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Can we predict which children with pneumonia will have a severe prognosis?

Orejón de Luna G[1], Eduardo Cuestas E[2]
[1]*Primary Care Paediatrician. Centro de Salud General Ricardos. SERMAS. Madrid. Spain.*
[2]*Professor of Clinical Paediatrics. School of Medical Sciences. Universidad Nacional de Córdoba. Córdoba. Argentina.*

Correspondence: Gloria Orejón de Luna, gloriaglo04@gmail.com

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Can we predict which children with pneumonia will have a severe prognosis?

Orejón de Luna G[1], Eduardo Cuestas E[2]

[1]Primary Care Paediatrician. Centro de Salud General Ricardos. SERMAS. Madrid. Spain.

[2]Professor of Clinical Paediatrics. School of Medical Sciences. Universidad Nacional de Córdoba. Córdoba. Argentina.

Correspondence: Gloria Orejón de Luna, gloriaglo04@gmail.com

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Abstract

Authors' conclusions: three risk models are presented that accurately estimate the risk for severe pneumonia in children, which will improve treatment and prognosis in this population.

Reviewers' commentary: the study proposes a promissory clinical tool to predict pneumonia´s outcomes that could be validated internationally.

Key words: pneumonia, severity, children.

¿Podemos predecir qué niños con neumonía van a tener un pronóstico grave?

Resumen

Conclusiones de los autores del estudio: se presentan tres modelos de riesgo para poder estimar con precisión el riesgo de neumonía grave en niños, lo que permitirá mejorar el tratamiento y el pronóstico en esta población.

Comentario de los revisores: el estudio propone una herramienta, simple y de fácil aplicabilidad, para predecir el curso clínico de la neumonía que aún debe ser validada internacionalmente.

Palabras clave: neumonía, severidad, niños.

STRUCTURED ABSTRACT

Objective: to predict severe pneumonia outcomes in children.

Design: prospective observational study for the purpose of developing a prognostic model for clinical practice.

Setting: hospital-based study in three paediatric hospitals located in Memphis, Nashville and Salt Lake City (USA).

Study population: patients aged less than 18 years admitted to hospital with a diagnosis of community-acquired pneumonia between January 2010 and June 2012. The inclusion criteria were admission to hospital with signs or symptoms of acute infection, acute respiratory illness and radiographic evidence of pneumonia. Children with a recent hospitalisation, severe immunosuppression, cystic fibrosis, tracheostomy or a clear alternative diagnosis were excluded.

Risk factor assessment: based on the most severe outcome that occurred during their hospital stay, children were classified as having a severe (children that died, required invasive mechanical ventilation or developed shock requiring vasoactive medications), moderate (children admitted to the intensive care unit but who did not meet the severity criteria) or mild prognosis (all others).

Outcome measurement: the authors selected twenty predictor variables that included demographic, clinical, radiologic, laboratory and comorbidity variables for the purpose of developing three prognostic models. The first one included all

20 variables. For the second model, the authors selected 14 variables that were mainly clinical and assessed on a scale of 1 to 5, and those with a median score of 4 or higher and which were considered important or very important were ultimately selected, resulting in a reduced model with 10 variables. The third model included nine variables that are documented routinely at the time of admission (age, sex, ethnicity, vital signs and white blood cell count). Aetiologic assessments included blood culture, serology for eight respiratory viruses, pneumococcal and group A streptococcal polymerase chain reaction (PCR), and naso-oropharyngeal swabs for PCR for 13 respiratory viruses, *Mycoplasma pneumoniae* and *Chlamydophila pneumoniae*.

Main results: Twenty-one percent of the 2319 children included in the study had a severe or moderate prognosis. The three assessed models correctly predicted the risk of moderate or severe pneumonia. The concordance index was 0.81 (95% confidence interval [95 CI], 0.79 to 0.83) for the first model, 0.79 (95 CI, 0.77 to 0.81) for the second, and 0.78 (95 CI, 0.76 to 0.80) for the third. The variables associated most strongly with severe prognosis were age (the lower the age, the poorer the prognosis), altered mental status, breathing difficulty, abnormal vital signs (pulse oximetry, body temperature, systolic blood pressure) and presence of a radiologic pattern of multilobar or interstitial infiltration. The reduced models with ten and nine variables included the main predictors of severity. Cases of pneumonia by *Streptococcus pneumoniae, Staphylococcus aureus* and *Streptoccoccus pyogenes* were associated more frequently with moderate or severe pneumonia.

Conclusion: the authors present three prognostic models for the accurate estimation of risk of severe pneumonia in children, which would allow improving care and outcomes in this population.

Conflicts of interest: none noted.

Funding source: National Institutes of Health, Agency for Healthcare Research and Quality, National Center for Advancing Translational Sciences, National Center for Immunizations and Respiratory Diseases at the CDC.

COMMENTARY

Justification: it is estimated that pneumonia causes nearly 20% of deaths in children aged less than 5 years globally. The use of the indicators proposed by the Integrated Management of Childhood Illness programme of the World Health Organization (WHO), based on simple clinical findings, allows the identification of children with pneumonia, but cannot be used to predict the severity of illness with sufficient sensitivity. This calls for the development of objective and simple clinical tools that could be useful in every possible health care setting worldwide.[1,2].

Scientific validity/rigour: the study was well designed to develop a prognostic model of severity using simple clinical variables. The population was hospital-based and representative of children in the United States. The study underwent a strict internal validation process that included assessments of fit using likelihood ratios, quality using the Akaike information criterion, and of predictive accuracy—discrimination and calibration—using concordance indices (which are analogous to ROC curves), among others. The authors also performed an internal bootstrap validation simulation with 500 replications. The main limitation of the study is that the tool has yet to be validated in non-hospital settings and in different populations.

Clinical relevance: the prognostic models assessed in the study demonstrated a similar accuracy in the identification of moderate to severe cases of pneumonia. Reed *et al*[3] included a simple set of variables (hypoxia, chest indrawing, food refusal, malnutrition and age). Their scale is capable of estimating the risk of death based on clinical information that can be obtained in care settings with limited resources where the impact of mortality is greater. On the other hand, the study by Williams *et al* was designed in settings with adequate resources, although it also used simple clinical variables (age, chest indrawing, tachypnoea, fever, hypotension, tachycardia, hypoxaemia and radiographic features). Both studies used adjusted odds ratios in ordinal logistic regression models with 95% confidence intervals, and differ solely in the malnutrition variable. The tool holds a high potential both to identify severe cases requiring hospitalisation and to discriminate low-risk cases, which would decrease hospitalisations and unnecessary treatments.

Applicability to clinical practice: this study proposes a tool that includes clinical variables that are easy to assess and can be applied in any health care setting, from primary to inpatient care, to predict the severity of pneumonia, which remains to be validated internationally.

Conflicts of interest: the authors of the commentary have no conflicts of interest to declare.

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