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Treatment of COPD Exacerbation in Switzerland: Results and Recommendations of the European COPD Audit

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Keywords

Chronic obstructive pulmonary disease · Switzerland · Exacerbation · GOLD · ERS · Europe · Audit · Therapy · Bundle · Recommendations

Abstract

Background: The European COPD Audit initiated by the European Respiratory Society (ERS) evaluated the management of hospital admissions due to exacerbation of chronic obstructive pulmonary disease (COPD) in several European countries. Data on the treatment of severe acute exacerbations of COPD (AECOPDs) in Switzerland are scarce. ***Objectives:*** In light of the GOLD 2010 guidelines, this work aims to examine the quality of care for AECOPD and to provide specific recommendations for the management of severe AECOPD in Switzerland. ***Methods:*** A total of 295 patients requiring hospital admission to 19 Swiss hospitals due to exacerbation of COPD during a predefined 60 days in 2011 were included in the study. We compared the Swiss data to the official GOLD 2010 recommendations and to the results of the other European countries. ***Results:*** Approximately 43% of the Swiss patients with severe AECOPD were current smokers at hospital admission, compared to 33% of the patients in other European countries ($p < 0.001$). In Switzerland and in Europe, spirometry data were not available for most patients at hospital admission (65 and 60%, respectively; $p = 0.08$). In comparison to other European countries, anti-

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biotics were prescribed 14% less often in Switzerland ($p < 0.001$). Only 79% of the patients in the Swiss cohort received treatment with a short-acting bronchodilator at admission. ***Conclusions:*** Considering the overall high standard of health care in Switzerland, in light of the GOLD 2010 guidelines we are able to make 7 recommendations to improve and standardize the management of severe AECOPD for patients treated in Switzerland.

Introduction

Chronic obstructive pulmonary disease (COPD) remains associated with high morbidity and mortality. According to the World Health Organisation (WHO), in 2020 COPD will rank fifth worldwide in burden of disease. Furthermore, it is a leading cause of death and expected to become the seventh leading cause of disability-adjusted life years lost [1, 2]. In Switzerland, around 200,000–300,000 patients suffer from COPD of GOLD (Global Initiative for Chronic Obstructive Lung Disease) stage II or higher [3].

Many COPD patients experience exacerbations of the disease. The GOLD defines COPD exacerbation as "an acute event characterized by a worsening of the patient's respiratory symptoms that is beyond normal day-to-day variations and leads to change of the medication" [4]. The clinical presentation for exacerbations of COPD is heterogeneous and can be triggered by infectious and non-infectious conditions. Determining the cause of the exacerbation is challenging, and thus far there are no tools capable of diagnosing or predicting the duration of an acute exacerbation of COPD (AECOPD) [5]. AECOPDs requiring hospital admission are considered to be severe and are associated with increased mortality [6] as well as with an increased mortality risk of 30–43% within the 12 months following the AECOPD [6–8]. There is a direct correlation between the number of severe AECOPDs and the mortality rate among hospitalized patients with COPD [9]. The administration of noninvasive ventilation (NIV) to hypercapnic patients decreases the mortality rate by 21% [10], which strongly suggests that in-hospital management directly influences the prognosis of patients with severe AECOPD. Therefore, it is of paramount importance to provide adequate and comprehensive treatment to this severely affected patient population.

The European COPD Audit initiated by the European Respiratory Society (ERS) in collaboration with the Forum of European Respiratory Societies (FERS) aimed to monitor the management of severe AECOPD in 13 European countries (Austria, Belgium, Croatia, Greece, Malta, Poland, Ireland, Romania, Slovakia, Spain, Switzerland, Turkey, and the UK) [11–13]. In Switzerland, patients were recruited from 19 hospitals distributed throughout 13 Swiss cantons.

Data on the management of AECOPD in Switzerland are scarce. Thus, the aim of this study was to examine the quality of care for AECOPD in Swiss hospitals in light of the GOLD 2010 guidelines and to provide specific recommendations for the management of severe AECOPD in Switzerland.

Materials and Methods

The study was classified as a quality control study by the Ethics Committee of Basel (307/10), and as such, no patient consent was required.

The full methodology of the study has been reported [12]. Patients requiring hospital admission due to AECOPD during a predefined 2-month period in 2011 at 19 Swiss hospitals (Kantonsspital Aarau, Universitätsspital Basel, St. Claraspital Basel, Spital Bern-Tiefenau, Inselspital Bern, Kantonsspital Chur, Kantonsspital Liestal, Kantonsspital Bruderholz, Spitalzentrum Biel, Spital Laufenburg, Lungenpraxis Hirslanden – Klinik St. Anna Luzern, Luzerner Höhenklinik Montana, Zuger Kantonsspital, Bürgerspital Solothurn, Kantonsspital St. Gallen, Spital Thun, Kantonsspital Münsterlingen, GZO Spital Wetzikon, and Lungenzentrum Hirslanden Zürich) were considered eligible for the study. The inclusion and exclusion criteria have been reported previously [12]. In short, patients who were admitted to the hospital for ≥12 h with a senior clinician-made diagnosis of COPD exacerbation or any other synonym, confirmed at discharge by the investigator/audit lead, and patients who were admitted to the hospital for ≥12 h with a respiratory cause of admission as indicated by the discharge report and a history compatible with COPD were included in the study. Most of the Swiss hospitals from which patients were recruited were located in the German-speaking areas of Switzerland. The hospital catchment population was 3,524,177 citizens [12].

The cases were examined by a respiratory specialist in charge of the emergency ward. When an exacerbation was identified, detailed demographic and medical history data were collected and entered into a Web-based application. Data collection and imputation were standardized and centrally managed by a trained professional. The follow-up period was 90 days. Figure 1 depicts the flowchart for patient inclusion in the study.

The following GOLD recommendations were investigated according to the European COPD Audit Study data: (1) symptoms; (2) arterial blood gas results; (3) chest radiograph results; (4) medical treatment; (5) oxygen therapy; and (6) type of mechanical ventilation [12].

Statistical Analysis

Differences in dichotomous variables were evaluated using the χ^2 test or Fisher's exact test, as appropriate. Normally distributed parameters were analyzed using the Student *t* test for equality of

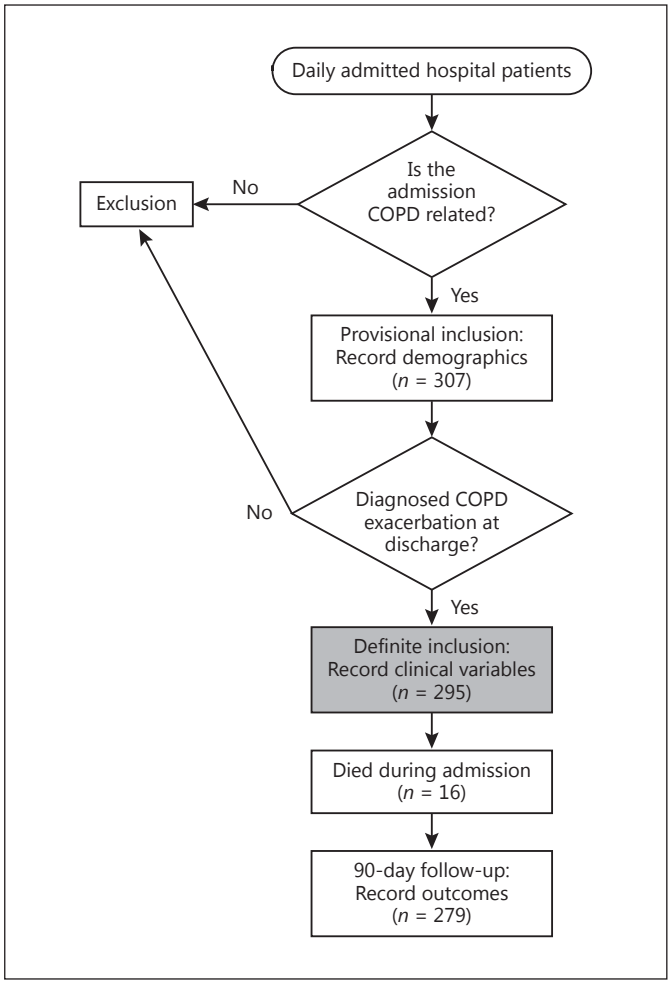

Fig. 1. Flowchart depicting patient inclusion. COPD, chronic obstructive pulmonary disease.

means. All other continuously nonnormally distributed parameters were evaluated using the nonparametric Mann-Whitney U test or the Kruskal-Wallis test, as appropriate.

The Statistical Package for the Social Sciences (SSPS Inc., version 19 and 23 for Windows) was used. All tests were two-tailed; a p value of <0.05 was considered significant. The results are expressed as mean (standard deviation) or median and interquartile range, unless otherwise stated.

Results

Patient Characteristics

A total of 307 Swiss patients were included in the database, and the data on 295 patients were analyzed (Fig. 1). Six of the discharged patients had been misdiagnosed, 1 died, 1 left within the first 12 h of hospitalization, 3 were moved to a nonparticipating hospital, and 1 had an incorrect admission date. The other European countries included 15,723 patients. The patient characteristics for Switzerland and the other European countries are presented in Table 1.

In the Swiss cohort, there were 165 (55.9%) male patients, the mean age was 70.7 years (SD 12), the average body mass index was 25 (SD 6.5), and the mean forced expiratory volume in 1s (FEV_1) was 44.8% predicted (SD 19). A total of 43.1% (122/283) of the Swiss patients with an AECOPD were classified as smokers at hospital admission, in contrast to 32.8% (4,890/14,898) in the other European countries ($p < 0.001$). The main symptoms in both the Swiss cohort and the cohorts of the other European countries were increased dyspnea (92.5 vs. 97.1%; $p < 0.001$) and increased sputum volume (49.3 vs. 68.9%; $p < 0.001$). Most of the patients requiring hospitalization for AECOPD suffered from GOLD stage III COPD (50.7% in Switzerland vs. 45.5% in Europe; $p = 0.391$).

The most frequent comorbidities are shown in Figure 2. Congestive heart failure ($p < 0.001$), metastatic solid malignancy ($p < 0.001$), dementia ($p < 0.001$), and renal disease ($p < 0.001$) were significantly more common in the Swiss patients than in the patients from the other European countries. Conversely, myocardial infarction ($p < 0.001$), cerebrovascular disease ($p = 0.006$), and ulcer disease ($p = 0.011$) were more common in the other European countries than in Switzerland.

Organization and Resources

The organization and resources of the hospitals caring for AECOPD patients in Switzerland and in other countries of Europe are depicted in Table 2. The resources of the Swiss hospitals were superior or equivalent to those of the other European hospitals in several categories (Table 2). NIV was available in 100% of the participating Swiss hospitals compared to 86.9% of the hospitals in the other European countries ($p = 0.417$). In 94.7% of the Swiss hospitals, a high dependency unit was available, compared to 47.1% of the hospitals in the other European countries ($p = 0.001$). In Switzerland, patients have access to a pulmonary rehabilitation program in 89.5% of the participating hospitals, compared to 48.1% of the participating hospitals in the other European countries ($p = 0.004$). There were also significant differences in the types of rehabilitation program offered, with home-based therapy being the most prominent program offered in Switzerland compared to the other European countries (68.4 vs. 4.8%). A hospital-based program was the main therapy in the other European countries compared to Switzerland (17.7 vs. 5.3%).

Table 1. Patient characteristics

Characteristics	Switzerland		Europe		*p*
	n or mean (% or SD)	patients, *n*	*n* or mean (% or SD)	patients, *n*	
Total patients	100%	295	98.2%	15,723	0.068
Age, years	70.7 (12.1)	295	70.8 (10.7)	15,721	0.915
Male gender	165 (55.9)	295	10,700 (68.1)	15,723	<0.001
Height, cm	166.8 (8.0)	251	165.7 (9.0)	9,307	0.046
Weight, kg	70.1 (18.6)	274	73.2 (18.8)	9,449	0.007
BMI	25.0 (6.5)	250	26.7 (6.4)	9,139	<0.001
Smoking status					
Smoker	122 (43.1)	283	4,890 (32.8)	14,898	<0.001
Ex-smoker	138 (48.8)	283	9,179 (61.6)	14,898	<0.001
Never-smoker	23 (8.3)	283	829 (5.6)	14,898	0.085
Pack-years	54.9 (24.3)	109	53.2 (28)	3,777	0.538
Symptoms					
Dyspnea increased	273 (92.5)	295	15,136 (97.1)	15,584	<0.001
Sputum increased	145 (49.3)	294	10,228 (68.9)	14,834	<0.001
Sputum color change	109 (37.8)	288	8,025 (56.0)	14,332	<0.001
ABGA					
Taken	238 (85.6)	278	12,953 (84.1)	15,397	<0.001
pH	7.40 (0.078)	233	7.40 (0.074)	12,808	0.813
HCO_3, mmol/L	26.5 (4.7)	228	28.1 (5.2)	12,207	<0.001
pO_2, kPa	9.4 (4.9)	237	8.6 (3.4)	12,826	0.015
pCO_2, kPa	6.1 (2.1)	236	6.4 (2.2)	12,833	0.033
Spirometry					
FVC, % predicted	69.6 (21.4)	144	65.4 (20.4)	8,863	0.014
FEV_1, % predicted	44.8 (19.0)	186	44.0 (17.4)	9,089	0.573
FEV_1/FVC, % predicted	58.0 (16.7)	148	53.6 (15.3)	9,064	0.002
X-ray result					
Normal	59 (20)	295	3,496 (22.3)	15,700	0.0181
Bronchiectasis	5 (1.7)	295	867 (5.5)	15,700	0.007
Hyperinflation	76 (25.8)	295	5,331 (34.0)	15,700	0.007
Consolidation	71 (24.1)	295	2,898 (18.5)	15,700	0.013
Pleural effusion	29 (9.8)	295	426 (2.7)	15,700	<0.001
Lung cancer	5 (1.7)	295	394 (2.5)	15,700	0.175
GOLD stage					
1	5 (3.4)	148	190 (2.4)	8,057	0.45
2	31 (20.9)	148	2,144 (26.5)	8,057	0.12
3	75 (50.7)	148	3,662 (45.5)	8,057	0.391
4	37 (25)	148	2,061 (25.6)	8,057	0.775

BMI, body mass index; ABGA, arterial blood gas analysis; FVC, forced vital capacity; FEV_1, forced expiratory volume in 1 s.

Pharmacological Treatment for COPD before Admission, during Hospitalization, and after Discharge

The prescribed pharmacological therapy for COPD before, during, and after hospital admission in Switzerland and the other European countries is presented in Table 3. Differences were noted in the frequency of theophylline administration before admission (3.7 vs. 16.6%; $p < 0.001$), during hospitalization (1.0 vs. 14.5%; $p < 0.001$), and after discharge (3.1 vs. 20.2%; $p < 0.001$) be-

Table 2. Organization and resources

Characteristics	Switzerland		Europe		
	n (%)	hospitals, *n*	*n* (%)	hospitals, *n*	*p*
ICU available	17 (89.5)	19	370 (91.4)	405	0.928
Spirometry available	18 (94.7)	19	400 (98.8)	405	0.471
Respiratory physician on call every day	15 (78.9)	19	195 (48.1)	405	0.061
Respiratory ward available	13 (68.4)	19	332 (82.0)	405	0.455
Respiratory team available	17 (89.5)	19	363 (89.6)	405	0.945
Respiratory outpatient clinic available	18 (94.7)	19	362 (89.8)	403	0.808
Respiratory outpatient clinic for COPD	13 (68.4)	19	248 (61.5)	403	0.717
Respiratory specialists available*	3.0 (2.1)	19	6.5 (6.9)	403	<0.001
Respiratory physiotherapists available*	5.8 (6.7)	19	1.9 (2.1)	403	0.02
Specialty triage for COPD operated	6 (31.6)	19	129 (32.0)	403	0.925
High dependency unit available*	18 (94.7)	19	190 (47.1)	403	0.001
Seen by physiotherapists*	79.2 (25.8)	12	52.3 (40.7)	336	0.004
Seen by a respiratory specialist	67.1 (30.7)	17	69.5 (33.7)	371	0.772
NIV available	19 (100)	19	359 (89.1)	403	0.417
Invasive mechanical ventilation available	17 (89.5)	19	303 (75.2)	403	0.469
Pulmonary rehabilitation program available*	17 (89.5)	19	194 (48.1)	403	0.004
Hospital-based pulmonary rehabilitation*	1 (5.3)	19	70 (17.7)	395	<0.001
Home-based pulmonary rehabilitation*	13 (68.4)	19	19 (4.8)	395	<0.001
Early discharge program available	7 (36.8)	19	128 (31.8)	403	0.875
Palliative care available	8 (42.1)	19	244 (60.5)	403	0.377
Long-term oxygen program available	18 (94.7)	19	351 (87.1)	403	0.692

ICU, intensive care unit; COPD, chronic obstructive pulmonary disease; NIV, noninvasive ventilation. * Significant.

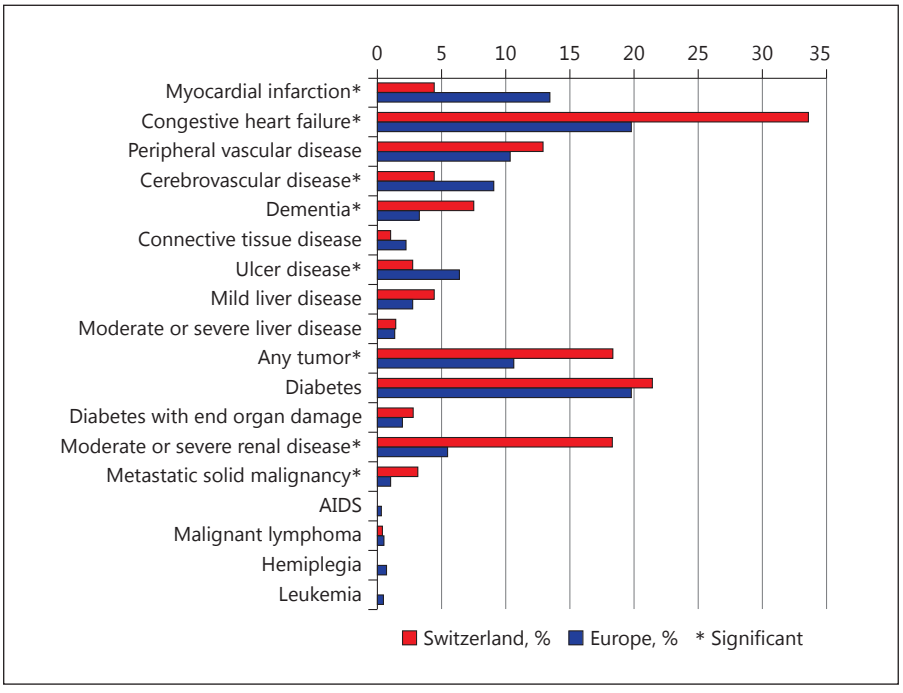

Fig. 2. The most frequent comorbidities with chronic obstructive pulmonary disease exacerbation.

Table 3. Pharmacological treatment before and during hospital admission and after discharge

Treatment	Switzerland before	Europe before	*p*	Switzerland during	Europe during	*p*	Switzerland after	Europe after	*p*
LABA + ICS	157 (53.2)	9,027 (57.4)	0.149				169 (57.3)	10,990 (69.9)	<0.001
LABA	23 (7.8)	1,459 (9.3)	0.384				29 (9.8)	1,530 (9.7)	0.954
LAMA	132 (44.7)	7,319 (46.5)	0.538				166 (56.)3	9,428 (60)	0.2
Oral theophylline	11 (3.7)	2,606 (16.6)	<0.001				9 (3.1)	3,170 (20.2)	<0.001
IV theophylline				3 (1)	2,273 (14.5)	<0.001			
SABA	102 (34.6)	9,483 (60.3)	<0.001	233 (79)	13,322 (84.7)	0.007	115 (39.0)	8,948 (56.9)	<0.001
SAMA	80 (27.1)	4,202 (26.7)	0.88	221 (74.9)	12,185 (77.5)	0.293	95 (32.2)	3,861 (24.6)	0.003
Systemic corticosteroids	78 (26.4)	2,907 (18.5)	0.001	227 (76.9)	12,960 (82.4)	0.015	129 (43.7)	8,103 (51.5)	0.008
ICS	32 (10.8)	1,949 (12.4)	0.424	46 (15.6)	5,394 (34.1)	<0.001	30 (10.2)	1,856 (11.8)	0.388
Antibiotics	54 (18.3)	3,148 (20)	0.465	214 (72.5)	13,559 (86.2)	<0.001	73 (24.7)	6,581 (41.9)	<0.001
Oxygen	51 (17.3)	3,905 (24.8)	0.003	258 (93.1)	13,344 (86.1)	<0.001	85 (32.9)	5,173 (33.9)	0.76
Diuretics				73 (24.7)	4,159 (26.5)	0.51			
IVS				14 (5.1)	272 (1.7)	<0.001			
NIV	22 (7.5)	416 (2.6)	<0.001	92 (33.3)	2,043 (13.4)	<0.001	21 (8.2)	793 (5.2)	0.033
No oxygen							173 (67.1)	10,139 (66.1)	0.062
Ambulatory oxygen							3 (1.2)	195 (1.3)	0.947
Long-term oxygen							81 (31.4)	4,660 (30.4)	0.496

Values are presented as *n* (%). LABA, long-acting β_2-agonist; ICS, inhaled corticosteroids; LAMA, long-acting muscarinic antagonist (anticholinergic); SABA, short-acting β_2-agonist; SAMA, short-acting muscarinic antagonist; IVS, invasive ventilatory support; NIV, noninvasive ventilatory support.

Table 4. Patient outcomes

	Switzerland		Europe		*p*
	n or mean (% or SD)	patients, *n*	*n* or mean (% or SD)	patients, *n*	
Length of stay, days*	11.3 (8.9)	294	8.7 (8.3)	15,687	<0.001
Readmission within 90 days*	71 (25.4)	279	5,278 (35.3)	14,949	0.003
Mortality during admission	16 (5.4)	295	774 (4.9)	15,723	0.694
Follow-up mortality*	8 (2.9)	279	934 (6.2)	14,949	0.028
Overall mortality	24 (8.1)	295	1,708 (10.9)	15,723	0.135

* Significant, $p < 0.05$.

tween Switzerland and the other European countries. There were also significant differences in the administration of short-acting β_2-agonists before admission (34.6 vs. 60.3%; $p < 0.001$), during hospitalization (79.0 vs. 84.7%; $p = 0.007$), and after discharge (39 vs. 56.9%; $p < 0.001$) between Switzerland and the other European countries. Administration of systemic corticosteroids was significantly higher before admission (26.4 vs. 18.5%; $p = 0.001$) in Switzerland than in the other European countries, but it became higher during hospitalization (82.4 vs. 76.9%; $p = 0.015$) and after discharge (51.5 vs. 43.7%; $p = 0.008$) in the other European countries than in Switzerland (Table 3). In Switzerland, NIV support before admission (7.5 vs. 2.6%; $p < 0.001$), during hospitalization (33.3 vs. 13.4%; $p < 0.001$), and after discharge (8.2 vs. 5.2%; $p = 0.033$) was significantly higher than in the other European countries. At discharge, Swiss physicians less commonly prescribed the combination LABA/ICS (57.3 vs. 69.9%; $p < 0.001$) and antibiotics (24.7 vs. 41.9%; $p < 0.001$) as compared to the other European physicians.

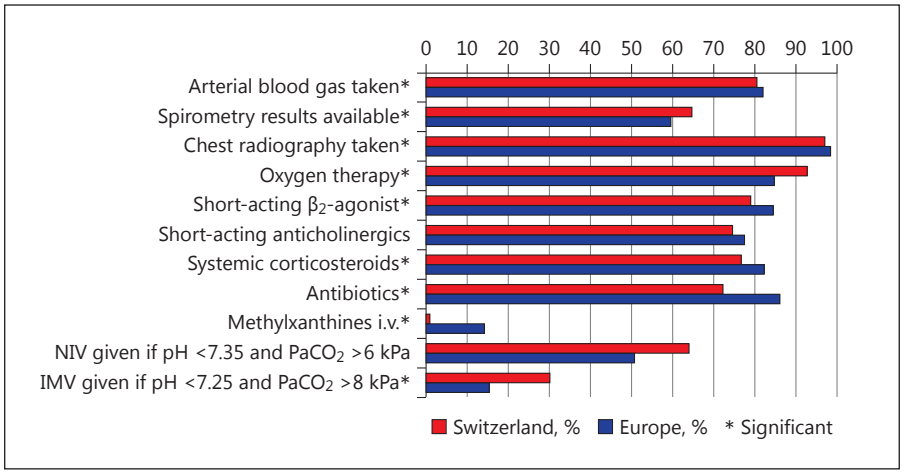

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Fig. 3. Implementation of GOLD recommendations for the treatment of acute exacerbation of chronic obstructive pulmonary disease in Switzerland in comparison with other countries in Europe.

Implementation of the GOLD Recommendations for the Treatment of COPD Exacerbations

The implementation of the GOLD recommendations for AECOPD treatment in Switzerland and in other European countries is presented in Figure 3.

1 *Arterial blood gas (ABG) should be taken to assess the severity of the exacerbation.* In 85.6% (238/278) of all admissions in Switzerland, an arterial blood gas analysis had been performed, compared to 84.1% (12,953/15,397) in the other European countries. The average partial oxygen pressure (PaO_2) was 9.4 kPa and the $PaCO_2$ was 6.1 kPa in Switzerland, compared to 8.6 kPa and 6.4 kPa, respectively, in the other European countries.
2 *Spirometry results should be available on admission.* 64.0% (185/289) of the patients had spirometry results available at hospital admission in Switzerland, compared to 59.1% (9,246/15,654) of the patients in the other European countries ($p = 0.057$). 12.8% (37/289) of the Swiss patients and 7.6% (1,189/15,654) of the patients from the other European countries had a non-obstructive FEV_1/FVC >70% and were treated for exacerbation ($p = 0.001$).
3 *Oxygen therapy should be offered on admission.* In Switzerland, 93.1% (258/277) of the patients received oxygen therapy on admission, compared to 86.1% (13,344/15,492) of the patients in the other European countries ($p < 0.001$). 94% of the Swiss patients had a pO_2 <8 kPa. Although there was no reported arterial blood sample taken, 7.2% (20/277) of these patients received oxygen.
4 *Chest radiography should be performed at admission.* In Switzerland, chest radiography was performed in 97.3% (287/295) of all cases. In 26.5% (76/287) of these, hyperinflation was diagnosed, and in 1.7% (5/287) the chest X-ray revealed lung cancer; 20.6% (59/287) of the patients had a normal chest X-ray result and 24.7% (71/287) had consolidation. The results were similar in the other European countries (Table 1).
5 *Short-acting β_2-agonists should be used.* A total of 79% (233/295) of the patients were treated with a short-acting β_2-agonist during hospitalization in Switzerland, as compared to 84.7% (13,322/15,723) patients in the other European countries ($p = 0.007$).
6 *Short-acting anticholinergics can be used as an addition to short-acting β_2-agonists.* 74.9% (221/295) of the patients were treated with short-acting anticholinergics during their hospitalization in Switzerland, as compared to 77.5% (12,185/17,723) of the patients in the other European countries ($p = 0.293$).
7 *Inhaled or intravenous corticosteroids are recommended.* 76.9% (227/295) of the patients received systemic corticosteroids and 15.6% (46/295) inhaled corticosteroids during hospitalization in Switzerland, as compared to 82.4% (12,960/15,723) of the patients receiving systemic corticosteroids and 34.3% (5,396/15,723) inhaling corticosteroids in the other European countries ($p = 0.015$ and $p < 0.001$, respectively).
8 *Antibiotic treatment is to be administered when a bacterial infection is suspected.* In Switzerland, 72.5% (214/295) of the patients were treated with antibiotics during hospitalization. Amongst those patients who received antibiotics were 5 patients with sputum purulence and invasive mechanical ventilation (IMV) and 3 patients with no color change of the sputum,

nonincreased sputum, and nonincreased dyspnea. In the other European countries, 86.2% (13,559/15,723) of the patients received antibiotic treatment ($p < 0.001$).

9 *Methylxanthines can be used as second-line therapy after short-acting bronchodilators*. 1.0% (3/295) of the Swiss patients received methylxanthines; in the other European countries, 14.5% (2,273/15,723) of the patients were treated with this drug ($p = 0.001$).

10 *NIV or IMV should be considered*. 33.3% (92/276) of the patients received noninvasive and 5.1% (14/276) received IMV. 36 patients (12.2%) in Switzerland fulfilled the British Thoracic Society guidelines for NIV (pH <7.35 and pCO_2 >6 kPa) [14], and 66.7% of these patients received NIV, compared to 51.3% in the other European countries. 30% (3/10) of the patients who fulfilled the GOLD IMV criteria (pH <7.25 and pCO_2 >8 kPa) [4] received IMV treatment, compared to 15.2% (70/461) in the rest of Europe.

Outcomes

The outcomes of the patients with severe AECOPD included in the audit in Switzerland and in the other European countries are presented in Table 4. In Switzerland, the patients had a prolonged hospital length of stay (on average 11.3 vs. 8.7 days; $p < 0.001$), but a lower 90-day readmission rate (25.4 vs. 35.3%; $p = 0.003$). Although the overall mortality rate tended to be lower in Switzerland (8.1%) than in the other European countries (10.9%), Switzerland had a slightly higher rate of in-hospital deaths (5.4%) than the other European countries (4.9%).

Discussion

The European COPD Audit provided a unique overview of the management of exacerbations of COPD and their outcomes in Europe. The Swiss COPD Audit comprised 19 hospitals, thus representing the only available multicenter study in the country focusing specifically on the management of COPD exacerbations. Although the number of patients included was relatively modest and represented only 50% of the Swiss population, the Swiss COPD Audit offered objective data for the formation of action plans for exacerbation care in Switzerland.

A reliable diagnosis and accurate therapy are essential to improve patient outcomes after COPD exacerbation [4]. The diagnosis of COPD and the clinical diagnosis of exacerbation of COPD both benefit from spirometric information. The absence of this information at admission may lead to incorrect diagnosis and treatment especially, since spirometry is not recommended during an acute exacerbation [4]. That said, 36% of the Swiss patients did not have any spirometry results available at admission, although the Swiss hospitals were better equipped than those of the other European countries.

Pulmonary rehabilitation improves the exercise capacity and quality of life of a patient [15]. Although pulmonary rehabilitation was available in 89.5% of all Swiss hospitals, only 40% of the patients took advantage of this therapeutic option. This could be attributed to the following: (1) pulmonary rehabilitation is not reimbursed by health insurance for any patients with mild disease; (2) pulmonary rehabilitation is offered as ambulatory treatment and many patients are too sick with too many comorbidities to be able to attend; and/or (3) physicians do not prescribe the rehabilitation program.

Evaluation of the severity of an exacerbation requires a blood gas analysis, particularly in those patients with hypoxemia as evidenced by transcutaneous oximetry [4]. It is especially striking that although a blood gas analysis is recommended in the GOLD guidelines [1], this examination was performed on only 85.6% of the patients fulfilling the criteria for severe exacerbation and thus requiring hospitalization. NIV reduces the mortality rate and the length of ICU and hospital stay [16]; yet only 66.7% of the patients fulfilling the ABG criteria for NIV received this therapy, and only 30.0% of those requiring IMV were treated accordingly. In the other European countries, NIV was administered to only 51.3% of the patients fulfilling the ABG criteria, and IMV to only 15.2% of the patients. NIV was, however, only available in 89.1% of the hospitals in the other European countries, and this could partly account for the lack of administration of this treatment in those countries. In Switzerland, NIV was available in all the participating hospitals.

Antibiotic use was significantly lower in the Swiss hospitals during hospitalization and after discharge, compared to the rest of Europe. The GOLD guidelines state that antibiotics should be administered when a bacterial infection is suspected [1]. With the increased usage of faster and more efficient molecular techniques, such as polymerase chain reaction, for detecting the type and presence of bacterial infections, as well as the use of circulating blood C-reactive protein (CRP) and procalcitonin (PCT) levels for determining the initiation of antibiotic administration, antibiotic usage can be decreased [17, 18]. In view of the threat of an increase in antibiotic-

resistant bacteria, less antibiotic usage during an exacerbation of COPD should be considered by the other European countries.

Administration of systemic corticosteroids before hospital admission was significantly higher in Switzerland than in the other European countries, but during hospitalization and after discharge, the Swiss patients were administered less systemic corticosteroids than the patients in the other European countries. The increased use of corticosteroids before admission may be due to the national model of care in Switzerland, where most patients referred for hospital admission have already been seen and have usually been treated by their general practitioner.

In accordance with the GOLD report 2010, fewer methylxanthines were used as a treatment option in Switzerland compared to the other European countries. Although more methylxanthines were used in the other European countries, the 90-day readmission and follow-up mortality rates were significantly higher than in Switzerland. According to the GOLD recommendations, the beneficial effects of methylxanthines on lung function and other clinical end points are modest and inconsistent [1]. Recent data showing the effects of methylxanthines on inflammation and fibrosis may account for the increased use of methylxanthines in the other European countries [19–21].

More Swiss patients had consolidation than had patients from the other European countries. Saleh et al. [22] found that patients with COPD exacerbation who have consolidation have a more severe disease and worse prognosis than patients without consolidation. This could account for the longer hospital stay experienced by the Swiss patients compared to the patients from the other European countries.

There were significant differences in the prevalence of comorbidities between the Swiss patients and the patients from the other European countries. These differences may be due to differences in the complexity of workups in the various health-care systems across Europe. Since there are so many significant differences in treatment before and during hospitalization, it is difficult to determine which aspect of the treatment resulted in longer hospitalization, decreased readmission, and decreased follow-up mortality. It is also possible that these differences merely reflect different health-care models, as the length of hospital stay is not only determined by the severity of the disease but also by social and logistic factors facilitating home or institutional care.

Swiss Recommendations for an Action Plan for AECOPDs

Based on the available literature, collected data, and workshops involving respiratory physicians (hospital managers) representing all recruiting institutions, the following recommendations were established for the management of exacerbations of COPD in Switzerland. It is important to note that these recommendations may not be generalizable to all institutions in Switzerland.

1 **Smoking cessation and vaccination information should be offered to COPD patients admitted to the hospital for exacerbation.** Patients should be offered smoking cessation counselling and information regarding influenza and pneumococcal vaccination every time they are admitted to the hospital with an exacerbation. However, at the moment there is no reimbursement for non-physician smoking cessation counselling in the Swiss health care system, which may deter the introduction of this action [23]. We, therefore, additionally recommend including non-physician smoking cessation support in the Swiss tariff system and the fostering of a closer cooperation with the Swiss lung organization (Lungenliga).

2 **ABG or venous blood gas should be measured.** Patients' blood gas should be evaluated at presentation. The treatment and the diagnosis of exacerbation of COPD are very dependent on the blood gas analysis results; thus, for every patient with suspicion of severe exacerbation of COPD, we recommend that at least a venous blood gas analysis be performed [24, 25].

3 **Medical staff should be trained in administering bronchodilators through a nebulizer with oxygen in the emergency ward.** Patients should be offered oxygen at presentation. The cornerstone of treatment for AECOPD is bronchodilation with short-acting β_2-agonists at an increased dosis and frequency [4]. Medical staff should be trained in administering bronchodilators through a nebulizer with oxygen in the emergency ward to facilitate fast and correct therapy.

4 **Systemic steroids should be administered.** Patients should receive systemic steroids. Systemic steroids are efficient in the treatment of AECOPD, and they should be administered if there is a reasonable suspicion for an AECOPD. They reduce the recovery time of FEV_1, hospital length of stay, and mortality rate [26]. The main effect of the steroids shows in the first 72 h of exacerbation. Based on the newest literature, we recommend a dose of 20–60 mg prednisone for 5 days [3, 27–29].

5 **Antibiotics should be given to patients with increased sputum volume, purulent sputum, and increased CRP or PCT, and to patients requiring ICU admission.** Patients should receive antibiotics only in selected cases. Antibiotic treatment is effective only in a small subgroup of patients with exacerbations. Indications for antibiotic administration include: increased sputum volume, sputum color, and purulence; need for ventilator support; or need for ICU transfer [30, 31]. In addition to the clinical condition of the patient, circulating CRP and PCT levels (e.g. >50 mg/dL and >0.25 μg/L, respectively) should be evaluated to determine whether to initiate antibiotic treatment [17, 18].

6 **NIV is indicated if pH <7.35 and pCO_2 >6 kPa.** Patients should receive ventilator support if pH <7.35 and pCO_2 >6 kPa. NIV should be administered as soon as possible when clinical and functional signs of acute respiratory distress are evident [32–36]. In this study, it was found that patients administered NIV had a survival probability of 80.4%, compared to 64.4% of the patients treated with IMV [37]. NIV therapy outside the emergency ward or ICU is, however, challenging in Swiss hospitals, and these challenges will need to be addressed before this recommendation can be implemented.

7 **Spirometry should be performed before discharging a patient or at least 4–6 weeks thereafter.** Patients' lung function should be evaluated before discharge, or at least 4–6 weeks after discharge if this information is not available [36].

The European COPD Audit has some limitations, such as the lack of information on mucolytics and the vaccination status of the patients. Moreover, the recommended FEV_1/FVC quotient for diagnosing COPD could overestimate the prevalence of the disease, particularly among elderly people.

In conclusion, considering the overall high standard of health care in Switzerland and in light of the GOLD 2010 guidelines, we were able to make 7 recommendations to improve and standardize the management of severe AECOPD for patients treated in Switzerland.

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