Detection, Diagnosis and Localization of Pediatric Pneumonia Based on Pattern Detection in Chest Radiographic Images

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INTRODUCTION

- Pediatric pneumonia remains a common condition associated with considerable morbidity and mortality with approx. 120 million new cases occurring each year with almost 1 million deaths among children under 5 years of age.[1]
- Establishing the etiology of pneumonia (viral vs bacterial) is essential to ensuring the most effective therapy since each agent requires a very different form of management (mere supportive care satisfactory for viral vs urgent antibiotic treatment required for bacterial).
- The derivation of the necessary diagnostic information requires advanced equipment (such as X-rays) and clinical expertise to correctly assess observational clinical signs; both of which are often unavailable in resource-constrained settings.
- We address these challenges through a machine learning tool, facilitating automated detection and diagnosis of pediatric pneumonia utilizing chest x-ray images. Notably, we demonstrate our ability to localize areas that are most indicative of infection.

METHOD

- **Data:** We used a set of publicly-available pediatric X-rays (CXR).[2] The dataset includes chest X-ray images (anterior-posterior) of pediatric patients of one to five years old from Guangzhou Women and Children's Medical Center, Guangzhou, China.

Table 1. Dataset and its characteristics

Category	Training Samples	Test Samples
Normal vs Pneumonia	5216	624
Bacterial vs Viral	3875	390

- **Localization:** Most methods require additional localization data such as specific coordinates of the bounding box

- Localization of the decision-making signal without any localization data

- Applications to other domains:
  - Banking
  - Self-driving cars
  - Passenger property screening

RESULTS

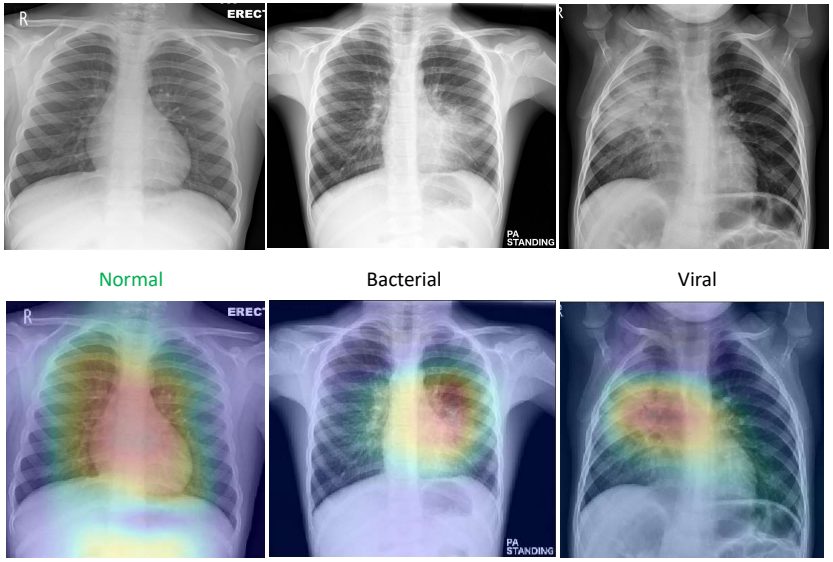

Figure 1. Top row: Chest X-ray images of pediatric patients from [2]. Bottom row: Processed images showing localization of decision making signal indicative of disease as heat maps.

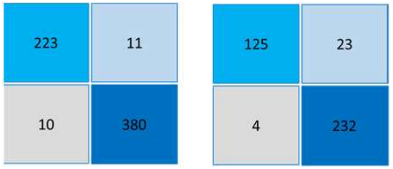

Figure 2. Confusion matrices for the performance of the model: a) Normal vs Pneumonia and b) Viral

Table 2. Performance statistics of our model vs state-of-the-art.

	Model	Normal vs Pneumonia	Viral vs Bacterial
Recall	**PCI**	**97.4**	**98.3**
	Kermany et al.	93.2	88.6
Precision	**PCI**	**97.2**	**90.9**
	Kermany et al.	-	-
Accuracy	**PCI**	**96.6**	**92.9**
	Kermany et al.	92.8	90.7
AUROC	**PCI**	**0.992**	**0.976**
	Kermany et al.	0.968	0.940

CONCLUSIONS

- We have developed an ML based decision support system to detect pneumonia in pediatric CXRs to expedite accurate diagnosis of the pathology.
- These results suggest that a suite of targeted ML tools can be used to support multi-faceted diagnosis of childhood pneumonia in resource-constrained settings, compensating for the shortage of expensive equipment and specialists.
- Further research is necessary to determine the feasibility of applying this algorithm in a clinical setting and to test improved care and outcomes compared with current assessment of the pediatric community-acquired pneumonia.

REFERENCES

1. Walker CL. Rudan I. et al. Global burden of childhood pneumonia and diarrhoea. Lancet. 2013 Apr 20;381(9875):1405-1416. doi: 10.1016/S0140-6736(13)60222-6. Epub 2013 Apr 12.
2. Kermany et. al. Identifying Medical Diagnoses and Treatable Diseases by Image-Based Deep Learning. Cell. 2018 Feb 22;172(5):1122-1131.