

Machine learning used to find a simpler way to diagnose and understand childhood pneumonia infections

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Oxford researchers are developing a tool to make it much easier and cheaper to diagnose pneumonia—the number one killer of children under 5. Their latest research is published in *Journal of the Royal Society Interface*.

Currently, correctly diagnosing pneumonia and understanding how severe it is requires specialist doctors and expensive equipment like X-ray machines. Neither is available to community health workers in developing nations, where 99% of the annual 1.1 million childhood pneumonia deaths happen.

Elina Naydenova from Oxford University's Institute for Biomedical Engineering explained: "With the nearest hospital hours away, generalist [health workers](#) depend on a set of guidelines known as IMCI. These can sometimes be good at identifying cases of pneumonia but not so good at screening out cases that are not pneumonia. There is also huge variability across users. In settings, where there isn't a clinical expert to set a conclusive diagnosis, the number of unnecessary antibiotic prescriptions has increased as a result—depleting vital drug supplies and adding to the problem of antibiotic-resistant infections. We wanted to apply smart engineering to develop a robust automated system that was consistently more accurate."

Accurate diagnosis can cut death rates by 42% but involves more than

just correctly identifying if a child has pneumonia. Health workers also need to judge how severe the infection is to decide whether a child needs referral to hospital, and whether the infection is bacterial or viral to decide if antibiotics will have any effect. However, they need to be able to do all this with only a basic set of easily portable equipment.

For an automated system to be effective, it needs to be able to work with data from that basic equipment, so the Oxford team took the in depth data from a clinical study in the Gambia and used machine learning techniques to see whether they could develop an algorithm that could diagnose pneumonia.

Elina said: "For identifying pneumonia we found four features that can be measured with two pieces of equipment. Heart rate, respiratory rate and oxygen saturation can all be measured using a pulse oximeter. Temperature requires a thermometer. These are things that can be made available to a health worker with basic training.

"Using these four measures, we achieved 98.2% sensitivity and 97.5% specificity [ie—they could correctly identify 982 out of every 1000 pneumonia cases and only falsely identified pneumonia in 25 of every 1000 people without the disease], compared to IMCI, where the best performance is 94% sensitivity and 69% specificity."

By adding an assessment of two lung sounds, using a stethoscope, the team were able to work out the severity of an infection with 72.4% sensitivity and 82.2% specificity (IMCI achieves 79.3% and 67.7% respectively). Adding a test for the biomarker C Reactive Protein (CRP) delivered 89.1% sensitivity and 81.3% specificity, although the team point out that this would involve additional cost.

Finally, by assessing heart and respiratory rates and oxygen saturation in tandem with a biomarker called Lipocalin-2, the team could identify

whether [pneumonia](#) was bacterial or viral with 81.8% sensitivity and 90.6% specificity. When IMCI was applied, it was 100% sensitive to severe bacterial infection but 0% specific—all severe viral cases would also have been prescribed antibiotics that would have made no difference. Whilst low-cost tests for these biomarkers are not yet commercially available, a number of research teams around the world are already looking into developing such tests for use in resource-constrained settings.

Elina said: "We have identified a set of features that could offer an alternative to the combination of X-rays and blood cultures only available in a well-equipped hospital. These will be used in a mobile application linked to a set low-cost diagnostic equipment, which we will be trialling in the next couple of years."

More information: Elina Naydenova et al, The power of data mining in diagnosis of childhood pneumonia, *Journal of The Royal Society Interface* (2016). [DOI: 10.1098/rsif.2016.0266](https://doi.org/10.1098/rsif.2016.0266)

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