



21st

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WARSAW INTERNATIONAL MEDICAL CONGRESS

ABSTRACT

BOOK

Infectious Diseases Session

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Multimodal Deep Learning to Differentiate Viral vs Bacterial Pneumonia Using Chest Radiographs and Early Clinical Data: Development and External Validation on Open Datasets

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Introduction

Distinguishing viral from bacterial pneumonia early is clinically important but often uncertain from imaging alone. Large-scale open chest radiograph datasets enable multimodal modeling, yet etiology labels are not directly available in most radiology corpora.

Aim of the study

To develop and externally validate a multimodal deep learning model that classifies pneumonia etiology (viral vs bacterial) using chest X-ray (CXR) images and early clinical variables.

Materials and methods

We assembled a retrospective cohort from MIMIC-CXR-JPG linked to MIMIC-IV, deriving etiology labels from microbiology and virology testing within 8 hours of the index CXR: viral pneumonia (positive respiratory viral PCR/antigen; and bacterial pneumonia (positive blood/respiratory culture or urinary antigen; excluding mixed/indeterminate cases. Clinical features available at/near imaging time included demographics, comorbidities, vitals, and laboratory values (binary and continuous; total features). We trained a multimodal transformer fusion model comprising a pretrained Swin Transformer image encoder and a TabTransformer clinical encoder with gated cross-attention fusion ("Swin-TabFusion"). Baselines included image-only (Swin), tabular-only (XGBoost/MLP), and late-fusion (concatenation + MLP). Data were split at the patient level into train/validation/test (75%/15%/10%). Ongoing post-hoc analyses assessing impact on healthcare costs, diagnostic speed, as well as the prevention of complications such as sepsis and inappropriate use of antibiotics in a viral pneumonia. These findings, alongside administered antibiotics, will be presented at the conference.

Results

On the internal validation set, Swin-TabFusion achieved an AUC of 0.84 [0.81-0.85] and AUCPR 0.65 [0.63-0.69]. Sensitivity for bacterial pneumonia was 78%, specificity was 75%. Calibration was acceptable (Brier score 0.11). Explainability analyses highlighted lung opacity patterns (Grad-CAM) and inflammatory biomarkers (SHAP) as key contributors.

Conclusions

A multimodal transformer combining CXR images with early clinical data can differentiate viral vs bacterial pneumonia with strong discrimination and calibration, and shows generalizability across open external datasets. This framework supports future prospective evaluation for antibiotic stewardship decision support. Post-hoc analysis will outline the clinical and economic burdens, including antibiotic stewardship.

sesja	tytuł	autor	miejsce
Anaesthesiology & Intensive Care Case Report Poster Session	Fatal Nocardia brasiliensis sepsis following knee injury in an immunocompetent pa	Maksymilian Górski	1
Anaesthesiology & Intensive Care Case Report Poster Session	Extensive Subcutaneous emphysema and Pneumoperitoneum after Percutaneous	Tara Radaideh	2
Anaesthesiology & Intensive Care Case Report Poster Session	Recurrent CRRT circuit clotting in acute pancreatitis: A case of true heparin resista	Zuzanna Czarnecka	3
Cardiology & Cardiac Surgery Case Report Poster Session	Multiple Ventricular Tachycardia Morphologies in Repaired Tetralogy of Fallot Treat	Wiktorja Mazepa	1
Cardiology & Cardiac Surgery Case Report Poster Session	When the Dialysis Catheter Reaches the Heart: ECMO-Assisted Thrombectomy of a	Natan Adamów	2
Cardiology & Cardiac Surgery Case Report Poster Session	Fine-Tuning Cardiac Care: EV-ICD for a Young Violinist with Arrhythmogenic Right V	Magdalena Warych	3
Cardiology & Cardiac Surgery Session I	No-touch aorta off-pump LIMA-radial artery Y-graft CABG- long-term follow up	Dominik Mendyka	1
Cardiology & Cardiac Surgery Session I	CardioAtlas: An Evidence-Grounded Multimodal Agentic AI Co-Pilot for Cardiologis	Arman Sürmeli	2
Cardiology & Cardiac Surgery Session I	Electrocardiogram as a Non-Invasive Marker of Clinical and Hemodynamic Improv	Olaf Zabłocki	2
Cardiology & Cardiac Surgery Session I	Evolution of Repolarization Patterns During Mavacamten Therapy in Obstructive Hy	Arkadiusz Botkun	3
Cardiology & Cardiac Surgery Session II	Serum Proteomic Profiling of Carotid Plaques using Machine Learning Algorithms	Jakub K. Tuchliński	1
Cardiology & Cardiac Surgery Session II	Ventricular tachycardia ablation in patients with non-ischemic and ischemic struct	Ewa Lewandowska	2
Cardiology & Cardiac Surgery Session II	Optimizing Left Bundle Branch Area Pacing: Simulating electrophysiological lead pl	Jakub Garbacz	3
Case Report Oral Session	Bilateral Lung Transplantation as a Salvage Therapy for Bleomycin-Induced Pneum	Maciej Pawlica	1
Case Report Oral Session	Stent or Stand Down? An Overnight STEMI Where Conservative Care Was the Right	Ewelina Bilka	2
Case Report Oral Session	Delayed diagnosis of Mayer-Rokitansky-Küster-Hauser syndrome complicated by s	Nafea Inayat	3
Case Report Oral Session	Near-infrared spectroscopy monitoring as a detector of cerebral ischemia during a	Paweł Kosiorek	3
Dentistry & Maxillofacial Surgery Session	Evaluating the Color Stability of 3D-Printing Resins Against Various Dietary Coloran	Natalia Gryko	1
Dentistry & Maxillofacial Surgery Session	Comparison of the accuracy of extraoral scans obtained using a professional face s	Mateusz Kowalczyk	2
Dentistry & Maxillofacial Surgery Session	Retrospective analysis of the incidence of purulent complications following extract	Bartosz Bieniek	3
Emergency Case Report Poster Session	Varicella Zoster Virus Encephalitis Presenting as Severe Headache Mimicking Acute	Vaiva Petrauskaitė	1
Obstetrics, Gynecology & Perinatology Session	Large Language Models and Specialty Certification Examinations in Obstetrics and	Anna Owczarek	1
Psychiatry & Clinical Psychology Session	The association between cumulative sexual violence experiences and post-trauma	Annija Gabriela Roze MD	1
Radiology Session	Chest X-Ray–Predicted Age as a Biomarker for Short- and Long-Term Mortality: Dev	Deya aldeen Al drabee	1
Infectious Diseases Session	Multimodal Deep Learning to Differentiate Viral vs Bacterial Pneumonia Using Ches	Mohammed Al-azzawi	1
Infectious Diseases Session	The Prevalence of Risk Factors for Long-Acting Injectable Antiretroviral Therapy Fail	Michał Dowiatt	2
Internal Medicine Case Report Poster Session	Not Always Drug-Induced Liver Injury: Acute Liver Failure During Targeted Therapy ii	Patryk Jesiotowski	1
Internal Medicine Case Report Poster Session	The way to a man's heart is through his kidneys: blood culture - negative endocarditi	Małgorzata Sebestjaniuk	2
Internal Medicine Case Report Poster Session	A rare cause of lower back pain: Osteodiscitis as a complication of Staphylococcus	Yin Qi Lee	3
Internal Medicine Session I	Association between Sleep Quality and Graft Function in a Population of Kidney Tra	Zuzanna Malinowska	1
Internal Medicine Session I	CHARACTERISTICS OF RECIPIENTS OF ORTHOTOPIC LIVER TRANSPLANTS (OLT) A	Maciej Ponczek	2
Internal Medicine Session I	Enoxaparin Dosing in Challenging Populations: A Model Based on Anti-Xa Activity	Michał Zieliński	3
Internal Medicine Session II	Airway obstruction in patients with sarcoidosis: incidence and impact of sarcoidosi	Magdalena Dąbrowska	1
Internal Medicine Session II	The Outcome of Liver Transplantation in Elderly Patients – a Single Centre Study	Oliwia Stryjewska	2
Internal Medicine Session II	Clinical Variability of aHUS: Organ Involvement and Underlying Variants in Patients	Aleksandra Hapunik	3
Laboratory Medicine Session	Phenotyping of maternal Lewis blood group antigens directly from human milk: a nc	Klaudia Pawlikowska	1