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Abstract Title

Detection of Free Air on Neonatal Abdominal Radiographs Using a Deep Convolutional Neural Network

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Background

Neonatal pneumoperitoneum is a surgical emergency requiring timely diagnosis, and small volumes of free air can be difficult to detect on abdominal radiography, particularly without immediate access to expert radiology support.

Objective

To evaluate whether a convolutional neural network (CNN) can be trained to identify free intraperitoneal air on neonatal abdominal radiographs with clinically useful diagnostic accuracy.

Methods

We performed a retrospective diagnostic accuracy study using 968 neonatal abdominal radiographs from 311 patients at a single tertiary pediatric center. Separate ResNet18-based CNN classifiers were trained for anteroposterior (AP) and lateral views to distinguish images with and without free air. Images were de-identified, resized, normalized, and stripped of superimposed text. Stratified group cross-validation assigned all images from a given patient to a single fold to prevent data leakage, and a weighted random sampler addressed class imbalance during training. Model discrimination was assessed using the area

under the receiver operating characteristic curve (AUC).

Results

The dataset comprised 712 AP radiographs (50 with free air, 662 without) and 256 lateral radiographs (47 with free air, 209 without). The AP-view model achieved an AUC of 0.77, with an equal error rate of 0.29 at a probability threshold of 0.44. The lateral-view model performed better, achieving an AUC of 0.84, with an equal error rate of 0.27 at a threshold of 0.51. Both models demonstrated moderate discrimination between free air and no free air, with the lateral-view model outperforming the AP-view model.

Conclusion

A CNN trained on a modest but clinically relevant neonatal radiograph dataset can detect free intraperitoneal air with moderate accuracy, particularly on lateral views. With larger multicenter datasets and external validation, this approach may support earlier recognition and triage of neonates with suspected bowel perforation.