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ARTIFICIAL INTELLIGENCE IN PEDIATRIC SURGICAL CARE: A SYSTEMATIC REVIEW OF PREDICTIVE, DIAGNOSTIC, AND DECISION SUPPORT MODELS

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Artificial Intelligence (AI) has demonstrated significant potential in healthcare by enhancing diagnostic accuracy and supporting clinical decision-making, yet its application within pediatric surgery remains largely unexplored. The unique challenges presented by pediatric patients, including distinct developmental and physiological needs, diverse cognitive abilities, and communication difficulties, make the integration of AI particularly valuable for improving surgical care outcomes. Despite this potential, the current evidence regarding AI's utility in pediatric surgery remains fragmented, with varying model quality, performance metrics, and validation standards.

This systematic review aimed to comprehensively analyze the current state of AI applications in pediatric surgery, with specific focus on examining model architectures, clinical applications, performance metrics, validation status, and explainability of AI models in pediatric surgical care.

Following the 2020 PRISMA guidelines, we conducted a systematic search across nine electronic databases from their inception through January 24, 2023. The search strategy, developed by a senior medical librarian, encompassed terms related to artificial intelligence, machine learning, and pediatric surgical conditions. Two independent reviewers screened articles using Rayyan.ai, achieving a final inter-rater reliability kappa score of 86%. Data extraction utilized a standardized form capturing study metadata, patient demographics, AI algorithm details, and performance metrics. Risk of bias was assessed using QUADAS-2 for diagnostic models and PROBAST for predictive and decision support models.

The review analyzed 112 studies encompassing 155 AI models trained on 570,099 pediatric patients. The models were categorized by purpose: predictive (52%), focusing on adverse events (25%), surgical outcomes (19%), and survival/mortality (8%); diagnostic (28%); and decision support (20%). Neural networks (43.8%) and ensemble learners (35.7%) emerged as the predominant techniques. General surgery (31%) and neurosurgery (25%) represented the most frequent specialties.

The pooled mean accuracy across all models was 0.86 ± 0.10 , with diagnostic models achieving the highest accuracy (0.91 ± 0.05). However, significant limitations were identified: only 6% of models underwent external validation, 44% demonstrated interpretability, and 40% exhibited a high risk of bias. These findings highlight the current challenges in translating AI models into clinical practice within pediatric surgery.

While AI demonstrates promising potential in pediatric surgery, particularly in diagnostics and outcome prediction, several critical barriers impede its clinical implementation. The lack of external validation, limited interpretability, and high risk of bias in existing models necessitate focused efforts to develop more robust and clinically applicable solutions. Future research should prioritize the development of externally validated, interpretable models with minimal bias, alongside the implementation of post-deployment monitoring systems. Additionally, expanding research to include low- and middle-income countries would enhance the global applicability of AI in pediatric surgical care.