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Research Article

Corticosteroid Therapy in COVID-19 Associated With In-hospital Mortality in Geriatric Patients: A Propensity Matched Cohort Study

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Abstract

Background: Few data are available on the prognosis of older patients who received corticosteroids for COVID-19. We aimed to compare the in-hospital mortality of geriatric patients hospitalized for COVID-19 who received corticosteroids or not.

Methods: We conducted a multicentric retrospective cohort study in 15 acute COVID-19 geriatric wards in the Paris area from March to April 2020 and November 2020 to May 2021. We included all consecutive patients aged 70 years and older who were hospitalized with confirmed COVID-19 in these wards. Propensity score and multivariate analyses were used.

Results: Of the 1 579 patients included (535 received corticosteroids), the median age was 86 (interquartile range 81–91) years, 56% of patients were female, the median Charlson Comorbidity Index (CCI) was 2.6 (interquartile range 1–4), and 64% of patients were frail (Clinical Frailty Score 5–9). The propensity score analysis paired 984 patients (492 with and without corticosteroids). The in-hospital mortality was 32.3% in the matched cohort. On multivariate analysis, the probability of in-hospital mortality was increased with corticosteroid use (odds ratio [OR] = 2.61 [95% confidence interval (CI) 1.63–4.20]). Other factors associated with in-hospital mortality were age (OR = 1.04 [1.01–1.07], CCI (OR = 1.18 [1.07–1.29], activities of daily living (OR = 0.85 [0.75–0.95], oxygen saturation < 90% on room air (OR = 2.15 [1.45–3.17], C-reactive protein level (OR = 2.06 [1.69–2.51], and lowest lymphocyte count (OR = 0.49 [0.38–0.63]). Among the 535 patients who received corticosteroids, 68.3% had at least one corticosteroid side effect, including delirium (32.9%), secondary infections (32.7%), and decompensated diabetes (14.4%).
Conclusions: In this multicentric matched-cohort study of geriatric patients hospitalized for COVID-19, the use of corticosteroids was significantly associated with in-hospital mortality.

Keywords: Older patients, SARS-CoV-2, Treatment

In 2020, the World Health Organization (WHO) declared the COVID-19 outbreak as a global pandemic. By March 2022, more than 470 million confirmed cases and more than 6 million deaths were reported (1). The population over 70 is the age group with the highest mortality with COVID-19 infection. Indeed, in-hospital mortality is 3.5 higher than for younger adults and ranges from 35% with age 70–79 years to 60% with age 80 years and older (2). This outcome could be explained by modifications induced by age on the immune system (3) and a higher rate of comorbidities in the geriatric population (4,5). All of these factors contribute to increased risk of critical illness, induced by an inappropriate immune response leading to a "cytokine storm," lung damage, acute respiratory distress syndrome, and multiorgan failure (6).

Corticosteroids, with their well-known broad-spectrum anti-inflammatory and immunomodulatory effects, are emerging as a beneficial treatment. According to the results of the RECOVERY trial (7), a large randomized trial evaluating the effectiveness of dexamethasone in COVID-19, corticosteroids have emerged as the standard of care for severe and critical COVID-19 and have been recommended by the WHO since September 2020 (8).

However, only few data are available on the prognosis of older patients hospitalized for COVID-19 and receiving corticosteroids (9), and their results are heterogeneous. Two retrospective observational studies concluded a benefit of corticosteroids in COVID-19 for older patients (10,11), but subgroup analysis of RECOVERY trial data (7) did not find a significant difference in terms of mortality and ventilator-free days at 28 days between older adults patients (≥70 years old) who received corticosteroids and those who did not. Because of the high rate and severity of side effects of corticosteroids in the geriatric population (12,13), the risk/benefit balance could be even more questionable in the context of COVID-19 for this population.

The objective of this large multicentric observational study was to compare the in-hospital mortality rate of geriatric patients hospitalized for COVID-19 who received corticosteroids or not.

Materials and Methods

Ethical Support

This study was approved by the COVID-19 Assistance Publique-Hôpitaux de Paris (APHP) research committee and the ethics board of Sorbonne University on April 2021 (CER-2020-102). All included patients or their legal representative received an information letter specifying their rights and the terms of use of their medical data. Nonobjection was collected by the physicians in charge of the patients.

This report follows the STROBE recommendations (Supplementary Methods 1).

Study Design, Setting, and Participants

This was a multicentric retrospective cohort study including 15 acute COVID-19 geriatric wards in Paris, France. We included all consecutive patients hospitalized in these wards during 2 distinct periods corresponding to the first COVID-19 wave (March 13, 2020–April 15, 2020; GERICOVID cohort published by Zerah et al. (14)) and the second and third waves (November 1, 2020–May 31, 2021; GERICOCO cohort). Patients included had confirmed COVID-19, were aged 70 years and older, and COVID-19 was diagnosed by RT-PCR for severe acute respiratory coronavirus (SARS-CoV-2) or chest CT according to the WHO interim guidance (15). Patients were excluded if they refused the use of their medical data. The clinical outcome (ie, in-hospital mortality) was monitored up to May 7, 2020 for GERICOVID and up to June 31, 2021 for GERICOCO, the final date of follow-up (discharge of the last patient included). We had no missing data on death or destination at discharge.

Because of lack of recommendations before September 2020, several patients of the GERICOVID cohort received corticosteroids according to the local medical decision. For the GERICOCO cohort, according to the WHO recommendations (September 2020) (16), all patients with severe or critical COVID-19 (defined as oxygen saturation <90% on room air and/or signs of pneumonia and/or respiratory rate > 30 breaths per minute) received corticosteroids. The choice of corticosteroid type was left to the discretion of practitioners.

Data Collection and Outcomes

Data were collected as part of routine care (no clinical or biological procedures added in the creation of the database) retrospectively by 2 physicians per ward from medical records and included sociodemographic data (age, sex, place of living), comorbidities and Charlson Comorbidity index (CCI) (17), number of medications (polypharmacy defined as ≥5 chronic medicines per day (18)), frailty (Clinical Frailty Score [CFS] (19): 1–3, fit; 4, vulnerable; 5–9, frail), and functional autonomy (activities of daily living [ADL] (20)). Also recorded were characteristics of COVID-19 such as the date of COVID-19 onset (defined as the day when the first symptoms were noticed), diagnosis (RT-PCR and/or chest CT anomalies), severity (fever, respiratory rate, oxygen saturation on room air, quick Sepsis-related Organ Failure Assessment [qSOFA] (21)). We also recorded biological data (C-reactive protein [CRP] level, lymphocyte count, presence of cytolysis, and cholestasis), and type of corticosteroids

used. Finally, we recorded the status at the end of hospitalization in the acute geriatric ward (alive, dead, place of discharge). Side effects attributed to corticosteroids during the hospitalization were collected for only the GERICOCO cohort. Delirium (defined according to the Confusion Assessment Method (22)), behavioral disorder, gastrointestinal bleeding, acute cardiac failure, hypertension, diabetes decompensation, and secondary infections occurring during hospitalization for patients receiving corticosteroids were considered potential side effects.

The primary outcome was in-hospital mortality. The secondary outcome was corticosteroids side effects in the GERICOCO cohort during hospitalization.

Statistical Analysis

The statistical plan of the study was worked out before the study start (Supplementary Methods 2). The main objective of this study was to compare the in-hospital mortality rate of geriatric patients hospitalized for COVID-19 who received corticosteroids or not. In our previous publication, the in-hospital mortality rate was 31% (95% confidence interval [CI] 27–33) (14). To demonstrate a reduction of 6% in in-hospital mortality with corticosteroid use (7), we estimated that we needed 690 participants per group (power 80%, alpha risk .05).

Characteristics of patients are described as frequencies (percentages) for categorical variables and median (interquartile range [IQR]) for continuous variables. Categorical variables were compared by chi-square or Fisher's exact test and continuous variables by Wilcoxon's rank-sum test. Normality was assessed by a graphical representation of the data distribution.

In-hospital mortality was compared between patients with and without corticosteroid use by using the propensity score framework. The propensity-score approach aims at creating a new dataset in which the probability to receive corticosteroids or not is equally balanced among patient baseline characteristics (age, sex, CCI, depression, Parkinson disease, obesity, polypharmacy, institutionalization, CFS, and ADL score). Patients with or without corticosteroids were matched by using a 1:1 nearest-neighbor matching algorithm without replacement, with a caliper of 0.1 of the standard deviation of the propensity score on the logit scale (23). Covariate balance between the 2 groups was assessed after matching, and an absolute standardized difference < 0.1 was considered as evidence of balance (24). Then, within the matched data set, we created a logistic mixed model with a center effect as a random effect to assess independent variables associated with in-hospital mortality; adjusted odds ratios (ORs) and their 95% CIs were calculated. Variables included in the models were all variables with $p < .10$ on univariate analysis (stepwise selection). qSOFA score at COVID-19 onset was forced into the model because it was found significantly associated with in-hospital mortality in our first initial cohort (14). Multicollinearity bias was checked by using the variance inflation factor. We assessed missing values and their distribution in the 2 cohorts. Because missing values represented <2% of the data and were balanced between the 2 cohorts, no specific strategy was necessary.

Results

Characteristics of Patients at Admission to Geriatric Wards

During the 2 screened periods, 1 579 patients were included (Figure 1): 535 (33.9%) received corticosteroids, 119 (22.2%) in the GERICOVID cohort and 416 (77.8%) in the GERICOCO cohort. In the prematched cohort, the median age was 86 (IQR 81–91) years, 56.3% patients were female, the median CCI was 2.6 (IQR 1–4), the median ADL score was 3.9 (IQR 2–6), 64.4% of patients were frail (CFS 5–9), and 21.3% of patients lived in a nursing home. Clinical characteristics are available in Supplementary Results 1. We could match 984 participants (492 in each group). Baseline characteristics before and after pairing are in Table 1.

In the matched cohort (Table 2), patients receiving corticosteroids had significantly less dementia and clinically more severe condition than patients without corticosteroids, and the qSOFA score at COVID-19 onset was significantly higher. Furthermore, the minimum lymphocyte count was lower, maximal CRP rate higher and length of hospital stay longer for patients receiving corticosteroids.

In-hospital Mortality and Associated Factors

Within the unmatched cohort (n = 1 579), 465 (29.4%) patients died in hospital: 250 (30.3%) from the GERICOVID cohort and 215 (28.4%) from the GERICOCO cohort (Figure 1). Within the matched data set (N = 984), 318 (32.3%) patients died in hospital. On univariate analysis, in-hospital mortality was significantly higher with than without corticosteroid use (44.3% vs 20.3%; $p < .001$; Table 2). In the multivariate logistic mixed model (N = 821 patients), corticosteroid use was significantly associated with in-hospital mortality (OR = 2.61 [95% CI 1.63–4.20]; $p < .001$; Table 3). The other factors significantly associated with the outcome were minimal lymphocyte count, maximal CRP level, CCI, age, ADL, and oxygen saturation < 90% on room air.

Corticosteroid Use and Side Effects

In the whole cohort, many patients (n = 401, 75.0%) received dexamethasone 6 mg/d. The other patients received methylprednisolone (n = 58, 10.8%), hydrocortisone (n = 28, 5.2%), prednisolone (n = 14, 2.6%), and methylprednisone (n = 5, 0.9%). The type of corticosteroid used was not reported for 23 patients.

Among the 416 patients who received some corticosteroids in the GERICOCO cohort, 284 (68.3%) experienced at least one corticosteroid-related side effect. Delirium (32.9%), secondary infections (32.7%), and decompensated diabetes (14.4%) were the most frequent. In 11 (3.4%) cases, corticosteroid use was disrupted because of the severity of side effect.

Discussion

Our cohort study evaluated the prognosis of geriatric patients receiving corticosteroids for COVID-19 in real life. The in-hospital mortality was 32.3% after propensity-score matching, and we identified several risk factors for death in this population. In particular, the in-hospital mortality was 2-fold increased with corticosteroid use (OR = 2.61 [95% CI 1.63–4.20]), and 68.3% of patients who received corticosteroids had side effects such as secondary infections and delirium.

The efficacy of corticosteroids for reducing mortality in COVID-19 in older patients is still controversial and could depend on the severity of disease, degree of inflammation or age (25,26). In the RECOVERY trial, a large randomized controlled trial (RCT) evaluating the benefit of dexamethasone in patients hospitalized for COVID-19, corticosteroid use significantly reduced 28-day mortality (OR = 0.83 [95% CI 0.75–0.93]; $p < .001$) (7), but the age-group analysis concluded that corticosteroid use was not associated

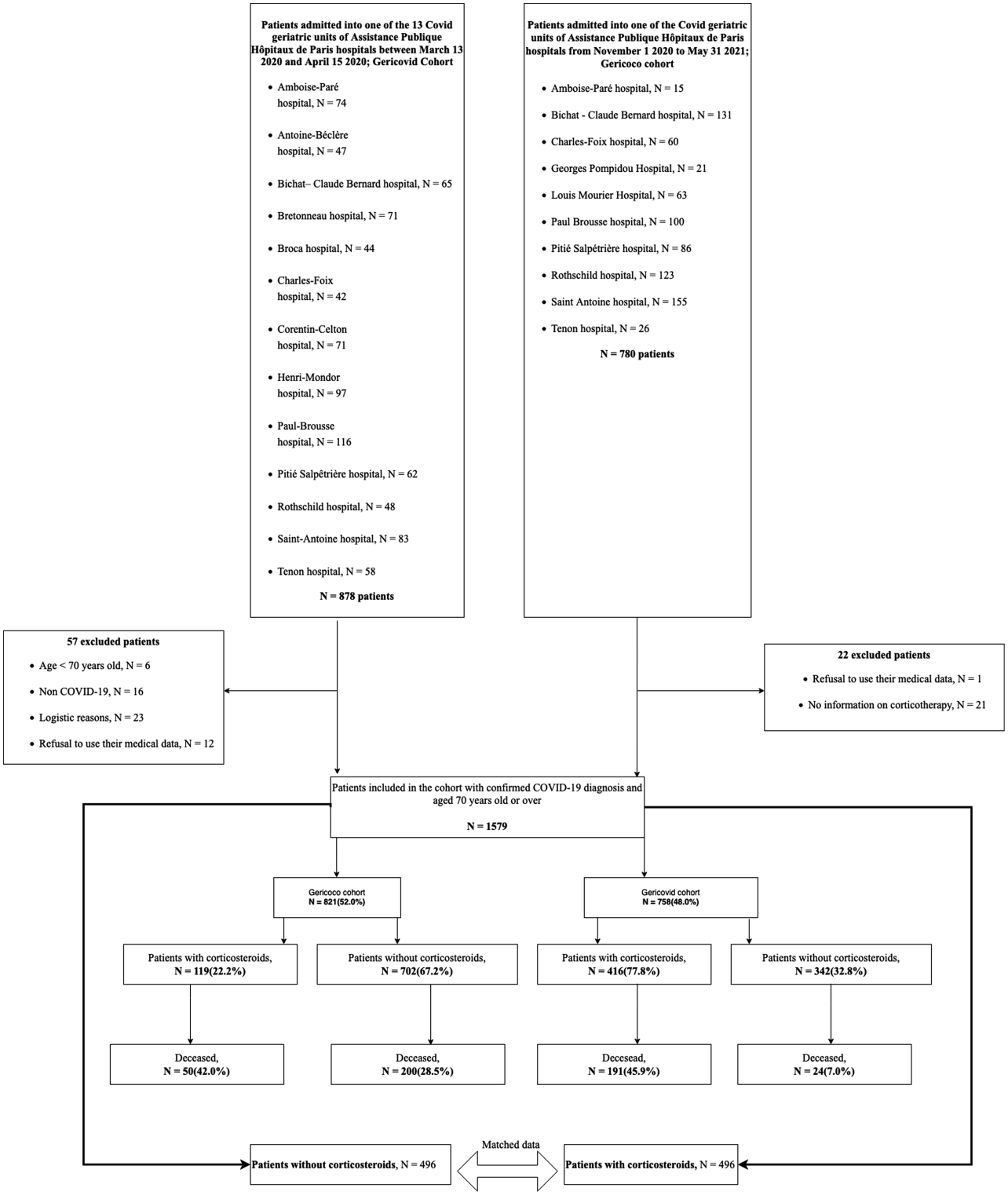

Figure 1. Flow chart.

with reduced mortality in patients over 70 years old (age 70–80: relative risk = 1.03 [95% CI 0.84–1.25] and over 80: relative risk = 0.89 [95% CI 0.75–1.05]) (7). The meta-analysis from the REACT Working group pooled data for 1703 patients from 7 RCTs including the RECOVERY trial and concluded that corticosteroid use was associated with significantly lower 28-day mortality rate (OR = 0.66 [95% CI 0.53–0.82]; $p < .001$) (27). The age-group analysis also concluded a reduction in 28-day mortality with corticosteroids and age over 60 years, but the cut-off age was low and patients were younger than in our study. van Paassen et al. published

Table 1. Baseline Characteristics of Patients Without and With Corticosteroids Before and After Propensity-Score Matching

	Before Matching, *N* = 1579			**After Matching, *N* = 984**			
	Without Corticosteroids, *N* = 1 044 (66.1)	With Corticosteroids, *N* = 535 (33.9)	*p* Value	Without Corticosteroids, *N* = 492 (50)	With Corticosteroids, *N* = 492 (50)	*p* Value	SMD
Age (y), median (IQR)	86.4 (81–91)	85.2 (80–90)	<.001	85.4 (81–90)	85.2 (80–90)	.339	0.30
Sex, female	408 (30.1)	282 (52.7)	<.001	250 (50.5)	234 (47.3)	.309	0.053
Charlson Comorbidity Index, median (IQR)	2.6 (1–4)	2.8 (1–4)	.267	2.7 (1.0–4.0)	2.8 (1.0–4.0)	.965	0.023
Missing values	41 (3.9)	17 (3.2)					
Depression	312 (29.9)	112 (20.9)	<.001	104 (21)	105 (21.2)	.938	0.020
Missing values	1 (0.1)	0 (0)					
Parkinson disease	45 (4.3)	22 (4.1)	.84	17 (3.4)	22 (4.4)	.437	0.041
Missing values	2 (0.2)	0 (0)		1 (0.2)	0 (0)		
Obesity	105 (10.1)	72 (13.5)	.041	68 (13.7)	65 (13.1)	.780	<0.001
Missing values	11 (1.1)	7 (1.3)					
Polypharmacy	628 (60.2)	366 (68.4)	.001	350 (70.7)	340 (68.7)	.489	0.022
Missing values	3 (0.3)	1 (0.2)					
CFS			<.001			.990	0.009
CFS 1–3, fit	195 (18.7)	160 (29.9)		146 (29.7)	147 (29.9)		
CFS 4, vulnerable	115 (11)	60 (11.2)		55 (11.2)	56 (11.4)		
CFS 5–9, frail	705 (67.5)	312 (58.3)		291 (59.1)	289 (58.7)		
Missing values	29 (2.8)	3 (0.6)					
ADL, median (IQR)	3.7 (2–6)	4.3 (3–6)	<.001	4.4 (3.0–6.0)	4.4 (3.0–6.0)	.915	0.053
Missing values	32 (3.1)	11 (2.1)					
Living in nursing home	266 (25.5)	70 (13.1)	<.001	62 (12.5)	68 (13.7)	.572	0.012
Missing values	4 (0.4)	0 (0)					

Notes: ADL = activities of daily living; CFS = Clinical Frailty Score; IQR = interquartile range; SMD = standardized mean difference. Data are number (%) unless otherwise indicated. Propensity score was established on age, sex, ADL, living in a nursing home, polypharmacy, obesity, depression, and Charlson Comorbidity Index. Polypharmacy: ≥5 drugs. In case of no missing value, we kept the line empty.

another meta-analysis including 20 197 patients from 44 studies (RCTs and observational) and also concluded an association of corticosteroid use with reduced short-term mortality (28 days, 30 days, and in-hospital OR = 0.72 [0.57–0.87]), but the authors did not perform an age analysis (28). However, a meta-analysis including 12 studies (15 754 patients) concluded an association of corticosteroid use with mortality (OR = 1.94 [95% CI 1.11-3.4]), but the authors did not analyze the age-group effect (29).

All these studies were not specific for older populations and did not consider comorbidities and functional status of patients, which are powerful prognostic factors in geriatric patients. Two retrospective cohort studies including 143 (10) and 267 (11) patients (mean age 85 years) concluded an association of corticosteroids with reduced mortality (hazards ratio = 0.61 [95% CI 0.41–0.93] for in-hospital mortality and 0.67 [95% CI 0.46–0.99] for 14-day mortality, respectively (10,11)). However, the size of the population was lower than in our study, and we performed a propensity-score analysis to balance baseline characteristics in the 2 groups before performing a logistic mixed analysis. Moreover, patients admitted in geriatric wards probably have a severity bias selection related to the need for management of complex multiorgan comorbidities in an acute condition and to limited access to intensive care units (ICUs) despite an indication. Thus, when compared with these previous studies, this population is characterized by multiorgan morbidity and functional dependency, with numerous patients with ICU profiles and close to ICU studies. In this ICU context, the COVIP study included 3 008 patients over 70 years old and concluded that corticosteroids remained associated with increased 30-day mortality (OR = 1.6 [95% CI 1.26–2.04]; $p < .0001$) (9).

We performed a large matched-cohort study considering comorbidities, polypharmacy, and functional status of real-life geriatric patients who were hospitalized for COVID-19. We found a significant association between corticosteroid use and in-hospital mortality. Several hypotheses could explain this result in the older population. The first is that corticosteroids affect the senescent immune system. Corticosteroids induce a transitory decrease in lymphocyte count, especially naive T cells (30), the T-cell compartment being the most affected by aging (31). This transitory effect could have a greater effect on older adults. Furthermore, lymphopenia is strongly associated with mortality in COVID-19 (32), which we confirmed in our cohort. This transitory worsening immunosuppression induced by corticosteroid use in older infected patients could extend the duration of viral clearance (33) but also increase the risk of secondary infections (34). The second hypothesis is that the risk of corticosteroids side effects could negatively affect the prognosis of comorbid patients, and we bring original and strong data on this point. The proportions of side effects occurring with corticosteroid use in the context of COVID-19 treatment are heterogenous, ranging from 11% to 13% for serious side effects and from 35% to 70% for overall side effects (35,36). In the geriatric population, this proportion ranges from 17% to 52% (10,11) to 68.3% in our cohort. Although the study design did not allow for a comparison with patients without corticosteroids, this prevalence appears important. Delirium, the most frequent complication reported in our cohort, is known to be associated with mortality in COVID-19 (37) and the severity of delirium increases with age and corticosteroid use (38). Secondary infections were reported in 7% of patients hospitalized for COVID-19 (39) but concerned 32.7% of our patients who received corticosteroids. This

Table 2. Matched Population Characteristics Without and With Corticosteroids

	Total	Without Corticosteroids	With Corticosteroids	*p* Value
	N = 984	*n* = 492 (50)	*n* = 492 (50)	
Comorbidities				
Dementia	425 (43.2)	228 (46.3)	197 (40)	**.0046**
Parkinson disease	40 (4.1)	18 (3.7)	22 (4.5)	.518
Hypertension	692 (70.3)	351 (71.3)	341 (69.3)	.485
Diabetes	293 (29.8)	141 (28.7)	152 (30.9)	.443
Atrial fibrillation	289 (29.4)	158 (32.1)	131 (26.6)	.059
Chronic heart failure	252 (25.6)	127 (25.8)	125 (25.4)	.884
Stroke	207 (21.0)	112 (22.8)	95 (19.3)	.184
Myocardial infraction	241 (24.5)	122 (24.8)	119 (24.2)	.884
Peripheral vascular disease	143 (14.5)	70 (12.2)	73 (14.8)	.786
COPD	166 (16.9)	83 (16.9)	83 (16.9)	1
Connective tissue disease	14 (1.4)	6 (1.2)	8 (1.6)	.590
Liver disease	1 (0.1)	0 (0)	1 (0.2)	1
Missing values	3 (0.3)	3 (0.6)	0 (0)	
Peptic ulcer disease	61 (6.2)	36 (7.3)	25 (5.1)	.146
Hemiplegia	35 (3.6)	21 (4.4)	14 (2.8)	.128
Chronic kidney disease	359 (36.5)	189 (38.4)	170 (34.6)	.208
Solid tumor	28 (2.8)	10 (2.0)	18 (3.7)	.125
Leukemia/lymphoma	21 (2.1)	3 (0.6)	18 (3.7)	**<.001**
AIDS	3 (0.3)	2 (0.4)	1 (0.2)	1
Symptoms				
Max temperature (°C), median (IQR)	38.2 (37.7–39.0)	38.0 (37.6–38.9)	38.3 (37.8–39.0)	**.004**
Missing values	38 (3.9)	23 (4.7)	15 (3.0)	
Respiratory rate/min, median (IQR)	30.7 (25–36)	28.1 (24–32)	33.0 (28–40)	**<.001**
Missing values	103 (10.5)	67 (13.6)	36 (7.3)	
Oxygen saturation < 90% on room air	474 (48.2)	162 (32.9)	312 (63.4)	**<.001**
Missing values	2 (0.2)	1 (0.2)	1 (0.2)	
qSOFA ≥ 2	153 (15.5)	57 (11.6)	96 (19.5)	**<.001**
Missing values	133 (13.5)	75 (15.2)	58 (11.8)	
Biology				
Min lymphocyte count (G/L), median (IQR)	0.7 (0.4–0.9)	0.8 (0.5–1.0)	0.6 (0.3–0.8)	**<.001**
Missing values	19 (1.9)	14 (2.8)	5 (1)	
C-reactive protein level (mg/L), median (IQR)	132 (62–188)	115 (43–164)	149 (85–199)	**<.001**
Missing values	20 (2.0)	15 (3.0)	5 (1.0)	
Cytolysis	310 (31.5)	124 (25.2)	186 (37.8)	**<.001**
Missing values	45 (4.6)	30 (6.1)	15 (3.0)	
Cholestasis	270 (27.4)	115 (23.4)	155 (31.5)	**.009**
Missing values	46 (4.7)	30 (6.1)	16 (3.3)	
RT-PCR positive	937 (95.2)	455 (92.5)	482 (98.0)	**<.001**
Missing values	11 (1.1)	9 (1.8)	2 (0.4)	
COVID-19 anomalies on chest CT	615 (62.5)	204 (41.5)	411 (83.5)	**<.001**
Missing values	104 (10.6)	92 (18.7)	12 (2.4)	
Length of stay (d), median (IQR)	12.3 (6–16)	10.9 (6–14)	13.7 (7–18)	**<.001**
Missing values	5 (0.5)	1 (0.2)	4 (0.8)	
Destination at discharge				**<.001**
Return home	180 (18.3)	108 (22.0)	72 (14.6)	
Transfer in rehabilitation unit	401 (40.8)	240 (48.8)	161 (32.7)	
Death	318 (32.3)	100 (20.3)	218 (44.3)	
Other*	81 (8.2)	41 (8.3)	40 (8.1)	

Notes: AIDS = acquired immuno-deficiency syndrome; COPD = chronic obstructive pulmonary disease; CT = computed tomography; IQR = interquartile range. Data are number (%) unless otherwise indicated.

*Transfer to other units (intensive care unit, palliative care unit, other medical ward). In case of no missing value, we kept the line empty.

incidence suggests that secondary infections are more frequent with corticosteroid use (28) and that they could have a major prognostic impact because they are also associated with mortality.

In our study, age, comorbidities and functional autonomy were also associated with in-hospital mortality, which is congruent with other geriatric cohort studies of patients hospitalized for COVID-19 (40,41). Contrary to several studies (40,42), frailty was not significantly associated with in-hospital mortality in our cohort, but we found a trend (CFS 5–9, OR = 1.28 [95% CI 0.75–2.18]). One explanation could be the great proportion of frail patients included in our study (64% in the unmatched cohort and 59% in the matched cohort).

Table 3. Logistic Mixed Model of Factors Associated With In-hospital Mortality in the Matched Data Set

	Deceased		
Predictors	OR	95% CI	*p* Value
Max CRP level (mg/L)	2.06	1.69–2.51	**<.001**
Min lymphocyte count (G/L)	0.49	0.38–0.63	**<.001**
ADL	0.85	0.75–0.95	**<.001**
Oxygen saturation < 90% on room air			
No	Ref	Ref	
Yes	2.15	1.45–3.17	**<.001**
Charlson Comorbidity Index	1.18	1.07–1.29	**.001**
Corticosteroid use			**.001**
No	Ref	Ref	
Yes	2.61	1.63–4.20	
Age	1.04	1.01–1.07	**.013**
qSOFA ≥ 2	1.27	0.81–2.01	.295
CFS			
CFS 1–3, fit	Ref	Ref	
CFS 4, vulnerable	1.01	0.52–1.98	.972
CFS 5–9, frail	1.28	0.75–2.18	.363
GERICOCO cohort	0.75	0.45–1.24	.267
Random effects			
ICC	0.11		
N_{Center}	15		
Observations	821		
Marginal R^2/conditional R^2	.413/.479		

Notes: 95% CI = 95% confidence interval; ADL = activities of daily living; CRP = C-reactive protein; CFS = Clinical Frailty Score; ICC = intraclass correlation coefficient; OR = odds ratio; qSOFA = quick Sequential Organ Failure Assessment.

Table 4. Side Effects Attributed to Corticosteroid Use During Hospitalization in the GERICOCO Cohort

	N
Side effects (≥1)	284 (68.3)
Gastrointestinal hemorrhage	11 (2.8)
Decompensated diabetes	60 (14.4)
Acute hypertension (>180/100 mmHg)	51 (12.3)
Delirium	137 (32.9)
Behavioral disorder	59 (14.2)
Secondary infections	136 (32.7)
Glucocorticoid disruption	11 (3.4)

Note: Data are *n* (%).

Limitations

The study included patients only within the Paris area, but this is the most affected area in France in terms of death from COVID-19 and the fourth in terms of COVID-19 incidence (43). Although this study was observational (with known limitations of retrospective data), it allowed us to include all consecutive hospitalized patients, with no restrictions on comorbidities, frailty, and autonomy. In addition, disease was more severe for patients with corticosteroid use than without corticosteroid use, but the propensity-score approach and the multivariate analysis, which included inclusion period and severity, limited this bias on baseline characteristics. Because of the retrospective design, some values were missing but concerned <2% of the overall data, which highlights the quality of data collection. Finally, our results may relate in part to certain characteristics of the French health care system and may not be extrapolated to other countries.

Conclusion

In this multicentric propensity matched-cohort study of 1 579 geriatric patients with confirmed COVID-19 in the Paris area, the hospital mortality was high (31.9%), and the use of corticosteroids for COVID-19 was associated with in-hospital mortality. RCTs are urgently needed to confirm these results in a geriatric population.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Supplementary Results 1. Characteristics of the unmatched cohort.

Supplementary Methods 1. STROBE Statement—Checklist of items that should be included in reports of cohort studies.

Supplementary Methods 2. Original statistical analysis plan.

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Conflict of Interest

J.B. reported personal fees for lectures from VIFOR Pharma and Baxter companies outside the submitted work. All other authors declare no conflicts of interest.

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Author Contributions

H.V. had full access to all the data in the study and takes responsibility for the integrity and the accuracy of the data. Study concept and design: H.V. and L.Z. Acquisition of the data: V.L.-R., E.B., P.C.-A., C.B., H.E., A.R., M.B., C.To., A.R., S.T., R.V., C.A., M.P., C.L.-L., E.D., P.E.C., D.H., N.L., E.P., A.R.S., C.Th., J.B. Statistical analysis: E.B. Drafting of the manuscript: V.L.-R., L.Z., and H.V. Critical revision of the manuscript for important intellectual content: all authors. English editing: Laura Smales from BioMedEditing (Toronto, Canada).

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