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Severity of COVID-19 and survival in patients with rheumatic and inflammatory diseases: data from the French RMD COVID-19 cohort of 694 patients

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ABSTRACT

Objectives There is little known about the impact of SARS-CoV-2 on patients with inflammatory rheumatic and musculoskeletal diseases (iRMD). We examined epidemiological characteristics associated with severe disease, then with death. We also compared mortality between patients hospitalised for COVID-19 with and without iRMD.

Methods Individuals with suspected iRMD-COVID-19 were included in this French cohort. Logistic regression models adjusted for age and sex were used to estimate adjusted ORs and 95% CIs of severe COVID-19. The most significant clinically relevant factors were analysed by multivariable penalised logistic regression models, using a forward selection method. The death rate of hospitalised patients with iRMD-COVID-19 (moderate–severe) was compared with a subset of patients with non-iRMD-COVID-19 from a French hospital matched for age, sex, and comorbidities.

Results Of 694 adults, 438 (63%) developed mild (not hospitalised), 169 (24%) moderate (hospitalised out of the intensive care unit (ICU) and 87 (13%) severe (patients in ICU/deceased) disease. In multivariable imputed analyses, the variables associated with severe infection were age (OR=1.08, 95% CI: 1.05–1.10), female gender (OR=0.45, 95% CI: 0.25–0.80), body mass index (OR=1.07, 95% CI: 1.02–1.12), hypertension (OR=1.86, 95% CI: 1.01–3.42), and use of corticosteroids (OR=1.97, 95% CI: 1.09–3.54), mycophenolate mofetil (OR=6.6, 95% CI: 1.47–29.62) and rituximab (OR=4.21, 95% CI: 1.61–10.98). Fifty-eight patients died (8% (total) and 23% (hospitalised)). Compared with 175 matched hospitalised patients with non-iRMD-COVID-19, the OR of mortality associated with hospitalised patients with iRMD-COVID-19 was 1.45 (95% CI: 0.87–2.42) (n=175 each group).

Conclusions In the French RMD COVID-19 cohort, as already identified in the general population, older age, male gender, obesity, and hypertension were found to be associated with severe COVID-19. Patients with iRMD on corticosteroids, but not methotrexate, or tumour necrosis factor alpha and interleukin-6 inhibitors, should be considered as more likely to develop severe COVID-19. Unlike common comorbidities such as obesity, and cardiovascular or lung diseases, the risk of death is not significantly increased in patients with iRMD.

Trial registration number ClinicalTrials.gov Registry (NCT04353609).

Key messages

What is already known about this subject?

- As stated by recent European League Against Rheumatism guidelines, there is no evidence that patients with inflammatory rheumatic and musculoskeletal diseases (iRMD) are at higher risk of SARS-CoV-2 infection than individuals without iRMD, nor have a worse prognosis with a diagnosis of COVID-19.
- In patients with iRMD, glucocorticoid therapy at doses ≥10 mg/day of equivalent (prednisone) is associated with higher odds of hospitalisation and anti-tumour necrosis factor (TNF) with decreased odds.

What does this study add?

- Patients with iRMD are more likely to develop severe SARS-CoV-2 infection when they have comorbidities already identified as risk factors of severe COVID-19 infection in the general population, such as older age, male gender, obesity, and hypertension.
- Regardless of the dose, corticosteroids were associated with severe infection, whereas methotrexate, and TNFα and interleukin-6 (IL-6) inhibitors were not. Anti-TNF use was associated with less frequent hospitalisation.
- When matched for common comorbidities, the population with iRMD may not have more frequent death compared with the population with non-iRMD.

How might this impact on clinical practice or future developments?

- In addition to common risk factors for severe SARS-CoV-2 infection, patients with iRMD on any dose of corticosteroid should be considered as particularly fragile and at high risk for developing severe disease, whereas patients on methotrexate and TNFα and IL-6 inhibitors are not.
- A potential risk of more severe COVID-19 in patients with interstitial lung disease or treated by rituximab justifies further research.

INTRODUCTION

In December 2019, COVID-19, caused by the SARS-CoV-2, emerged from Wuhan, China.[1 2] Beginning 1 February 2020, France had a total of six confirmed cases and was under nationwide lockdown by 17 March,[3] and now has just over 344 000 confirmed cases and over 30 000 deaths (as of 5 October 2020),[4] with a mean age 68 years for hospitalised patients and 79 years for those who

died.[5] Stay-at-home restrictions in France decreased hospitalisations nearly 11-fold[5]; however, there remains an urgent need for safe, effective COVID-19 therapies.

There is a concern that patients undergoing immunosuppressive therapy for inflammatory rheumatic and musculoskeletal diseases (iRMD) could be more vulnerable to SARS-CoV-2 infection and hospitalisation than the general population, particularly in those patients with comorbidities such as diabetes, chronic obstructive pulmonary disease, and renal failure.[6 7] Several recent studies in patients with iRMD[8–10] and inflammatory bowel diseases (IBD)[11] suggested an increased risk for hospitalisation and severe disease when using glucocorticoids, although no effect on severity or mortality was found with biological disease-modifying anti-rheumatic drug (DMARD) use. A decreased risk for severe COVID-19 was suggested in such populations with respect to anti-tumour necrosis factor alpha (TNFα) drugs.[11 12] Although these studies indicate that the incidence of immune-mediated inflammatory disease among patients with COVID-19 was consistent with the general population and not associated with worse outcomes, population size was a major limitation. Recent European League Against Rheumatism (EULAR) guidelines suggested that patients with RMD are not at greater risk for developing SARS-CoV-2 infection or more severe disease,[13] but as additional information is obtained through ongoing research and clinical trials, recommendations are continually updated.

Taken together, to provide optimal care and ensure positive clinical outcomes in patients with RMD who contracted SARS-CoV-2 infection, it is imperative to understand how these diseases, their comorbidities and the use of immunotherapies may affect progression to severe COVID-19 or death. The primary objective of the current study, by analysing a French cohort of 694 patients with iRMD and COVID-19, was to investigate the frequency of severe infection and predictive factors associated with disease severity. The secondary objectives were to identify predictive factors associated with death and to compare the death rate in patients with moderate to severe COVID-19 with and without RMD.

METHODS

Study design and patients

This is an observational, multicentre, French national cohort study in which patients of all ages with confirmed iRMD (table 1) and highly suspected/confirmed diagnosis of COVID-19 were enrolled. All eligible patients/representatives were informed. The study was performed in accordance with the principles of the Declaration of Helsinki. Positive diagnosis of COVID-19 included biological confirmation (PCR/serology), presence of ground-glass opacities in CT scan, or anosmia or sudden ageusia in the absence of rhinitis or nasal obstruction, or typical clinical

Table 1 Descriptive table of diagnoses according to severity of COVID-19*

Classification, n (%)	Overall (n=694)	Patients with mild infection (n=438)	Patients with moderate infection (n=169)	Patients with severe infection (n=87)	Survivors (n=617)	Non-survivors (n=58)
Chronic inflammatory arthritis						
Rheumatoid arthritis	213 (30.7)	129 (29.5)	55 (32.5)	29 (33.3)	187 (30.3)	20 (34.5)
Axial and peripheral spondyloarthritis	165 (23.8)	135 (30.8)	25 (14.8)	5 (5.8)	161 (26.1)	1 (1.7)
Psoriatic arthritis	70 (10.1)	52 (11.9)	12 (7.1)	6 (6.9)	64 (10.4)	3 (5.2)
Non-systemic idiopathic juvenile arthritis	2 (0.3)	2 (0.5)	0	0	2 (0.3)	0
Other inflammatory arthritis	14 (2.0)	7 (1.6)	5 (3.0)	2 (2.3)	13 (2.1)	1 (1.7)
Autoinflammatory diseases						
Still's disease	5 (0.7)	1 (0.2)	2 (1.2)	2 (2.3)	4 (0.7)	1 (1.7)
Periodic fever syndromes†	15 (2.2)	8 (1.8)	5 (3.0)	2 (2.3)	13 (2.1)	2 (3.5)
Systemic idiopathic juvenile arthritis	3 (0.4)	2 (0.5)	1 (0.6)	0	3 (0.5)	0
Other autoinflammatory diseases	4 (0.6)	2 (0.5)	1 (0.6)	1 (1.2)	3 (0.5)	1 (1.7)
Vasculitis						
Giant cell arteritis and polymyalgia rheumatica	30 (4.3)	8 (1.8)	10 (5.9)	12 (13.8)	21 (3.40)	9 (15.5)
Behcet's disease	7 (1.0)	3 (0.7)	3 (1.8)	1 (1.2)	6 (1.0)	1 (1.7)
Vasculitis associated with cytoplasmic antineutrophil antibodies	17 (2.5)	4 (0.9)	4 (2.4)	9 (10.4)	10 (1.6)	7 (12.1)
Takayasu's arteritis	1 (0.1)	1 (0.2)	0	0	1 (0.2)	0
Other vasculitis (including Kawasaki's disease)	10 (1.4)	5 (1.1)	5 (3.0)	0	9 (1.5)	0
Systemic autoimmune diseases						
Systemic lupus erythematosus	46 (6.6)	32 (7.3)	11 (6.5)	3 (3.5)	42 (6.8)	2 (3.5)
Systemic sclerosis	25 (3.6)	17 (3.9)	6 (3.6)	2 (2.3)	23 (3.7)	2 (3.5)
Primary Sjögren syndrome	17 (2.5)	7 (1.6)	7 (4.1)	3 (3.5)	15 (2.4)	2 (3.5)
Inflammatory myopathy (including dermatomyositis, polymyositis)	12 (1.7)	6 (1.4)	3 (1.8)	3 (3.5)	8 (1.3)	3 (5.2)
Undifferentiated connective tissue disease	3 (0.4)	3 (0.7)	0	0	1 (0.2)	0
Mixed connective tissue disease	4 (0.6)	0	3 (1.8)	1 (1.2)	3 (0.5)	1 (1.7)
Other						
Sarcoidosis	15 (2.2)	6 (1.4)	5 (3.0)	4 (4.6)	12 (1.9)	2 (3.5)
Eye inflammation (including uveitis)	3 (0.4)	2 (0.5)	1 (0.6)	0	3 (0.5)	0
IgG_4-related disease	3 (0.4)	1 (0.2)	1 (0.6)	1 (1.2)	3 (0.5)	0
Other	10 (1.4)	5 (1.1)	4 (2.4)	1 (1.2)	10 (1.6)	0

*Total number of survivors and non-survivors as presented excludes 19 patients whose status at day 21 was unknown at the time of data cut-off.
†Includes TNF receptor-associated periodic syndrome, cryopyrin-associated periodic syndromes, familial Mediterranean fever, and mevalonate kinase deficiency.
TNF, tumour necrosis factor.

signs of COVID-19 (cough, fever, nose/throat symptoms, digestive symptoms without any other diagnosis, influenza syndrome in a patient with recent close contact with a known COVID-19 positive patient). Patients were informed about the objective of the study, and patient consent was obtained for the use of medical data, which was carried out according to French law and good clinical practices. Approval from an ethics committee was not required according to French law.[14] The study was performed in compliance with MR-004,[15] received permission from Lille University Hospital, was declared to the Commission Nationale de l'Informatique et des Libertés (reference DEC20-107).

To compare the death rate resulting from moderate to severe COVID-19 between the population with iRMD and non-iRMD, the Lille University Hospital COVID-19 Research Network (LICORNE) was used. This includes 335 patients with COVID-19 hospitalised in the Lille University Hospital between 24 February and 17 April 2020 for moderate to severe COVID-19. Among them, 256 patients were selected as potential controls, to match to the moderate to severe (hospitalised/intensive care unit (ICU)/death) patients from the French RMD COVID-19 cohort. All patients with iRMD and control patients received care from the same national health system.

Data collection

All cases of highly suspected/confirmed patients with iRMD-COVID-19 were reported retrospectively. The individual data regarding iRMD diagnosis/specific treatments were captured from rheumatologists, internal medicine physicians or paediatric physicians via one national data entry portal. All treating physicians are members of the FAI^{2}R/SFR/SNFMI/SOFREMIP/CRI/IMIDIATE consortium. Data collected from the patient's medical record included demographics and clinical information such as onset of iRMD and current treatments, presence of comorbidities, details of COVID-19 diagnosis, management and outcome with an evaluation of the vital status assessment at least 21 days after the first clinical sign of COVID-19. The main diagnosis was selected for analysis, which justified the management and the choice of treatments. To ensure secure transmission of data, information was collected from the investigating physician via the electronic case report form or a provided file. Data cut-off was on 18 May 2020. Before freezing, the final database was monitored to collect missing data, validate the evolution of COVID-19, remove duplicate or erroneous reports, and check data consistency. All deaths were verified by Eric Hachulla and Christophe Richez to ensure complete data were obtained and if missing, to collect data directly by contacting the physician.

Outcomes

The primary endpoint was the frequency of severe infection in patients with iRMD and predictive factors associated with disease severity. The severity of COVID-19 was assessed and classified according to the care needed for each patient: mild=ambulatory; moderate=hospitalised out of ICU; and severe=ICU or deceased. The secondary objectives were to identify predictive factors associated with death and to compare the death rate in patients with moderate to severe COVID-19 with and without inflammatory iRMD.

Statistical analysis

Categorical variables were expressed as numbers (percentage) and quantitative variables as mean±SD. Comparisons of severe versus mild or moderate patients and survivors versus non-survivors were made using logistic regression models (in case of cell frequency <5, a penalised logistic regression (Firth method)[14] was used), with and without adjustment on pre-specified factors (age and sex). No statistical comparisons were done for categorical variables with a frequency <10 in the overall sample. Odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated as effect size. Factors associated with severity and hospitalisation status in the age-sex adjusted analyses ($p<0.05$) were introduced into multivariable penalised logistic regression models with a forward stepwise selection procedure (entrance criterion=0.05) to limit overfitting. To avoid case deletion in multivariable analyses, missing data for candidate predictors were imputed by multiple imputations using the regression-switching approach (chained equations, n=10 imputations).[16] The imputation procedure was performed under the missing-at-random assumption using all candidate predictors, with logistic regression (binary, ordinal or multinomial) models for categorical variables. Rubin's rules were used to combine the estimates derived from multiple imputed data sets.[17] Multivariate analysis was performed in available cases (without missing data on candidate predictors) as sensitivity analysis. French RMD COVID-19 cases and LICORNE controls were matched for age, sex, and comorbidities (cardiac disease, diabetes, hypertension, body mass index/BMI, and renal failure) using a propensity score estimation, calculated using a multivariable logistic regression model. Choice of these confounders was based on published literature.[18 19] The two groups were matched (1:1) using an optimal algorithm with calliper width of 0.2 SD of logit for propensity score.[20 21] To evaluate the bias reduction, absolute standardised differences were calculated before and after matching. An absolute standardised difference >10% was interpreted as a meaningful difference.[22] OR for death (iRMD vs controls) was estimated using a mixed logistic regression. All statistical tests were performed at the two-tailed α level of 0.05 using SAS software, V.9.4.

Patient and public involvement

Patients were not directly involved in the design, recruitment, or conduct of the study.

RESULTS

Patient characteristics

We collected a total of 758 records and the final evaluation of COVID-19 severity (primary endpoint) was available for 694 patients (the 13 children were not included in the statistical analysis and are described separately). COVID-19 diagnosis was confirmed in 59% of cases based on PCR or serology (408/694). Of those patients with confirmed COVID-19, approximately 47% (193/408) had a mild, 34% (138/408) moderate, and 19% (77/408) severe infection. In the other patients, COVID-19 diagnosis was confirmed by typical CT scan in 6% (46/694), anosmia/ageusia in 14% (96/694), and typical clinical symptoms in 21% (144/694).

Patients were mainly women (66.6%, 462/694) with a mean age of 56.1±16.4 years, and 51.6% (358/694) were over the age of 55 years (figure 1). Seventy-one percent of the population had at least one comorbidity (492/694), with hypertension (n=182, 26.3%), obesity with a BMI over 30 kg/m^2 (n=146, 21%), respiratory disease (n=99, 14.3%), and cardiovascular disease (n=85, 12.3%) as the most common. Chronic inflammatory arthritis diseases were the most frequent diagnoses in the cohort (66.9%, 464/694), mostly rheumatoid arthritis (RA) and spondyloarthritis, followed by systemic autoimmune diseases

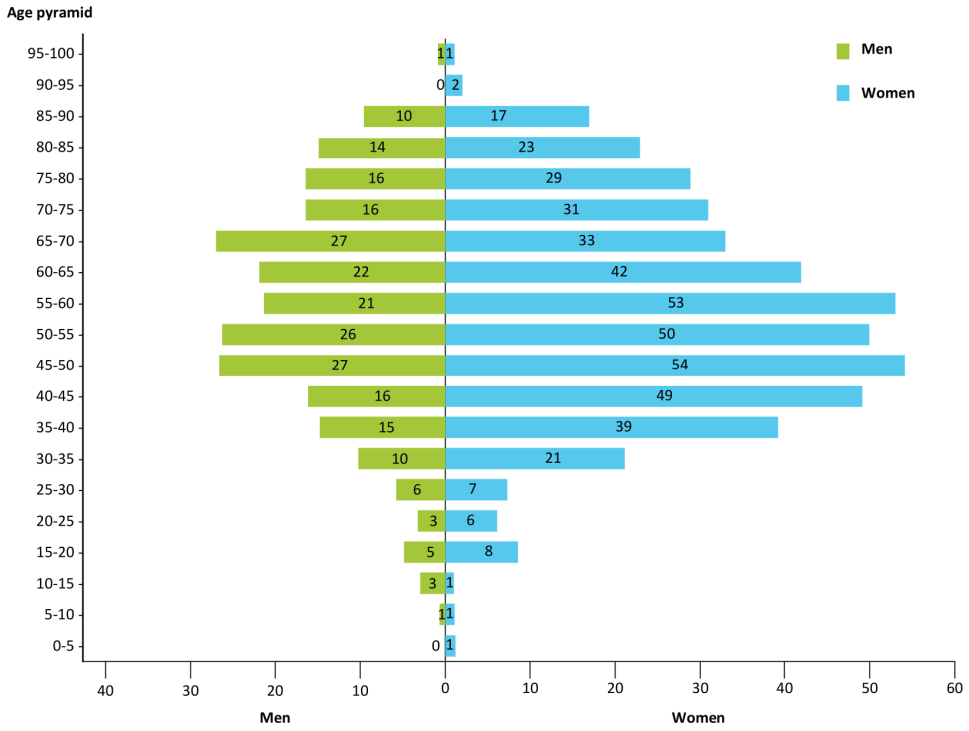

Figure 1 Age-pyramid including the 694 adult patients used in the statistical analysis as well as the 13 children.

(15.4%, 107/694). A detailed description of all iRMD diagnoses included in the cohort is presented in table 1.

Development of severe disease

The frequency of severe COVID-19 in patients with iRMD with confirmed or highly suspected diagnosis of symptomatic COVID-19 was 12.5% (87/694). Age was a driver of disease severity, as only 11 patients between 18 and 54 years developed severe COVID-19, whereas this number increased to 20 in patients between 65 and 74 years (adjusted OR (aOR)=6.46, 95% CI: 2.97–14.06), and to 45 in patients over 75 years (aOR=19.82, 95% CI: 9.69–40.52). There were no severe paediatric cases. When adjusted for age and sex, among the most common comorbidities correlated with severe disease were morbid obesity (BMI ≥40 kg/m^2) (aOR=4.10, 95% CI: 1.28–13.11), diabetes (aOR=2.14, 95% CI: 1.12–4.12), and hypertension (aOR=2.30, 95% CI: 1.34–3.96). Interestingly, interstitial lung disease (aOR=2.87, 95% CI: 1.06–7.80) and chronic renal failure (aOR=3.22, 95% CI: 1.51–6.90) were also associated with disease severity. Severe disease was observed more frequently in patients with vasculitis (aOR=2.25, 95% CI: 1.13–4.41) and autoinflammatory diseases (aOR=7.88, 95% CI: 1.39–37.05), compared with patients with chronic inflammatory arthritis. These results are summarised in table 2. Morbid obesity, diabetes, hypertension, and chronic renal failure were still correlated with severe disease when the analysis was focused only on patients with PCR-confirmed COVID-19 (online supplemental table 1). While not significant, there was also an association with interstitial lung disease (aOR=2.64, 95% CI: 0.94–7.36). In the PCR-confirmed population, severe disease was still observed more frequently in patients with vasculitis (aOR=2.39, 95% CI: 1.14–4.98), compared with patients with chronic inflammatory arthritis.

Regarding treatments for iRMDs, more frequent severe disease was observed with the use of corticosteroids (aOR=2.25, 95% CI: 1.33–3.79), mycophenolate mofetil (aOR=7.67, 95% CI: 1.73–28.04) and rituximab (aOR=4.34, 95% CI: 1.77–10.63). It should be noted that use of TNFα blockers (n=202, aOR=0.44, 95% CI: 0.19–1.04), interleukin-6 (IL-6) inhibitors (n=26, aOR=0.63, 95% CI: 0.12–2.28), methotrexate (n=252, aOR=0.63, 95% CI: 0.37–1.08) and hydroxychloroquine (HCQ) (n=57, aOR=1.06, 95% CI: 0.31–2.96) were not associated with severe COVID-19 (table 3). When the same analysis was performed on the population with PCR-confirmed COVID-19, rituximab was still identified as a contributor to the development of severe disease (aOR=6.35, 95% CI: 2.23–18.11) (online supplemental table 2). However, there was no significant increase in the development of severe disease with the use of corticosteroids (aOR=1.72, 95% CI: 0.98–3.04) nor significant decrease in the development of severe disease with the use of TNF blockers (aOR=0.42, 95% CI: 0.16–1.15).

Similar results were observed in patients with RA (n=213) with respect to the severity of disease including age (aOR age ≥75=16.89, 95% CI: 4.90–88.60), hypertension (aOR=3.36, 95% CI: 1.23–8.60), and use of corticosteroids (aOR=2.57, 95% CI: 1.01–6.52) or rituximab (aOR=5.97, 95% CI: 1.18–27.63) (online supplemental tables 3 and 4).

Results of the multivariable analysis are presented in table 4. Due to the number of events (87 patients with severe infection), the analysis was limited to no more than seven variables, which were selected based on clinical expertise. Older age (OR=1.08, 95% CI: 1.05–1.10), female gender (OR=0.45, 95% CI: 0.25–0.80), BMI (OR=1.07, 95% CI: 1.02–1.12), hypertension (OR=1.86, 95% CI: 1.01–3.42), and use of corticosteroids (OR=1.97, 95% CI: 1.09–3.54), mycophenolate mofetil (OR=6.6, 95% CI: 1.47–29.62) and rituximab (OR=4.21, 95% CI: 1.61–10.98) were significantly associated with COVID-19 severity. Results of the imputed analysis are similar compared with the available case analysis (see table 4).

Table 2 Association between demographic and clinical characteristics and severity of COVID-19

	All patients (n=694)	Patients with mild infection (n=438)	Patients with moderate infection (n=169)	Patients with severe infection (n=87)	OR (95% CI)*	P value	aOR (95% CI)*†	P value†
Age (years)						<0.001		<0.001
18–54	336 (48.4)	268 (61.2)	57 (33.7)	11 (12.6)	1.00 (ref.)	–	1.00 (ref.)	–
55–64	138 (19.9)	95 (21.7)	32 (18.9)	11 (12.6)	2.56 (1.08–6.05)	0.032	2.58 (1.09–6.12)	0.032
65–74	107 (15.4)	52 (11.9)	35 (20.7)	20 (23.0)	6.79 (3.14–14.71)	<0.001	6.46 (2.97–14.06)	<0.001
≥75	113 (16.3)	23 (5.3)	45 (26.6)	45 (51.7)	19.55 (9.62–39.73)	<0.001	19.82 (9.69–40.52)	<0.001
Mean±SD	56.1±16.4	50.6±13.9	61.8±16.1	72.4±13.8				
Female gender	462 (66.6)	309 (70.6)	109 (64.5)	44 (50.6)	0.46 (0.29–0.73)	<0.001	0.45 (0.27–0.75)	0.002
Comorbidities‡								
Respiratory disease (all)	99 (14.3)	53 (12.2)	25 (14.8)	21 (24.1)	2.15 (1.25–3.71)	0.006	1.61 (0.87–2.99)	0.13
Interstitial lung disease	26 (3.8)	10 (2.3)	7 (4.1)	9 (10.3)	3.99 (1.72–9.26)	0.001	2.87 (1.06–7.80)	0.038
COPD	28 (4.0)	14 (3.2)	6 (3.6)	8 (9.2)	2.96 (1.26–6.95)	0.013	1.08 (0.42–2.76)	0.88
Asthma	52 (7.5)	32 (7.3)	14 (8.3)	6 (6.9)	0.90 (0.37–2.18)	0.82	1.24 (0.46–3.33)	0.67
Cardiac disease (all)	85 (12.3)	22 (5.0)	31 (18.3)	32 (36.8)	6.06 (3.61–10.18)	<0.001	1.78 (0.97–3.28)	0.064
Coronary heart diseases	68 (9.8)	15 (3.4)	25 (14.8)	28 (32.2)	6.70 (3.86–11.65)	<0.001	1.86 (0.97–3.56)	0.063
Stroke	25 (3.6)	7 (1.6)	10 (5.9)	8 (9.2)	3.50 (1.46–8.38)	0.005	1.68 (0.63–4.47)	0.30
Diabetes	62 (9.0)	12 (2.8)	29 (17.2)	21 (24.1)	4.38 (2.44–7.85)	<0.001	2.14 (1.12–4.12)	0.022
Obesity						0.050		0.043
<30	459 (75.9)	303 (78.7)	105 (71.9)	51 (68.9)	1.00 (ref.)	–	1.00 (ref.)	–
30–39.9	126 (20.8)	74 (19.2)	35 (24.0)	17 (23.0)	1.25 (0.69–2.25)	0.46	1.47 (0.76–2.82)	0.25
≥40	20 (3.3)	8 (2.1)	6 (4.1)	6 (8.1)	3.43 (1.26–9.32)	0.016	4.10 (1.28–13.11)	0.017
Hypertension	182 (26.3)	71 (16.3)	60 (35.5)	51 (58.6)	5.13 (3.21–8.19)	<0.001	2.30 (1.34–3.96)	0.003
Cancer	33 (4.8)	13 (3.0)	13 (7.7)	7 (8.0)	1.95 (0.82–4.64)	0.13	0.83 (0.31–2.21)	0.71
Chronic renal failure	42 (6.1)	11 (2.5)	12 (7.1)	19 (21.8)	7.07 (3.66–13.65)	<0.001	3.22 (1.51–6.90)	0.003
No. of patients with at least one comorbidity	492 (71.1)	274 (62.8)	136 (80.5)	82 (94.3)	7.80 (3.11–19.54)	<0.001	3.52 (1.35–9.17)	0.010
Disease history§						<0.001		0.023
Chronic inflammatory arthritis	464 (66.9)	325 (74.2)	97 (57.4)	42 (48.3)	1.00 (ref.)	–	1.00 (ref.)	–
Autoinflammatory diseases	12 (1.7)	5 (1.1)	4 (2.4)	3 (3.4)	3.66 (0.89–12.07)	0.053	7.88 (1.39–37.05)	0.014
Vasculitis	65 (9.4)	21 (4.8)	22 (13.0)	22 (25.3)	5.14 (2.80–9.32)	<0.001	2.25 (1.13–4.41)	0.020
Systemic autoimmune diseases	122 (17.6)	73 (16.7)	35 (20.7)	14 (16.1)	1.33 (0.69–2.45)	0.38	1.64 (0.80–3.25)	0.17

Values are presented as frequency (percentage) unless otherwise indicated.
*ORs were calculated for patients with severe infection, using patients with mild or moderate infection as reference.
†Adjusted for age and sex.
‡Two missing values for comorbidities except for obesity where 89 values are missing.
§Penalised logistic regression (Firth method) was used due to low number of patients (n<5) in an analysed group.
aOR, adjusted OR; COPD, chronic obstructive pulmonary disease.

Hospitalisation status

Hospitalisation status of the whole population (n=694) was also affected, and was more frequently related to older age (aOR age ≥75=15.51, 95% CI: 9.11–26.40) as well as the presence of coronary heart disease (aOR=2.73, 95% CI: 1.40–5.30), diabetes (aOR=5.37, 95% CI: 2.66–10.85), hypertension (aOR=1.99, 95% CI: 1.33–2.98), and chronic renal failure (aOR=2.76, 95% CI: 1.26–6.04) (online supplemental table 5). Use of corticosteroids (aOR=2.76, 95% CI: 1.90–4.02) and TNFα inhibitors (aOR=0.35, 95% CI: 0.22–0.55) also affected hospitalisation status and were harmful or protective, respectively (online supplemental table 6). Within the multivariable imputed analysis, age (OR=1.05, 95% CI: 1.04–1.07), diabetes (OR=4.33, 95% CI: 2.07–9.07), BMI (OR=1.06, 95% CI: 1.02–1.10), use of corticosteroids (OR=1.94, 95% CI: 1.24–3.05) and colchicine (OR=3.34, 95% CI: 1.14–9.79) remain associated with a higher risk of hospitalisation. Use of TNF inhibitors (OR=0.55, 95% CI: 0.32–0.95) and female gender (OR=0.65, 95% CI: 0.43–0.99) were associated with less frequent hospitalisation (online supplemental table 7).

Paediatric cases

Thirteen patients were paediatric cases and are described in table 5.

Survival

Fifty-eight patients in our cohort died, resulting in an overall death rate of 8.3%, which corresponds to 22.6% of death in the hospitalised subgroup (58/256) (table 6). Of 335 patients in the LICORNE cohort (patients with non-RMD COVID-19), only 175 controls were matched for age, sex and comorbidities (cardiac disease, diabetes, hypertension, BMI and renal failure) (online supplemental table 8). By matching patients to the LICORNE cohort, a death rate of 25.1% (95% CI: 18.7–31.6) was observed in the French RMD COVID-19 compared with 18.9% (95% CI: 13.1–24.7, respectively) with an OR of 1.45 (95% CI: 0.87–2.42; n=175 in each group). In the iRMD COVID-19 cohort, death was more frequent in patients aged ≥55 years (aOR (55–64)=5.54, 95% CI: 1.62–23.13; aOR (65–74)=6.70, 95% CI: 1.95–28.07; aOR (≥75)=59.02, 95% CI: 21.79–221.45), and with the presence of interstitial lung disease (aOR=3.82, 95% CI: 1.27–11.49), coronary heart disease (aOR=2.18, 95% CI: 1.05–4.53), diabetes (aOR=2.89, 95% CI:

Table 3 Association between rheumatic disease treatments and severity of COVID-19

	All patients (n=694)	Patients with mild infection (n=438)	Patients with moderate infection (n=169)	Patients with severe infection (n=87)	OR (95% CI)*	P value	aOR (95% CI)*†	P value†
Rheumatic or inflammatory disease treatments‡								
Corticosteroid	215 (31.1)	88 (20.1)	76 (45.2)	51 (59.3)	3.93 (2.46–6.26)	<0.001	2.25 (1.33–3.79)	0.002
Daily prednisone ≥10 mg or equivalent	73 (34.3)	28 (31.8)	22 (29.3)	23 (46.0)	1.93 (1.01–3.68)	0.048	1.69 (0.83–3.45)	0.15
NSAIDs§	73 (10.5)	61 (13.9)	10 (6.0)	2 (2.3)	0.22 (0.05–0.66)	0.022	0.50 (0.10–1.58)	0.31
Colchicine	24 (3.5)	12 (2.7)	8 (4.8)	4 (4.7)	1.56 (0.48–4.09)	0.41	3.18 (0.77–11.24)	0.090
Hydroxychloroquine§	57 (8.2)	40 (9.1)	13 (7.7)	4 (4.7)	0.56 (0.18–1.37)	0.26	1.06 (0.31–2.96)	0.91
Methotrexate	252 (36.4)	164 (37.4)	62 (36.9)	26 (30.2)	0.73 (0.45–1.19)	0.20	0.63 (0.37–1.08)	0.096
Leflunomide	27 (3.9)	19 (4.3)	8 (4.8)	0	NA	NA	NA	NA
Sulfasalazine	9 (1.3)	5 (1.1)	4 (2.4)	0	NA	NA	NA	NA
Mycophenolate mofetil/ mycophenolic acid§	16 (2.3)	9 (2.1)	4 (2.4)	3 (3.5)	1.84 (0.47–5.54)	0.33	7.67 (1.73–28.04)	0.004
Azathioprine§	9 (1.3)	5 (1.1)	3 (1.8)	1 (1.2)	NA	NA	NA	NA
IgIV§	7 (1.0)	3 (0.7)	2 (1.2)	2 (2.3)	NA	NA	NA	NA
Biologics								
Anti-TNF	202 (29.2)	170 (38.8)	25 (14.9)	7 (8.1)	0.19 (0.09–0.41)	<0.001	0.44 (0.19–1.04)	0.060
Anti-IL-6§	26 (3.8)	19 (4.3)	5 (3.0)	2 (2.3)	0.70 (0.14–2.21)	0.61	0.63 (0.12–2.28)	0.54
Rituximab	34 (4.9)	16 (3.7)	7 (4.2)	11 (12.8)	3.72 (1.74–7.93)	<0.001	4.34 (1.77–10.63)	0.001
Anti-IL-17a§	27 (3.9)	19 (4.3)	6 (3.6)	2 (2.3)	0.67 (0.14–2.12)	0.57	2.34 (0.45–8.21)	0.24
Anti-IL-1§	8 (1.2)	3 (0.7)	3 (1.8)	2 (2.3)	NA	NA	NA	NA
Abatacept§	18 (2.6)	10 (2.3)	7 (4.2)	1 (1.2)	0.59 (0.07–2.39)	0.55	0.37 (0.04–1.80)	0.31
JAK inhibitor§	21 (3.0)	13 (3.0)	4 (2.4)	4 (4.7)	1.84 (0.56–4.91)	0.27	1.94 (0.54–5.98)	0.28
Other biologic	16 (2.3)	11 (2.5)	5 (3.0)	0	NA	NA	NA	NA

Values are presented as frequency (percentage) unless otherwise indicated.
Not applicable (NA) when <10/694 patients or when 0 patients with severe infection.
*ORs were calculated for patients with severe infection, using patients with mild or moderate infection as reference.
†Adjusted for age and sex.
‡Two patients with missing information for treatments.
§Penalised logistic regression (Firth method) was used due to low number of patients (n<5) in an analysed group.
aOR, adjusted OR; IgIV, immunoglobulin intravenous; IL, interleukin; NSAIDs, non-steroidal anti-inflammatory drugs; TNF, tumour necrosis factor.

1.39–6.02), hypertension (aOR=3.08, 95% CI: 1.56–6.08) or chronic renal failure (aOR=5.22, 95% CI: 2.22–12.31). In addition, systemic autoimmune diseases were more frequently associated with death (aOR=2.65, 95% CI: 1.15–5.95) compared with chronic inflammatory arthritis (table 6). Regarding treatments, use of corticosteroids (aOR=2.64, 95% CI:1.36–5.12), colchicine (aOR=8.21, 95% CI: 1.60–37.97), mycophenolate mofetil (aOR=14.20, 95% CI: 2.26–70.24) or rituximab (aOR=4.04, 95% CI: 1.35–12.04) was associated with a higher frequency of death, whereas a reduced hazard was observed in patients taking methotrexate for iRMD (aOR=0.34, 95% CI: 0.16–0.70) (table 7). Of note, the use of TNFα or IL-6 inhibitors was not associated with death (aOR=0.74, 95% CI: 0.22–2.01 and aOR=0.50, 95% CI: 0.05–2.38, respectively). A detailed description of all fatalities is available in online supplemental table 9.

Treatments used in French patients with iRMD who contracted SARS-CoV-2 infection

With respect to COVID-19-specific treatment used in the French iRMD-COVID-19 cohort, among the total population, 18.6% (129/694) received antiviral or immunomodulating therapies, which increased to 30.2% (51/169) with moderate infection and 37.9% (33/87) with severe infection. HCQ, alone or in

Table 4 Multivariable analyses for disease severity

	Imputed analysis* (n=694)			Available case analysis (n=601)		
Variable	n/N	OR (95% CI)	P value	n/N	OR (95% CI)	P value
Age (years)	87/694	1.08 (1.05–1.10)	<0.001	73/601	1.08 (1.05–1.10)	<0.001
Female gender	44/462	0.45 (0.25–0.80)	0.007	37/395	0.43 (0.24–0.78)	0.005
BMI	87/694	1.07 (1.02–1.12)	0.006	73/601	1.07 (1.02–1.12)	0.007
Hypertension	51/182	1.86 (1.01–3.42)	0.047	42/162	1.83 (0.99–3.37)	0.054
Corticosteroids	51/216	1.97 (1.09–3.54)	0.024	45/188	2.04 (1.13–3.67)	0.018
Mycophenolate mofetil/mycophenolic acid	3/16	6.60 (1.47–29.62)	0.014	3/14	6.51 (1.45–29.23)	0.015
Rituximab	11/34	4.21 (1.61–10.98)	0.003	10/32	4.60 (1.75–12.11)	0.002

ORs were calculated using multivariable penalised logistic regression models (Firth method), using a forward selection method, with patients with mild or moderate infection as reference. Only variables selected by the model are presented. Full model included age, sex, interstitial lung disease, diabetes, BMI, hypertension, chronic renal failure, disease history, corticosteroids, mycophenolate mofetil/mycophenolic acid and rituximab.
n/N indicated the number of events/number of cases.
*ORs and p value were calculated after multiple imputations (m=10) to handle missing data.
BMI, body mass index.

Table 5 Treatment and outcomes of paediatric patients

	Type of RMD	Age/gender	Comorbidities including BMI	RMD treatment		Outpatient management (Y/N)	COVID-19 treatment	COVID outcome	Other comments	SARS-CoV-2 PCR/ serology
				Corticosteroid	DMARD					
Pt 1	Autoimmune bullous dermatosis	4/F	Asthma/17		IgIV, RITU	Y: increase of IgIV dosage	0	Benign		PCR+
Pt 2	Non-systemic JIA	17/M	None/NA		NSAID, MTX, ADA	Y: stop NSAID, MTX and ADA	0	Benign		ND
Pt 3	Non-systemic JIA	7/F	None/14		MTX, ADA	Y: stop ADA and MTX	0	Benign	Relapse of the JIA, recurrent herpes labialis	ND
Pt 4	Non-systemic JIA	14/M	None/18			N	0	Benign	Herpes zoster recurrence	ND
Pt 5	FMF	17/F	None/21		Colchicine	N	0	Benign		Serology+
Pt 6	FMF	16/M	None/23		Colchicine, ADA	N	0	Moderate		PCR+
Pt 7	Systemic–onset JIA	16/F	Smoking/22		TOCI	Y: stop TOCI	0	Benign	Anaemia	PCR+
Pt 8	SLE	17/F	Smoking; obesity/45		Hydroxychloroquine	N	0	Benign	Joint relapse	PCR+
Pt 9	Sarcoidosis and uveitis	13/F	None/20	Prednisone 20 mg/day		N	0	Benign	Relapse of orbital pain	PCR+
Pt 10	Non-systemic JIA	16/M	None/22		NSAID, MTX, ETA	Y: stop NSAID	0	Benign		PCR–
Pt 11	Non-systemic JIA	12/M	None/23			N	0	Benign		ND
Pt 12	Non-systemic JIA	11/M	None/16		ETA	N	0	Benign		ND
Pt 13	Cryopyrinopathy	9/M	None/21			N	0	Benign		ND

ADA, adalimumab; BMI, body mass index; DMARD, disease-modifying anti-rheumatic drug; ETA, etanercept; FMF, familial Mediterranean fever; IgIV, immunoglobulin intravenous; JIA, juvenile idiopathic arthritis; MTX, methotrexate; NA, not applicable; ND, not detected; NSAID, non-steroidal anti-inflammatory drug; RITU, rituximab; RMD, rheumatic and musculoskeletal diseases; SLE, systemic lupus erythematosus; TOCI, tocilizumab.

Table 6 Association between demographic and clinical characteristics and survival*

	Survivors (n=617)	Non-survivors (n=58)	OR (95% CI)†	P value	aOR (95% CI)†‡	P value‡
Age§ (years)				<0.001		<0.001
18–54	327 (53.0)	3 (5.2)	1.00 (ref.)	–	1.00 (ref.)	–
55–64	126 (20.4)	7 (12.1)	5.55 (1.62–23.14)	0.009	5.54 (1.62–23.13)	0.009
65–74	98 (15.9)	7 (12.1)	7.13 (2.08–29.79)	0.003	6.70 (1.95–28.07)	0.004
≥75	66 (10.7)	41 (70.7)	58.39 (21.65–218.44)	<0.001	59.02 (21.79–221.45)	<0.001
Mean±SD	53.9±15.3	76.6±12.6				
Female gender	418 (67.8)	30 (51.7)	0.51 (0.30–0.88)	0.015	0.48 (0.25–0.89)	0.020
Comorbidities¶						
Respiratory disease (all)	82 (13.3)	15 (25.9)	2.27 (1.21–4.27)	0.011	1.64 (0.78–3.43)	0.19
Interstitial lung disease	18 (2.9)	8 (13.8)	5.31 (2.20–12.81)	<0.001	3.82 (1.27–11.49)	0.017
COPD	21 (3.4)	6 (10.3)	3.26 (1.26–8.44)	0.015	0.95 (0.32–2.81)	0.93
Asthma§	48 (7.8)	3 (5.2)	0.74 (0.20–1.99)	0.60	1.15 (0.27–3.72)	0.83
Cardiac disease (all)	56 (9.1)	27 (46.6)	8.69 (4.85–15.60)	<0.001	1.87 (0.93–3.76)	0.081
Coronary heart diseases	41 (6.7)	25 (43.1)	10.61 (5.77–19.49)	<0.001	2.18 (1.05–4.53)	0.037
Stroke	19 (3.1)	6 (10.3)	3.62 (1.39–9.46)	0.009	1.52 (0.51–4.56)	0.46
Diabetes	43 (7.0)	18 (31.0)	6.00 (3.17–11.32)	<0.001	2.89 (1.39–6.02)	0.005
Obesity§				0.053		0.072
<30	419 (77.3)	33 (66.0)	1.00 (ref.)	–	1.00 (ref.)	–
30–39.9	108 (19.9)	13 (26.0)	1.56 (0.78–2.97)	0.19	1.95 (0.88–4.18)	0.093
≥40	15 (2.8)	4 (8.0)	3.64 (1.07–10.29)	0.026	3.77 (0.86–15.09)	0.070
Hypertension	133 (21.6)	40 (69.0)	8.05 (4.47–14.51)	<0.001	3.08 (1.56–6.08)	0.001
Cancer	25 (4.1)	6 (10.3)	2.73 (1.07–6.94)	0.036	1.05 (0.35–3.11)	0.93
Chronic renal failure	22 (3.6)	18 (31.0)	12.13 (6.02–24.44)	<0.001	5.22 (2.22–12.31)	<0.001
No. of patients with at least one comorbidity§	419 (68.1)	57 (98.3)	17.96 (4.83–159.20)	<0.001	5.61 (1.41–50.93)	0.043
Disease history§				<0.001		0.039
Chronic inflammatory arthritis	427 (69.2)	25 (43.1)	1.00 (ref.)	–	1.00 (ref.)	–
Autoinflammatory diseases	10 (1.6)	2 (3.5)	3.99 (0.74–14.77)	0.069	8.98 (0.94–63.49)	0.040
Vasculitis	47 (7.6)	17 (29.3)	6.18 (3.10–12.13)	<0.001	2.09 (0.93–4.56)	0.070
Systemic autoimmune diseases	105 (17.0)	12 (20.7)	1.99 (0.95–3.97)	0.059	2.65 (1.15–5.95)	0.020

Values are presented as frequency (percentage) unless otherwise indicated.
*Total number of survivors and non-survivors as presented excludes 19 patients whose status at day 21 was unknown at the time of data cut-off.
†ORs were calculated for non-survivors, using survivors as reference.
‡Adjusted for age and sex.
§Penalised logistic regression (Firth method) was used due to low number of patients (n<5) in an analysed group.
¶Two missing values for comorbidities except for obesity where 83 values are missing.
aOR, adjusted OR; COPD, chronic obstructive pulmonary disease.

combination with azithromycin, was the most used therapy, in 9.4% (65/694) of the patients. Routinely available antiviral therapies (ritonavir in combination with lopinavir or darunavir) were mainly administered to hospitalised patients (10.5%; 27/256). Use of anti-cytokine therapies (tocilizumab and anakinra) was rare (0.6%) (online supplemental table 10).

DISCUSSION

The current observational, multicentre, French cohort study examined the frequency of severe COVID-19 and factors associated with outcomes of SARS-CoV-2 infection in patients with iRMD. Though similar in objective to the Global Rheumatology Alliance Study,[23] the present investigation analysed a larger patient population with iRMD from a single country and monitored individual data for at least 21 days after the first clinical sign of disease to confirm evolution of COVID-19 and retrieve missing data. While the results do not suggest causality, they inform on treatment options for COVID-19 in patients with iRMD.

Underlying immune dysfunction and treatment with immunosuppressive agents raised the possibility of an increased COVID-19 severity in patients with iRMD. In addition to age (≥75 years), comorbidities such as chronic respiratory disease, cardiovascular disease, diabetes, hypertension, obesity (BMI ≥40 kg/m^2), and renal failure increased the risk for severe COVID-19, again reflecting the observed trend in subjects with non-rheumatic diseases.[6 7] In the present study, death was observed more frequently in patients with iRMD, but this difference in the frequency of mortality did not reach statistical significance. Systemic autoimmune diseases (mainly systemic lupus, systemic sclerosis, Sjögren syndrome and myositis) and vasculitis were found to be independent factors for severe infection and/or mortality, suggesting that a history of drug-induced immunosuppression may worsen the prognosis.[24 25] For autoinflammatory diseases, the results should be interpreted with caution due to the very low number of patients (n=13). The use of higher continual doses of corticosteroids in these populations could have led to a poor outcome.

Within the current cohort, RMD treatments had a variable association with COVID-19 severity and mortality. We assessed the association of each medication separately because the number of different medications was too high to compare to a single reference group and also because of possible overlap between medications, such as conventional synthetic DMARD and biologic DMARD (bDMARD) combination therapy. Studies of patients with RMD and IBD showed that long-term corticosteroid use increased the risk of severe COVID-19 infection and death.[8 11] In contrast, two other studies, CHIC[26] and

Table 7 Association between rheumatic disease treatments and survival*

	Survivors (n=617)	Non-survivors (n=58)	OR (95% CI)†	P value	aOR (95% CI)†‡	P value‡
Rheumatic or inflammatory disease treatments§						
Corticosteroid	172 (27.9)	39 (68.4)	5.59 (3.11–10.05)	<0.001	2.64 (1.36–5.12)	0.004
Daily prednisone doses ≥10 mg or equivalent	50 (29.4)	21 (53.8)	2.80 (1.38–5.70)	0.005	2.91 (1.28–6.59)	0.011
NSAIDs	73 (11.9)	0	NA	NA	NA	NA
Colchicine¶	20 (3.2)	4 (7.0)	2.45 (0.75–6.50)	0.10	8.21 (1.60–37.97)	0.009
Hydroxychloroquine¶	52 (8.4)	2 (3.5)	0.48 (0.10–1.47)	0.28	0.93 (0.16–3.55)	0.92
Methotrexate	237 (38.5)	12 (21.1)	0.43 (0.22–0.82)	0.011	0.34 (0.16–0.70)	0.003
Leflunomide	27 (4.4)	0	NA	NA	NA	NA
Sulfasalazine	9 (1.5)	0	NA	NA	NA	NA
Mycophenolate mofetil/mycophenolic acid¶	14 (2.3)	2 (3.5)	1.87 (0.36–6.32)	0.38	14.20 (2.26–70.24)	0.002
Azathioprine	8 (1.3)	1 (1.8)	NA	NA	NA	NA
IgIV	6 (1.0)	1 (1.8)	NA	NA	NA	NA
Biologics						
Anti-TNF¶	194 (31.5)	4 (7.0)	0.18 (0.06–0.44)	<0.001	0.74 (0.22–2.01)	0.58
Anti-IL-6R¶	25 (4.1)	1 (1.8)	0.62 (0.07–2.43)	0.58	0.50 (0.05–2.38)	0.47
Rituximab	27 (4.4)	7 (12.3)	3.05 (1.27–7.36)	0.013	4.04 (1.35–12.04)	0.012
Anti-IL-17a	25 (4.1)	0	NA	NA	NA	NA
Anti-IL-1	6 (1.0)	2 (3.5)	NA	NA	NA	NA
Abatacept¶	17 (2.8)	1 (1.8)	0.91 (0.10–3.71)	0.92	0.58 (0.06–3.09)	0.59
JAK inhibitor¶	18 (2.9)	2 (3.5)	1.46 (0.29–4.77)	0.59	1.36 (0.23–5.61)	0.71
Other biologic	16 (2.6)	0	NA	NA	NA	NA

Values are presented as frequency (percentage) unless otherwise indicated.
Not applicable (NA) when <10/617 patients or 0 non-survivors.
*Total number of survivors and non-survivors as presented excludes 19 patients whose status at day 21 was unknown at the time of data cut-off.
†ORs were calculated for non-survivors, using survivors as reference.
‡Adjusted for age and sex.
§Two patients with missing information for treatments.
¶Penalised logistic regression (Firth method) was used due to low number of patients (n<5) in an analysed group.
aOR, adjusted OR; IgIV, immunoglobulin intravenous; IL, interleukin; NSAIDs, non-steroidal anti-inflammatory drugs; TNF, tumour necrosis factor.

RECOVERY,[27] recently demonstrated that methylprednisolone 250 mg or dexamethasone 6 mg were beneficial when patients with COVID-19 develop a severe form (cytokine storm syndrome), respectively. These studies and ours suggest that the beneficial or aggravating effect of corticosteroids is a matter of timing. Conversely, anti-TNFα therapies were associated with a lower frequency of severe infection or mortality and also with less frequent hospitalisation. These findings are consistent with a previous study that found lower odds of hospitalisation with bDMARD/targeted synthetic DMARD monotherapy, driven largely by anti-TNF therapies.[8] Of note, similar observations have been made outside the scope of SARS-CoV-2, suggesting a beneficial effect of bDMARDs on the risk of sepsis after serious infection or a fatal outcome.[28] Methotrexate use significantly reduced mortality and was not associated with the risk of severe disease, yet we caution against causal inference regarding drug effects given significant potential for residual confounding, notably indication bias. Interestingly, IL-6 inhibitors did not appear to affect COVID-19 severity or related death in our study. However, the number of patients taking anti-IL-6 agents or JAK inhibitors was small and may have been insufficient to demonstrate other underlying effects. Likewise, the small number of patients treated with colchicine, mycophenolate mofetil, azathioprine, and rituximab (less than 10 patients with severe disease or death) does not allow for conclusions on a potential risk. Furthermore, potential indication bias exists since these drugs are mostly prescribed in patients with autoinflammatory, systemic autoimmune diseases, and vasculitis, all of which were associated with a higher frequency of severe infection in our cohort. Finally, as patients with active or very active iRMD tend to be more heavily medicated and we were unable to obtain information about disease activity, we cannot rule out that the higher frequencies identified with some treatments could be confounded by indication. To further explore these results, ancillary studies will be performed, with the potential merging of data with GRA and EULAR cohorts. Similarly, treatment with agents such as HCQ did not appear to have a positive impact on the frequency of severe disease or death.[29] Our study shows that patients previously treated with HCQ can develop COVID-19, consistent with a report of severe COVID-19 in patients with lupus taking HCQ.[30] We also collected information about the antiviral and immunomodulating therapies, notably HCQ, used by French clinicians to manage COVID-19. Our study is informative, but not built to inform on potential efficacy of antiviral and/or immunomodulating therapies in COVID-19 management.

Despite communication to all French paediatric rheumatology centres, the RMD COVID-19 cohort contained only 13 children that displayed minor symptoms. This strengthens the previous reports on the lack of severe COVID-19 in children with rheumatic diseases.[31] In addition, no iRMD COVID-19 paediatric case fulfilled the criteria for the recently recognised SARS-CoV-2-related paediatric inflammatory multisystem syndrome, a post-infection disease.[32] This latter observation could suggest that inflammatory diseases in children are not a risk factor for this specific syndrome.

There are several limitations to the current study. The first limitation is that no formal sample size calculation was performed for primary and secondary objectives and we cannot exclude a lack of adequate statistical power to detect significant differences. Moreover, due to the small number of events, multivariate analysis was not performed for death. The mortality rate in our cohort (8.3%) was similar to a previous report (7.2%).[23]

Though the current study analysed a large patient population assessed within a single country, the impact of selection bias on the observed frequency of death cannot be dismissed. During the beginning phases of the pandemic, immense pressure on the French medical system precluded PCR testing in all patients and focused confirmatory efforts on subjects with the most severe disease. Despite this shortcoming of unconfirmed diagnosis, our cohort includes a substantial ambulatory subgroup with mild disease. Since the French RMD COVID-19 cohort is an observational multicentre cohort study, we cannot rule out that all highly suspected/confirmed symptomatic patients with COVID-19 were enrolled by comparison to LICORNE registry of all suspected/confirmed patients with COVID-19 admitted at the Lille University Hospital. A potential selection bias in favour of inclusion of more patients with severe iRMD COVID-19 could explain the observed non-significant higher mortality in hospitalised population with iRMD compared with a cohort with non-iRMD. Furthermore, the care provided for patients of LICORNE registry may be different than that delivered to patients from the French iRMD COVID-19 cohort. Indeed, even if all patients come from the same country, discrepancies could exist in the care delivered to patients across the country, with respect to the type of hospital (secondary or tertiary care, academic, non-academic), resources available (including ICU beds and ventilators), the availability of alternative care and palliative care facilities, and the treatment approach itself, especially at the beginning of the pandemic. Moreover, within countries, another variable is the differential effect of the pandemic over time across the country. Nevertheless, an increased risk of death has recently been shown in 19 patients with RA/systemic lupus erythematosus/psoriasis-COVID-19 with an adjusted HR of 1.19 (1.11–1.27).[6]

In conclusion, the present study assesses the frequency of mild, moderate and severe COVID-19 and mortality in a large cohort of patients with rheumatic, autoinflammatory and autoimmune diseases being treated in France. In addition to monitoring the evolution of COVID-19 severity and outcomes, we confirmed the impact of comorbidities within the population with iRMD and generated preliminary data on the effects of anti-rheumatic therapies on disease prognosis following SARS-CoV-2 infection. We observed a higher frequency of death in the hospitalised population with iRMD compared with a cohort with non-iRMD from hospitalised patients with similar comorbidities, although the difference did not reach statistical significance. Furthers studies are warranted to confirm these results.

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Tables

Supplementary Table 1: Demographic and clinical characteristics of patients with positive PCR or serology, according to severity of COVID-19

	All patients (n=408)	Patients with mild infection (n=193)	Patients with moderate infection (n=138)	Patients with severe infection (n=77)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age (years)						<0.001		<0.001
18-54	166 (40.7)	112 (58.0)	44 (31.9)	10 (13.0)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	75 (18.4)	40 (20.7)	26 (18.8)	9 (11.7)	2.13 (0.83 to 5.48)	0.12	2.14 (0.83 to 5.53)	0.12
65-74	75 (18.4)	28 (14.5)	29 (21.0)	18 (23.4)	4.93 (2.15 to 11.30)	<0.001	4.88 (2.11 to 11.26)	<0.001
≥75	92 (22.5)	13 (6.7)	39 (28.3)	40 (51.9)	12.00 (5.61 to 25.68)	<0.001	12.47 (5.78 to 26.90)	<0.001
Mean ± SD	59.4 ± 16.8	52.0 ± 14.6	62.6 ± 16.0	72.3 ± 13.7				
Female gender	258 (63.2)	127 (65.8)	92 (66.7)	39 (50.7)	0.53 (0.32 to 0.87)	0.012	0.46 (0.27 to 0.81)	0.006
Comorbidities[3]								
Respiratory disease (all)	61 (15.0)	22 (11.5)	19 (13.8)	20 (26.0)	2.47 (1.35 to 4.52)	0.004	1.93 (0.98 to 3.78)	0.057
Interstitial lung disease	22 (5.4)	6 (3.1)	7 (5.1)	9 (11.7)	3.22 (1.32 to 7.83)	0.010	2.64 (0.94 to 7.36)	0.065
COPD	19 (4.7)	8 (4.2)	4 (2.9)	7 (9.1)	2.64 (1.01 to 6.95)	0.049	1.32 (0.46 to 3.77)	0.61
Asthma	25 (6.2)	10 (5.2)	9 (6.5)	6 (7.8)	1.38 (0.53 to 3.58)	0.51	1.75 (0.60 to 5.06)	0.31
Cardiac disease (all)	67 (16.5)	12 (6.3)	28 (20.3)	27 (35.1)	3.90 (2.20 to 6.92)	<0.001	1.59 (0.82 to 3.08)	0.17
Coronary heart diseases	54 (13.3)	9 (4.7)	22 (15.9)	23 (29.9)	4.09 (2.22 to 7.55)	<0.001	1.58 (0.77 to 3.20)	0.21
Stroke	20 (4.9)	3 (1.6)	10 (7.2)	7 (9.1)	2.43 (0.94 to 6.31)	0.068	1.56 (0.55 to 4.46)	0.40
Diabetes	50 (12.3)	7 (3.7)	23 (16.7)	20 (26.0)	3.50 (1.86 to 6.58)	<0.001	2.18 (1.09 to 4.38)	0.029
Obesity						0.16		0.059
<30	268 (74.2)	137 (77.8)	84 (71.8)	47 (69.1)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	77 (21.3)	34 (19.3)	28 (23.9)	15 (22.1)	1.14 (0.60 to 2.17)	0.70	1.43 (0.70 to 2.94)	0.33
≥40	16 (4.4)	5 (2.8)	5 (4.3)	6 (8.8)	2.82 (0.98 to 8.14)	0.055	4.16 (1.24 to 13.99)	0.021
Hypertension	123 (30.3)	27 (14.1)	50 (36.2)	46 (59.7)	4.86 (2.88 to 8.19)	<0.001	2.51 (1.37 to 4.59)	0.003
Smoking	34 (8.4)	17 (8.9)	8 (5.8)	9 (11.7)	1.61 (0.72 to 3.60)	0.25	1.69 (0.68 to 4.22)	0.26
Cancer	22 (5.4)	7 (3.7)	9 (6.5)	6 (7.8)	1.65 (0.63 to 4.37)	0.31	0.90 (0.31 to 2.64)	0.85
Chronic renal failure	34 (8.4)	8 (4.2)	10 (7.2)	16 (20.8)	4.53 (2.19 to 9.38)	<0.001	2.36 (1.04 to 5.34)	0.040
No. of patients with at least 1 comorbidity	303 (74.6)	119 (62.3)	112 (81.2)	72 (93.5)	6.11 (2.39 to 15.59)	<0.001	3.42 (1.29 to 9.09)	0.013
Disease History[4]						<0.001		0.056
Chronic inflammatory arthritis	249 (61.0)	139 (72.0)	75 (54.3)	35 (45.5)	1.00 (ref.)	-	1.00 (ref.)	-
Auto-inflammatory diseases	8 (2.0)	1 (0.5)	4 (2.9)	3 (3.9)	NA	NA	NA	NA

Vasculitis	50 (12.3)	11 (5.7)	19 (13.8)	20 (26.0)	4.06 (2.08 to 7.88)	<0.001	2.39 (1.14 to 4.98)	0.021
Systemic auto-immune diseases	77 (18.9)	34 (17.6)	30 (21.7)	13 (16.9)	1.27 (0.62 to 2.46)	0.50	1.58 (0.73 to 3.30)	0.24

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]2 missing value for comorbidities except for obesity where 47 values are missing.[4]Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: COPD, chronic obstructive pulmonary disease; OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/408 patients or when 0 patients with severe infection.

Supplementary Table 2: Treatments of patients with positive PCR or serology, according to severity of COVID-19

	All patients (n=408)	Patients with mild infection (n=193)	Patients with moderate infection (n=138)	Patients with severe infection (n=77)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Rheumatic or inflammatory disease treatments[3]								
Corticosteroid	158 (38.8)	46 (23.8)	68 (49.3)	44 (57.9)	2.62 (1.57 to 4.35)	<0.001	1.72 (0.98 to 3.04)	0.059
Daily prednisone doses ≥10 mg or equivalent	55 (35.0)	15 (32.6)	21 (31.3)	19 (43.2)	1.63 (0.80 to 3.33)	0.18	1.40 (0.64 to 3.04)	0.40
NSAIDs[4]	29 (7.1)	20 (10.4)	8 (5.8)	1 (1.3)	0.21 (0.02 to 0.83)	0.072	0.43 (0.05 to 1.77)	0.33
Colchicine[4]	19 (4.7)	8 (4.1)	7 (5.1)	4 (5.3)	1.27 (0.38 to 3.47)	0.67	2.27 (0.57 to 7.90)	0.22
Hydroxychloroquine[4]	32 (7.9)	18 (9.3)	11 (8.0)	3 (3.9)	0.49 (0.13 to 1.35)	0.22	0.76 (0.19 to 2.35)	0.66
Methotrexate	156 (38.3)	83 (43.0)	48 (34.8)	25 (32.9)	0.75 (0.44 to 1.27)	0.28	1.79 (0.44 to 1.40)	0.42
Leflunomide	11 (2.7)	5 (2.6)	6 (4.3)	0	NA	NA	NA	NA
Sulfasalazine	4 (1.0)	1 (0.5)	3 (2.2)	0	NA	NA	NA	NA
Mycophenolate Mofetil / mycophenolic acid	9 (2.2)	3 (1.6)	4 (2.9)	2 (2.6)	NA	NA	NA	NA
Azathioprine	6 (1.5)	3 (1.6)	2 (1.4)	1 (1.3)	NA	NA	NA	NA
IgIV	6 (1.5)	2 (1.0)	2 (1.4)	2 (2.6)	NA	NA	NA	NA
Biologics								
anti-TNF	90 (22.1)	67 (34.7)	18 (13.0)	5 (6.6)	0.20 (0.08 to 0.52)	<0.001	0.42 (0.16 to 1.15)	0.090
anti-IL6[4]	13 (3.2)	6 (3.1)	5 (3.6)	2 (2.6)	0.94 (0.18 to 3.26)	0.93	0.65 (0.12 to 2.53)	0.58
Rituximab	21 (5.2)	6 (3.1)	5 (3.6)	10 (13.2)	4.41 (1.80 to 10.80)	0.001	6.35 (2.23 to 18.11)	<0.001
anti-IL17a[4]	16 (3.9)	10 (5.2)	4 (2.9)	2 (2.6)	0.73 (0.14 to 2.47)	0.67	1.96 (0.36 to 7.32)	0.38
anti-IL1	5 (1.2)	0	3 (2.2)	2 (2.6)	NA	NA	NA	NA
Abatacept[4]	14 (3.4)	6 (3.1)	7 (5.1)	1 (1.3)	0.47 (0.05 to 1.96)	0.40	0.32 (0.03 to 1.56)	0.24
JAK inhibitor	9 (2.2)	2 (1.0)	3 (2.2)	4 (5.3)	NA	NA	NA	NA
Other biologic	9 (2.2)	4 (2.1)	5 (3.6)	0	NA	NA	NA	NA

Values are presented as frequency (percentage).
[1] Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]1 missing value. [4] Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/408 patients or 0 patients with moderate or severe infection.

Supplementary Table 3: Demographic and clinical characteristics of rheumatoid arthritis patients according to severity of COVID-19

	All patients (n=213)	Patients with mild infection (n=129)	Patients with moderate infection (n=55)	Patients with severe infection (n=29)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age[3] (years)						<0.001		<0.001
18-54	70 (32.9)	58 (45.0)	10 (18.2)	2 (6.9)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	53 (24.9)	43 (33.3)	8 (14.5)	2 (6.9)	1.33 (0.20 to 8.88)	0.76	1.24 (0.19 to 8.31)	0.82
65-74	44 (20.7)	22 (17.1)	15 (27.3)	7 (24.1)	5.48 (1.38 to 30.51)	0.026	5.00 (1.25 to 27.98)	0.035
≥75	46 (21.6)	6 (4.7)	22 (40.0)	18 (62.1)	17.79 (5.17 to 93.32)	<0.001	16.89 (4.90 to 88.60)	<0.001
Mean ± SD	61.0 ± 15.2	54.3 ± 12.4	68.7 ± 13.8	76.0 ± 10.9				
Female gender	156 (73.2)	100 (77.5)	38 (69.1)	18 (62.1)	0.55 (0.24 to 1.24)	0.15	0.59 (0.23 to 1.47)	0.26
Comorbidities[4]								
Respiratory disease (all)	30 (14.2)	11 (8.6)	13 (23.6)	6 (20.7)	1.73 (0.64 to 4.68)	0.28	1.30 (0.42 to 4.07)	0.65
Interstitial lung disease	7 (3.3)	1 (0.8)	3 (5.5)	3 (10.3)	NA	NA	NA	NA
COPD[3]	11 (5.2)	4 (3.1)	5 (9.1)	2 (6.9)	1.67 (0.31 to 6.30)	0.51	0.78 (0.13 to 3.45)	0.77
Asthma[3]	14 (6.6)	6 (4.7)	6 (10.9)	2 (6.9)	1.25 (0.23 to 4.48)	0.77	1.46 (0.21 to 7.53)	0.68
Cardiac disease (all)	32 (15.1)	4 (3.1)	17 (30.9)	11 (37.9)	4.72 (1.96 to 11.33)	<0.001	1.27 (0.46 to 3.56)	0.65
Coronary heart diseases	26 (12.3)	3 (2.3)	14 (25.5)	9 (31.0)	4.39 (1.73 to 11.16)	0.002	1.04 (0.35 to 3.14)	0.94
Stroke	9 (4.2)	1 (0.8)	5 (9.1)	3 (10.3)	NA	NA	NA	NA
Diabetes	26 (12.3)	7 (5.5)	12 (21.8)	7 (24.1)	2.75 (1.04 to 7.28)	0.042	1.24 (0.41 to 3.73)	0.70
Obesity[3]						0.008		0.008
<30	146 (78.9)	96 (82.1)	36 (78.3)	14 (63.6)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	33 (17.9)	19 (16.2)	10 (21.7)	4 (18.2)	1.39 (0.40 to 4.06)	0.57	1.73 (0.46 to 5.85)	0.40
≥40	6 (3.2)	2 (1.7)	0	4 (18.2)	NA	NA	NA	NA
Hypertension	74 (34.9)	28 (21.9)	25 (45.5)	21 (72.4)	6.44 (2.69 to 15.44)	<0.001	3.36 (1.23 to 8.60)	0.017
Smoking[3]	20 (9.4)	13 (10.2)	5 (9.1)	2 (6.9)	0.81 (0.16 to 2.78)	0.77	1.21 (0.20 to 5.14)	0.81
Cancer	14 (6.6)	4 (3.1)	5 (9.1)	5 (17.2)	4.03 (1.25 to 13.02)	0.020	3.06 (0.77 to 12.21)	0.11
Chronic renal failure	8 (3.8)	2 (1.6)	1 (1.8)	5 (17.2)	NA	NA	NA	NA
No. of patients with at least 1 comorbidity	159 (75.0)	82 (64.1)	49 (89.1)	28 (96.6)	11.11 (1.47 to 83.81)	0.020	4.39 (0.54 to 35.39)	0.17

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group. [4]1 missing value for comorbidities except for obesity where 28 values are missing.
Abbreviations: OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/213 patients or 0 patients with moderate or severe infection.

Supplementary Table 4: Treatments of rheumatoid arthritis patients according to severity of COVID-19

	All patients (n=213)	Patients with mild infection (n=129)	Patients with moderate infection (n=55)	Patients with severe infection (n=29)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Corticosteroid	72 (34.0)	31 (24.0)	23 (41.8)	18 (64.3)	4.33 (1.88 to 9.99)	<0.001	2.57 (1.01 to 6.52)	0.047
Daily prednisone doses ≥10 mg or equivalent	13 (18.1)	3 (9.7)	3 (13.0)	7 (38.9)	5.09 (1.43 to 18.17)	0.012	4.10 (0.99 to 16.96)	0.051
NSAIDs[4]	22 (10.4)	19 (14.7)	3 (5.5)	0	NA	NA	NA	NA
Hydroxychloroquine[4]	10 (4.7)	5 (3.9)	3 (5.5)	2 (7.1)	1.96 (0.36 to 7.59)	0.39	5.13 (0.77 to 29.07)	0.079
Methotrexate	131 (61.8)	86 (66.7)	31 (56.4)	14 (50.0)	0.57 (0.26 to 1.27)	0.17	0.49 (0.20 to 1.20)	0.12
Leflunomide	18 (8.5)	13 (10.1)	5 (9.1)	0	NA	NA	NA	NA
Sulfasalazine	1 (0.5)	0	1 (1.8)	0	NA	NA	NA	NA
Biologics								
anti-TNF[4]	50 (23.6)	41 (31.8)	8 (14.5)	1 (3.6)	0.15 (0.02 to 0.60)	0.028	0.33 (0.04 to 1.47)	0.22
anti-IL6[4]	17 (8.0)	14 (10.9)	2 (3.6)	1 (3.6)	0.56 (0.06 to 2.38)	0.52	0.89 (0.08 to 4.95)	0.91
Rituximab[4]	13 (6.1)	7 (5.4)	3 (5.5)	3 (10.7)	2.28 (0.55 to 7.61)	0.22	5.97 (1.18 to 27.63)	0.027
Abatacept[4]	16 (7.5)	9 (7.0)	6 (10.9)	1 (3.6)	0.60 (0.06 to 2.56)	0.57	0.45 (0.04 to 2.45)	0.43
JAK inhibitor[4]	17 (8.0)	9 (7.0)	4 (7.3)	4 (14.3)	2.33 (0.67 to 6.95)	0.16	2.79 (0.68 to 10.39)	0.14
Other biologic	2 (0.9)	2 (1.6)	0	0	NA	NA	NA	NA

Values are presented as frequency (percentage).
[1] Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]1 missing value. [4] Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/213 patients or 0 patients with moderate or severe infection.

Supplementary Table 5: Demographic and clinical characteristics according to hospitalization status

	Outpatients (n=438)	Inpatients (n=256)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age (years)				<0.001		<0.001
18-54	268 (61.2)	68 (26.6)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	95 (21.7)	43 (16.8)	1.78 (1.14 to 279)	0.011	1.80 (1.14 to 2.82)	0.011
65-74	52 (11.9)	55 (21.5)	4.17 (2.62 to 6.62)	<0.001	4.06 (2.55 to 6.47)	<0.001
≥75	23 (5.3)	90 (35.2)	15.42 (9.08 to 26.19)	<0.001	15.51 (9.11 to 26.40)	<0.001
Mean ± SD	50.6 ± 13.9	65.4 ± 16.1				
Female gender	309 (70.6)	153 (59.8)	0.62 (0.45 to 0.86)	0.004	0.63 (0.44 to 0.90)	0.012
Comorbidities[3]						
Respiratory disease (all)	53 (12.2)	46 (18.0)	1.58 (1.03 to 2.43)	0.036	1.24 (0.76 to 2.02)	0.38
Interstitial lung disease	10 (2.3)	16 (6.3)	2.84 (1.27 to 6.36)	0.011	2.36 (0.92 to 6.06)	0.075
COPD	14 (3.2)	14 (5.5)	1.74 (0.82 to 3.72)	0.15	0.62 (0.27 to 1.43)	0.26
Asthma	32 (7.3)	20 (7.8)	1.07 (0.60 to 1.91)	0.82	1.34 (0.70 to 2.57)	0.37
Cardiac disease (all)	22 (5.0)	63 (24.6)	6.14 (3.67 to 10.28)	<0.001	2.41 (1.35 to 4.30)	0.003
Coronary heart diseases	15 (3.4)	53 (20.7)	7.33 (4.03 to 13.31)	<0.001	2.73 (1.40 to 5.30)	0.003
Stroke	7 (1.6)	18 (7.0)	NA	NA	NA	NA
Diabetes	12 (2.8)	50 (19.5)	8.58 (4.47 to 16.46)	<0.001	5.37 (2.66 to 10.85)	<0.001
Obesity				0.032		0.027
<30	303 (78.7)	156 (70.9)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	74 (19.2)	52 (23.6)	1.37 (0.91 to 2.04)	0.13	1.55 (0.99 to 2.44)	0.055
≥40	8 (2.1)	12 (5.5)	NA	NA	NA	NA
Hypertension	71 (16.3)	111 (43.4)	3.94 (2.76 to 5.61)	<0.001	1.99 (1.33 to 2.98)	<0.001
Smoking	48 (11.0)	22 (8.6)	0.76 (0.45 to 1.29)	0.31	0.78 (0.44 to 1.41)	0.42
Cancer	13 (3.0)	20 (7.8)	2.76 (1.35 to 5.64)	0.006	1.56 (0.70 to 3.47)	0.27
Chronic renal failure	11 (2.5)	31 (12.1)	5.32 (2.63 to 10.79)	<0.001	2.76 (1.26 to 6.04)	0.011
No. of patients with at least 1 comorbidity	274 (62.8)	218 (85.2)	3.39 (2.28 to 5.04)	<0.001	2.05 (1.33 to 3.14)	0.001
Disease History				<0.001		<0.001
Chronic inflammatory arthritis	325 (74.2)	139 (54.3)	1.00 (ref.)	-	1.00 (ref.)	-
Auto-inflammatory diseases	5 (1.14)	7 (2.7)	NA	NA	NA	NA
Vasculitis	21 (4.8)	44 (17.2)	4.90 (2.81 to 8.54)	<0.001	2.61 (1.40 to 4.87)	0.003
Systemic auto-immune diseases	73 (16.7)	49 (19.1)	1.57 (1.04 to 2.37)	0.032	2.06 (1.29 to 3.29)	0.003

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for inpatients, using outpatients as reference. [2]Adjusted for age and sex. [3]2 missing values for comorbidities except for obesity where 89 values are missing.
Abbreviations: OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/438 patients.

Supplementary Table 6: Rheumatic and inflammatory disease treatments according to hospitalization status

	Outpatient (n=438)	Inpatient (n=256)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Rheumatic or inflammatory disease treatments[3]						
Corticosteroid	88 (20.1)	127 (50.0)	3.98 (2.83 to 5.58)	<0.001	2.76 (1.90 to 4.02)	<0.001
Daily prednisone doses ≥10 mg or equivalent	28 (31.8)	45 (36.0)	1.21 (0.68 to 2.15)	0.53	1.01 (0.53 to 1.92)	0.99
NSAIDs	61 (13.9)	12 (4.7)	0.31 (0.16 to 0.58)	<0.001	0.45 (0.23 to 0.89)	0.021
Colchicine	12 (2.7)	12 (4.7)	1.76 (0.78 to 3.98)	0.17	4.13 (1.59 to 10.74)	0.004
hydroxychloroquine	40 (9.1)	17 (6.7)	0.71 (0.40 to 1.29)	0.26	1.17 (0.60 to 2.28)	0.65
Methotrexate	164 (37.4)	88 (34.6)	0.89 (0.64 to 1.22)	0.46	0.71 (0.50 to 1.02)	0.066
Leflunomide	19 (4.3)	8 (3.1)	0.72 (0.31 to 1.66)	0.44	0.94 (0.38 to 2.29)	0.89
Sulfasalazine	5 (1.1)	4 (1.6)	NA	NA	NA	NA
Mycophenolate Mofetil / mycophenolic acid	9 (2.1)	7 (2.8)	1.35 (0.50 to 3.67)	0.56	3.22 (1.09 to 9.57)	0.035
Azathioprine	5 (1.1)	4 (1.6)	NA	NA	NA	NA
IgIV	3 (0.7)	4 (1.6)	NA	NA	NA	NA
Biologics						
anti-TNF	170 (38.8)	32 (12.6)	0.23 (0.15 to 0.35)	<0.001	0.35 (0.22 to 0.55)	<0.001
anti-IL6	19 (4.3)	7 (2.8)	0.63 (0.26 to 1.51)	0.30	0.56 (0.21 to 1.49)	0.24
Rituximab	16 (3.7)	18 (7.1)	2.01 (1.01 to 4.02)	0.048	1.95 (0.90 to 4.23)	0.091
anti-IL17a	19 (4.3)	8 (3.1)	0.72 (0.31 to 1.66)	0.44	1.45 (0.60 to 3.53)	0.41
anti-IL1	3 (0.7)	5 (2.0)	NA	NA	NA	NA
anti-IL4/IL13	1 (0.2)	0 (0.0)	NA	NA	NA	NA
abatacept	10 (2.3)	8 (3.1)	1.39 (0.54 to 3.57)	0.49	1.24 (0.43 to 3.60)	0.69
JAK inhibitor	13 (3.0)	8 (3.1)	1.06 (0.44 to 2.60)	0.89	0.94 (0.35 to 2.53)	0.91
Other biologic	11 (2.5)	5 (2.0)	0.78 (0.27 to 2.27)	0.65	0.89 (0.28 to 2.81)	0.84

Values are presented as frequency (percentage).
[1]Odds-ratio were calculated for inpatients, using outpatients as reference. [2]Adjusted for age and sex. [3]2 missing values.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/438 patients.

Supplementary Table 7: Multivariable analyses for hospitalization status

Variable	Imputed analysis[1] (n=694)			Available case analysis (n=601)		
	n / N	OR [95%CI]	P	n / N	OR [95%CI]	P
Age	256 / 694	1.05 (1.04 to 1.07)	<0.001	218 / 601	1.05 (1.04 to 1.06)	<0.001
Female gender	153 / 462	0.65 (0.43 to 0.99)	0.046	129 / 365	0.62 (0.41 to 0.93)	0.21
Diabetes	50 / 62	4.33 (2.07 to 9.07)	<0.001	44 / 55	4.39 (2.08 to 9.27)	<0.001
BMI	256 / 694	1.06 (1.02 to 1.10)	0.002	218 / 601	1.06 (1.02 to 1.09)	0.003
Disease History			0.039	-	-	-
Chronic inflammatory arthritis	139 / 464	1.00 (ref.)	-	-	-	-
Auto-inflammatory diseases	7 / 12	6.37 (1.45 to 28.05)	0.014	-	-	-
Vasculitis	44 / 65	1.60 (0.76 to 3.31)	0.21	-	-	-
Systemic auto-immune diseases	49 / 122	1.51 (0.87 to 2.62)	0.15	-	-	-
Corticosteroids	128 / 216	1.94 (1.24 to 3.05)	0.004	108 / 188	2.25 (1.47 to 3.45)	<0.001
Colchicine	12 / 24	3.34 (1.14 to 9.79)	0.028	12 / 22	3.87 (1.39 to 10.75)	0.009
Anti-TNF	32 / 202	0.55 (0.32 to 0.95)	0.031	28 / 175	0.47 (0.28 to 0.78)	0.003

Odds-ratio were calculated using multivariable penalized logistic regression models (Firth method), using a forward selection method, with patients with mild or moderate infection as reference. Only variables selected by the model are presented. Full model included age, sex, cardiac disease, diabetes, BMI, hypertension, chronic renal failure, disease history, corticosteroids, NSAIDs, colchicine, Mycophenolate Mofetil / mycophenolic acid and anti-TNF.

n / N indicates the number of events / number of cases.

[1]Odds-ratio and p-value were calculated after multiple imputations (m=10) to handle missing data.

Abbreviations: OR, odds-ratio; CI, confidence interval; BMI, body mass index.

Supplementary Table 8: Differences in predefined confounders factors between cases and controls before and after propensity score matching

	Before matching			After matching		
	Cases from French RMD COVID-19 cohort (n=218)	**Controls from LICORNE (n=280)**	**ASD (%)**	**Cases from French RMD COVID-19 cohort (n=175)**	**Controls from LICORNE (n=175)**	**ASD (%)**
Age	65.0 ± 16.4	62.9 ± 15.0	13.2	64.1 ± 16.2	64.6 ± 15.3	3.3
Sex (Male)	89 (40.8)	194 (69.3)	59.7	89 (50.9)	93 (53.1)	4.6
BMI	27.5 ± 6.3	29.2 ± 6.7	26.0	28.1 ± 6.6	28.3 ± 6.3	3.2
Cardiac disease	57 (26.1)	66 (23.6)	6.0	44 (25.1)	43 (24.6)	1.3
Diabetes	45 (20.6)	79 (28.2)	17.7	42 (24.0)	40 (22.9)	2.7
Hypertension	97 (44.5)	141 (50.4)	11.8	80 (45.7)	79 (45.1)	1.2
Renal failure	27 (12.4)	26 (9.3)	10.0	19 (10.9)	18 (10.3)	1.9

Values are presented as mean ± standard deviation or frequency (percentage).
Abbreviations: ASD, absolute standardized difference; BMI, body mass index.

Supplementary Table 9. Summary of deaths during study

Patient Number **Age/Gender**	**Type of inflammatory RMD**	**Comorbidities**	**Concomitant corticosteroids**	**DMARDs**	**COVID-19 Pulmonary complication**	**COVID-19 treatment**
1 34/M	Behçet disease	Diabetes Hypertension Obesity (BMI=43)	none	Colchicine	Yes	HCQ Corticosteroids Anti-IL6
2 37/M	Systemic Sclerosis	Cardiac disease Hypertension ILD Stroke	10 mg/day	Mycophenolate Mofetil Rituximab	Yes	none
3 50/M	Rheumatoid Arthritis	Cancer	4 mg/day	Methotrexate Rituximab	Yes	Azithromycin
4 57/M	Recurrent periodic fever and AA amyloidosis	Hypertension Renal insufficiency	none	Colchicine Anakinra	Yes	none
5 58/M	Inflammatory Myopathy	Smoker	10 mg/day	none	Yes	Lopinavir Ritonavir
6 61/F	Sarcoidosis	Cardiac disease COPD Diabetes Hypertension Obesity (BMI=38) Smoker	7.5 mg/day	Methotrexate Infliximab	Yes	Lopinavir Ritonavir
7 62/M	Spondyloarthritis	Renal insufficiency		Adalimumab	Yes	none
8 63/F	Systemic Lupus Erythematosus	Diabetes Hypertension Obesity (BMI=33)	15 mg/day	HCQ	Yes	none
9 63/F	Systemic Lupus Erythematosus	Hypertension Renal insufficiency	5 mg/day	Mycophenolate Mofetil	Yes	none
10 64/F	Rheumatoid Arthritis	Diabetes Hypertension PID	5 mg/day	HCQ Rituximab	Yes	Azithromycin HCQ Corticosteroids
11 66/M	Psoriatic arthritis	Asthma		Adalimumab	Yes	none
12 67/F	Rheumatoid Arthritis	Cancer Hypertension Smoker	75 mg/day	none	Yes	none
13 68/M	ANCA vasculitis	Renal insufficiency	5 mg/day	Rituximab	Yes	none
14 69/M	ANCA vasculitis	Renal insufficiency	none	Azathioprine	Yes	none
15 69/F	UCTD	none	none	Methotrexate	Yes	none

16 70/M	Systemic Sclerosis	Cardiac disease PID Stroke	none	Bosentan	Yes	none
17 72/M	Polymyalgia rheumatica	Diabetes	10 mg/day	none	Yes	none
18 75/M	ANCA vasculitis	Cancer COPD Hypertension	30 mg/day	Rituximab	No	Azithromycin HCQ Corticosteroids
19 75/F	Auto-inflammatory disease	Cardiac disease COPD	3 mg/day	Lenalidomide Bortezomib	Yes	Lopinavir Ritonavir
20 75/M	Sjögren syndrome	Cardiac disease Diabetes Hypertension Renal insufficiency	none	none	Yes	none
21 76/F	Inflammatory Myopathy	Cardiac disease Hypertension Obesity (BMI=30)	10 mg/day	Immunoglobulin	Yes	none
22 77/F	Rheumatoid Arthritis	Cardiac disease Hypertension	7.5 mg/day	none	No	Corticosteroids
23 78/M	ANCA vasculitis	none	50 mg/day	Rituximab	Yes	none
24 78/F	Rheumatoid Arthritis	Hypertension Renal insufficiency	2.5 mg/day	Methotrexate	Yes	none
25 78/M	Rheumatoid Arthritis	Cancer Obesity (BMI=31)	5 mg/day	Methotrexate Abatacept	Yes	none
26 78/M	MCTD	Hypertension Obesity (BMI=34) PID	10 mg/day	Cyclophosphamide	Yes	none
27 80/F	Rheumatoid Arthritis	Cardiac disease	1 mg/day	Etanercept	No	none
28 80/M	Periodic fever	COPD Cardiac disease Hypertension Smoker	none	Colchicine Anakinra	Yes	none
29 80/M	Rheumatoid Arthritis	Diabetes Hypertension Renal insufficiency	5 mg/day	none	No	Lopinavir Ritonavir
30 81/F	Rheumatoid Arthritis	Hypertension	20 mg/day	Methotrexate	Yes	Corticosteroids
31 81/F	Rheumatoid Arthritis	Hypertension	3 mg/day		Yes	none
32 82/M	Psoriatic arthritis	none	none	none	Yes	none
33 82/F	Rheumatoid Arthritis	Hypertension	5 mg/day	Methotrexate	No	none
34	Rheumatoid Arthritis	Cardiac disease	18 mg/day	Tofacitinib	Yes	none

82/F		Hypertension				
35 82/F	Sjögren syndrome	Asthma Diabetes Hypertension Obesity (BMI=35) ILD	65 mg/day	none	Yes	none
36 83/F	Giant cell arteritis	Cardiac disease Diabetes Hypertension Obesity (BMI=33) Renal insufficiency	3 mg/day	Tocilizumab	Yes	none
37 83/F	Psoriatic arthritis	Cardiac disease Diabetes Hypertension Obesity (BMI=30)	none	none	Yes	Lopinavir Ritonavir
38 84/F	ANCA vasculitis	Hypertension Stroke	none	none	Yes	none
39 84/M	Polymyalgia rheumatica	Cardiac disease Hypertension	10 mg/day	none	Yes	Darunavir Ritonavir
40 84/M	Adult onset Still disease	Cancer Cardiac disease Renal insufficiency Smoker Stroke	none	none	Yes	none
41 85/F	Rheumatoid Arthritis	Hypertension	10 mg/day	none	Yes	none
42 85/M	Giant cell arteritis	Diabetes Hypertension	10 mg/day	none	Yes	none
43 85/M	Giant cell arteritis	Hypertension Obesity (BMI=37)	4 mg/day	Methotrexate	Yes	Azithromycin HCQ
44 85/M	Giant cell arteritis	Cardiac disease Hypertension	10 mg/day	none	No	none
45 85/F	Inflammatory Myopathy	Hypertension Obesity (BMI=33)	70 mg/day	Colchicine	Yes	HCQ
46 86/F	Rheumatoid Arthritis	Cardiac disease Diabetes Hypertension Obesity (BMI=31)	none	none	No	none
47 86/F	Rheumatoid Arthritis	Diabetes Hypertension Obesity (BMI=42) Renal insufficiency	none	Tofacitinib	Yes	HCQ Azithromycin
48 86/F	Rheumatoid Arthritis	Diabetes Hypertension	none	Methotrexate	Yes	none
49	ANCA vasculitis	Cardiac disease	10 mg/day	none	Yes	Corticosteroids

87/F		COPD Hypertension Renal insufficiency				
50 87/F	Rheumatoid Arthritis	Asthma Diabetes Obesity (BMI=42) ILD Renal insufficiency	none	Methotrexate	Yes	none
51 87/F	Sarcoidosis	Cardiac disease Diabetes Obesity (BMI=45) Renal insufficiency	7.5 mg/day	none	Yes	HCQ
52 87/M	Rheumatoid Arthritis	Cancer Cardiac disease Diabetes Hypertension	10 mg/day	Methotrexate	Yes	Corticosteroids
53 88/M	ANCA vasculitis	Cardiac disease Renal insufficiency	55 mg/day	Rituximab	Yes	Corticosteroids
54 88/F	Rheumatoid Arthritis	Cardiac disease Hypertension Stroke Renal insufficiency	75 mg/day	none	Yes	HCQ
55 88/F	Giant cell arteritis	Cardiac disease Diabetes Hypertension ILD Smoker	none	none	Yes	none
56 89/M	Rheumatoid Arthritis	Cardiac disease Hypertension ILD	5 mg/day	Methotrexate	Yes	none
57 95/M	Polymyalgia rheumatica	Cardiac disease	7 mg/day	none	Yes	Corticosteroids
58 98/F	Polymyalgia rheumatica	Cardiac disease COPD Hypertension Renal insufficiency	none	none	Yes	none

HCQ, hydroxychloroquine; RMD, rheumatic musculoskeletal diseases; BMI, body mass index; COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease; UCTD, undifferentiated connective tissue diseases; MCTD, mixed connective tissue diseases.

Supplementary Table 10. Anti-viral and immunomodulating therapies used for the management of COVID-19 in the French COVID-19 RMD cohort

Treatment	All patients (n=694)	Patients with mild infection (n=438)	Patients with moderate infection (n=169)	Patients with severe infection (n=87)
Total	129 (18.6%)	45 (10.3%)	51 (30.2%)	33 (37.9%)
HCQ	40 (5.8%)	10 (2.2%)	22 (13%)	8 (9.2%)
AZI	26 (3.7%)	23 (5.2%)	2 (1.2%)	1 (1.1%)
Lopinavir/Ritonavir	21 (3%)	4 (0.9%)	6 (3.5%)	11 (12.6%)
Darunavir/Ritonavir	10 (1.4%)	-	9 (5.3%)	1 (1.1%)
Remdesivir	2 (0.3%)	-	-	2 (2.3%)
Tocilizumab	3 (0.4%)	1 (0.2%)	1 (0.6%)	1 (1.1%)
Anakinra	1 (0.1%)	-	1 (0.6%)	-
HCQ + AZI	24 (3.5%)	7 (1.6%)	10 (5.9%)	7 (8%)
HCQ + AZI + anakinra	1 (0.1%)	-	-	1 (1.1%)

HCQ: hydroxychloroquine; AZI: azithromycin

Tables

Supplementary Table 1: Demographic and clinical characteristics of patients with positive PCR or serology, according to severity of COVID-19

	All patients (n=408)	Patients with mild infection (n=193)	Patients with moderate infection (n=138)	Patients with severe infection (n=77)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age (years)						<0.001		<0.001
18-54	166 (40.7)	112 (58.0)	44 (31.9)	10 (13.0)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	75 (18.4)	40 (20.7)	26 (18.8)	9 (11.7)	2.13 (0.83 to 5.48)	0.12	2.14 (0.83 to 5.53)	0.12
65-74	75 (18.4)	28 (14.5)	29 (21.0)	18 (23.4)	4.93 (2.15 to 11.30)	<0.001	4.88 (2.11 to 11.26)	<0.001
≥75	92 (22.5)	13 (6.7)	39 (28.3)	40 (51.9)	12.00 (5.61 to 25.68)	<0.001	12.47 (5.78 to 26.90)	<0.001
Mean ± SD	59.4 ± 16.8	52.0 ± 14.6	62.6 ± 16.0	72.3 ± 13.7				
Female gender	258 (63.2)	127 (65.8)	92 (66.7)	39 (50.7)	0.53 (0.32 to 0.87)	0.012	0.46 (0.27 to 0.81)	0.006
Comorbidities[3]								
Respiratory disease (all)	61 (15.0)	22 (11.5)	19 (13.8)	20 (26.0)	2.47 (1.35 to 4.52)	0.004	1.93 (0.98 to 3.78)	0.057
Interstitial lung disease	22 (5.4)	6 (3.1)	7 (5.1)	9 (11.7)	3.22 (1.32 to 7.83)	0.010	2.64 (0.94 to 7.36)	0.065
COPD	19 (4.7)	8 (4.2)	4 (2.9)	7 (9.1)	2.64 (1.01 to 6.95)	0.049	1.32 (0.46 to 3.77)	0.61
Asthma	25 (6.2)	10 (5.2)	9 (6.5)	6 (7.8)	1.38 (0.53 to 3.58)	0.51	1.75 (0.60 to 5.06)	0.31
Cardiac disease (all)	67 (16.5)	12 (6.3)	28 (20.3)	27 (35.1)	3.90 (2.20 to 6.92)	<0.001	1.59 (0.82 to 3.08)	0.17
Coronary heart diseases	54 (13.3)	9 (4.7)	22 (15.9)	23 (29.9)	4.09 (2.22 to 7.55)	<0.001	1.58 (0.77 to 3.20)	0.21
Stroke	20 (4.9)	3 (1.6)	10 (7.2)	7 (9.1)	2.43 (0.94 to 6.31)	0.068	1.56 (0.55 to 4.46)	0.40
Diabetes	50 (12.3)	7 (3.7)	23 (16.7)	20 (26.0)	3.50 (1.86 to 6.58)	<0.001	2.18 (1.09 to 4.38)	0.029
Obesity						0.16		0.059
<30	268 (74.2)	137 (77.8)	84 (71.8)	47 (69.1)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	77 (21.3)	34 (19.3)	28 (23.9)	15 (22.1)	1.14 (0.60 to 2.17)	0.70	1.43 (0.70 to 2.94)	0.33
≥40	16 (4.4)	5 (2.8)	5 (4.3)	6 (8.8)	2.82 (0.98 to 8.14)	0.055	4.16 (1.24 to 13.99)	0.021
Hypertension	123 (30.3)	27 (14.1)	50 (36.2)	46 (59.7)	4.86 (2.88 to 8.19)	<0.001	2.51 (1.37 to 4.59)	0.003
Smoking	34 (8.4)	17 (8.9)	8 (5.8)	9 (11.7)	1.61 (0.72 to 3.60)	0.25	1.69 (0.68 to 4.22)	0.26
Cancer	22 (5.4)	7 (3.7)	9 (6.5)	6 (7.8)	1.65 (0.63 to 4.37)	0.31	0.90 (0.31 to 2.64)	0.85
Chronic renal failure	34 (8.4)	8 (4.2)	10 (7.2)	16 (20.8)	4.53 (2.19 to 9.38)	<0.001	2.36 (1.04 to 5.34)	0.040
No. of patients with at least 1 comorbidity	303 (74.6)	119 (62.3)	112 (81.2)	72 (93.5)	6.11 (2.39 to 15.59)	<0.001	3.42 (1.29 to 9.09)	0.013
Disease History[4]						<0.001		0.056
Chronic inflammatory arthritis	249 (61.0)	139 (72.0)	75 (54.3)	35 (45.5)	1.00 (ref.)	-	1.00 (ref.)	-
Auto-inflammatory diseases	8 (2.0)	1 (0.5)	4 (2.9)	3 (3.9)	NA	NA	NA	NA

Vasculitis	50 (12.3)	11 (5.7)	19 (13.8)	20 (26.0)	4.06 (2.08 to 7.88)	<0.001	2.39 (1.14 to 4.98)	0.021
Systemic auto-immune diseases	77 (18.9)	34 (17.6)	30 (21.7)	13 (16.9)	1.27 (0.62 to 2.46)	0.50	1.58 (0.73 to 3.30)	0.24

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]2 missing value for comorbidities except for obesity where 47 values are missing.[4]Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: COPD, chronic obstructive pulmonary disease; OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/408 patients or when 0 patients with severe infection.

Supplementary Table 2: Treatments of patients with positive PCR or serology, according to severity of COVID-19

	All patients (n=408)	Patients with mild infection (n=193)	Patients with moderate infection (n=138)	Patients with severe infection (n=77)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Rheumatic or inflammatory disease treatments[3]								
Corticosteroid	158 (38.8)	46 (23.8)	68 (49.3)	44 (57.9)	2.62 (1.57 to 4.35)	<0.001	1.72 (0.98 to 3.04)	0.059
Daily prednisone doses ≥10 mg or equivalent	55 (35.0)	15 (32.6)	21 (31.3)	19 (43.2)	1.63 (0.80 to 3.33)	0.18	1.40 (0.64 to 3.04)	0.40
NSAIDs[4]	29 (7.1)	20 (10.4)	8 (5.8)	1 (1.3)	0.21 (0.02 to 0.83)	0.072	0.43 (0.05 to 1.77)	0.33
Colchicine[4]	19 (4.7)	8 (4.1)	7 (5.1)	4 (5.3)	1.27 (0.38 to 3.47)	0.67	2.27 (0.57 to 7.90)	0.22
Hydroxychloroquine[4]	32 (7.9)	18 (9.3)	11 (8.0)	3 (3.9)	0.49 (0.13 to 1.35)	0.22	0.76 (0.19 to 2.35)	0.66
Methotrexate	156 (38.3)	83 (43.0)	48 (34.8)	25 (32.9)	0.75 (0.44 to 1.27)	0.28	1.79 (0.44 to 1.40)	0.42
Leflunomide	11 (2.7)	5 (2.6)	6 (4.3)	0	NA	NA	NA	NA
Sulfasalazine	4 (1.0)	1 (0.5)	3 (2.2)	0	NA	NA	NA	NA
Mycophenolate Mofetil / mycophenolic acid	9 (2.2)	3 (1.6)	4 (2.9)	2 (2.6)	NA	NA	NA	NA
Azathioprine	6 (1.5)	3 (1.6)	2 (1.4)	1 (1.3)	NA	NA	NA	NA
IgIV	6 (1.5)	2 (1.0)	2 (1.4)	2 (2.6)	NA	NA	NA	NA
Biologics								
anti-TNF	90 (22.1)	67 (34.7)	18 (13.0)	5 (6.6)	0.20 (0.08 to 0.52)	<0.001	0.42 (0.16 to 1.15)	0.090
anti-IL6[4]	13 (3.2)	6 (3.1)	5 (3.6)	2 (2.6)	0.94 (0.18 to 3.26)	0.93	0.65 (0.12 to 2.53)	0.58
Rituximab	21 (5.2)	6 (3.1)	5 (3.6)	10 (13.2)	4.41 (1.80 to 10.80)	0.001	6.35 (2.23 to 18.11)	<0.001
anti-IL17a[4]	16 (3.9)	10 (5.2)	4 (2.9)	2 (2.6)	0.73 (0.14 to 2.47)	0.67	1.96 (0.36 to 7.32)	0.38
anti-IL1	5 (1.2)	0	3 (2.2)	2 (2.6)	NA	NA	NA	NA
Abatacept[4]	14 (3.4)	6 (3.1)	7 (5.1)	1 (1.3)	0.47 (0.05 to 1.96)	0.40	0.32 (0.03 to 1.56)	0.24
JAK inhibitor	9 (2.2)	2 (1.0)	3 (2.2)	4 (5.3)	NA	NA	NA	NA
Other biologic	9 (2.2)	4 (2.1)	5 (3.6)	0	NA	NA	NA	NA

Values are presented as frequency (percentage).
[1] Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]1 missing value. [4] Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/408 patients or 0 patients with moderate or severe infection.

Supplementary Table 3: Demographic and clinical characteristics of rheumatoid arthritis patients according to severity of COVID-19

	All patients (n=213)	Patients with mild infection (n=129)	Patients with moderate infection (n=55)	Patients with severe infection (n=29)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age[3] (years)						<0.001		<0.001
18-54	70 (32.9)	58 (45.0)	10 (18.2)	2 (6.9)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	53 (24.9)	43 (33.3)	8 (14.5)	2 (6.9)	1.33 (0.20 to 8.88)	0.76	1.24 (0.19 to 8.31)	0.82
65-74	44 (20.7)	22 (17.1)	15 (27.3)	7 (24.1)	5.48 (1.38 to 30.51)	0.026	5.00 (1.25 to 27.98)	0.035
≥75	46 (21.6)	6 (4.7)	22 (40.0)	18 (62.1)	17.79 (5.17 to 93.32)	<0.001	16.89 (4.90 to 88.60)	<0.001
Mean ± SD	61.0 ± 15.2	54.3 ± 12.4	68.7 ± 13.8	76.0 ± 10.9				
Female gender	156 (73.2)	100 (77.5)	38 (69.1)	18 (62.1)	0.55 (0.24 to 1.24)	0.15	0.59 (0.23 to 1.47)	0.26
Comorbidities[4]								
Respiratory disease (all)	30 (14.2)	11 (8.6)	13 (23.6)	6 (20.7)	1.73 (0.64 to 4.68)	0.28	1.30 (0.42 to 4.07)	0.65
Interstitial lung disease	7 (3.3)	1 (0.8)	3 (5.5)	3 (10.3)	NA	NA	NA	NA
COPD[3]	11 (5.2)	4 (3.1)	5 (9.1)	2 (6.9)	1.67 (0.31 to 6.30)	0.51	0.78 (0.13 to 3.45)	0.77
Asthma[3]	14 (6.6)	6 (4.7)	6 (10.9)	2 (6.9)	1.25 (0.23 to 4.48)	0.77	1.46 (0.21 to 7.53)	0.68
Cardiac disease (all)	32 (15.1)	4 (3.1)	17 (30.9)	11 (37.9)	4.72 (1.96 to 11.33)	<0.001	1.27 (0.46 to 3.56)	0.65
Coronary heart diseases	26 (12.3)	3 (2.3)	14 (25.5)	9 (31.0)	4.39 (1.73 to 11.16)	0.002	1.04 (0.35 to 3.14)	0.94
Stroke	9 (4.2)	1 (0.8)	5 (9.1)	3 (10.3)	NA	NA	NA	NA
Diabetes	26 (12.3)	7 (5.5)	12 (21.8)	7 (24.1)	2.75 (1.04 to 7.28)	0.042	1.24 (0.41 to 3.73)	0.70
Obesity[3]						0.008		0.008
<30	146 (78.9)	96 (82.1)	36 (78.3)	14 (63.6)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	33 (17.9)	19 (16.2)	10 (21.7)	4 (18.2)	1.39 (0.40 to 4.06)	0.57	1.73 (0.46 to 5.85)	0.40
≥40	6 (3.2)	2 (1.7)	0	4 (18.2)	NA	NA	NA	NA
Hypertension	74 (34.9)	28 (21.9)	25 (45.5)	21 (72.4)	6.44 (2.69 to 15.44)	<0.001	3.36 (1.23 to 8.60)	0.017
Smoking[3]	20 (9.4)	13 (10.2)	5 (9.1)	2 (6.9)	0.81 (0.16 to 2.78)	0.77	1.21 (0.20 to 5.14)	0.81
Cancer	14 (6.6)	4 (3.1)	5 (9.1)	5 (17.2)	4.03 (1.25 to 13.02)	0.020	3.06 (0.77 to 12.21)	0.11
Chronic renal failure	8 (3.8)	2 (1.6)	1 (1.8)	5 (17.2)	NA	NA	NA	NA
No. of patients with at least 1 comorbidity	159 (75.0)	82 (64.1)	49 (89.1)	28 (96.6)	11.11 (1.47 to 83.81)	0.020	4.39 (0.54 to 35.39)	0.17

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group. [4]1 missing value for comorbidities except for obesity where 28 values are missing.
Abbreviations: OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/213 patients or 0 patients with moderate or severe infection.

Supplementary Table 4: Treatments of rheumatoid arthritis patients according to severity of COVID-19

	All patients (n=213)	Patients with mild infection (n=129)	Patients with moderate infection (n=55)	Patients with severe infection (n=29)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Corticosteroid	72 (34.0)	31 (24.0)	23 (41.8)	18 (64.3)	4.33 (1.88 to 9.99)	<0.001	2.57 (1.01 to 6.52)	0.047
Daily prednisone doses ≥10 mg or equivalent	13 (18.1)	3 (9.7)	3 (13.0)	7 (38.9)	5.09 (1.43 to 18.17)	0.012	4.10 (0.99 to 16.96)	0.051
NSAIDs[4]	22 (10.4)	19 (14.7)	3 (5.5)	0	NA	NA	NA	NA
Hydroxychloroquine[4]	10 (4.7)	5 (3.9)	3 (5.5)	2 (7.1)	1.96 (0.36 to 7.59)	0.39	5.13 (0.77 to 29.07)	0.079
Methotrexate	131 (61.8)	86 (66.7)	31 (56.4)	14 (50.0)	0.57 (0.26 to 1.27)	0.17	0.49 (0.20 to 1.20)	0.12
Leflunomide	18 (8.5)	13 (10.1)	5 (9.1)	0	NA	NA	NA	NA
Sulfasalazine	1 (0.5)	0	1 (1.8)	0	NA	NA	NA	NA
Biologics								
anti-TNF[4]	50 (23.6)	41 (31.8)	8 (14.5)	1 (3.6)	0.15 (0.02 to 0.60)	0.028	0.33 (0.04 to 1.47)	0.22
anti-IL6[4]	17 (8.0)	14 (10.9)	2 (3.6)	1 (3.6)	0.56 (0.06 to 2.38)	0.52	0.89 (0.08 to 4.95)	0.91
Rituximab[4]	13 (6.1)	7 (5.4)	3 (5.5)	3 (10.7)	2.28 (0.55 to 7.61)	0.22	5.97 (1.18 to 27.63)	0.027
Abatacept[4]	16 (7.5)	9 (7.0)	6 (10.9)	1 (3.6)	0.60 (0.06 to 2.56)	0.57	0.45 (0.04 to 2.45)	0.43
JAK inhibitor[4]	17 (8.0)	9 (7.0)	4 (7.3)	4 (14.3)	2.33 (0.67 to 6.95)	0.16	2.79 (0.68 to 10.39)	0.14
Other biologic	2 (0.9)	2 (1.6)	0	0	NA	NA	NA	NA

Values are presented as frequency (percentage).
[1] Odds-ratio were calculated for patients with severe infection, using patients with mild or moderate infection as reference. [2]Adjusted for age and sex. [3]1 missing value. [4] Penalized logistic regression (Firth method) was used due to low number of patients (n<5) in an analyzed group.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/213 patients or 0 patients with moderate or severe infection.

Supplementary Table 5: Demographic and clinical characteristics according to hospitalization status

	Outpatients (n=438)	Inpatients (n=256)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Age (years)				<0.001		<0.001
18-54	268 (61.2)	68 (26.6)	1.00 (ref.)	-	1.00 (ref.)	-
55-64	95 (21.7)	43 (16.8)	1.78 (1.14 to 279)	0.011	1.80 (1.14 to 2.82)	0.011
65-74	52 (11.9)	55 (21.5)	4.17 (2.62 to 6.62)	<0.001	4.06 (2.55 to 6.47)	<0.001
≥75	23 (5.3)	90 (35.2)	15.42 (9.08 to 26.19)	<0.001	15.51 (9.11 to 26.40)	<0.001
Mean ± SD	50.6 ± 13.9	65.4 ± 16.1				
Female gender	309 (70.6)	153 (59.8)	0.62 (0.45 to 0.86)	0.004	0.63 (0.44 to 0.90)	0.012
Comorbidities[3]						
Respiratory disease (all)	53 (12.2)	46 (18.0)	1.58 (1.03 to 2.43)	0.036	1.24 (0.76 to 2.02)	0.38
Interstitial lung disease	10 (2.3)	16 (6.3)	2.84 (1.27 to 6.36)	0.011	2.36 (0.92 to 6.06)	0.075
COPD	14 (3.2)	14 (5.5)	1.74 (0.82 to 3.72)	0.15	0.62 (0.27 to 1.43)	0.26
Asthma	32 (7.3)	20 (7.8)	1.07 (0.60 to 1.91)	0.82	1.34 (0.70 to 2.57)	0.37
Cardiac disease (all)	22 (5.0)	63 (24.6)	6.14 (3.67 to 10.28)	<0.001	2.41 (1.35 to 4.30)	0.003
Coronary heart diseases	15 (3.4)	53 (20.7)	7.33 (4.03 to 13.31)	<0.001	2.73 (1.40 to 5.30)	0.003
Stroke	7 (1.6)	18 (7.0)	NA	NA	NA	NA
Diabetes	12 (2.8)	50 (19.5)	8.58 (4.47 to 16.46)	<0.001	5.37 (2.66 to 10.85)	<0.001
Obesity				0.032		0.027
<30	303 (78.7)	156 (70.9)	1.00 (ref.)	-	1.00 (ref.)	-
30-39.9	74 (19.2)	52 (23.6)	1.37 (0.91 to 2.04)	0.13	1.55 (0.99 to 2.44)	0.055
≥40	8 (2.1)	12 (5.5)	NA	NA	NA	NA
Hypertension	71 (16.3)	111 (43.4)	3.94 (2.76 to 5.61)	<0.001	1.99 (1.33 to 2.98)	<0.001
Smoking	48 (11.0)	22 (8.6)	0.76 (0.45 to 1.29)	0.31	0.78 (0.44 to 1.41)	0.42
Cancer	13 (3.0)	20 (7.8)	2.76 (1.35 to 5.64)	0.006	1.56 (0.70 to 3.47)	0.27
Chronic renal failure	11 (2.5)	31 (12.1)	5.32 (2.63 to 10.79)	<0.001	2.76 (1.26 to 6.04)	0.011
No. of patients with at least 1 comorbidity	274 (62.8)	218 (85.2)	3.39 (2.28 to 5.04)	<0.001	2.05 (1.33 to 3.14)	0.001
Disease History				<0.001		<0.001
Chronic inflammatory arthritis	325 (74.2)	139 (54.3)	1.00 (ref.)	-	1.00 (ref.)	-
Auto-inflammatory diseases	5 (1.14)	7 (2.7)	NA	NA	NA	NA
Vasculitis	21 (4.8)	44 (17.2)	4.90 (2.81 to 8.54)	<0.001	2.61 (1.40 to 4.87)	0.003
Systemic auto-immune diseases	73 (16.7)	49 (19.1)	1.57 (1.04 to 2.37)	0.032	2.06 (1.29 to 3.29)	0.003

Values are presented as frequency (percentage) unless otherwise indicated.
[1]Odds-ratio were calculated for inpatients, using outpatients as reference. [2]Adjusted for age and sex. [3]2 missing values for comorbidities except for obesity where 89 values are missing.
Abbreviations: OR, odds-ratio; CI, confidence interval; SD, standard deviation; NA, not applicable when <10/438 patients.

Supplementary Table 6: Rheumatic and inflammatory disease treatments according to hospitalization status

	Outpatient (n=438)	Inpatient (n=256)	OR [95%CI][1]	P	aOR [95%CI][1,2]	P[2]
Rheumatic or inflammatory disease treatments[3]						
Corticosteroid	88 (20.1)	127 (50.0)	3.98 (2.83 to 5.58)	<0.001	2.76 (1.90 to 4.02)	<0.001
Daily prednisone doses ≥10 mg or equivalent	28 (31.8)	45 (36.0)	1.21 (0.68 to 2.15)	0.53	1.01 (0.53 to 1.92)	0.99
NSAIDs	61 (13.9)	12 (4.7)	0.31 (0.16 to 0.58)	<0.001	0.45 (0.23 to 0.89)	0.021
Colchicine	12 (2.7)	12 (4.7)	1.76 (0.78 to 3.98)	0.17	4.13 (1.59 to 10.74)	0.004
hydroxychloroquine	40 (9.1)	17 (6.7)	0.71 (0.40 to 1.29)	0.26	1.17 (0.60 to 2.28)	0.65
Methotrexate	164 (37.4)	88 (34.6)	0.89 (0.64 to 1.22)	0.46	0.71 (0.50 to 1.02)	0.066
Leflunomide	19 (4.3)	8 (3.1)	0.72 (0.31 to 1.66)	0.44	0.94 (0.38 to 2.29)	0.89
Sulfasalazine	5 (1.1)	4 (1.6)	NA	NA	NA	NA
Mycophenolate Mofetil / mycophenolic acid	9 (2.1)	7 (2.8)	1.35 (0.50 to 3.67)	0.56	3.22 (1.09 to 9.57)	0.035
Azathioprine	5 (1.1)	4 (1.6)	NA	NA	NA	NA
IgIV	3 (0.7)	4 (1.6)	NA	NA	NA	NA
Biologics						
anti-TNF	170 (38.8)	32 (12.6)	0.23 (0.15 to 0.35)	<0.001	0.35 (0.22 to 0.55)	<0.001
anti-IL6	19 (4.3)	7 (2.8)	0.63 (0.26 to 1.51)	0.30	0.56 (0.21 to 1.49)	0.24
Rituximab	16 (3.7)	18 (7.1)	2.01 (1.01 to 4.02)	0.048	1.95 (0.90 to 4.23)	0.091
anti-IL17a	19 (4.3)	8 (3.1)	0.72 (0.31 to 1.66)	0.44	1.45 (0.60 to 3.53)	0.41
anti-IL1	3 (0.7)	5 (2.0)	NA	NA	NA	NA
anti-IL4/IL13	1 (0.2)	0 (0.0)	NA	NA	NA	NA
abatacept	10 (2.3)	8 (3.1)	1.39 (0.54 to 3.57)	0.49	1.24 (0.43 to 3.60)	0.69
JAK inhibitor	13 (3.0)	8 (3.1)	1.06 (0.44 to 2.60)	0.89	0.94 (0.35 to 2.53)	0.91
Other biologic	11 (2.5)	5 (2.0)	0.78 (0.27 to 2.27)	0.65	0.89 (0.28 to 2.81)	0.84

Values are presented as frequency (percentage).
[1]Odds-ratio were calculated for inpatients, using outpatients as reference. [2]Adjusted for age and sex. [3]2 missing values.
Abbreviations: OR, odds-ratio; CI, confidence interval; NA, not applicable when <10/438 patients.

Supplementary Table 7: Multivariable analyses for hospitalization status

Variable	Imputed analysis[1] (n=694)			Available case analysis (n=601)		
	n / N	OR [95%CI]	P	n / N	OR [95%CI]	P
Age	256 / 694	1.05 (1.04 to 1.07)	<0.001	218 / 601	1.05 (1.04 to 1.06)	<0.001
Female gender	153 / 462	0.65 (0.43 to 0.99)	0.046	129 / 365	0.62 (0.41 to 0.93)	0.21
Diabetes	50 / 62	4.33 (2.07 to 9.07)	<0.001	44 / 55	4.39 (2.08 to 9.27)	<0.001
BMI	256 / 694	1.06 (1.02 to 1.10)	0.002	218 / 601	1.06 (1.02 to 1.09)	0.003
Disease History			0.039	-	-	-
Chronic inflammatory arthritis	139 / 464	1.00 (ref.)	-	-	-	-
Auto-inflammatory diseases	7 / 12	6.37 (1.45 to 28.05)	0.014	-	-	-
Vasculitis	44 / 65	1.60 (0.76 to 3.31)	0.21	-	-	-
Systemic auto-immune diseases	49 / 122	1.51 (0.87 to 2.62)	0.15	-	-	-
Corticosteroids	128 / 216	1.94 (1.24 to 3.05)	0.004	108 / 188	2.25 (1.47 to 3.45)	<0.001
Colchicine	12 / 24	3.34 (1.14 to 9.79)	0.028	12 / 22	3.87 (1.39 to 10.75)	0.009
Anti-TNF	32 / 202	0.55 (0.32 to 0.95)	0.031	28 / 175	0.47 (0.28 to 0.78)	0.003

Odds-ratio were calculated using multivariable penalized logistic regression models (Firth method), using a forward selection method, with patients with mild or moderate infection as reference. Only variables selected by the model are presented. Full model included age, sex, cardiac disease, diabetes, BMI, hypertension, chronic renal failure, disease history, corticosteroids, NSAIDs, colchicine, Mycophenolate Mofetil / mycophenolic acid and anti-TNF.

n / N indicates the number of events / number of cases.

[1]Odds-ratio and p-value were calculated after multiple imputations (m=10) to handle missing data.

Abbreviations: OR, odds-ratio; CI, confidence interval; BMI, body mass index.

Supplementary Table 8: Differences in predefined confounders factors between cases and controls before and after propensity score matching

	Before matching			After matching		
	Cases from French RMD COVID-19 cohort (n=218)	**Controls from LICORNE (n=280)**	**ASD (%)**	**Cases from French RMD COVID-19 cohort (n=175)**	**Controls from LICORNE (n=175)**	**ASD (%)**
Age	65.0 ± 16.4	62.9 ± 15.0	13.2	64.1 ± 16.2	64.6 ± 15.3	3.3
Sex (Male)	89 (40.8)	194 (69.3)	59.7	89 (50.9)	93 (53.1)	4.6
BMI	27.5 ± 6.3	29.2 ± 6.7	26.0	28.1 ± 6.6	28.3 ± 6.3	3.2
Cardiac disease	57 (26.1)	66 (23.6)	6.0	44 (25.1)	43 (24.6)	1.3
Diabetes	45 (20.6)	79 (28.2)	17.7	42 (24.0)	40 (22.9)	2.7
Hypertension	97 (44.5)	141 (50.4)	11.8	80 (45.7)	79 (45.1)	1.2
Renal failure	27 (12.4)	26 (9.3)	10.0	19 (10.9)	18 (10.3)	1.9

Values are presented as mean ± standard deviation or frequency (percentage).
Abbreviations: ASD, absolute standardized difference; BMI, body mass index.

Supplementary Table 9. Summary of deaths during study

Patient Number **Age/Gender**	**Type of inflammatory RMD**	**Comorbidities**	**Concomitant corticosteroids**	**DMARDs**	**COVID-19 Pulmonary complication**	**COVID-19 treatment**
1 34/M	Behçet disease	Diabetes Hypertension Obesity (BMI=43)	none	Colchicine	Yes	HCQ Corticosteroids Anti-IL6
2 37/M	Systemic Sclerosis	Cardiac disease Hypertension ILD Stroke	10 mg/day	Mycophenolate Mofetil Rituximab	Yes	none
3 50/M	Rheumatoid Arthritis	Cancer	4 mg/day	Methotrexate Rituximab	Yes	Azithromycin
4 57/M	Recurrent periodic fever and AA amyloidosis	Hypertension Renal insufficiency	none	Colchicine Anakinra	Yes	none
5 58/M	Inflammatory Myopathy	Smoker	10 mg/day	none	Yes	Lopinavir Ritonavir
6 61/F	Sarcoidosis	Cardiac disease COPD Diabetes Hypertension Obesity (BMI=38) Smoker	7.5 mg/day	Methotrexate Infliximab	Yes	Lopinavir Ritonavir
7 62/M	Spondyloarthritis	Renal insufficiency		Adalimumab	Yes	none
8 63/F	Systemic Lupus Erythematosus	Diabetes Hypertension Obesity (BMI=33)	15 mg/day	HCQ	Yes	none
9 63/F	Systemic Lupus Erythematosus	Hypertension Renal insufficiency	5 mg/day	Mycophenolate Mofetil	Yes	none
10 64/F	Rheumatoid Arthritis	Diabetes Hypertension PID	5 mg/day	HCQ Rituximab	Yes	Azithromycin HCQ Corticosteroids
11 66/M	Psoriatic arthritis	Asthma		Adalimumab	Yes	none
12 67/F	Rheumatoid Arthritis	Cancer Hypertension Smoker	75 mg/day	none	Yes	none
13 68/M	ANCA vasculitis	Renal insufficiency	5 mg/day	Rituximab	Yes	none
14 69/M	ANCA vasculitis	Renal insufficiency	none	Azathioprine	Yes	none
15 69/F	UCTD	none	none	Methotrexate	Yes	none

16 70/M	Systemic Sclerosis	Cardiac disease PID Stroke	none	Bosentan	Yes	none
17 72/M	Polymyalgia rheumatica	Diabetes	10 mg/day	none	Yes	none
18 75/M	ANCA vasculitis	Cancer COPD Hypertension	30 mg/day	Rituximab	No	Azithromycin HCQ Corticosteroids
19 75/F	Auto-inflammatory disease	Cardiac disease COPD	3 mg/day	Lenalidomide Bortezomib	Yes	Lopinavir Ritonavir
20 75/M	Sjögren syndrome	Cardiac disease Diabetes Hypertension Renal insufficiency	none	none	Yes	none
21 76/F	Inflammatory Myopathy	Cardiac disease Hypertension Obesity (BMI=30)	10 mg/day	Immunoglobulin	Yes	none
22 77/F	Rheumatoid Arthritis	Cardiac disease Hypertension	7.5 mg/day	none	No	Corticosteroids
23 78/M	ANCA vasculitis	none	50 mg/day	Rituximab	Yes	none
24 78/F	Rheumatoid Arthritis	Hypertension Renal insufficiency	2.5 mg/day	Methotrexate	Yes	none
25 78/M	Rheumatoid Arthritis	Cancer Obesity (BMI=31)	5 mg/day	Methotrexate Abatacept	Yes	none
26 78/M	MCTD	Hypertension Obesity (BMI=34) PID	10 mg/day	Cyclophosphamide	Yes	none
27 80/F	Rheumatoid Arthritis	Cardiac disease	1 mg/day	Etanercept	No	none
28 80/M	Periodic fever	COPD Cardiac disease Hypertension Smoker	none	Colchicine Anakinra	Yes	none
29 80/M	Rheumatoid Arthritis	Diabetes Hypertension Renal insufficiency	5 mg/day	none	No	Lopinavir Ritonavir
30 81/F	Rheumatoid Arthritis	Hypertension	20 mg/day	Methotrexate	Yes	Corticosteroids
31 81/F	Rheumatoid Arthritis	Hypertension	3 mg/day		Yes	none
32 82/M	Psoriatic arthritis	none	none	none	Yes	none
33 82/F	Rheumatoid Arthritis	Hypertension	5 mg/day	Methotrexate	No	none
34	Rheumatoid Arthritis	Cardiac disease	18 mg/day	Tofacitinib	Yes	none

82/F		Hypertension				
35 82/F	Sjögren syndrome	Asthma Diabetes Hypertension Obesity (BMI=35) ILD	65 mg/day	none	Yes	none
36 83/F	Giant cell arteritis	Cardiac disease Diabetes Hypertension Obesity (BMI=33) Renal insufficiency	3 mg/day	Tocilizumab	Yes	none
37 83/F	Psoriatic arthritis	Cardiac disease Diabetes Hypertension Obesity (BMI=30)	none	none	Yes	Lopinavir Ritonavir
38 84/F	ANCA vasculitis	Hypertension Stroke	none	none	Yes	none
39 84/M	Polymyalgia rheumatica	Cardiac disease Hypertension	10 mg/day	none	Yes	Darunavir Ritonavir
40 84/M	Adult onset Still disease	Cancer Cardiac disease Renal insufficiency Smoker Stroke	none	none	Yes	none
41 85/F	Rheumatoid Arthritis	Hypertension	10 mg/day	none	Yes	none
42 85/M	Giant cell arteritis	Diabetes Hypertension	10 mg/day	none	Yes	none
43 85/M	Giant cell arteritis	Hypertension Obesity (BMI=37)	4 mg/day	Methotrexate	Yes	Azithromycin HCQ
44 85/M	Giant cell arteritis	Cardiac disease Hypertension	10 mg/day	none	No	none
45 85/F	Inflammatory Myopathy	Hypertension Obesity (BMI=33)	70 mg/day	Colchicine	Yes	HCQ
46 86/F	Rheumatoid Arthritis	Cardiac disease Diabetes Hypertension Obesity (BMI=31)	none	none	No	none
47 86/F	Rheumatoid Arthritis	Diabetes Hypertension Obesity (BMI=42) Renal insufficiency	none	Tofacitinib	Yes	HCQ Azithromycin
48 86/F	Rheumatoid Arthritis	Diabetes Hypertension	none	Methotrexate	Yes	none
49	ANCA vasculitis	Cardiac disease	10 mg/day	none	Yes	Corticosteroids

87/F		COPD Hypertension Renal insufficiency				
50 87/F	Rheumatoid Arthritis	Asthma Diabetes Obesity (BMI=42) ILD Renal insufficiency	none	Methotrexate	Yes	none
51 87/F	Sarcoidosis	Cardiac disease Diabetes Obesity (BMI=45) Renal insufficiency	7.5 mg/day	none	Yes	HCQ
52 87/M	Rheumatoid Arthritis	Cancer Cardiac disease Diabetes Hypertension	10 mg/day	Methotrexate	Yes	Corticosteroids
53 88/M	ANCA vasculitis	Cardiac disease Renal insufficiency	55 mg/day	Rituximab	Yes	Corticosteroids
54 88/F	Rheumatoid Arthritis	Cardiac disease Hypertension Stroke Renal insufficiency	75 mg/day	none	Yes	HCQ
55 88/F	Giant cell arteritis	Cardiac disease Diabetes Hypertension ILD Smoker	none	none	Yes	none
56 89/M	Rheumatoid Arthritis	Cardiac disease Hypertension ILD	5 mg/day	Methotrexate	Yes	none
57 95/M	Polymyalgia rheumatica	Cardiac disease	7 mg/day	none	Yes	Corticosteroids
58 98/F	Polymyalgia rheumatica	Cardiac disease COPD Hypertension Renal insufficiency	none	none	Yes	none

HCQ, hydroxychloroquine; RMD, rheumatic musculoskeletal diseases; BMI, body mass index; COPD, chronic obstructive pulmonary disease; ILD, interstitial lung disease; UCTD, undifferentiated connective tissue diseases; MCTD, mixed connective tissue diseases.

Supplementary Table 10. Anti-viral and immunomodulating therapies used for the management of COVID-19 in the French COVID-19 RMD cohort

Treatment	All patients (n=694)	Patients with mild infection (n=438)	Patients with moderate infection (n=169)	Patients with severe infection (n=87)
Total	129 (18.6%)	45 (10.3%)	51 (30.2%)	33 (37.9%)
HCQ	40 (5.8%)	10 (2.2%)	22 (13%)	8 (9.2%)
AZI	26 (3.7%)	23 (5.2%)	2 (1.2%)	1 (1.1%)
Lopinavir/Ritonavir	21 (3%)	4 (0.9%)	6 (3.5%)	11 (12.6%)
Darunavir/Ritonavir	10 (1.4%)	-	9 (5.3%)	1 (1.1%)
Remdesivir	2 (0.3%)	-	-	2 (2.3%)
Tocilizumab	3 (0.4%)	1 (0.2%)	1 (0.6%)	1 (1.1%)
Anakinra	1 (0.1%)	-	1 (0.6%)	-
HCQ + AZI	24 (3.5%)	7 (1.6%)	10 (5.9%)	7 (8%)
HCQ + AZI + anakinra	1 (0.1%)	-	-	1 (1.1%)

HCQ: hydroxychloroquine; AZI: azithromycin