RESEARCH

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Ineffective airway clearance: accuracy of clinical indicators in asthmatic children

Desobstrução ineficaz de vias aéreas: acurácia dos indicadores clínicos em crianças asmáticas

Desobstrucción ineficaz de vías aéreas: exactitud de indicadores clínicos en niños asmáticos

Ocília Maria Costa Carvalho[I], Viviane Martins da Silva[I], Rafaela Carolini de Oliveira Távora[I], Marília Viana Araújo[II], Francisca Risoleta Pinheiro[II], Tamires Mesquita de Sousa[II], Marcos Venícios de Oliveira Lopes[I]

[I] *Universidade Federal do Ceará, School of Pharmacy, Dentistry, and Nursing, Postgraduate Program in Nursing. Fortaleza, Ceará, Brazil.*
[II] *Universidade Federal do Ceará, School of Pharmacy, Dentistry, and Nursing, Department of Nursing. Fortaleza, Ceará, Brazil.*

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ABSTRACT

Objective: to analyze the accuracy measurements of clinical indicators of the nursing diagnosis Ineffective airway clearance. **Method:** cross-sectional study with 205 asthmatic children treated in the emergency unit of a hospital in the city of Fortaleza, Ceará. An interview script and pulmonary evaluation were used for data collection. **Results:** the diagnosis of Ineffective airway clearance was present in 89.3% of the sample. The most prevalent clinical indicators were dyspnea, change in respiratory rate, change in respiratory rhythm, orthopnea, adventitious respiratory sounds and ineffective cough. The clinical indicators with highest sensitivity were dyspnea, change in respiratory rate, change in respiratory rhythm, orthopnea and adventitious respiratory sounds. Ineffective cough and adventitious respiratory sounds were the indicators with best specificity. **Conclusion**: the clinical indicator adventitious respiratory sounds was the best predictor of Ineffective airway clearance in asthmatic children treated in emergency units.

Key words: Asthma; Nursing Diagnosis; Child.

RESUMO

Objetivo: analisar as medidas de acurácia dos indicadores clínicos do diagnóstico de enfermagem Desobstrução ineficaz de vias aéreas. **Método:** estudo transversal, realizado com 205 crianças asmáticas atendidas no setor de emergência de um hospital municipal da cidade de Fortaleza – CE. Utilizou-se roteiro de entrevista e avaliação pulmonar para a coleta de dados. **Resultados:** o diagnóstico Desobstrução ineficaz de vias aéreas esteve presente em 89,3% da amostra. Os indicadores clínicos mais prevalentes foram dispnéia, mudança na frequência respiratória, mudança no ritmo respiratório, ortopnéia, ruídos adventícios e tosse ineficaz. Os indicadores clínicos de maior sensibilidade foram dispnéia, mudança na frequência respiratória, mudança no ritmo respiratório, ortopnéia e ruídos adventícios respiratórios. Tosse ineficaz e ruídos adventícios respiratórios foram os indicadores com melhor especificidade. **Conclusão:** o indicador clínico ruídos adventícios respiratórios foi o melhor preditor para desobstrução ineficaz de vias aéreas em crianças asmáticas atendidas em emergência.

Descritores: Asma; Diagnóstico de Enfermagem; Criança.

RESUMEN

Objetivo: analizar las medidas de precisión de indicadores clínicos de diagnóstico de enfermería desobstrucción de la vía aérea ineficaz. **Método:** estudio transversal, con 205 niños asmáticos atendidos en el sector de urgencias de hospital local de Fortaleza-CE, Brasil. Se utilizó guión de entrevista y evaluación pulmonar para recolección de datos. **Resultados:** el diagnóstico de enfermería desobstrucción de la vía aérea ineficaz estaba presente en 89,3% de la muestra. Los indicadores clínicos más frecuentes fueron disnea, cambio en la frecuencia y ritmo respiratorio, ortopnea, ruidos y tos ineficaz. Los indicadores clínicos de mayor sensibilidad

fueron disnea, cambio en la frecuencia y ritmo respiratorio, ortopnea y estertores respiratorios. Tos y estertores respiratorios ineficaces fueron los indicadores con mayor especificidad. **Conclusión:** el indicador clínico estertores clínicos respiratorios fue el mejor predictor para desobstrucción ineficaz de las vías respiratorias en niños asmáticos atendidos en urgencias.
Palabras clave: Asma; Diagnóstico de Enfermería; Niño.

CORRESPONDING AUTHOR **Ocília Maria Costa Carvallho** E-mail: ociliacarvalho@hotmail.com

INTRODUCTION

Asthma is the most common chronic disease in childhood, and it affects approximately 4.8 million children in the world every year. Studies carried out over the last two decades have shown an increase in its incidence, especially in children, and it has become a common cause for treatment in emergency rooms. Its morbimortality is frequently associated with the lack of recognition of its seriousness, inadequate actions and undertreatment[1-2].

These manifestations can be severe and impair respiratory function and alveolar ventilation, which may result in hypoxemia, acidosis and respiratory failure[3]. In view of this situation, intensive care is required from nurses, as well as permanent monitoring and effective and fast interventions.

It is known that the reversible and diffuse inflammatory process of airways caused by asthma is characterized by: edema, bronchospasm and increased mucus production. The symptomatology associated with this process includes cough, dyspnea, wheeze, variable airflow limitation and increased mucus secretion[4]. When these complications occur, the child has difficulties to breathe, to clear secretions and keep the airways unobstructed. These indicators point to the occurrence of respiratory diagnoses in nursing, among which, the Ineffective airway clearance[5].

In order to elaborate this diagnosis, it is essential to perform a careful assessment of the respiratory function and a good clinical reasoning on the manifestations presented. For an accurate identification, clinical indicators with good predictive capability are necessary. In this sense, nurses must focus on the selection of indicators that are more sensitive and specific to a diagnostic conclusion[6].

Therefore, being aware of predictive clinical indicators for a diagnosis of specific population enables nurses to plan their care service, to propose well-founded and specific interventions, and to implement effective and immediate actions in order to solve identified problems.

A recent study conducted with an asthmatic population showed relevant clinical evidence for the definition of the diagnosis Ineffective airway clearance in hospitalized children[7]. However, in a review study on the topic, it was found that few studies have focused on the knowledge of respiratory diagnosis and its elements in asthmatic children[7-10], which seems a paradox due to its epidemiological relevance.

The nurse plays an important role in the care of asthmatic children at different levels of care, either in outpatient, clinical or emergency environments. In emergency units, more complex procedures are adopted for nursing care of patients with breathing disorders. For this reason, emergency nurses must have experience and a deep knowledge of evidence-based nursing care[11].

This study is justified on the grounds of the clinical evidence it produced and that contributes to refine knowledge of clinical indicators with better predictive capability for the nursing diagnosis of Ineffective airway clearance of asthmatic children in emergency situations.

OBJECTIVE

To analyze the accuracy measurements of clinical indicators of the respiratory diagnosis Ineffective airway clearance in asthmatic children treated in emergency units.

METHOD

This is a cross-sectional and quantitative study conducted in the emergency unit of a hospital in the Brazilian city of Fortaleza, Ceará. Subjects of the study were children from both genders, who were diagnosed with asthma, aged between one and five years old, and who were admitted to the emergency unit between April and September 2013. Exclusion criteria were: presence of comorbidities such as pneumopathies, neuropathies or cardiopathies. There were no cases of exclusion.

In order to determine the sample size, the formula indicated for accuracy studies was used: $n = Z^2\alpha.Se(1-Se)/(L^2.P)$ [12], where Z α: the significance level; P: diagnosis prevalence; Se: minimum acceptable sensitivity for each indicator; L: acceptable difference of ratio for sensitivity value; and n: sample size. The confidence level that was considered was 95% (Zα), 80% of sensitivity (Se), 10% of one half of the confidence intervals length (L) and 29.95% of prevalence. The prevalence of the phenomenon was estimated based on studies about nursing respiratory diagnoses in asthmatic children[8-9].

Based on the above parameters, the sample was composed of 205 children, selected for convenience and consecutively.

For data collection, an instrument composed of two parts was used. The first part contained personal identification data such as: gender, origin, medical diagnosis, number of hospitalizations over the last 12 months, date of birth and date of admission of the children studied. The second addressed the review of symptoms (cough, sputum, dyspnea and pulmonary evaluation) and explored the clinical indicators of nursing respiratory diagnoses according to NANDA-I taxonomy II[4].

Data were collected by the researcher and three nursing students of a public university in the northeast of Brazil. An eight-hour workshop was conducted by the researcher prior to the study, in order to review and discuss the propaedeutic methods essential to pulmonary evaluation, the instrument

and the evaluation technique for each clinical indicator present in the studied diagnosis.

It is worth highlighting that for some clinical indicators, the different degrees of manifestation were assessed (namely slight, moderate and severe), aiming to obtain a more detailed analysis of signs and symptoms presented by patients. These indicators were: dyspnea, change in respiratory rate, change in respiratory rhythm, cyanosis, orthopnea, adventitious respiratory sounds, reduced respiratory sounds, lack of cough, ineffective cough and hampered vocalization. This information was made available during the inference process, in order to minimize uncertainties and insecurities regarding the determination of human responses.

Information regarding objective data of pulmonary evaluation was collected directly with the children and included general inspection, palpation, percussion and auscultation, according to the procedures described in the literature. Data on identification and review of symptoms were collected from the children's parents or guardians.

In the data collection instrument, clinical indicators described by the literature as relevant and complementary to pulmonary evaluation[13] and which are not described in NANDA-I taxonomy were added, namely: altered tactile vocal fremitus, increased respiratory sounds and altered chest percussion.

After data collection, a protocol with conceptual and operational definitions of each clinical indicator was adopted. The definitions were used to classify the presence or absence of these indicators. The definitions were created by the authors based on specific literature.

For the diagnostic inference phase, four nurses from the Study Group of Nursing Diagnosis, Interventions and Results of a public university in northeast Brazil were selected. These nurses had a master's degree, publications which included nursing diagnosis, interventions or results and one year of clinical or teaching practice.

The nurses attended an eight-hour training course, in which the following topics were addressed: elements that compose respiratory diagnoses, critical thinking, diagnostic reasoning and diagnostic inference, and clinical characteristics of the population studied. After training, they were submitted to an evaluation for the resolution of 15 fictitious clinical cases, which were randomly applied in three rounds. In the end, the effectiveness (E), false positive rate (FPR), false negative rate (FNR) and tendency (T) were assessed. The cut-off point to consider nurses fit for diagnostic inference were: $E > 0.8$; FPR and FNR ≤ 0.10; T between 0.8 and 1.2[14]. The four nurses obtained acceptable scores for all parameters assessed in the first round.

Diagnostic inference was carried out in October and November 2013, with a summary of data collected in the previous phase, organized in Excel spreadsheets. They contained information related to the presence or absence of clinical indicators and complementary data that aimed to describe the aspects of each indicator. The nurses were divided into two pairs. Each pair was provided with an average of 50 spreadsheets, sent every 15 days, thus making 100 spreadsheets for each pair. The occurrence or not of a diagnosis was determined by the full agreement between each pair of diagnosticians. In situations of disagreement, the pair had to reach a consensus.

Data were organized in charts and submitted to descriptive analysis based on absolute frequency and percentages and in measures of central tendency and dispersion. To analyze the association between categorical variables, Pearson's chi-squared test was applied. Fischer's exact test was applied when expected frequencies of categorical variables were below five. To check normality of numerical data, the Kolmogorov-Sminorv test was used. For diagnostic accuracy, the following measures were calculated: sensitivity, specificity, predictive value (positive and negative), likelihood ratio (positive and negative) and diagnostic odds ratio of clinical indicators, for which a cut-off point of 80% was used. The significance level chosen was 0.05.

The study obtained the assent from the Municipal Health-School System and the Research Ethics Committee of a public university in the northeast of Brazil (protocol number 237.389/13), in compliance with the recommendations of resolution 466/12 regarding human research. The consent of diagnosticians was also requested, as well as that of children's parents and guardians, upon the signature of a Free and Informed Consent Form.

RESULTS

Of the 205 participants, 53.2% were male and 70% had a family history of asthma. Forty percent of these children had been exclusively breastfed for six months. The median age was 36 months and the median family income was BRL 678.00.

The nursing diagnosis Ineffective airway clearance had a high prevalence and was present in 89.3% of children. The clinical indicators dyspnea (99%), change in respiratory rate (91.7%), orthopnea (91.2%), change in respiratory rhythm (90.7%), adventitious respiratory sounds(85.9%) and ineffective cough (62.9%) had a higher prevalence.As for the clinical indicators that were not listed on NANDA-I taxonomy, only altered chest percussion had a rate above 50%, with a prevalence of 53.2%.

Data provided below describe the association between the clinical indicators and the diagnosis Ineffective airway clearance.

Table 1 shows that the following clinical indicators had a statistically significant association with Ineffective airway clearance: change in respiratory rate ($p < 0.001$), change in respiratory rhythm ($p < 0.001$), adventitious respiratory sounds ($p < 0.001$), ineffective cough ($p < 0.001$), reduced respiratory sounds ($p < 0.005$) and orthopnea ($p = 0.006$). Worthy of note that no clinical indicator listed on NANDA-I had a significant association with the discussed diagnosis ($p > 0.05$).

In the following table, accuracy measurements of clinical indicators of the nursing diagnosis Ineffective airway clearance are described (Table 2).

According to the figures presented in Table 2, it was clear that adventitious respiratory sounds was the main clinical indicator for the diagnosis, with significant values of sensitivity (95.43%), specificity (95.45%) and positive predictive value (99.43%). Asthmatic children with this clinical indicator are more likely to present the diagnosis in question (DOR = 495.37).

Table 1 - Association between clinical indicators and the occurrence of Ineffective airway clearance in asthmatic children, Fortaleza, Ceará, Brazil, 2013

Clinical indicators	Ineffective airway clearance		
	Yes	No	p value
Change in respiratory rate			< 0.001**
Presence	173	15	
Absence	10	07	
Change in respiratory rhythm			< 0.001**
Presence	171	15	
Absence	12	07	
Orthopnea			0.006**
Presence	171	16	
Absence	12	07	
Adventitious respiratory sounds			< 0.001**
Presence	175	01	
Absence	08	21	
Reduced respiratory sounds			0.005*
Presence	49	00	
Absence	134	22	
Ineffective cough			< 0.001*
Presence	125	04	
Absence	58	18	
Dyspnea			1.000**
Presence	181	22	
Absence	02	0	
Restlessness			0.335**
Presence	09	02	
Absence	174	20	
Excessive amount of mucus			0.139*
Presence	52	03	
Absence	131	19	
Lack of cough			1.000**
Presence	04	0	
Absence	179	22	
Hampered vocalization			0.060**
Presence	21	0	
Absence	129	20	
Cyanosis			0.092**
Presence	20	0	
Absence	163	22	
Clinical indicators not listed on NANDA-I			
Increased respiratory sounds			0.436**
Presence	04	01	
Absence	179	21	
Altered tactile vocal fremitus			0.239*
Presence	71	06	
Absence	84	13	
Altered chest percussion			0.752*
Presence	98	11	
Absence	85	11	

Note:
** Pearson's Chi-squared test;*
***Fisher's Exact Test*

The clinical indicator ineffective cough was highly significant and had a specificity of 81.82%, a positive predictive value of 96.89%, valid likelihood ratios and an odds ratio of 9.69, which indicates a high predictive value for this indicator to determine an ineffective airway clearance.

The clinical indicators change in respiratory rate and change in respiratory rhythm had high values of sensitivity (94.53% and 93.44% respectively), and a significant value of diagnostic odds ratio, valid likelihood ratios and positive predictive values. This fact suggests that the presence of these indicators increases the probability of Ineffective airway clearance when compared to children who do not have such indicators.

Orthopnea had high values of sensitivity (93.44%), a positive predictive value (91.44%), and valid likelihood ratios. Its presence indicates greater probability of asthmatic children presenting the diagnosis when compared to those who do not have this indicator (DOR = 5.34).

The clinical indicators reduced respiratory sounds, cyanosis, hampered vocalization and lack of cough had a specificity of 100% and a high positive predictive value, showing a good predictive capability of these indicators for the inference of Ineffective airway clearance.

DISCUSSION

The direction of care and the rationale of nursing knowledge in specific clinical situations are based on the use of precise nursing diagnoses. The identification of clinical indicators with good predictive capability directly affects the choice for the diagnosis and the respective interventions[6]. In this sense, the present study identified the most relevant clinical indicators of Ineffective airway clearance in asthmatic children treated in emergency units.

Regarding characterization data, a slight prevalence of the male gender was found (53.2%). Until the age of five, the airway gage is smaller when compared to the female gender, thus

Table 2 - Descrição das medidas de acurácia dos indicadores clínicos do diagnóstico de enfermagem Desobstrução ineficaz de vias aéreas e dos indicadores clínicos não listados na taxonomia NANDA-I em crianças com asma, Fortaleza, Ceará, Brasil, 2013

	Se	Es	PPV	NPV	PLR (IC 95%)	NLR (95%)	DOR (IC 95%)
Clinical indicators							
Dyspnea	98.90	-	89.16	-	0.98[0.97-1.00]	Inf[NaN-Inf]	0[0-NaN]
Restlessness	4.91	90.90	81.82	10.31	0.54[0.12-2.34]	1.04[0.91-1.19]	0.51[0.10-2.56]
Change in respiratory rate	94.53	31.81	92.02	41.17	1.38[1.04-1.84]	0.17[0.07-0.40]	8.07[2.69-24.27]
Change in respiratory rhythm	93.44	31.81	91.93	36.84	1.37[1.02-1.82]	0.20[0.09-0.46]	6.65[2.27-19.41]
Orthopnea	93.44	27.27	91.44	33.33	1.28[0.99-1.66]	0.24[0.10-0.57]	5.34[1.76-16.14]
Excessive amount of mucus	28.41	86.36	94.54	12.66	2.08[0.71-6.11]	0.82[0.68-1.00]	2.51[0.71-8.85]
Adventitious respiratory sounds	95.63	95.45	99.42	72.41	21.04[3.09-142]	0.05[0.02-0.09]	459.37[54.72-3.857.17]
Reduced respiratory sounds	26.77	100.00	100.00	14.10	Inf[NaN-Inf]	0.73[0.67-0.79]	Inf[NaN-Inf]
Lack of cough	2.19	100.00	100.00	10.94	Inf[NaN-Inf]	0.97[0.95-0.99]	Inf[NaN-Inf]
Ineffective cough	68.30	81.82	96.89	23.68	3.75[1.54-9.16]	0.38[0.28-0.51]	9.69[3.14-29.94]
Hampered vocalization	14.00	100.00	100.00	13.42	Inf[NaN-Inf]	0.86[0.80-0.91]	Inf[NaN-Inf]
Cyanosis	10.93	100.00	100.00	11.89	Inf[NaN-Inf]	0.89[0.84-0.93]	Inf[NaN-Inf]
Clinical indicators not listed in NANDA-I							
Increased respiratory sounds	2.18	95.45	80.00	10.50	0.48[0.05-4.11]	1.02[0.93-1.12]	0.46[0.05-4.39]
Altered tactile vocal fremitus	45.80	68.42	92.20	13.40	1.45[0.73-2.87]	0.79[0.56-1.11]	1.83[0.66-5.07]
Altered chest percussion	53.55	50.00	89.90	11.45	1.07[0.69-1.66]	0.92[0.59-1.45]	1.15[0.47-2.79]

Note:
Se = Sensitivity;
Sp = Specificity;
PPV = Positive Predictive Value;
NPV: Negative Predictive Value;
PLR = Positive Likelihood Ratio;
NLR = Negative Likelihood Ratio;
DOR = Diagnostic Odds Ratio;
CI 95% = Confidence Interval of 95%.

increasing the risk of a bronchospasm. It is also known that hyper-reactivity of airways is more common and severe in the male gender[2]. Studies carried out with asthmatic children showed a prevalence of 64.4% and 64.3% for the male gender, which confirms the finding of our study[7,9].

The literature points that the early cessation of breastfeeding increases asthma susceptibility in the first year of life[16], which confirms the findings of the present study: only 40% of children had been exclusively breastfed for six months. The studied children had a median of 36 months of age, which is in line with another study carried out with a similar population, which found an average age of 34.9[10].

The diagnosis Ineffective airway clearance had a prevalence of 89.3%. In certain studies, the prevalence of 66.7% was found for asthmatic children and 100% of Ineffective airway clearance, which supports the findings of our study[8,10]. Contrary to our findings, another study carried out with hospitalized asthmatic children had a prevalence of 55.8% of Ineffective airway clearance[6]. This fact can be explained by the context in which the study was carried out and by the sample size.

A cross-sectional study conducted with 151 hospitalized children diagnosed with acute respiratory infection which sought to identify the prevalence of respiratory diagnoses showed that 37.7% of children developed Ineffective airway clearance[17]. This difference between prevalence values can be explained by factors such as the pathophysiology of the patient's clinical condition and the setting in which the assessments were made.

The clinical indicators associated with Ineffective airway clearance were: change in respiratory rate, change in respiratory rhythm, orthopnea, adventitious respiratory sounds, reduced respiratory sounds and ineffective cough.

Researchers who worked with a similar population showed the same clinical indicators as more relevant for Ineffective airway clearance: ineffective cough, adventitious respiratory sounds, change in respiratory rhythm, change in respiratory rate and dyspnea[7-8]. The high incidence of these signs and symptoms may be attributed to the typical clinical picture of asthma attacks.

During the attack, there is a significant increase in resistance to airflow and, as the obstruction evolves, there is a progressive decrease of tidal volume, which triggers hypoventilation and clinical signs of shortness of breath. The presence of secretion inside airways produce adventitious respiratory sounds when touched by airflow (wheeze, snoring, and crackling). Cough is present, with or without production of mucus. Sometimes mucus is so tightly stuck to narrowed airways that the child is not able to expectorate. The child tries to increase the chest volume in order to have a greater air supply for the lungs in lateral decubitus position and head-elevated prone position[5].

As for accuracy measurements, the indicator adventitious respiratory sounds was the most representative for the inference of Ineffective airway clearance. Just like the present investigation, studies carried out with asthmatic and cardiac patients also showed relevant values for the aforementioned indicator[7-8,18].

The indicator adventitious respiratory sounds can be easily identified in a condition of asthma. Wheeze is one of the clinical signs that compose the triad of symptoms. The collision between air and secretions that result from the increase in mucus produces snoring and cracklings. When the asthmatic child inhales greater volumes of air, wells are hyperinsuflated and cough efficiency is reduced; the inability to expectorate also contributes to the occurrence of ineffective cough[3,5].

Worthy of note that the study was conducted in an emergency unit and in some situations the pulmonary evaluation of the child was made after emergency interventions. These interventions sometimes resulted in a significant improvement of the respiratory pattern of studied children and this might have influenced the results.

The findings of this study can help nurses who work in pediatric emergency units, where there is a high number of asthmatic children. It is essential that nurses be prepared to provide care in this situation of physiological stress in children's body by means of actions that correspond to their specific needs.

CONCLUSIONS

This study allowed for the identification of a prevalence of 89.3% of the diagnosis Ineffective airway clearance in a sample of 205 asthmatic children. Of the clinical indicators studied, those with statistical significance were: change in respiratory rate, change in respiratory rhythm, orthopnea, adventitious respiratory sounds, reduced respiratory sounds and ineffective cough.

The clinical indicators with higher sensitivity were dyspnea, change in respiratory rate, change in respiratory rhythm, orthopnea and adventitious respiratory sounds. Ineffective cough and adventitious respiratory sounds were the best specificity indicators.

Studying the accuracy of clinical indicators of Ineffective airway clearance was relevant, since it gave a direction toward effectiveness in the assessment of clinical indicators, which contributes to the improvement of diagnosis. Also, a population composed of asthmatic children may benefit from this type of study in which more specific clinical evidence is determined.

For the nursing practice, we believe that the knowledge of the diagnostic profile of specific populations may support practice and favor the choice for more adequate nursing actions.

We also highlight that the results presented refer to asthmatic children treated in an emergency unit. In that sense, the mainstreaming of accuracy measurements presented herein to other populations or contexts must be done with special caution.

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