Reliability of a monitoring system for respiratory emergency room admissions

F. Martínez, J. Sunyer, J.M. Antó


ABSTRACT: A respiratory emergency room admissions monitoring system (RERAMS) was set up in Barcelona between 1985-1989, in order to investigate asthma epidemics in the city. Information on emergency room admissions for asthma and chronic obstructive pulmonary disease (COPD) was recorded daily from the four main hospitals of the city. The present study aims at assessing the reliability and coverage of this monitoring system.

Identification of asthma and COPD emergencies was repeated by a reference observer, following the same protocol to extract data as that used by the register. To assess the coverage of the monitoring system, information was collected over 28 randomly selected days, from the emergency room clinical records for the seven additional hospitals in the city with five or more daily emergencies.

Identification of asthma emergencies was highly reliable (kappa value, κ=0.81) as was the discrimination between asthma and COPD diagnoses (κ=0.91). Reliability for emergencies classified as COPD was lower, but still good (κ=0.65). The monitoring system covered 76% and 78% of all Barcelona asthma and COPD emergency room admissions, respectively. Emergency room admissions from our monitoring system did not differ in terms of social and demographic characteristics from emergencies recorded at the other hospitals.

We conclude that the monitoring system for the Barcelona respiratory emergency room admissions was highly reliable, which suggests that, when adequately collected, information from clinical records of respiratory emergencies could be used for environmental epidemiological purposes.

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Ambulatory medical visits [1], in particular visits to hospital emergency rooms, have been used in epidemiology to study the effect of various environmental factors, such as atmospheric pollution [2-4], in addition to detecting asthma epidemics [5-13]. Daily data on emergency room admissions for asthma and chronic obstructive pulmonary disease (COPD) were used in Barcelona, Spain, to monitor epidemics of asthma emergency room admissions [14, 15], in order to investigate the causes of Barcelona asthma epidemics through ecological and case-control studies [16, 17], and to assess the association between air pollution and emergency room admissions for COPD [18].

Monitoring systems for emergency room admissions face certain limitations, since the number of emergencies may be affected by several factors other than the disease occurrence: these include the quality of ambulatory care, access to emergency rooms, previous experience of asthma attacks of patients treated in emergency services, and the patient’s perception of the seriousness of an attack [4, 19]. It is also necessary to recognize that the quality of the diagnoses made in an emergency room can be limited by the availability of adequate complementary tests. In the case of asthma, there is, in addition, the problem of misclassification with other airway diseases, due to the lack of a satisfactory definition [20, 21]. All of these factors reduce the quality of the information generated from emergency services. The effect of these limitations can be minimized, if emergencies are recorded accurately, using operational definitions adapted to the characteristics of the information contained in clinical records of emergency rooms, and if validity and reliability studies are carried out.

The objective of the present study was to measure the reliability of the Respiratory Emergency Room Admissions Monitoring System (RERAMS) of Barcelona. An additional objective was to assess the coverage of this monitoring system in relation to all emergencies in the city. Validity of the register has been assessed in a different study, which shows that a high percentage of those patients identified as asthma emergency room admissions by the register (92%) were patients with asthma (unpublished data).
Material and methods

The respiratory emergency room admissions monitoring system (RERAMS)

In order to study the asthma epidemics occurring in Barcelona, a Collaborative Asthma Group was established. The first step made by this group was to set up a monitoring system in order to identify the emergency room admissions for asthma and chronic obstructive pulmonary disease in the four largest hospitals of the city, during the period 1985–1989. Clinical records of all the emergency room admissions were reviewed by physicians, specially trained to adhere to the protocol of the Collaborative Asthma Group.

A panel of chest-physicians drew up a list of equivalent terms usually used by clinicians to qualify for both diseases. Thus, an emergency room admission for asthma was defined as a visit during which any asthma-related diagnosis was recorded in the diagnosis section of the clinical record. The terms qualifying for asthma were: asthma, severe asthma attack, asthmatic bronchitis, spas tic bronchitis, bronchial hyperreactivity, asthmatic status, wheezing and bronchospasm. The list of terms that would qualify for inclusion as chronic obstructive pulmonary disease were: chronic obstructive pulmonary disease (COPD), COPD exacerbation, chronic respiratory insufficiency, chronic respiratory insufficiency exacerbation, chronic bronchitis, emphysema, cor pulmonale, or chronic airflow limitation.

In order to classify the emergency room admissions, all labels included in the diagnostics section of the clinical records were considered. When the label in the first position was one of those included in the list of equivalent terms, the emergency room admission was classified according to this label. However, if any term equivalent to asthma occurred with a term equivalent to COPD, the patient was classified as COPD irrespective of the relative order. If the first label was a nonspecific diagnostic term, but likely to be related to COPD (e.g. fever, dyspnoea, reinfection), the observer used the rest of the information in the clinical record to classify the admission. Doubtful cases were discussed and classified in consensus meetings (this occurred in less than 1% of cases).

For patients admitted as emergencies with asthma or COPD their age, sex, address, day and hour of arrival and details of their referral or discharge from the emergency room were recorded on an extraction form. Data were collected daily during the period 1985–1987, with a maximum delay of one week. Completeness of data was checked bi-monthly. Data for the period 1988–1989, when the asthma epidemics had disappeared, were collected during 1990 over a three month period.

Reliability study

To assess the reliability of the data, a "reference observer" (a different physician from those who carried out the monitoring) repeated the data collection for three random samples, consisting of all emergencies from 28, 28, and 12 days of the years 1985, 1987, and 1989, respectively. Data collection for the reliability study was carried out during 1990, concurrently with the data collection of the monitoring system for the period 1988–1989. The reference observer used the same protocol and criteria mentioned above for the register, and had the same training as the physicians who had reviewed the clinical records. Measures of agreement between the monitoring system and reference observer were obtained for each of the three samples, in terms of both diagnostic classification and transcription of other variables. Agreement in classifying emergency room admissions according to each diagnostic category ('asthma' versus 'not-asthma', 'COPD' versus 'not-COPD', and 'asthma' versus 'COPD') were calculated. 'Not-asthma' was defined as those emergencies classified as COPD, or as neither asthma nor COPD. Similarly, 'not-COPD' was defined as those emergencies classified as asthma, or as neither asthma nor COPD.

Agreement on the qualitative variables (diagnosis, sex, referral status) was assessed using simple kappa estimates (k) [22], and proportions of agreement (PA) [23], which is an extension of the method of Bland and Altman [24] originally designed for continuous variables. This method measures interobserver variation of categorical variables separately for each category. For quantitative variables (age, time of arrival), the intraclass correlation coefficient was estimated [22]. The significance of the observed values of k and intraclass correlation coefficient was estimated from the methods proposed by Fleiss [22]. For proportions of agreement, 95% confidence intervals were calculated [23].

For the years 1985 and 1987, the reliability study was performed 5 and 3 yrs later, respectively, than the monitoring system data collection. Because of this span of time, some clinical records originally available for the monitoring system were not accessible for the reliability study. Thus, the total number of emergency room admissions for all causes reviewed by the monitoring system was 20% higher than those of the reliability study. This suggests that around 20% of clinical records of emergencies that would qualify for COPD or asthma would be missing. In contrast, in 1989, when data of the system and the study were collected simultaneously there were no missing records.

Coverage study

Emergency room admissions for the seven hospitals in the city that received more than five medical emergencies a day and did not belong to the monitoring system were collected. Data were traced using the same protocol as the monitoring system described above. A sample of 28 days, chosen at random for the year 1989, was selected. For these 28 days the proportion of emergency room admissions collected for the hospitals of the monitoring system over that of all the hospitals was determined. The average daily number of emergencies,
as well as the mean values for characteristics of the patients (sex, age, referral status, hour of arrival) were compared between the monitoring system hospitals and the other hospitals.

Results

1989

During the 12 random days of the year 1989, the total number of emergency room admissions identified either by the monitoring system or by the reference observer was 172; of these 159 were identified by the monitoring system and 157 by the reference observer (Table 1). Of the 172 admissions, 144 were classified as asthma or COPD by both observers, while the remaining 28 were classified by only one. The agreement in classifying "asthma" versus "not-asthma" was excellent (κ=0.81, PA=0.74) (Table 2). For COPD, the value of kappa was lower (κ=0.65), although the proportion of agreement was similar (PA=0.80). Of the 144 emergencies classified by both observers as asthma or COPD, the monitoring system classified a greater number as "asthma" than the reference observer, with a high level of agreement regarding the diagnosis (κ=0.91, PA=0.88); the reference observer classified more emergencies as "COPD" than the monitoring system, also with a high level of agreement (κ=0.91, PA=0.95).

Table 1. Number of emergencies identified classified as asthma or chronic obstructive pulmonary disease (COPD) by respiratory emergency admissions monitoring system (RERAMS) and by the reference observer, years 1985 and 1989

<table>
<thead>
<tr>
<th>Year</th>
<th>Monitoring System</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Asthma</td>
<td>COPD</td>
<td>Not-asthma</td>
<td>Not-COPD</td>
<td>Total</td>
</tr>
<tr>
<td>1985</td>
<td>86</td>
<td>5</td>
<td>22</td>
<td>113</td>
<td></td>
</tr>
<tr>
<td>1989</td>
<td>35</td>
<td>2</td>
<td>5</td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Agreement between respiratory emergency room admissions monitoring system (RERAMS) and reference observer in classifying the diagnosis, years 1985 and 1989

<table>
<thead>
<tr>
<th>Category under study</th>
<th>Reference category</th>
<th>n</th>
<th>%</th>
<th>%</th>
<th>%</th>
<th>Kappa</th>
<th>Proportion of agreement (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>Not-asthma</td>
<td>514</td>
<td>26.5</td>
<td>22.0</td>
<td>86</td>
<td>0.59*</td>
<td>0.55 (0.47, 0.63)</td>
</tr>
<tr>
<td>COPD</td>
<td>Not-COPD</td>
<td>514</td>
<td>56.2</td>
<td>43.6</td>
<td>59</td>
<td>0.20*</td>
<td>0.42 (0.37, 0.47)</td>
</tr>
<tr>
<td>Asthma</td>
<td>COPD</td>
<td>248</td>
<td>36.7</td>
<td>36.7</td>
<td>95</td>
<td>0.91*</td>
<td>0.89 (0.83, 0.95)</td>
</tr>
<tr>
<td>COPD</td>
<td>Asthma</td>
<td>248</td>
<td>63.3</td>
<td>63.3</td>
<td>95</td>
<td>0.91*</td>
<td>0.94 (0.90, 0.98)</td>
</tr>
<tr>
<td>1989</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asthma</td>
<td>Not-asthma</td>
<td>172</td>
<td>23.3</td>
<td>24.4</td>
<td>93</td>
<td>0.81*</td>
<td>0.74 (0.61, 0.87)</td>
</tr>
<tr>
<td>COPD</td>
<td>Not-COPD</td>
<td>172</td>
<td>69.2</td>
<td>66.9</td>
<td>89</td>
<td>0.65*</td>
<td>0.80 (0.73, 0.87)</td>
</tr>
<tr>
<td>Asthma</td>
<td>COPD</td>
<td>144</td>
<td>26.4</td>
<td>25.7</td>
<td>97</td>
<td>0.91*</td>
<td>0.88 (0.78, 0.98)</td>
</tr>
<tr>
<td>COPD</td>
<td>Asthma</td>
<td>144</td>
<td>73.6</td>
<td>74.3</td>
<td>97</td>
<td>0.91*</td>
<td>0.95 (0.91, 0.99)</td>
</tr>
</tbody>
</table>

*: p<0.01 for all kappa indices; COPD: chronic obstructive pulmonary disease; CI: confidence intervals.
For logistical reasons, the reference observer and field-workers from the monitoring system sometimes examined the clinical records for the reliability study at the same time and in the same place. This could have introduced some "contamination" between the repeated observations. As this occurred only in hospitals 1 and 2, and never in hospitals 3 and 4, reliability for each hospital was analysed, with the hypothesis that reliability would be higher in hospitals 1 and 2. The results (table 4) did not confirm this hypothesis, and supported the conclusion that any contamination, if it existed, was of no practical relevance.

Bates et al. [4] described the more important requirements that are necessary to ensure the quality of information provided by emergency monitoring systems. These were: inclusion of more than one hospital to reduce systematic misclassifications and diagnostic classification by the same observer, or if there are several observers, the use of standard criteria and arrangements for facilitating a high degree of communication between them. These conditions were fulfilled by the RERAMS in Barcelona.

The kappa statistic [22] has been widely used to measure the variability of qualitative variables. Unlike other statistics of agreement, this statistic takes into consideration the degree of agreement attributed merely to chance. However kappa has some limitations [23]: categorization of the values of kappa is arbitrary, and when one category contains a small number of observations, agreement is overestimated, even when agreement for the category under study is poor. In contrast to kappa, the proportion of agreement [23] assesses separately the agreement relative to each of the two categories compared. Consequently, when the proportion of the category concerned is low, the value of the estimator is not influenced by the agreement relative to the other category. In our study, the kappa index was higher for the classification of asthma emergencies than for COPD emergencies, whereas the proportion of agreement was higher for the classification of COPD emergencies. These divergences do not modify our conclusions, but show that the kappa index overestimates the agreement for a category with few observations (asthma emergencies in our case) relating to a reference category with a higher number (COPD emergencies).

Hospitals in the monitoring system received a lower proportion of respiratory emergencies (76%) than was reported in earlier publications (90% estimated in 1980) [25]. This could be due to changes in the use of health

Table 3. - Numbers of respiratory emergencies (resp. emerg.) recorded by hospitals included in the respiratory emergency room admissions monitoring system (RERAMS) and by the remaining hospitals, year 1989

| Hospitals | Asthma | COPD | Total 
|-----------|--------|------|-------
| RERAMS | 5.4 (2.3) | 14.4 (5.9) | 44.9 (13.4) |
| Others | 1.7 (1.6) | 4.0 (2.3) | 17.9 (6.1) |
| Total | 7.1 (2.1) | 18.4 (5.1) | 62.8 (11.3) |

Data are presented as mean (sd). COPD: chronic obstructive pulmonary disease.

Table 4. - Agreement between respiratory emergency room admissions monitoring system (RERAMS) and reference observer in classifying the diagnosis, by hospitals, year 1989

<table>
<thead>
<tr>
<th>Category under study</th>
<th>Reference category</th>
<th>Hosp. 1</th>
<th>Hosp. 2</th>
<th>Hosp. 3</th>
<th>Hosp. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma</td>
<td>Not-asthma</td>
<td>0.74</td>
<td>0.85</td>
<td>0.86</td>
<td>0.88</td>
</tr>
<tr>
<td>COPD</td>
<td>Not-COPD</td>
<td>0.68</td>
<td>0.68</td>
<td>0.55</td>
<td>0.60</td>
</tr>
<tr>
<td>Asthma</td>
<td>COPD</td>
<td>0.87</td>
<td>0.95</td>
<td>0.86</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Note: all kappa estimates had p values <0.05. COPD: chronic obstructive pulmonary disease.

Discussion

The main finding of the present study was the high reliability of the Barcelona RERAMS for classifying the emergency visits of patients with asthma and COPD as asthma and COPD. Discrimination between asthma and COPD was also highly reliable. In general terms, the agreement in diagnostic classification between observers was better in 1989 than in earlier years, although agreement in discriminating asthma from COPD was similar for all periods. A possible explanation for the better agreement in 1989, is that both observers classified the emergencies from the same data set in 1989, whereas for 1985 and 1987, the second observer carried out the classification of emergency room admissions 5 and 3 yrs later than the monitoring system. For the later two periods, some of the original medical records used by the monitoring system were not available for the reliability study. By contrast, agreement in the discrimination of asthma from COPD would only be made for the emergencies for which records had been located by the monitoring system and the reference observer. The lower agreement found in 1985 and 1987 may, therefore, be due to lack of records, rather than to the quality of the monitoring system.
services. The absence of differences between the characteristics of the emergencies received by the hospitals in the monitoring system and the other hospitals, however, allows the results of the monitoring system to be extrapolated to the city as a whole.

Monitoring respiratory emergency room admissions has been very useful for identifying and studying asthma epidemics in Barcelona, and for the assessment of the effects of air pollution on health [4, 18]. The present study showed a high consistency in the information provided by our register, especially for the identification of asthma admissions and discrimination between asthma and COPD admissions. This finding indicates that, when carefully collected, data on respiratory emergencies provide an adequate instrument for studies of environmental epidemiology, and it strengthens the findings of research on asthma epidemics in Barcelona by establishing the reliability of the data.

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References