

Instrument for the Stratification of Patients with Community-Acquired Pneumonia in the Emergency Department: its Usefulness in the Prognostic Assessment on Admission

Instrumento para la estratificación de pacientes con neumonía adquirida en la comunidad en el Departamento de Urgencias: su utilidad en la valoración pronóstica al ingreso

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ABSTRACT

Background: Risk stratification of patients with community-acquired pneumonia is a very important process for the comprehensive evaluation of the patient.

Objective: To determine the usefulness of a tool that was created for the stratification of patients with pneumonia in the prognostic assessment on admission. **Materials and Methods:** Descriptive research including 2,203 patients diagnosed with community pneumonia, divided in five series between 2009 and 2020; the mortality rate was calculated according to the stratification class and category. For the statistical analysis, we used the cross-product ratio (*Odds Ratio*) with its 95% confidence interval.

Results: We observed a progressive increase in mortality from mild to severe class, both in the total number of cases (mild: 5%; moderate: 17%; severe: 59%) and in each one of the series. There was statistical significance in the mortality differences between severe and moderate pneumonia (OR 7[5.6;8.6]). In patients who had moderate and severe pneumonia on admission, the mortality in category B was higher than in category A (moderate pneumonia: 18% vs. 11%, OR 1.7[1;2.7]; severe pneumonia: 68% vs. 29%, OR 5.2[3.4;8]).

Conclusions: We have proven the usefulness of the tool in predicting the progression of patients with pneumonia and its importance in guiding the decision-making process. The behavior of the mortality rate in the different strata of the tool supports the purpose envisioned for it.

Key words: Pneumonia; Community-Acquired Infections; Hospital Admission

RESUMEN

Introducción: La estratificación de riesgo del paciente con neumonía adquirida en la comunidad constituye una acción médica de mucho valor en la evaluación integral del enfermo.

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Objetivo: Determinar la utilidad de un instrumento para la estratificación de pacientes con neumonía en la valoración pronóstica al momento del ingreso. Material y métodos: Investigación descriptiva, que abarcó 2203 pacientes con diagnóstico de neumonía comunitaria, divididos en cinco series entre los años 2009 y 2020; se calculó la letalidad por clase y por categoría de estratificación. En el análisis estadístico, se utilizó la razón de productos cruzados (Odds Ratio) con su intervalo de confianza de 95%.

Resultados: Se observó un incremento progresivo de la letalidad desde la clase ligera hasta la grave, tanto para el total de casos (ligera: 5%; moderada: 17%; grave: 59%), como en cada una de las series. Hubo significación estadística en las diferencias en la letalidad entre la neumonía grave y la neumonía moderada (OR 7[5,6;8,6]). En los pacientes con neumonía moderada y en los pacientes con neumonía grave al ingreso, la letalidad fue mayor en la categoría B que en la A (neumonía moderada: 18% vs. 11%, OR 1,7[1;2,7]; neumonía grave: 68% vs. 29%, OR 5,2[3,4;8]).

Conclusiones: Se demostró la utilidad del instrumento empleado en la predicción del curso evolutivo del paciente con neumonía, además de su valor orientador para la toma de decisiones. El comportamiento de la letalidad en los diferentes estratos del instrumento avala la manera en que ha sido concebido.

Palabras clave: Neumonía; Infecciones comunitarias adquiridas; Ingresos hospitalarios

INTRODUCTION

Community-acquired pneumonia (CAP) is an important health problem in Cuba, in the Cienfuegos province, and also on a global level¹⁻¹⁰.

The high incidence and mortality rate of this disease turn it into a challenge for the healthcare systems; other characteristics that contribute to this challenge are the great damage it causes to the elderly^{11, 12}, and the fact that ageing population is one of the features that characterizes many countries in general, and our national and provincial context in particular, from a demographic point of view^{10, 13}.

Efforts to create instruments that allow for the initial prognostic assessment of patients with CAP are not recent¹⁴: some of this working tools, such as the CURB-65 (or its variant, the CRB-65) and the pneumonia severity index (PSI)^{15, 16}, to give just two examples, have been widely used in the most diverse scenarios. We must recognise that most societies of Internal Medicine worldwide have used some of these tools for risk assessment in patients with CAP in the emergency department¹⁷⁻²⁰.

The Internal Medicine Department of our Institution introduced the stratification of patients with CAP in 2001, and used the PSI. But it wasn't a favorable experience, since the stratification index, an indicator used to evaluate the process, decreased progressively and reached very low values. This situation entailed a critical analysis of

the tool that we had been using and, accordingly, the creation and introduction of our own instrument, built from a qualitative approach and called "IENAC" (instrument of stratification of patients with community-acquired pneumonia, for its acronym in Spanish).

Unlike most widely used scales, as the ones already mentioned, the IENAC doesn't have the aim of establishing the patient's prognosis on hospital admission; its function has been to help the general practitioner with the decision-making process regarding treatment behavior and management.

Apart from that function, the purpose for which the IENAC was created suggests a secondary yet evident usefulness in establishing an estimation of what will happen with the patient throughout the course of the disease, considering such prognosis in terms of probability of having a fatal outcome.

The objective of this work was to determine the usefulness of the IENAC in the prognostic assessment of patients with CAP on hospital admission.

MATERIALS AND METHODS

Observational, descriptive-design study including a population of 2,203 hospitalized patients with the same diagnosis of CAP both on admission and discharge, between June 1, 2009 and January 30, 2020, distributed in five series. The diagnosis of pneumonia, verified by the authors, has been based on established clinical, radiological and necropsic (if applicable) criteria^{5, 17, 21}; for the community-acquired

origin, we checked if the patients weren't hospitalized or hadn't been admitted to a hospital 14 days before the onset of symptoms^{3, 22, 23}.

Techniques and Procedures

Information was obtained retrospectively. The authors located and reviewed each patient's medical record, and ensured the presence of clinical and radiological information necessary to do control stratification sampling independent of the stratification performed in the emergency department. In some cases, certain information was clarified directly with the patient or his/her relatives. All the patients were divided into severity strata according to the IENAC criteria.

Description of the IENAC

The IENAC is based on the general practitioner's use of clinical information supplemented with radiological information (Chart 1) in order to classify the patient into one of three classes, according to the severity of the process: mild, moderate or severe pneumonia.

In turn, each class is divided into two categories (A or B), in accordance with specific criteria for each class. In patients with mild pneumonia, the criterion used is the existence or non-existence of some factor of whatever nature that limits or affects the possibility of receiving outpatient treatment. In patients with moderate pneumonia, the criterion is related to the existence of some particularity that increases the probability that the patient shows an unfavorable disease course, even if his/her condition isn't severe at the moment of the initial assessment. In the case of patients with severe

or serious pneumonia, the criterion is related to the analysis of the patient's odds of recovery.

Thus, class and category integration give place to six strata of patients (Chart 2).

Stratification through the IENAC implies the physician's compliance of certain suggestions related to four aspects of the patient's management: the specific area inside the emergency department where the patient is going to receive medical care (urgency with no immediate risk of death, or yellow zone/emergency with immediate risk of death, or red zone); the question as to whether the patient needs to be hospitalized or not; the location of the patient inside the institution, in case he/she needs hospitalization (location in conventional ward or in the intensive care unit); and the empiric antimicrobial to be used initially if there isn't any special situation that justifies another more specific therapeutic approach (Chart 3).

We proceeded with the determination of mortality as an outcome measure in each class and category (strata), according to each series and in the total number of cases. The mortality comparison was made both in the horizontal sense of the instrument (comparison between classes) and in the vertical sense in each class (comparison between categories).

For the statistical processing of data we used the SPSS program, version 15.0 for Windows. Results are shown in tables and graphics, expressed in numbers and percentages.

Statistical analysis

For the statistical analysis of the results, we used the cross-product ratio (*odds ratio*, OR) with its 95% confidence interval.

CHART 1. Classification criteria with the "Instrument of stratification of patients with community-acquired pneumonia" (IENAC)

CLASS I (mild pneumonia)	CLASS II (moderate pneumonia)	CLASS III (severe or serious pneumonia)
<p>Category A (without adverse socio-familial conditions) Patient context:</p> <ul style="list-style-type: none"> • Younger than 60 years. • Good general condition. • Without symptoms of respiratory function compromise. • No pleural effusion. • Discrete lung infiltrate circumscribed to a lobe. • No associated previous chronic or respiratory diseases. • Favorable social and economic conditions and access to medical services 	<p>Category A (low probability of unfavorable evolution) Patient context:</p> <ul style="list-style-type: none"> • Younger than 60 years. • Moderate worsening of general condition. • No symptoms of respiratory function compromise, no impairment of consciousness and no cardiac decompensation. • If there is pleural effusion, it is small. • The chest X-ray doesn't show impairment of more than one lobe. 	<p>Category A (high probability of recovery) Patient context:</p> <ul style="list-style-type: none"> • Any age. • Marked worsening of general condition. • Symptoms and signs of respiratory function compromise; with impairment of consciousness. • The chest x-ray shows impairment of more than one lobe, large or medium-volume pleural effusion. • Underlying disease: None of the diseases included in category B.
<p>Category B (with adverse socio-familial conditions) Patient context:</p> <ul style="list-style-type: none"> • Younger than 60 years. • Good general condition. • Without symptoms of respiratory function compromise. • No pleural effusion. • Discrete lung infiltrate circumscribed to one lobe. • Unfavorable social and economic conditions and access to healthcare services. 	<p>Category B (high probability of unfavorable evolution) Patient context:</p> <ul style="list-style-type: none"> • Any age. • No symptoms of respiratory function compromise, no impairment of consciousness. • Medium-volume pleural effusion, without functional compromise. • There may be impairment of more than one lobe in the chest X-ray. • Previous chronic kidney, cardiac, liver or respiratory diseases, slightly descompensated or with high probability of decompensation. 	<p>Category B (low probability of recovery) Patient context:</p> <ul style="list-style-type: none"> • The same as category A, except for the following: • Associated underlying disease: dementia with impaired functional validism; functional class IV heart failure; grade V CRF (chronic renal failure) without dialysis; advanced chronic liver failure, advanced cancer, severe mental retardation; irreversible bed confinement.

CHART 2. IENAC Strata

Stratum IA	Mild pneumonia without any adverse socio-familial or economic conditions and without any problem with access to healthcare services.
Stratum IB	Mild pneumonia with adverse socio-familial and economic conditions and problems with access to healthcare services.
Stratum IIA	Moderate pneumonia with low probability of unfavorable evolution.
Stratum IIB	Moderate pneumonia with high probability of unfavorable evolution.
Stratum IIIA	Severe pneumonia with high probability of recovery.
Stratum IIIB	Severe pneumonia with low probability of recovery.

CHART 3. IENAC suggestions related to patient management

STRATUM IA Area where the patient is to be attended: yellow zone Behavior: outpatient management	STRATUM IIA Area where the patient is to be attended: yellow zone Behavior: admission to conventional ward	STRATUM IIIA Area where the patient is to be attended: red zone Behavior: admission to the ICU
STRATUM IB Area where the patient is to be attended: yellow zone Behavior: admission to conventional ward	STRATUM IIB Area where the patient is to be attended: yellow zone Behavior: admission to conventional ward	STRATUM IIIB Area where the patient is to be attended: red zone Behavior: admission to conventional ward

Class I (mild pneumonia)	Class II (moderate pneumonia)	Class III (severe or serious pneumonia)
<ul style="list-style-type: none"> – Amoxicillin 500 mg - 1 g every 8 h oral route or cephalexin 500 mg every 6 h oral route. <p>plus</p> <ul style="list-style-type: none"> – Azithromycin 250-500 mg every 12 h oral route. <p>Alternative treatment</p> <ul style="list-style-type: none"> – Crystalline penicillin, 1 million units every 6 h. 	<ul style="list-style-type: none"> – Cefuroxime 750 mg - 1.5 g every 8 h intramuscular or endovenous route, or amoxicillin-sulbactam (Trifamox) 750 mg every 8 h endovenous route. <p>plus</p> <ul style="list-style-type: none"> – Azithromycin 250 mg every 12 h oral route. 	<ul style="list-style-type: none"> – Ceftriaxone 1 g every 12 h endovenous route only associated with azithromycin 250 mg every 12 h oral route. – Cefotaxime 1 g every 8 h endovenous route only associated with azithromycin 250 mg every 12 h oral route. – Amoxicillin-sulbactam (Trifamox) 1.5 g every 8 h endovenous route associated with azithromycin 250 mg every 12 h oral route.

CHART 4. Distribution of patients according to series and severity strata

Serie	Mild pneumonia		Moderate pneumonia		Severe pneumonia	
	Category A	Category B	Category A	Category B	Category A	Category B
Series A (n = 394)	1	1	51	236	16	89
Series B (n = 421)	–	–	24	312	17	68
Series C (n = 421)	1	2	30	298	30	60
Series D (n = 521)	1	3	63	307	50	97
Series E (n = 446)	7	3	26	276	20	114
Total (n = 2203)	10	9	194	1429	133	428

Ethical considerations

Given the characteristics of the study, particular bioethical considerations aren't necessary. However, we have ensured the strictly scientific use of the obtained results and stated opinions. The study was evaluated and approved by the Ethics Committee of the Institution.

Study Limitations

The subjects of the research were patients attended under real healthcare conditions of an emergency department. Almost all the information used for the research has been gathered under those conditions, considering the implications of that situation in its

full reliability and proper registration in the medical report. The authors recognize that the retrospective reconstruction of the patient's condition upon admission for the control stratification, a key procedure for the development of the research, includes inevitable risks with certain degree of inaccuracy that may have influenced the results.

The authors recognize that in the outcome to be measured (mortality) there may be a great diversity of factors, including those related to the intervention of the general practitioner post-admission; these factors are not considered in this study due to the complexity they would imply for the analysis.

RESULTS

Taking into account all the cases of the study, we observed a progressive increase of mortality from the mild to the severe or serious classes (Figure 1). The evident differences observed in the mortality rate of patients with moderate pneumonia versus those with severe pneumonia were statistically significant (OR 7 [5.6;8.6]).

The same behavior was observed in each of the series that form part of the study population (except for series D, in which the order of the mild and moderate series was inverted, conditioned by the low number of patients in the mild class), with significant differences between patients with moderate and severe pneumonia, in all the series (series A: OR 9.2[5.5;15.2]; series B: OR 5.4[3.3;9]; series C: OR 16.2[9.2;28.3]; series C: OR 3.9[2.6;6]; series E: OR 8.5[5.3;13.8]) (Table 1).

In the same way, the three classes showed a higher mortality rate in category B than

in category A (Figure 2); this was significant both in patients with severe pneumonia (OR 5.2[3.4;8]) and those with moderate pneumonia (OR 1.7[1;2.7]).

This analysis between categories (vertical comparison) and classified by study series (Table 2) showed the same mortality behavior for the total number of cases: higher probability of dying in patients from category B than those from category A in each of the five series, regardless of the initial degree of severity (given the low number of patients hospitalized with mild pneumonia, no category comparison was made in this class).

Differences in mortality between categories A and B were statistically significant in patients with severe pneumonia in all the independent series (series A: 6[1.8;19.2]; series B: 7.8[2.2;26.8]; series C: 6[2.2;15.7]; series D: 6.5[2.9;14.4]; series E: 2.7[1;7.4]), which is not the case with patients with moderate pneumonia.

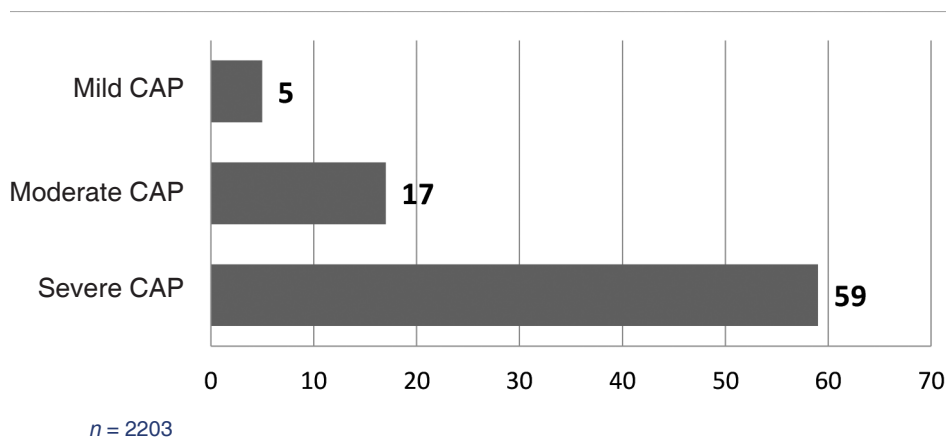
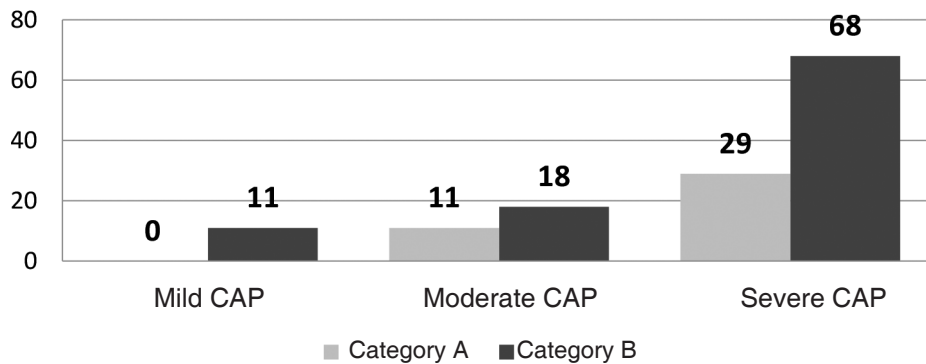


Figure 1. Mortality associated with CAP (in %) according to initial degree of severity.

TABLE 1. Letalidad por NAC según gravedad inicial y serie de estudio

Series	Mild pneumonia		Moderate pneumonia		Severe pneumonia	
	Deceased	Mortality	Deceased	Mortality	Deceased	Mortality
Series A	0	0%	53	18%	71	68%
Series B	–	–	75	22%	52	61%
Series C	0	0%	36	11%	60	66%
Series D	1	25%	75	20%	74	50%
Series E	0	0%	39	13%	75	56%



$n = 2203$

Figure 2. Mortality associated with CAP (in %) according to initial degree of severity and category.

TABLA 2. Letalidad por NAC según gravedad inicial y categoría, por serie de estudio (pacientes con neumonía moderada y grave)

Series	Moderate pneumonia		Severe pneumonia	
	Category A	Category B	Category A	Category B
Series A	12%	20%	31%	74%
Series B	12%	23%	24%	71%
Series C	3%	12%	40%	80%
Series D	19%	21%	22%	65%
Series E	0%	14%	35%	60%

DISCUSSION

The results obtained have revealed an existent close relationship between the probability of dying from CAP and the classification strata of the patient with pneumonia, based on the criteria suggested by the IENAC for patient stratification.

It is necessary to repeat that the IENAC hasn't been essentially created as a tool to establish a prognosis, but as an instrument that guides the physician in the decision-making process related to the patient's management, basing on the patient's classification of severity degree on admission to the emergency department.

However, it is reasonable to assume that patient classification into three classes according to the severity of the disease implies a prognostic element: the patient with mild pneumonia should have a better prognosis than the patient with moderate pneumonia, whereas the patient with severe or serious pneumonia should have a worse prognosis

than the patient with moderate pneumonia. The results obtained from the comparison between classes (horizontal direction of the instrument) confirm this supposition: interestingly enough, in 59% of patients with severe CAP (according to the criteria of the IENAC), the therapeutic intervention was unsuccessful.

As we already explained, apart from the severity assessment of the pneumonic process (which determines the three classes), patient stratification through the IENAC is carried out with other features based on different criteria for each stratum or class, thus determining the formation of categories A and B.

This second stratification into categories also has additional implications in the initial prognostic estimate: hypothetically speaking, patients who belong to category B of whatever class or stratum will have a less favorable prognosis than those of category A of the same class; this supposition is more evident in the moderate and severe classes

due to the specific criteria used to classify them. This supposition was also confirmed with the results obtained from the analysis with a vertical direction of the instrument, that is to say, with the comparison between categories as explained in Figure 3.

During the creation of the initial version of the IENAC, every patient with moderate pneumonia was included in only one stratum, but after studying mortality in this group of patients over time it was possible to identify an excessively high mortality rate for the evolutionary state (not severe) at the moment of the admission. The analysis of this situation allowed us to identify subgroups of patients with different mortality rates but also different features, mainly related to advanced age, radiological extension of the infectious process, the size of the pleural effusion and specially, the presence of comorbidities²⁴.

In the same way, given the high mortality rate of patients with severe pneumonia, we distinguished between two subgroups of patients whose main difference was the probability to overcome the acute disease plus previous conditions generally associated with functional decline and prolonged bed confinement.

In this study, the behavior of mortality we observed in patients who were initially severe and also in those with moderate pneumonia confirms the convenience of defining two categories of patients with different prognosis in both classes; having verified strong differences in terms of mortality between categories A and B of initially severe patients is our unquestionable evidence.

The authors recognize the value of other more widely used tools such as the CURB-65 and the PSI as instruments to establish a prognosis in patients with CAP who are examined to be hospital-

ized. Also the current use and future perspectives of other prognostic factors such as biomarkers (procalcitonin, proadrenomedullin) are being recognized²⁵⁻³⁰.

The results of this research plus the ease of use and feasibility of this instrument (it only uses clinical and radiological information) allow us to propose the IENAC as a tool to be considered particularly in a healthcare context of limited material resources. Thus, the IENAC becomes an alternative to set the stratification of CAP patients in these workplace scenarios.

The robustness of the results obtained is based on the statistical significance achieved in many of the comparisons and also on the consistency and reproducibility of global results in each of the case series that were part of the universe of study. But, the lack of a comparison with other tools for the stratification of CAP patients is considered an additional limitation. Such a comparison would have contributed to the soundness of these results.

To conclude, the tool for the stratification of patients with community-acquired pneumonia attending the emergency department, called IENAC, has shown its usefulness in predicting a favorable or unfavorable outcome at the moment of admission; thus, it becomes a clearly valuable tool for the initial prognostic evaluation, apart from being useful as a guide to the decision-making process related to therapeutic behavior and management.

Also the mortality rate behavior in the different classes and categories (strata) in which patients can be classified through the IENAC is an important element that supports the purpose envisioned for this stratification instrument, in terms of its structure and also the criteria used for placing the patient in each stratum.

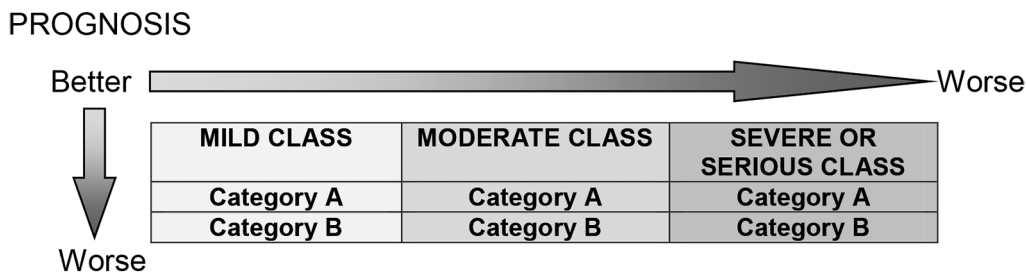


Figure 3. Progression of the prognosis according to class and category.

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