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Original article

Validation and comparison of two pneumonia severity criteria: A cross-sectional study of paediatric community-acquired pneumonia in Indonesia

Michelle Patricia Muljono[1], Charista Lydia Budiputri[1], Gilbert Sterling Octavius[1]

[1] Faculty of Medicine, Universitas Pelita Harapan Banten, Indonesia

*Corresponding author: mulyonomichelle12@gmail.com

Abstract

Background *: Community-acquired pneumonia (CAP) is a major cause of paediatric morbidity and hospitalization. Early identification of severe disease is essential for appropriate management. Several severity assessment tools, including the British Thoracic Society (BTS) and Paediatric Infectious Diseases Society/Infectious Diseases Society of America (PIDS/IDSA) criteria, are used to identify severe CAP in children, but their diagnostic performance varies. This study aimed to evaluate and compare the ability of the BTS and PIDS/IDSA severity scores to identify severe CAP in children.*

Methods*: Data were collected from medical records of hospitalized children (0-18 years) with radiologically confirmed pneumonia from December 2015 to December 2019. Demographic, clinical, and laboratory data were gathered, and severe pneumonia was classified using World Health Organization (WHO), BTS, and PIDS/IDSA criteria. Diagnostic performance was evaluated through sensitivity, specificity, predictive values, and ROC curve analysis.*

Results*: A total of 217 participants were included, with 100 cases (46%) meeting WHO criteria for severe pneumonia. The PIDS criteria had a higher sensitivity (72%) for predicting severe pneumonia, whereas the BTS criteria had a higher specificity (92.3%). The BTS criteria showed a positive predictive value (PPV) of 81.6%, a negative predictive value (NPV) of 64.3%, and an area under the curve (AUC) of 0.66. In comparison, the PIDS criteria had a PPV of 49.7%, NPV of 61.1%, and an AUC of 0.54.*

Conclusion: *The PIDS criteria showed a higher sensitivity but had lower specificity and discrimination, whereas the BTS criteria had high specificity and low sensitivity. Additional studies are*

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needed to improve and validate these criteria.

Keywords: *community-acquired pneumonia, children scoring system, severity assessment tools*

Introduction

Community-acquired pneumonia (CAP) has become one of the leading causes of morbidity and mortality in children worldwide (1). Severe pneumonia in children is associated with significantly higher mortality rates compared to non-severe cases. One study found that the overall mortality of children diagnosed with severe CAP was 4.7% (95% CI: 3.10, 6.70) (2). A study focusing on children transferred to the Pediatric Intensive Care Unit (PICU) for severe CAP showed a mortality rate ranging from 7.2% until 12.4%, consistent with other published reports (3,4). Recognizing severe pneumonia is significant because it aids clinical decision-making (3–6). The parameters for severe pneumonia, as defined by the World Health Organization (WHO) guidelines, are recognized as predictors of mortality in children with pneumonia (7). Despite the established parameters, significant variations still exist in the diagnosis and management of children with severe pneumonia (8,9).

Several assessment tools for identifying severe CAP in adults were developed and proved effective in reducing hospital admissions (10,11). However, only a limited number of scoring systems have been developed specifically for children with severe CAP, creating a gap in effective, standardized tools for paediatric care (8,12,13). The British Thoracic Society (BTS) severity criteria were developed as part of the BTS revised guidelines, established in 2011, to address the management of CAP in children, alongside those created for adults (14,15). The BTS guideline offers age-specific criteria for mild to moderate and severe disease. These severity criteria, which include hypoxia, fever, tachypnoea, and tachycardia, are designed to guide decisions regarding hospital admission and, potentially, admission to intensive care unit (ICU). Despite their widespread use, these criteria have only been validated in few studies (13).

Other pediatric CAP severity criteria were developed in 2011 y the Pediatric Infectious Disease Society (PIDS) and the Infectious Diseases Society (IDS) (16). The PIDS-IDS created pediatric CAP evidence-based guidelines to address the diagnosis and management of CAP in infants and children older than 3 months in inpatient and outpatient settings. The recommendations were intended to reduce management discrepancies and improve clinical outcomes. This guideline includes a validated scoring system that extrapolates severity criteria from the prior adult guideline for pediatric use (16,17). Clinicians need to consider care in an intensive care unit or a unit with continuous cardiorespiratory monitoring for the child having ≥1 major or ≥2 minor criteria (16). Additionally, there is a lack of comparative studies

evaluating the effectiveness of this scoring system against other paediatric pneumonia severity tools, such as the BTS criteria, in real -world clinical practice.

The unclear classification of pneumonia severity into mild, moderate, and severe in children results in overestimation of diagnostic testing and hospitalizations, as well as delays in initial management when severity is underestimated (8). Correct and unified severity stratification of paediatric CAP based on scoring systems will guide site-of-care decisions, thereby decreasing morbidity and mortality rates (1,8). This study aims to assess the diagnostic performance of the BTS and PIDS-IDS severity scores in diagnosing severe CAP in paediatric patients.

Methods

Study design and period

This cross-sectional retrospective study was conducted in Indonesia at two tertiary-care hospitals: Siloam General Hospital and Siloam Hospital Lippo Village (SHLV). Siloam General Hospital is a teaching hospital where patients receive treatment under Indonesia's National Health Insurance system. In contrast, SHLV primarily serves patients with private health insurance or those who pay out -of-pocket. The data were obtained retrospectively from medical records using a consecutive sampling method from December 2015 to December 2019. All hospitalized children-aged 0–18 years who met the eligibility criteria during the study period were included.

Inclusion and exclusion criteria

The study population was identified using a two-step process. First, potential pneumonia cases were identified by querying the electronic health records for International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) codes for pneumonia listed in any diagnostic position. Second, medical records were manually reviewed to confirm a provider diagnosis of pneumonia and to verify radiological confirmation in accordance with World Health Organization (WHO) guidelines (1). Patients were excluded if they had severe immunodeficiency conditions, such as human immunodeficiency virus/ acquired immunodeficiency syndrome (HIV/ AIDS), or an alternative diagnosis. To reduce the likelihood of including hospital-acquired infections, children transferred from another healthcare institution or those with an emergency department visit or hospitalization within 14 days prior to the index admission were also excluded. Data were extracted using a standardized data collection form. Reviewers conducting the data abstraction were blinded to the study objectives to minimize potential bias

Data collection and analysis

Demographic data (sex, age, and nutritional status) and clinical manifestations, including fever, cough, shortness of breath, decreased appetite, convulsions, vomiting, and lethargy, were collected. Physical findings such as

apnea, tachypnea, cyanosis, nasal flaring, grunting, retraction, signs of dehydration, reduced vesicular breath sound (VBS), rhonchi, wheezing, and refractory shock were collected. The severity of dehydration was evaluated using the WHO criteria, consisting of examining the eyes, tears, anterior fontanelle, mucous membrane, skin turgor, general condition, and the ability to drink. Invasive mechanical ventilation was defined as using an endotracheal or tracheostomy tube to deliver positive pressure to the lung. Laboratory data including complete blood count and neutrophil lymphocyte ratio (NLR) were collected. Patient outcomes (survival, death, or referral to other hospital) were recorded.

Study variables

Pneumonia was diagnosed when a child had cough and/or difficulty of breathing, with or without fever, with either lower chest wall indrawing (LCWI) or age-appropriate tachypnoea (≥50 breaths per minute if the children were 2-12 months, ≥40 breaths per minute if ≥12 months). Severe pneumonia was defined according to the WHO criteria as the reference standard (1). Children presenting with chest indrawing with or without fast breathing or any general danger signs were classified as severe pneumonia. General danger signs include not being able to drink, central cyanosis or oxygen saturation below 90%, persistent vomiting, convulsions, lethargy or unconscious, stridor in a calm child or severe malnutrition (7).

Criteria for severe pneumonia based on the British Thoracic Society (BTS) (14) and the Pediatric Infectious Diseases Society/ Infectious Diseases Society of America (PIDS/ IDSA)(16) are summarized in Table 1. Severe pneumonia according to PIDS/IDSA criteria was defined as the presence of at least one major or two minor criteria. All criteria were assessed before admission. Vital signs were determined using the highest recorded respiratory rate and heart rate, as well as the lowest recorded oxygen saturation, as these values were considered to best reflect the patient's worst clinical condition during the initial presentation and early hospitalization period. As the BTS guidelines do not specify the number of criteria required to define severe pneumonia, severity was defined as the presence of any listed criterion, consistent with previous studies using the BTS classification system (18). This threshold was selected to maximize the identification of potentially severe cases in clinical practice.

Table 1: Summary of British Thoracic Society (BTS) and Pediatric Infectious Diseases Society (PIDS) severe pneumonia criteria and study-specific definitions.

British Thoracic Society (14)	Pediatric Infectious Diseases Society (16)	Study-specific definitions
Infant Temperature >38.5°C Respiratory rate >70 breaths/ min Moderate to severe recession Nasal flaring Cyanosis Intermittent apnoea Grunting respiration Not feeding Tachycardia Capillary refill time ≥2s **Older children** Temperature >38.5°C Respiratory rate >50 breaths/ min Severe difficulty in breathing Nasal flaring Cyanosis Grunting respiration Signs of dehydration Tachycardia Capillary refill time ≥ 2seconds	**Major Criteria** Invasive mechanical ventilation Fluid refractory shock [a] Acute need for NIPPV[b] Hypoxemia requiring FiO_2 greater than the inspired concentration or flow feasible in general care area[c] **Minor Criteria** Respiratory rate higher than WHO classification for age Age 0–2 months: >60 Age 2–12 months: >50 Age 1–5 Years: >40 Age >5 Years: >20 Apnea Increased work of breathing (retractions, dyspnea, nasal flaring, grunting) [d] PaO_2/FiO_2 ratio <250[e] Multilobar infiltrates[f] PEWS score >6[g] Altered mental status [h] Hypotension[i] Presence of effusion Comorbid conditions [j] Unexplained metabolic acidosis[k]	a. Receive 3 or more isotonic fluid boluses b. Receive high-flow nasal canula, continuous positive airway pressure, or bag-valve-mask ventilation c. The use of aerosol or non-rebreather mask oxygen with oxygen saturation of <92% d. Clinical identification of retractions, dyspnoea, flaring, grunting, or increased work of breathing e. Data obtained from the measurement of arterial blood gases. If arterial blood gases were not obtained, SpO2:FiO2 was used as a proxy. An SpO2:FiO2 of <231 correlates with PaO2:FiO2 of <250 f. Documentation of infiltrates, consolidations, or opacities in more than one lobe in the chest radiograph documented on the official radiology report g. Reference (19) h. Clinical identification of altered mental status, sleeping and not arousable, or lethargic i. Reference (20) j. No comorbid conditions were considered in this study k. CO2 of ≤15 on a chemistry panel or pH <7.35 with HCO3 <15 or a base deficit ≤−5 on a blood gas.

Sample size determination

The sample size was estimated using the single population proportion formula. Assuming a 95% confidence level, a 5% margin of error, and an estimated prevalence of severe pneumonia of 18% based on a previous study conducted at Siti Khodijah Muhammadiyah Hospital in Indonesia (21). This study was chosen as the reference due to its comparable Indonesian tertiary-care setting and similar pediatric disease profile. The minimum required sample size was calculated as follows:

$$N = \frac{(Z_{1-\alpha/2})^2 \times p \times (1-p)}{d^2}$$

$$N = \frac{(1.96)^2 \times 0.18 \times 0.82}{(0.06)^2}$$

$$N = 158$$

Where:

$Z_{1-\alpha/2} = 1.96$ (95% confidence level)

p = estimated proportion of severe pneumonia (0.18)

d = margin of error (0.05)

Statistical analysis

The collected data was analyzed using IBM SPSS 26.0 (Statistical Package for the Social Sciences, IBM Corp., Armonk, NY, USA). Data distribution was assessed for normality. Normally distributed variables were presented as mean ± standard deviation, while non- normally distributed variables were summarized as median and interquartile range (IQR). The diagnostic performance of the BTS and PIDS/IDSA criteria for predicting severe pneumonia was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), likelihood ratios (LRs), and diagnostic accuracy, with 95% confidence intervals. Receiver operating characteristic (ROC) curves were constructed, and the area under the curve (AUC) was assessed to determine discriminatory ability, with an AUC of 0.5 indicating no discrimination and 1.0 indicating perfect discrimination.

Results

A total of 307 paediatric patients with pneumonia were identified through electronic medical records using ICD-10-CM pneumonia codes from December 2015 to December 2019 at Siloam General Hospital and Siloam Hospital Lippo Village. All records were screened for eligibility and radiological confirmation based on WHO criteria. A total of 90 records were excluded due to incomplete medical records (n = 16), lack of radiological confirmation (n = 24), alternative diagnoses (n = 36), severe immunodeficiency (n = 5), or transfer from another hospital (n = 9). A total of 217 participants were included in the final analysis, consisting of 100 patients with severe pneumonia and 117 patients with non-severe pneumonia according to WHO classification criteria.

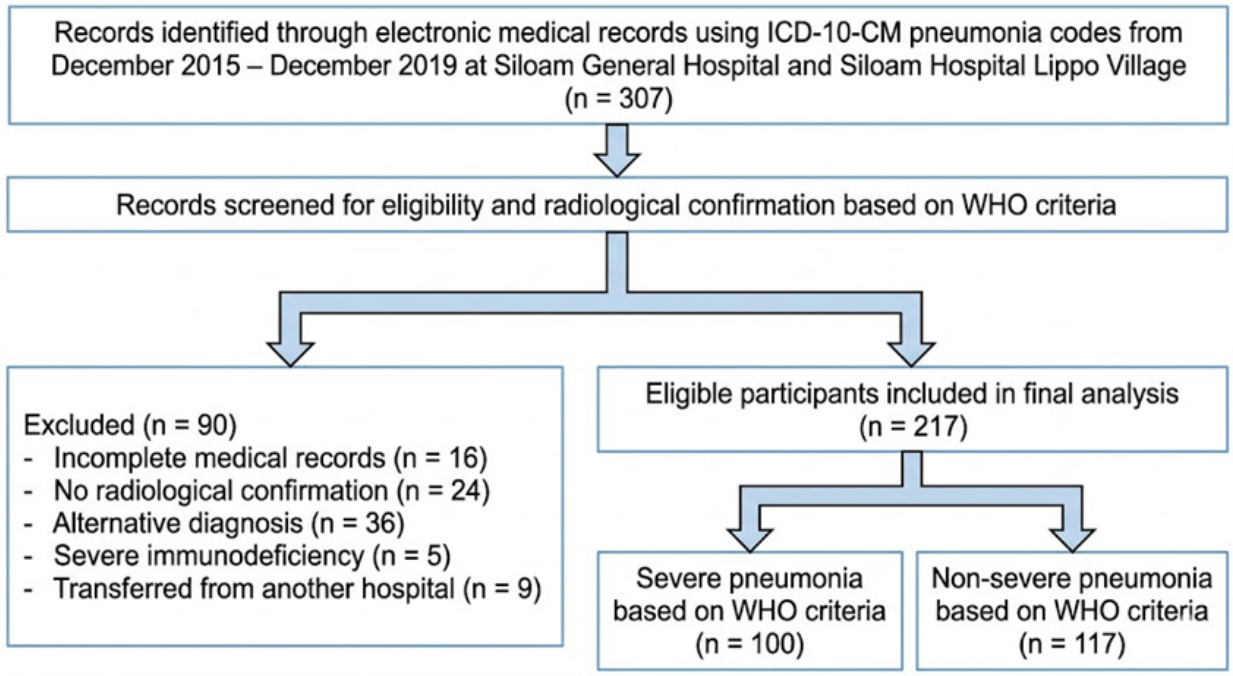

Figure 1: Patient flow diagram

A total of 217 participants who met the eligibility criteria were included in this study, with 100 cases (46%) of severe pneumonia based on the WHO criteria (Table 2). The patients were male predominance in both groups as seen in Table 2. The median age of participants in this study was 1.4 years old (0.01-17.38) in the severe group and 3.2 years old (0.2-18.2) in the non-severe group. Fever and cough were the most frequent clinical manifestations in both groups, followed by decreased appetite, shortness of breath, and vomiting. Seventeen patients (17%) in the severe pneumonia group experienced seizures. Upon physical examination, rhonchi were present in most patients in both groups: 84 patients (84%) in the severe group and 86 patients (73.5%) in the non-severe group. Patients in the severe pneumonia group had more frequent chest retractions (66% vs. 0%), tachypnoea (28% vs. 21.4%), and wheezing (33% vs. 9.4%).

The hematological profile showed that severe pneumonia patients had a higher leukocyte count, with a median of 14.27x103 cells/mm3 (3.57-54.15x103 cells/mm3) compared to 13.2 x103 cells/mm3 (1.67-36.9 x103 cells/mm3) in the non-severe group. Hematocrit level is lower in severe pneumonia patients than in non-severe pneumonia patients 33.15% (4.33-51.1%) vs 36.15% (4.62-45.8%). The percentage of deaths in the severe pneumonia group was 5%.

Table 2. Patient profiles by pneumonia severity according to WHO Criteria (n = 217)

Characteristics	Category	Severe (n = 100) n (%)	Non-severe (n = 117) n (%)
Demographic	Male	62 (62)	68 (58.1)
	Age (years), median (IQR)	1.4 (5.8)	3.2 (6.7)
	Normal nutritional status	44 (44)	80 (68.4)
Clinical manifestations	Fever	93 (93)	110 (94)
	Cough	92 (92)	112 (95.7)
	Shortness of breath	46 (46)	28 (23.9)
	Decreased appetite	48 (48)	44 (37.6)
	Convulsion	17 (17)	0 (0)
	Vomit	35 (35)	23 (19.7)
	Lethargy	5 (5)	0 (0)
Physical findings	Apnea	1 (1)	1 (0.9)
	Tachypnea	28 (28)	25 (21.4)
	Cyanosis	5 (5)	0 (0)
	Nasal flaring	19 (19)	3 (2.6)
	Grunting	1 (1)	0 (0)
	Retraction	66 (66)	0 (0)
	Signs of dehydration	12 (12)	3 (2.6)
	Reduced VBS	8 (8)	14 (12)
	Rhonchi	84 (84)	86 (73.5)
	Wheezing	33 (33)	11 (9.4)
	Refractory shock	7 (7)	0 (0)
Laboratory findings	Hemoglobin (g/dL), median (IQR)	(n = 94) 11 (3.1)	(n = 114) 11.9 (2.8)
	Leukocyte (10^3 cells/mm^3) , median (IQR)	(n = 94) 14.3 (12.9)	(n = 114) 13.2 (11.7)
	Haematocrit (%), median (IQR)	(n = 94) 33.2 (15.6)	(n = 114) 36.2 (13.7)
	NLR, median (IQR)	(n = 94) 1.6 (4.3)	(n = 111) 1.7 (16.6)
Outcome	Alive	94 (94)	112 (95.7)
	Death	5 (5)	2 (1.7)
	Referred to other hospital	1 (1)	2 (1.7)

The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), and negative likelihood ratio (LR-) of both scoring systems are presented in Tables 3 and 4. The PIDS criteria were found to have a higher sensitivity to predict severe pneumonia (72.0%; 95% CI 62.1–80.5), but the BTS criteria had a higher specificity (92.3%; 95% CI 85.9–96.4) in predicting severe pneumonia. The BTS criteria had a PPV of 81.6%, NPV of 64.3%, LR+ of 5.2, and LR− of 0.7 for predicting severe

CAP in children. In comparison, the PIDS criteria had a PPV of 49.7%, NPV of 61.1%, LR+ of 1.2, and LR− of 0.7. The BTS criteria demonstrated better overall discriminatory ability, with an AUC of 0.66 (95% CI 0.59–0.74; $p < 0.001$), compared with the PIDS , which had an AUC of 0.55 (95% CI 0.47–0.63; $p = 0.22$), as shown in Figure 2.

Table 3:Diagnostic performance of BTS and PIDS criteria for pneumonia severity using WHO reference standard, including sensitivity, specificity, predictive values, and likelihood ratios

Scoring system	Severity levels	WHO		Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	LR+ (95% CI)	LR- (95% CI)
		Severe	Non-severe						
BTS	Severe	40	9	40% (30.3-50.3)	92.3% (85.9-96.4)	81.6% (69.4-89.7)	64.3% (60.3-68.1)	5.2 (2.7-10.2)	0.7 (0.6-0.8)
	Non-severe	60	108						
PIDS	Severe	72	73	72% (62.1-80.5)	37.6% (28.8-47)	49.7% (45-54.3)	61.1% (51.5-69.9)	1.2 (1-1.4)	0.7 (0.5-1.1)
	Non-severe	28	44						

Table 4: AUC for both severity criteria

Scoring criteria	Area under the curve (95% CI)	Standard error	P-value
BTS	0.66 (0.59-0.74)	0.04	<0.001
PIDS	0.55 (0.47-0.63)	0.04	0.22

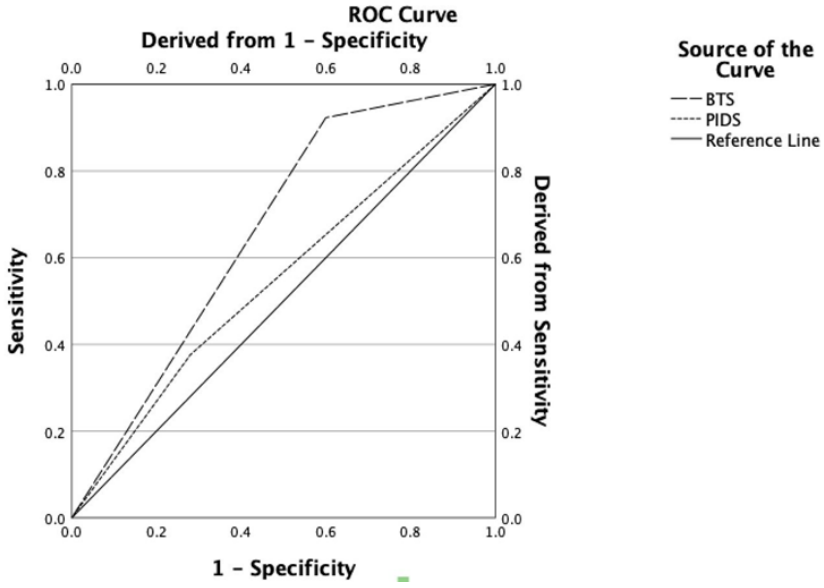

Figure 2: ROC curve for both severity criteria

Discussion

Previous studies have produced mixed results regarding the effectiveness of the BTS criteria in predicting severe pneumonia in children (13,18,22). One study found that while the BTS criteria were highly effective in distinguishing between children who were admitted to the hospital and those who were not, they had limited ability to identify children who met the need for further hospitalization (NFH) criteria. The NFH criteria, which pertain to outcomes occurring after leaving the emergency department (ED), include interventions based on physiologic parameters (e.g., supplemental oxygen for hypoxia), procedures requiring inpatient care (e.g., chest drainage), and interventions indicating disease progression (e.g., broadening of antibiotic therapy). Despite the high specificity of the BTS criteria, which helped identify children requiring hospital admission, their low sensitivity highlighted limitations in predicting NFH and patient disposition (admitted vs discharged) (13).

This study found that the BTS criteria had a high specificity of 92.3% in predicting severe pneumonia, which aligns with previous studies on the validation of BTS criteria for hospital admission in paediatric CAP (13). This study found that the BTS pneumonia criteria demonstrated good predictive ability and acceptable discriminatory power in classifying severe and non-severe cases. The positive predictive value (PPV) of 81.6% further supported the accuracy of these criteria in correctly identifying severe cases. However, the low sensitivity of 40% and NPV of 64.3% observed in this study corroborated the limitations of the BTS criteria in capturing all cases requiring hospitalization or further intervention. This limitation was also seen also evident in previous studies, where some children with severe CAP were not admitted despite meeting severity criteria (13,18).

Additionally, a study by Clark et al. revealed that although the BTS criteria were effective at identifying children needing hospitalization, 4% of those identified as having severe CAP were not admitted, whereas less than 1% of children in the mild and moderate severity groups were not admitted (18). This finding suggests a gap between the theoretical application of the BTS criteria and real-world clinical decision-making, highlighting potential discrepancies between expert-derived guidelines and hospital practices. Another study examined the relationship between pneumonia severity and chest radiography findings, finding no significant association using the BTS criteria. In contrast, an association was found when applying any of the WHO criteria, such as stridor, fast breathing, chest wall indrawing, and difficulty in breathing (22,23). These further underscores the variability in the effectiveness of BTS severity criteria.

The PIDS/IDSA created a pediatrics CAP guideline that included severity criteria to assist clinical decision-making. These criteria

were not derived directly from children but rather a modification from the prior adult version consensus guidelines (17). Several studies have validated the 2007 Infectious Diseases Society of America/American Thoracic Society Criteria CAP criteria to define severe pneumonia in adults from different countries (24–26). One meta-analysis reported a pooled sensitivity of 84% and a specificity of 78% of PIDS criteria for predicting ICU admission with one major or three minor criteria (27).

The pediatric CAP severity criteria include major and minor factors used to predict the NFH, ICU care, or a unit with continuous cardiorespiratory monitoring (17). This study found that the PIDS criteria had moderate sensitivity (72%, 95% CI: 62.1-80.5) but poor to fair specificity (37.6%, 95% CI: 28.8-47). Previous studies have shown that more than half of children classified as having severe CAP by the PIDS-IDSA criteria were safely discharged, without requiring hospitalization or interventions, highlighting the high sensitivity but poor specificity of the criteria, which leads to misclassification of some children as having severe disease. The study further specifies that the PIDS criteria have a fair to good ability to differentiate between children who are admitted and those who are discharged. However, they are only marginally effective in distinguishing children who require further interventions or have diagnoses that would justify hospitalization (i.e., NFH) (12).The PIDS criteria identified severe pneumonia in children with an AUC 0.55 (95%CI= 0.47-0.63, p-value 0.22), which shows that this model has poor discrimination. The poor discrimination of PIDS criteria for severe pneumonia might be due to the inclusion of several criteria such as the use PaO2:FiO2 ratio, multilobar infiltrate, presence of effusion, and metabolic acidosis that occurs infrequently and have both measurement and interpretation challenges (12,16). Furthermore, the criteria included in PIDS such as the use of mechanical ventilation and PaO2:FIO2 ratio were supposed to be used in children with acute respiratory distress syndrome in intensive care. However, most of our data was obtained when the children were admitted to the emergency which means that most children are in room air on presentation and thus may affect the performance of that ratio for those children.

The BTS and PIDS severity criteria both have advantages and disadvantages in distinguishing severe pneumonia. It is noteworthy that most of the BTS criteria are clinical conditions that can be easily accessed through physical examination in an emergency setting. This allows for quicker identification of severe pneumonia, leading to faster and more appropriate management. In contrast, the PIDS criteria include parameters that require further evaluation, such as arterial blood gases to assess metabolic acidosis, the PaO2/FiO2 ratio, and radiographs to identify infiltrates or consolidations. This may complicate the assessment of severe pneumonia in an

emergency setting. This allows for quicker identification of severe pneumonia, leading to faster and more appropriate management. In contrast, the PIDS criteria include parameters that require further evaluation, such as arterial blood gases to assess metabolic acidosis, the PaO2/FiO2 ratio, and radiographs to identify infiltrates or consolidations. This may complicate the assessment of severe pneumonia in an emergency setting. However, the PIDS criteria have higher sensitivity in recognizing severe pneumonia, while the BTS criteria have higher specificity and a higher positive predictive value (PPV) for identifying true severe pneumonia. Interestingly, the WHO guidelines, used as the gold standard in this study, emphasize clinical presentation to determine severe pneumonia, like the BTS criteria. This may explain the high specificity of the BTS criteria observed in this study.

Abnormal nutritional status was significantly more prevalent in the severe pneumonia group compared to the non-severe group (56% vs. 31.6%). This disparity was further reflected in clinical outcomes; while the severe group had a 5% mortality rate (5/100), two deaths (1.7%) also occurred in the non-severe group. The association between malnutrition and disease severity is rooted in a complex pathophysiological process in which protein-energy malnutrition leads to secondary immunodeficiency, including impaired cell-mediated immunity, reduced cytokine production, and atrophy of lymphoid tissues, thereby diminishing the host's ability to contain pulmonary pathogens (28–30). Furthermore, infection itself increases metabolic demand and energy expenditure while simultaneously reducing nutrient intake, creating a synergistic vicious cycle between malnutrition and infection (31). This cycle contributes to the depletion of protein, energy, minerals, and vitamins, further increasing susceptibility to severe infection and adverse clinical outcomes. These findings align with previous studies in developing countries, such as those by Chisti et al., which identified underweight status as a primary predictor of mortality and treatment failure in paediatric pneumonia (28). A systematic review by Nascimento-Carvalho et al. and findings from UNICEF/WHO reports identified malnutrition as one of the strongest predictors of pneumonia-related mortality in children under five years of age (30).

The findings of this study may also be relevant to pediatric practice in resource-limited settings, including many regions in Africa where childhood pneumonia remains a major contributor to morbidity and mortality. The BTS criteria mainly rely on bedside clinical assessment and include more clinical parameters than the WHO criteria (14). These criteria can be assessed without advanced diagnostic tools and may be useful in distinguishing children who require hospital admission from those who can be managed without inpatient care. Although several components of the

PIDS/IDSA criteria require advanced investigations such as arterial blood gas analysis, chest radiography, and assessment of intensive respiratory support, many elements of the PIDS/IDSA criteria are still based on bedside clinical evaluation (16). Based on our findings, the higher sensitivity of the PIDS/IDSA criteria may help clinicians identify children at risk of severe pneumonia who require closer monitoring or further interventions.

Our study has several limitations. First, the cross-sectional retrospective design limits the ability to determine temporal relationships or establish causal associations between predictors and pneumonia severity. In addition, the use of medical record–based data may introduce information bias due to incomplete or inconsistently documented variables. This study also had a relatively small sample size and included a wide age range. The severity of CAP may be influenced by several factors, such as parental smoking status, birth weight, immunization status, nutritional status, and comorbid conditions, which were not fully controlled in our analysis. Some important variables, including SpO2, FiO2, PaO2, and several laboratory parameters, were missing in a proportion of cases, limiting the statistical power for further analysis. Furthermore, data were collected from only two hospitals, and the catchment area for pneumonia cases may not represent the broader population, thereby limiting the generalizability of the findings. Nevertheless, the inclusion of two hospitals with different patient populations enabled the recruitment of children from diverse demographic and socioeconomic backgrounds, including both low- and middle-income as well as high-income families. The strengths of this study include detailed clinical data collection, accurate radiological and laboratory confirmation, and the evaluation of pneumonia severity criteria in a topic that remains underexplored in our setting.

Conclusion

This study intends to compare and validate two pneumonia severity criteria (BTS and PIDS criteria) for pediatric patients with CAP. The PIDS criteria has some value in sensitivity but poor to fair specificity with poor discrimination. On the other hand, the BTS criteria were found to have low sensitivity in recognizing severe pneumonia but high specificity. Therefore, in a busy emergency setting, the PIDS criteria may help avoid missing potentially severe cases, while the BTS criteria may better identify patients who truly require intensive management. Future studies are still needed to further validate and refine practical severity criteria for paediatric CAP with improved discriminatory performance and balanced sensitivity and specificity.

Abbreviations

BTS: British Thoracic Society

PIDS: Pediatric Infectious Diseases Society

NIPPV: non-invasive positive pressure ventilation

FiO_2: fraction of inspired oxygen

WHO: World Health Organization:

PaO_2: partial pressure of arterial oxygen

SpO_2: peripheral oxygen saturation

PEWS: Pediatric Early Warning Score

CI: confidence interval

PV: positive predictive value;

NPV: negative predictive value

LR+: positive likelihood ratio

LR−: negative likelihood ratio

IQR: interquartile range

NLR: neutrophil-to-lymphocyte ratio

VBS: vesicular breath sound.

Declarations

Ethical Considerations

The Universitas Pelita Harapan Ethics Committee approved this study with approval number 174/K-LKJ/ETIK/XII/2020.

Conflict of interest

The authors declare no conflict of interest

Authors contribution

MM lead conceptualization, methodology, data curation, statistical analysis, review and editing, CB involved in conceptualization, methodology, investigation, review and editing and GO involved in supervision, validation, formal analysis

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AI use

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