	311.00						Diagnosis
Major Depression		F33.X	296.2x						Diagnosis
Depression episode		F32.x	296.x						Single episode of depression. Not a chronic condition.
Polysomnography	11348-0								CPT code 95810
History of COVID		Z86.16							Diagnosis
Post COVID-19 condition		U09.9							Long COVID code

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To determine codes and the ICD 10 hierarchy Use the US edition for SNOMED mapping. National Standard for Medications

[A Survey on Recent Advances in Machine Learning -based Sleep Apnea diction systems](#)

This 2021 review covers research based on machine learning, deep learning, and sensor fusion

[An introduction to artificial intelligence in sleep medicine.](#)

A 2021 introduction paper to using AI/ML in detecting sleep disorders and their severity

[Application of machine learning to predict obstructive sleep apnea syndrome severity](#)

A 2020 study on predicting severity of obstructive sleep apnea. This shows how hard it can be to build an accurate machine learning model

Recommended Clinical Factors for AI/ML features

Mild Traumatic Brain Injury

ICD-10 code range: **Z87.820**

S06.x

Text Description	LOINC	ICD-10	ICD-9	SNOMED	Units	Normal Range		Comments
						Min	Max	
Body Height	8302-2				cm	< 137	> 213	Used to calculate Body Mass Index.
Body Mass Index Weight	29463-7				kg	< 13	> 113	Used to calculate Body Mass Index.
Body Max Index	39156-5				NA	<18.5	>29.9	Overweight between 25 and 29.9. Obesity starts at 30. BMI = weight (kg) / height (m) ² .
Systolic Blood Pressure	8480-6				mmHG	90	<140	
Diastolic Blood Pressure	8462-4				mmHG	< 60	<90	
Personal history of concussion		Z87.820	V15.52	15663121000119104				Documentation of more than one concussion would use the same code.
Concussion without loss of consciousness		S06.0X0	850.0	62106007				Diagnosis
Concussion with loss of consciousness of 30 minutes or less		S06.0X1	907.0	209827006				Diagnosis
Concussion with loss of consciousness of unspecified duration		S06.0X0A	850.9	62564004				Diagnosis
APOE ε4 allele	48023-6			None available		Negative	Positive	Patients with this genetic marker increase the likelihood of cognition problems and dementia.
Thyroid Stimulating Hormone	3024-7				mIU/L	<= .4	> 4.0	Thyroid conditions can affect cognition.
HemoglobinA1c	4548-4				%	< 5.7	> = 6.5	Normal: HbA1c below 5.7%. Pre-diabetes: HbA1c between 5.7% and 6.4%. Diabetes: HbA1c of 6.5% or higher.
Vitamin B12	13955-0				pg/mL	<200	>= 200	Low B12 levels can cause cognitive decline.
Folate	2937-4				ng/mL	< 2.7	> = 17	
Alanine aminotransferase level (fasting)	1742-6				U/L	< 7	> 55	
Aspartate transaminase (AST):	1920-8				U/L	< 8	>48	
Alkaline phosphatase	6768-6				U/L	<20	> 140	
Glomerular Filtration Rate (GFR)	48642-3				mL/min/1.73m	< 90	>= 90	Renal Function that determines severity of chronic kidney disease.
Mini-Mental State Examination (MMSE)	72107-6 (test) and 72106-8 (test results)			447316007		< 24	>= 24	The higher the score, the better cognition.
Montreal Cognitive Assessment	72133-2 (test) and 72172-0 (test results)					<26	>= 26	Note: This has a range from 0 to 30 with 26 or over showing greater cognition in a number of areas. It is widely used in clinical trials and medical practice. It takes an average of 10 minutes for the patient to complete.
Magnetic resonance imaging (MRI) of Head	18748-4			241601008				The challenge is that the result (Radiologist Impression) is in text in most health centers. So this would require NLP which has been successfully done by others.
CT Scan of Head	18750-9			169873005				See above information for MRI results.
Chronic traumatic encephalopathy		F07.81	310.2	1187004001				Late onset complication found in those with repetitive head impacts as in football.
Diabetes Type 2		E11.x	250.00					Diagnosis: Add additional number for specifics of diabetic condition (i.e. complications and blood sugar control).
Diabetes Type 1		E10.x	250.01					Diagnosis: Only 10% of diabetics
Ischemic Heart Disease		I20.x through I25.x	410 through 414					Diagnosis
Substance Use Disorders		F10.x through F19.x	291 - 292, 303-305					Diagnosis
Smoking Status	72166-2			365980008				This term is used in various ways in EHR data.
Obesity		E66.9	278.00					Diagnosis
Hypertension		I10	401.90					Diagnosis
History of COVID		Z86.16		292508471000119000				Diagnosis
Post COVID-19 condition U09.9		U09.9		1119304009				Long COVID code

References

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[ICD 10Data Tool](#)

[Unified Medical Language System* \(UMLS*\) SNOMED Browser](#)

[Unified Medical Language System* \(UMLS*\) RxNorm Browser](#)

[Epidemiology of mild traumatic brain injury and neurodegenerative disease. Molecular and Cellular Neuroscience, 66, 75-80.](#)

[Artificial intelligence as an emerging technology in the current care of neurological disorders](#)

[Association of Mild Traumatic Brain Injury \(i.e. concussion\) With and Without Loss of Consciousness With Dementia in US Military Veterans](#)

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National Standard for Medications

This is a summary article explaining the link of concussions to degenerative changes in the brain.

This journal article covers AI in prediction of a number of neurological diseases, including concussion. Scroll down the first information page to the article.

In this cohort study of more than 350 000 veterans, even mild TBI (concussion) without LOC was associated with more than a 2-fold increase in the risk of dementia diagnosis. Studies of strategies to determine mechanisms, prevention, and treatment of TBI-related dementia in veterans are urgently needed.