Applications of Artificial Intelligence as a Prognostic Tool in the Management of Acute Aortic Syndrome and Aneurysm: A Systematic Review

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Introduction: Acute Aortic Syndromes (AAS) and thoracic aortic aneurysms are life-threatening conditions requiring urgent diagnosis and intervention. Despite surgical advances, mortality and complication rates remain high. Conventional risk assessments, based largely on aortic diameter, may be insufficient. Recently, artificial intelligence (AI), especially machine learning (ML), has emerged as a promising tool for improving prognosis prediction and guiding clinical decisions in cardiovascular care. This review aimed to evaluate current AI applications in predicting outcomes in AAS and thoracic aneurysms.

Methods: A systematic literature search of PubMed, Embase, and Web of Science was conducted on 01.09.2024, following PRISMA guidelines. English-language studies applying ML to predict prognostic outcomes in thoracic AAS or aneurysms were included. Abdominal aorta–only studies, case reports, and reviews were excluded. A total of 31 studies involving 17,935 patients were analyzed. Data on disease type, model used, input variables, and performance (e.g., AUC) were extracted. Quality was assessed using the PROBAST tool.

Results: Among 31 studies, 76% focused on aortic dissection. Logistic Regression and Support Vector Machines were the most frequently used algorithms (14.8% each). Mortality prediction appeared in 10 studies, with AUCs ranging from 0.790 to 0.927. The 5A score using XGBoost showed strong external validation (AUC = 0.875). Rupture risk was assessed in six studies, achieving up to 95.58% accuracy. AI also effectively predicted renal failure (AUC 0.738–0.89), MODS (AUC 0.837), stroke (AUC 0.921), IMH destabilization (AUC 0.765), aneurysm growth (AUC 0.94; RMSE 0.066 mm/month), and post-TEVAR remodeling and reintervention (AUCs up to 0.884). Only three studies included external validation.

Discussion: AI demonstrates high potential in predicting key outcomes in AAS and aneurysms. While promising, broader validation, standardized reporting (e.g., TRIPOD-AI), and ethical safeguards are essential for clinical adoption.

Keywords: Acute Aortic Syndrome, Aortic Dissection, Aneurysm, Machine Learning, Artificial Intelligence