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Original Article

Validation of a Foreign Body Aspiration Scoring System in Critically Ill Children: Retrospective Analysis of Outcomes and Bronchoscopy

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ABSTRACT

Aim: Foreign body aspiration (FBA) is a common and potentially life-threatening emergency in pediatric patients. While bronchoscopy remains the gold standard for diagnosis, it carries procedural risks and may be unnecessary in a substantial number of cases. The Foreign Body Aspiration Score (FOBAS) was developed in order to improve diagnostic accuracy, but its utility in pediatric intensive care unit (PICU) settings has not been validated. This study aimed to externally validate the FOBAS system in a PICU population and assess its diagnostic performance and clinical applicability.

Materials and Methods: In this single-centre retrospective cohort study, 54 children aged 1 month to 18 years, admitted to a PICU with suspected FBA and undergoing bronchoscopy between 2015 and 2024, were analysed. Demographics, clinical findings, imaging, and FOBAS parameters were evaluated. The association between FOBAS scores and bronchoscopy results was statistically analysed.

Results: Of the 54 patients, 35 (64.8%) had a confirmed foreign body. The median FOBAS score was significantly higher in the positive group (7.0 vs. 3.0, $p<0.001$). Receiver operating characteristic analysis revealed excellent diagnostic performance (area under the curve: 0.910), with a cut-off of 6.5 providing 74.3% sensitivity and 88.5% specificity. Multivariate analysis identified foreign body exposure and total FOBAS score as independent predictors of positive bronchoscopy.

Conclusion: FOBAS demonstrates high diagnostic accuracy in critically ill children with suspected FBA and may reduce unnecessary bronchoscopies in the PICUs. A cut-off score of ≥6.5 effectively stratifies risk and supports clinical decision-making in intensive care settings.

Keywords: Foreign body aspiration, FOBAS score, pediatric intensive care unit, validation, bronchoscopy

Introduction

Foreign body aspiration (FBA) is a notable cause of childhood morbidity and mortality, with an incidence of around 1.4 per 100,000 person-years (1). Most cases occur in boys aged 1-3 years, linked to developmental factors such as oral exploration, poor chewing ability, and lack of coordination (2,3).

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Clinical presentations vary, and the classical triad (cough, wheezing, and reduced breath sounds) is seen in only a minority of cases (4). Typical symptoms such as cough, wheezing, respiratory distress, and fever may be present, yet the physical exam can be normal, making timely diagnosis difficult (5). Chest X-rays are often non-diagnostic with about half appearing normal (6). Common radiographic manifestations of FBA include unilateral air trapping, segmental or lobar atelectasis, and, less frequently, consolidation. Radiopaque objects are rare, as most aspirated materials are organic and not visible (7). Bronchoscopy remains the diagnostic and therapeutic gold standard, despite being invasive, requiring anaesthesia, and carrying complication risks. Its high false-negative rate (20-50%) also leads to unnecessary procedures and resource waste (8,9).

In order to address this, decision support tools have been introduced. Lee et al. (10) identified air trapping, unilateral decreased breath sounds, and witnessed choking as key predictors, while other models such as those by Özyüksel et al. (11), Fasseeh et al. (12), and Stafler et al. (13) have shown promise. The Foreign Body Aspiration Score (FOBAS), developed by Pozailov et al. (14), has demonstrated high sensitivity and specificity but lacks broad external validation.

Pediatric intensive care unit (PICU) patients may differ from other emergency populations due to comorbidities and more severe presentations, requiring tailored evaluation (15). Validating FOBAS in this setting is essential in order to reduce both missed diagnoses and unnecessary bronchoscopies. While timely diagnosis is vital for safety and resource use, delayed recognition increases complications (16). Thus, a reliable, PICU-specific scoring system is needed. This study aimed to externally validate FOBAS in PICU patients with suspected FBA and assess its diagnostic performance and clinical relevance.

Materials and Methods

This retrospective cohort study was conducted at a PICU, a nine-bed level III referral centre. We included all patients aged 1 month to 18 years admitted with suspected FBA between January, 2015 and December, 2024 who underwent bronchoscopy.

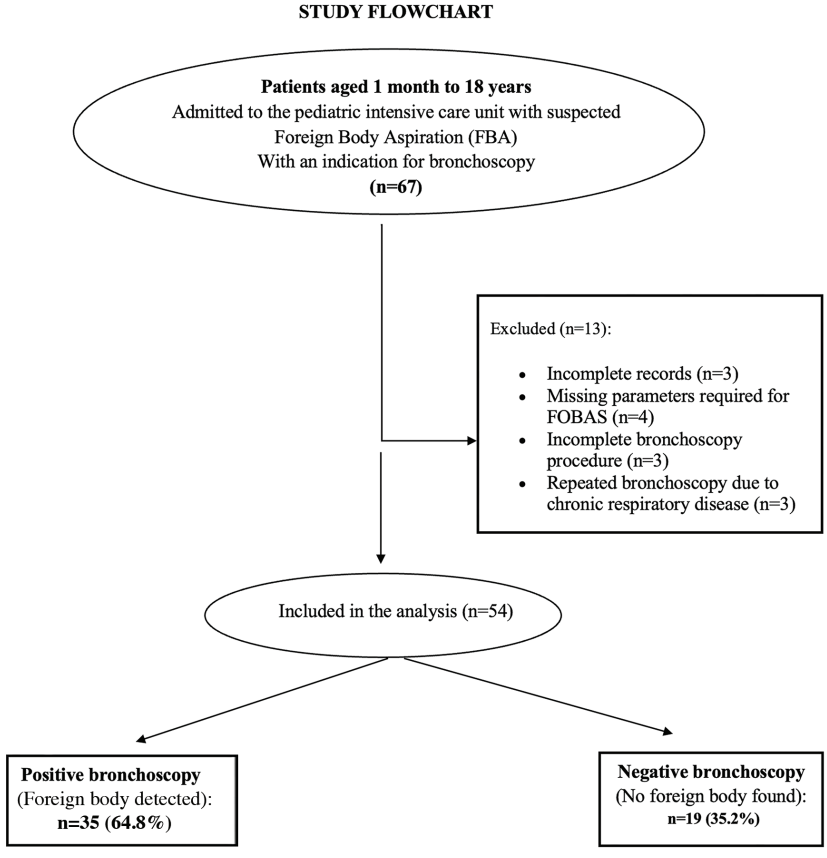

Figure 1. Study flowchart
FOBAS: Foreign Body Aspiration Score

The exclusion criteria were incomplete bronchoscopy, missing data required for FOBAS calculation, and repeated procedures due to chronic respiratory conditions (Figure 1). Of the 67 eligible patients, 54 met the criteria for analysis. Data were retrospectively collected from the electronic and archived medical records using a standardized form, covering demographics, comorbidities, aspiration history, clinical findings, vital signs, lab and imaging results, FOBAS parameters, bronchoscopy outcomes, complications, treatments, and follow-up.

FOBAS, developed and validated by Pozailov et al. (14), assigns a 0-10 score based on eight criteria: choking, exposure to a foreign object, sudden cough, absence of fever and rhinorrhoea, unilateral decreased breath sounds or wheezing, stridor, radiological findings, and radiopaque appearance. Risk levels are classified as low (1-3), moderate (4-6), or high (7-10). Each patient's score was calculated accordingly.

All bronchoscopies were performed under general anaesthesia, systematically examining the trachea and bronchi. Findings were recorded as positive (foreign body detected) or negative. Object characteristics and removal status were documented. Initial labs and chest X-rays were reviewed, along with intensive care unit/hospital stay durations, complications, and clinical outcomes.

Upon admission, all patients received blood tests [complete blood count, C-reactive protein (CRP), procalcitonin, biochemistry, blood gases] and posteroanterior chest radiographs, evaluated for signs of FBA (e.g., air trapping, atelectasis, consolidation, pneumothorax, mediastinal shift, radiopaque foreign body).

This study was approved by the Non-interventional Clinical Research Ethics Committee of Göztepe Prof. Dr. Süleyman Yalçın City Hospital (approval no.: 2025/0164, dated: 11.09.2025). Due to its retrospective nature, individual consent was waived. All data were anonymized and securely stored, in accordance with the Declaration of Helsinki (17).

Statistical Analysis

Statistical analysis was performed using SPSS version 26.0 (IBM Corp.). The Shapiro-Wilk test assessed normality. Continuous variables are presented as mean ± standard deviation or median (interquartile range) and categorical data as frequencies and percentages. Group comparisons used independent samples t-test, Mann-Whitney U tests, chi-square or Fisher's exact tests as appropriate. Length of stay was analysed both as continuous and categorical data (>3 days in PICU, >7 days in hospital).

Diagnostic performance of FOBAS was evaluated with receiver operating characteristic (ROC) curve analysis and Youden's index in order to determine the optimal cut-off (18). Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for total score, risk groups, and individual FOBAS items. In multivariate logistic regression, only variables with $p<0.005$ in univariate analysis were included, adhering to the "events per variable" rule (≥10 positive cases per variable) (19). The final model included foreign body exposure, total FOBAS score, sudden cough, and unilateral decreased breath sounds. All tests were two-tailed, with $p<0.05$ considered statistically significant. Reporting followed Standards for Reporting of Diagnostic Accuracy Studies (20) and Strengthening the Reporting of Observational Studies in Epidemiology (21) guidelines.

Results

Patient Characteristics

Among the 54 patients included, 35 (64.8%) had positive bronchoscopy findings and 19 (35.2%) had negative results. The mean age was 33.6±16.1 months ($p=0.101$), and 59.3% were male. Although body weight was higher in the negative group, the difference was not significant. In the analysis of comorbid conditions, developmental delay was observed in 0% of the control group compared to 21.1% in the negative bronchoscopy group ($p=0.012$). Additionally, gastroesophageal reflux was present in 17.1% of the control group versus 47.4% in the negative bronchoscopy group ($p=0.027$) (Table I). The mean age of the study cohort was 33.6±16.1 months. The mean ages for the groups with positive and negative bronchoscopy results were 31.5±16.4 months and 37.5±15.2 months, respectively, with no statistically significant difference observed ($p=0.101$). The majority of participants were aged between 6 and 48 months. Although individuals with positive bronchoscopy outcomes tended to be younger, the distribution of age groups did not differ significantly between the two groups ($p>0.05$).

Clinical, Laboratory, and Imaging Findings

Witnessed aspiration was significantly more frequent in the positive group (80.0% vs. 31.6%; $p=0.001$), as were sudden cough (82.9% vs. 42.1%; $p=0.006$), dyspnoea (74.3% vs. 42.1%; $p=0.041$), and unilateral decreased breath sounds (77.1% vs. 21.1%; $p<0.001$). Rhinorrhoea was more frequent in the negative group (36.8% vs. 8.6%; $p=0.023$). Chest X-rays showed more unilateral air trapping (45.7% vs. 10.5%; $p=0.020$) and more FBA-suggestive findings (77.1%

Table I. Patient characteristics, demographics, comorbidities, and medical history

Parameter	Total (n=54)	Positive bronchoscopy (n=35)	Negative bronchoscopy (n=19)	p-value
Age (months), mean ± SD	33.6±16.1	31.5±16.4	37.5±15.2	0.101
Age categories, n (%)				
6-24 months	20 (37.0)	16 (45.7)	4 (21.1)	0.155
25-48 months	22 (40.7)	13 (37.1)	9 (47.4)	0.574
>48 months	12 (22.2)	6 (17.1)	6 (31.6)	0.365
Sex, n (%)				
Male	32 (59.3)	20 (57.1)	12 (63.2)	0.667
Female	22 (40.7)	15 (42.9)	7 (36.8)	
Body weight (kg), mean ± SD	17.2±8.3	15.8±8.1	19.8±8.1	0.056
Height (cm), mean ± SD	84.8±8.0	84.1±7.4	86.1±9.0	0.517
Comorbidities and medical history, n (%)				
Asthma	4 (7.4)	3 (8.6)	1 (5.3)	>0.999
Cerebral palsy	4 (7.4)	1 (2.9)	3 (15.8)	0.119
Developmental delay	4 (7.4)	0 (0.0)	4 (21.1)	0.012
Gastroesophageal reflux	15 (27.8)	6 (17.1)	9 (47.4)	0.027
Any comorbidity	26 (48.1)	13 (37.1)	13 (68.4)	0.056

SD: Standard deviation

vs. 42.1%; p=0.023) in the positive group, while consolidation was more common in the negative group (42.1% vs. 14.3%; p=0.043) (Table II).

Laboratory values such as leukocyte count (12.5 vs. 9.9 $\times 10^3/\mu L$; p=0.047), CRP (p=0.007), and procalcitonin (p<0.001) were higher in the negative group. Positive cases had lower pO_2 levels (85.6 vs. 92.6 mmHg; p=0.011), and more frequently required mechanical ventilation (20.0% vs. 0%; p=0.044) and respiratory support (77.1% vs. 36.8%; p=0.008) (Table II).

Among the 35 confirmed FBA cases, 94.3% involved organic materials, most commonly peanuts (45.7%), sunflower seeds (20.0%), and walnuts (14.3%). The right main bronchus was the most frequent location (60.0%), followed by the left main bronchus (22.9%).

FOBAS Score Analysis

The median FOBAS score was higher in the positive group (7.0 vs. 3.0; p<0.001), with most positive cases in the high-risk category (74.3%) and over half of the negative cases in the low-risk category (57.9%; p<0.001). Significant predictors of positive bronchoscopy included foreign body exposure (p<0.001), sudden cough (p=0.002), absence of fever/rhinorrhoea (p=0.026), unilateral decreased breath sounds (p=0.002), and radiological findings (p=0.011) (Table III).

In univariate logistic regression, foreign body exposure (OR: 23.11), sudden cough (OR: 6.65), absence of fever/rhinorrhoea (OR: 3.74), unilateral decreased breath sounds (OR: 6.86), and suggestive radiology (OR: 4.64) were all significant. Each 1-point increase in FOBAS raised the likelihood of a positive bronchoscopy by 2.30 times (p<0.001). In multivariate analysis, only foreign body exposure (OR: 7.23; p=0.045) and total FOBAS score (OR: 2.07; p=0.015) remained independent predictors. Moderate-risk (OR: 33.6) and high-risk (OR: 243.8) categories were strongly associated with positive findings (Table IV).

Diagnostic Performance of FOBAS

ROC analysis showed excellent diagnostic accuracy for FOBAS, with an area under the curve (AUC) of 0.910 (95% CI: 0.860-0.960). The optimal cut-off was 6.5, yielding 74.3% sensitivity and 88.5% specificity. Positive and negative predictive values were 91.2% and 80.0%, respectively. The positive likelihood ratio was 7.1, and the negative likelihood ratio was 0.29. These results indicate that FOBAS is a reliable tool for identifying FBA, particularly at scores ≥6.5,

Table II. Clinical and laboratory data of foreign body aspiration cases

Parameter	Total (n=54)	Positive (n=35)	Negative (n=19)	p-value
Witnessed aspiration	34 (63.0)	28 (80.0)	6 (31.6)	0.001*
Time from aspiration to hospital admission (median, IQR, hours)	13.6 (5.5-29.6)	9.8 (5.1-22.0)	21.1 (9.3-35.0)	0.051
<24 hours	38 (70.4)	28 (80.0)	10 (52.6)	0.073
24-48 hours	13 (24.1)	6 (17.1)	7 (36.8)	0.181
2-8 days	2 (3.7)	1 (2.9)	1 (5.3)	1.000
>8 days	1 (1.9)	0 (0.0)	1 (5.3)	1.000
Clinical findings and physical examination				
Sudden cough	37 (68.5)	29 (82.9)	8 (42.1)	0.006*
Dyspnoea/shortness of breath	34 (63.0)	26 (74.3)	8 (42.1)	0.041*
Wheezing	40 (74.1)	24 (68.6)	16 (84.2)	0.331
Stridor	11 (20.4)	9 (25.7)	2 (10.5)	0.292
Cyanosis	10 (18.5)	8 (22.9)	2 (10.5)	0.465
Fever (≥38 °C)	17 (31.5)	9 (25.7)	8 (42.1)	0.351
Rhinorrhoea	10 (18.5)	3 (8.6)	7 (36.8)	0.023*
Unilateral decreased breath sounds	31 (57.4)	27 (77.1)	4 (21.1)	<0.001*
Unilateral wheezing	16 (29.6)	13 (37.1)	3 (15.8)	0.184
Rhonchi	0 (0.0)	0 (0.0)	0 (0.0)	1.000
Rales	0 (0.0)	0 (0.0)	0 (0.0)	1.000
Oxygen saturation (%)	96.2±2.6	96.2±2.4	96.2±3.0	0.731
Heart rate (beats/min)	120.7±16.1	123.2±16.0	116.2±15.7	0.142
Respiratory rate (breaths/min)	24.9±5.1	25.1±5.1	24.6±5.3	0.709
Systolic blood pressure (mmHg)	90.6±9.8	91.1±10.4	89.8±8.7	0.878
Chest X-ray findings				
Normal radiograph	13 (24.1)	6 (17.1)	7 (36.8)	0.181
Unilateral air trapping	18 (33.3)	16 (45.7)	2 (10.5)	0.020*
Atelectasis	22 (40.7)	15 (42.9)	7 (36.8)	0.889
Mediastinal shift	6 (11.1)	6 (17.1)	0 (0.0)	0.080
Pneumonia/consolidation	13 (24.1)	5 (14.3)	8 (42.1)	0.043*
Pneumothorax	0 (0.0)	0 (0.0)	0 (0.0)	1.000
Radiopaque foreign body	6 (11.1)	6 (17.1)	0 (0.0)	0.080
Radiological findings suggestive of FBA	35 (64.8)	27 (77.1)	8 (42.1)	0.023*
Laboratory and microbiological findings				
Haemoglobin (g/dL)	12.0±1.6	12.0±1.6	12.1±1.7	0.664
Haematocrit (%)	36.1±4.8	35.9±4.7	36.3±5.2	0.657
White blood cell count ($\times 10^3/\mu L$)	10.8±3.9	9.9±3.2	12.5±4.5	0.047*
Neutrophil (%)	59.3±12.0	61.3±11.0	55.6±13.1	0.062
Platelet count ($\times 10^3/\mu L$)	333.8±83.4	344.7±81.7	313.9±84.8	0.145
CRP at admission (mg/L)	17.5 (5.1-31.5)	12.7 (3.8-24.1)	31.5 (14.8-50.3)	0.007*
Peak CRP (mg/L)	20.9 (6.2-37.8)	15.2 (4.6-28.8)	37.8 (17.8-60.4)	0.007*
Procalcitonin at admission (ng/mL)	0.3 (0.1-0.7)	0.2 (0.1-0.3)	1.1 (0.6-2.1)	<0.001*
Peak procalcitonin (ng/mL)	0.4 (0.2-0.9)	0.2 (0.1-0.4)	1.4 (0.8-2.7)	<0.001*

Table II. Continued

Parameter	Total (n=54)	Positive (n=35)	Negative (n=19)	p-value
pH at admission	7.40±0.04	7.40±0.05	7.40±0.04	0.841
pCO_2 at admission (mmHg)	40.69±4.98	41.02±5.10	40.09±4.82	0.538
pO_2 at admission (mmHg)	88.02±9.73	85.57±10.02	92.55±7.45	0.011*
HCO_3 at admission (mEq/L)	24.20±2.63	23.87±2.42	24.81±2.95	0.177
Lactate (mmol/L)	1.32±1.36	1.17±1.03	1.60 ±1.81	0.496
Treatment and respiratory support				
Antibiotic use	33 (61.1)	19 (54.3)	14 (73.7)	0.270
Steroid use	9 (16.7)	4 (11.4)	5 (26.3)	0.251
Bronchodilator use	35 (64.8)	19 (54.3)	16 (84.2)	0.057
Oxygen support	29 (53.7)	22 (62.9)	7 (36.8)	0.122
Mechanical ventilation	7 (13.0)	7 (20.0)	0 (0.0)	0.044*
Any respiratory support	34 (63.0)	27 (77.1)	7 (36.8)	0.008*
Complications				
Laryngospasm	4 (7.4)	2 (5.7)	2 (10.5)	0.607
Bronchospasm	5 (9.3)	4 (11.4)	1 (5.3)	0.646
Bleeding	2 (3.7)	1 (2.9)	1 (5.3)	1.000
Any early complication	11 (20.4)	7 (20.0)	4 (21.1)	1.000
Pneumonia	10 (18.5)	5 (14.3)	5 (26.3)	0.297
Atelectasis	6 (11.1)	3 (8.6)	3 (15.8)	0.653
Clinical outcomes and prognosis				
PICU length of stay (days)	2.5 (1.4-4.0)	2.5 (1.4-3.8)	2.7 (1.7-4.0)	0.550
PICU stay >3 days	20 (37.0)	12 (34.3)	8 (42.1)	0.785
Total hospital length of stay (days)	4.5 (2.6-6.6)	4.4 (2.8-6.5)	4.6 (2.7-6.9)	0.928
Mortality	3 (5.6)	3 (8.6)	0 (0.0)	0.544

Statistical significance: *p<0.05
Categorical variables are presented as n (%); continuous variables as mean ± standard deviation or median (IQR) as appropriate
IQR: Interquartile range, FBA: Foreign body aspiration, CRP: C-reactive protein, PICU: Pediatric intensive care unit

Table III. FOBAS analysis

Parameter	Total (n=54)	Positive (n=35)	Negative (n=19)	p-value
Choking episode	2 (0-2)	2 (0-2)	1 (0-2)	0.147
Foreign body exposure	1 (0-1)	1 (1-1)	0 (0-1)	<0.001
Sudden cough	1 (0-1)	1 (1-1)	0 (0-1)	0.002
Absence of fever/rhinorrhoea	1 (0-1)	1 (0-1)	0 (0-1)	0.026
Unilateral wheezing/decreased sounds	2 (0-2)	2 (2-2)	2 (0-2)	0.002
Stridor	0 (0-0)	0 (0-1)	0 (0-0)	0.194
Radiological findings	2 (0-2)	2 (2-2)	2 (0-2)	0.011
Radiopaque object	0 (0-0)	0 (0-0)	0 (0-0)	0.060
Total FOBAS (median, IQR)	7.0 (4.0-8.8)	7.0 (6.5-9.0)	3.0 (2.0-5.0)	<0.001
FOBAS risk category				
Low (1-3 points)	11 (20.4)	0 (0.0)	11 (100.0)	<0.001
Moderate (4-6)	15 (27.8)	9 (60.0)	6 (40.0)	
High (7-10)	28 (51.9)	26 (92.8)	2 (7.1)	

FOBAS: Foreign Body Aspiration Score, IQR: Interquartile range

Table IV. Logistic regression analysis of FOBAS parameters in relation to foreign body aspiration

FOBAS parameter	Positive group (n=35)	Negative group (n=19)	Univariable analysis			Multivariable analysis		
			OR	95% CI	p value	OR	95% CI	p-value
Individual FOBAS parameters								
Choking episode	25 (71.4%)	11 (57.9%)	1.82	0.56-5.85	0.481			
Foreign body exposure	32 (91.4%)	6 (31.6%)	23.11	5.01-106.57	**<0.001***	7.23	1.04-50.13	**0.045***
Sudden cough	29 (82.9%)	8 (42.1%)	6.65	1.87-23.56	**0.006***			
Absence of fever and rhinorrhoea	24 (68.6%)	7 (36.8%)	3.74	1.16-12.10	**0.050***			
Unilateral wheezing/ decreased breath sounds	28 (80.0%)	7 (36.8%)	6.86	1.97-23.86	**0.004***	1.02	0.33-3.15	0.968
Stridor	9 (25.7%)	2 (10.5%)	2.94	0.57-15.32	0.292			
Radiological findings	27 (77.1%)	8 (42.1%)	4.64	1.39-15.48	0.023*			
Radiopaque foreign body	6 (17.1%)	0 (0.0%)	8.59†	0.46-161.39	0.080			
FOBAS total score and risk categories								
FOBAS total score	8.9±4.2	3.7±2.1	2.30‡	2.28-2.33	**<0.001***	2.07‡	1.15-3.70	**0.015***
FOBAS risk categories								
Low risk (1-3 points)	0 (0.0%)	11 (100.0%)	1.00 (Ref)					
Moderate risk (4-8 points)	9 (60.0%)	6 (40.0%)	33.62	1.67-676.61	**<0.001***			
High risk (9+ points)	26 (92.9%)	2 (7.1%)	243.80	10.83-5489.80	**<0.001***			

Categorical variables are presented as n (%); continuous variables as mean ± standard deviation. Multivariable analysis included only variables with p<0.005 in univariable analysis, following the events per variable (EPV) rule
*: p<0.05, †: Odds ratio calculated using Haldane correction due to zero cell, ‡: Odds ratio per 1-point increase in FOBAS score
FOBAS: Foreign Body Aspiration Score, OR: Odds ratio, CI: Confidence interval

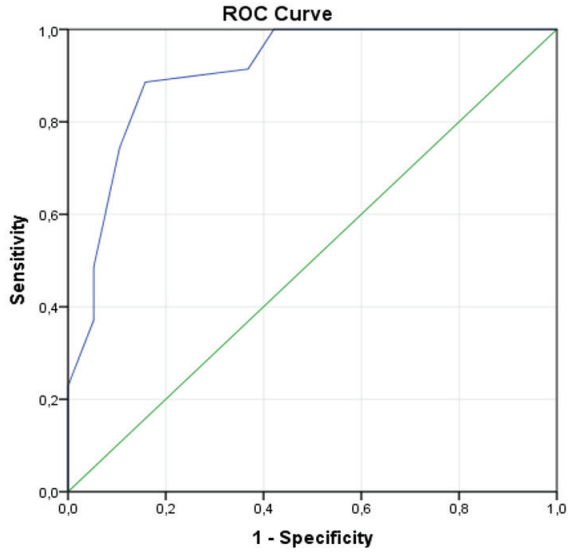

Figure 2. ROC curve demonstrating the diagnostic accuracy of the Foreign Body Aspiration Score for predicting positive bronchoscopy findings (AUC=0.910)
ROC: Receiver operating characteristic, AUC: Area under the curve

Table V. Diagnostic performance of FOBAS (ROC curve analysis)

Parameter	Value	95% CI
Area under the curve (AUC)	0.910	0.860–0.960
Optimal cut-off (Youden index)	6.5	
Sensitivity (%)	74.3	
Specificity (%)	88.5	
Positive predictive value (%)	91.2	
Negative predictive value (%)	80.0	
Positive likelihood ratio	7.1	
Negative likelihood ratio	0.29	

FOBAS: Foreign Body Aspiration Score, ROC: Receiver operating characteristic, CI: Confidence Interval

and may help reduce unnecessary bronchoscopies due to its strong positive predictive value (Table V, Figure 2).

Discussion

Our study presents the first external validation of FOBAS in patients admitted to a PICU for FBA. Our findings demonstrate that FOBAS shows strong diagnostic

performance in a PICU setting (AUC: 0.910), indicating its potential use not only in the general pediatric population but also as a reliable clinical decision support tool in critically ill children. To the best of our knowledge, this study represents the first external validation of the FOBAS specifically in critically ill pediatric patients, underscoring its potential to address a significant gap in clinical decision-making within the PICU setting.

The epidemiological findings of our study are consistent with the literature. A total of 94% of the detected foreign bodies were organic in nature, with peanuts and sunflower seeds being the most commonly identified objects. This ratio parallels the findings of Ding et al. (22) (93.5%) and aligns with the conclusions of Bajaj et al. (23), who reported that organic foreign bodies were associated with increased complication risks. Our findings are also important in demonstrating that regional dietary habits may influence the epidemiology of FBA.

PICU patients differ in many aspects from the general pediatric population. In our cohort, the rate of underlying diseases was 48.1%. Particularly, gastroesophageal reflux, cerebral palsy, and aspiration risks were more frequently observed in the negative bronchoscopy group. This indicates that symptoms mimicking FBA due to comorbidities can complicate the diagnostic process. It is clear that conditions such as neurological disorders and reflux make diagnosis more challenging and may affect the performance of FOBAS in these subgroups. As emphasized by Mîndru et al. (24), socio-demographic factors and comorbidities complicate the diagnostic process, thus making objective scoring systems even more critical in the PICU setting.

The literature indicates a lack of standardized and validated clinical algorithms for children presenting with suspected FBA, and most existing protocols are retrospective and limited in nature (25). Our study serves as the first external validation of FOBAS in a PICU cohort and demonstrates a higher predictive value with an AUC of 0.91. This suggests that FOBAS may be a reliable diagnostic tool not only in emergency department admissions but also in intensive care settings.

In the present study, exposure to a foreign body, sudden cough, absence of fever and rhinorrhoea, unilateral wheezing or decreased breath sounds, and radiological findings were all significantly associated with positive bronchoscopy findings. In contrast, choking episodes and stridor were not found to be statistically significant. In the original validation study (14), although stridor and absence of fever/rhinorrhoea did not reach statistical significance, they were included in the score for clinical reasons. Similarly, in our study, stridor was not significant, but absence of fever and rhinorrhoea was significantly associated with positive bronchoscopy. This discrepancy may be explained by the higher prevalence of infectious comorbidities in the PICU. Therefore, the contribution of FOBAS parameters may vary depending on patient characteristics, and absence of fever/rhinorrhoea may become a stronger predictor in the PICU.

Although many parameters showed significance in the univariate analysis, the CIs were wide. Multivariate analysis identified only a history of foreign body exposure and the total FOBAS score as independent predictors. This supports the observation reported in the original study: individual parameters are associated with various clinical situations and have limited discriminative power, whereas the total score offers a much more specific predictor. The high AUC (0.91) and specificity rate (88.5%) observed in our study demonstrate that FOBAS is a strong tool, especially in reducing unnecessary bronchoscopies in the PICU setting.

No FBA cases were identified in the low-risk group (1-3 points), indicating that bronchoscopy may be safely avoided in these patients. The FBA rate in the moderate-risk group (4-6 points) was 60% (n=9/15), which is higher than the original study's 36.6%. In the high-risk group (7-10 points), a positivity rate of 92.8% (n=26/28) was observed, which is largely consistent with the original study's 90%. These data indicate that FOBAS is effective in reducing unnecessary bronchoscopies in the low-risk group and in maintaining strong predictive values in the high-risk group within the PICU setting, while in the moderate-risk group, its performance may vary depending on the patient population.

The diagnostic performance of FOBAS was found to be similar to that reported in the original development study. While Pozailov et al. (14) prospective validation study reported an AUC of 0.89, our PICU cohort yielded an AUC of 0.910. This strong performance is also notable when compared to other scoring systems recently developed in pediatric critical care. Sautin et al. (26) highlighted that the time between suspected FBA and bronchoscopy impacts mortality and emphasized the importance of early diagnosis. Similarly, Zheng et al. (27) identified diagnostic challenges in developing countries through a global epidemiological study and noted the importance of standardized scoring systems in promoting healthcare equity.

In a study by Goodarzy et al. (28), the diagnostic value of chest CT in detecting FBA was assessed, emphasizing the limitations of conventional radiological methods. The CT

sensitivity was 89.2% and its specificity was 76.8%; when compared to FOBAS (sensitivity: 74.3%, specificity: 88.5%), FOBAS showed superior performance as a non-invasive method.

Lee et al. (10) reported C-statistics for current clinical prediction models ranging from 0.74 to 0.88; our findings exceeded the upper limit of this range. That same study identified air trapping (OR: 8.3), unilateral decreased breath sounds (OR: 4.8), and witnessed choking (OR: 3.1) as the strongest predictors of FBA. Similarly, in our cohort, unilateral breath sound reduction (77.1%) and witnessed aspiration (80%) were significantly higher in the positive bronchoscopy group. In a study by Yi et al. (29), a nomogram to predict major postoperative respiratory complications following rigid bronchoscopy was developed and reported an AUC of 0.847. This finding underlines the risks associated with bronchoscopy itself and emphasizes the importance of appropriate patient selection. The high negative predictive value (80%) of FOBAS allows for the safe postponement of bronchoscopy in low-risk patients, thereby reducing such risks.

Among the methodological strengths of our study are the external validation of FOBAS in a different patient population and the implementation of a comprehensive data collection process. The determination of the optimal cut-off value via ROC analysis and the evaluation of its association with clinical outcomes enhance the scientific value of this study. The shared multidisciplinary language provided by FOBAS suggests that it may serve as a practical tool which can facilitate decision-making processes among paediatricians, otolaryngologists, and anaesthesiologists.

However, our study also had several limitations. Due to its retrospective design, there is a risk of bias, and the single-centre experience may limit its generalizability. Although the sample size (54 patients) was adequate according to power analysis, validation in larger cohorts is still necessary. The PICU-specific characteristics of the patient selection (high pre-test probability, severe clinical presentations, coexisting comorbidities) may also have affected our results.

Our study supports the applicability of FOBAS in the PICU setting and presents one of the first datasets in this field. In the future, validation in larger, multicentre prospective studies will be essential in order to confirm these findings across broader populations. The development of a modified version tailored to PICU-specific factors (FOBAS-PICU), along with cost-effectiveness and long-term outcome analyses and integration with artificial intelligence, may further enhance its diagnostic power. Additionally, evaluation of its performance across different age groups and analysis of socioeconomic factors will contribute to its global applicability.

This study demonstrates that the FOBAS is a reliable and valid tool for predicting the presence of foreign bodies in children admitted to the PICU with suspected FBA. The high diagnostic accuracy, with an AUC of 0.910 and a cut-off score of 6.5 providing optimal sensitivity and specificity, supports its use as a clinical decision-making aid in critically ill pediatric patients. The FOBAS system may help reduce unnecessary bronchoscopies while minimizing the risk of missed diagnoses, thus improving both patient safety and resource utilization in intensive care settings. Further prospective, multicentre studies are warranted in order to confirm its utility across different PICU populations and clinical environments.

Study Limitations

Among the primary limitations of this study are its single-center and retrospective design, which may result in unavoidable record deficiencies and information bias. Additionally, the study's limited external validity is attributable to the patient profile specific to a tertiary-level PICU, and the relatively small subgroups contribute to wide CIs in multivariate analyses. Furthermore, the operator-dependent interpretation of bronchoscopy findings heightens the risk of observer variability, particularly in borderline cases. The retrospective nature of the study precludes the assessment of long-term outcomes, symptom recurrence, or cost-effectiveness. Consequently, prospective and multicenter studies are necessary to validate these findings.

Conclusion

The present study has established that FOBAS exhibits high diagnostic accuracy in pediatric patients admitted to the PICU with suspected FBA, and it may serve as a reliable decision-support tool for evaluating the necessity of bronchoscopy. The ability of FOBAS to deliver strong sensitivity and specificity, particularly at a threshold value of ≥6.5, the significant increase in positive bronchoscopy rates within the high-risk group, and its potential to minimize unnecessary interventions in the low-risk group, render the score an effective triage tool that could standardize clinical decision-making processes in intensive care practice. Despite variability observed in the moderate-risk group, the findings indicate that FOBAS is a valuable tool for predicting FBA in PICU patients and underscore the need for the score

to be validated through prospective studies across different centers and larger populations.

Ethics

Ethics Committee Approval: This study was approved by the Non-interventional Clinical Research Ethics Committee of Göztepe Prof. Dr. Süleyman Yalçın City Hospital (approval no.: 2025/0164, dated: 11.09.2025).

Informed Consent: Due to its retrospective nature, individual consent was waived.

Footnotes

Authorship Contributions

Surgical and Medical Practices: M.D., A.A., S.A., Ç.U.D., Concept: M.D., A.A., Design: M.D., Ç.U.D., Data Collection or Processing: M.D., A.A., S.A., Analysis or Interpretation: M.D., AA., Literature Search: M.D., S.A., Writing: M.D., Ç.U.D.

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