Exacerbations of chronic obstructive pulmonary disease
An analysis of the care process in a regional hospital emergency department

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Abstract
To describe the characteristics of patients visiting a Hospital Emergency Department (HED) due to chronic obstructive pulmonary disease (COPD) exacerbation (AECOPD) and to evaluate their management.

A cross-sectional study of the first 219 patients with AECOPD visiting the HED of the University Hospital Arnau de Vilanova, Lleida, Spain, was performed from January to May 2016. The data collected included the following: main patient characteristics, diagnostic tests, applied treatments, response times, discharge destination, need for hospital admission, and re-admissions and deaths at 90 days. Comparisons were made according to sex and need for hospitalization.

The patients consisted of 84% men, with a mean age (standard deviation [SD]) of 75.9 (11) years and a FEV1/FVC of 56 (13)%; 63% were ex-smokers. The median time (P25–P75) in the HED was 6 (4–10) hours, with shorter waiting times for severe patients. Additionally, 74% of patients required hospital admission. The percentages of re-admissions and mortality at 90 days were 25% and 14%, respectively. Among female patients, 63% never consumed tobacco, and the most frequent clinical phenotype was asthma combined with COPD; female patients visited the family doctor sooner after AECOPD than men (4 vs 7 days). Overall, the following areas of improvement were identified: use of sputum culture (performed in 3% of patients); documentation of variables; patient care times; and reduction in the time until first medical check-up.

The overall quality of care provided to AECOPD patients was satisfactory and consistent with current clinical guidelines. Nevertheless, improving the quality of care at the HED requires establishing protocols that ensure that the necessary diagnostic tests are performed, optimize response times and guarantee that all relevant information is collected.

Abbreviations: AECOPD = chronic obstructive pulmonary disease exacerbation, COPD = chronic obstructive pulmonary disease, ECAP = primary care electronic medical record, GOLD = global initiative for chronic obstructive lung disease, HED = Hospital Emergency Department, HH = home hospitalization, mMRC = Modified Medical Research Council, PC = primary care, SD = standard deviation.

Keywords: care management, chronic obstructive pulmonary disease, chronic obstructive pulmonary disease exacerbation, emergencies

1. Introduction
Chronic obstructive pulmonary disease (COPD) is a progressive and debilitating respiratory condition that leads to significant burden in terms of hospital resources, generating more than 50,000 admissions per year with an average stay of 8.25 days.[1] In Spain, COPD accounts for 10% of all hospital admissions and 2% of all visits to hospital emergency departments (HEDs).[2] However, the quality of care provided in HEDs for COPD exacerbations (AECOPD) is not homogeneous, and usual practice is not always systematic or consistent with the recommendations of the clinical guidelines.[3]

The need for hospital admissions has been of increasing concern. In fact, a study conducted in a Spanish third-level hospital estimated that the rate of unjustified hospital admissions exceeded 17%, mainly due to organizational factors related to the care process.[4]

Different factors influencing the admission and management of COPD patients have been studied,[1] and tools such as the ADIEPOC,[5] that allows for assessment of whether an admission from the HED is needed, have been developed. Similarly, the efficient use of alternative routes to conventional hospitalization, such as home hospitalization programs (HH), has demonstrated a significant impact on hospital dynamics (bed availability) and costs associated with AECOPD while maintaining high patient care and satisfaction standards.[7] Finally, in the area of prevention of new AECOPD, coordination between the different...
areas of care (emergency department, primary care [PC], and specialized hospital care) has proven to be fundamental.\(^\text{[6]}\) The recommendations of national and international guidelines indicate that the first contact with PC should occur within the first 30 days after discharge after AECOPD.\(^\text{[6]}\)\(^\text{[7]}\)

Therefore, a precise characterization of the actual health care situation in each HED would allow for the identification of specific aspects to be improved and is thus necessary to achieve substantial improvements in the care provided to AECOPD patients. These improvements are especially important in HEDs located in low population density regions, which are usually under-studied and experience additional organizational difficulties arising from the large geographic area that needs to be covered. An example of such centers is the University Hospital Arnau de Vilanova de Lleida, Spain, the only referral hospital for 450,000 patients in an extensive territorial area (both urban and rural). Therefore, our objective was to identify the characteristics of the patients visiting the HED due to AECOPD and to evaluate the current management at the health care level, the necessity of hospital admission, and the use of HH and other alternatives to conventional hospitalization, all within the framework of a study to improve AECOPD care.

2. Methods
2.1. Study design and participants
A descriptive cross-sectional study of patients with a diagnosis of AECOPD treated at the University Hospital Arnau de Vilanova de Lleida, Spain, was performed between January 1st and May 31st, 2016. At the time of data collection, all the patients had either a spirometric confirmation of COPD according to the international guidelines or a COPD diagnosis with specific follow-up for COPD in PC or Respiratory department. In the latter case, inclusion required corroboration of the case by the research team based on the information available in the electronic clinical records of the hospital or PC. The exclusion criteria were: presence of any identifiable causes of worsening of symptoms (pneumonia, pneumothorax, decompensated or unrecognized arrhythmia, ischemic heart disease, pulmonary thromboembolism, and left heart failure); need for invasive mechanical ventilation (orotracheal intubation) at the time of first medical care (as patients requiring invasive mechanical ventilation upon arrival at the ED are transferred to the Intensive Care Unit and thus not managed in the ED); or monitoring and control by home care programs or palliative care units.

2.2. Measures
Based on the data available in the electronic medical records of each patient, the following variables were collected: sociodemographic and lifestyle data (age, sex, smoking, and alcohol consumption); comorbidities (age-modified Charlson index); baseline characteristics of COPD (degree of obstruction, basal dyspnea, history of exacerbations during the last 12 months, Global Initiative for Chronic Obstructive Lung Disease [GOLD] 2017 ABCD classification and usual treatment); and AECOPD-related variables (date of onset of symptoms, Anthonisen criteria, previous treatment received, vital signs, pulse oximetry oxygen saturation, inspired oxygen fraction, complementary tests, and pharmacological treatment). The following data were extracted from the Registry of Management of the HED: waiting times; triage category; and destination at discharge. The necessity of hospital admission was evaluated using the ADIEPOC tool used in the Research on Results and Health Services (IRYSS) COPD project\(^\text{[6]}\); this tool takes into account variables such as the partial pressure of oxygen and carbon dioxide in the arterial blood (PaO\(_2\) and PaCO\(_2\), respectively), degree of dyspnea, and level of consciousness. Finally, the following data were obtained from the information available in the primary care electronic medical record (ECAP): time to first PC assessment after AECOPD; number of readmissions at 30 and 90 days; and mortality at 30 and 90 days.

All data were collected by medical research personnel and entered into an anonymized database. The study was approved by the ethics committee of the University Hospital Arnau de Vilanova de Lleida (approval number: 10/2015).

2.3. Statistical analysis
Means (standard deviation [SD]) or medians (P25–P75) were used for continuous variables, whereas categorical variables were reported as the absolute number and percentage. Comparisons were performed between subjects who did and did not require hospitalization after care in the HED. The statistical significance of comparisons was assessed by Chi square test, Student t test, or Mann–Whitney U test, according to the characteristics of each variable. Additionally, stratified analyses according to sex were performed. All contrasts were bilateral, and a value of P < 0.05 was considered statistically significant. All analyses were performed using Stata 12.1 software (StataCorp, College Station, TX).

3. Results
Between January 1st and May 31st, 2016, 250 patients were treated in the studied HED with a diagnosis of AECOPD. Thirty-one patients were excluded (10 for having spirometry measures not compatible with the diagnosis of COPD and 21 because of the presence of a non-COPD predominant respiratory disease). The final sample consisted of 219 patients, 84% of whom were men, the mean age (SD) was 76 (11) years, and the mean (SD) Charlson index was 6.6 (2.1). In the final sample, 81% of patients had mild to moderate obstruction and 19% had severe to very severe obstruction. The mean (SD) number of exacerbations in the year prior to admission was 2.1 (1.7) for mild to moderate exacerbations and 0.9 (1.3) for severe exacerbations. One hundred sixty-one patients (74%) were hospitalized, and only 1% were in HH programs. According to the ADIEPOC tool, no unnecessary hospital admissions occurred, with 4% of admissions classified as doubtful and 96% as justified. The median time (P25–P75) in the HED was 6 (4–10) hours. Sputum culture was requested in only 3% of cases, and an electrocardiogram was performed in 50% of the cases.

Table 1 shows the main characteristics of AECOPD patients treated in the HED, the variables specific to AECOPD, treatment variables and care management depending on whether the patient required hospitalization. No significant differences were observed between the 2 groups regarding the rate of re-consultation at the HED, re-hospitalization, and mortality at 30 and 90 days. Age, FEV\(_1\)/FVC ratio, number of admissions in the previous year, and hypoxemia constituted the main differences between the patients who did and did not require hospitalization. Table 1 also shows the number of patients with complete data for each variable. It should be noted that although the registry was close to 100% for most variables, variables such as respiratory rate were recorded in only 50% of patients.
| Table 1 | Description of the main characteristics and care data of patients with COPD exacerbation depending on admission to the hospital. |
|---|---|
| **n** | **All (n=219)** | **No admission (n=58)** | **Admission (n=161)** | **P-value** |
| **Sociodemographic variables** | | | | |
| Age, y | 219 | 75.9 (11.1) | 72.5 (11.4) | 77.1 (10.8) | .007 |
| Sex | 219 | | | | .910 |
| Men | 184 (84%) | 49 (84%) | 135 (84%) | | |
| Women | 35 (16%) | 9 (16%) | 26 (16%) | | |
| **Comorbidity and lifestyle** | | | | | .227 |
| Tobacco | 218 | | | | |
| Never | 39 (18%) | 11 (19%) | 28 (18%) | | |
| Current smoker | 41 (19%) | 15 (26%) | 26 (16%) | | |
| Ex-smoker | 138 (63%) | 32 (55%) | 106 (66%) | | |
| Alcohol (Units/d) | 200 | 0 (0–2) | 1 (0–2) | 0 (0–1) | .003 |
| Charlson index | 219 | 6.6 (2.1) | 6.3 (2.4) | 6.6 (1.9) | .272 |
| **Baseline COPD variables** | | | | | |
| Clinical phenotype | 211 | | | | .665 |
| Non-exacerbating | 34 (16%) | 9 (16%) | 25 (16%) | | |
| Exacerbating emphysema | 61 (29%) | 17 (30%) | 44 (28%) | | |
| Exacerbating chronic bronchitis | 80 (38%) | 18 (32%) | 62 (40%) | | |
| Asthma/COPD | 36 (17%) | 12 (21%) | 24 (15%) | | |
| Clinical category (GOLD 2017) | 204 | | | | |
| A | 54 (27%) | 15 (28%) | 39 (26%) | .667 |
| B | 4 (2%) | 0 (0%) | 4 (3%) | |
| C | 113 (55%) | 30 (57%) | 83 (53%) | | |
| D | 33 (16%) | 8 (15%) | 25 (16%) | | |
| Bronchiectasis | 209 | 51 (24%) | 12 (22%) | 39 (25%) | .603 |
| Dyspnea, MRC score | 213 | | | | .286 |
| 0/1 | 51 (24%) | 18 (33%) | 33 (21%) | | |
| 2 | 124 (58%) | 28 (51%) | 96 (61%) | | |
| 3 | 36 (17%) | 9 (16%) | 27 (17%) | | |
| 4 | 2 (1%) | 0 (0%) | 2 (1%) | | |
| FVC (% provided) | 184 | 61.1 (18.3) | 62.9 (19.7) | 60.4 (17.9) | .426 |
| FEV1 (%) provided | 184 | 48.2 (19.8) | 51.9 (21.9) | 46.9 (18.9) | .133 |
| FEV1/FVC (%) | 184 | 56.2 (12.7) | 59.5 (13.2) | 55.1 (12.4) | .040 |
| Mild/moderate exacerbations 12 months | 216 | 2.1 (1.7) | 2.1 (1.4) | 2.1 (1.8) | .963 |
| Severe exacerbations 12 months | 211 | 0.9 (1.3) | 0.6 (1.2) | 1 (1.4) | .053 |
| COPD exacerbation variables | | | | | |
| Anthonisen criteria | 219 | | | | |
| Dyspnea | 215 (96%) | 57 (96%) | 158 (98%) | .946 |
| Expectoration | 150 (68%) | 41 (71%) | 109 (68%) | .674 |
| Sputum purulence | 61 (28%) | 17 (29%) | 44 (27%) | .773 |
| Arterial blood gas analysis | 215 | 183 (85%) | 33 (60%) | 150 (94%) | .001 |
| Thorax x-ray performed | 217 | 212 (98%) | 53 (93%) | 159 (99%) | .006 |
| Sputum culture performed | 214 | 6 (3%) | 1 (2%) | 5 (3%) | .591 |
| Blood test performed | 219 | 203 (94%) | 47 (81%) | 156 (99%) | .001 |
| ECG performed | 203 | 102 (50%) | 16 (35%) | 86 (55%) | .014 |
| Respiratory rate | 109 | 27 (8) | 24.8 (8.1) | 28.1 (7.7) | .066 |
| Heart rate | 194 | 95 (19) | 91.1 (19.5) | 96.5 (18.6) | .082 |
| Systolic blood pressure | 192 | 137 (28) | 134.4 (22.6) | 137.6 (20.6) | .481 |
| Diastolic blood pressure | 192 | 74 (13) | 74.6 (11.7) | 73.4 (13.4) | .554 |
| \(\text{SpO}_2\) | 193 | 92 (6) | 94.4 (4.3) | 90.5 (5.9) | .001 |
| | | | | | |
| Exacerbation treatment | | | | | |
| Oxygen therapy | 162 | 149 (92%) | 33 (83%) | 116 (96%) | .011 |
| VMNI | 87 | 20 (23%) | 0 (0%) | 20 (32%) | .002 |
| Inhaled therapy | 160 | 160 (96%) | 38 (80%) | 122 (90%) | .001 |
| Antibiotic | 111 | 70 (63%) | 10 (38%) | 60 (71%) | .003 |
| Corticoids | 130 | 104 (80%) | 17 (55%) | 87 (66%) | .001 |
| Care management | | | | | |
| Time spent in ER | 219 | 6 (4.3–9.7) | 6 (4.2–8) | 5.9 (4.3–12) | .254 |
| Destination after discharge | 219 | | | | .001 |
| Home | 53 (24%) | 53 (91%) | 0 (0%) | | |
| Pneumology | 27 (12%) | 0 (0%) | 27 (17%) | | |
| Internal medicine | 97 (44%) | 0 (0%) | 97 (60%) | | |
| Geriatrics | 35 (16%) | 0 (0%) | 35 (22%) | | |
| Home hospitalization | 2 (1%) | 1 (2%) | 1 (1%) | | |
| Nursing home | 3 (1%) | 2 (3%) | 1 (1%) | | |
Table 2 presents the same data according to sex. The majority of women who visited the HED had never consumed tobacco (63%), and their most frequent clinical phenotype was asthma/COPD overlap. In addition, women visited their family doctor 3 days earlier after AECOPD onset than men (3.8 vs 6.8 days, P-value = 0.048).

Finally, Table 3 shows the patients’ attendance times and triage levels. The median (P25–P75) time elapsed between arrival to the HED and the triage was 7 (4–11) minutes, and the time between triage and the beginning of the medical care was 38 (15–82) minutes. The waiting times were shorter for more severe patients.

4. Discussion

In this study, which included 219 patients treated for AECOPD in the HED of the University Hospital Arnau de Vilanova de Lleida, multiple facets of the health care situation were described in detail, including: characteristics of the patients; performed diagnostic tests; applied treatments; main care management characteristics including response times, destination at discharge, and need of hospital admission; and finally, a review of the case at the first medical control visit to PC. While men exhibited a median of 7 days until their first visit, in women, this time was reduced to 4 days. This difference suggests the need for focused actions directed towards men to reduce the time until the first PC control visit.

4.2. AECOPD and sex influences

The volume of female patients evaluated in our HED was similar to that reported in previous studies. However, some of the characteristics are worth noting; first, there was a high proportion of women who had never smoked (63%), and asthma/COPD overlap was the most usual phenotype. Although no significant differences were found between men and women in terms of systematic care (diagnostic tests, treatments applied, response times, admission adequacy, re-admissions, and deaths), a significant difference was found in the time elapsed between discharge and the first medical control visit to PC. While men exhibited a median of 7 days until their first visit, in women, this time was reduced to 4 days. This difference suggests the need for focused actions directed towards men to reduce the time until the first PC control visit.

4.3. Care management

One of the priorities of our project was to identify areas for improvement that could reduce patient care times. Patients with AECOPD exhibited an average of 38 minutes between the assessment by the nursing staff in triage and the beginning of medical care. To date, no relevant study has evaluated the attendance times for AECOPD. However, according to the recommendations of the Catalan Health Institute, the mean waiting time of patients with a triage degree of II–III should not exceed 45 minutes. One possibility for improving attendance times might be to incorporate an advanced triage system, in which nursing staff has the ability to initiate the necessary diagnostic tests after the usual prioritization of patients but prior to the first contact with HED physicians. This type of methodology would allow for the efficient use of patients’ waiting time, making the results of key diagnostic tests available to emergency physicians from the moment that they evaluate the patient. Advanced triage systems have previously been used for medical problems such as thoracic and abdominal pain,
Table 2
Description of main characteristics and care data of patients with COPD exacerbation depending on patient sex.

|                       | Men                        | Women                       | P-value |
|-----------------------|----------------------------|-----------------------------|---------|
| Sociodemographic variables |                            |                             |         |
| Age, y                | 76 (11)                    | 75.2 (11.8)                 | .700    |
| Comorbidity and lifestyle |                            |                             |         |
| Tobacco               |                            |                             | <.001   |
| Never                 | 17 (9%)                    | 22 (63%)                    | .358    |
| Current smoker        | 36 (20%)                   | 5 (14%)                     | .301    |
| Ex-smoker             | 130 (71%)                  | 8 (23%)                     | .215    |
| Alcohol (Units/d)     | 0 (0–2)                    | 0 (0–4)                     | .002    |
| Charlson index        | 6.6 (2.1)                  | 6.4 (2)                     | .524    |
| Baseline COPD variables |                            |                             |         |
| Clinical phenotype    |                            |                             | <.001   |
| Non-exacerbating      |                            |                             |         |
| Bronchiectasis        | 46 (26%)                   | 5 (15%)                     | .150    |
| AECOPD                | 20 (11%)                   | 16 (48%)                    | .536    |
| Clinical category (GOLD 2017) |              |                             |         |
| A                     | 44 (26%)                   | 10 (32%)                    | .220    |
| B                     | 4 (2%)                     | 0 (0%)                      | .308    |
| C                     | 95 (55%)                   | 18 (58%)                    | .220    |
| D                     | 30 (17%)                   | 3 (10%)                     | .340    |
| Bronchiectasis        | 46 (26%)                   | 5 (15%)                     | .150    |
| Dyspnea, MRC score    | 0.1/1                      | 44 (25%)                    | .611    |
| 0/1/2                 | 101 (56%)                  | 23 (68%)                    | .219    |
| 3                     | 32 (18%)                   | 4 (12%)                     | .357    |
| 4                     | 2 (1%)                     | 5 (1%)                      | .758    |
| FEV1 (% predicted)    | 60.5 (17.7)                | 64.8 (21.4)                 | .220    |
| FEV1/FVC (%)          | 46.7 (18.9)                | 56 (22.3)                   | .017    |
| Mild/moderate exacerbations 12 months | 55.3 (12.9)                | 60.7 (10.6)                 | .034    |
| Severe exacerbations 12 months | 2.1 (1.7)                 | 2.5 (1.9)                   | .228    |
| COPD exacerbation 12 months | 0.9 (1.3)                  | 0.6 (1.3)                   | .258    |
| Anthonisen criteria   |                            |                             |         |
| Dyspnea               | 181 (98%)                  | 34 (97%)                    | .619    |
| Expectoration         | 127 (69%)                  | 23 (66%)                    | .699    |
| Sputum purulence      | 52 (28%)                   | 9 (26%)                     | .758    |
| Arterial blood gas analysis | 156 (86%)                | 27 (79%)                    | .308    |
| Thorax x-ray performed | 179 (98%)                  | 33 (94%)                    | .142    |
| Sputum culture performed | 5 (3%)                    | 1 (3%)                      | .958    |
| Blood test performed  | 175 (96%)                  | 31 (89%)                    | .134    |
| ECG performed         | 43 (49%)                   | 19 (53%)                    | .357    |
| Respiratory rate      | 27.5 (7.7)                 | 26.8 (8.4)                  | .706    |
| Heart rate            | 95.5 (20)                  | 93.4 (13.4)                 | .562    |
| Systolic blood pressure | 136.6 (28.6)              | 137.4 (24.7)                | .885    |
| Diastolic blood pressure | 73.6 (13.2)               | 73.9 (12.1)                 | .899    |
| SpO2                  | 91.7 (5.2)                 | 90.9 (7.3)                  | .443    |
| Exacerbation treatment |                            |                             |         |
| Oxygen therapy        | 122 (91%)                  | 27 (96%)                    | .340    |
| VMNI                  | 17 (22%)                   | 3 (33%)                     | .436    |
| Inhaled therapy       | 131 (95%)                  | 29 (100%)                   | .215    |
| Antibiotics           | 60 (65%)                   | 10 (53%)                    | .301    |
| Corticoids            | 84 (79%)                   | 20 (87%)                    | .358    |
| Care management       |                            |                             |         |
| Time spent in ER      | 6 (4.3–9.6)                | 5.6 (4.3–9.9)               | .983    |
| Destination after discharge |                    | 3.98                        |         |
| Home                  | 45 (24%)                   | 8 (23%)                     | .308    |
| Pneumology            | 21 (11%)                   | 6 (17%)                     | .467    |
| Internal medicine     | 80 (43%)                   | 17 (49%)                    | .268    |
| Geriatrics            | 31 (18%)                   | 2 (6%)                      | .821    |
| Home hospitalization  | 1 (1%)                     | 1 (3%)                      | .821    |
| Nursing home          | 2 (1%)                     | 1 (3%)                      | .821    |
| Deseased              | 2 (1%)                     | 0 (0%)                      | .688    |

Case revision

| Appropriateness of admission | Justified | Doubtful | Unjustified | P-value |
|------------------------------|-----------|----------|-------------|---------|
| 137 (90%)                    | 24 (83%)  | .294     |
| 16 (10%)                     | 5 (17%)   | .265     |
| 0 (0%)                       | 0 (0%)    | .017     |

Time until next emergency
- <72 hours: 31 (17%) vs. 4 (12%), P = .423
- ≥72 hours: 47 (26%) vs. 6 (18%), P = .317
- <30 days: 17 (9%) vs. 4 (11%), P = .687
- ≥30 days: 25 (14%) vs. 5 (15%), P = .871

Re-entry at 30 days
- 7.4 (5) vs. 6.3 (2.5), P = .265

Re-entry at 90 days
- 6.8 (8.2) vs. 3.8 (4.7), P = .048

*Chi-squared test, Student’s T-test, Mann-Whitney U test, as appropriate.

5. Conclusions

The quality of care provided to AECOPD patients in the HED was satisfactory and consistent with current clinical guidelines. However, the following potential areas of improvement were identified: realization of sputum cultures when required; documentation of variables; patient care times; and time to first PC medical follow-up. Therefore, the improvement in quality of care involves establishing protocols at the HED level to ensure...
that the necessary diagnostic tests are performed, optimize response times, and ensure the correct documentation of all information. Likewise, the need to establish more effective coordination mechanisms between the HED and PC to ensure appropriate post-discharge follow-up and to prevent future exacerbations was evident.

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