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# Risk and outcome of COVID-19 infection in sarcoidosis patients: results of a self-reporting questionnaire

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**Abstract.** *Background:* It has been suggested that sarcoidosis patients, especially those on immunosuppressive medications, are at increased risk for COVID-19 infection and more severe disease. *Methods:* A questionnaire was developed in four languages (English, Dutch, Italian, and Spanish). The questionnaire queried whether patients had been infected with COVID-19 and outcome of the infection. Risk factors for COVID-19 infection were collected. *Results*: A total of 5200 sarcoidosis patients completed the questionnaire with 116 (2.23%) reporting infection and 18 (15.8%) required hospitalization. Increased hazard ratio (HR) for COVID-19 infection were seen for those with a COVID-19 infected roommate (HR=27.44, p<0.0001), health care provider (HR=2.4, p=0.0001), pulmonary sarcoidosis (HR=2.48, p=0.001), neurosarcoidosis (HR=2.02, p<0.01), or rituximab treatment (HR=5.40, p<0.0001). A higher rate of hospitalization was found for those with underlying heart disease (HR=3.19 (1.297-7.855), p<0.02). No other feature including race, other immunosuppressive agent, age, or underlying condition was associated with a significant increased risk for infection or more severe disease. *Conclusion*: The overall rate of COVID-19 was 2.23%, suggesting an increased rate of COVID-19 infection. However, when an analysis of the questionnaires of sarcoidosis and non-sarcoidosis patients was performed in one localized area over this time period, the rate of COVID-19 infection was similar in both groups. Sarcoidosis patients who cohabitated with COVID-19 infected individuals, worked in health care, had pulmonary or neurologic sarcoidosis, or were treated with rituximab had an increased risk for COVID-19 infection. No significant increased risk for hospitalization could be identified based on age, race, gender or any specific immunosuppressive treatment. *(Sarcoidosis Vasc Diffuse Lung Dis 2020; 37 (4): e2020009)*

**Key words:** COVID-19, sarcoidosis, immunosuppression

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## Introduction

The COVID-19 pandemic has dramatically changed and challenged the practice of medicine. Both sarcoidosis patients and their health care providers are concerned that sarcoidosis may increase the risk of contracting COVID-19 and may be associated with poor outcomes from COVID-19 infection (1). Sarcoidosis patients may have several risk factors associated with an increased rate and a poor outcome from COVID-19 infection including underlying lung disease and the use of glucocorticoids and other immunosuppressive agents (2;3). However, it is not clear that use of immunosuppressive therapy alone is a risk factor for increased rate of COVID-19 infection (4;5). A worse outcome from COVID-19 infection may be result of the common presence of other co-morbidities including heart disease, diabetes, and hypertension (2;6-8). Because of the potential risk of COVID-19 infection in those receiving immunosuppressive medications, sarcoidosis experts have proposed modifying the treatment of sarcoidosis (9). However, these recommendations were based almost exclusively on expert opinion and extrapolation from other medical conditions because of the absence of sarcoidosis-specific outcome data concerning COVID-19 infection.

Because of the lack of specific information concerning risk of acquiring COVID-19 infection and its outcomes in sarcoidosis patients, we initiated an IRB approved questionnaire survey of sarcoidosis patients between April and July 2020 to investigate the prevalence of COVID-19 infection, clinical outcomes and possible risk factors for contracting COVID-19 in several sarcoidosis cohorts across several countries. The questionnaire was distributed through several platforms and was available in four languages: English, Dutch, Italian, and Spanish. Five versions of the questionnaire that were minimally different (vide infra) were distributed to various cohorts. One version of the questionnaire was distributed to sarcoidosis patients who participated in a previously described registry (10). In order to compare these findings with another high-risk group, we also surveyed a cohort of breast cancer patients during this time period. The results of these five questionnaires were pooled and analyzed to provide data concerning the frequency, severity, potential risk factors and outcomes for COVID-19 infection in sarcoidosis patients.

## Methods

A questionnaire regarding COVID-19 infection was developed by three of the authors (RPB, EEL, and MAJ). The questionnaire was approved by the University of Cincinnati Institutional Review Board and is shown in Supplement S-1. IRB approval for the FSR questionnaire was obtained from Advarra (Columbus, MD), where the registry number for the FSR Registry is Pro00008556 and modification number for this sub-study is: MOD00087736.

The questionnaire queried whether patients had been infected with COVID-19. If infected, they were asked to provide details regarding level of care (treated at home, hospital, or intensive care unit). They were also queried concerning risk factors for COVID-19 infection including household contacts and whether they were health care providers. The patients were asked if they had underlying medical conditions associated with increased risk for COVID-19 infection. They were also asked to provide information regarding their age, sex, and self-declared race. They provided their current residence, including their state for those living in the United States. Patients with sarcoidosis were queried about the duration of disease, specific organ involvement, and current and past immunosuppressive therapy. The questionnaire responses were collected in an anonymous manner with no patient identifiers captured. At time of completing the questionnaire, patients were asked to provide consent for use of their questionnaire responses. The distribution was meant to reach as wide an audience as possible. Patients were enrolled without incentives, since the survey was anonymous. Respondents were asked to complete the questionnaire even if they did not have any symptoms related to COVID-19 infection. There was no restriction for patients to complete more than one questionnaire.

A total of five questionnaires were distributed (Supplement S-1 to S-4). Table 1 summarizes the features of the five questionnaires. All were based on the University of Cincinnati/Albany Medical Center (UC/AMC) questionnaire. The same questionnaire was distributed to those patients who were Foundation for Sarcoidosis Research (FSR) registry. The questionnaire was translated into Dutch and distributes by the Dutch Sarcoidosis Society (Sarcoidose.nl) and the ild care foundation. The Italian Asso-

**Table 1.** Summary of Questionnaires used in Study

| Title of questionnaire | Questionnaire version | Invitation distribution | Sarcoidosis patient group | Control group | Dates of Survey | Method of capture | Comments |
|---|---|---|---|---|---|---|---|
| UC/AMC | UC/AMC English | Posted on FSR website and all patients see at Cincinnati clinic | World wide including Cincinnati OH USA | Cincinnati OH USA | 4/1/2020 to 7/1/2020 | REDCap | For those in USA, state also indicated |
| FSR | UC/AMC English | Invitation to those in FSR registry | World wide | N/A | 4/6/2020 to 7/1/2020 | SurveyMonkey | |
| Dutch | Dutch version UC/AMC | Members of Sarcoidose.nl, and advertisement at the ILD Center of Excellence, Nieuwegein, the Netherlands | Netherlands | N/A | 6/29/2020 to 7/29/2020 | SurveyMonkey | Collected also if on no medication for sarcoidosis and patient's BMI |
| Italian | Italian version of UC/AMC | e-mail contacts of the Italian Association for Sarcoidosis patients (ACSI) | Italy | N/A | 4/1/2020 to 7/1/2020 | Google Forms | |
| Spanish | Spanish version of UC/AMC | recruited through membership of the Spanish association of patients with sarcoidosis (ANES-Asociación Española de) using e-mail contact | Spain | N/A | May 2020 | Google Forms | |

UC/AMC: University of Cincinnati/Albany Medical Center; FSR: Foundation for Sarcoidosis Research; N/A: not available; ild care: interstial lung disease care; BMI: body mass index
REDcap: Research electronic data capture https://redcap.research.cchmc.org/
SurveyMonkey: www.surveymonkey.com
Google Forms: https://www.google.com/intl/en-US/forms/about/

ciation for Sarcoidosis patients (ACSI) prepared the Italian version of the COVID-19 questionnaire. The Spanish association of patients with sarcoidosis (ANES-Asociación Española de) prepared a Spanish version of the COVID-19 questionnaire.

*Statistics*

The hazard ratio (HR) with 95% confidence interval (CI) was calculated for various factors for each questionnaire using a statistical software package (MedCalc Software limited, Ostend, Belgium). For those questions which were identical (except for language), the results were summed. HR were calculated for the individual questionnaires and for summary data when available. A p value of less than 0.05 was considered significant.

## Results

Supplement Figures S1-S5 show the numbers of patients who completed the questionnaire for each site, including those who did not give consent for final analysis or were excluded for other reasons. Table 2 summarizes the values for 5200 sarcoidosis patients who were analyzed. A total of 116 (2.23%) reported COVID-19 infection. The overall rate of COVID-19 infection is shown for each site and ranged from 0.8 to 4.76%. As shown in the table, there was no significant difference in the rate of infection based on sex, race, or age. In the Dutch questionnaire an additional question revealed that 96 out of 973 COVID-19 negative patients (10%) reported COVID-19 symptoms but were not tested.

The results of the individual questionnaires are provided in Supplement S5-S9. Table 3 summarizes

**Table 2.** Rate of COVID-19 infection for five questionnaires and total

| | UC/AMC | FSR | Dutch | Italy | Spain | Total |
|---|---|---|---|---|---|---|
| Total number Sarcoidosis patients | 1972 | 1616 | 996 | 511 | 105 | 5200 |
| Number COVID positive | 66 | 13 | 23 | 9 | 5 | 116 |
| Rate of COVID | 3.35% | 0.80% | 2.31% | 1.76% | 4.76% | 2.23% |
| | | | | | | |
| **Percent COVID-19 based on gender** | | | | | | |
| Male | 3.70% | 0.72% | 1.42% | 1.44% | 3.57% | 2.18% |
| Female | 3.24% | 1.59% | 2.98% | 1.68% | 5.19% | 2.81% |
| | | | | | | |
| **Percent COVID-19 based on race** | | | | | | |
| Black | 2.88% | 3.23% | NA | NA | NA | 2.95% |
| White | 3.62% | 1.15% | 2.31% | 1.83% | 4.90% | 2.66% |
| | | | | | | |
| **Mean age of patients with or without COVID-19 infection** | | | | | | |
| Age COVID-19 positive, years | 54.5 ± 11.39* | 54.4 ± 11.29 | 55.3 ± 6.0 | 55.8± 8.63 | 49.80 ± 9.20 | 53.5 + 9.47 |
| Age, COVID-19 Negative, years | 53.0 ± 9.60 | 56.6 ± 10.39 | 55.0±10.8 | 51.8 ± 9.74 | 44.88 ± 8.82 | 52.4 + 9.90 |
| | | | | | | |
| **Percent COVID-19 infected versus current prednisone therapy** | | | | | | |
| Yes | 3.08% | 1.55% | 2.02% | 0.38% | 4.76% | 2.68% |
| No | 3.52% | 0.62% | 2.38% | 3.00% | 4.76% | 2.08% |
| | | | | | | |
| **Percent COVID-19 based on living with COVID-19 infected roommate** | | | | | | |
| Roommate COVID positive | 55.3% | 40.0% | 26.8% | 62.5% | 0.0% | 52.7% |
| No roommate with COVID | 2.33% | 0.68% | 1.26% | 0.80% | 4.95% | 1.53% |
| | | | | | | |
| **Percent COVID-19 based on occupation as health care provider** | | | | | | |
| Health care provider | 5.74% | 1.20% | 3.88% | 4.26% | 18.75% | 5.46% |
| Not health care provider | 3.09% | 0.78% | 2.13% | 1.52% | 2.33% | 2.82% |

NA: not analyzed because less than 10 patients who were this race

*Mean ± standard deviation

**Table 3.** Hazard ratio for developing COVID-19 infection: Summary of all five questionnaires

| | Percent with feature | Total pos | Total neg | Total number | Percent Pos | Hazards Ratio | 95% CI | P value |
|---|---|---|---|---|---|---|---|---|
| **Social factors** | | | | | | | | |
| Roommate COVID positive | **1.81%** | **39** | **55** | **94** | **41.49%** | **27.44** | **19.798-38.048** | **<0.0001** |
| No roommate with COVID | | **77** | **5016** | **5093** | **1.51%** | | | |
| | | | | | | | | |
| Health care provider | **8.85%** | **22** | **436** | **458** | **4.80%** | **2.41** | **1.532-3.799** | **0.0001** |
| Not health care provider | | **94** | **4626** | **4720** | **1.99%** | | | |
| | | | | | | | | |
| **Current treatment for sarcoidosis** | | | | | | | | |
| Current Prednisone | | | | | | | | |
| Yes | **30.93%** | **36** | **1567** | **1603** | **2.25%** | **1.02** | **0.689-1.503** | **>0.10** |
| No | | **79** | **3501** | **3580** | **2.21%** | | | |
| | | | | | | | | |
| If taking prednisone: | | | | | | | | |
| Prednisone >10 mg or more | **22.29%** | **16** | **520** | **536** | **2.99%** | **0.98** | **0.567-1.690** | **>0.10** |
| Prednisone < 10 mg | | **57** | **1812** | **1869** | **3.05%** | | | |
| | | | | | | | | |
| Hydroxychloroquine | | | | | | | | |
| Yes | **9.20%** | **8** | **417** | **425** | **1.88%** | **0.80** | **0.391-1.628** | **>0.10** |
| No | | **99** | **4095** | **4184** | **2.36%** | | | |
| | | | | | | | | |
| anti-TNF monoclonal antibodies (infliximab, adalmumab) | | | | | | | | |
| Yes | **7.89%** | **8** | **389** | **397** | **2.02%** | **0.89** | **0.437-1.812** | **>0.10** |
| No | | **105** | **4531** | **4636** | **2.26%** | | | |
| | | | | | | | | |
| Cytotoxic (methotrexate, azathioprine, mycophenolate, leflunomide) | | | | | | | | |
| Yes | **22.54%** | **27** | **1141** | **1168** | **2.31%** | **1.05** | **0.688-1.615** | **>0.10** |
| No | | **88** | **3926** | **4014** | **2.19%** | | | |
| | | | | | | | | |
| Rituximab | | | | | | | | |
| Yes | **1.28%** | **7** | **53** | **60** | **11.67%** | **5.3993** | **2.621-11.123** | **<0.0001** |
| No | | **100** | **4528** | **4628** | **2.16%** | | | |
| | | | | | | | | |
| **Comorbidities** | | | | | | | | |
| COPD | | | | | | | | |
| Yes | **11.43%** | **16** | **578** | **594** | **2.69%** | **1.25** | **0.744-2.108** | **>0.10** |
| No | | **99** | **4503** | **4602** | **2.15%** | | | |

*(continued)*

**Table 3** ***(continued).*** Hazard ratio for developing COVID-19 infection: Summary of all five questionnaires

| | Percent with feature | Total pos | Total neg | Total number | Percent Pos | Hazards Ratio | 95% CI | P value |
|---|---|---|---|---|---|---|---|---|
| Diabetes mellitus | | | | | | | | |
| Yes | **10.25%** | **9** | **524** | **533** | **1.69%** | **0.74** | **0.375-1.445** | **>0.10** |
| No | | **107** | **4558** | **4665** | **2.29%** | | | |
| | | | | | | | | |
| Heart disease | | | | | | | | |
| Yes | **10.40%** | **9** | **375** | **384** | **2.34%** | **1.034** | **0.522-2.048** | **>0.10** |
| No | | **75** | **3234** | **3309** | **2.27%** | | | |
| | | | | | | | | |
| Hypertension | | | | | | | | |
| Yes | **19.62%** | **24** | **1003** | **1027** | **2.34%** | **1.07** | **0.686-1.666** | **>0.10** |
| No | | **92** | **4115** | **4207** | **2.19%** | | | |
| | | | | | | | | |
| **Organ involvement from sarcoidosis** | | | | | | | | |
| Lung | | | | | | | | |
| Yes | **73.09%** | **101** | **3696** | **3797** | **2.66%** | **2.48** | **1.446-4.249** | **0.001** |
| No | | **15** | **1383** | **1398** | **1.07%** | | | |
| | | | | | | | | |
| Cardiac | | | | | | | | |
| Yes | **9.02%** | **15** | **442** | **457** | **3.28%** | **1.5** | **0.878-2.555** | **>0.10** |
| No | | **101** | **4509** | **4610** | **2.19%** | | | |
| | | | | | | | | |
| Neurologic | | | | | | | | |
| Yes | **8.33%** | **18** | **415** | **433** | **4.16%** | **2.02** | **1.234-3.307** | **0.0052** |
| No | | **98** | **4664** | **4762** | **2.06%** | | | |
| | | | | | | | | |
| **Demographic features** | | | | | | | | |
| Sex | | | | | | | | |
| Male | **32.42%** | **31** | **1420** | **1451** | **2.14%** | **0.7784** | **0.518-1.117** | **>0.10** |
| Female | | **83** | **2941** | **3024** | **2.74%** | | | |
| | | | | | | | | |
| Race | | | | | | | | |
| Black | **32.78%** | **36** | **1399** | **1435** | **2.51%** | **0.9346** | **0.633-1.379** | **>0.10** |
| White | | **79** | **2864** | **2943** | **2.68%** | | | |
| | | | | | | | | |
| Duration of disease | | | | | | | | |
| Sarcoidosis > 5 years | **71.61%** | **75** | **2735** | **2810** | **2.67%** | **1.1012** | **0.713-1.700** | **>0.10** |
| Sarcoidosis < 5 years | | **27** | **1087** | **1114** | **2.42%** | | | |

†Data not available from Dutch registry
CI: confidence interval; anti-TNF: anti-tumor necrosis factor antibody; COPD: chronic obstructive pulmonary disease

the hazard ratio (HR) for developing COVID-19 for all five sites. Forty-one percent of those with a COVID-19 infected roommate had COVID-19 infection (HR=27.44 (19.798-38.048, 95% confidence intervals, p<0.0001)). We did not collect information about which person was diagnosed first with COVID-19. All but the Spanish questionnaire identified a significant increased risk for COVID-19 for those with a roommate with COVID-19. In the Spanish questionnaire, only two patients reported a COVID-19 infected roommate. Neither of these sarcoidosis patients had COVID-19 infection at the time of completing the survey.

The overall risk for health care workers to have COVID-19 infection was 2.41 (1.532-3.799, p=0.0001), with nearly five percent of heath care workers who had sarcoidosis reporting COVID-19 infection. For the Spanish questionnaire, 18.8% of heath care workers reported COVID-19 infection, while less than six percent for all other questionnaires. The HR was only significant for the UC/AMC and Spanish questionnaires.

For sarcoidosis immunosuppressive therapy, rituximab treatment was associated with an increased risk of COVID-19 infection (HR=5.40 (2.621-11.123), p<0.0001). Only the UC/AMC and FSR included more than one patient treated with rituximab. However, both of these identified an increased risk with rituximab use. There was no significant increase in risk for COVID-19 infection for those on any other immunosuppressive therapy. For those receiving prednisone, there was no increased risk for patients prescribed 10 mg or more a day versus a lower dose. A total of 425 patients were prescribed hydroxychloroquine. There was no difference in the risk for COVID-19 among the other questionnaires or for the summary data of all sarcoidosis patients compared to all others. In the Dutch questionnaire, patients who reported to receive any medication for sarcoidosis had a decreased COVID-19 risk (HR=0.40, 0.165 to 0.958, P<0.05). There was no significant difference for the larger UC/AMC questionnaire (HR=1.49, 0.916 to 2.437, p>0.10) or for the combined data.

There was no increased risk with any of the associated with age, race, sex, duration of disease, or the comorbidities investigated. In the Dutch questionnaire, there was no difference in HR for those with a BMI above 25.

There was an increased risk for sarcoidosis patients with lung involvement (HR=2.48 (1.446-4.249), p=0.001). However, the FSR was the only individual questionnaire which identified this as a significant risk. The summary identified neurosarcoidosis as an increased risk factor for COVID-19 infection (HR=2.02 (1.234-3.307), p<0.01). For neurosarcoidosis, there was a significant HR seen for the Spanish and FSR questionnaire and borderline for UC/AMC (p=0.0619).

Most patients responding to the UC/AMC questionnaire provided their country of residence or state of residence if they lived in the United States, and the percentage of patients with COVID-19 infection by residence is shown in Table S-10. There was no significant difference in rates of infections between the United States and non-United States residents. For the United States, there was a wide range but not a significantly different rate of infection between states.

For the UC/AMC questionnaire, we analyzed the risk of COVID-19 infection for two groups of patients seen by either EEL or RPB at the University of Cincinnati from April1 to June 30, 2020. During that time, 547 cancer patients were seen at University of Cincinnati (UC cancer). Two (0.37%) reported COVID-19 infection. Only 3 of 541 (0.55%) sarcoidosis patients seen at the UC sarcoidosis clinic during this time reported COVID-19 infection. The hazard ratio for COVID-19 infection in sarcoidosis patients at the University of Cincinnati was not significantly higher than those with cancer (HR=1.52, 0.254 to 9.041, P>0.10).

*Outcome of COVID-19 infection*

Table 4 shows the reported rate of hospitalization for those with COVID-19 infection for each questionnaire and for the total group. A mean of 15.8% (range 13 to 27%) of COVID-19 infected patients were hospitalized with about one-third cared for in the intensive care unit at some time during hospitalization.

For 105 of the COVID-19 infected patients we had information regarding current immunosuppressive therapy. Nineteen (18.1%) of these were hospitalized. Table 5 summarizes these outcomes and calculates the HR for hospitalization for various immunosuppressive therapies. There were no

**Table 4.** Outcome of COVID-19 infected patients

| | UC/AMC | FSR | Dutch | Italy | Spain | Total |
|---|---|---|---|---|---|---|
| Home | 57 | 8 | 20 | 7 | 4 | 96 |
| Hospitalized (%) | 9 (17.6%) | 3 (27.3%) | 3 (13.0%) | 2 (22.2%) | 1 (20%) | 18 (15.8%) |
| Unknown | | 2 | | | | |

**Table 5.** Outcome of sarcoidosis patients infected with COVID-19 versus immunosuppressive therapy*

| DRUG | Home | Hospital | Percent in hospital | HR | 95% CI | p |
|---|---|---|---|---|---|---|
| All patients | 86 | 19 | 18.1% | | | |
| | | | | | | |
| Prednisone | | | | | | |
| Yes | 29 | 5 | 14.7% | 0.75 | 0.293-1.901 | >0.10 |
| No | 57 | 14 | 19.7% | | | |
| | | | | | | |
| If prednisone | | | | | | |
| Prednisone ≥ 10 mg | 13 | 2 | 13.3% | 0.76 | 0.186-3.106 | >0.10 |
| Prednisone < 10mg | 47 | 10 | 17.5% | | | |
| | | | | | | |
| anti-TNF monoclonal antibodies (infliximab, adalmumab) | | | | | | |
| Yes | 5 | 2 | 28.6% | 1.65 | 0.473-5.740 | >0.10 |
| No | 81 | 17 | 17.3% | | | |
| | | | | | | |
| Hydroxychloroquine | | | | | | |
| Yes | 7 | 1 | 12.5% | 0.67 | 0.103-4.416 | >0.10 |
| No | 79 | 18 | 18.6% | | | |
| | | | | | | |
| Cytotoxic (methotrexate, azathioprine, mycophenolate, leflunomide) | | | | | | |
| Yes | 17 | 7 | 29.2% | 1.97 | 0.873-4.440 | >0.10 |
| No | 69 | 12 | 14.8% | | | |
| | | | | | | |
| Rituximab | | | | | | |
| Yes | 6 | 1 | 14.3% | 0.78 | 0.121-5.006 | >0.10 |
| No | 80 | 18 | 18.4% | | | |

*Data not available on all patients.
HR: hazard ratio; anti-TNF: anti-tumor necrosis factor antibody;

**Table 6.** Outcome of COVID-19 infection versus underlying comorbidities*

| | Home | Hospital | Number pos | Rate | HR | 95% CI | P |
|---|---|---|---|---|---|---|---|
| **Total** | | | | | | | |
| DM | 9 | 2 | 11 | 11.46% | 1.19 | 0.308-4.585 | >0.10 |
| no DM | 72 | 13 | 85 | | | | |
| | | | | | | | |
| HTN | 14 | 5 | 19 | 19.79% | 2.03 | 0.784-5.234 | >0.10 |
| no HTN | 67 | 10 | 77 | | | | |
| | | | | | | | |
| COPD | 12 | 3 | 15 | 15.63% | 1.35 | 0.432-4.217 | >0.10 |
| no COPD | 69 | 12 | 81 | | | | |
| | | | | | | | |
| Heart disease | 8 | 5 | 13 | 13.54% | 3.19 | 1.297-7.855 | 0.0115 |
| no heart disease | 73 | 10 | 83 | | | | |
| | | | | | | | |
| **Any feature** | **35** | **7** | **42** | **43.75%** | **1.12** | **0.444-2.854** | **>0.10** |
| **No feature** | **46** | **8** | **54** | | | | |

DM: diabetes mellitus; HTN: hypertension; COPD: chronic obstructive pulmonary disease; HR hazard ratio.
*Summary data from UC/AMC, FSR, and Dutch

significant HR with any specific therapy. For the 96 COVID-19 infected patients from three questionnaires (UC/AMC, FSR, and Dutch), we were able to analyze the clinical outcome versus presence of diabetes, hypertension, COPD, and heart disease. Table 6 shows the results of this analysis. Only those with underlying heart disease had an increased rate of hospitalization (HR=3.19, 1.297-7.855, p<0.02).

## Discussion

In this analysis of five surveys of sarcoidosis patients from the USA and Europe concerning COVID-19 infection, we found evidence that the rate of COVID-19 infection in sarcoidosis patients was higher than in the general population. We found that sarcoidosis patients who were healthcare workers or were living with a person infected with COVID were at higher risk of COVID infection; these data have been reported in the general population (12;13) and support the well-established fact that COVID-19 is highly infectious and is easily transmitted to individuals who are in close proximity to an actively infected person (14). In regard to immunosuppressive therapy, only rituximab was associated with increased risk for COVID-19 infection in sarcoidosis patients. The lack of association of prednisone use with the development of COVID-19 infection held even when comparing ≥ 10 versus < 10 mg/day. In sarcoidosis patients with diabetes, hypertension, heart disease, and co-existing chronic obstructive pulmonary disease no increased risk of acquiring COVID-19 infection was identified, even though these comorbidities have also been identified as risk factors for COVID-19 infection (6;8;15).

The current data surveyed sarcoidosis patients mostly in United States and Europe from April through July 2020. This time frame co-indices with the onset of the pandemic in these two parts of the world. In our analysis of a questionnaire administered to 5200 sarcoidosis patients, 2.23% or 22,308 cases per million had become infected with COVID-19 during this time. During the time period in which this questionnaire was administered, the number of confirmed cases of COVID-19 in the United States was estimated as 1,060 per million (https://en.wikipedia.org/wiki/Template:COVID-19_pandemic_data/United_States_medical_cases). The same site reported that the cumulative rate of COVID-19 infection in Spain was 5197 per 1 million, Italy 3853 per 1 million, and Netherlands 3141 per 1 million. How-

ever, the rate of infection for COVID-19 infection in the general population may be higher. For example, a recent survey using serologic testing found that 2.5% of the Italian population had acquired COVID-19 infection by July 15, 2020 ( http://www.salute.gov.it/imgs/C_17_notizie_4998_0_file.pdf). While there was some variation in the rates of COVID-19 infection from the various questionnaires, overall there was no significant difference in the rate of COVID-19 infection. This was also true when examining the UC/AMC questionnaire, which included 1601 (3.1% infected) responders from US versus 361 (4.2% infected) from outside the United States.

These data suggest that the rate of COVID infection is higher in sarcoidosis patients than the general population. However, the rate of COVID-19 infection varies by the time period as well as from country to country and even within the United States. It is therefore possible, that the rate of COVID-19 in sarcoidosis patients was no different from the general population. A significant number of the sarcoidosis patients completing the UC/AMC questionnaire were seen at the University of Cincinnati Sarcoidosis Clinic, which is in southwestern Ohio. As of July 1, 2020, the reported cumulative rate of COVID-19 infection for this area was 5103 per 1 million (https://coronavirus.ohio.gov/wps/portal/gov/covid-19/dashboards/overview). This is similar to the rate of 5545 per 1 million for our sarcoidosis patients and 3656 per 1 million for the cancer patients. The lower rate of COVID-19 infections for sarcoidosis patient at University of Cincinnati clinic versus other patients completing the questionnaires may be due to lower overall rate of COVID-19 infection in the area and/or the more rigorous criteria for diagnosis, since at our clinic we required verification by culture. This criterion may underestimate the number of cases of COVID-19 infection (16). The hospitalization rates for COVID-19 may be more accurate, since such cases are usually confirmed by cultures.

For sarcoidosis patients, we identified five features associated with increased for COVID-19 infection. Sarcoidosis patients with a COVID-19 infected roommate had a greater than 20-fold increased risk for COVID-19 infection. In one meta-analysis, the risk of in home transmission of disease has been estimated as ten-fold (17). There was also a nearly two-fold increased risk for sarcoidosis patients who were health care workers. This increased risk has been noted for some time (12). The higher risk in Spain may be a reflection that some areas were hit sooner than other parts of the world. The widespread use of N-95 and other respiratory policies later in the pandemic and in other parts of the world may have blunted this risk factor (13;18). Comorbidities in sarcoidosis include diabetes, hypertension, heart disease, and co-existing chronic obstructive pulmonary disease (10;19). These have also been identified as risk factors for COVID-19 infection and more severe disease (2;6;8;15). However, in the current study, none of these was associated with an increased risk for infection.

In regards to immunosuppression therapy, only rituximab was associated with increased risk for COVID-19 infection for sarcoidosis patients. This is not surprising, since rituximab has been noted to have increased the risk for acquiring viral infections (20). In addition, viral infections are more severe when patients are receiving rituximab. We studied only seven patients with COVID-19 infection treated with rituximab.

Sarcoidosis is a multi-organ disease and the effect of sarcoidosis on different organs may affect the patient's ability to avoid COVID-19 infection. In this study, we found that patients with lung or neurologic involvement were at increased risk for COVID-19 infection. Chronic lung disease has been identified as a risk factor for infection and more severe disease (21).

In terms of the outcomes of COVID-19 infected sarcoidosis patients, we found that less than twenty percent required hospitalization. In a recent, retrospective study of 37 sarcoidosis patients with COVID-19 infection, the rate of hospitalization for infection was 60% and no different from the non-sarcoidosis patients seen at that center (3). However, the rate of adverse outcome as defined by requiring intubation and/or mortality was significantly higher than the non-sarcoidosis patients (3). The current study would have missed the very severe cases, at least the ones who died, as it was a study analyzing a self-reported questionnaire. In our study, the use of immunosuppressive therapy was not associated with a significant increased risk for hospitalization. The overall outcome of these patients appears more favorable than that reported in rheumatoid arthritis patients treated with immunosuppression (22-24). In one study (23), the use of $\geq$ 10 mg per day

of prednisone or its equivalent was associated with increased risk. That study analyzed 600 COVID-19 infected patients and our study may have been underpowered to detect that difference. Interestingly, that study found that anti-TNF therapy was associated with a significantly lower risk for COVID-19 infection (23).

Hydroxychloroquine has been proposed as a potential therapy for patients with COVID-19 infection and ongoing studies are evaluating this drug (25). Over 400 of our sarcoidosis patients were receiving hydroxychloroquine at time of survey. There was no change in the rate of infection or rate of hospitalization for the seven patients who developed COVID-19 infection while on hydroxychloroquine. This has also been noted in a study of patients treated with hydroxychloroquine for various rheumatologic conditions (23).

Several comorbidities have been associated with a worse clinical outcome from COVID-19 infection (7;8;21;23). We were able to analyze the outcome of 96 sarcoidosis patients with COVID-19 infection and reported comorbidities. Underlying heart disease was associated with an increased risk for hospitalization. Other comorbidities examined included diabetes, COPD, and hypertension were not felt to be significant risk factors.

There are several limitations to our study. The questionnaire did not try to quantitate severity of disease, especially significant pulmonary fibrosis. Therefore, we could not comment on impact of severe lung disease on risk or outcome of COVID-19 infection. Because of the low number of incident cases, we may have been underpowered to detect smaller, but significant risk factors including comorbidities and the impact of immunosuppression therapy. The questionnaires were completed by the patients, usually on-line. With the exception of those seen at the University of Cincinnati, there was no attempt to verify COVID-19 infection. Patients who had severe disease or even died would be unlikely to be able to complete the questionnaire, so this group was underrepresented. Also, the rate of COVID-19 infection in sarcoidosis patients varies based on local conditions and time into the pandemic. The rate of COVID-19 infection in the general population during the study period may be better understood over time, especially as serologic testing becomes more widely used. However, the rate of infection for COVID-19 infection in the general population may be higher. We compared our results to a standard reporting site which provided cumulative rates for various parts of the world. In the sub-study at University of Cincinnati, the rate of infection was not significantly different from cancer patients seen at the same time period. Future reports may provide a better understanding of the rate of COVID-19 infection in the community studied. Future rates may be affected as vaccines become available. Vaccines for other conditions have proved to be effective in preventing infections in sarcoidosis patients (26).

In summary, our data suggests an increased rate of COVID-19 infection in sarcoidosis patients. However, when compared to non-sarcoidosis patients in the same area and time of the study, the rate of COVID-19 infection was not significantly different. The most obvious risk factor for COVID-19 infection was having a roommate with COVID-19. This means that hygiene measures and distancing are extremely important at home as well as in public. To facilitate research on prevalence and risk factors of COVID-19 infection in chronic diseases, sarcoidosis specifically, it would be helpful to report in population registries not only numbers of patients with COVID-19, but also their characteristics, such as comorbidities and medication use.

## Acknowledgements

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**Figure S1**

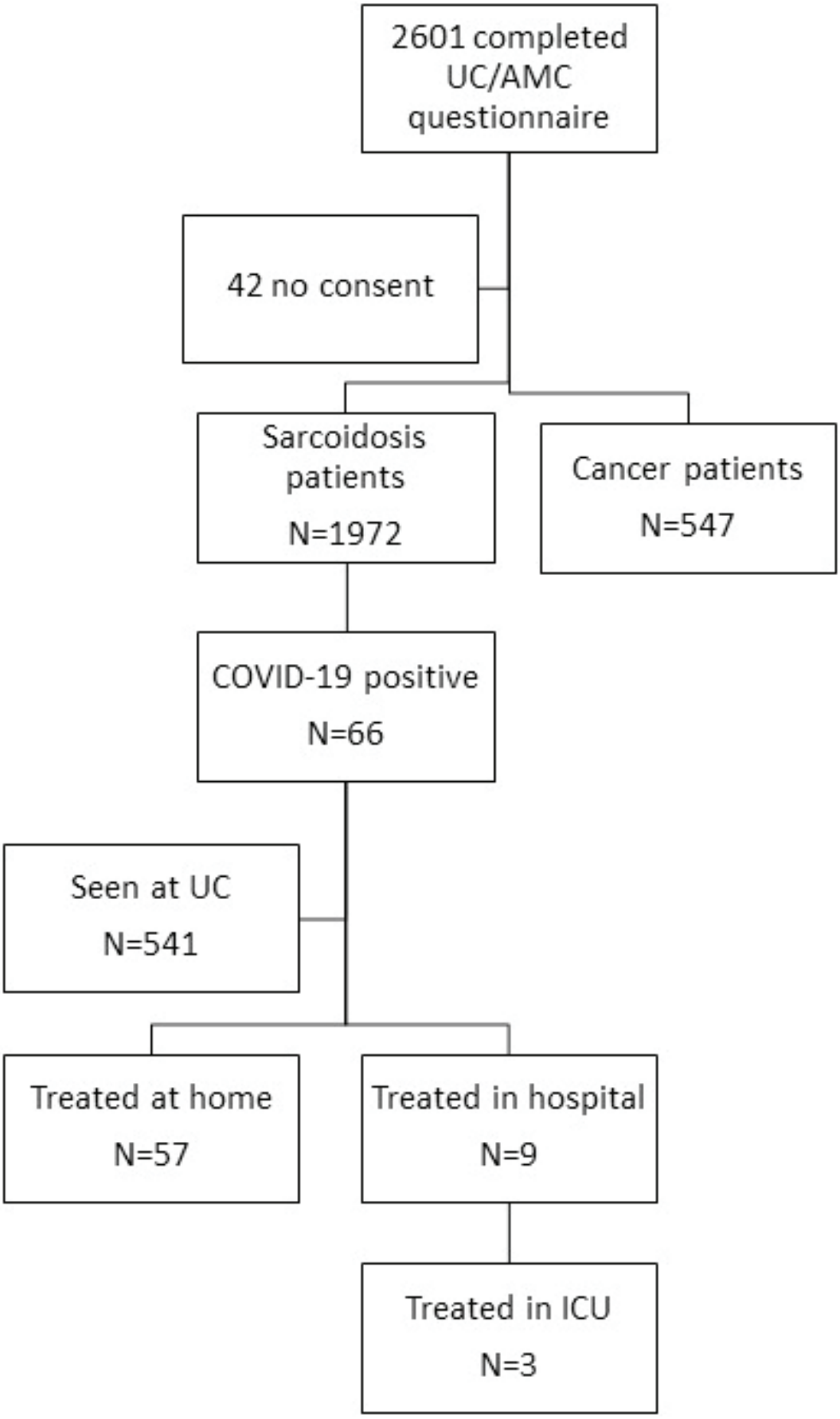
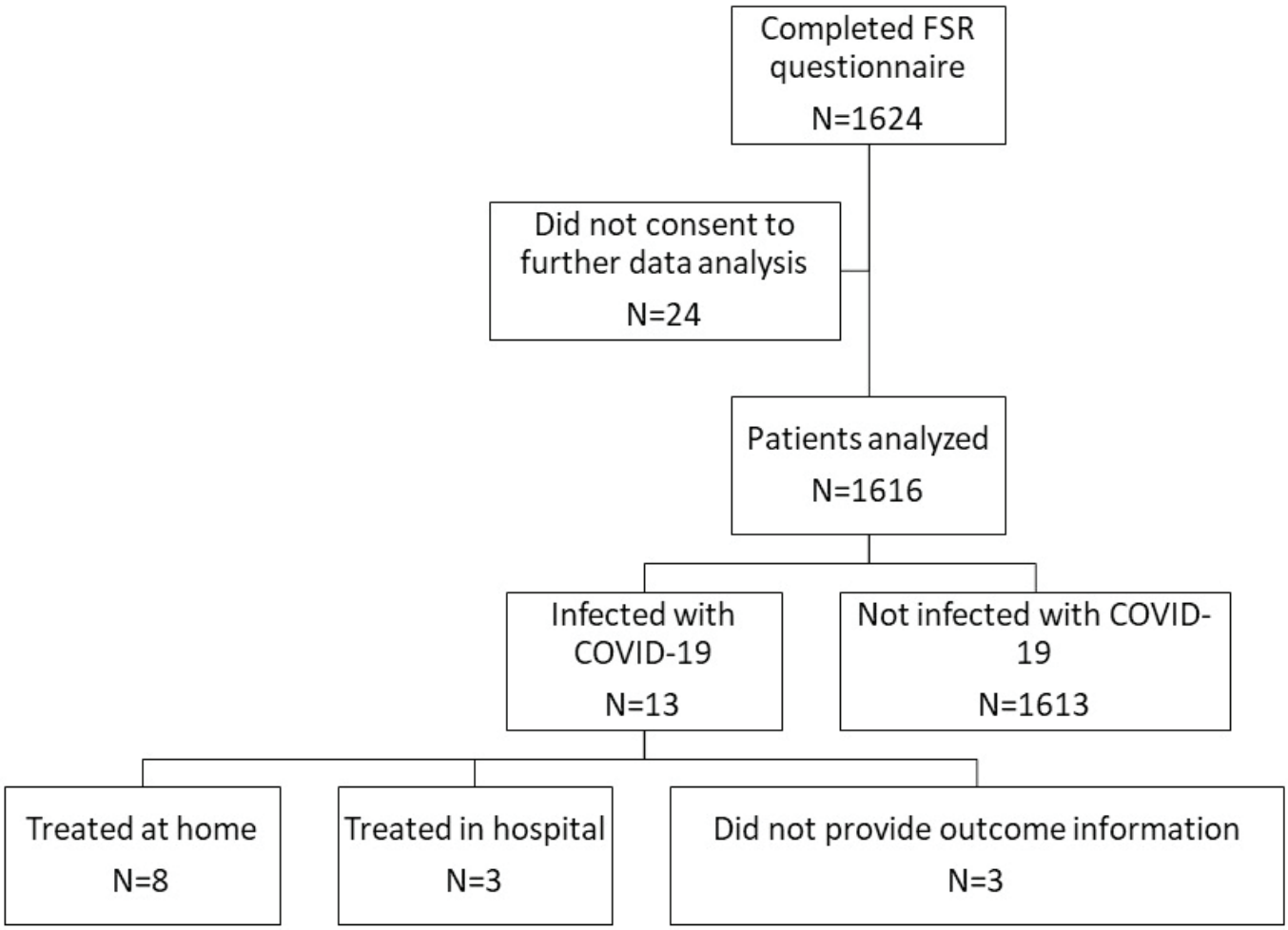

2601 completed UC/AMC questionnaire
42 no consent
Sarcoidosis patients N=1972
Cancer patients N=547
COVID-19 positive N=66
Seen at UC N=541
Treated at home N=57
Treated in hospital N=9
Treated in ICU N=3

**Figure S2**


Completed FSR questionnaire
N=1624
Did not consent to further data analysis
N=24
Patients analyzed
N=1616
Infected with COVID-19
N=13
Not infected with COVID-19
N=1613
Treated at home
N=8
Treated in hospital
N=3
Did not provide outcome information
N=3

## Figure S3

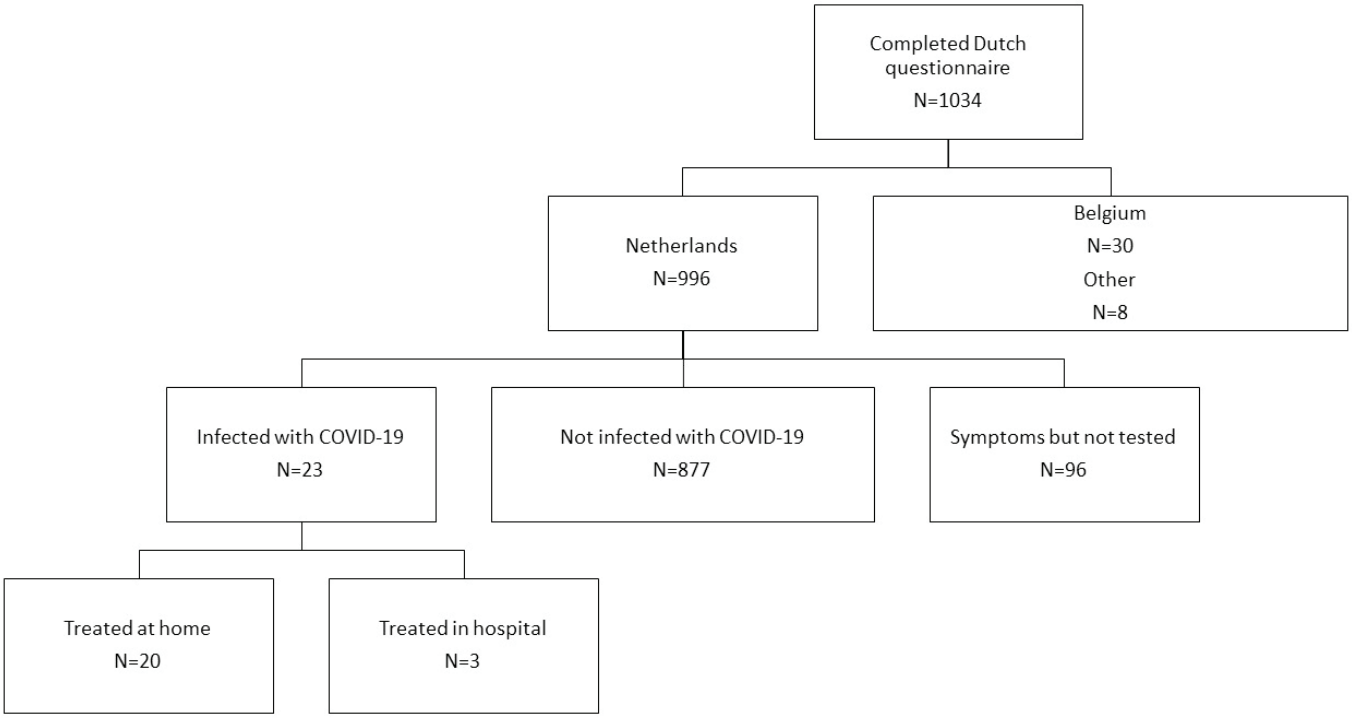

Completed Dutch questionnaire
N=1034
Netherlands
N=996
Belgium
N=30
Other
N=8
Infected with COVID-19
N=23
Not infected with COVID-19
N=877
Symptoms but not tested
N=96
Treated at home
N=20
Treated in hospital
N=3

**Figure S4**

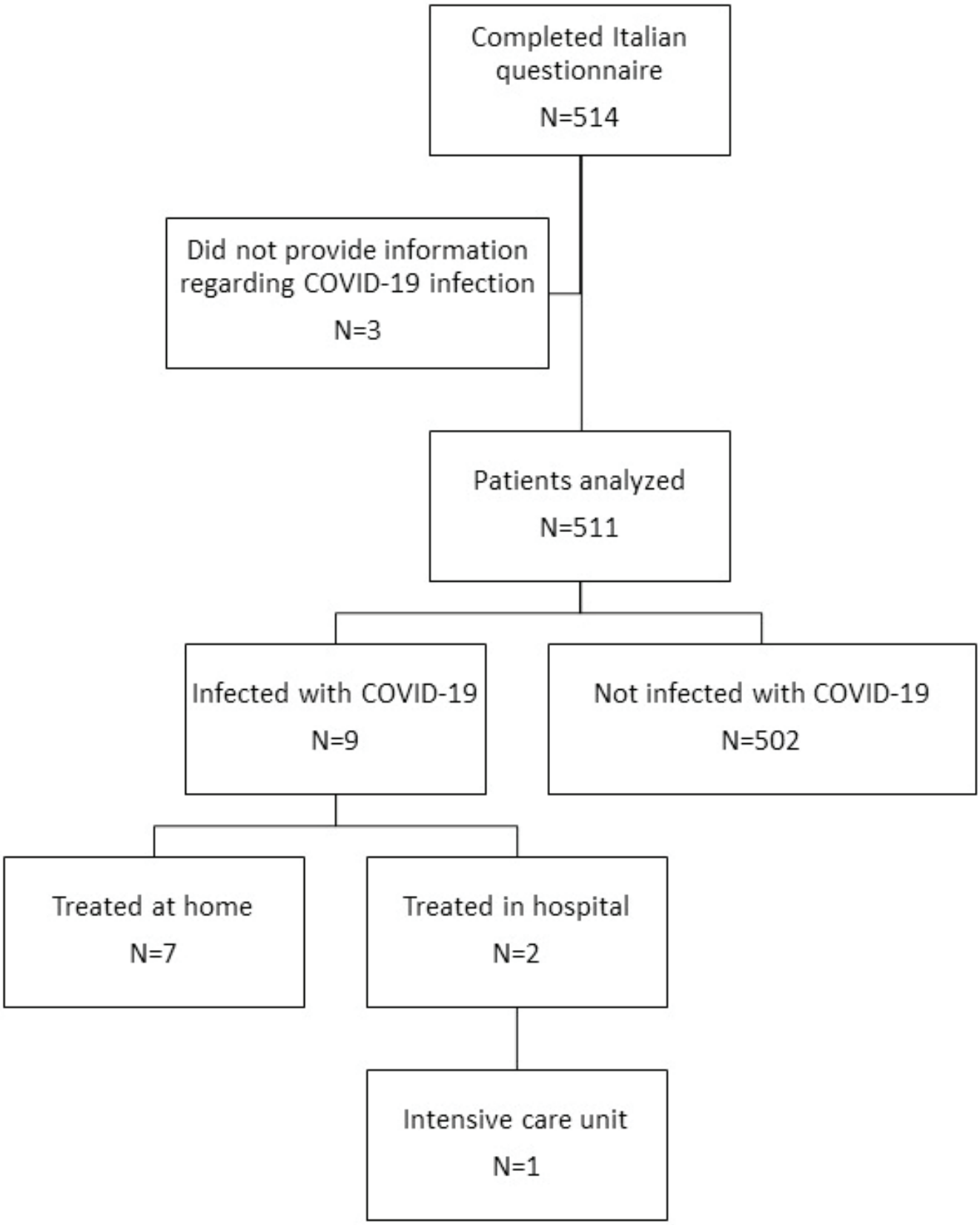
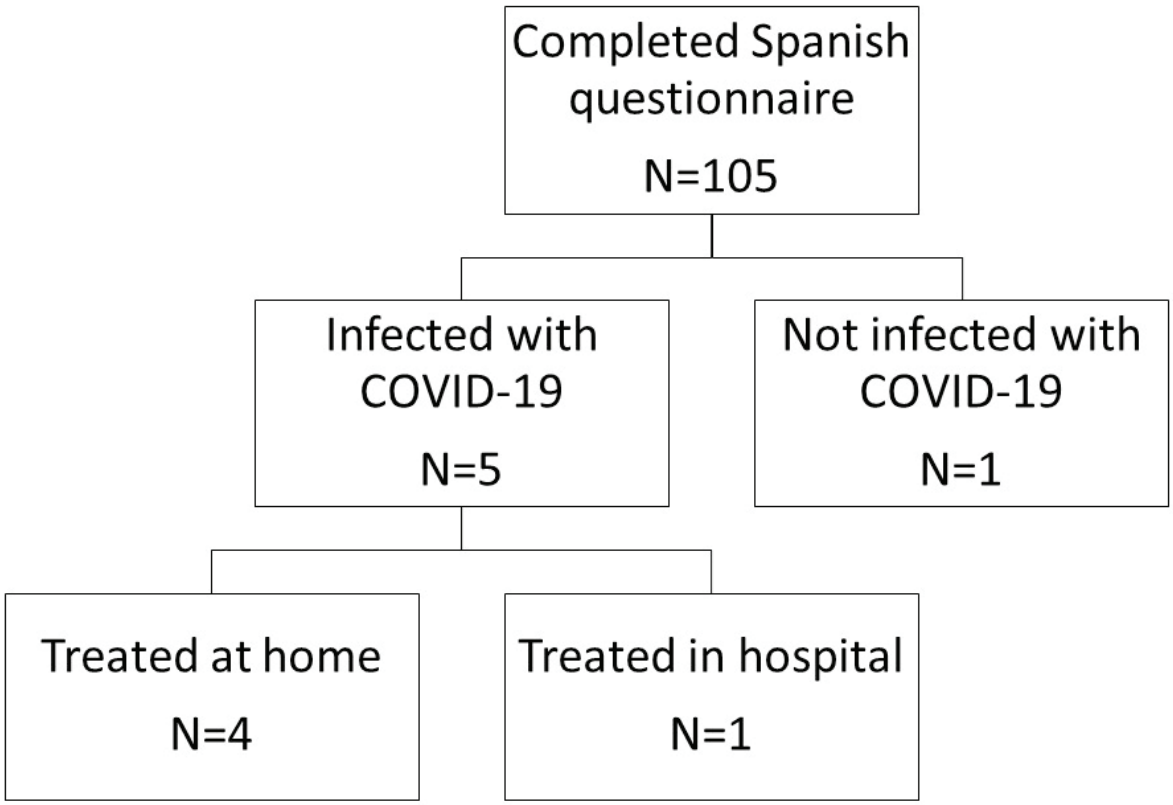

Completed Italian questionnaire
N=514
Did not provide information regarding COVID-19 infection
N=3
Patients analyzed
N=511
Infected with COVID-19
N=9
Not infected with COVID-19
N=502
Treated at home
N=7
Treated in hospital
N=2
Intensive care unit
N=1

**Figure S5**


Completed Spanish questionnaire
N=105
Infected with COVID-19
N=5
Not infected with COVID-19
N=1
Treated at home
N=4
Treated in hospital
N=1

**Supplement S-1 Questionnaires**

**UC/AMC and FSR questionnaire**

COVID-19 questionnaire

1. By completing this questionnaire, you are agreeing to have this data shared with others and understand that a summary of data may be published. **Do you agree?**
    - **Yes**
    - **No**
2. Have you been infected with COVID-19 (corona virus)?
    - Yes
    - No
    a. If yes, what was outcome (check all that apply)
        - Treated only at home
        - I was hospitalized but I did not go to an intensive care area
        - Treated at any time in an intensive care area
        - At any time on a ventilator (breathing machine)
3. Have any people who live in the same house/apartment as me been diagnosed with COVID-19 (corona virus)?
    - Yes
    - No
4. Are you a health care provider? □ Yes □ No
5. I have the following medical conditions (check all that apply)
    - Sarcoidosis
        i. If sarcoidosis, how many years have you had sarcoidosis: _____
    - COPD/Asthma
    - Cancer
    - Diabetes
    - Heart disease
    - Hypertension
    - Other
6. Your age: _____
7. Your race (check all that apply
    - Black
    - White

- Asian
- Other

8. Sex:
    - Female
    - Male
9. I live in the following state (if United States) or country (if not USA): _____

**IF I HAVE SARCOIDOSIS, PLEASE ANSWER THE FOLLOWING FIVE QUESTIONS**

10. I have sarcoidosis in the following areas of my body (check all that apply)
    - Lung
    - Heart
    - Brain
    - Other
11. I have been treated in past 3 months for sarcoidosis with (check all that apply)
    - Prednisone/prednisolone
        i. If yes, current daily dose of prednisone/prednisolone _____
    - Methotrexate/Azathioprine (Imuran)/Mycophenolate (Cellcept)/Leflunomide(Arava)
    - Infliximab (Remicade/Renflexis/Inflectra)/Adalimumab(Humira)
    - Hydroxychloroquine(Plaquenil)/Chloroquine
    - Rituximab (Rituxan)
    - Other chemotherapy
    - Other
12. In the past, have you been treated for sarcoidosis with (check all that apply)?
    - Prednisone/prednisolone/decadron
    - Methotrexate/Azathioprine (Imuran)/Mycophenolate (Cellcept)/Leflunomide(Arava)
    - Infliximab (Remicade/Renflexis/Inflectra)/Adalimumab(Humira)
    - Hydroxychloroquine(Plaquenil)/Chloroquine
    - Rituximab (Rituxan)
    - Other chemotherapy
    - Other
13. This is the initial questionnaire?
    - Yes
    - No

14. If this is the initial questionnaire, do you agree to being contacted in 3-6 months to complete this questionnaire a second time?

    - Yes
    - No

**Supplement S-2**

**Dutch Questionnaire**

**COVID-19 / Corona vragenlijst voor sarcoïdosepatiënten**

Patient information:

In korte tijd heeft COVID-19 wereldwijd toegeslagen en het leven veranderd. Het heeft tot veel onzekerheden geleid.

Bent u sarcoïdosepatiënt dan wordt u gevraagd deze survey in te vullen. Met nadruk willen we erop wijzen dat ook wanneer u geen COVID-19 infectie heeft gehad, u toch wordt verzocht de vragenlijst in te vullen.

Met uw hulp kunnen we dan trachten betrouwbare cijfers ook uit Nederland te verzamelen.

Betreffende sarcoïdose en COVID-19 kwamen allerlei vragen naar voren:

· Heeft een sarcoïdosepatiënt een hoger risico op het krijgen van een COVID-19 infectie?

· Als een sarcoïdosepatiënt geïnfecteerd raakt, heeft hij of zij dan een ernstiger beloop?

. Hebben sarcoïdosepatiënten die prednison of andere immunosuppressiva (medicijnen die het afweersysteem onderdrukken) gebruiken een hoger risico op het geïnfecteerd raken met COVID-19?

. Beschermt het gebruik van hydroxychloroquine een sarcoïdosepatiënt tegen COVID-19?

. Heeft geslacht, ras, gewicht, of leeftijd invloed op het risico of de uitkomst van COVID-19?

Om deze vragen te kunnen beantwoorden zijn de Foundation for Sarcoidosis Research (FSR) en de Universiteit van Cincinnati, met als hoofdonderzoeker prof. Robert Baughman, een survey onder sarcoïdosepatiënten gestart in de USA. Om hierover ook een indruk te krijgen in de rest van de wereld zijn diverse landen benaderd om ook deze vragenlijst onder sarcoïdosepatiënten uit te zetten, waaronder Nederland. Deze vragenlijst wordt in Nederland op verzoek van de initiatiefnemers verspreid door de ild care foundation in samenwerking met Sarcoidose.nl.

Door deze vragenlijst in te vullen, stemt u ermee in dat de gegevens anoniem verwerkt worden. Een samenvatting van het onderzoek zal, op basis van anonieme gegevens, gepubliceerd worden.

Bij voorbaat hartelijk dank voor uw medewerking!

1. Bent u besmet (geweest) met COVID-19 (coronavirus)?

- Ja
- Nee
- Weet het niet zeker, ben niet getest, maar heb wel symptomen (gehad)

2. Zo ja, wat was er nodig voor de behandeling? (vink aan wat van toepassing is) :

- Kon thuis worden behandeld
- Ben opgenomen geweest in een ziekenhuis, maar ben niet op de intensive care verpleegd
- Ben opgenomen geweest op een intensive care afdeling
- Ben beademd met een ventilator (beademingsmachine)
- Niet van toepassing, geen COVID-19 gehad

3. Zijn er mensen die in hetzelfde huis/ appartement wonen als u, die besmet zijn geweest met COVID-19 (corona virus)?

- Ja
- Nee

4. Bent u een zorgverlener?

- Ja
- Nee

5. Hoe lang heeft u al sarcoïdose? (jaren, maanden)

6. Ik heb sarcoïdose in de volgende organen/delen van mijn lichaam: (vink aan wat van toepassing is, meerdere keuzes mogelijk)

- Longen
- Hart
- Hersenen / zenuwstelsel
- Anders, nl.:

7. Ik heb naast sarcoïdose ook de volgende medische aandoeningen (vul in wat van toepassing is)

- geen andere aandoeningen
- Kanker
- Diabetes
- Hart-vaataandoening
- Hartfalen
- Hypertensie / hoge bloeddruk
- COPD
- Astma
- Andere aandoening:

8. Nadat ik COVID-19 heb gehad, zijn mijn klachten:

- verergerd
- minder geworden dan voorheen
- hetzelfde gebleven
- niet van toepassing, heb geen COVID-19 gehad.

9. Wat is u leeftijd? (jaren)

10. Wat is uw gewicht? (in kg)

11. Wat is uw lengte (in cm)

12. Wat is uw geslacht?

- Vrouw
- Man
- gender neutraal

13. Wat is uw etniciteit?

- Kaukasisch / wit
- Negroïde / Afro Amerikaans / zwart
- Aziatisch
- Anders, nl./:

14. Ik woon in (land) :

- Nederland
- België
- Anders, nl.:

15. Bent u in de afgelopen 3 maanden behandeld voor sarcoïdose met: (vink aan wat van toepassing is, meerdere antwoorden mogelijk)

- Prednison/prednisolon (graag de huidige dagelijkse dosis onderaan deze vraag invullen)
- Methotrexaat
- Azathioprine (Imuran)
- Cellcept (Mycophenolaat)
- Leflunomide (Arava)
- Infliximab (Remicade/Renflexis/Inflectra)
- Adalimumab (Humira)
- Hydroxychloroquine (Plaquenil)/Chloroquine
- Rituximab (Rituxan)
- Andere immunotherapie
- Andere behandelwijze

- Geen medicatie of behandeling

Dosering Prednison per dag (in mg):

Bewerken Opties

Bewerken Opties Logica Verplaatsen Kopiëren Verwijderen

16. Bent U In het verleden behandeld voor sarcoïdose met (vink aan wat van toepassing is)?

- Prednison/prednisolon (graag de huidige dagelijkse dosis onderaan deze vraag invullen)
- Methotrexaat
- Azathioprine (Imuran)
- Cellcept (Mycophenolaat)
- Leflunomide (Arava)
- Infliximab (Remicade/Renflexis/Inflectra)
- Adalimumab (Humira)
- Hydroxychloroquine (Plaquenil)/Chloroquine
- Rituximab (Rituxan)
- Andere immunotherapie
- Andere behandelwijze
- Geen medicatie of behandeling

Dosering Prednison per dag (in mg):

Bewerken Opties

Nieuwe vraag

Hartelijk dank voor uw medewerking!

**Supplement S-3**

**Italian Questionnaire**

The following questionnaire was created using GOOGLE FORMS.

For further infos, please visit https://www.google.com/intl/en-US/forms/about/

Every single answer or group of answers generate both visual data and an excel file with the sum of all data.

## Dati epidemiologici

1. Completando questo questionario, si autorizza alla condivisione dei dati qui raccolti e si dà il benestare alla eventuale pubblicazione anonima dei dati stessi. Dai il tuo consenso?

- Sì
- No

2. Età

Scegli (choose – dropdown menu)

3. Sesso

- Maschile
- Femminile
- Preferisco non rispondere

4. Etnia

- Caucasica (prevalentemente europea)
- Afro-americana
- Asiatica
- Preferisco non rispondere

5. Sei un operatore sanitario?

- Sì
- No

6. In quale regione vivi?

Scegli (choose – dropdown menu)

## Covid-19 e Sarcoidosi

7. Sei stata/o contagiata/o dal COVID-19 (coronavirus)?

- Sì

No

7a. Se sì, quale esito ha avuto (segnare tutte opzioni  pertinenti)

- Trattamento esclusivamente a casa
- Ricovero in ospedale ma non in area intensiva
- Curato in terapia intensiva
- Curato con ventilazione assistita

8. Ci sono state persone conviventi nella tua abitazione che sono state contagiate dal COVID-19 (coronavirus)?

- Sì
- No

9. Attualmente soffri di una o più delle seguenti patologie? (segnare tutte le patologie in essere)

- Sarcoidosi
- BPCO/Asma
- Cancro
- Diabete
- Ipertensione
- Altro

9a. Se hai segnato la sarcoidosi, da quanti anni ne soffri? (non si intende da che età, ma gli anni di malattia)

Scegli (choose – dropdown menu)

10. Quale area del tuo corpo è interessata dalla Sarcoidosi? (specificare quale o quali)

- Polmoni
- Cuore
- Sistema nervoso
- Altro

11. Negli ultimi 3 mesi ti sei stato sottoposto ad una o più d'una delle seguenti terapie? (indica le voci pertinenti)

- Prednisone/Prednisolone (farmaci cortisonici)
- Metotrexato/Azatriopina/Micofenolato/Leflunomide
- Infliximab/Adalimumab
- Idrossiclorochina/Clorochina (Plaquenil)
- Rituximab
- Altre chemioterapie
- Nessuna terapia

11a. Se hai assunto prednisone/prednisolone (farmaci cortisonici), qual è stata la dose giornaliera (quantificata in mg)?

Scegli (choose – dropdown menu)

11a.2 Se alla domanda precedente hai indicato 'altro' scrivi qui la dose giornaliera di cortisonici (quantificata in mg)

---------- risposta aperta (open response)

11b. Se hai assunto Idrossiclorochina/Clorochina (Plaquenil), qual è stata la dose giornaliera (quantificata in mg)? (this question is only in the Italian Survey)

Scegli (choose – dropdown menu)

11b.2 Se alla domanda precedente hai indicato 'altro' scrivi qui la dose giornaliera di Idrossiclorochina/Clorochina(quantificata in mg)

---------- risposta aperta (open response)

12. In passato sei stato sottoposto ad una o più d'una delle seguenti terapie? (indica le voci pertinenti)

- Prednisone/Prednisolone (farmaci cortisonici)
- Metotrexato/Azatriopina/Micofenolato/Leflunomide
- Infliximab/Adalimumab
- Idrossiclorochina/Clorochina (Plaquenil)
- Rituximab
- Altre chemioterapie
- Nessuna terapia

13. Una versione precedente di questo questionario è già stata condotta durante il mese di aprile. Hai già compilato il 1° questionario di aprile?

- Sì
- No

**Supplement S-4**

**Spanish Questionnaire**

# Cuestionario COVID-19

1- Al completar este cuestionario, acepta compartir estos datos con otros y comprende que se puede publicar un resumen de los datos. ¿Está de acuerdo?

○SÍ ○NO

2- ¿Ha sido infectado con COVID-19 (coronavirus)?

○SÍ ○NO

a) En caso afirmativo, cuál fue el resultado (marque todos los que correspondan)

○Tratado solo en casa

○Fui hospitalizado pero no fui a un área de cuidados intensivos

○Tratado en cualquier momento en un área de cuidados intensivos

○En cualquier momento en un ventilador (máquina de respiración)

3- ¿Alguna de las personas que viven en la misma casa / departamento que yo ha sido diagnosticada con COVID-19 (coronavirus)?

○SÍ ○NO

4- ¿Es usted un proveedor de atención médica?

○SÍ ○NO

- ○Sarcoidosis Si tiene sarcoidosis, ¿cuántos años ha tenido sarcoidosis? _____
- ○EPOC / Asma
- ○Cáncer
- ○Diabetes
- ○Enfermedad del corazón
- ○Hipertensión
- ○Otro

6- Edad: _____

7- Origen étnico

- ○Negro
- ○Blanco
- ○Asiático
- ○Otros
- ○Prefiero no responder

8-

○Masculino

○ Femenino

○Prefiero no responder

9- Vivo en el siguiente estado/país _____

10- Este es el cuestionario inicial?

○Si ○No

SI TIENE SARCOIDOSIS, RESPONDA LAS SIGUIENTES CINCO PREGUNTAS

11-Tengo sarcoidosis en las siguientes áreas de mi cuerpo (marque todas las que correspondan)

○Pulmón

○Corazón

○Cerebro

○Otro

corresponda)

○Prednisona / prednisolona

a. En caso afirmativo, la dosis diaria actual de prednisona / prednisolona _____

○Metotrexato / Azatioprina (Imuran) / Micofenolato (Cellcept) / Leflunomida (Arava)

○Infliximab (Remicade / Renflexis / Inflectra) / Adalimumab (Humira)

○Hidroxicloroquina (Plaquenil) / Cloroquina

○Rituximab (Rituxan)

○Otra quimioterapia

○Otro

○Ninguna

13- En el pasado, ¿ha recibido tratamiento para la sarcoidosis con (marque todo lo que corresponda)?

- ○Prednisona / prednisolona / decadron
- ○Metotrexato / Azatioprina (Imuran) / Micofenolato (Cellcept) / Leflunomida (Arava)
- ○Infliximab (Remicade / Renflexis / Inflectra) / Adalimumab (Humira)
- ○Hidroxicloroquina (Plaquenil) / Cloroquina
- ○Rituximab (Rituxan)
- ○Otra quimioterapia
- ○Otro
- ○Ninguna

**Supplement S-5**

**Results of UC/AMC questionnaire**

| | Covid Positive | Covid negative | | Percent with feature | Percent COVID positive | Hazards ratio | 95% CI | P | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **ALL PATIENTS** | | | | | | | | | |
| Sarcoidosis | 66 | 1906 | 1972 | | 3.35% | 9.15 | 2.249-37.253 | 0.002 | |
| Cancer | 2 | 545 | 547 | | 0.37% | | | | |
| | | | | | | | | | |
| **LOCAL** | | | | | | | | | |
| OH/KY/IN | 3 | 538 | 541 | | 0.55% | 1.5166 | 0.2544-9.041 | | Cincinnati Clinic patients |
| Cancer | 2 | 545 | 547 | | 0.37% | | | | Sarc versus cancer |
| | | | | | | | | | |
| **Sarc patients** | | | | | | | | | |
| Male | 19 | 495 | 514 | 26.18% | 3.70% | 1.14 | 0.675-1.923 | >0.10 | |
| Female | 47 | 1402 | 1449 | 73.82% | 3.24% | | | | 9 no sex indicated |
| | | | | | | | | | |
| Black | 11 | 371 | 382 | 20.07% | 2.88% | 0.796 | 0.4209-1.5066 | >0.10 | |
| White | 55 | 1466 | 1521 | 79.93% | 3.62% | | | | 9 patients biracial |
| | | | | | | | | | |
| Roommate with COVID | | | | | | | | | |
| yes | 21 | 17 | 38 | 1.94% | 55.26% | 23.6772 | 15.769-35.5514 | <0.0001 | |
| no | 45 | 1883 | 1928 | 98.22% | 2.33% | | | | |
| | | | | | | | | | |
| Health care provider | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Yes | 12 | 197 | 209 | 10.65% | 5.74% | 1.8565 | 1.0099 - 3.4127 | 0.0464 | |
| no | 54 | 1692 | 1746 | 88.95% | 3.09% | | | | |
| | | | | | | | | | |
| Current meds | | | | | | | | | |
| Prednisone | 24 | 755 | 779 | 39.50% | 3.08% | 0.8751 | 0.5343 - 1.4332 | >0.10 | |
| No prednisone | 42 | 1151 | 1193 | 60.50% | 3.52% | | | | |
| | | | | | | | | | |
| Prednisone >10 mg or more | 13 | 361 | 374 | 18.97% | 3.48% | 1.048 | 0.5774 - 1.9022 | >0.10 | |
| Prednisone < 10 mg | 53 | 1545 | 1598 | 81.03% | 3.32% | | | | |
| | | | | | | | | | |
| Plaquenil | 7 | 239 | 246 | 12.47% | 2.85% | 0.8324 | 0.3846 - 1.8016 | >0.10 | |
| No plaquenil | 59 | 1667 | 1726 | 87.53% | 3.42% | | | | |
| | | | | | | | | | |
| anti-TNF | 6 | 183 | 189 | 9.58% | 3.17% | 0.9434 | 0.4131 - 2.1542 | >0.10 | |
| no anti-TNF | 60 | 1723 | 1783 | 90.42% | 3.37% | | | | |
| | | | | | | | | | |
| Cytotoxic | 21 | 537 | 558 | 28.30% | 3.76% | 1.1826 | 0.7111 - 1.9666 | >0.10 | |
| No cytotoxic | 45 | 1369 | 1414 | 71.70% | 3.18% | | | | |
| | | | | | | | | | |
| Rituximab | 6 | 42 | 48 | 2.43% | 12.50 % | 4.0083 | 1.8213 - 8.8217 | 0.0006 | |
| No rituximab | 60 | 1864 | 1924 | 97.57% | 3.12% | | | | |
| | | | | | | | | | |
| Underlying | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COPD | 12 | 321 | 333 | 16.89% | 3.60% | 1.0938 | 0.5917 - 2.0217 | >0.10 | |
| | 54 | 1585 | 1639 | 83.11% | 3.29% | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Diabetes | 5 | 292 | 297 | 15.06% | 1.68% | 0.4623 | 0.1873 - 1.1408 | 0.0941 | |
| | 61 | 1614 | 1675 | 84.94% | 3.64% | | | | |
| | | | | | | | | | |
| Heart disease | 8 | 254 | 262 | 13.29% | 3.05% | 0.9002 | 0.4348 - 1.8637 | >0.10 | |
| | 58 | 1652 | 1710 | 86.71% | 3.39% | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Hypertension | 15 | 480 | 495 | 25.10% | 3.03% | 0.8776 | 0.498- 1.5466 | >0.10 | |
| | 51 | 1426 | 1477 | 74.90% | 3.45% | | | | |
| | | | | | | | | | |
| Organ involved | | | | | | | | | |
| Lung | 58 | 1596 | 1654 | 83.87% | 3.51% | 1.3939 | 0.6721 - 2.8907 | >0.10 | |
| | 8 | 310 | 318 | 16.13% | 2.52% | | | | |
| | | | | | | | | | |
| Cardiac sarc | 12 | 278 | 290 | 14.71% | 4.14% | 1.3303 | 0.7206 - 2.4557 | >0.10 | |
| | 54 | 1628 | 1682 | 85.29% | 3.21% | | | | |
| | | | | | | | | | |
| Neuro sarc | 11 | 184 | 195 | 9.89% | 5.64% | 1.8228 | 0.9704 - 3.4229 | 0.0619 | |
| | 55 | 1722 | 1777 | 90.11% | 3.10% | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Origin | | | | | | | | | |
| US | 50 | 1551 | 1601 | 81.19% | 3.12% | 0.7516 | 0.4269 - 1.3232 | >0.10 | |
| non US | 15 | 346 | 361 | 18.31% | 4.16% | | | | No country entered: 10 |
| | | | | | | | | | |
| OH/KY/IN | 3 | 538 | 541 | 27.43% | 0.55% | | | | |
| | 63 | 1368 | 1431 | 72.57% | 4.40% | | | | |
| | | | | | | | | | |
| **Sarcoid age** | | | | | | | | | |
| Covid Positive | | | | | | | 54.5 ± 11.39 years | 0.088 | |
| Covid negative | | | | | | | 53.0 ± 9.60 years | | |
| | | | | | | | | | |
| COVID outcome | Home | Hospital | ICU | Ventilator | | | | | |
| Sarc | 44 | 9 | 3 | 0 | | | | | |
| Cancer | 1 | 1 | 0 | 0 | | | | | |
| | | | | | | | | | |
| Sarc ≥ 5 yr | 48 | 1274 | 1322 | 67.35% | 3.63% | 1.3321 | 0.7629 -2.359 | >0.01 | |
| Sarc < 5 yr | 16 | 571 | 587 | 29.90% | 2.73% | | | | |
| | | | | | | | | | |
| | | | | | | | | | Hospital considered bad outcome |
| **COVID positive** | **Home** | **Hospital** | | | | | | | Hazard ration for |
| Prednisone | | | | | | | | | Hospitalization |
| Yes | 20 | 4 | 24 | 1.22% | 83.33 % | 0.875 | 0.2941 - 2.6036 | >0.10 | |
| No | 34 | 8 | 42 | 2.14% | 80.95 % | | | | |
| | | | | | | | | | |
| If prednisone | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Prednisone ≥ 10 mg | 11 | 2 | 13 | 19.70% | 15.38 % | 0.8154 | 0.2027 - 3.2794 | >0.10 | |
| Prednisone < 10mg | 43 | 10 | 53 | 80.30% | 18.87 % | | | | |
| | | | | | | | | | |
| Infliximab | | | | | | | | | |
| Yes | 4 | 2 | 6 | 0.31% | 66.67 % | 0.8154 | 0.2027 - 3.2794 | >0.10 | |
| No | 50 | 10 | 60 | 3.06% | 83.33 % | | | | |
| | | | | | | | | | |
| Plaquenil | | | | | | | | | |
| Yes | 6 | 1 | 7 | 0.36% | 85.71 % | 0.7662 | 0.1156 - 5.9785 | >0.10 | |
| No | 48 | 11 | 59 | 3.01% | 81.36 % | | | | |
| | | | | | | | | | |
| Cytotoxic | | | | | | | | | |
| Yes | 14 | 7 | 21 | 1.07% | 66.67 % | 3 | 1.0773 -83539 | 0.0355 | |
| No | 40 | 5 | 45 | 2.29% | 88.89 % | | | | |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| Yes | 6 | 0 | 6 | 0.31% | 100.00 % | 0.3486 | 0.0230 3- 5.2723 | >0.10 | |
| No | 48 | 12 | 60 | 3.06% | 80.00 % | | | | |

*9 patients did not indicate sex.

†9 patients biracial

¶ Included inflixiamb, adlimumab, and biosimilars

§Included methotrexate, azathioprine, mycophenolate, and leflunomide

**63 patients did not provide information regarding duration of disease.

UC: University of Cincinnati clinic

## Results from FSR questionnaire

| | Covid Positive | Covid negative | | Percent with feature | Percent COVID positive | Hazards ratio | 95% CI | P | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **ALL PATIENTS** | | | | | | | | | |
| Sarcoidosis | 13 | 1603 | 1616 | | 0.80% | | | | |
| | | | | | | | | | |
| **Sarc patients** | | | | | | | | | |
| Male | 2 | 275 | 277 | 14.11% | 0.72% | 0.4545 | 0.1003-2.0624 | >0.10 | |
| Female | 10 | 620 | 630 | 32.09% | 1.59% | | | | 709 no sex indicated |
| | | | | | | | | | |
| Black | 3 | 90 | 93 | 4.89% | 3.23% | 2.817 | 0.7764-10.2227 | >0.10 | |
| White | 9 | 777 | 786 | 41.30% | 1.15% | | | | 826 patients biracial |
| | | | | | | | | | |
| Roommate with COVID | | | | | | | | | |
| yes | 2 | 3 | 5 | 0.25% | 40.00% | 58.5818 | 17.2179-1999.317 | <0.0001 | |
| no | 11 | 1600 | 1611 | 82.07% | 0.68% | | | | |
| | | | | | | | | | |
| Health care provider | | | | | | | | | |
| Yes | 1 | 82 | 83 | 4.23% | 1.20% | 1.5392 | 0.2025-11.6963 | >0.10 | |
| no | 12 | 1521 | 1533 | 78.09% | 0.78% | | | | |
| | | | | | | | | | |
| **Current meds *** | | | | | | | | | **If no response, assume** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Prednisone | 5 | 318 | 323 | 16.38 % | 1.55% | 2.5019 | 0.824-7.5971 | >0.10 | **drug not used** |
| No prednisone | 8 | 1285 | 1293 | 65.57 % | 0.62% | | | | |
| | | | | | | | | | |
| Plaquenil | 0 | 115 | 115 | 5.83% | 0.00% | 0.4572 | 0.02735-7.6429 | >0.10 | |
| No plaquenil | 13 | 1418 | 1431 | 72.57 % | 0.91% | | | | |
| | | | | | | | | | |
| anti-TNF | 1 | 115 | 116 | 5.88% | 0.86% | 1.0273 | 0.1348-7.8316 | >0.10 | |
| no anti-TNF | 12 | 1418 | 1430 | 72.52 % | 0.84% | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Cytotoxic | 2 | 272 | 274 | 13.89 % | 0.73% | 0.8905 | 0.1985-3.9952 | >0.10 | |
| No cytotoxic | 11 | 1331 | 1342 | 68.05 % | 0.82% | | | | |
| | | | | | | | | | |
| Rituximab | 1 | 10 | 11 | 0.56% | 9.09% | 12.1515 | 1.7255-85.5785 | 0.0122 | |
| No rituximab | 12 | 1592 | 1604 | 81.34 % | 0.75% | | | | |
| | | | | | | | | | |
| Underlying | | | | | | | | | |
| COPD | 3 | 177 | 180 | 9.13% | 1.67% | 2.3933 | 0.6648-8.6150 | >0.10 | |
| | 10 | 1426 | 1436 | 72.82 % | 0.70% | | | | |
| | | | 1616 | | | | | | |
| Diabetes | 1 | 134 | 135 | 6.85% | 0.74% | 0.9142 | 0.1198-6.9776 | >0.10 | |
| | 12 | 1469 | 1481 | 75.10 % | 0.81% | | | | |
| | | | 1616 | | | | | | |
| Heart disease | 1 | 116 | 117 | 5.93% | 0.85% | 1.067 | 0.14-8.1402 | >0.10 | |
| | 12 | 1487 | 1499 | 76.01 % | 0.80% | | | | |
| | | | 161 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 6 | | | | | | |
| Hypertension | 4 | 275 | 279 | 14.15% | 1.43% | 2.1298 | 0.6605-6.8673 | >0.10 | |
| | 9 | 1328 | 1337 | 67.80% | 0.67% | | | | |
| | | | 1616 | | | | | | |
| **Organ involved*** | | | | | | | | | **If no response, assume** |
| Lung | 10 | 728 | 738 | 37.42% | 1.36% | 3.9657 | 1.0954-14.3563 | 0.0358 | **not involved** |
| | 3 | 875 | 878 | 44.52% | 0.34% | | | | |
| | | | 1616 | | | | | | |
| Cardiac sarc | 1 | 12 | 13 | 0.66% | 7.69% | 9.4551 | 1.3244-67.5027 | 0.0251 | |
| | 12 | 1463 | 1475 | 74.80% | 0.81% | | | | |
| | | | 1488 | | | | | | |
| Neuro sarc | 4 | 84 | 88 | 4.46% | 4.55% | 7.7172 | 2.424-24.5693 | 0.0005 | |
| | 9 | 1519 | 1528 | 77.48% | 0.59% | | | | |
| | | | 1616 | | | | | | |
| Origin | | | | | | | | | |
| US | NA | NA | 0 | 0.00% | #VALUE! | | | | NOT AVAILABLE |
| non US | NA | NA | 0 | 0.00% | #VALUE! | | | | |
| | | | 0 | | | | | | |
| | | | | | | | | | |
| **Sarcoid age** | | | | | | | | | |
| Covid Positive | | | | | | | 54.4 ± 11.29 years | >0.10 | |
| Covid negative | | | | | | | 56.6 ± 10.39 years | | |
| | | | | | | | | | |
| Sarc ≥ 5 yr | 8 | 720 | 728 | 38.14 | 1.10% | 0.5357 | 0.163- | >0.01 | Information |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | % | | | 1.7602 | | missing on 986 patients |
| Sarc < 5 yr | 4 | 191 | 195 | 10.21 % | 2.05% | | | | |

| **COVID outcome** | **Home** | **Hospital** | **ICU** | **Vent** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sarc** | **8** | **3** | **0** | **0** | | | | | **2 no information** |

| | | | #REF! | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **COVID positive** | **Home** | **Hospital** | | | | | | | If in hospital, considered |
| Prednisone | | | | | | | | | bad outcome |
| Yes | 3 | 1 | 4 | 6.06% | 75.00 % | 1.05 | 0.5037-2.1889 | >0.10 | Hazard ration for |
| No | 5 | 2 | 7 | 10.61 % | 71.43 % | | | | Hospitalization |
| | | | | | | | | | |
| Infliximab | | | | | | | | | |
| Yes | 0 | 0 | 0 | 0.00% | 0.00% | 0.7059 | 0.09617-5.1812 | >0.10 | |
| No | 8 | 3 | 11 | 16.67 % | 72.73 % | | | | |
| | | | | | | | | | |
| Plaquenil | | | | | | | | | |
| Yes | 0 | 0 | 0 | 0.00% | 0.00% | 0.7059 | 0.09617-5.1812 | >0.10 | |
| No | 8 | 3 | 11 | 16.67 % | 72.73 % | | | | |

| Cytotoxic | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Yes | 1 | 0 | 1 | 1.52% | 100.00 % | 1.4286 | 0.9512-2.1435 | 0.0849 | |
| No | 7 | 3 | 10 | 15.15 % | 70.00 % | | | | |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| Yes | 0 | 1 | 1 | 1.52% | 0.00% | 0.3235 | 0.02872-3.6449 | >0.10 | |
| No | 8 | 2 | 10 | 15.15 % | 80.00 % | | | | |
| | | | | | | | | | |

**S-7**

**Results from Netherlands questionnaire**

| Site: Netherlands | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | **Covid Positive** | **Covid negative** | | **Percent with feature** | **Percent COVID positive** | **Hazards ratio** | **95% CI** | **P** | **Comments** |
| **Sarcoidosis (996 who live in the Netherlands, out of 1034 respondents)** | **23** | **973** | 996 | | **2.31%** | | | | |
| Male | 6 | 418 | 424 | 21.60% | 1.42% | 0.4745 | 0.1187-1.1932 | >0.10 | |
| Female | 17 | 553 | 570 | 29.04% | 2.98% | | | | 2 no sex indicated |
| | | | | | | | | | |
| White | 22 | 932 | 954 | 48.60% | 2.31% | 0.9682 | 0.1337-7.0165 | >0.10 | |
| Other | 1 | 41 | 42 | 2.14% | 2.38% | | | | |
| | | | | | | | | | |
| BMI categories | | | | | | | | | |
| | | | | | | | | | |
| BMI < 25 | 8 | 348 | 356 | 18.14% | 2.25% | 0.958 | 0.4029-2.2323 | >0.10 | |
| BMI ≥ 25 | 15 | 623 | 638 | 32.50% | 2.35% | | | | |
| | | | | | | | | | |
| Current meds | | | | | | | | | |
| Prednisone | 4 | 194 | 198 | 10.09% | 2.02% | 0.84585 | 0.2919-2.4661 | >0.01 | of 28 patients the dose is missing |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| No prednisone | 19 | 779 | 798 | 40.65% | 2.38% | | | | |
| | | | | | | | | | |
| Prednisone ≥ 10 mg | 2 | 76 | 78 | 3.97% | 2.56% | 1.1795 | 0.1701-8.1803 | >0.10 | |
| Prednisone < 10mg | 2 | 90 | 92 | 4.69% | 2.17% | | | | |
| | | | | | | | | | |
| Plaquenil | 1 | 57 | 58 | 2.95% | 1.72% | 0.7351 | 0.1008-5.3585 | >0.10 | |
| No plaquenil | 22 | 916 | 938 | 47.78% | 2.35% | | | | |
| | | | | | | | | | |
| anti-TNF (infliximab (6), adalimumab (7)) | 0 | 76 | 76 | 3.87% | 0.00% | 0.2545 | 0.01561-4.14497 | >0.10 | |
| no anti-TNF (de lege cellen uit dezelfde kolommen) | 23 | 897 | 920 | 46.87% | 2.50% | | | | 1 patient was treated with both infliximab and adalimumab |
| | | | | | | | | | |
| Cytotoxic (methotrexate (2), azathioprine (3), leflunomide (5)) | 2 | 227 | 229 | 11.67% | 0.87% | 0.319 | 0.07536-1.3502 | >0.10 | |
| No cytotoxic (lege cellen in dezelfde kolommen) | 21 | 746 | 767 | 39.07% | 2.74% | | | | 3 patients were treated with both methotrexate and azathioprine |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| yes | 0 | 1 | 1 | 0.05% | 0.00% | 10.5957 | 0.9295-120.7801 | 0.0573 | |
| no | 23 | 972 | 99 | 50.69 | 2.31% | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 5 | % | | | | | |
| | | | | | | | | | |
| Current medication | | | | | | | | | |
| yes | 7 | 515 | 572 | 26.74 % | 1.34% | 0.40 | 0.165-0.958 | <0.05 | |
| no | 16 | 458 | 474 | 24.04 % | 3.38% | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Underlying | | | | | | | | | |
| | | | | | | | | | |
| COPD | 0 | 20 | 20 | 1.02% | 0.00% | 0.9899 | 0.6217-15.7596 | >0.10 | |
| | 23 | 953 | 976 | 49.72 % | 2.36% | | | | |
| | | | | | | | | | |
| Asthma | 2 | 80 | 82 | 4.18% | 2.44% | 1.0616 | 0.2534-4.448 | >0.10 | |
| | 21 | 893 | 914 | 46.56 % | 2.30% | | | | |
| Diabetes | 2 | 47 | 49 | 2.50% | 4.08% | 1.8406 | 0.441-7.628 | >0.10 | (past) use of prednison can be studied additionally |
| | 21 | 926 | 947 | 48.24 % | 2.22% | | | | |
| | | | | | | | | | |
| Heart failure | 0 | 27 | 27 | 1.38% | 0.00% | 0.7371 | 0.04592-11.8322 | >0.10 | |
| | 23 | 946 | 969 | 49.36 % | 2.37% | | | | |
| | | | | | | | | | |
| Circulation | 2 | 35 | 37 | 1.88% | 5.41% | 2.4685 | 0.601-10.1387 | >0.10 | |
| | 21 | 938 | 959 | 48.85 % | 2.19% | | | | |
| | | | | | | | | | |
| Hypertension | 1 | 107 | 108 | 5.50% | 0.93% | 0.3737 | 0.05088-2.7452 | >0.10 | |
| | 22 | 866 | 888 | 45.24 % | 2.48% | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cancer | 0 | 20 | 20 | 1.02% | 0.00% | 0.9899 | 0.06217-15.7596 | >0.10 | |
| | 23 | 953 | 976 | 49.72% | 2.36% | | | | |
| | | | | | | | | | |
| Organ involved | | | | | | | | | |
| | | | | | | | | | |
| Lung | 20 | 820 | 840 | 42.79% | 2.38% | 1.2381 | 0.3724-4.1165 | >0.10 | |
| no Lung | 3 | 153 | 156 | 7.95% | 1.92% | | | | |
| | | | | | | | | | |
| heart | 0 | 115 | 115 | 5.86% | 0.00% | 0.1618 | 0.009892-2.645 | >0.10 | |
| no heart | 23 | 858 | 881 | 44.88% | 2.61% | | | | |
| | | | | | | | | | |
| CNS | 1 | 118 | 119 | 6.06% | 0.84% | 0.335 | 0.04557-2.426 | >0.10 | |
| no CNS | 22 | 855 | 877 | 44.68% | 2.51% | | | | |
| | | | | | | | | | |
| **Sarcoid age** | | | | | | | | | |
| **COVID positive** | | | | | | | 55.3 ± 6.0 years | | |
| **COVID negative** | | | | | | | 55.0±10.8 years | | |
| **COVID uncertain** | | | | | | | 50.5 ± 11.0 years | | |
| | | | | | | | | | |
| COVID outcome | Home | Hospital | ICU | Vent | | | | | |
| Sarc | 20 | 3 | 0 | 0.00% | | | | | |
| | | | | | | | | | |
| Sarc ≥ 5 yr | 15 | 678 | 693 | 70.14% | 2.16% | 0.912 | 0.3758-2.2141 | >0.10 | |
| Sarc < 5 yr | 7 | 288 | 295 | 29.86% | 2.37% | | | | 8 unknown |
| | | | 98 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | 8 | | | | | | |
| | | | | | | | | | |
| Roommates with COVID-19 | | | | | | | | | |
| yes | 11 | 30 | 41 | 4.12% | 26.83 % | 21.3516 | 10.0247-45-4768 | <0.0001 | |
| no | 12 | 943 | 955 | 95.88 % | 1.26% | | | | |
| | | | 996 | | | | | | |
| Work in healthcare | | | | | | | | | |
| Yes | 4 | 99 | 103 | 10.34 % | 3.88% | 1.8252 | 0.6331-5.2618 | >0.10 | |
| No | 19 | 874 | 893 | 89.66 % | 2.13% | | | | |
| | | | 996 | | | | | | |
| **COVID positive** | **Home** | **Hospital** | | **Percent on drug** | **Percent treated in hospital** | | | | If in hospital, considered |
| | | | | | | | | | bad outcome |
| | | | | | | | | | Hazard ration for |
| Prednisone | | | | | | | | | Hospitalization |
| Yes | 4 | 0 | 4 | 17.39 % | 0.00% | 0.5714 | 0.03487-9.3644 | >0.10 | |
| No | 16 | 3 | 19 | 82.61 % | 15.79 % | | | | |
| | | | | | | | | | |
| Prednisone ≥ 10 mg | 2 | 0 | 2 | 50.00 % | 0.00% | | | | TOO SMALL |
| Prednisone < 10mg | 2 | 0 | 2 | 50.00 % | 0.00% | | | | |
| | | | | | | | | | |
| Infliximab | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | there were no COVID - 19 positive patients who were treated with infliximab |
| | | | | | | | | | |
| Plaquenil | | | | | | | | | |
| Yes | 1 | 0 | 1 | 4.35% | 0.00% | 1.6428 | 0.1236-21.835 | >0.10 | |
| No | 19 | 3 | 22 | 95.65 % | 13.64 % | | | | |
| | | | | | | | | | |
| Cytotoxic | | | | | | | | | |
| yes | 2 | 0 | 2 | 8.70% | 0.00% | 1.0476 | 0.06994-15.6914 | >0.10 | |
| no | 18 | 3 | 21 | 91.30 % | 14.29 % | | | | |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| | | | | | | | | | none of the COVID-19 positive patients was treated with rituximab |
| | | | | | | | | | |

**S-8**

**Results from Italian Questionnaire**

| | Covid Positive | Covid negative | | Percent with feature * | Percent COVID positive | Hazards ratio | 95% CI | P | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **ALL PATIENTS** | | | | | | | | | |
| Sarcoidosis | 9 | 502 | 511 | | 1.76% | | | | |
| | | | | | | | | | |
| **Sarc patients** | | | | | | | | | |
| Male | 3 | 205 | 208 | 40.70 % | 1.44% | 0.87 | 0.203-3.628 | >0.10 | |
| Female | 5 | 293 | 298 | 58.32 % | 1.68% | | | | 5 no sex identified |
| | | | | | | | | | |
| Black | 0 | 6 | 6 | 1.17% | 0.00% | | | | less than 10 blacks |
| White | 9 | 483 | 492 | 96.28 % | 1.83% | | | | 13 no race indicated |
| | | | | | | | | | |
| Roommate with COVID | | | | | | | | | |
| yes | 5 | 3 | 8 | 1.57% | 62.50 % | 205.8 | 36.24-1169.14 | <0.0001 | |
| no | 4 | 494 | 498 | 97.46 % | 0.80% | | | | 5 no answer |
| | | | | | | | | | |
| Health care provider | | | | | | | | | |
| Yes | 2 | 45 | 47 | 9.20% | 4.26% | 2.89 | 0.583-14.324 | >0.10 | |
| no | 7 | 455 | 462 | 90.41 % | 1.52% | | | | 2 no answer |
| | | | | | | | | | |
| **Current meds *** | | | | | | | | | |
| Prednisone | 1 | 260 | 261 | 51.08 % | 0.38% | 0.12 | 0.015-1.017 | 0.052 | |
| No prednisone | 7 | 226 | 233 | 45.60 % | 3.00% | | | | 17 no answer |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Prednisone>10 mg | 1 | 83 | 84 | 16.44 % | 1.19% | | | | |
| Prednisone<10 mg | 0 | 177 | 177 | 34.64 % | 0.00% | 6.38 | 0.257-158.215 | >0.10 | only 1 COVID on prednisone |
| | | | | | | | | | |
| anti-TNF | 0 | 9 | 9 | 1.76% | 0.00% | 3.23 | 0.1697-61.655 | >0.10 | |
| no anti-TNF | 6 | 399 | 405 | 79.26 % | 1.48% | | | | 97 no answer |
| | | | | | | | | | |
| | | | | | | | | | |
| Cytotoxic | 2 | 86 | 88 | 17.22 % | 2.27% | 1.55 | 0.307-7.793 | >0.10 | |
| No cytotoxic | 6 | 399 | 405 | 79.26 % | 1.48% | | | | 18 no answer |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| No rituximab | | | | | | | | | No answers on ritux |
| | | | | | | | | | |
| Underlying | | | | | | | | | |
| COPD | 2 | 48 | 50 | 9.78% | 4.00% | 2.68 | 0.542-13.289 | >0.10 | |
| | 7 | 451 | 458 | 89.63 % | 1.53% | | | | 3 no answer |
| | | | | | | | | | |
| Diabetes | 0 | 32 | 32 | 6.26% | 0.00% | 0.76 | 0.043-13.328 | >0.10 | |
| | 9 | 468 | 477 | 93.35 % | 1.89% | | | | 2 no answer |
| | | | | | | | | | |
| Heart disease | | | | | | | | | not answered |
| | | | | | | | | | |
| | | | | | | | | | |
| Hypertension | 4 | 126 | 130 | 25.44 % | 3.08% | 2.37 | 0.628-8.980 | >0.10 | |
| | 5 | 374 | 379 | 74.17 % | 1.32% | | | | 2 did not nswer |
| | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Organ involved*** | | | | | | | | | **If no response, assume** |
| Lung | 9 | 459 | 468 | 91.59 % | 1.92% | 1.67 | 0.096-29.299 | >0.10 | **not involved** |
| | 0 | 40 | 40 | 7.83% | 0.00% | | | | 3 did not answer |
| | | | | | | | | | |
| Cardiac sarc | 2 | 33 | 35 | 6.85% | 5.71% | 4.03 | 0.806-20.198 | 0.0896 | |
| | 7 | 466 | 473 | 92.56 % | 1.48% | | | | 3 did nto answer |
| | | | | | | | | | |
| Neuro sarc | 0 | 23 | 23 | 4.50% | 0.00% | 1.07 | 0.060-18.895 | >0.10 | |
| | 9 | 476 | 485 | 94.91 % | 1.86% | | | | 3 did not answer |
| | | | | | | | | | |
| | | | | | | | | | |
| **Sarcoid age** | | | | | | | | | |
| Covid Positive | | | | | | | 55.0 ± 8.63 years | >0.10 | |
| Covid negative | | | | | | | 51.8 ± 9.74 years | | |
| | | | | | | | | | |

| **COVID outcome** | **Home** | **Hospital** | **ICU** | **Vent** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Sarc** | **7** | **2** | **1** | **0** | | | | | |

***Percent positive of 511 patients who participated in study.**

**S-9**

**Results from Spanish questionnaire**

| | Covid Positive | Covid negative | | Percent with feature | Percent COVID positive | Hazards ratio | 95% CI | P | Comments |
|---|---|---|---|---|---|---|---|---|---|
| **ALL PATIENTS** | | | | | | | | | |
| Sarcoidosis | 5 | 100 | 105 | | 4.76% | | | | |
| | | | | | | | | | |
| **Sarc patients** | | | | | | | | | |
| Male | 1 | 27 | 28 | 26.67% | 3.57% | 0.6875 | 0.08022 -5.8917 | >0.05 | |
| Female | 4 | 73 | 77 | 73.33% | 5.19% | | | | |
| | | | | | | | | | |
| Other | 0 | 2 | 2 | 1.90% | 0.00% | DNC | | | |
| White | 5 | 97 | 102 | 97.14% | 4.90% | | | | 1 No Answer |
| | | | | | | | | | |
| Current meds | | | | | | | | | |
| Prednisone | 2 | 40 | 42 | 40.00% | 4.76% | 1 | 0.1745-5.7322 | >0.05 | |
| No prednisone | 3 | 60 | 63 | 60.00% | 4.76% | | | | |
| | | | | | | | | | |
| Prednisone $\geq$ 10 mg | 0 | 19 | 19 | 18.10% | 0.00% | 0.24 | 0.01222 -4.715 | >0.05 | |
| Prednisone < 10mg | 2 | 21 | 23 | 21.90% | 8.70% | | | | |
| | | | | | | | | | |
| Plaquenil | 0 | 6 | 6 | 5.71% | 0.00% | 1.2987 | 0.07692 -21.834 | >0.05 | |
| No plaquenil | 5 | 94 | 99 | 94.29% | 5.05% | | | | |
| | | | | | | | | | |
| anti-TNF | 1 | 6 | 7 | 6.67% | 14.29% | 3.5 | 0.4493-27.264 | >0.05 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| no anti-TNF | 4 | 94 | 98 | 93.33% | 4.08% | | | | |
| | | | | | | | | | |
| Cytotoxic | 0 | 19 | 19 | 18.10% | 0.00% | 0.3955 | 0.02278 -6.8641 | >0.05 | |
| No cytotoxic | 5 | 81 | 86 | 81.90% | 5.81% | | | | |
| | | | | | | | | | |
| Rituximab | 0 | 0 | 0 | 0.00% | 0.00% | DNC | | | |
| No rituximab | 5 | 100 | 105 | 100.00 % | 4.76% | | | | |
| | | | | | | | | | |
| Underlying | | | | | | | | | |
| COPD | 0 | 12 | 12 | 11.43% | 0.00% | 0.6573 | 0.03854 - 11.2108 | >0.05 | |
| | 5 | 88 | 93 | 88.57% | 5.38% | | | | |
| | | | | | | | | | |
| Diabetes | 1 | 19 | 20 | 19.05% | 5.00% | 1.0625 | 0.1254- 8.9993 | >0.05 | |
| | 4 | 81 | 85 | 80.95% | 4.71% | | | | |
| | | | 105 | | | | | | |
| Heart disease | 0 | 5 | 5 | 4.76% | 0.00% | 1.5303 | 0.09537 - 24.5561 | >0.05 | |
| | 5 | 95 | 100 | 95.24% | 5.00% | | | | |
| | | | 105 | | | | | | |
| | | | | | | | | | |
| Hypertension | 0 | 15 | 15 | 14.29% | 0.00% | 0.517 | 0.3003- 8.9023 | >0.05 | |
| | 5 | 85 | 90 | 85.71% | 5.56% | | | | |
| | | | 105 | | | | | | |
| Organ involved | | | | | | | | | 2 no answer |
| Lung | 4 | 93 | 97 | 92.38% | 4.12% | 0.2474 | 0.3249- 1.8845 | >0.05 | |
| | 1 | 5 | 6 | 5.71% | 16.67% | | | | |
| | | | 103 | | | | | | |
| Cardiac sarc | 0 | 4 | 4 | 3.81% | 0.00% | 1.8182 | 0.116- 28.5055 | >0.05 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 5 | 94 | 99 | 94.29% | 5.05% | | | | |
| | | | 103 | | | | | | |
| Neuro sarc | 2 | 6 | 8 | 7.62% | 25.00% | 7.9167 | 1.5399-40.701 | 0.0133 | |
| | 3 | 92 | 95 | 90.48% | 3.16% | | | | |
| | | | 103 | | | | | | |
| Origin | | | | | | | | | |
| SPAIN | 4 | 100 | 104 | 5.30% | 3.85% | | | | |
| NOT SPANISH | 1 | 0 | 1 | 0.05% | 100.00% | | | | |
| | | | 105 | | | | | | |
| | | | | | | | | | |
| **Sarcoid age** | | | | | | | | | |
| Covid Positive | | | | | | | 49.80 ± 9.20years | 0.3 | |
| Covid negative | | | | | | | 44.88 ± 8.82 years | | |

| COVID outcome | Home | Hospital | ICU | Vent | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sarc | 4 | 1 | 0 | 0 | | | | | |
| | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Sarc ≥ 5 yr | 4 | 63 | 67 | 3.51% | 5.97% | 5.0294 | 0.27827 - 90.9223 | >0.05 | 1 no answer |
| Sarc < 5 yr | 0 | 37 | 37 | 1.94% | 0.00% | | | | |
| | | | 104 | | | | | | |
| **COVID positive** | **Home** | **Hospital** | | **Percent on drug** | **Percent treated in hospital** | | | | If in hospital, considered |
| Prednisone | | | | | | | | | bad outcome |
| Yes | 2 | 0 | 2 | 3.03% | 0.00% | | | | Hazard ration for |
| No | 2 | 1 | 3 | 4.55% | 33.33% | | | | Hospitalizati |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | on |
| | | | | | | | | | |
| Prednisone ≥ 10 mg | 0 | 0 | 0 | 0.00% | #DIV/0! | | | | |
| Prednisone < 10mg | 2 | 0 | 2 | 3.03% | 0.00% | | | | |
| | | | | | | | | | |
| Infliximab | | | | | | | | | |
| Yes | 1 | 0 | 1 | 1.52% | 0.00% | | | | |
| No | 3 | 1 | 4 | 6.06% | 25.00% | | | | |
| | | | | | | | | | |
| Plaquenil | | | | | | | | | |
| Yes | 0 | 0 | 0 | 0.00% | #DIV/0! | | | | |
| No | 4 | 1 | 5 | 7.58% | 20.00% | | | | |
| | | | | | | | | | |
| Cytotoxic | | | | | | | | | |
| Yes | 0 | 0 | 0 | 0.00% | #DIV/0! | | | | |
| No | 4 | 1 | 5 | 7.58% | 20.00% | | | | |
| | | | | | | | | | |
| Rituximab | | | | | | | | | |
| Yes | 0 | 0 | 0 | 0.00% | #DIV/0! | | | | |
| No | 4 | 1 | 5 | 7.58% | 20.00% | | | | |

| | **Covid Positive** | **Covid negative** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Roommate | 0 | 2 | 2 | 1.90% | 0.00% | 3.0909 | 0.2167-44.087 | >0.05 | 2 no answer |
| No roommate | 5 | 96 | 101 | 96.19% | 4.95% | | | | |
| | | | | | | | | | |
| Health provider | 3 | 13 | 16 | 15.24% | 18.75% | 8.0625 | 1.4614-44.4791 | 0.0166 | 3 no answer |
| No healtg provider | 2 | 84 | 86 | 81.90% | 2.33% | | | | |

**Supplement Table S-10**

**Number of patients and percent positive for individual countries and states within United States**

| Country | State | Total Number | Number positive | Percent Positive |
|---|---|---|---|---|
| US | Total | 1601 | 50 | 3.1% |
| | Alabama | 20 | 4 | 20.0% |
| | Alaska | 4 | 0 | 0.0% |
| | Arizona | 16 | 0 | 0.0% |
| | Arkansas | 10 | 0 | 0.0% |
| | California | 50 | 0 | 0.0% |
| | Colorado | 21 | 0 | 0.0% |
| | Conneticut | 13 | 1 | 7.7% |
| | District of Columbia | 3 | 0 | 0.0% |
| | Deleware | 5 | 1 | 20.0% |
| | Florida | 60 | 1 | 1.7% |
| | Georgia | 24 | 0 | 0.0% |
| | Hawaii | 1 | 0 | 0.0% |
| | Idaho | 4 | 0 | 0.0% |
| | Illinois | 61 | 0 | 0.0% |
| | Indiana | 46 | 4 | 8.7% |
| | Iowa | 17 | 0 | 0.0% |
| | Kansas | 5 | 0 | 0.0% |
| | Kentucky | 77 | 8 | 10.4% |
| | Lousiana | 12 | 0 | 0.0% |
| | Maine | 7 | 0 | 0.0% |
| | Maryland | 13 | 0 | 0.0% |
| | Massachusetts | 38 | 0 | 0.0% |
| | Michigan | 51 | 1 | 2.0% |
| | Minnesota | 14 | 0 | 0.0% |
| | Mississippi | 8 | 0 | 0.0% |
| | Missouri | 19 | 1 | 5.3% |
| | Montana | 5 | 0 | 0.0% |
| | Nebraska | 2 | 0 | 0.0% |
| | Nevada | 7 | 0 | 0.0% |
| | New Hampshire | 11 | 0 | 0.0% |
| | New Jersey | 30 | 0 | 0.0% |
| | New Mexico | 3 | 0 | 0.0% |
| | New York | 85 | 3 | 3.5% |
| | North Carolina | 38 | 0 | 0.0% |
| | North Dakota | 2 | 0 | 0.0% |

| | | | | |
|---|---|---|---|---|
| | Ohio | 468 | 22 | 4.7% |
| | Oklahoma | 14 | 0 | 0.0% |
| | Oregon | 12 | 0 | 0.0% |
| | Pennsylvania | 52 | 1 | 1.9% |
| | Rhode Island | 2 | 0 | 0.0% |
| | South Carolina | 21 | 0 | 0.0% |
| | South Dakota | 3 | 0 | 0.0% |
| | Tennessee | 22 | 2 | 9.1% |
| | Texas | 42 | 0 | 0.0% |
| | Utah | 12 | 0 | 0.0% |
| | Virginia | 38 | 0 | 0.0% |
| | Washington | 27 | 0 | 0.0% |
| | West Virginia | 16 | 2 | 12.5% |
| | Wisconsin | 11 | 2 | 18.2% |
| | Wyoming | 2 | 0 | 0.0% |
| | | | | |
| Non US | Total | 361 | 15 | |
| Argentina | | 1 | 0 | 0.0% |
| Australia | | 64 | 0 | 0.0% |
| Austria | | 1 | 0 | 0.0% |
| Belarus | | 1 | 0 | 0.0% |
| Belgium | | 2 | 0 | 0.0% |
| Brazil | | 2 | 1 | 50.0% |
| Canada | | 62 | 3 | 4.8% |
| Columbia | | 2 | 0 | 0.0% |
| Czech | | 1 | 0 | 0.0% |
| Denmark | | 12 | 0 | 0.0% |
| Ecuador | | 1 | 0 | 0.0% |
| Egypt | | 2 | 0 | 0.0% |
| England | | 96 | 2 | 2.1% |
| Finland | | 1 | 0 | 0.0% |
| France | | 5 | 0 | 0.0% |
| Germany | | 9 | 0 | 0.0% |
| Hungary | | 1 | 0 | 0.0% |
| India | | 2 | 0 | 0.0% |
| Ireland | | 20 | 0 | 0.0% |
| Italy | | 1 | 0 | 0.0% |
| Mexico | | 2 | 1 | 50.0% |
| Morroco | | 1 | 0 | 0.0% |
| New Zealand | | 4 | 0 | 0.0% |
| Nigeria | | 3 | 0 | 0.0% |

| | | | | |
|---|---|---|---|---|
| Norway | | 3 | 0 | 0.0% |
| Palestine | | 2 | 0 | 0.0% |
| Poland | | 2 | 0 | 0.0% |
| Portugal | | 3 | 0 | 0.0% |
| Puerto Rico | | 1 | 0 | 0.0% |
| Romania | | 3 | 0 | 0.0% |
| Russia | | 1 | 0 | 0.0% |
| Scotland | | 9 | 1 | 11.1% |
| Slovania | | 1 | 0 | 0.0% |
| South Africa | | 10 | 0 | 0.0% |
| Spain | | 5 | 0 | 0.0% |
| Sweden | | 4 | 3 | 75.0% |
| Switzerland | | 1 | 0 | 0.0% |
| The Netherlands | | 2 | 0 | 0.0% |
| Turkey | | 1 | 0 | 0.0% |
| UAE | | 1 | 0 | 0.0% |
| Wales | | 1 | 0 | 0.0% |
| Zimbabwe | | 1 | 0 | 0.0% |