Supplementary Table 4: Data mining with structured big data					
Classification	**Title**	**Authors**	**Year**	**ML**	**Prediction**
Diagnosis and Management	A novel interpretable deep learning model for diagnosis in emergency department dyspnoea patients based on complete data from an entire health care system.	Heyman ET, et al.	2024	(CareNet) CatBoost	Acute Heart Failure, Chronic obstructive pulmonary disease, pneumonia diagnosis
Diagnosis and Management	A step forward in the diagnosis of urinary tract infections: from machine leaning to clinical practice	Flores E, et al.	2024	Random Forest, Neural Network, Clinical Decision Support Systems (CDSS)	Urinary tract infection diagnosis
Diagnosis and Management	Accurate diagnosis of acute appendicitis in the emergency department: an artificial intelligence-based approach.	Roshanaei G, et al.	2024	Support Vector Classifier, Random Forest, Gradient Boosting, Gaussian Naive Bayes	Acute appendicitis diagnosis
Diagnosis and Management	Acute cholecystitis diagnosis in the emergency department: an artificial intelligence-based approach.	Saboorifar H, et al.	2024	Machine learning-based classification (SVM)	Acute cholecystitis diagnosis
Diagnosis and Management	Acute myocardial infarction risk prediction in emergency chest pain patients: An external validation study.	Chang CH, et al.	2025	Machine learning-based predictive modeling (RF, LR, SVM, KNN) - Synthetic Minority Oversampling Technique (SMOTE) for class balancing in model development	Adverse cardiac event diagnosis
Diagnosis and Management	Analysis of hematological indicators via explainable artificial intelligence in the diagnosis of acute heart failure: a retrospective study.	Yilmaz R, et al.	2024	XGBoost, LASSO, SHAP	AHF diagnosis
Diagnosis and Management	Artificial Intelligence Model Predicts Sudden Cardiac Arrest Manifesting With Pulseless Electric Activity Versus Ventricular Fibrillation	Holmstrom L, et al.	2024	Extreme Gradient Boosting (XGBoost), SHAP explanations, external validation in different cohorts	PEA vs VF diagnosis
Diagnosis and Management	Assessment of Sepsis Risk at Admission to the Emergency Department: Clinical Interpretable Prediction Model	Aygun U, et al.	2024	Extreme Gradient Boosting (XGBoost), Shapley Values	Sepsis diagnosis

Diagnosis and Management	Decrease of haemoconcentration reliably detects hydrostatic pulmonary oedema in dyspnoeic patients in the emergency department - a machine learning approach.	Gavelli F, et al.	2024	- Gradient Boosting Machine (GBM) model with Shapley values (SHAP) for feature importance	Hydrostatic pulmonary oedema
Diagnosis and Management	Diagnostic accuracy of a machine learning algorithm using point-of-care high-sensitivity cardiac troponin I for rapid rule-out of myocardial infarction	Betül Toprak et al.	2024	ARTEMIS-POC AI model	MI role-out
Diagnosis and Management	Early prediction of sepsis in emergency department patients using various methods and scoring systems.	Song YF, et al.	2024	- Logistic regression, Random Forest, XGBoost, AutoScore - SHAP (Shapley Additive Explanations)	Sepsis diagnosis
Diagnosis and Management	Interpretable ML for Predicting Sepsis Risk in Emergency Triage Patients	Liu Z, et al.	2025	Gradient Boosting, SHAP, LIME	Early sepsis detection
Diagnosis and Management	Machine Learning in Diagnostic Support in Medical Emergency Departments	Brasen CL, et al.	2024	19 ML models (varied algorithms)	Diagnosis and outcomes
Diagnosis and Management	Machine learning prediction of refractory ventricular fibrillation in out-of-hospital cardiac arrest	Rahadian ER, et al.	2024	Compared Logistic Regression, LASSO, and Random Forest	Refractory VF and VT diagnosis
Diagnosis and Management	Machine-learning based prediction of appendicitis for patients presenting with acute abdominal pain	Schipper A, et al.	2024	XGBoost models trained and validated on Dutch ED data	Acute appendicitis diagnosis
Diagnosis and Management	Real-time machine learning-assisted sepsis alert enhances the timeliness of antibiotic administration and diagnostic accuracy in emergency department patients with sepsis: a cluster-randomized trial.	Kijpaisalratana N, et al.	2024	Random forest model	Early sepsis prediction
Diagnosis and Management	Using machine learning to predict bacteremia in urgent care patients on the basis of triage data and laboratory results.	Chiu CP, et al.	2024	LR, RF, XGBoost, and Ensemble Model	Bacteremia prediction

Outcome and risk prediction	A comparative study of explainable ensemble learning and logistic regression for predicting in-hospital mortality in the emergency department	Rahmatinejad Z, et al.	2024	Bagging, AdaBoost, Random Forest, Stacking, XGBoost, Logistic Regression	In-hospital mortality
Outcome and risk prediction	A machine learning-based Coagulation Risk Index predicts acute traumatic coagulopathy in bleeding trauma patients.	Richards JE, et al.	2024	Extreme Gradient Boosting Trees	Acute traumatic coagulopathy
Outcome and risk prediction	A Machine Learning-Based Decision Support System for the Prognostication of Neurological Outcomes in Successfully Resuscitated Out-of-Hospital Cardiac Arrest Patients.	Lee S, et al.	2024	Random Forest-based model	Neurological outcome prognostication
Outcome and risk prediction	A risk prediction model for efficient intubation in the emergency department: A 4-year single-center retrospective analysis	Ding H, et al.	2024	Extreme Gradient Boosting (XGBoost), Logistic Regression, Random Forest, SHAP explanations	Predicting ED intubation
Outcome and risk prediction	An AI-based multiphase framework for improving the mechanical ventilation availability in emergency departments	Ortiz-Barrios M, et al.	2024	Random Forest, Discrete-Event Simulation (DES), cross-sectional study	Mechanical ventilation need, ventilator wait time
Outcome and risk prediction	Aspiring to clinical significance: Insights from developing and evaluating a machine learning model to predict emergency department return visit admissions.	Zhang Y, et al.	2024	XGBoost, DICE, Logistic Regression	72-hour return visits admission
Outcome and risk prediction	Construction of prognosis prediction model and visualization system of acute paraquat poisoning based on improved machine learning model	Long L, et al.	2024	HHO-XGBoost ML, multivariate logistic regression, prognosis visualization system	Prognosis prediction
Outcome and risk prediction	Deep Learning-Based ED In-Hospital Cardiac Arrest Prediction (Deep EDICAS) for early prediction of cardiac arrest and cardiopulmonary resuscitation in the emergency department	Deng YX, et al.	2024	Deep Learning, Time-Series Analysis	Cardiac arrest prediction

Outcome and risk prediction	Development and Validation of a Deep Learning Model for Prediction of Adult Physiological Deterioration.	Shashikumar SP, et al.	2024	Deep learning-based deterioration prediction - Temporal difference (TD) learning for patient trajectory modeling	Physiological deterioration prediction
Outcome and risk prediction	Development and validation of prognostic machine learning models for short- and long-term mortality among acutely admitted patients based on blood tests	Jawad BN, et al.	2024	Automated ML (PyCaret)	Short- and long-term mortality
Outcome and risk prediction	Development of a Predictive Model for Survival Over Time in Patients With Out-of-Hospital Cardiac Arrest Using Ensemble-Based Machine Learning.	Choi HJ, et al.	2024	Ensemble-based machine learning (Survival Quilts)	Survival prediction
Outcome and risk prediction	Early Prediction of Mortality for Septic Patients Visiting Emergency Room Based on Explainable Machine Learning: A Real-World Multicenter Study	Park SW, et al.	2024	Logistic regression, SVM, Random Forest, XGBoost, CatBoost, SHAP	Mortality prediction
Outcome and risk prediction	Experimentation of AI Models Towards the Prediction of Medium-Risk Emergency Department Cases	Siakopoulou S, et al.	2024	XGBoost, Random Forest, Logistic Regression	Medium-risk prediction
Outcome and risk prediction	External Validation and Comparison of Statistical and Machine Learning-Based Models in Predicting Outcomes Following Out-of-Hospital Cardiac Arrest	Wang CH, et al.	2024	Machine learning, logistic regression	Post cardiac arres outcomes
Outcome and risk prediction	External Validation of an AI Model Using Clinical Variables, Including ICD-10 Codes, for Predicting In-Hospital Mortality Among Trauma Patients	Lee S, et al.	2025	Deep learning, ICD-10 codes	In-hospital mortality
Outcome and risk prediction	Interpretable Deep Learning System for Identifying Critical Patients Through the Prediction of Triage Level, Hospitalization, and Length of Stay: Prospective Study.	Lin YX, et al	2024	Multimodal deep learning approach - TabNet for structured tabular data - MacBERT (BERT variant for Chinese) for text-based chief	Triage level prediction-Hospitalization prediction - Length of stay prediction

				complaints	
Outcome and risk prediction	Interpretable machine learning for the prediction of death risk in patients with acute diquat poisoning.	Li H, et al.	2024	Machine learning-based predictive modeling - Logistic Regression, Random Forest, SVM, Gradient Boosting	Mortality prediction
Outcome and risk prediction	Machine learning in the prediction of massive transfusion in trauma: a retrospective analysis as a proof-of-concept.	Nikouline A, et al.	2024	- XGBoost, Random Forest, Gradient Boosting, MLP, AdaBoost	Massive transfusion prediction
Outcome and risk prediction	Machine Learning Models for Predicting Mortality in Patients with Cirrhosis and Acute Upper Gastrointestinal Bleeding at an Emergency Department: A Retrospective Cohort Study.	Tsai SC, et al.	2024	XGBoost, Neural Network, Linear Regression	Mortality prediction
Outcome and risk prediction	Multisite development and validation of machine learning models to predict severe outcomes and guide decision-making for emergency department patients with influenza.	Hinson JS, et al.	2024	- Random Forest classifier	Severe outcome prediction
Outcome and risk prediction	Outcome prediction of methadone poisoning in the United States: implications of machine learning in the National Poison Data System (NPDS).	Mehrpour O, et al.	2024	- XGBoost, LightGBM (LGBM), Random Forest (RF), Logistic Regression (LR)	Minor, moderate, major outcomes
Outcome and risk prediction	Patient stratification based on the risk of severe illness in emergency departments through collaborative ML models	Chen JY, et al.	2024	ANN models	Patient stratification
Outcome and risk prediction	Pilot deployment of a machine-learning enhanced prediction of need for hemorrhage resuscitation after trauma - the ShockMatrix pilot study.	Gauss T, et al.	2024	- XGBoost with SHAP feature selection	Need for hemorrhage resuscitation

Outcome and risk prediction	Predicting suicide death after emergency department visits with mental health or self-harm diagnoses.	Simon GE, et al.	2024	- LASSO logistic regression (best-performing model) - Random forest	Suicide death prediction
Outcome and risk prediction	Prospective and External Validation of ML for Short- and Long-Term Mortality in ED Patients	Jawad BN, et al.	2024	LightGBM	Short- and long-term mortality prediction
Outcome and risk prediction	Real-time artificial intelligence predicts adverse outcomes in acute pancreatitis in the emergency department: Comparison with clinical decision rule.	Chang CH, et al.	2024	LightGBM, XGBoost, Random Forest, Logistic Regression, SVM	Adverde outcomes
Outcome and risk prediction	Use of machine learning models to predict neurologically intact survival for advanced age adults following out-of-hospital cardiac arrest.	Soundararajan K, et al.	2024	- Boosted Trees, Decision Tree models	Neurologically intact survival prediction
Outcome and risk prediction	Using machine learning to assist decision making in the assessment of mental health patients presenting to emergency departments.	Higgins O, et al.	2024	Random Forest, XGBoost, CatBoost, kNN, Explainable Boosting Machine, SVM	Mental health ward admission
Outcome and risk prediction	Utilizing ultra-early continuous physiologic data to develop automated clinical severity measures	Yang S, et al.	2024	ECG, PPG, Blood pressure-based ML models	In-hospital mortality
Outcome and risk prediction	Validation of an Electronic Health Record-Based Machine Learning Model Compared With Clinical Risk Scores for Gastrointestinal Bleeding.	Shung DL, et al	2024	- Gradient Boosted Trees (XGBoost), Random Forest, Elastic Net Regularized Regression, Deep Neural Networks	Risk stratification
Overcrowding	A Granular View of Emergency Department Length of Stay: Improving Predictive Power and Extracting Real-Time, Actionable Insights.	Canellas MM, et al.	2024	Logistic Regression, Random Forest, XGBoost	Factors affecting prolonged ED length of stay
Overcrowding	An Explainable ML Approach for Hospital ED Visits Forecasting	Peláez-Rodríguez C, et al.	2024	Multi-model regression, clustering algorithms	Improved short- and long-term prediction accuracy
Overcrowding	Emergency Department Length of Stay Classification Using Ensemble Methods	Aziz W, et al.	2024	Random Forest, Gradient Boosting	ED LOS classification

Overcrowding	Enhanced Forecasting of ED Patient Arrivals Using Feature Engineering	Porto BM, et al.	2024	XGBoost, NNA, LightGBM, SVM, SVM-RBF	ED arrival prediction
Overcrowding	Exploring Hospital Overcrowding with an Explainable Time-to-Event ML Approach	Haraldsson T, et al.	2024	Gradient Boosting, Survival Analysis	Overcrowding prediction
Overcrowding	Fairness gaps in Machine learning models for hospitalization and emergency department visit risk prediction in home healthcare patients with heart failure.	Davoudi A, et al.	2024	- LightGBM and AutoGluon	Prediction of hospitalization and emergency department visits
Overcrowding	Prediction of emergency department revisits among child and youth mental health outpatients using deep learning techniques	Saggu S, et al.	2024	GNN vs RNN, XGBoost, Decision Tree, Logistic Regression	Predicting 30-day ED revisits
Overcrowding	Synergistic patient factors are driving recent increased pediatric urgent care demand.	Lehan E, et al.	2024	Random Forest, Linear Regression	Pediatric urgent care demand
Patient safety	A machine learning algorithm-based predictive model for pressure injury risk in emergency patients: A prospective cohort study.	Wei L, et al.	2024	Logistic regression, Decision Tree, Neural Network	Pressure injury risk prediction
Patient safety	A machine learning technology for addressing medication-related risk in older, multimorbid patients.	Seger DL, et al.	2024	Logistic regression, decision trees, random forests, and graph neural networks - Python (PyTorch) implementation	Stratifying medication-related risk and prediction of emergency department (ED) visits and hospitalizations
Patient safety	A study of left against medical advice emergency department patients: an optimized explainable artificial intelligence framework	Ahmed A, et al.	2024	XGBoost with Adaptive Tabu Simulated Annealing, SHAP explanations	Optimized XGB model had AUC of 76% and sensitivity of 82% for LAMA prediction
Patient safety	Development of Machine-learning Model to Predict Anticoagulant Use and Type in Geriatric Traumatic Brain Injury	Fujiwara G, et al.	2024	RF and heatmap visualization	Prediction of anticoagulant use and type of anticoagulation
Patient safety	Machine learning models for predicting unscheduled return visits of patients with abdominal pain at ED	Hsu C, et al.	2024	various ML models applied to patient data	72-hour unscheduled return visits

Patient safety	Prediction of high-risk emergency department revisits from a machine-learning algorithm	Sung CW, et al.	2024	Stacked ensemble model, Deep Learning, Random Forest, XGBoost	Prediction of 72-hour high-risk revisits
Prehospital	Advancing a machine learning-based decision support tool for pre-hospital assessment of dyspnoea by emergency medical service clinicians: a retrospective observational study.	Kauppi W, et al.	2025	- Gradient Boosting, LASSO, Logistic Regression	Serious adverse events
Prehospital	Analyzing Prehospital Delays in Recurrent Acute Ischemic Stroke	Jiang Y, et al.	2024	XGBoost, SHAP	Risk factos for stroke transport
Prehospital	Assessing the Severity of ODT and Factors Determinants of Late Arrival in Young Patients with Acute Ischemic Stroke	Zhu L, et al.	2024	Machine learning (XGBoost, Random Forest),	Factors contributing pre-hospital delays
Prehospital	Clinical phenotypes and short-term outcomes based on prehospital point-of-care testing and on-scene vital signs	López-Izquierdo R, et al.	2024	Unsupervised ML clustering, point-of-care testing	All cause 2, 7 and 30-day mortality risk
Prehospital	Development and validation of a prehospital termination of resuscitation (TOR) rule for out - of hospital cardiac arrest (OHCA) cases using general purpose artificial intelligence (AI).	K, Kajino et al.	2024	Deep learning-based predictive modeling	TOR decision
Prehospital	Predictive modelling of transport decisions and resources optimisation in pre-hospital setting	Farhat H, et al.	2024	Random Forest, SVM, XGBoost, and AdaBoost	Transport decisions
Prehospital	Prehospital Post-Resuscitation Vital Sign Phenotypes are Associated with Outcomes Following Out-of-Hospital Cardiac Arrest.	T, Smida et al.	2024	Unsupervised machine learning (ML) clustering - K-means clustering - Multivariable logistic regression - Kaplan-Meier survival analysis for time-to-rearrest	Mortality and rearrest
Prehospital	The emergency medical service dispatch recommendation system using simulation based on bed availability	Xu Y, et al.	2024	Simulation-based approach integrating real-time data from 48 hospitals	Forecasting availability of ICU and ED beds

Prehospital	The prediction of the survival in patients with severe trauma during prehospital care: Analyses based on NTDB database.	Peng C, et al.	2024	Survival Tree (ST), Random Forest for Survival (RFS), Gradient Boosting Machine (GBM), Cox regression - Feature selection via SHAP analysis - 5-fold cross-validation for model validation	8 hour and 24 hour survival
Triage	Development and validation of a machine learning framework for improved resource allocation in the emergency department.	El Ariss AB, et al.	2024	- 144 AutoML-trained models (Azure) - Soft Voting Ensemble method to combine models	Resource needs
Triage	Enhancing Performance of the National Field Triage Guidelines Using Machine Learning: Development of a Prehospital Triage Model to Predict Severe Trauma.	Chen Q, et al.	2024	Machine learning predictive modeling - XGBoost model with Shapley values (SHAP) for feature importance	Severe trauma and critical resource use
Triage	Enhancing Trauma Triage in Low-Resource Settings Using ML	Nsubuga M, et al.	2025	Random Forest, Gradient Boosting, SVM	Triage decisions
Triage	Evaluating the Reliability of a Remote Acuity Prediction Tool in a Canadian Academic Emergency Department.	Nasser L, et al.	2024	Vtriage - Random Forest & XGBoost models trained with gradient boosting	- Exact modal agreement- Undertriage - Overtriage
Triage	Identification of avoidable patients at triage in a Paediatric Emergency Department: a decision support system using predictive analytics.	Viana J, et al.	2024	- Decision Tree, Naïve Bayes, Logistic Regression, Random Forest, XGBoost, Deep Learning (TabNet, TensorFlow/Keras)	Avaodable pediatric ED visits
Triage	Identifying low acuity Emergency Department visits with a machine learning approach: The low acuity visit algorithms (LAVA).	Chen AT, et al.	2024	Logistic Regression, Random Forest, XGBoost	Identifying low aquity visits
Triage	Improved interpretable machine learning emergency department triage tool addressing class imbalance.	Look CS, et al.	2024	AutoScore-Imbalance framework for mortality prediction	Improving class imbalance

Triage	Inter hospital external validation of interpretable machine learning based triage score for the emergency department using common data model.	Yu JY, et al.	2024	AutoScore framework for feature selection & scoring	2 day mortality
Triage	Leveraging graph neural networks for supporting automatic triage of patients.	Defilippo A, et al.	2024	Graph Neural Network (GNN) architecture - GraphSAGE, Graph Convolutional Networks (GCN), Graph Attention Networks (GATv2Conv)	Triage decisions
Triage	Leveraging Machine Learning to Identify Subgroups of Misclassified Patients in the Emergency Department: Multicenter Proof-of-Concept Study.	Wyatt S, et al.	2024	- Random Forest (Trondheim), XGBoost (Bergen)	Misclassification (over and undertriage)
Triage	Machine and Deep Learning Models for Hypoxemia Severity Triage in CBRNE Emergencies.	Nanini S, et al.	2024	XGBoost, LightGBM, GRU, LSTM	Hypoxemia severity in CBRN cases
Triage	Machine learning based prediction models for analyzing risk factors in patients with acute abdominal pain: a retrospective s	Gan T, et al.	2024	Artificial Neural Networks, Logistic Regression	Abdominal pain triage
Triage	Machine learning outperforms the Canadian Triage and Acuity Scale (CTAS) in predicting need for early critical care.	Grant L, et al.	2025	Deep Learning, Gradient-Boosted Trees, LASSO Regression	Need for critical care within 12 hour
Triage	Managing low-acuity patients in an Emergency Department through simulation-based multiobjective optimization using a neural network metamodel.	Boresta M, et al.	2024	Machine learning-based simulation modeling - Artificial Neural Network (ANN) as a metamodel for ED simulations - Multiobjective optimization (minimizing patient waiting times & operating costs) - Compared ANN-based approach vs. standard DFO	Identifying low aqutity patients

				optimization	
Triage	Triage in major incidents: Development and external validation of novel ML-derived triage tools	Xu Y, et al.	2024	Random Forest, XGBoost, Decision Trees	MI triage decisions

RF: Random Forest, LR:Logistic Regression, SVM: Support Vector Machines, DT: Decision Trees, ED: Emergency Department, ANN: Artificial Neural Network, DNN: Deep Neural Network, CNN: Convolutional Neural Network, XGB: Extreme Gradient Boosting, NB: Naive Bayes, GBM: Gradient Boosting Machine, MI: Myocardial Infarction, DES: Discrete-Event Simulation - SHAP: SHapley Additive exPlanations for feature importance, SMOTE: Synthetic Minority Oversampling Technique (SMOTE) for class balancing