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Pulmonary Vascular Disease

SESSION TITLE: Sail from Symptoms to Solutions: Innovations in Pulmonary Hypertension Screening and Diagnosis
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REVOLUTIONIZING PULMONARY HYPERTENSION DETECTION: A MULTICENTER STUDY ON A COMPREHENSIVE MULTIMODAL DEEP LEARNING APPROACH

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PURPOSE: Pulmonary hypertension (PH) is a progressive, life-threatening condition that often remains undetected until it reaches advanced stages. The lack of specificity and sensitivity in current diagnostic tools, such as transthoracic echocardiography (TTE), necessitates invasive right heart catheterization (RHC) for confirmation. This underscores the urgent need for more precise diagnostic methodologies. Hence, this study aims to develop and validate a Multimodal Fusion Model for Pulmonary Hypertension (MMF-PH) that combines data from electronic health records, including demographics, chest X-rays (CXR), electrocardiograms (ECG), and TTE, to enhance the accuracy of PH detection and establish its superiority over conventional TTE-based screening.

METHODS: A retrospective dataset comprising 4,576 patients suspected of PH, with 2,451 confirmed via RHC between 2019 and 2021 at Beijing Fuwai Hospital, was analyzed. This was augmented with a control group selected from a larger pool to maintain analytical balance. The MMF-PH model leveraged deep learning for rigorous training, validation, and testing phases, including comparisons with a prospective dataset of 477 patients from 2022 and an external dataset from two other medical facilities. Performance evaluation metrics for the model included accuracy, sensitivity, specificity, positive and negative predictive values (PPV and NPV), F1 score, and the areas under the receiver operating characteristic (AUROC) and precision-recall (AUPRC) curves. Furthermore, MMF-PH's efficacy was contrasted with TTE and another derived model in delineating PH hemodynamic subtypes.

RESULTS: The MMF-PH model markedly surpassed TTE in PH detection, with a retrospective accuracy of 96.2% and an AUROC of 0.994. Prospectively, the model maintained high efficacy with an AUROC of 0.969, displaying enhanced specificity (96.9%) and sensitivity (95.4%) compared to TTE, alongside significant improvements in predictive values and an F1 score of 0.961. MMF-PH exhibited superior specificity of 70% at equal sensitivity rates in the retrospective analysis, compared to 53.3% for TTE, and 89.1% over TTE's 65.2% in the prospective analysis. Subgroup analyses consistently validated MMF-PH's accuracy across different demographics and clinical severities. External validation reinforced the model's reliability, evidencing a sensitivity of 92.0% and an F1 score of 87.9%. Additionally, MMF-PH effectively distinguished between PH subtypes, demonstrating sensitivities of 96.9% for non-PH and 82.7% for pre-capillary PH in the retrospective cohort.

CONCLUSIONS: The MMF-PH algorithm significantly advances PH detection and subtyping, exhibiting superior accuracy compared to traditional TTE methods. It achieves high diagnostic performance and demonstrates extensive applicability across diverse patient groups and clinical environments. Future studies are expected to further explore its capabilities and validate its widespread clinical utility.

CLINICAL IMPLICATIONS: This study on developing and validating a multimodal deep learning algorithm for pulmonary hypertension (PH) detection has critical clinical implications, including enabling early and accurate identification of PH, reducing the need for invasive diagnostic procedures like right heart catheterization, and facilitating personalized treatment approaches. The algorithm's ability to accurately classify PH subtypes enhances patient management and treatment optimization, potentially leading to improved patient outcomes and lowering healthcare costs. Its successful multicenter validation indicates its applicability across diverse healthcare settings, paving the way for broader clinical adoption and signifying a leap forward in integrating advanced artificial intelligence in the diagnosis and management of complex diseases such as PH.

DISCLOSURES:

No relevant relationships by Zhihua Huang

No relevant relationships by Zhihong Liu

No relevant relationships by Qin Luo

No relevant relationships by Zhihui Zhao

No relevant relationships by Wei Zhao

No relevant relationships by Qing Zhao

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