Objectives

To determine the sensitivity and specificity of CAD4WHOKids for:

- Chest X-ray primary end-point pneumonia (CXR-PEP) vs. non-CXR-PEP;
- Chest X-ray PEP vs. Other Infiltrate Only.

Methods

- This study was nested within the cross sectional PERCH study, South African site.
- Chest X-rays were independently evaluated by 3 radiologists in South Africa using WHO standardized interpretation criteria.
- The majority consensus reading was used as the reference standard.
- The work-flow adopted for CAD in our study entailed:
  1. Automatic lung field segmentation, followed by manual inspection and correction;
  2. Training: Areas of CXR-PEP were manually outlined in a sub-set of training CXRs. Pixels in outlined regions were used as positive examples. Training and testing was done in 10-fold cross validation;
  3. Feature extraction: Pixel data was filtered with Gaussian derivatives on multiple scales, extracting texture features to classify each region;
  4. Classification: To obtain an image score, the 95th percentile score of the pixels was used.

Results

- 858 interpretable CXRs: 333 with CXR-PEP, 208 with other infiltrate only and 317 were Normal based on a 3 reader consensus reading.
- Lung fields were manually outlined in 25% (n=214) of randomly selected CXRs.
- Automatic lung field segmentation was used
- On manual inspection, lung fields had to be manually outlined in 37% (237/644) of the CXRs with CXR-PEP.

Introduction

The chest X-ray (CXR) remains the most readily available and common imaging modality for the assessment of childhood pneumonia. Standardization of CXR interpretation is important to allow comparison between studies. The number of paediatric radiologists in low income countries is limited, as are the number of paediatricians with training and expertise in standardized CXR interpretation recommended by the WHO methodology.

Computer-aided diagnostic (CAD) approaches to the interpretation of paediatric CXR have the potential to overcome these barriers for the interpretation of CXR in children with pneumonia.

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Conclusions

- CAD4WHOKids texture analysis is promising for identifying WHO CXR-PEP in children and differentiating from other infiltrate and normal chest X-rays.
- Further multicentre studies with larger sample sizes are required for optimization of automatic lung field segmentation, validation of the CAD4WHOKids software, and subsequent use in clinical studies.

References

3. The PERCH was supported by grant 48968 from The Bill & Melinda Gates Foundation to the International Vaccine Access Center, Department of International Health, Johns Hopkins Bloomberg School of Public Health.

FIGURE 2. ROC curve for using computer aided diagnosis (CAD) to differentiate CXR-PEP vs non CXR-PEP*.

For CXR-PEP vs non-CXR-PEP, from 858 chest X-rays where 333 had CXR-PEP, CAD4WHOKids had a sensitivity of 76%, specificity of 80%, and area under the ROC curve of 0.850 (95% CI 0.823-0.876).

*Non CXR-PEP: includes chest X-rays with OI only and normal chest X-rays.

Figure 1: To visualise the working of the texture system, for each image a colour heat map was generated with red representing high likelihood of being abnormal, yellow intermediate, green low, and blue very low. The 2 examples represented here demonstrate good correlation between CAD4WHOKids colour heat map and the areas of CXR-PEP on the test images.

Limitations

- JPG format chest X-rays used, results in loss of image information in the reduction to 8 bit (256) gray values.
- Dicom data cold have provided better resolution.
- Lung fields were manually corrected in 37% (237/644) of the chest X-rays with CXR-PEP.
- Need for improvement of automatic lung field segmentation.

CONCLUSIONS

- CAD4WHOKids texture analysis is promising for identifying WHO CXR-PEP in children and differentiating from other infiltrate and normal chest X-rays.
- Further multicentre studies with larger sample sizes are required for optimization of automatic lung field segmentation, validation of the CAD4WHOKids software, and subsequent use in clinical studies.

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