COVID-19 Post-acute Care Major Organ Damage: A Living Rapid Review

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WHAT'S NEW

Updated September 2021
Search current as of May 19, 2021

Prevalence estimates have been updated to include 34 new studies (124 total). Recent evidence includes 4 large database studies with control groups. Evidence from these studies suggests increased risk for disease in adults hospitalized for COVID-19. Limitations of the available evidence include poorly described study populations, lack of patient-centered clinical outcomes, and few control groups or pre-COVID-19 data. Outcomes following COVID variants are unknown.

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PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted healthcare topics of importance to clinicians, managers, and policymakers as they work to improve the health and healthcare of Veterans. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The program comprises three ESP Centers across the US and a Coordinating Center located in Portland, Oregon. Center Directors are VA clinicians and recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Center Program. The Coordinating Center was created to manage program operations, ensure methodological consistency and quality of products, and interface with stakeholders. To ensure responsiveness to the needs of decision-makers, the program is governed by a Steering Committee composed of health system leadership and researchers. The program solicits nominations for review topics several times a year via the program website.

Comments on this report are welcome and can be sent to Nicole Floyd, Deputy Director, ESP Coordinating Center at Nicole.Floyd@va.gov.

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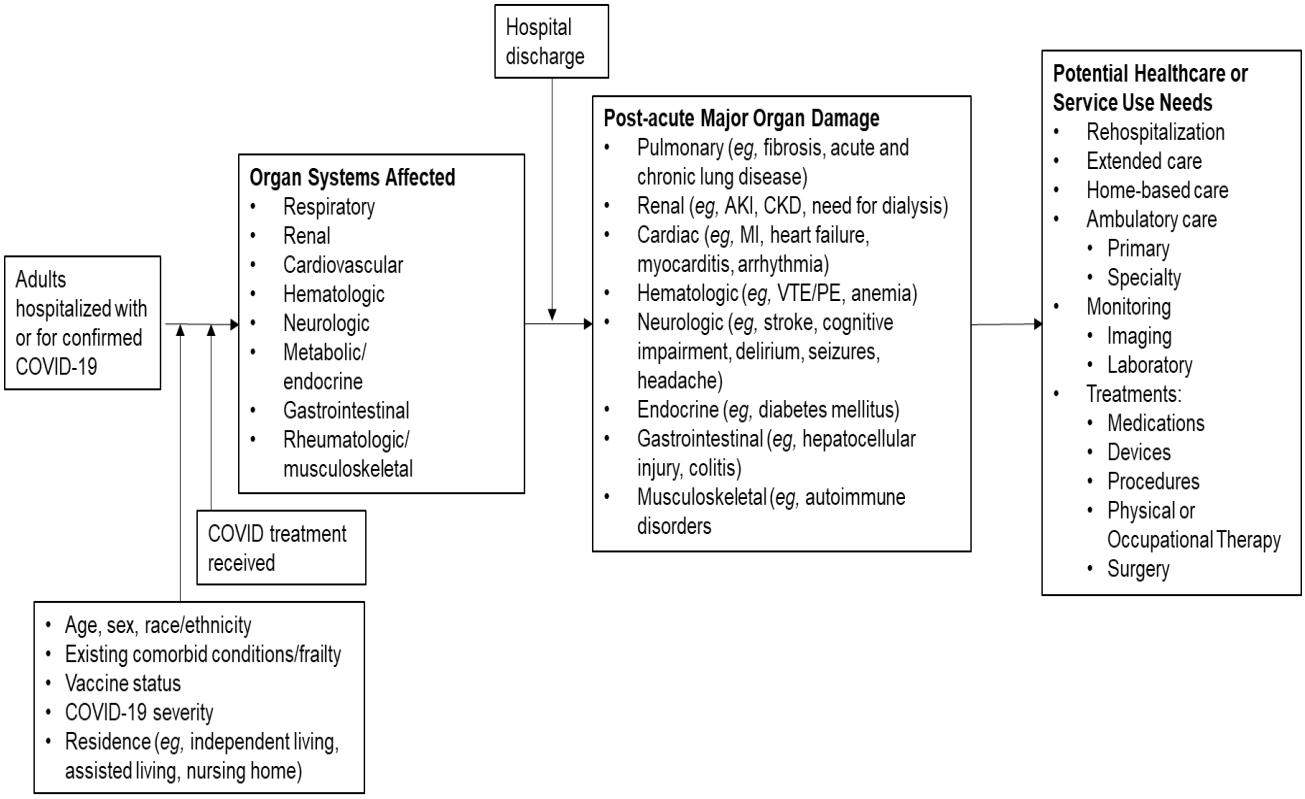
BACKGROUND

Coronavirus disease-2019 (COVID-19) is a viral illness that, as of August 30, 2021, was identified in over 216 million individuals (over 38 million in the US) in over 220 countries, areas, or territories (https://www.who.int/emergencies/diseases/novel-coronavirus-2019, https://coronavirus.jhu.edu/, https://covid.cdc.gov/covid-data-tracker/#cases_casesper100klast7days). Over 4.5 million deaths worldwide (over 637,000 in the US) are attributed to COVID-19. Within the VA, as of August 30, 2021, 13,601 deaths and 284,532 convalescent cases have been reported based on publicly available data (https://www.accesstocare.va.gov/Healthcare/COVID19NationalSummary), though these figures likely underestimate the number of Veterans receiving VA healthcare infected with and dying from COVID-19. COVID-19 is caused by the severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) and was declared a pandemic by the World Health Organization on March 11, 2020. In addition to the potential for severe pulmonary disease, there have been numerous reports of other major organ system manifestations and complications in patients hospitalized with COVID-19 including cardiovascular,[1,2,3] renal,[4,3,5] neurological,[6,7] hematologic,[3,8-10] endocrine,[3,11] and gastrointestinal.[3,12]

Persistent *symptoms* have been reported in patients following recovery from acute COVID-19, with fatigue, shortness of breath, muscle or body pain, and difficulty concentrating being most common.[13-17] Multi-organ damage[18] and long-term clinical outcomes[19] following other coronavirus outbreaks – severe acute respiratory syndrome (SARS) and Middle East Respiratory syndrome (MERS) – have been reported, suggesting the potential for similar multi-organ damage and adverse long-term clinical outcomes with COVID-19 infections. In addition, because many COVID-19 patients are admitted to intensive care units, outcomes similar to those observed in post-intensive care syndrome or post-sepsis syndrome have also been suggested as possible long-term consequences of COVID-19 infections.[20]

The purpose of this living rapid review is to determine the prevalence of post-acute care major organ damage and healthcare or service use needs associated with major organ damage in adults who were hospitalized with or for COVID-19. Our review is limited to post-hospital major organ damage or healthcare/service use needs – a subset of post-acute sequelae of SARS-CoV-2 infection (PASC) as described by the National Institutes of Health (https://www.nih.gov/about-nih/who-we-are/nih-director/statements/nih-launches-new-initiative-study). The topic was nominated by the VA Evidence Synthesis Program Coordinating Center in collaboration with VHA clinical and operations partners in order to guide future clinical care decisions and resource needs related to COVID-19. It is 1 in a series of 3 living rapid reviews conducted across VA ESP sites addressing post-acute care prevalence related to: 1) mental health, 2) rehabilitation/ functional status, and 3) major organ damage in patients hospitalized with or for COVID-19. Our analytic framework is shown in Figure 1.

Figure 1. Analytic Framework



KEY QUESTIONS AND SCOPE

Key Question 1: What is the post-acute care prevalence of major organ damage among adults hospitalized with or for proven COVID-19 disease?

Key Question 2: Does the post-acute care prevalence of major organ damage among adults with or for COVID-19 disease vary by patient characteristics (*eg,* age, sex, race/ethnicity, preexisting co-morbidities/frailty, place of residence), COVID-19 disease severity, or other factors (*eg*, treatment for COVID-19)?

Key Question 3: What are the short- (< 3 months) and long-term (≥ 3 months) healthcare or service use needs of adults surviving COVID-19 disease with major organ damage?

ORIGINAL SCOPE

For the initial report (December 2020) and first update (June 2021), based on consultation with VA Central Office operational partners, we included studies of adults hospitalized for COVID-19 and studies of adults hospitalized for another indication who have a positive COVID-19 test. Additionally, in collaboration with our local clinical content experts we prioritized conditions likely of greatest clinical relevance and included criteria for determining definitions and measures of symptomatic versus asymptomatic as well as acute versus chronic major organ damage. All patients had laboratory-confirmed COVID-19. We defined post-acute to include major organ damage or healthcare/service use needs reported on the day of hospital discharge or

any time post-discharge. We included studies reporting "surrogate measures" (*eg*, a radiologic or laboratory measure consistent with a definition of a disease such as pulmonary function tests, radiographic pulmonary abnormalities, laboratory liver function tests or imaging studies, creatinine, glucose or hemoglobin A1c values, cardiac imaging defined as abnormal, or imaging studies for venous thromboembolism). We excluded studies reporting only mean or median values for these tests, as mean or median values do not provide a reliable measure of organ damage prevalence or healthcare/service use. We also excluded studies reporting only general symptoms (*eg*, fatigue, pain), and did not extract these data from included studies, because symptoms are not specific to a disease or organ damage. We included studies reporting on dyspnea as we determined dyspnea to be most consistent with pulmonary or cardiac damage. As noted above, post-acute mental health and functional status are addressed in separate ESP reviews. We excluded studies of children and studies of adults who had COVID-19 but were not hospitalized. We also excluded studies that did not provide information at the time of or after hospital discharge even if they included patient information during hospitalization.

UPDATED SCOPE – SEPTEMBER 2021 UPDATE

For the September 2021 (final) update of the review, we made minor changes to the scope. These changes reflect the growing body of literature on post-acute COVID-19. For the September 2021 update:

1. we only report outcomes post-discharge (*ie,* studies only reporting outcomes at the time of discharge were excluded),

2. we required a minimum of 50 patients with COVID-19, and

3. we only reported healthcare/resource utilization outcomes that were specific to major organ damage (*ie,* all-cause readmission was no longer an outcome of interest).

METHODS

Our protocol was registered in PROSPERO: CRD42020204788.

SEARCH STRATEGY

We searched MEDLINE, Embase, and the Cochrane Library. Our initial report (December 2020) included studies identified in a search from January 1, 2019 to October 6, 2020. The first update (June 2021) included studies identified in a search through January 12, 2021. This version of the report (September 2021) includes studies identified in a search through May 19, 2021. The search strategy (Appendix A) was developed with input from expert medical librarians. We also reviewed non-peer-reviewed public postings about post-COVID-19 complications for links to peer-reviewed data reports.

SCREENING PROCESS

Consistent with established rapid review methods, abstracts were reviewed by 1 investigator. A subset of 200 abstracts underwent dual independent review with substantial agreement between the 2 investigators. All articles identified as potentially eligible based on abstract review were

independently reviewed by 2 investigators at the full-text level. Reasons for exclusion were noted. Conflicts were resolved by discussion. Our inclusion and exclusion criteria are reported in Table 1. We did not require studies to include a comparison group nor did we require that studies provide information about "pre-COVID-19" health status/conditions or the primary reason for hospitalization (*ie, due to* COVID-19 compared to *for other conditions* where COVID-19 may be a contributing factor or identified incidentally on screening).

Table 1. Study Eligibility Criteria

Study Characteristic	Include	Exclude
Population	Adults (age 18 and older)	Children or adolescents, age <18; MERS; SARS
Intervention	Discharge from hospitalization after admission with or for proven COVID-19[a]	Data only collected from patients during ongoing hospital acute-care admission with or for proven COVID-19
Comparator	Discharge from hospitalization for individuals without COVID-19 (ideally another respiratory condition); a comparator was not required	Not applicable
Outcomes	Prevalence and severity of major organ damage (respiratory, renal, cardiovascular, hematologic, neurologic, metabolic/ endocrine, gastrointestinal, and rheumatologic/musculoskeletal); healthcare or service use needs related to major organ damage[b]	No outcomes of interest
Timing	Short-term (< 3 months) and long-term (≥ 3 months) post-discharge	Not applicable
Setting	Any post-discharge setting (*eg*, home, rehabilitation or long-term care facility); may include re-hospitalization	Not applicable
Study Designs	Cohort, case series, other observational; may prioritize articles using a best-evidence approach	Case report, narrative review, descriptive/opinion article with no data

[a]In the original and first update, we reported outcomes at the time of discharge. For the September 2021 update, patients must be discharged with post-discharge outcome data available.
[b]In the original report, we included studies reporting "re-positive" RT-PCR test results following discharge. For the June 2021 update, we excluded studies only reporting "re-positive" test results and removed those studies from the original set of included studies. As more information about the natural history of SARS-CoV-2 has become available, it has been recognized that patients may be PCR positive for prolonged periods after an initial COVID illness, and an isolated PCR positivity in such patients (especially for the first 90 days after diagnosis) does not by itself reflect a new infection.

DATA ABSTRACTION

Study characteristics (location, design, funding), study inclusion and exclusion criteria, baseline demographic data (age, sex, race, comorbidities), hospitalization characteristics (COVID-19 severity, ICU admission, mechanical ventilation, length of hospital stay), length of time post-hospital, and outcomes data were abstracted by 1 investigator and verified by a second. Discrepancies were resolved by discussion.

RISK OF BIAS ASSESSMENT

We did not formally rate risk of bias of individual studies.[21] We assessed study quality characteristics using the Joanna Briggs Critical Appraisal Tool for case series[22] taking into account clarity of inclusion criteria and completeness of inclusion, use of standard methods for identification and assessment of the condition, and inclusion of adequate information about the subjects and setting.

SYNTHESIS

Due to heterogeneity in study populations, study designs, and methods of outcome assessment, we were unable to pool most outcomes data. We used R (http://www.rstudio.com/) to calculate random effects pooled estimates for 3 pulmonary outcomes. We narratively synthesized the remaining evidence.

LIVING REVIEW

Our review was updated approximately every 3 months through September 2021, using the literature search strategy outlined above to identify evidence related to post-acute major organ damage and associated healthcare/service use needs. Study eligibility criteria were modified based on increased reporting of post-acute outcomes in published studies. Procedures for data abstraction and risk of bias assessment remained the same. Our data synthesis plan was reviewed at the time of each update but remained unchanged.

PEER REVIEW

A draft version of each update of this report will undergo peer review by content experts and clinical leadership. Reviewer comments and our responses will be presented in Appendix B and the final report will incorporate the comments.

RESULTS

KEY FINDINGS

Key Question 1: Recent evidence includes 4 large database studies, 2 from the US including 1 study of US Veterans, identifying post-hospitalization, incident respiratory, cardiac, neuromuscular, endocrine, renal, gastrointestinal, and hematologic disease in COVID-19 and control groups. However, the majority of studies enroll convenience samples without controls, providing wide-ranging prevalence estimates based mainly on physiologic data.

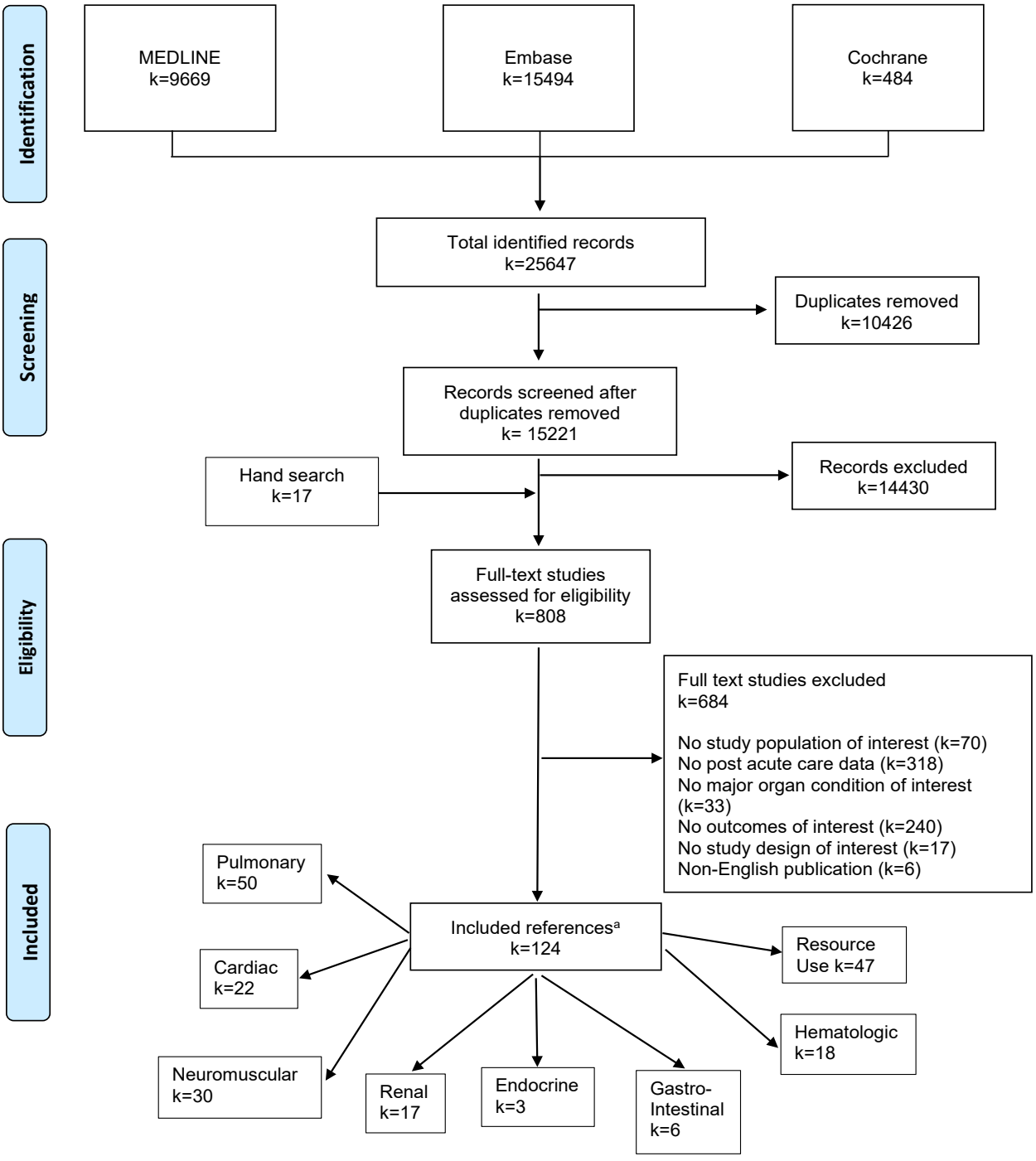
Key Question 2: Information is insufficient to assess if prevalence varies by patient, disease, and comorbidity factors.

Key Question 3: Post-hospitalization resource use including discharge disposition and readmission varies by outcome definition and timing. Results are limited by use of convenience samples and lack of controls.

PRISMA FLOW DIAGRAM

The results of our literature search and study selection process are depicted in Figure 2.

Figure 2. PRISMA Flow Diagram



[a]Studies may have reported more than 1 category of outcomes

OVERVIEW OF INCLUDED STUDIES

Our December 2020 report included 42 studies. After removing 3 of those studies only reporting "re-positive" results (see Table 1 footnote b) and adding 51 studies identified in the literature search through January 2021, we included 90 studies in the June 2021 update. For the current version of the report, with a literature search through May 19, 2021 and with modified inclusion criteria as noted above, we added 34 new studies. Outcomes data (Table 2) were reported at the time of hospital discharge (k=35, none of which were from the May 2021 search per modified inclusion criteria),[23-55] post-discharge (31 studies at 30 days or fewer follow-up and 17 at 3 months or longer) (k=81),[56-135] or both (k=7, again, none from the May 2021 search).[136-142] One study did not report time post-hospitalization.[143]

Fifty studies reported pulmonary outcomes,[24,27,29,30,34,45,55,57,60,61,63,71,73-75,81,82,85,88,91,94-96,100,101,103,104,106-110,115-120,122,124,126-128,130,132-134,141,143,144] 22 studies reported cardiovascular outcomes,[24,57,62,66,75,81,82,96,99,104,106,110-112,114,115,120,123,124,127,131,135] 30 reported neuromuscular outcomes,[23,25,31,33,36,39,46,48,53,61,77,81,82,91,104,105,109-111,114,117,120,122,124,125,127,129,130,132,142] 17 reported renal outcomes,[35,47,49,57,83,85,97,102,104,106,109,110,120,121,124,139,140,145] 3 reported endocrine outcomes,[104,106,110] 6 reported gastrointestinal outcomes,[57,85,104,106,110,111] 18 reported hematologic outcomes,[24,65,68,75,79,81,84,85,92,93,98,104,109,110,113-115,126] and 47 reported healthcare or resource utilization outcomes.[26,28,31,32,37,38,40-44,47,50-52,54,56,58,59,64,65,67,69-72,76-78,80-83,85-87,89,90,112,127,128,136-138,142,143,146] Studies were typically described as retrospective, case series, or cross-sectional, although 38 reported that data were collected prospectively [23,24,38,49,57,58,61,66,68,71,75,78,81,82,86,94-96,99,103,105,107,108,111,113,116-120,123-125,131,132,135,142,147] including 18 of the 34 studies added for the September 2021 version of the review. Study inclusion and exclusion criteria, patient demographics, and hospitalization characteristics are reported in Appendix C, Table 1.

Study quality assessments are reported in Appendix C, Table 2. In 36% (45/124) of the studies, it was unclear whether all patients were assessed for eligibility or whether consecutive patients were enrolled. Fifty-six percent (69/124) were conducted at a single site. In 39% (48/124), fewer than 100 patients were enrolled (for the September 2021 update with fewer than 50 COVID-19 cases were excluded). Training and experience of individuals abstracting data from medical records, administering tests, or interpreting imaging results was rarely reported. Although many studies obtained data from electronic medical records, it was often unclear what data were abstracted (*eg,* ICD codes). Many studies did not report COVID-19 severity; among those that did, different criteria were used. Pre-existing comorbidities and COVID-19 severity were rarely linked to outcomes.

Table 2. Overview of Included Studies

								
	Pulmonary	**Cardiac**	**Neuro-muscular**	**Renal**	**Endocrine**	**Gastro-intestinal**	**Hematologic**	**Resource Use**
Number of Studies Reporting[a]	50	22	30	17	3	6	18	47
Outcomes Frequently Reported (number of studies reporting the outcome)	Respiratory Disease (5) Fibrosis (12) CT Abnormalities (15) Impaired Pulmonary Function (20) Dyspnea (26)	Cardio-vascular Disease (9) Impaired or Reduced EF (8) Fibrosis and/or Inflammation (by cMRI) (3) Pericardial Effusion (6) Elevated hsTNT (3)	Stroke (6) Neuro-cognitive Disorders (4) Cognitive Impairment (9) Cognitive symptoms (11) Modified Rankin Scale Scores (8) Neuro-muscular (2)	CKD (3) AKD (at- and post-discharge) (5) Persistent Kidney Dysfunction (3) Need for RRT (8)	Diabetes (3)	Gastro-intestinal Disease (2) Liver Test Abnormalities (2) Liver Imaging Abnormal-ities (2)	Thrombo-embolism (18) Bleeding Events (3) Coagulation Disorders (3)	Discharge Disposition (24) Readmission (22) Oxygen Therapy (9) Post-Acute Care (8)

Abbreviations: AKD=acute kidney disease; cMRI=cardiovascular magnetic resonance imaging; EF=ejection fraction; hsTNT=high-sensitivity Troponin T; RRT=renal replacement therapy

[a]Studies may have reported more than 1 category of outcomes

PULMONARY OUTCOMES

Key Findings

Interpretation of findings is limited by varying degrees of COVID-19 severity and different outcome definitions, assessment methods, sampling strategies, and follow-up lengths across studies.

In studies with control groups, incident respiratory disease may be higher in post-hospitalization COVID-19 cases (k=3). Prevalences ranged from 2% to 22% in COVID-19 groups compared to less than 1% in control groups. Dyspnea was more prevalent (64% vs 10%) or Veterans were at greater risk for dyspnea (HR 1.14 [95%CI 1.04, 1.26]) in COVID-19 groups than in control groups. Other reported pulmonary outcomes included radiographically defined fibrosis at varying time intervals (k=12, none with control groups) with estimates ranging from 0% to 61% of enrolled patients, abnormal diffusing capacity of the lung for carbon monoxide (DLCO) in 16% to 57% (k=15, none with control groups), and dyspnea present at greater than 1 month post-discharge in 2 to 81% (k=26, including 2 with control groups noted above).

Overview of Studies

Of the 50 studies reporting pulmonary outcomes (Appendix C, Tables 1 and 3), 18 were from Europe,[27,29,30,60,61,81,82,96,107,108,118,120,126-128,130,132,144] 16 were from China,[34,45,55,63,71,73,74,85,88,100,101,103,116,119,133,141] 5 were from the US,[91,104,109,110,117] 5 were from the UK,[57,106,115,124,143] 3 were from the Middle East,[24,75,94] 2 were from Africa,[122,134] and 1 was from Canada.[95] Sample sizes ranged from 18 to 29,335 COVID-19 patients, with only 5 studies enrolling over 1000 individuals and 18 studies enrolling fewer than 100 individuals. Mean or median ages ranged from 37 to 73 years and the percentage of males enrolled ranged from 38% to 94%. Only 7 studies reported race with 14% to 78% White and 5% to 34% Black. A history of chronic obstructive pulmonary disease (COPD) was reported in 0% to 19% of participants (29 studies) and a history of smoking in 0% to 44% (22 studies). Thirteen studies reported the percentage of study participants with severe or critical COVID-19. Four studies enrolled only patients with severe COVID-19.[24,75,116,133] Of the remaining 16 studies, fewer than 50% were classified as severe in 13 studies. Three studies excluded patients who received mechanical ventilation.[34,81,147] Five of the studies (4 of which were large database studies) included a comparison to non-COVID-19 patients.[104,106,109,110,124] Reported outcomes varied across the studies, with most reporting surrogate measures of health outcomes.

Respiratory Disease

Studies with Control Groups

Three large database studies reported incident respiratory disease. A study from the UK, with over 56,000 records, reported a statistically significant difference (P<.001) in new onset respiratory disease between the COVID-19 (22% [6,085/28,335]) and general population control (0.8% [240/28,335]) groups at approximately 146 days post-discharge.[106] A study from the US, with over 54,000 records, reported odds ratios for new onset pneumonia (except that caused by tuberculosis) in the COVID-19 group versus a hospitalized non-COVID control group.[109] At 1-30 days post-discharge, the odds ratio was statistically significant (OR 5.5 [95%CI 4.1, 7.5]); at 31-60, 61-90, and 91-120 days post-discharge, the odds ratio was no longer statistically

significant. A similar pattern was observed for "respiratory failure, insufficiency, or arrest" with an odds ratio of 3.3 (95%CI 2.6, 4.1) at 0-30 days post discharge and non-statistically significant odds ratios at the other follow-up times. A study from the US, with over 36,000 records, reported a higher incidence of overall respiratory failure in the COVID-19 group (2.6%) than in a non-COVID control group (0.2%) (P<.001) at 4 months after acute illness.[110] The pattern was the same when acute respiratory failure, chronic respiratory failure, and interstitial lung disease were evaluated separately.

Studies without Control Groups

Two smaller studies without control groups also reported respiratory disease. A study from Italy reported no incidence of respiratory failure at 60 days post-discharge.[127] Fifty-nine percent of the study participants had severe or critical COVID-19. A study from France reported emphysema in 18% (10/55) patients at a median of 144 days post-discharge.[126] Participants in this study were experiencing residual symptoms during a clinic evaluation at 3 months. After referral to the pulmonology department, those with residual symptoms not explained by pre-existing respiratory disease underwent CT evaluation.

Radiographic Fibrosis

Twelve studies, none with control groups, reported the percentage of patients with pulmonary fibrosis (Table 3). Definitions of fibrosis varied across studies with broad to very specific criteria; 4 studies did not provide a definition. In some studies, evaluation for fibrosis was limited to those most ill with lingering symptoms.

Table 3. Radiographic Pulmonary Fibrosis (shaded rows indicate studies added for September 2021 update)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Definition/ Assessment	Pulmonary Fibrosis
Hu, 2020[45] China	17% severe	Discharge	Artificial intelligence to calculate fibrosis volume or % of fibrosis in entire lung	61% (46/76)
Yu, 2020[74] China	ICU admission: 16%	9 days post-discharge (median)	Fibrosis: combination of parenchymal bands, irregular interfaces, course reticular pattern, and traction bronchiectasis	44% (14/32)
Zhang, 2020[100] China	17% severe	14 days post-discharge	NR	31% (35/112)
Hall, 2021[115] United Kingdom	ICU admission: 39%	28-42 days post-discharge	Poorly defined; "persistent interstitial change" per interpreting radiologist	32% (64/200)
Huang Y, 2020[63] China	30% severe	30 days post-discharge	NR	7% (4/57)
You, 2020[73] China	34% severe/critical	40 days post-discharge (mean)	NR	22% (4/18)

Yasin, 2021[134] Egypt	ICU admission: 25%	42 days post-discharge (mean)	Parenchymal bands, irregular interfaces (bronchovascular, pleural, or mediastinal), coarse reticular pattern, and traction bronchiectasis	48% (101/210)
Wu, 2021[133] China	100% severe (inclusion criteria)	98 days 189 days 275 days 348 days post-discharge (medians)	'Established fibrosis' (NOTE: study reports abnormalities which may have been included as fibrotic changes as defined by other studies)	0% (0/83)
Boari, 2021[108] Italy	NR	120 days post-discharge	Poorly defined; chest CT confirmed presence of indices of pulmonary fibrosis	25% (24/94)
Morin, 2021[120] France	ICU admission: 30%	125 days post-discharge (median)	NR	19% (33/170) Intubated: 36.7% (18/49) Non-intubated: 12.4% (15/121)
Remy-Jardin, 2021[126] France	ICU admission: 42%	144 days post-discharge (median)	Bronchial/bronchiolar dilatation within areas of ground-glass attenuation	12.7% (7/55)
Han, 2021[116] China	100% severe	175 days post-disease onset (mean)	Features of fibrosis (*ie*, honeycomb cysts) or features potentially suggestive of fibrosis (*ie*, bronchial and/or bronchiolar dilatation within areas of ground-glass opacities and/or reticulation)	Fibrotic-like changes at 6 months: 35% (40/114) de Novo abnormalities: 95% (38/40)

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity

Other Computed Tomography Findings

Several studies reported other findings from computed tomography (CT) (Table 4). Only 1 included a control group.[104]

Table 4. Chest CT Findings (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Findings
Xia, 2020[55] China	Mild or moderate	Discharge	Residual infiltrates without fibrosis: 82% (233/282) Residual infiltrates and consolidation fibrosis: 14% (39/282)

Liu, 2020[141] China	Mild or moderate	Discharge 14 days 28 days post-discharge (median)	Consolidations D/C: 49% (25/51) 14 d: 8% (4/51) 28 d: 2% (1/51)
Wang, 2020[71] China	53% severe	7-14 days 21-28 days post-discharge	Chest CT Deterioration[c] 7-14 d: 6% (2/36) 21-28d: 0% (0/54)
Zhang, 2020[100] China	83% non-severe	14 days post-discharge	Normal CT 40% (45/112)
Huang Y, 2020[63] China	30% severe	30 days	Residual Abnormality 54% (31/57) Severe: 94% (16/17) Non-severe: 38% (15/40)
Sonnweber, 2020[96] Austria	ICU admission: 22%	63 days 103 days post-diagnosis (means)	Pathological CT 63 d: 77% (112/145 103 d: 63% (84/133)
Shah, 2020[95] Canada	22% requiring mechanical ventilation	90 days post-symptom onset	Abnormal 88% (53/60)
Qin, 2021[103] China	49% severe	90 days post-discharge	Pulmonary Interstitial damage (from subset of 45 patients who received chest CT): 71% (32/45)
Li, 2021[119] China	45% critical/severe	90-180 days post-discharge	Lesions (incomplete resolution) 72% (44/61)
Wu, 2021[133] China	100% severe (inclusion criteria)	98 days 189 days 275 days 348 days post-discharge (medians)	Residual Changes 98d: 78% (65/83) 189d: 48% (40/83) 275d: 27% (22/83) 348d: 24% (20/83)
Morin, 2021[120] France	ICU admission: 30%	125 days post-discharge (median)	Abnormal CT 53% (106/171) Persistent GGO 42% (72/170)
Remy-Jardin, 2021[126] France	ICU admission: 42%	144 days post-discharge (median)	Lung Infiltrates (“residual findings”) 73% (40/55)
Al-Aly, 2021[104] USA (Veterans)	ICU admission: 26%	150 days post-discharge (median)	**Interstitial lung disease (ICD-10)** COVID group: 1.60% Non-COVID Control group: 0.13% Risk difference 1.47% (95%CI 1.14, 1.98)
Huang C, 2021[85] China	ICU admission: 4%	153 days post-discharge (median)	At least 1 Abnormal CT Pattern[b] Scale 3: 52% (49/89) Scale 4: 54% (87/161) Scale 5-6: 54% (50/92)
Han, 2021[116] China	100% severe	175 days post-disease onset (mean)	Pleural Effusions 9% (10/114)

Abbreviations: CT=computed tomography; GGO=ground glass opacity

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Scale 3=no supplemental oxygen; Scale 4=requiring supplemental oxygen; Scale 5-6=requiring high flow nasal cannula, non-invasive ventilation, or invasive mechanical ventilation
[c]Outcomes did not differ by COVID-19 severity

Other Imaging

Studies with Control Groups

An MRI study reported lung parenchymal abnormalities in 60% (32/53) of the COVID-19 group and 11% (3/28) of the non-COVID control group at a median of 144 days post-discharge.[124]

Studies without Control Groups

One study reported "lung abnormalities" (worsening or appearance of X-ray pulmonary infiltrates) in 85% (6/7) at the time of hospital discharge.[30] Patients in this study were all receiving maintenance hemodialysis at the time of hospitalization.

Another study measured lung impairment with MRI at a median of 105 days after a positive COVID-19 result.[57] Deep breathing fractional area change of <31% was observed in 12% (4/34) evaluated.

Pleural effusions were detected using point-of-care ultrasound in 2% (1/64).[24] At ICU admission, pleural effusions had been observed in 22.4% (20/89). A second study reported pleural effusions in 19% (24/127) at 2 months and 12% (15/127) at 4 months post-discharge.[75] Both studies enrolled patients admitted to the ICU, most of whom required invasive mechanical ventilation.

Pulmonary Function

Pulmonary function tests were reported by 20 studies (Table 5). Studies reporting abnormal forced expiratory volume in 1 second (FEV_1) are shown in Figure 3, abnormal forced vital capacity (FVC) in Figure 4, and abnormal DLCO in Figure 5. Abnormal was defined as either <80% predicted or described by the author as abnormal (see Table 5). At follow-up periods of up to 348 days, FEV_1 was reported to be abnormal in 9% to 25%, FVC was reported to be abnormal in 4% to 27% and DLCO was reported to be abnormal in 16% to 57%.

Studies with Control Groups

Only 1 study included a control group and found no statistically significant difference between COVID-19 cases and non-hospitalized, non-COVID cases for either FEV_1 or FVC at a median of 48 days post-discharge.[124]

Table 5. Pulmonary Function Test Findings (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	Time of Assessment (post-discharge unless noted)	COVID-19 Severity[a]	FEV_1 <80% Predicted (unless noted)	FVC <80% Predicted (unless noted)	DLCO <80% Predicted (unless noted)
Frija-Masson, 2020[60] France	30 days after symptom onset	50% severe	Abnormal lung function: 52% (26/50)		
Mo, 2020[34] China	Discharge	17% severe	14% (15/110)[b]	9% (10/110)[b]	47% (51/110) Mild: 30% (7/24) Pneumonia: 42% (28/67) Severe: 84% (16/19) P<.01 Severe vs others
Lv, 2020[88] China	14 days post-discharge	20% severe	NR	24% (33/137) Severe: 56% (15/27) Non-severe: 16% (18/110)	NR
Hall, 2021[115] United Kingdom	28-42 days post-discharge	ICU admission: 39%	NR	27% (16/59) with complete lung function tests	NR
Huang Y, 2020[63] China	30 days post-discharge	30% severe	9% (5/57)[c]	11% (6/57)[c]	53% (30/57) Severe: 77% (13/17) Non-severe: 43% (17/40) P=.02
You, 2020[73] China	40 days post-discharge (mean)	34% severe or critical	17% (3/18)[b]	17% (3/18)[b]	NR
Ramani, 2021[91] USA	40 days post-discharge (median)	86% requiring mechanical ventilation	Abnormal lung function: 39% (10/26)		Reduced diffusion capacity: 27% (7/26)
Raman, 2021[124] United Kingdom	48 days post-discharge (median)	ICU admission: 36%	11% (6/56) Controls 4% (1/28) P=.42	13% (7/56) Controls 0% (0/28) P=.09	NR
Sonnweber, 2020[96] Austria	63 and 103 days post-diagnosis (means)	ICU admission: 22%	63 d: 22% (28/127) 103 d: 22% (30/136)	63 d: 27% (34/125) 103 d: 22% (29/132)	63d: 31% (39/125) 103d: 21% (28/133)
Venturelli, 2021[132] Italy	81 days post-discharge (median)	ICU admission: 9%	NR	NR	Reduced: 19% (136/716)

Author, Year Country	Time of Assessment (post-discharge unless noted)	COVID-19 Severity[a]	FEV_1 <80% Predicted (unless noted)	FVC <80% Predicted (unless noted)	DLCO <80% Predicted (unless noted)
Shah, 2020[95] Canada	90 days post-symptom onset	ICU admission: 16%	NR	NR	Abnormal: 52% (31/60)
Zhao, 2020[101] China	90 days post-discharge	7% severe	Abnormal: 11% (6/55)	Abnormal: 11% (6/55)	Abnormal: 16% (9/55)
Qin, 2021[103] China	90 days post-discharge	49% severe	NR	21% (17/81)	54% (44/81)
Sibilia, 2021[144] Spain	101 days post-discharge (mean)	71% severe	25% (43/172)	24% (42/171)	57% (98/172)
Bellan, 2021[107] Italy	90-120 days post-discharge	ICU admission: 12%	NR	NR	52% (113/219)
Wu, 2021[133] China	98, 189, and 348 days post-discharge (medians)	100% severe (inclusion criteria)	98d: 30% (25/83) 189d: 24% (20/83) 348d: 16% (13/83)	98d: 23% (19/83) 189d: 16% (13/83) 348d: 11% (9/83)	98d: 55% (46/83) 189d: 54% (45/83) 348d: 33% (27/83)
Boari, 2021[108] Italy	120 days post-discharge	NR	NR	NR	32% (30/94)
Morin, 2021[120] France	125 days post-discharge (median)	NR	NR	NR	<70% Predicted 22% (33/152)
Huang C, 2021[85] China	153 days post-discharge (median)	ICU admission: 4%	Overall: 6% (22/349) Scale 3: 8% (7/89)[c] Scale 4: 2% (4/172) Scale 5-6: 13% (11/88)	Overall: 4% (14/349) Scale 3: 3% (3/89)[c] Scale 4: 1% (1/172) Scale 5-6: 11% (10/88)	Overall: 34% (114/336) Scale 3: 22% (18/83)[c] Scale 4: 29% (48/165) Scale 5-6: 56% (48/88)
Han, 2021[116]	175 days post-disease onset (mean)	100% severe (inclusion criteria)	NR	NR	26% (27/104)

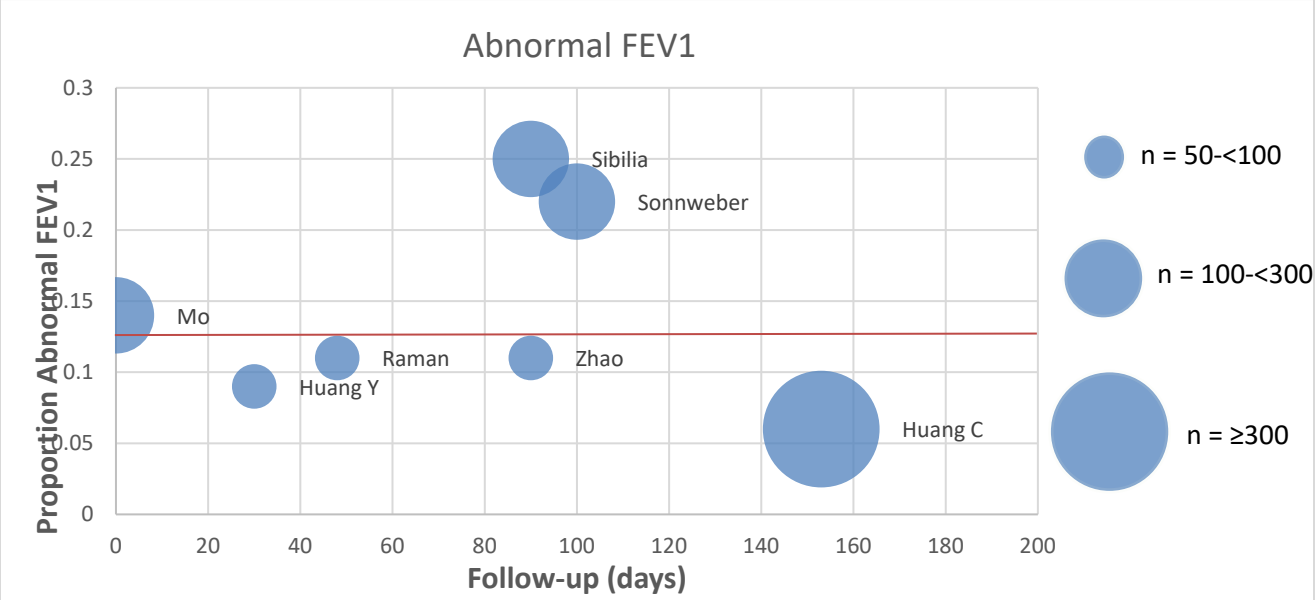
Abbreviations: DLCO=diffusing capacity of the lung for carbon monoxide; FEV_1=forced expiratory volume in 1 second; FVC=forced vital capacity

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity

[b]Outcomes did not differ by COVID-19 severity

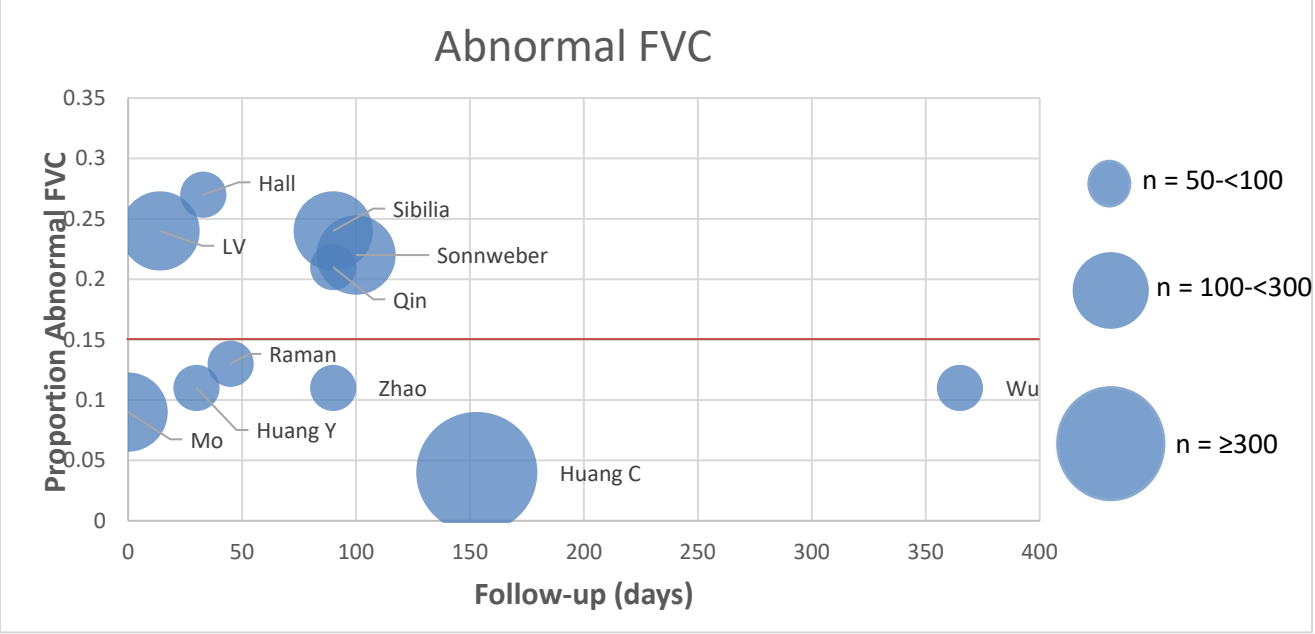
[c]Scale 3=no supplemental oxygen; Scale 4=requiring supplemental oxygen; Scale 5-6=requiring high flow nasal cannula, non-invasive ventilation, or invasive mechanical ventilation

Figure 3. Abnormal Spirometry – FEV_1[a]



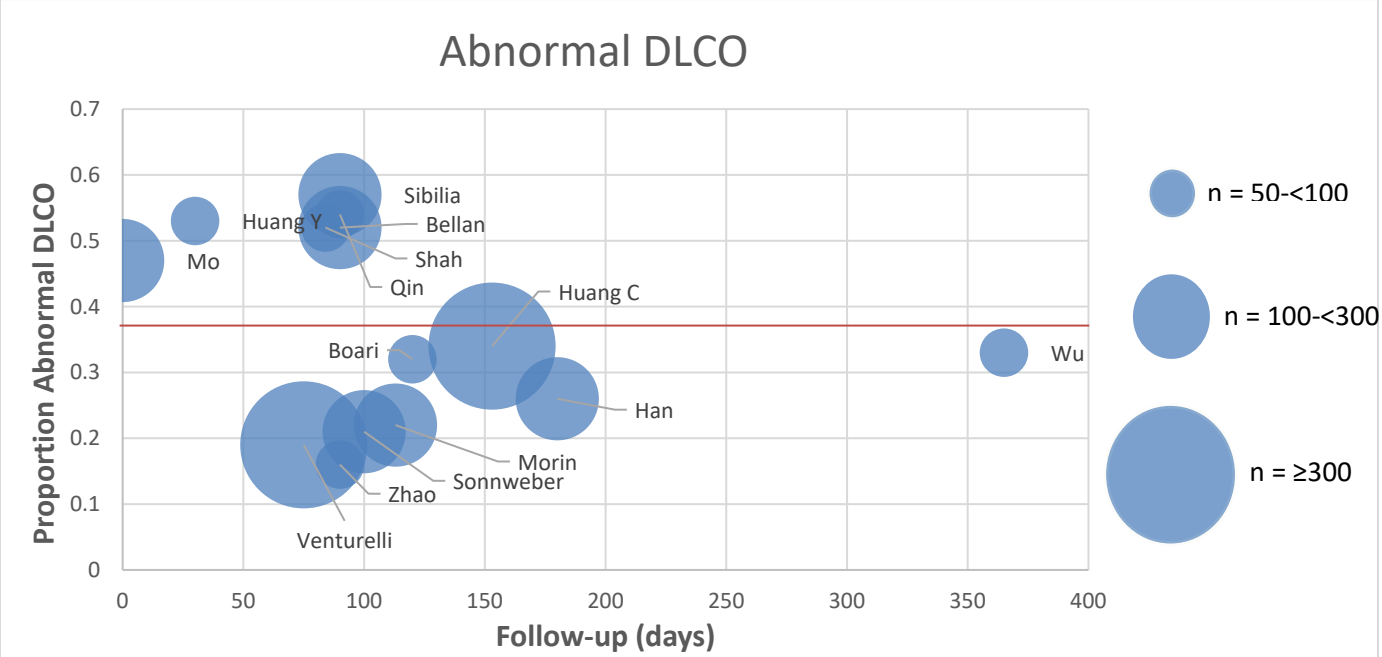
[a]Studies of n≥50; abnormal defined as <80% predicted for most studies (see table below); red line indicates random effects pooled estimate

Figure 4. Abnormal Spirometry – FVC[a]



[a]Studies of n≥50; abnormal defined as <80% predicted for most studies (see table below); red line indicates random effects pooled estimate

Figure 5. Abnomal DLCO[a]



[a]Studies of n≥50; abnormal defined as <80% predicted for most studies (see table below); red line indicates random effects pooled estimate

Five studies provided more detail on the abnormal findings. One study reported a restrictive pattern in 8% (4/50 enrolled patients), restriction with altered diffusion capacity in 18% (9/50), and altered diffusion capacity only in 26% (13/50).[60] The study by Huang further described the observed pulmonary dysfunction as obstructive in 11% (6/57), restrictive in 12% (7/57), and combined obstructive and restrictive in 4% (2/57).[63] Ramani et al reported obstruction in 15% (4/26), restriction in 19% (5/26), and mixed obstruction and restriction in 4% (1/26).[91] The fourth study reported 17% (3/18) with obstructive and 17% (3/18) with restrictive ventilatory impairment.[73] Venturelli reported pulmonary obstruction in 4% (27/716) and pulmonary restriction in 12% (85/716).[132]

Dyspnea

Measures of dyspnea were reported in 26 studies (Table 6). Eight used a modified Medical Research Council (mMRC) measure (https://mrc.ukri.org/research/facilities-and-resources-for-researchers/mrc-scales/mrc-dyspnoea-scale-mrc-breathlessness-scale/) where:

Grade 1 indicates not troubled by breathlessness except on strenuous exertion
Grade 2 indicates short of breath when hurrying on the level or walking up a slight hill
Grade 3 indicates having to walk slower than most people on the level or having to stop after a mile or so (or after ¼ hour) on the level while walking at self-selected pace
Grade 4 indicates having to stop for breath after walking about 100 yards (or after a few minutes) on the level
Grade 5 indicates too breathless to leave the house, or breathless after undressing.

Assessment of dyspnea varied across studies – both the time of assessment post-discharge and the method of assessment (including different cut points for the mMRC). In studies assessing dyspnea at or within 1 month of discharge, reported prevalence ranged from 10-100%. In studies assessing dyspnea beyond 1 month post-discharge, prevalences ranged from 2-81%.

Studies with Control Groups

In studies with control groups, dyspnea was more prevalent[124] or Veterans were at greater risk for dyspnea[104] in the COVID-19 groups than in the control groups.

Table 6. Dyspnea Findings (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Assessment	Dyspnea
Fuglebjerg, 2020[29] Denmark	ICU admission: 31%	Discharge	Borg Scale following 6 min walk test	Generally <3 on 10-point scale ("moderate" dyspnea)[b]
Curci, 2020[27] Italy	ICU admission: 100%	Admission to rehabilitation unit	mMRC	Grade 4: 13% (4/32) Grade 5: 88% (28/32)
Osikomaiya, 2021[122] Nigeria	42% moderate or severe	15 days post-discharge (median)	Dyspnea (symptom)	10% (25/274)
Karaarsian, 2021[118] Turkey	ICU admission: 0%	14 and 30 days post-discharge	Shortness of breath (symptom)	14d: 38% (114/300) 30d: 26% (78/300)
De Lorenzo, 2020[82] Italy	ICU admission: 3%	22 days post-discharge (median)	mMRC	Mild: 25% (31/126) Moderate: 3% (4/126) Severe: 2% (3/126) Very Severe: 2% (2/126)
Sami, 2020[94] Iran	ICU admission: 8%	30 days post-discharge	Dyspnea (symptom)	Non-severe: 15% (59/400) Severe: 19% (10/52)
Jacobs, 2020[117] USA	95% mild	35 days post-discharge	Shortness of breath (symptom)	45% (58/128)
Tomasoni, 2021[130] Italy	NR	46 days post-discharge (median)	Dyspnea (symptom); on-going	7% (7/105)
Daher, 2020[81] Germany	100% severe	42 days post-discharge (median)	Dyspnea (symptom questionnaire)	33% (11/33)
Raman, 2021[124] United Kingdom	100% moderate to severe	48 days post-discharge (median)	mMRC ≥2	COVID-19: 64% (36/56) Community controls: 10% (3/29) P<.001
Sonnweber, 2020[96] Austria	ICU admission: 22%	63 days 103 days post-diagnosis (mean)	mMRC 3-4	63d: 2% (3/145) 103d: 4% (5/133)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Assessment	Dyspnea
Spinicci, 2021[127] Italy	59% severe or critical	60 days post-discharge (median)	Dyspnea (symptom)	30% (30/100)
Venturelli, 2021[132] Italy	ICU admission: 9%	81 days post-discharge (median)	mMRC	Grades 1-4: 30% (228/767) Grade 1: 23% (176/767) Grade 2: 6% (42/767) Grade 3: 1% (10/767) Grade 4: 0% (0/767)
Wu, 2021[133] China	100% severe	98 days 189 days 275 days 348 days post-discharge (medians)	mMRC ≥1	98d: 81% (67/83) 189d: 30% (25/83) 275d: 12% (10/83) 348d: 5% (4/83)
Shah, 2020[95] Canada	NR	90 days post-symptom onset	Dyspnea (symptom)	21% (12/60)
Qin, 2021[103] China	49% severe	90 days post-discharge	Dyspnea (symptom)	9% (56/647) Non-severe: 7% Severe: 12%
Sibilia, 2021[144] Spain	71% severe	101 days post-discharge (mean)	Dyspnea (symptom)	40% (68/172)
Suarez-Robles, 2021[128] France	ICU admission: 1%	90 days post-discharge	Dyspnea (symptom)	40% (54/134)
Bellan, 2021[107] Italy	ICU admission: 12%	90-120 days post-discharge	Dyspnea (symptom)	6% (13/238)
Garrigues, 2020[61] France	ICU admission: 20%	111 days post-discharge (mean)	mMRC Grade 2 or more	29% (35/120) Ward: 28% ICU: 33%
Morin, 2021[120] France	ICU admission: 30%	113 days post-discharge (median)	Dyspnea (symptom); new onset during or after hospitalization and persisting at time of assessment	16% (78/478)
Boari, 2021[108] Italy	NR	120 days post-discharge	"Effort dyspnea" (questionnaire)	36% (33/91)
Hall, 2021[115] United Kingdom	ICU admission: 39%	28-42 days post-discharge	mMRC; persistent reduction of ≥2 points from self-rated pre-illness score	18% (36/200)
Huang C, 2021[85] China	ICU admission: 4%	153 days post-discharge (median)	mMRC ≥1	26% (419/1615)
Al-Aly, 2021[104] USA (Veterans)	ICU admission: 26%	150 days post-discharge (median)	Shortness of breath (ICD-10) (incident)	HR 1.14 (95%CI 1.04, 1.26) vs seasonal influenza control group

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Assessment	Dyspnea
Han, 2021[116] China	100% severe	175 days post-disease onset (mean)	"Slight exertional" dyspnea	14% (16/114)

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Study also reported presence of exercise-induced hypoxia (defined as SpO_2 <90%) in 50% (13/26); 6 of the patients underwent further testing and pulmonary embolism was confirmed in 67% (4/6)

Other Pulmonary Outcomes

Studies with Control Groups

In patients with moderate to severe COVID-19 who completed a symptom-limited cardiopulmonary exercise test on a bicycle ergometer at a median of 48 days post-discharge, peak oxygen consumption less than 80% of predicted maximum was reported in 55% (28/51) of the COVID-19 group and 7% (2/27) of the non-COVID control group (P<.001).[124]

Studies without Control Groups

A study of patients admitted to a rehabilitation unit following hospitalization (with ICU admission) for COVID-19 reported that 41% (13/32) required oxygen via nasal cannula, 13% (4/32) required an oxygen mask, and 25% (8/32) required a Venturi mask at admission.[27] A study of patients referred for clinical signs of dysphagia during hospitalization for COVID-19 reported no new cases of aspiration pneumonia.[143] Length of follow-up was not reported.

CARDIOVASCULAR OUTCOMES

Key Findings

In studies with control groups, patients with COVID-19 were at greater risk for post-discharge incident cardiovascular disease outcomes (including acute myocardial infraction, coronary disease, and heart failure) compared to controls. Prevalences of new cardiovascular events ranged from approximately 1 to 3% of the COVID-19 groups and less than 1% in the control groups (k=3).

Myocardial inflammation/fibrosis was more prevalent in COVID-19 patients than controls (k=3). Pericardial effusion was reported in 0% to 20% (k=6). Impairment in left ventricular ejection fraction (LVEF) was noted in 0 to 22% (k=8).

Overview of Studies

Cardiovascular outcomes were reported in 22 studies (Appendix C, Tables 1 and 4) – 9 from Europe,[66,81,82,96,111,120,123,127,131] 4 from the US,[104,110,112,114] 4 from the UK,[57,106,115,124] 3 from China,[62,99,135] and 2 from the Middle East.[24,75] Sample sizes range from 26 to 28,335 COVID-19 patients, mean or median ages ranged from 38 to 70 years, and the percentage of males enrolled ranged from 38% to 94%. Six studies reported race. A history of CVD or CAD was reported in 0% to 40% (15 studies) with a history of hypertension in 5% to 59% (17 studies). Severity of COVID-19 was reported in 7 studies, with 2 enrolling only patients with severe or critical

COVID-19 and 2 studies excluding severe cases. Seven studies included comparison groups.[62,66,99,104,106,110,124]

Cardiovascular Disease

Studies with Control Groups

Three large database studies reported diagnoses of cardiovascular disease following hospitalization for COVID-19. A study of over 27,000 US Veterans reported hazard ratios (HR) for incident acute coronary disease (HR 1.3 [95%CI 1.1, 1.5]) and heart failure (HR 1.2 [95%CI 1.03, 1.4)]) for the COVID-19 group versus individuals hospitalized with seasonal influenza.[104] Outcomes were assessed during the 6 months following COVID-19 infection.

A second study from the US, including over 36,000 individuals in COVID-19 and non-COVID control groups, reported new diagnoses over 4 months following acute COVID-19 infection.[110] Coronary disease (including myocardial infarction, acute coronary syndrome, and cardiogenic shock) was reported in 1.05% of the COVID-19 group and 0.18% of the control group (P<.001). Congestive heart failure was reported in 1.54% of the COVID-19 group and 0.20% of the control group (P<.001). The incidence of myocarditis did not differ between groups (COVID-19: 0.09%, Control: 0.01%).

A study from the UK reported major adverse cardiovascular events (MACE) during a mean of approximately 146 days post-discharge.[106] Included were heart failure, myocardial infarction, stroke, and arrhythmia. New onset events were reported in 2.6% (945/36,130) of the COVID-19 group and 0.5% (190/36,130) of the general population (non-COVID) control group. The difference was statistically significant (P<.001).

Studies without Control Groups

Several smaller studies without control groups also reported cardiovascular diagnoses. A study from the US reported no cases of acute myocardial infarction among 367 individuals hospitalized for COVID-19 at a median of 49 days follow-up.[112] Another US study reported non-ST-segment myocardial infarctions in 0.8% (4/447) within 30 days of hospital discharge.[114] A study from Italy reported "heart failure and other cardiac conditions" in 5% (5/100).[127] A study from the UK identified "previously undiagnosed or deterioration of existing" cardiac causes for ongoing symptoms of breathlessness at 4 to 6 weeks post-discharge in 4% (8/200 enrolled) or 10% (8/81 experiencing breathlessness).[115] Another study from the UK reported evidence of myocarditis in 22% (8/37) at a median of 105 days after COVID-19 diagnosis.[57] A study from China reported newly detected atrial fibrillation in 1% (1/97) at a median of 11 days post-discharge.[135]

Ejection Fraction

Seven studies used echocardiography to assess left ventricular ejection fraction (LVEF).

Studies with Control Groups

Only 1 study included a control group.[124] The authors reported that left ventricular function was normal and comparable between the COVID-19 group and a community-dwelling non-COVID group.

Studies without Control Groups

Another study assessed LVEF at admission and at 6 weeks follow-up.[81] Findings were normal for 94% (17/18) of patients with severe COVID-19 on admission and 88% (29/33) at 6 weeks. In another study, with COVID-19 severity not reported, LVEF was less than 52% in 22% (18/81) of COVID-19 patients at 1.5 months post-discharge.[111] Another study reported LVEF <53% for 3% (4/145) at both 60 days and 100 days post-discharge.[96] In this study, 75% of study participants were hospitalized. In the fourth study, 12% (10/83) had LVEF <50% at a median of 125 days post-discharge.[120] It was noted that no patient had an LVEF <40%. In a study of non-severe COVID-19 patients, LVEF<50% was reported for 1% (1/97) at a median of 11 days post-discharge.[135] A study from Romania enrolled a select group of volunteers under age 55 without prior history of cardiovascular disease.[131] At 6 to 10 weeks post-discharge, diastolic dysfunction was reported in 17% (21/125) and both diastolic dysfunction and impaired left ventricular systolic function was reported in 9% (11/125).

A study from the United Kingdom reported LVEF, assessed with cMRI, for 37 previously hospitalized patients at a median of 105 days after COVID-19 diagnosis.[57] Impairment (≤51%) was noted in 11% (4/37).

Fibrosis and/or Inflammation by Cardiovascular Magnetic Resonance Imaging (cMRI)

Studies with Control Groups

Three studies used cMRI to assess myocardial injury. In a study from Germany, 100 patients were assessed at a median of 71 days following diagnosis.[66] Thirty-three had been hospitalized. The mean age of the patients was 49 years and 53% were male. Among the hospitalized patients, 2 underwent mechanical ventilation and 17 underwent non-invasive ventilation. The study also reported imaging findings for 50 healthy controls and 57 risk factor-matched controls. Late gadolinium enhancement (LGE), reflecting scarring, was observed in 32% (32/100) (myocardial) and 22% (22/100) (pericardial) of the COVID-19 group. Myocardial LGE was significantly more prevalent (P<.05) in the COVID-19 patients than in the healthy controls (0%) or the risk factor-matched controls (17% (9/57)). Pericardial LGE was significantly more prevalent (P<.05) in the COVID-19 patients than in the healthy controls (0%) but not compared with the risk factor-matched controls (14% (8/57)). Abnormal native T1 values were observed in 73% (73/100) of all COVID-19 patients, with significantly higher values (P=.008) in those who had required hospitalization, although the difference was characterized as small. Reporting of T1 and T2 abnormalities, which generally reflect myocardial inflammation, indicated that abnormal native T1 was reported in 12% (6/50) of the healthy controls and 58% (33/57) of the risk factor-matched controls (both P<.05 vs the COVID-19 group). Abnormal native T2 values were observed in 60% (60/100) of the COVID-19 group with no difference between hospitalized and non-hospitalized patients. Prevalences were 12% (6/50) and 26% (15/57) in the healthy controls and risk factor-matched groups, respectively (both P<.05 vs the COVID-19 group).

A second study, from the UK, enrolled patients with moderate to severe COVID-19.[124] Outcomes were assessed at a median of 48 days post-discharge. A matched control group of community-dwelling, non-COVID individuals was included. LGE was observed in 12% (6/52) (myocarditis pattern) of the COVID-19 group and 7% (2/28) of the control group, with

pericardial LGE in 2% (1/52) of the COVID-19 group and 0% (0/28) of the control group. The differences between groups were not statistically significant for either measure. Abnormal native T1 (basal myocardium) was observed in 26% (13/50) in the COVID-19 group and 4% (1/28) in the control group (P=.015). The differences between the COVID-19 and control groups for abnormal native T1 mid-myocardium (COVID-19: 8%, Control 0%) and abnormal apical myocardium (COVID-19: 2%, Control 4%) did not reach statistical significance.

The third study, from China, evaluated 26 patients referred for CMR due to cardiac symptoms post-discharge.[62] Patients with a history of coronary artery disease or myocarditis were excluded. COVID-19 was reported as severe for 15% (4/26) and moderate for 85% (22/26). The study reported data from healthy controls (similar age and gender with no cardiovascular disease or systemic inflammation) who underwent CMR at the same hospital. CMR for the COVID-19 patients was completed at a median of 47 days after the onset of cardiac symptoms. Myocardial edema was noted in 54% (14/26). Of the 14 with edema, 50% (7/14) had positive LGE and 50% (7/14) had a small pericardial effusion. A total of 8 patients (1 without myocardial edema) had positive LGE. Native T1, T2, and extracellular volume (ECV) were significantly elevated in the recovered COVID-19 patients with positive CMR findings compared with the healthy controls.

Pericardial Effusion

Six studies reported pericardial effusion.

Studies with Control Groups

The study from Germany, described above, used CMR imaging and reported pericardial effusion (>10 mm) in 20% (20/100) of the COVID-19 patients, 0% of the healthy controls, and 7% (4/57) of the risk factor-matched controls.[66] The difference between the COVID-19 group and the other groups was statistically significant (P<.05). The UK study, also described above, reported pericardial effusion (>10 mm) in 2% (1/52) of the COVID-19 group and 0% (0/28) of the community-dwelling, non-COVID control group.[124]

Studies without Control Groups

Four studies used ultrasound to assess pericardial effusion. Two studies, both from Saudi Arabia, included only patients admitted to the ICU. One reported pericardial effusion at hospital discharge in 2% (1/64)[24] while the second reported rates of 16% (20/127) at 2 months and 11% (14/127) at 4 months.[75] The third study, from Austria, reported pericardial effusion at 60 days (6% [8/145]) and 100 days (1% [1/134]) in patients, the majority of whom did not require ICU admission.[96] The fourth study, conducted in Germany, reported no pericardial effusion at a median of 6 weeks in patients who did not require mechanical ventilation.[81]

High Sensitivity Troponin T (hsTNT)

Studies with Control Groups

The CMR study from Germany also reported blood test results.[66] Detectable hsTNT (>3 pg/mL) was reported in 71% (71/100) of the COVID-19 group, with significantly elevated hsTNT (>13.9 pg/mL) in 5% (5/100). The mean hsTNT value was significantly lower (P=.002) in patients who recovered at home compared with those who were hospitalized; the difference was described as small. The percentage of patients with detectable hsTNT was significantly higher (P<.05) in the

COVID-19 group than the healthy controls (22% [11/50]) or risk factor-matched controls (54% [31/57]). The UK study, with a control group of non-COVID-19 community members (*ie,* not hospitalized) reported no cases of abnormal troponin T in either the COVID-19 (moderate to severe disease) or control groups at a median of 48 days following discharge.[124]

Studies without Control Groups

Two additional studies reported abnormal troponin T. A study of individuals attending a COVID-19 outpatient clinic 6 weeks post-discharge reported "elevated" troponin T in 19% (15/81).[111] A study of individuals with non-severe COVID-19 referred to an infectious disease clinic and invited to participate, reported elevated troponin T (greater than the 99th percentile of the upper reference limit) in 6% (6/97) at a median of 11 days post-discharge.[135] Individuals with elevated troponin or electrocardiogram abnormalities underwent cMRI. There was no evidence of acute myocarditis in that subgroup.

Other Findings

Studies with Control Groups

A study from China reported newly diagnosed hypertension in 1% (7/538) of the COVID-19 group and 0% (0/184) of a non-COVID-19 control group quarantined at home for greater than 3 months.[99]

Studies without Control Groups

A study from Turkey used echocardiography to identify left ventricular global longitudinal strain (LV-GLS).[123] LV-GLS greater than -18%, an indicator of subclinical myocardial deformation, was observed in 38% (28/74) at a mean of 30 days post-discharge. This included 57% (16/28) of a group with myocardial injury based on troponin level during hospitalization and 26% (12/46) with no myocardial injury. Two studies reported outcomes related to hypertension. A study from Italy reported uncontrolled blood pressure requiring a change in medication in 21% (26/126) at a median of 22 days post-discharge.[82]

NEUROMUSCULAR OUTCOMES

Key Findings

Post-discharge, the prevalence of, or risk for, stroke was higher in COVID-19 groups than in matched control groups (k=2). The incidence of dementia or Alzheimer's post-COVID-19 was low but may exceed that of non-COVID cases.

Several studies reported on cognitive function with most indicating some dysfunction. In 5 studies using established assessment tools with specified thresholds, cognitive impairment was observed in 23% to 57%. One of the studies included a community-based control group and reported no statistically significant difference between the COVID-19 and control groups. Cognitive symptoms including attention deficits, confusion, and memory difficulty were reported in 5% to 34% of COVID-19 patients (k=9). In 2 additional studies with control groups, memory problems were more frequently reported in the COVID-19 groups.

In patients hospitalized for stroke and testing positive for COVID-19, a "good" prognosis based on modified Rankin Scale scores at the time of discharge was reported in 17% to 60% (k=6).

Overview of Studies

Thirty studies reported neurological outcomes (Appendix C, Tables 1 and 5). Twelve were conducted in Europe,[25,61,81,82,105,111,120,125,127,130,132,142] 10 in the US,[31,33,77,91,104,109,110,114,117,129] 3 in multiple nations,[23,36,48] 2 in the UK,[53,124] and 1 each in the Middle East,[39] India,[46] and Africa.[122] Sample sizes ranged from 13 to 236,279 COVID-19 patients, mean or median ages ranged from 42 to 76 years, and between 39% and 94% were male. In 13 studies reporting race, 14% to 80% were White, 0% to 40% were Black, 6% to 57% were Hispanic, and 0% to 19% were Asian. Six studies reported on severity of COVID-19 with 3% to 62% of enrollees with severe or critical COVID-19. Ten studies included a comparison group (either concurrent non-COVID-19 or pre-COVID-19 patients).

Stroke and Other Diagnoses

Studies with Control Groups

The large database study of US Veterans without a history of stroke in the past year reported the hazard ratio (HR) for stroke in the 6 months following COVID-19 infection vs a matched control group consisting of individuals hospitalized for seasonal influenza was 1.30 (95%CI 1.05, 1.60).[104] Another US database study, with a non-COVID control group, reported the prevalence of new onset stroke during the 4 months after acute illness.[110] Ischemic and hemorrhagic stroke was reported in 1.12% of the COVID-19 group and 0.29% of the matched non-COVID control group (risk difference 0.83% [95%CI 0.4, 1.2], P<.001). A US study, without a control group for the subgroup of patients hospitalized, reported a first ischemic stroke in 6 months following COVID-19 in 1.6% (741/46,302) and a first intracranial hemorrhage in 0.6% (292/46,302).[129]

For incident neurocognitive disorders, US Veterans hospitalized for COVID-19, compared to hospitalized seasonal influenza cases, had an excess burden of 16.2 (95%CI 10.4, 21.2) per 1000 COVID-19 persons at 6 months.[104] In another large database study, the odds ratios for neurocognitive disorders (vs hospitalized non-COVID control patients) were 1.6 (95%CI 1.2, 2.1) in the first 30 days after discharge.[109] The odds ratios were not statistically significant at 60, 90, or 120 days.

In a large database study from the US, dementia was newly diagnosed in 0.23% of the COVID-19 group and 0.03% of the non-COVID control group (risk difference 0.2% [95%CI 0.7, 0.3], P<001) at 4 months after-acute illness.[110] In the same study, Alzheimer's disease was reported in 0.04% of the COVID-19 group and 0% of the control group (P<.001).

Studies without Control Groups

A study from the US reported 1 case of ischemic stroke (0.22% [1/447]) in 30 days post-discharge.[114] A study from Denmark reported stroke in 4% (2/45) of patients with 3 month follow-up data.[142] A study from Austria reported stroke with clinical symptoms at 3 months post-discharge (not diagnosed before COVID-19) in 1% (1/135).[125]

A US study, without a control group for the subgroup of patients who were hospitalized, reported the incidence of dementia at 6 months post-discharge was 1.5% (676/46,302).[129]

Other disease diagnoses reported included "any" neurological disease (not diagnosed before COVID-19) in 15% (20/135) at 3 months,[125] encephalopathy in 2% at 3 months,[125,142] and Parkinsonism in 0.2% to 1.0% at 3 or 6 months.[125,129]

Brain Imaging

A study from the UK, with a community-dwelling control group, reported brain abnormalities on MRI in 24% (13/54) in the COVID-19 group and 21% (6/28) in the control group (P=.79) at a median of 1.6 months post-discharge.[124] Of the abnormalities noted, 2 in the COVID-19 group and none in the control group were hemorrhagic or ischemic abnormalities.

NIH Stroke Scale

Two studies, both with control groups, reported NIH Stroke Scale scores at discharge.[25,31] Scores range from 0 (no symptoms) to 42 (severe symptoms) with scores between 1 and 4 indicating minor stroke symptoms and scores between 5 and 15 indicating moderate stroke symptoms (https://www.stroke.nih.gov/resources/scale.htm). The study from Italy, enrolling patients admitted primarily for neurological disease, reported median [IQR] scores of 9.0 [1.0-19.0] in the COVID-19 group and 2.0 [0.0-6.8] in the non-COVID-19 group (P=.005).[25] The study from the US reported median [IQR] scores of 11 [4-23] in the overall study group of 13 patients (6 admitted for COVID-19 symptoms who experienced a stroke during hospitalization, 7 admitted for stroke and testing positive for COVID-19) and 3 [2-13] in the non-COVID comparison group.[31]

Cognitive Impairment

Nine studies used established instruments to clinically assess cognitive impairment (Table 7).[82,91,105,111,120,124,125,130,132] Studies including at least 50 COVID-19 patients are shown on Figure 6.

Based on scores from the Montreal Cognitive Assessment (MoCA) at approximately 22 to 90 days post-discharge, between <1% and 73% had cognitive deficits. In the 4 studies specifying a cut-point of 24 to 26, deficits were noted in 23% to 57%. In 2 studies using the Mini Mental State Examination (MMSE), cognitive deficits were observed in 20%[105] and 40%[130] of the COVID-19 patients. Similar findings were observed in 2 studies using other cognitive instruments.

Studies with Control Groups

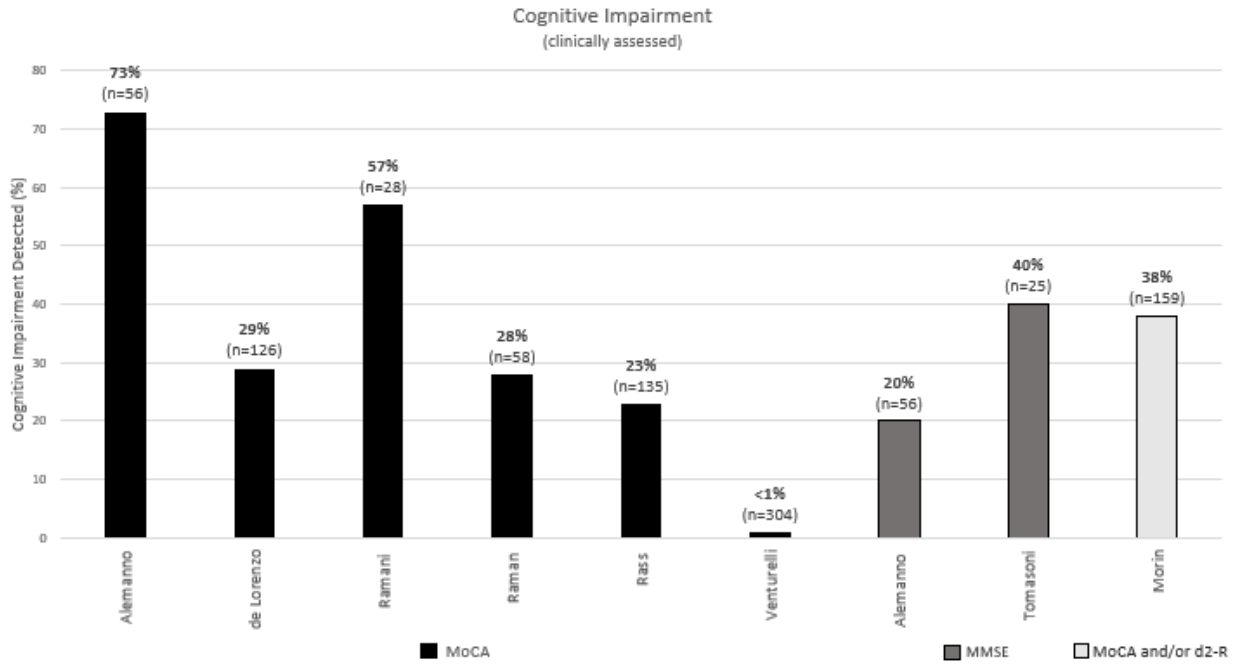
One of the 4 studies specifying a cut-point for the MoCA included a community-based control group and reported scores of less than 26 in 28% of the COVID-19 group and 17% of the control group (P=.30).[124]

Table 7. Clinical Assessment of Cognitive Impairment (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Cognitive Impairment
MMSE			
Alemanno, 2021[105] Italy	NR	30 days post-discharge	"Deficits"[b] 20% (11/56) (all mild or moderate)
Tomasoni, 2021[130] Italy	NR	46 days post-discharge (median)	40% (10/25) (MMSE<25)
MoCA			
De Lorenzo, 2020[82] Italy	ICU admission: 3%	22 days post-discharge (median)	29% (36/126) (MoCA <24)
Alemanno, 2021[105] Italy	NR	30 days post-discharge	"Deficits"[b] 73% (41/56)
Ramani, 2021[91c] US	NR	40 days post-discharge (median)	57% (16/28) (MoCA <26)
Raman, 2021[124] United Kingdom	ICU admission: 36%	48 days post-discharge (median)	28% (16/58) (MoCA <26) Community controls: 17% (5/30) P=.30
Venturelli, 2021[132] Italy	ICU admission: 9%	81 days post-discharge (median)	0.66% (2/304) ("Pathologic")
Rass, 2021[125] Austria	23% severe	90 days post-discharge	23% (29/135) (MoCA<26)
Other Instruments			
de Graaf, 2021[111] Netherlands	ICU admission: 42%	42 days post-discharge	CFQ: 27% (13/48) IQ-CODE-N: 26% (10/38)
Morin, 2021[120] France	ICU admission: 30%	113 days post-discharge (median)	MoCA or d2-R: 38% (61/159)

Abbreviations: CFQ=Cognitive Failures Questionnaire; IQ-CODE-N=Informant Questionnaire on Cognitive Functioning in the Elderly; MMSE=Mini Mental State Examination; MoCA=Montreal Cognitive Assessment
[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Cut-points for "deficits" not defined
[c]Study enrolled fewer than 50 and is not included on the figure below

Figure 6. Cognitive Impairment



Cognitive Symptoms

Eleven studies used self-report assessments of cognitive symptoms (Table 8).[61,81,104,110,117,120,122,125,127,130,132] Studies including at least 50 COVID-19 patients are shown on Figure 7. One study reported a composite measure of at least 1 cognitive complaint as well as individual measures of concentration problems, mental slowness, and memory difficulties.[120] Only the composite measure is shown on Figure 7.

Studies with Control Groups

Two large database studies included control groups. A study of over 26,000 US Veterans reported higher risk of memory problems over 6 months following COVID-19 infection (HR 1.42 [95%CI 1.23, 1.63]) in the COVID-19 group compared to a matched control group hospitalized for seasonal influenza.[104] A second US study with data from over 36,000 individuals reported amnesia/memory difficulty in 2.9% of the COVID-19 group and 0.4% of the matched non-COVID control group in the 4 months after acute illness (P<.001).[110]

Studies without Control Groups

In studies without control groups, attention deficits were noted in 5% to 27%, cognitive deficits in 18% to 21%, confusion in 5% to 10%, and memory difficulties in 17% to 34%.

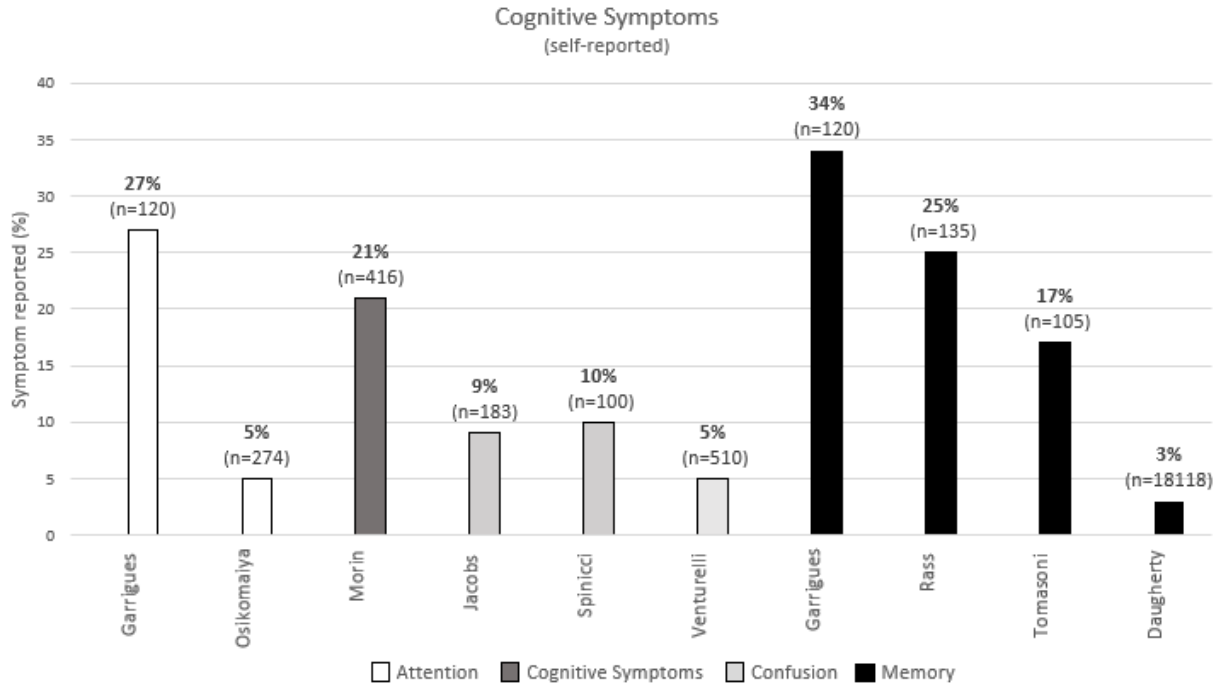
Table 8. Cognitive Symptoms (shaded rows indicate studies added for September 2021 update)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Findings
Attention Deficits			
Osikomaiya, 2021[122] Nigeria	3% severe	15 days post-discharge (median)	Attention or Memory Deficit: 5% (14/274)
Garrigues, 2020[61] France	ICU admission: 20%	111 days post-discharge (mean)	27% (32/120)
Morin, 2021[120b] France	ICU admission: 30%	113 days post-discharge (median)	Concentration Problems: 10% (41/412)
Cognitive Deficits			
Daher, 2020[81c] Germany	100% severe (inclusion criteria)	42 days post-discharge (median)	Cognitive Disorders (not defined): 18% (6/33)
Morin, 2021[120b] France	ICU admission: 30%	113 days post-discharge (median)	At Least 1 Cognitive Complaint (Memory, Mental Slowness, or Concentration): 21% (86/416) Mental Slowness: 10% (42/415)
Confusion			
Jacobs, 2020[117] US	NR (95% mild)	35 days post-discharge	9% (16/183)
Spinicci, 2021[127] Italy	59% severe or critical	60 days post-discharge (median)	10% (10/100)
Venturelli, 2021[132] Italy	ICU admission: 9%	81 days post-discharge (median)	5% (23/510)
Memory Difficulty			
Tomasoni, 2021[130] Italy	NR	46 days post-discharge (median)	Memory Disorder: 17% (18/105)
Rass, 2021[125] Austria	23% severe	90 days post-discharge	Forgetfulness, Trouble Concentrating, Difficulty Thinking: 25% (30/135)
Garrigues, 2020[61] France	ICU admission: 20%	111 days post-discharge (mean)	34% (41/120)
Morin, 2021[120b] France	ICU admission: 30%	113 days post-discharge (median)	Memory Difficulties: 18% (73/416)
Daugherty, 2021[110] US	ICU admission: 13%	120 days post-acute	Amnesia/Memory Difficulty:2.90% Matched control group: 0.43% N=18,118 per group; P<.001

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Findings
		infection (mean)	
Al-Aly 2021[104] USA(Veterans)	ICU admission: 26%	150 days post-discharge (median)	Memory Problems: HR 1.42 (95%CI 1.23, 1.63) vs matched controls hospitalized with seasonal influenza; N>13,000 per group

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Only the composite measure (at least 1 cognitive complaint) is shown on Figure below
[c]Study enrolled fewer than 50 and is not included on Figure below

Figure 7. Self-reported Cognitive Symptoms



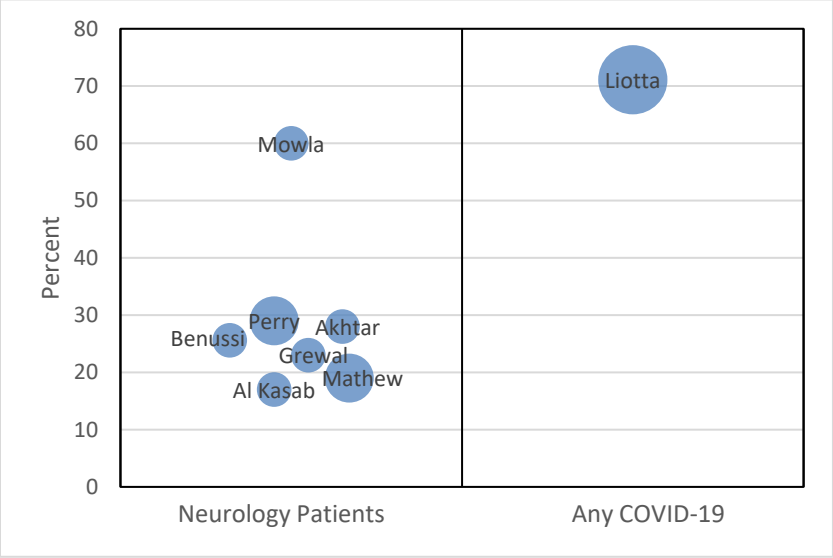
In addition to the studies in Tables 7 and 8, a study of patients who were admitted to home health care following hospitalization for COVID-19 reported that 23% (297/1302) required prompting and 6% (76/1302) required assistance and direction at the time of admission.[77] At discharge from home health care, the values were 10% (130/1302) and 3% (42/1302), respectively. This study also reported confusion in new and complex situations for 41% (536/1302) at admission and 19% (251/1302) at discharge.

Modified Rankin Scale

Eight studies reported modified Rankin Scale (mRS)(Modified Rankin Scale for Neurologic Disability - MDCalc) results at the time of hospital discharge (Figure 8, Table 9). Seven studies were in neurology patients, 6 of which enrolled patients hospitalized for neurological conditions and testing positive for COVID-19 (Table 9). All but 2 included non-COVID control groups.

Based on an mRS score of 0 to 2 being considered a good outcome – individuals are "able to look after their own affairs without assistance" – only 1 of the 7 studies of neurology patients reported that the majority had a good outcome at discharge.

Figure 8. Modified Rankin Scale (mRS) ≤2 ("Good Outcome") at Discharge



[a]Patients with stroke or other neurological manifestations; may have been hospitalized for neurological conditions and then tested positive for COVID-19 or hospitalized for COVID-19 with subsequent neurological diagnoses

LEGEND
Sample Size 0-50 51-100 >100

Table 9. Modified Rankin Scale (mRS) at Discharge – 'Good' Prognosis (Author, Year in bold indicates study with non-COVID comparator group)

Author, Year Country	Population	COVID-19 Severity[a]	'Good" Prognosis at Discharge
Akhtar, 2021[39] Qatar	Hospitalized for stroke	31% requiring mechanical ventilation	28% (9/32) Concurrent Non-COVID group: 52% (112/216) Pre-COVID era group: 60% (348/585) P=.001
Al Kasab, 2020[23] Multi-national	Mechanical thrombectomy post-stroke; symptomatic patients tested for COVID-19	39% requiring mechanical ventilation	17% (2/12) Concurrent Non-COVID group: 30% (94/316) P=.52
Benussi, 2020[25] Italy	Admitted for acute cerebrovascular disease and tested positive for COVID-19	NR	26% (11/43) Non-COVID group: 71% (48/68) P<.001
Grewal, 2020[31] USA	COVID admission followed by stroke (n=6) or stroke admission followed by positive for COVID-19 (n=7)	62% severe/critical	23% (3/13) Concurrent Non-COVID group: 53% (28/53) P=.047

Author, Year Country	Population	COVID-19 Severity[a]	'Good" Prognosis at Discharge
Liotta, 2020[33] USA	With and without neurological manifestations during hospitalization with COVID-19	26% severe	71% (363/509 With neurological manifestations 71% (299/419) No neurological manifestation: 70% (63/90)
Mathew, 2020[46] India	Hospitalized for stroke, testing positive for COVID-19	NR	19% (12/62)
Mowla, 2020[48] Multi-national	Hospitalized for stroke, testing positive for COVID-19	9% severe	60% (6/10) Historical control group: 77% (44/57) P=.26
Perry, 2020[53] United Kingdom	Hospitalized for stroke, testing positive for COVID-19	8% requiring mechanical ventilation	29% (estimated from plot) Concurrent non-COVID group: 46% (estimated from plot)

Abbreviations: NR=not reported
[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity

Another multi-nation study reported severe disability based on mRS scores in 51% (49 of 96 survivors).[36] The median [IQR] scores for the COVID-19 group and a propensity-matched group were 4 [2-6] and 2 [1-4], respectively (P<.001).

Neuromuscular Outcomes

Studies with Control Groups

Two large database studies from the US reported neuromuscular outcomes.[109,129] One reported a significantly greater odds of myopathies at 1 to 30 days post-discharge in the COVID-19 group versus the non-COVID-19 control group (OR 5.9 [95%CI 2.8, 12.4]).[109] The second study reported that 1.2% of patients (574/46,302) experienced myoneural junction or muscle disease in the 6 months following discharge.[129] This study did not include control group data for the hospitalized subgroup.

Studies without Control Groups

A smaller study from Europe reported polyneuropathy at 3 months post-discharge (not diagnosed before COVID-19) in 13% (17/135).[125]

RENAL OUTCOMES

Key Findings

The prevalence of, or risk for, new onset chronic kidney disease and acute kidney injury following hospitalization for COVID-19 was greater than in matched control groups (k=4). Need for renal replacement therapy (RRT) at discharge was reported in 4% to 34% of those who had required RRT during hospitalization (k=5).

Overview of Studies

Renal outcomes were reported by 18 studies (Appendix C, Tables 1 and 6): 10 from the US,[35,49,97,102,104,109,110,121,139,140] 4 from the UK,[57,83,106,124] and 1 each from Europe,[120] Brazil,[145] China,[85] and Japan.[47] Enrollments ranged from 37 to 28,335 with 10 including over 1000. Mean or median ages ranged from 50 to 71, with 38% to 94% male. Twelve studies reported race with 11% to 78% White, 5% to 40% Black, and 9% to 43% Hispanic. A history of chronic kidney disease was reported in 2% to 67% (10 studies) and hypertension in 5% to 89% (14 studies). Only 2 reported COVID-19 severity with 32% and 100% severe. Three studies enrolled only patients admitted to an ICU.

Chronic Kidney Disease (CKD)

Studies with Control Groups

CKD was reported in 3 large database studies.[104,106,110] In the study of US Veterans, the HR for a new diagnosis of CKD during the 6 months after acute infection in the COVID-19 group versus a seasonal influenza control group was 1.4 (95%CI 1.1, 1.7).[104] A second US study, with data from over 36,000 individuals, reported new diagnoses of CKD at 4 months after acute illness in 2.1% of the COVID-19 group and 0.7% of the non-COVID control group.[110] The third study, completed in the UK, with data from over 82,000 individuals, reported new onset CKD in 0.6% of the COVID-19 group and 0.3% of the general population control group at a mean of approximately 146 days post-discharge.[106]

Studies without Control Groups

Three smaller studies reported kidney dysfunction.[120,121,124] A study from France reported persistent alteration of kidney function at approximately 4 months post-discharge in 2% (2/95 who experienced AKI during hospitalization or 0.4% (2/478 overall).[120] Residual renal impairment (not present prior to COVID-19) was observed in 3% (2/58) at 2 to 3 months post-discharge in a study from the UK.[124] The third study, from the US, reported kidney dysfunction at 3-6 months post-discharge in 8% (15/182).[121] The study also reported a HR for kidney recovery by 3-6 months in those who hadn't achieved recovery by the time of hospital discharge (HR 0.6 [95%CI 0.35, 0.92], P=.02).

Acute Kidney Disease (AKD)

Five studies reported acute kidney disease.

Studies with Control Groups

Three database studies reported new diagnoses of acute kidney disease following discharge.[104,109,110] The study of over 27,000 US Veterans reported an adjusted hazard ratio (HR) for acute kidney injury during the 6 months following COVID-19 infection for the COVID-19 group versus a seasonal influenza control group (HR 1.2 (95%CI 1.1, 1.4)).[104] A second US study reported odds ratios (ORs) for acute and unspecified kidney failure versus a hospitalized non-COVID-19 control group.[109] The ORs decreased from 1.3 (95%CI 1.0, 1.6) at 30 days post-discharge to 0.6 (95%CI 0.4, 0.8) at 120 days post-discharge. The third study, also from the US, reported a new diagnosis of acute kidney injury during the 4 months after acute infection in 2.9%

of the COVID-19 group and 0.5% of the non-COVID control group.[110] The risk difference was 2.4 (95%CI 1.7, 3.1).

Studies without Control Groups

A study from the US reported acute kidney disease (AKD) at discharge in 25% (291/832).[102] Twenty-three percent were Stage 1, 6% Stage 2, and 6% Stage 3. AKD stages were defined according to Kidney Disease: Improving Global Outcomes (KDIGO) criteria based on creatinine (KI_SuppCover_2.1.indd (kdigo.org)). At a median follow-up of 21 days, data were available for n=77 with AKD at discharge. Of those, 36% (29/77) had recovered, 33% (25/77) were Stage 1, 13% (10/77) were Stage 2, and 18% (14/77) were Stage 3. Data were also available for n=135 who had recovered kidney function at discharge. Of those, 86% (116/135) remained recovered, 10% (14/135) had new Stage 1 AKD, 2% (3/135) had new Stage 2 AKD, and 2% (3/135) had new Stage 3 AKD.

A second study from the US reported on 3,854 individuals who developed acute kidney injury while hospitalized for COVID-19.[35] Among those who required RRT while hospitalized, 17% (108/638) survived. Of the survivors, 33% (36/108) had not recovered kidney function at the time of discharge. Authors reported that 58% (19/33) had underlying chronic kidney disease at hospital admission. Among those who did not require RRT while hospitalized, 52% (1663/3216) survived and 26% (430/1663) of those had not recovered kidney function.

Need for Renal Replacement Therapy (RRT)

Eight studies (none with a control group) reported the need for RRT (Table 10). Between 1% and 34% required RRT at the time of discharge. Two of the studies reported post-discharge data with 7% and 18% continuing to require RRT. Lack of pre-COVID RRT status limits conclusions.

Table 10. Need for Renal Replacement Therapy

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Renal Replacement
Doher, 2020[145] Brazil	ICU admission: 100%	Discharge	11% (1/9)
Gupta, 2020[139] US	ICU admission: 100%	Discharge 60 Days after ICU Admission	34% (73/216 discharged; required RRT during hospitalization) 18% (39/216 discharged; required RRT during hospitalization)
Hamilton, 2020[83] United Kingdom	ICU admission: 16%	Discharge	6% (2/32 who required RRT during hospitalization)
Hittesdorf, 2020[140] US	100% severe	Discharge 90 days after admission	4% (2/45 who required RRT during hospitalization) 7% (2/27 surviving at 90 days
Matsunaga 2020[47] Japan	32% severe	Discharge	1% (16/2,431)
Naar, 2020[49] US	ICU admission: 100%	Discharge	11% (5/46 who required RRT during hospitalization
Ng, 2020[35] US	ICU admission: 92%	Discharge	31% (33/108 who required RRT during hospitalization)

Author, Year Country	COVID-19 Severity[a]	Time of Assessment	Renal Replacement
Stevens, 2020[97] US	ICU admission: 100%	30 days (median) from RRT Initiation (in hospital)	8% (9/115) (NOTE: 2/9 had been discharged)

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity

Imaging Findings

A study from the UK reported an imaging finding at a median of 105 days post-COVID-19 diagnosis.[57] Impairment on kidney cortex T1 was observed in 5% (2/37) with normal findings in 95% (35/37). A study from China reported no abnormal kidney morphology (on ultrasound) at a median of 153 days post-discharge.[85]

ENDOCRINE OUTCOMES

Key Findings

Three large database studies, 1 from the US enrolling Veterans, reported greater risk of new onset diabetes following hospitalization for COVID-19 compared to matched control groups consisting of individuals either hospitalized for seasonal influenza, from the general population, or without COVID-19.

Overview of Studies

Three studies (2 from the US and 1 from the UK) reported endocrine outcomes (Appendix C, Table 7).[104,106,110] All were database studies with 13,654 to 28,335 COVID-19 patients. One study enrolled US Veterans. The mean age was 70 years; 94% were male, 58% were White and 34% were Black.[104] The other study from the US did not report demographic data for the subgroup of patients who were hospitalized for COVID-19.[110] In the study from the UK, 55% were male, 72% were White, 5% were Black, and 9% were Asian.[106] None of the studies reported the percentage with severe or critical COVID-19; between 10% and 25% were admitted to the ICU.

Diabetes

Studies with Control Groups

Three database studies, 2 from the US[104,110] and 1 from the UK,[106] reported the presence of diabetes (Appendix C, Table 1 and 7). One of the US studies, with data from over 27,000 Veterans, reported a greater risk for diabetes in the COVID-19 group than in a matched, seasonal influenza group (HR 1.6 [95%CI 1.36, 1.87]).[104] The findings were based on participants without a history of diabetes in the past year. At 6 months following COVID-19 infection, the excess burden per 1000 hospitalized COVID-19 patients was 21.4 (95%CI 15.1, 26.8). The second US study included over 36,000 hospitalized patients in COVID-19 and matched non-COVID-19 groups. Type 2 diabetes, through 4 months after acute illness, was reported in 3% of the COVID-19 group and 0.8% of the control group (risk difference 2.2% [95%CI 1.4, 3.2]).[110]

The UK study, with data from over 72,000 individuals (COVID-19 and a matched, general population control group) reported new onset diabetes, during a mean of approximately 146 days after discharge, in 1.1% (400/36,100) of the COVID-19 group and 0.3% (125/36,100) of the

control group.[106] The rates per 1000 person-years were 28.7 for the COVID-19 group and 8.2 for the control group.

GASTROINTESTINAL OUTCOMES

Key Findings

Large database studies identified an excess burden of incident gastrointestinal disorders in individuals hospitalized for COVID-19 compared to seasonal influenza and a higher incidence of new onset chronic liver disease in individuals hospitalized for COVID-19 compared to non-COVID controls.

Overview of Studies

Six studies reported gastrointestinal outcomes (Appendix C, Table 8) including 2 from the US,[104,110] 2 from the UK,[57,106] and 1 each from Europe[111] and China.[85] Sample sizes ranged from 37 to 28,335 COVID-19 patients; 4 of the 6 studies enrolled more than 1000 individuals. Mean or median age ranged from 50 to 70 years with 38% to 94% male. Three studies reported race with 58% to 76% White and 5% to 34% Black. None of the studies reported COVID-19 severity but between 4% and 42% were treated in the ICU (5 studies).

Gastrointestinal Disease

Studies with Control Groups

Two large database studies identified gastrointestinal disease using ICD-10 codes.[104,106] The study of Veterans identified incident gastrointestinal disorders (*eg,* dysphagia) in over 27,000 individuals hospitalized for either COVID-19 or the seasonal influenza (control group).[104] During 6 months follow-up starting 30 days after COVID-19 diagnosis, the excess burden per 1000 COVID-19 persons was 19.3 (95%CI 12.8, 25.1). The second study, from the UK, identified new onset chronic liver disease over a mean follow-up of 140 days among individuals hospitalized with COVID-19 (0.2% [70/46,395]) and the general population (0.04% [15/46,395]).[106] The difference was statistically significant (P<.001).

Liver Test Findings

Studies with Control Groups

In a US study with over 18,000 individuals in each group, new liver test abnormalities identified during 4 months following acute infection were reported in 3.3% of the COVID-19 group and 1.4% of the non-COVID-19 control group.[110] The risk difference was statistically significant (RD 1.95% [95%CI 1.06, 2.58]).

Studies without Control Groups

A smaller study from the Netherlands with 1.5 months follow-up reported elevated liver enzyme in 2% (2/81).[111]

Imaging Findings

Two studies reported liver imaging abnormalities (Appendix C, Tables 1 and 8). A UK study reported liver inflammation (cT1 in ms) was normal (<784 ms) in 76% (28/36 evaluated) and impaired (≥784 ms) in 24% (9/37) at a median of 105 days after COVID-19 diagnosis.[57] The study from China, reporting outcomes in 1733 patients at a median of 153 days post-discharge, observed no cases of abnormal liver morphology on ultrasound.[85]

HEMATOLOGIC OUTCOMES

Key Findings

Post-discharge VTE was reported in 0% to 14% (k=17). Bleeding events were rare. The prevalence of, or risk for, coagulation disorders was higher in COVID-19 groups than in control groups. Interpretation is limited by varying time points post-discharge (5 days to 153 days), little reporting on prophylactic anticoagulant use, and varying study inclusion criteria (*ie,* assessment of individuals with versus without signs or symptoms of VTE; follow-up of all patients via medical records, outpatient clinics, or telephone contact vs evaluation of patients with suspicion of VTE).

Overview of Studies

Eighteen studies reported hematologic outcomes defined as venous thromboembolism or bleeding events (Appendix C, Tables 1 and 9). Seven studies were from the US,[65,79,84,104,109,110,114] 4 were from the UK,[68,93,98,115] 3 from the Middle East,[24,75,92] 3 from Europe,[81,113,126] and 1 from China.[85] Sample sizes ranged from 9 to 27,284 COVID-19 patients, with 7 studies enrolling more than 1000. Mean or median ages of enrolled patients were 43 to 74 years and 48% to 94% were male. Only 3 studies reported race, with 37% to 58% White and 26% to 34% Black. Two studies from the Middle East enrolled only patients with severe or critical COVID-19 with 100% receiving treatment in the ICU.[24,75] No other studies specified COVID-19 severity but 4% to 42% were treated in the ICU (12 studies).

Thromboembolism

A study from Saudi Arabia reported the incidence of deep venous thrombosis (DVT) based on screening discharge ultrasound was 13% (8/64). All patients had been admitted to intensive care and received mechanical ventilation.[24] None had DVT signs or symptoms.

The other 17 studies reported VTE outcomes post-discharge (Table 11). Three studies included control groups.[104,109,110] Follow-up ranged from a mean of 5 days to a median of 153 days with VTE in 0% to 14.2%.

Table 11. Post-discharge Thromboembolism (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Anticoagulation at Discharge	Method of Assessment	Follow-up Time	Thromboembolism
Brosnahan, 2020[79]	NR	NR	Re-presented to study hospital or	5 days (mean time	Thrombotic event[b:] 0.46% (9/1,975)

Author, Year Country	COVID-19 Severity[a]	Anticoagulation at Discharge	Method of Assessment	Follow-up Time	Thromboembolism
US			ED with concern for a thrombotic event	to re-presenting)	
Hill, 2020[84] US	Mechanical ventilation: 52%	No routine post-discharge VTE prophylaxis	Medical records	21 days post-discharge (median)	VTE:0.14% (3/2,075)
Vlachou, 2021[98] United Kingdom	NR	100% “severe” (not defined)	Admissions post-discharge	28 days post-discharge	PE:1% (4/370 enrolled)[d]
Hall, 2021[115] United Kingdom	ICU admission: 39%	NR	Follow-up clinic with x-ray and other tests as indicated	28-42 days post-discharge	PE: 2% (4/200)
Patell, 2020[65] US	ICU admission: 26%	0% (excluded from primary analysis)	Medical records (at least 1 post-discharge contact)	30 days post-discharge	PE, intracardiac thrombus, thrombosed arteriovenous fistula, ischemic stroke (1 each): 2.5% (4/163)
Eswaran, 2021[114] US	ICU admission: 39%	43%	Medical records with manual validation	30 days post-discharge	PE: 1% (4/447) Total Events: 2% (9/447)
Chevinsky, 2021[109] USA	ICU admission: 40%	NR	Medical records	Post-discharge 30 days 60 days 90 days 120 days	Acute PE (vs non-COVID controls) OR 1.5 (95%CI 1.0, 2.1) OR 1.4 (95%CI 0.9, 2.1) OR 1.2 (95%CI 0.7, 1.0) OR 1.2 (95%CI 0.7, 2.1)
Roberts, 2020[68] United Kingdom	ICU admission: 11%	0% (thrombo-prophylaxis withdrawn on hospital discharge)	Imaging if suspicion of VTE on re-presentation or primary care referral	42 days post-discharge (median)	VTE: 0.48% (9/1,877) Comparison cohort 0.31% (56/18,159) OR 1.6 (95%CI 0.77, 3.1)
Salisbury, 2020[93] United Kingdom	ICU admission: 16%	0%[a]	Medical records	42 days post-discharge	VTE: 3% (4/152)[c]
Daher, 2020[81] Germany	Mechanical ventilation: 0%	None	Outpatient pulmonary clinic	42 days post-discharge (median)	Thromboembolic event: 0% (0/33)

Author, Year Country	COVID-19 Severity[a]	Anticoagulation at Discharge	Method of Assessment	Follow-up Time	Thromboembolism
Engelen, 2021 Belgium	ICU admission: 39%	28%	Follow-up clinic with DVT screen (ultrasound); further testing if high-risk	42 days post-discharge	DVT: 1% (1/146) PE: 1% (1/146)
Rashidi, 2020[92] Iran	ICU admission: 8%	NR	Telephone follow-up with in-person evaluation of patients reporting symptoms and documentation from patients already evaluated	45-55 days post-discharge	PE: 0.2% (3/1,529)
Alharthy, 2020[75] Saudi Arabia	ICU admission: 100%; "Severe" COVID-19	NR	All surviving patients assessed at 2 and 4 months; 49% were symptomatic at 4 months	60 days 120 days	DVT: 60 days: 14.2% (18/127) 120 days: 7.1% (9/127)
Daugherty, 2021[110] US	ICU admission: 13%	NR	Medical records	120 days post infection (mean)	DVT: COVID-19: 2.3% Control: 0.3% PE: COVID-19: 1.3% Control: 0.1%
Remy-Jardin, 2021[126] France	ICU admission: 42%	NR	Patients with residual respiratory symptoms and/or chest x-ray abnormalities who had dual-energy CT exam	144 days post-discharge (median)	PE: 2% (1/55)
Al-Aly, 2021[104] US (Veterans)	ICU admission: 26%	NR	Medical records	150 days post-discharge (median)	PE: Excess burden per 1000 COVID-persons vs seasonal influenza control group 18.31 (95%CI 15.8, 20.3) Thromboembolism: HR vs seasonal influenza group 2.3 (95%CI 1.9, 2.6)
Huang C, 2021[85] China	ICU admission: 4%	NR	21% randomly selected for US and CT post-discharge; 76% of those selected were evaluated	153 days post-discharge (median)	DVT or lower limbs (US): 0% (NOTE: post-discharge PE was an exclusion criteria [n=1])

Abbreviations: ICU=intensive care unit; NR=not reported; OR=odds ratio; VTE=venous thromboembolism

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]DVT, PE, limb ischemia due to coronary thrombosis, acute stroke, rapidly evolving hemodynamic instability with elevated D-dimer at time of presentation
[c]Subgroup of patients discharged without an indication for therapeutic anticoagulation and followed for 42 days although 5 (3%) received 7 days of standard dose low molecular weight heparin after a change in local COVID-19 guidelines
[d]Number discharged alive not reported

Bleeding Events

Three studies, none with control groups, reported bleeding events.[65,93,113] In a study from the US, at a median of 27 days post-discharge, 3.7% (6/163) experienced hemorrhagic events.[65] Two were considered 'major bleeds'; both followed falls. Four were considered 'clinically relevant non-major bleeding'. The patients experiencing thrombotic or hemorrhagic events had been discharged without anticoagulant therapy; among 13 patients discharged on thromboprophylaxis, there were no observed thrombotic or hemorrhagic complications. A study from Belgium reported no bleeding events at 6 weeks post-discharge regardless of thromboprophylaxis status[113] and a study from the UK reported no bleeding events at 6 weeks in the subgroup of patients discharged without an indication for therapeutic anticoagulation.[93]

Coagulation Disorders

Studies with Control Groups

Three database studies reported coagulations disorders.[104,109,110] The study of over 27,000 US Veterans reported an excess burden per 1000 COVID-19 persons at 6 months following COVID-19 infection of 14.3 (95%CI 10.1, 17.9) compared to a seasonal influenza control group.[104] Another US study, with data from over 36,000 individuals, reported a higher risk of hypercoagulability in the COVID-19 group (3.2%) than in a non-COVID control group (0.4%) during the 4 months after acute illness.[110] The risk difference was 2.8 (95%CI 2.3, 3.6) (P<.001). The third study, also from the US and including data from over 54,000 individuals, reported odds ratios (COVID-19 vs hospitalized non-COVID-19 patients) for coagulation and hemorrhagic disorders.[109] The ORs at 30, 60, 90, and 120 days were 1.3 (95%CI 1.0, 1.6), 1.3 (95%CI 0.95, 1.7), 0.65 (95%CI 0.5, 0.9), and 0.66 (95%CI 0.5, 0.97), respectively.

HEALTHCARE/RESOURCE UTILIZATION OUTCOMES

Key Findings

Frequently reported outcomes included discharge to a location other than home (3% to 47%, k=15) and all-cause hospital readmission (0% to 15%; k=20); 2-14% were readmitted within 30 days of discharge (k=11) and 0-15% at greater than 30 days (k=9). COVID-19-related readmissions were reported in 4-10% at follow-up periods of 5 to 90 days.

Few studies reported post-discharge oxygen or follow-up healthcare requirements.

Overview of Studies

Forty-seven studies – 25 from the US, 8 from Europe, 6 from the UK, 3 from China, 2 from Iran, and 1 each from the Democratic Republic of the Congo, Japan, and multiple nations – reported measures of healthcare and/or resource utilization (Appendix C, Tables 1 and 10).[26,28,31,32,37,38,40-

[44,47,50-52,54,56,58,59,64,65,67,69-72,76-78,80-83,85-87,89,90,112,127,128,136-138,142,143,146] Sample sizes ranged from 7 to 15,111 with 16 studies enrolling more than 1000 and 10 studies enrolling 100 or fewer. Mean or median ages ranged from 35 to 82. Between 0% and 94% were male. Race was reported in 28 studies with 5% to 90% White, 0% to 90% Black, 4% to 46% Hispanic, and 0% to 15% Asian. Diabetes was the most frequently reported comorbidity (42 studies), present in 2% to 71% of the study populations. COVID-19 severity was reported in 10 studies with 19% to 100% severe or critical. Between 1% and 100% were treated in the ICU (37 studies).

Discharge Disposition

Twenty-four studies reported on discharge disposition.[26,28,31,32,37,38,40-44,47,50-52,54,67,71,80,87,136-138,146] One included a control group.[28] As noted in the Methods, for the September 2021 version of the report we focused on post-discharge outcomes and therefore the findings from the June 2021 remain unchanged.

Five studies enrolled patients with stroke or neurological conditions and 4 enrolled other, specific populations are described below. Findings from the remaining studies are reported in Table 12. Studies reporting discharge other than to home are depicted in Figure 9.

Figure 9. Discharge Other Than Home

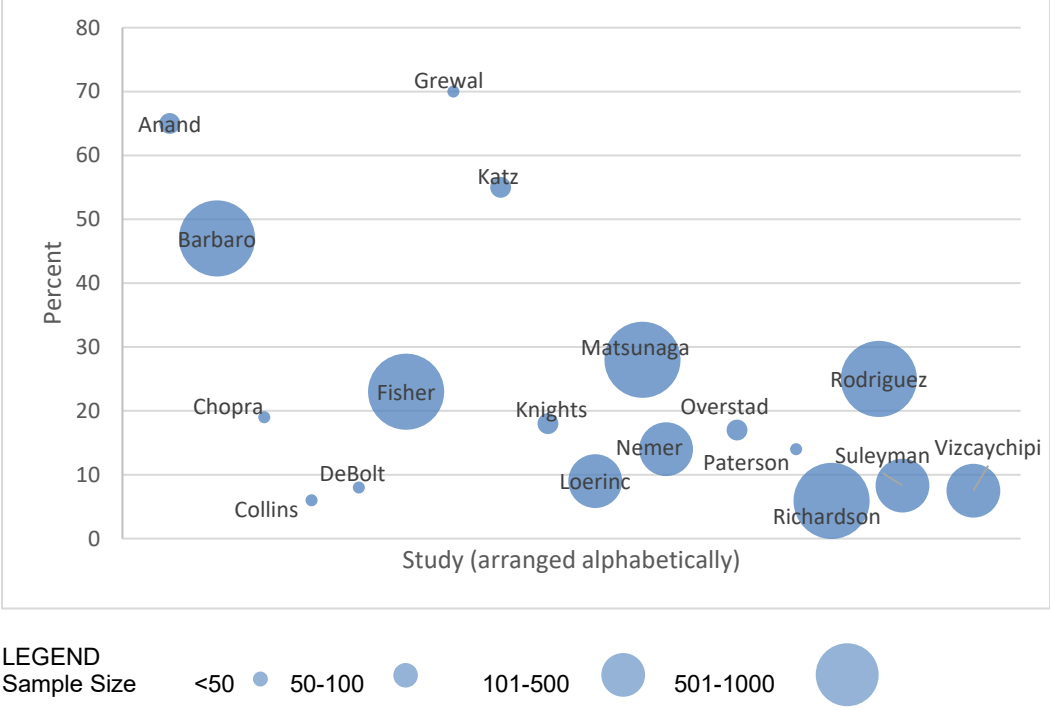


Table 12. Discharge Disposition (Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Home	Other Disposition
Atalla, 2020[136] USA	ICU admission: 33%	74% (14/19)[b] Home: 11; Hotel for Homeless with COVID-19: 3	Skilled nursing facility: 26% (5/19)[b]
Barbaro, 2020[41] Multi-national	ECMO support: 100%	Home or acute rehabilitation center: 53% (311/588)	Long-term acute care center or unspecified: 17% (101/588) Another hospital: 30% (176/588)
Chopra, 2020[80] USA	ICU admission: 13%	81% (13/16)	Nursing facility (permanent residence): 6% (1/16) Hotel for those with confirmed COVID-19: 13% (2/16)
Fisher, 2020[28] USA	ICU admission: 13%	77% (1,650/2,142) COVID-19 negative control group: 83% (788/950)	Nursing home: 23% (492/2142) COVID-19 negative control group: 17% (162/950)
Knights, 2020[137] United Kingdom	Invasive mechanical ventilation: 8%	81% (56/69)	Care home: 14% (10/69) Other not specified: 5% (3/69)
Loerinc, 2020[87] USA	ICU admission: 22%	91% (281/310)	Skilled nursing facility: 8% (25/310) Public health quarantine facility: 1% (4/310)
Matsunaga, 2020[47] Japan	32% severe	72% (1,762/2,437)	Long-term care facility: 2% (44/2,437) Another hospital: 18% (437/2,437) Non-medical (isolation) facility: 8% (194/2,437)
Nachega, 2020[50] Democratic Republic of the Congo	25% severe or critical	97% (645/665)	Home care: 3% (20/665)
Nemer, 2021[51] USA	ICU admission: 14%	85% (278/328)	Subacute facility: 12% (40/328) Hospice: 2% (8/328)
Overstad, 2020[52] Norway	19% critically ill	83% (52/63) ICU patients: 63% (5/8) Ward patients: 89% (49/55)	24-hour care: 17% (11/63) ICU patients: 38% (3/8) Ward patients: 13% (7/55)
Richardson, 2020[67] USA	ICU admission: 4%	94% (1,959/2,081)	Facility (*eg,* nursing home, rehabilitation): 6% (122/2,081)
Rodriguez, 2020[54] USA	ICU admission: 29%	74% (4,746/6,421)	Nursing facility: 17% (1,097/6,421) Another hospital: 5% (317/6,421) Hospice: 3% (192/6,421)
Suleyman, 2020[138] USA	ICU admission: 40%	92% (232/253) ICU patients: 79% (49/62) General practice unit: 96% (183/191)	Rehabilitation center: 8% (21/253) ICU patients: 21% (13/62) General practice unit: 4% (8/191)

Author, Year Country	COVID-19 Severity[a]	Home	Other Disposition
Vizcaychipi, 2020[38] United Kingdom	ICU admission: 14%	92.5% (614/664)	Temporary home: 2% (16/664) Residential care home: 5% (34/664)
Wang, 2020[71] China	53% severe	87% (114/131)	Community quarantine: 9% (12/131) Designated hospital: 4% (5/131)

Abbreviation: ECMO=extracorporeal membrane oxygenation
[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Discharge disposition for 19 patients readmitted at a median of 5 days post-discharge
[c]Pregnant women admitted to hospital for COVID-19

Patients with Stroke or Neurological Conditions

Five studies enrolled patients with stroke or other neurological conditions.[31,32,37,40,146] Four studies were from the US.

Studies with Control Groups

A US study of stroke patients (some had stroke onset during COVID-19 hospitalization and some had COVID-19 onset within 14 days of stroke onset) reported that 45% (25/56 discharged) were discharged home and 55% (31/56) to rehabilitation.[32] An additional 30 patients had died or were in hospice care (data not reported separately for deaths and hospice). In a comparison group of non-COVID-19 stroke patients, 52% (228/438 discharged) were discharged home and 48% (210/438) to rehabilitation. An additional 61 patients had died or were in hospice care.[32]

Another US study of patients with ICD-10 codes at discharge for ischemic stroke and COVID-19 reported a favorable discharge (home or acute rehabilitation) for 34% (707/2086).[146] The same outcome was reported for 66% (110,546/166,586) of a historical control group.

Studies without Control Groups

One US study of patients who experienced a stroke reported that 30% (3/10) were discharged home (including 2 of 6 hospitalized for COVID-19 who subsequently experienced a stroke ['COVID'] and 1 of 4 hospitalized for stroke symptoms who subsequently tested positive for COVID-19 ['Neuro']), 50% (5/10) were discharged to acute rehabilitation (3 of 6 in 'COVID' group, 2 of 4 in 'Neuro' group), and 20% (2/10) were discharged to long-term acute care (1 of 6 in "COVID' group and 1 of 4 in 'Neuro' group).[31] Another US study enrolled patients who received a neurologic or neurocritical care admission or consultation.[40] Of the 64 patients discharged, 34% (22/64) went home without services, 32% (20/64) went to a skilled nursing facility, 14% (9/64) went to acute rehabilitation, 8% (5/64) when home with services, 6% (4/64) were in inpatient hospice, 5% (3/64) were in a long-term acute care hospital, and 2% (1/64) was home with hospice. A study from the United Kingdom, reported that, of COVID-19 neurological patients discharged, 56% (9/16) went home and 31% (5/16) went to a rehabilitation or stroke unit; the location of 13% (2/16) was not reported.[37]

Other Populations

Studies with Control Groups

A US study of pregnant women admitted for severe or critical COVID-19 reported that 92% (35/38) were discharged home without oxygen required and 8% (3/38) were discharged to either a skilled nursing facility, long-term acute care, or home with oxygen required.[43] In a comparison group of non-pregnant women with severe or critical COVID-19, 85% (77/91) were discharged home without oxygen required and 15% (14/91 to another facility or home with oxygen required.

Another US study enrolled patients with a history of heart failure.[42] Among patients with COVID-19, 7% (428/6,357) were discharge to hospice and 41% (2,605/6,357) to skilled nursing or rehabilitative care. In a comparison group of non-COVID patients, 4% (4,068/95,556) were discharged to hospice and 21% (20,352/95,556) to skilled nursing or rehabilitative care.

Studies without Control Groups

One US study enrolled 20 patients with HIV who were hospitalized for COVID-19; 4 patients (20%) were from a VA Medical Center.[26] Of patients discharged, 81% (13/16) were discharged home, 6% (1/16) to a nursing facility (permanent residence), and 13% (2/16) to a hotel for those with confirmed COVID-19. Five of the 20 patients enrolled had been living in a group living situation prior to hospitalization (3 in nursing homes, 1 incarcerated, and 1 in a substance abuse recovery home).

Patients with COVID-19 and Takotsubu cardiomyopathy were included in a study from the US.[44] Three of 7 patients were discharged alive, 1 (33%) to a skilled nursing facility, and 2 (67%) to long-term acute care.

Hospital Readmission

Hospital readmission for any reason was reported by 22 studies.[56,58,59,64,65,67,69-71,77,78,80,83,86,87,89,90,136-138,142,143] For the current version of the report, we focused only on readmission related to COVID-19 and identified 3 additional studies.[112,127,128]

One study from the US enrolled individuals who were hospitalized for a hip fracture and tested positive for COVID-19 either before, during, or after (*ie,* during rehabilitation) hospitalization.[58] Twenty-nine percent had been admitted to the ICU. Within 30 days of follow-up, 12% (2/17) of the COVID-19 confirmed positive patients, 7% (1/14) of the COVID-19 suspected positive patients, and 3% (3/107) of the COVID-19 confirmed negative patients were readmitted.

The remaining studies are summarized in Table 13. One study included a control group.[78]

Table 13. Hospital Readmission (shaded rows indicate studies added for September 2021 update; Author, Year in bold indicates study with comparator group)

Author, Year Country	COVID-19 Severity[a]	Length of Follow-up	Readmission
Richardson, 2020[67] USA	ICU admission: 4%	3 days (median to readmission)	2% (45/2,081)

Author, Year Country	COVID-19 Severity[a]	Length of Follow-up	Readmission
Atalla, 2020[136] USA	ICU admission: 33%	5 days (median to readmission)	6% (19/339) (15 likely COVID-19 related)
Parra, 2020[90] Spain	ICU admission: 5%	6 days (median to readmission)	4% (61/1,368)
Wang, 2020[71] China	23% severe	7-14 days	4% (5/131)
Somani, 2020[70] USA	ICU admission: 19%	14 days	2% (56/2,864)
Brendish, 2020[78] United Kingdom	ICU admission: 10%	30 days	11% (30/352) COVID-19 negative control group: 18% (105/702)
Hamilton, 2020[83] United Kingdom	ICU admission: 16%	30 days	8% (86/1,032)
Loerinc, 2020[87] USA	ICU admission: 22%	30 days	5% (16/310) (69% [11/16] attributed to COVID-19)
Monday, 2020[89] USA(Veterans)	ICU admission: 34%	30 days (from admission)	14% (8/57)
Patell, 2020[65] USA	ICU admission: 26%	30 days	7% (12/163)
Suleyman, 2020[138] USA	ICU admission: 40%	30 days	11% (29/253) ICU: 3% (2/62) General practice unit: 14% (27/191)
Bowles, 2020[77] USA	NR	32 days (mean)	10% (137/1,409) while in home health care
Knights, 2020[137] United Kingdom	Invasive mechanical ventilation: 8%	36 days (median) (from admission)	5% (3/56)
Casas-Rojo, 2020[56] Spain	ICU admission: 8%	40 days (median)	5% (573/11,928)
De Michieli, 2021[112] USA	ICU admission: 28%	49 days (median)	10% (30/312) COVID-19 related
Chopra, 2020[80] USA	ICU admission: 13%	60 days	15% (189/1,250)
Spinicci, 2021[127] Italy	12% severe, 47% critical	60 days (median)	10% (10/100) COVID-19 related (5 for cardiac disease, 2 for infectious disease, 2 for neurologic disorders, 1 for respiratory symptoms)
Khalili, 2020[86] Iran	Invasive mechanical ventilation: 11%	90 days (from initial admission)	4% (10/254)
Nersesjan, 2021[142] Denmark	ICU admission: 47%	90 days	38% (17/45)[b]
Suarez-Robles, 2021[128] France	ICU admission: 1%	90 days	5% (7/134) for bacterial respiratory infection, pulmonary thromboembolism, exacerbated COPD
Dawson, 2020[143] United Kingdom	ICU admission: 49%	NR	0% (0/208)

Author, Year Country	COVID-19 Severity[a]	Length of Follow-up	Readmission
El Moheb, 2020[59] USA	ICU admission: 100% (inclusion criteria)	NR	11% (10/92) Matched COVID-19 negative:11% (10/92)
Lovinsky-Desir, 2020[64] USA	Invasive mechanical ventilation: 21%	NR	5% (40/832) in 40-65 age group without asthma 5% (5/111) in 40-65 age group with asthma
Sachdeva, 2020[69] USA	ICU admission: 27%	NR	9% (1/9)

[a]Severity (%) as defined by study authors; if severity not reported, maximum oxygen requirements or ICU admission used as markers of severity
[b]Patients were discharged to a tertiary referral center following hospitalization

Post-discharge Treatment

Oxygen Therapy

Use of oxygen therapy was reported in 9 studies. A US study of Veterans reported home oxygen was required in 39% (22/57).[89] Follow-up was 30 days. New home oxygen therapy was required for 13% (41/310) of patients in another US study (30 day follow-up).[87] A third US study reported 7% (32/488) required oxygen at home and 7% (34/488) required new use of CPAP or other assistance when sleeping.[80] Follow-up was 60 days.

A study from China reported that 6% (5/85) were receiving oxygen therapy via nasal cannula at home (time post-discharge not specified).[72] Wang et al, also from China, reported that at 1-2 weeks after discharge 7% (9/131) were treated with oxygen therapy.[71] At 3-4 weeks, the percentage decreased to 1% (1/131). Corticosteroid use was 4% (5/131) at 1-2 weeks and 2% (2/131) at 3-4 weeks. A study from Japan reported that 8% (182/2,430) required oxygen therapy at discharge.[47] A study from Germany reported that 82% (27/33) of patients required oxygen therapy at admission; at 6 week follow-up, only 1 patient required oxygen therapy.[81] Two additional studies from Europe reported oxygen therapy at 2 months for 5% (5/100)[127] and at 3 months for 3%.[128]

Post-acute Care

A US study reported need for post-acute rehabilitation in patients undergoing surgery for hip fracture.[58] Ninety percent (9/17) of the COVID-19 group was receiving rehabilitation compared with 78.3% (83/107) of patients negative for COVID-19. The difference was not statistically significant (P=.61). Another US study reported the need for physical or occupational therapy in 14% (42/310) and home nursing service in 5% (16/310).[87] Follow-up in both studies was 30 days.

Several studies reported on self-care ability post-discharge. In a study from Iran, where 18% of patients were admitted to the ICU, 88% (370/420) reported no problems with self-care at a mean of 22 days post-discharge.[76] A study from China reported that 1% (11/1,622) had personal care problems; median follow-up was 153 days.[85] Among patients from a study in Japan, 32% with severe COVID-19, 84% (2,045/2,4245) rated their self-care ability at the time of discharge the

same as before COVID-19, 10% (237/2,425) rated it worsened, and 4% (106/2,425) rated it improved.[47]

Follow-up health care was also reported in several studies. "Need for follow-up" was reported for 60% (75/126) of patients enrolled in a study from Italy.[82] Need was determined based on elevated respiratory rate, uncontrolled blood pressure, moderate to very severe dyspnea, malnutrition, or new onset cognitive impairment. Recommended follow-up care was identified in a study from the US.[87] Primary care appointments were recommended for 83% (258/310) and specialist appointments (including nephrology and cardiology) for 28% (90/310). Follow-up bloodwork was ordered for 10% (31/310) and follow-up radiology for 7% (21/310). A study from the US reported primary care follow-up within 60 days of discharge for 78% (382/488) of patients who completed a follow-up telephone survey.[80] Total enrollment was 1,250. As with most other outcomes, the lack of controls hospitalized without COVID-19 limits conclusions.

A study from the US reported new short-term medications were required by 67% (207/310) of patients with an average of 2.2 new prescriptions per patient.[87] New long-term medications were required for 23% (72/310) with an average of 1.6 new prescriptions per patient.

In a study from the United Kingdom, new "packages of care" were required for 2.9% (2/69) of patients discharged and an increase in mobility aids was noted for 11.6% (8/69).[137]

DISCUSSION

Our review identified 124 reports of post-acute major organ damage or healthcare/service use outcomes in patients who were hospitalized with or for COVID-19. Thirty-three studies were from the US including 2 studies exclusively of Veterans and 1 multisite US study that included patients from a VA Medical Center. The amount of data is increasing rapidly. We provide "Key Findings", "Limitations", and "Suggestions for Future Research".

KEY FINDINGS

Key Question 1

Recent evidence includes 4 large database studies, 2 from the US including 1 study of US Veterans, identifying post-hospitalization, incident respiratory, cardiac, neuromuscular, endocrine, renal, gastrointestinal, and hematologic disease in COVID-19 and control groups. However, the majority of studies enroll convenience samples without controls, providing wide-ranging prevalence estimates based mainly on physiologic data. Outcomes associated with COVID-19 variants are unknown.

Available evidence suggests:

- In studies with control groups, incident respiratory disease may be higher in post-hospitalization COVID-19 cases (k=3). Prevalences ranged from 2% to 22% in COVID-19 groups compared to less than 1% in control groups. Dyspnea was more prevalent (64% vs 10%) or Veterans were at greater risk for dyspnea (HR 1.14 [95%CI 1.04, 1.26]) in COVID-19 groups than in control groups. Other reported pulmonary outcomes included radiographically defined fibrosis at varying time intervals (k=12, none with

control groups) with estimates ranging from 0% to 61% of enrolled patients, abnormal diffusing capacity of the lung for carbon monoxide (DLCO) in 16% to 57% (k=15, none with control groups), and dyspnea present at >1 month post-discharge in 2 to 81% (k=26, including 2 with control groups noted above). Interpretation of the findings is limited by varying degrees of COVID-19 severity and different outcome definitions, assessment methods, sampling strategies, and follow-up lengths.

- In studies with control groups, patients with COVID-19 were at greater risk for post-discharge incident cardiovascular disease outcomes (including acute myocardial infraction, coronary disease, heart failure) compared to controls. Prevalences of new cardiovascular events ranged from approximately 1 to 3% of the COVID-19 groups and less than 1% in the control groups (k=3). Myocardial inflammation/fibrosis was more prevalent in COVID-19 patients than controls (k=3). Pericardial effusion was reported in 0% to 20% (k=6). Impairment in left ventricular ejection fraction (LVEF) was noted in 0-22% (k=8).

- The prevalence, or risk for, stroke was higher in COVID-19 groups than in matched control groups (k=2). The incidence of dementia or Alzheimer's post-COVID-19 was low but may exceed that of non-COVID cases. In 5 studies using established cognitive function assessment tools with specified thresholds, cognitive impairment was observed in 23% to 57%. One of the studies included a community-based control group and reported no statistically significant difference between the COVID-19 and control groups. Cognitive symptoms including attention deficits, confusion, and memory difficulty were reported in 5% to 34% of COVID-19 patients (k=9). Findings are limited by lack of assessment of cognition prior to hospitalization for COVID-19. A "good" prognosis based on modified Rankin Scale scores at the time of discharge was reported in 17% to 60% of patients hospitalized for stroke and testing positive for COVID-19 (k=6).

- The prevalence of, or risk for, new onset chronic kidney disease and acute kidney injury following hospitalization for COVID-19 was greater than in matched control groups (k=4). Need for renal replacement therapy (RRT) at discharge was reported in 4% to 34% of those who had required RRT during hospitalization (k=5).

- Three large database studies, 1 from the US enrolling Veterans, reported greater risk of new onset diabetes following hospitalization for COVID-19 compared to matched control groups consisting of individuals either hospitalized for seasonal influenza, from the general population, or without COVID-19.

- Large database studies identified an excess burden of incident gastrointestinal disorders in individuals hospitalized for COVID-19 compared to seasonal influenza and a higher incidence of new onset chronic liver disease in individuals hospitalized for COVID-19 compared to non-COVID controls.

- Post-discharge VTE was reported in 0% to 14% (k=17). Bleeding events were rare. The prevalence of, or risk for, coagulation disorders was higher in COVID-19 groups than in control groups. Interpretation is limited by varying time points post-discharge (5 days to 153 days), little reporting on prophylactic anticoagulant use, and varying study inclusion

criteria (*ie,* assessment of individuals with versus without signs or symptoms of VTE; follow-up of all patients via medical records, outpatient clinics, or telephone contact vs evaluation of patients with suspicion of VTE).

Key Question 2

We are unable to determine if post-acute care prevalence of major organ damage varies by patient characteristics (*eg,* age, sex, race/ethnicity, pre-existing comorbidities/frailty, type of residence), COVID-19 disease severity, or other factors (*eg,* vaccine status, treatment for COVID-19). Few studies reported outcomes for subgroups of patients.

Key Question 3

Frequently reported outcomes included discharge to a location other than home (3% to 47%, k=15) and all-cause hospital readmission (0% to 15%; k=20); 2-14% were readmitted within 30 days of discharge (k=11) and 0-15% at greater than 30 days (k=9). COVID-19 related readmissions were reported in 4-10% at follow-up periods of 5 to 90 days. Few studies reported post-discharge oxygen or follow-up health care requirements including post-hospital need for ambulatory care, imaging or laboratory monitoring needed, or treatments (*ie,* medications, devices, procedures, surgery) required.

LIMITATIONS

Additional limitations of the available evidence include:

- Although recent evidence includes 4 database studies with control groups, most available data are from studies of small, convenience samples (often from a single hospital site) with poorly described study populations or measures of major organ damage.
- Most studies were not conducted in the US and only 2, one reporting major organ damage and the other reporting readmission and need for home oxygen, enrolled exclusively Veterans.
- Reported prevalence rates are likely highly dependent on pre-existent demographics and comorbidities of the study population, COVID-19 disease severity, the measures used to assess and define major organ damage, and the timing of assessment relative to hospital discharge.
- Many studies assessed outcomes at discharge or had short follow-up post-discharge; long-term major organ damage prevalence and healthcare/service use needs are unknown.
- There are no data reporting on outcomes based on patient living situation prior to COVID-19 infection (*ie*, community dwelling versus nursing home or assisted care centers)
- No data exist to ascertain if outcomes differ based on COVID-19 vaccination status or with infection with different COVID-19 variants.

Limitations of our review methods include:

- We defined "post-acute COVID" as patients being post-hospital discharge. The applicability of these findings to non-hospitalized patients with acute COVID symptoms is unknown; this was out of our scope.

- Our literature search was through May 2021 and would not have included information published after that date.

FUTURE RESEARCH

Given the gaps in, and limitations of, the existing evidence,[148] the following may serve as a guide for future research to better inform healthcare systems as they plan for on-going care of patients recovering from COVID-19.[149]

Population

We chose to define "post-acute" as post-hospitalization but other definitions may be appropriate.[3,148] For example, patients with acute COVID-19 who are not hospitalized may have "post-acute" major organ damage. Limiting the scope of this review to patients hospitalized for acute COVID likely underestimates the total burden of post-acute major organ damage. This should be acknowledged for resource allocation planning in the future. Furthermore, we did not identify studies that assessed "long-haulers" or "long COVID" (*ie,* people who have either recovered from COVID-19 but still report lasting effects or who have had the usual symptoms for longer than might be expected).[150] This is a poorly defined entity and no published data were available. Additionally, there are likely important difference in patients hospitalized *for* COVID-19 versus patients hospitalized for another indication who have a positive COVID-19 test. We chose to include both, since given the protean manifestations of COVID-19 illness, it is often hard to clinically differentiate the two, but this could influence prevalence, severity, and causality of findings. We also limited eligibility to studies that assessed patients with "confirmed" COVID-19. While this increases the specificity and accuracy of our review it likely underestimates the magnitude of burden of post-acute.

Future studies should include all patients or consecutive patients rather than convenience samples. Study populations should be carefully described including severity of disease and treatments received. Results should be reported for subgroups based on age, gender, race/ethnicity, pre-existing conditions/frailty, vaccine status, type of residence (*eg,* independent living, assisted living, nursing home), COVID-19 severity, COVID-19 variant, and treatment received. Ideally, researchers would be able to link pre-COVID-19 data with post-COVID-19 data. Without pre- and post- data, it is difficult to isolate the effects of COVID-19.

Comparator

The use of matched non-COVID-19 control groups, ideally hospitalized for a non-COVID-19 respiratory illness such as influenza or RSV, would allow for a better understanding of the effects of COVID-19. Without appropriate comparators and information on pre-COVID comorbidities it is not possible to accurately determine the effect that COVID-19 has on post-discharge health outcomes. Nonetheless, given ongoing health and healthcare concerns associated with COVID-19, uncontrolled reports among patients with COVID-19 are still informative for care planning.

Outcomes

Many studies, excluded from our review, reported mean and median values of laboratory, radiologic, or physiologic measures. These data do not provide prevalence outcomes. Future research should include measures that will reflect prevalence of major organ damage or disease based on accepted definitions of disease, even if defined as asymptomatic laboratory, radiologic, or physiologic measures. Although many conditions have been reported to be associated with COVID-19 while patients are hospitalized, there has been little or no published post-hospital data for most of those conditions. Many reports were convenience samples and used testing measures available at that facility or selected for reporting for unclear reasons. Criteria for outcome assessment, reporting and definition will have important implications on major organ damage prevalence and severity.

Timing

Future research would ideally link pre-COVID-19 patient comorbidities to status at discharge and include standardized and longer follow-up to identify persistence of COVID-related conditions.

Setting

Information on major organ damage prevalence and healthcare/service use needs of non-hospitalized patients is also needed.

ONGOING DATA COLLECTION

We are aware of several ongoing studies:

- A study of COVID-19 sequelae among Veterans treated in the VA (https://www.hsrd.research.va.gov/research/abstracts.cfm?Project_ID=2141707422),
- A natural history study of COVID-19 titled "Epidemiology, Immunology and Clinical Characteristics of Emerging Infectious Diseases with Pandemic Potential" (EPICC-EID); a collaboration between the VA and the Department of Defense to better understand the clinical course of COVID-19 (https://www.research.va.gov/covid-19.cfm),
- A study sponsored by UK-based Perspectum Diagnostics (https://www.bioworld.com/articles/434620-perspectum-launches-study-of-post-covid-19-organ-damage),
- The Post-hospital COVID (PHOSP-COVID) study,[150]
- A multicenter observational registry, the North American COVID-19 ST-Segment-Elevation Myocardial Infarction (NACMI) registry, to collect data on ST elevation in COVID-19 patients to determine the etiology and associated clinical outcomes,[151]
- An initiative from the NIH: Post-Acute Sequelae of SARS-CoV-2 infection (PASC) (NIH launches new initiative to study "Long COVID" | National Institutes of Health (NIH)).

- The Johns Hopkins COVID Long Study (Johns Hopkins COVID Long Study (covid-long.com).

- The Collaborative Cohort of Cohorts for COVID-19 Research (C4R) Study (https://www.cuimc.columbia.edu/news/nationwide-study-covid-19-risk-and-long-term-effects-underway-37-academic-medical-centers); a nationwide study of more than 50,000 individuals jointly funded by the National Heart, Lung, and Blood Institute, the National Institute of Neurological Disorders and Stroke, and the National Institute on Aging of the National Institutes of Health (design paper: https://www.medrxiv.org/content/10.1101/2021.03.19.21253986v1.full.pdf)

Several major healthcare systems have established multidisciplinary post-COVID care clinics including the Mount Sinai (New York) Center for Post-COVID Care, the Penn Medicine Post-COVID Recovery Clinic, University of California San Francisco's OPTIMAL Clinic, the University of Michigan's Post ICU Longitudinal Survivor Experience (PULSE) Clinic (now focused on post-COVID-19), the Columbia University Irving Medical Center COVID-19 Rehabilitation Program, and the Mayo Clinic COVID Activity Rehabilitation Program (CARP). Anticipated post-acute care rehabilitation needs of patients and guidance on how to address those needs have been reported.[152-161] There is an emphasis on multi-disciplinary programs to address respiratory, cardiovascular, thromboembolism, and neurological sequelae along with physical function and mental health needs. Patient groups have also been organized with a focus on long-term symptoms. These include Survivor Corps (https://www.survivorcorps.com/) and the COVID-19 "Long Hauler" Symptoms Survey,[16] the Body Politic COVID-19 support group (https://www.wearebodypolitic.com/covid19), Long Covid SOS in the UK (www.longcovidsos.org), and the COVID Symptom Study with an app to study symptoms and track the spread of the virus (https://covid.joinzoe.com/us-2).

CONCLUSIONS

Our systematic review on post-acute COVID-19 major organ damage and healthcare/service use needs found that most studies were from outside the United States and only 2 enrolled exclusively Veterans. There was little information on patient-centered or clinical health outcomes; most data were based on laboratory or imaging tests. Data were largely from studies of convenience samples with poorly described study populations and lacked control groups or pre-COVID-19 data. However, recent evidence included 4 large database studies with COVID-19 and control groups. Evidence from these studies suggests that compared to non-COVID-19 controls, adults hospitalized for COVID-19 had higher post-hospitalization incident respiratory, cardiac, liver, chronic and acute kidney disease, stroke, diabetes, and coagulation disorders. There was little or no information about post-hospital care, monitoring, or treatments required. Future research should: 1) include clear descriptions of the patient populations and the timing of outcome assessment with respect to hospitalization, 2) link pre-COVID-19 data with post-COVID-19 data, and 3) assess outcomes that allow for determination of prevalence of major organ damage and healthcare/service use needs.

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In designing the study questions and methodology at the outset of this report, the ESP consulted several technical and content experts. Broad expertise and perspectives were sought. Divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Therefore, in the end, study questions, design, methodologic approaches, and/or conclusions do not necessarily represent the views of individual technical and content experts.

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Operational Partners

Operational partners are system-level stakeholders who have requested the report to inform decision-making. They recommend Technical Expert Panel (TEP) participants; assure VA relevance; help develop and approve final project scope and timeframe for completion; provide feedback on draft report; and provide consultation on strategies for dissemination of the report to field and relevant groups.

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APPENDIX A. SEARCH STRATEGIES

MEDLINE/EMBASE

1 (coronavir* or corona virus* or betacoronavir* or covid19 or covid 19 or nCoV or CoV 2 or CoV2 or sarscov2 **SARS 2 or SARS-CoV-2** or 2019nCoV or 2019 novel coronavirus* or 2019 novel CoV or wuhan virus* or ((wuhan or hubei or huanan) and (severe acute respiratory or pneumonia*))).ti,ab,kw.
2 Coronavirus Infections/ or Coronavirus/ or betacoronavirus/
3 1 or 2
4 Pulmonary fibrosis.ti,ab,kw. or exp Pulmonary Fibrosis/
5 exp Lung Diseases, Obstructive/
6 4 or 5
7 acute kidney injury.ti,ab,kw. or exp Acute Kidney Injury/
8 exp Renal Insufficiency, Chronic/
9 (end stage renal disease or ESRD or AKI or CKD).ti,ab,kw.
10 7 or 8 or 9
11 myocardial infarction.ti,ab,kw. or exp Myocardial Infarction/
12 (heart attack or heart failure or MI).ti,ab,kw.
13 myocarditis.ti,ab,kw. or exp Myocarditis/
14 exp Arrhythmias, Cardiac/
15 arrhythmia*.ti,ab,kw.
16 11 or 12 or 14 or 14 or 15
17 exp Venous Thrombosis/
18 exp Pulmonary Embolism/ or exp Venous Thromboembolism/
19 (deep ve* thrombosis or DVT or pulmonary embolism or PE).ti,ab,kw.
20 anemia.ti,ab,kw. or exp Anemia/
21 17 or 18 or 19 or 20
22 stroke.ti,ab,kw. or exp Stroke/
23 exp Cognitive Dysfunction/
24 exp Confusion/
25 exp Seizures/
26 exp Headache/
27 (stroke* or cerebrovascular accident* or cognitive impairment or cognitive dysfunction or delirium or confusion or seizure* or headache*).ti,ab,kw.
28 22 or 23 or 24 or 25 or 26 or 27
29 exp Diabetes Mellitus/
30 diabetes.ti,ab,kw.
31 29 or 30
32 exp Hepatitis/
33 exp Colitis/
34 (hepatitis or hepatocellular injur* or colitis).ti,ab,kw.
35 32 or 33 or 34
36 "Autoimmune Diseases of the Nervous System"/
37 autoimmune disease*.ti,ab,kw.
38 Musculoskeletal Diseases/
39 musculoskeletal.ti,ab,kw.
40 36 or 37 or 38 or 39
41 6 or 10 or 16 or 21 or 28 or 31 or 35 or 40
42 exp Hospitalization/ or exp Intensive Care Units/ or Inpatients/ or Subacute Care/
43 (hospital or hospitalized or hospitalization or intensive or ICU or care or post?acute or inpatient or inpatients or admit or admitted or admitting).ti,ab,kw.
44 42 or 43
45 3 and 41 and 44
46 limit 45 to english language
47 limit 46 to yr="2019 -Current"

COCHRANE LIBRARY

1 MeSH descriptor: [Coronavirus] explode all trees
2 (coronavirus):ti,ab,kw
3 (betacoronavirus):ti,ab,kw
4 (covid19):ti,ab,kw
5 (covid 19):ti,ab,kw
6 (nCoV):ti,ab,kw
7 (CoV2):ti,ab,kw
8 (CoV2):ti,ab,kw
9 (OR #1-#8)
10 ("pulmonary fibrosis"):ti,ab,kw
11 MeSH descriptor: [Pulmonary Fibrosis] this term only
12 MeSH descriptor: [Lung Diseases, Obstructive] explode all trees
13 (acute kidney injury):ti,ab,kw
14 MeSH descriptor: [Acute Kidney Injury] this term only
15 MeSH descriptor: [Renal Insufficiency, Chronic] this term only
16 ("end stage renal disease"):ti,ab,kw
17 (ESRD):ti,ab,kw
18 (AKI):ti,ab,kw
19 (CKD):ti,ab,kw
20 ("myocardial infarction"):ti,ab,kw
21 MeSH descriptor: [Myocardial Infarction] this term only
22 ("heart attack"):ti,ab,kw
23 ("heart failure"):ti,ab,kw
24 (myocarditis):ti,ab,kw
25 MeSH descriptor: [Myocarditis] this term only
26 (arrhythmia*):ti,ab,kw
27 MeSH descriptor: [Arrhythmias, Cardiac] this term only
28 MeSH descriptor: [Venous Thrombosis] this term only
29 MeSH descriptor: [Pulmonary Embolism] this term only
30 MeSH descriptor: [Venous Thromboembolism] this term only
31 ("deep venous thrombosis"):ti,ab,kw
32 ("pulmonary embolism"):ti,ab,kw
33 (anemia):ti,ab,kw
34 MeSH descriptor: [Anemia] this term only
35 MeSH descriptor: [Stroke] this term only
36 MeSH descriptor: [Cognitive Dysfunction] this term only
37 MeSH descriptor: [Confusion] this term only
38 MeSH descriptor: [Seizures] this term only
39 MeSH descriptor: [Headache] this term only
40 (stroke*):ti,ab,kw
41 ("cerebrovascular accident"):ti,ab,kw
42 ("cognitive impairment"):ti,ab,kw
43 ("Cognitive dysfunction"):ti,ab,kw
44 (delirium):ti,ab,kw
45 (confusion):ti,ab,kw
46 (seizure*):ti,ab,kw
47 (Headache*):ti,ab,kw
48 (diabetes):ti,ab,kw
49 MeSH descriptor: [Diabetes Mellitus] this term only
50 MeSH descriptor: [Hepatitis] this term only
51 MeSH descriptor: [Colitis] this term only
52 (hepatitis):ti,ab,kw
53 ("hepatocellular injur*"):ti,ab,kw

54 (colitis):ti,ab,kw
55 MeSH descriptor: [Autoimmune Diseases of the Nervous System] this term only
56 ("autoimmune disease"):ti,ab,kw
57 MeSH descriptor: [Musculoskeletal Diseases] this term only
58 (musculoskeletal):ti,ab,kw
59 (OR #10-#58)
60 (hospitalized):ti,ab,kw
61 (hospital):ti,ab,kw
62 (hospitalization):ti,ab,kw
63 ("intensive care"):ti,ab,kw
64 (ICU):ti,ab,kw
65 (Post-acute):ti,ab,kw
66 (Post acute):ti,ab,kw
67 (inpatient*):ti,ab,kw
68 (admit*):ti,ab,kw
69 MeSH descriptor: [Hospitalization] explode all trees
70 MeSH descriptor: [Intensive Care Units] this term only
71 MeSH descriptor: [Inpatients] this term only
72 MeSH descriptor: [Subacute Care] this term only
73 (OR #60-#72)
74 #9 AND #59 AND #73

APPENDIX B. PEER REVIEWER COMMENTS AND RESPONSES

Question Text	Comment	Author Responses
Are the objectives, scope, and methods for this review clearly described?	Yes	Thank you
	Yes	
	Yes	
	Yes	
	Yes	
Is there any indication of bias in our synthesis of the evidence?	No	Thank you
	No	
	No	
	No	
	No	
Are there any published or unpublished studies that we may have overlooked?	No	Thank you.
	No	
	No	
	No	
	No	
Additional suggestions or comments can be provided below. If applicable, please indicate the page and line numbers from the draft report.	Well done -- an exhaustive summary of major organ system 'damage' after hospitalization for / with COVID-19. A limitation of available evidence noted near the top of page 46 is that studies did not reliably state what pre-admission / pre-COVID levels of function / dysfunction were present; what organ dysfunction occurred during hospitalization / was present at discharge, and then persisted for what periods of time thereafter. This data may be more useful than comparison groups -- healthcare systems will be interested in what proportion of COVID patients with "x" degree of pulm disability at discharge will have "y" needs that they did not have prior to infection. Depending on what your group thinks about this, you might make a clearer recommendation for future research to include this (say, over comparison groups if authors are thinking about study design and relative importance of different points of comparison).	Thank you. We agree and have modified the statement on Timing in the future research section to include identification of pre-COVID, discharge, and persistent condition.
	Page 2, Figure 1. Analytic Framework: does not consider vaccination status as an independent variable, a missed opportunity Page 5, line 22: 'September 2021' needs appropriate spacing Page 6, line 32: arrow should point to the 'Hand search k=17' box, not away from it	Pg 2. We added vaccine status to the framework and in other places where modifying factors are discussed. Pg 5. We corrected the spacing. Pg 6. The arrow direction indicates that studies identified by hand-search underwent full-text review.

Question Text	Comment	Author Responses
	In the updated review “COVID19 Post-acute Care Makor Organ Damage: a Living Rapid Review, the authors report existing evidence for the prevalence of post-acute care major organ damage and healthcare or service use needs for patients hospitalized for/with COVID-19. The revision is excellent and appears to have include all of the relevant newer studies that I am aware of (and several that I wasn’t). The authors appropriately point out the limitations in the evidence due to convenience sampling, often low (albeit increasing) sample sizes, variation in measurement definitions, and resulting wide ranges of prevalence reported. I really like the visualization of the studies within figures, as it captures this variation nicely and aids in the reader’s overall impression of observed complications in the different studied populations. I have only 1 minor comment. As this is a scoping review, wherever possible, it would be useful to use the same format to ease the reader. The bubble plots within the pulmonary section are especially helpful as they demonstrate the variation in both prevalence and days to follow-up. Could other figures (ie, cognitive complications, healthcare resource utilization) take on a similar format?	Thank you. We appreciate the suggestion but chose to leave the figures as they appeared in the peer review version.
	Thank you for this comprehensive review! Consider editing as "impaired pulmonary function" for Table 2. Throughout, it would be useful if "study design" could be added to the main tables (e.g., Table 3), just as it is in the appendix tables. This will assist in interpretation. Typo on page 23, "Soc studies..." (line 20) Is this correct? "In a large database study from the US, dementia was newly diagnosed in 0.23% of the COVID19 group and 0.43% of the non-COVID control group (risk difference 0.2% [95%CI 0.7, 0.3], P<001).110" In the Key Findings, I would add a comment on the findings on respiratory endpoints in studies with control groups. This is done systematically for subsequent endpoints. Regarding C4R (c4r-nih.org): Currently, over 45,000 participants have completed COVID-19 questionnaires out of a target population of	Edited as suggested. Thank you.. We added a notation on the tables for the studies with a comparator group. Corrected. Thank you. Thank you – this was an error (corrected to read 0.03% of control group). The key respiratory findings section has been edited. Thank you. We now cite the design paper and look forward to the findings!

Question Text	Comment	Author Responses
	approximately 50,000. Major distinguishing features of C4R, which directly address several issues raised in the report, include the availability of research-quality pre-COVID measures of subclinical and subclinical disease, as well as behavioral factors, biomarkers, and multi-'Omics, in hospitalized and non-hospitalized COVID-19 patients and also non-infected comparators. The design paper is pre-printed here: https://www.medrxiv.org/content/10.1101/2021.03.19.21253986v1.full.pdf	

APPENDIX C. EVIDENCE TABLES

TABLE 1. STUDY CHARACTERISTICS

(Shaded rows indicate a newly included study since previous update)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Akhtar, 2021[39] Qatar Retrospective Funding: None	Inclusion: Patients with ischemic stroke also diagnosed with COVID-19 ("confirmed" – method not specified) Exclusion: None report NOTE: included comparisons with pre-COVID-19 ischemic stroke and negative for COVID-19 ischemic stroke	N=833 (32 COVID-19 positive) Age (years, mean): 54 (COVID-19 group: 49) Gender (% male): 81 (COVID-19 group: 88) Race/ethnicity: NR Comorbidities: CVD: 12% (COVID-19 group: 13%) CKD: NR COPD: NR DM: 56% (COVID-19 group: 32%) HTN: 72% (COVID-19 group: 41%) Obesity: NR Smoking: 28% (COVID-19 group: 13%)	COVID-19 severity: NR ICU admission: 44% (COVID-19 group) Respiratory support Mechanical ventilation or ECMO: 31% (COVID-19 group) NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 11 (COVID-19 group) Planned/reported time post-hospital (days): 0 (discharge)
Al-Aly, 2021[104] USA (Veterans) Retrospective Funding: VA	Inclusion: Admitted for COVID-19 within 30 days after or 5 days before first positive test and survived at least 30 days after hospital admission; selected from 98,661 patients with positive COVID-19 test between March 01, 2020 and November 30, 2020 Exclusion: None specified Controls were hospitalized for seasonal influenza and survived 30 days after hospital admission Propensity scores based on predefined variables were estimated to adjust for potential confounders	N=13,654 (COVID-19 group); N=13,997 (Control group) Age (years, mean): 70 (COVID-19 and Control groups) Gender (% male): 94 (COVID-19 and Control groups) Race/ethnicity: COVID-19 group: White 59%, Black 34%; Control group: White 73%, Black 22% Comorbidities: NR	COVID-19 severity: NR ICU admission: 26% (n=3586) Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned time post-hospital in patients that survived 30 days after diagnosis (days): 180 Reported time post-hospital (days, median): COVID-19 group: 150, Control group: 157

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Al Kasab, 2020[23] USA, South America, Europe (28 centers) Prospective Funding: None	Inclusion: Consecutive patients undergoing mechanical thrombectomy (MT) for large vessel occlusion; symptomatic patients were tested with RT-PCR methods Exclusion: None reported	N=13 COVID positive (NOTE: 458 patients underwent MT; 242 were tested for COVID) Age (years, median): 58 Gender (% male): 62 Race: 46% White Comorbidities: NR	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 39% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 8 Planned/reported time post-hospital (days): 0 (discharge)
Alemanno, 2021[105] Italy Prospective Funding: none	Inclusion: Positive swab for SARS-CoV-2, stable SatO2 and RR; no need for respiratory assistance or no more than 2 L/min; absence of fever; areas of dependence at the FIM evaluation (FIM score < 100) Exclusion: Treated for cognitive dysfunctions, under psychotropic drugs prior to recovery, presenting with COVID-19 encephalitis, disease onset <5 days and >20 days NOTE: separated into 4 groups based on type of respiratory assistance received during acute phase	N=87 (56 at follow-up; Group 1: n=31, Group 2: n=18, Group 3: n=29, Group 4: n=9) Age (years, mean): 67 (Group 1: 60; Group 2: 73; Group 3: 73; Group 4: 63) Gender (% male): 71 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: NR Respiratory Support Mechanical ventilation or ECMO: 36% (Group 1) NIV, HFNC, or CPAP: 21% (Group 2) Other: 33% (Group 3) Length of hospital stay: NR Planned time post-hospital (days): 30 Reported time post-hospital: NR
Alharthy, 2021[24] Saudi Arabia Prospective Funding: Hospital	Inclusion: Age >18 years; confirmed serious COVID-19 pneumonia (RT-PCR for SARS-CoV-2); ICU admission Exclusion: Did not undergo POCUS; 2 consecutive negative RT-PCR results at least 24 hours apart	N=89 Age (years, median): 43 Gender (% male): 84 Race: NR Comorbidities: NR CVD: CKD: COPD:	COVID-19 severity: 100% severe (dyspnea, respiratory rate ≥30 breaths/min, blood oxygen saturation ≤93%, PaO_2/FiO_2 <300, development of bilateral pulmonary infiltrates within 24-48 hours, or a combination thereof) ICU admission: 100% Respiratory support

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		DM: HTN: Obesity: Smoking:	Mechanical ventilation or ECMO: 84% on ICU admission, 100% within 48 hours (ventilation only); 6% (both) NIV, HFNC, or CPAP: 16% Other: NR Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Alharthy, 2020[75] Saudi Arabia Prospective Funding: Hospital	Inclusion: COVID-19 pneumonia patients admitted to COVID-19 designated ICU; age ≥18, diagnosed with severe COVID-19 (ARF including dyspnea, bilateral pulmonary infiltrates within 24-48 hours) Exclusion: Did not undergo POCUS for any reason, 2 consecutive negative RT-PCR tests at least 48 hours apart	N=127 survivors (of 171 total patients) Age (years, mean): 45 Gender (% male): 81 Race: NR Comorbidities: CVD: 12% CKD: 6% COPD: 13% DM: 35% HTN: 49% Obesity: NR Smoking: 12%	COVID-19 severity: 100% severe ICU admission: 100% Respiratory support Mechanical ventilation or ECMO: 76% NIV, HFNO or CPAP: 24% Other: 7% Length of hospital stay (days, mean): 20 Planned time post-hospital (days): 60 and 120 Reported time post-hospital: NR
Anand, 2020[40] USA Retrospective Funding: Foundation	Inclusion: Adults hospitalized with positive PCR testing for SARS-CoV-2 during hospitalization or in the 30 days prior to admission; received either 1) inpatient neurologic or neurocritical care admission or 2) inpatient neurologic or neurocritical care consultation any time during the study period Exclusion: None reported	N=74 (of 921 adults hospitalized during study period) Age (years, median): 64 Gender (% male): 57 Race/ethnicity: 51% Black or African-American, 30% unknown/declined, 22% Hispanic or Latino, 18% White, 1% Asian Comorbidities: CAD: 9% CKD: 27% COPD: NR DM: 39%	COVID-19 severity: NR ICU admission: 46% Respiratory support Mechanical ventilation or ECMO: 15% NIV or HFNC, or CPAP: NR Other: 38% Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		HTN: 58% Obesity: NR Smoking: 32%	
Arab-Zozani, 2020[76] Iran Cross-sectional Funding: Not reported	Inclusion: Discharged from a hospital dedicated to treatment of patients with COVID-19 Exclusion: None reported	N=409 Age (years, mean): 58 Age categories: 7% <=40 years, 26% 41-50 years, 41% 51-60 years, 26% >60 years Gender (% male): 60 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 64% HTN: 60% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 18% Respiratory support: NR Length of hospital stay (days, mean): 8 Planned time post-hospital: NR Reported time post-hospital (days, mean): 22
Atalla, 2020[136] USA Retrospective Funding: Not reported	Inclusion: Discharged from hospital; confirmed COVID-19 (RT-PCR for SARS-CoV-2); criteria for hospital admission were individualized – patients with significant comorbidities and moderate to severe COVID-19 (requiring O2 and having abnormal imaging findings) were admitted Exclusion: None reported NOTE: 68% of patients (13/19) were admitted for COVID-19; 32% (6/19) admitted for other conditions then developed symptoms and tested positive NOTE: Patients discharged were instructed to seek medical care for relapse of fever, shortness of breath, neurological or thrombotic events, or any change in clinical status; patients received a post-	N=339 (n=19 readmitted, n=320 not readmitted) Age (years, median): 61 Gender (% male): 56 Race: 37% Hispanic, 1% Asian, 16% African American, 43% Caucasian, 3% Other Comorbidities: CVD: NR CKD: 11%; P=NS between groups COPD: 15% Readmitted: 58%, Not Readmitted: 13%; P<.001 DM: 33% Readmitted: 58%, Not Readmitted: 32%; P=.021 HTN: 45% Readmitted: 68%, Not Readmitted: 44%; P=.038 Obesity: 40%; P=NS between groups Smoking: NR	COVID-19 severity: NR ICU admission: 33% Respiratory support Mechanical ventilation or ECMO: 19% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 7 (IQR 4-15) Planned time post-hospital (days): 30 Reported time post-hospital: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	discharge follow-up call to monitor recovery process		
Ayoubkhani, 2021[106] United Kingdom Retrospective Funding: none	Inclusion: Hospitalized for COVID-19, (positive laboratory test or clinical diagnoses) from January 1, 2020 to end of August 2020 Exclusion: Not discharged alive by August 31, 2020 or birth date or gender unknown Controls were individuals in general population, did not meet inclusion criteria for COVID-19, and had not died before January 1, 2020; 79% had prior hospital admission Patients and controls matched (1:1) on several confounding variables; all were active patients in National Health Service	N=47,780 (for both COVID-19 group and matched control group) Age (%): COVID-19 group Age <30: 5; 30-49: 16; 50-69: 33; ≥70: 46 Control group <30: 3; 30-49: 19; 50-69: 33; ≥70: 46 Gender (% male): 55 (COVID-19 and Control groups) Race/ethnicity: White 72%, Asian 9%, Black 5% (COVID-19 and Control groups) Comorbidities: MACE: 24% (COVID-19 and Control groups) CKD: !3% (COVID-19 and Control groups) COPD: COVID-19 group: 14%; Control group: 12% DM: 24% (COVID-19 and Control groups) HTN: 52% (COVID-19 and Control groups) Obesity (BMI ≥30): 32% (COVID-19 and Control groups) Smoking: 8% current, 41% former (COVID-19 and Control groups)	COVID-19 severity: NR ICU admission: 10% (n=4745) Respiratory support: NR Length of hospital stay: NR Planned time post-hospital: NR Reported time post-hospital (days, mean): COVID-19 group: 140, Control group: 153
Barbaro, 2020[41] Multi (International Registry) Retrospective cohort Funding: None	Inclusion: Age ≥16, had ECMO support and entered in ELSO registry, laboratory-confirmed COVID-19 Exclusion: No completed COVID-19 addendum; previous ECMO (before COVID-19 diagnosis)	N=1035 (588 discharged alive) Age (years, median): 49 Gender (% male): 74 Race: 34% Black, 33% White (non-Hispanic), 21% Hispanic, 15% Asian, 3% Middle Eastern or North African, 13% Other/Unknown/Multiple Comorbidities: CVD: 2% CKD: 2% COPD: 3% DM: 24% HTN: NR Obesity: 47%	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 100% (inclusion criteria) NIV, HFNC, or CPAP: 66% (pre-ECMO) Other: NR Length of hospital stay (days, median): 31 Planned/reported time post-hospital (days): 0 (discharge)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Smoking: NR	
Bellan, 2021[107] Italy Prospective Funding: Foundation	Inclusion: Patients aged 18 years or older who were discharged after they had been admitted for COVID-19 Exclusion: None reported	N=238 Age (years, median): 61 Gender (% male): 60 Race/ethnicity: NR Comorbidities: CVD: 4% CKD: 6% COPD: 6% DM: 15% HTN: 41% Obesity: 11% Smoking: 11%	COVID-19 severity: NR ICU admission: 12% Respiratory support Mechanical ventilation or ECMO: 9% NIV, HFNC, or CPAP: 21% Other: 43% Length of hospital stay (days, median): 8.5 Planned time post-hospital (days): 120 Reported time post-hospital (days): 90-120
Benussi, 2020[25] Italy Retrospective cohort Funding: None	Inclusion: Adult (≥18 years) admitted primarily for neurological disease; had outcome of discharge (home or rehabilitation facility) or death; SARS-CoV-2 detected by RT-PCR methods; confirmed COVID-19 Exclusion: None reported NOTES: reporting data only for patients with *cerebrovascular disease* on admission; included non-COVID controls	N=111 (43 with COVID-19; 68 non-COVID-19) Age (years, mean): 76 Gender (% male): 56 Race: NR Comorbidities: CVD: 14% CKD: 5% COPD: NR DM: 22% HTN: 69% Obesity: NR Smoking: 6%	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: 36% Other: NR Length of hospital stay (days, median): 5 Planned/reported time post-hospital (days): 0 (discharge)
Bhatt, 2021[42] USA Retrospective Funding: Not reported	Inclusion: History of heart failure (ICD-10 codes) subsequently hospitalized during pandemic period; hospitalizations categorized as related to acute heart failure, COVID-19, or other reasons; COVID-19 determined by ICD-10 code U07.1 Exclusion: None reported	N=8,383 COVID-19 hospitalizations (2,041,855 total hospitalizations during study period) Age (mean, years): 72 Gender (% male): 50 Race/ethnicity: <1% Black Hispanic, 23% Black non-Hispanic, 5% White Hispanic, 41% White non-Hispanic, 32% Other/Unknown Comorbidities:	COVID-19 severity: NR ICU admission: 29% Respiratory support Mechanical ventilation or ECMO: 17% NIV, HFNC, or CPAP: NR Other: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	NOTE: included non-COVID-19 hospitalizations group	CVD: 17% CKD: 60% COPD: 42% DM: 61% HTN: 84% Obesity: 29% Smoking: 44%	Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Boari, 2021, Boari 2020 (baseline characteristics)[108,162] Italy Prospective Funding: University	Inclusion: Confirmed COVID-19 infection (positive RT-PCR assay); bilateral pulmonary interstitial opacities on chest imaging not fully explained by congestive heart failure or other forms of volume overload; acute respiratory distress syndrome showing ≥1 of the following conditions: respiratory rate ≥30 breaths/min; peripheral capillary oxygen saturation (SpO2) ≤93% on ambient air or ratio of partial pressure of oxygen in arterial blood to fractional concentration of oxygen in inspired air (PaO2/FiO2) ≤300 mmHg Exclusion: None reported	N=258 (94 COVID-19 follow-up) Age (years, mean): 71 Gender (% male): 67 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: 14% DM: 26% HTN: 59% Obesity: 22% Smoking: 16%	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned time post-hospital (days):120 Reported time post-hospital (days): NR
Bowles, 2020[77] USA Retrospective cohort Funding: None	Inclusion: Admitted to home health care after hospitalization for laboratory-confirmed COVID-19; referred from a hospital Exclusion: None reported	N=1409 Age (years, mean): 67 Gender (% male): 51 Race: 27% Non-Hispanic White, 28% Non-Hispanic Black, 35% Hispanic, 9% Other Comorbidities: CVD: 1% CKD: NR COPD: 16% DM: NR HTN: NR Obesity: 9% Smoking: NR	COVID-19 severity: NR ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time from hospital discharge to first home health visit (days): NR Reported time from hospital discharge to first home health visit (days): 2.4

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Brendish, 2020[78] United Kingdom Prospective cohort Funding: Foundation, government	Inclusion: Age ≥18, acute respiratory illness or clinically suspected of having COVID-19, molecular point-of-care testing or Rt-PCR Exclusion: None reported Patients were part of a clinical trial of molecular point-of-care testing	N=1054 (352 COVID-19 positive, 702 COVID-19 negative) Age (years, median): Positive: 68 Negative: 69 Gender (% male): Positive: 57 Negative: 52 Race: Positive: 74% White, <1% Mixed, 13% Asian, 4% Black Negative: 90% White, 1% Mixed, 3% Asian, 1% Black Comorbidities- positive, negative: CVD: Positive 36%, negative 40% CKD: Positive 12%, negative 12% COPD: Positive 13%, negative 19% DM: Positive 26%, negative 22% HTN: Positive 41%, negative 40% Obesity: NR Smoking: Positive 6%, negative 17%	COVID-19 severity: NR ICU admission: Positive: 18% Negative: 6% Respiratory support Mechanical ventilation or ECMO: COVID Positive: 11%; COVID Negative: 3% NIV, HFNC, or CPAP: COVID Positive: 24%; COVID Negative 6% Other: Oxygen support - COVID Positive 71%; COVID Negative 41% Length of hospital stay (days, median): COVID Positive: 7.2; COVID Negative 3.7 Planned time post-hospital (days): 30 Reported time post-hospital: NR
Brosnahan, 2020[79] USA Retrospective Funding: Not reported	Inclusion: Confirmed COVID-19, discharged and re-presented with concerns for thrombotic event – included DVT, PE, limb ischemia due to arterial thrombosis, acute coronary syndromes due to coronary thrombosis, acute stroke, rapidly evolving hemodynamic instability with elevated D-dimer Exclusion: None reported	N=9 (of 1975 patients discharged during study period) Age (years, median): 74 Gender (% male): 67 Race/ethnicity: NR Comorbidities: CVD: NR CKD: 22% COPD: NR DM: 22% HTN: 33% Obesity: 33% Smoking: NR	COVID-19 severity: NR ICU admission: NR Respiratory support: NR Length of hospital stay (days, mean): 3 Planned time from discharge to re-presenting: Not applicable Reported time from discharge to re-presenting (days, mean): 5
Casas-Rojo, 2020[56]	Inclusion: Spanish Society of Internal Medicine registry; age ≥18 years; first	N=15,111 Age (years, median): 69	COVID-19 severity: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Spain Retrospective cohort Funding: Foundation/ Society	hospital admission; hospital discharge or in-hospital death (consecutive patients with confirmed SARS-CoV-2 (positive RT-PCR or positive result on serological testing and compatible clinical presentation) were eligible Exclusion: Subsequent admissions of the same patient; denial or withdrawal of consent	Gender (% male): 57 Race: 90% Caucasian, 10% Other Comorbidities: CVD: 20% CKD (moderate-severe): 6% COPD: 7% DM: 19% HTN: 51% Obesity (BMI ≥30 kg/m^2): 21% Smoking: 69% Never, 25% Moderate, 5% Current NOTE: 4% were healthcare workers	ICU admission: 8% Respiratory support Mechanical ventilation or ECMO: 7% NIV, HFNC, or CPAP: 13% Other: NR Length of hospital stay (days, median): 10 (range 1-62, discharged patients) Planned time post-hospital (days): 30 Reported time post-hospital (days, median): 40 (range 0-102)
Chan, 2021[102] USA Retrospective Funding: Several authors report funding; unclear if related to manuscript	Inclusion: Age ≥18, laboratory-confirmed SARS-CoV-2 and COVID-19 admitted to 1 of 5 Mount Sinai Health System hospitals 2/27/20-5/30/20 Exclusion: Known end-stage kidney disease prior to admission; hospitalized <48 hours, missing laboratory and vital signs during hospitalization	N=3,993 (demographics for all patients admitted; 3,869 [97%] were discharged) *(NOTE: 46% (1,835/3,993) experienced AKI while hospitalized*) Age (years, median): 64 Gender (% male): 57 Race: White 24%, Black 36%, Hispanic 26%, Asian 4%, Other or unknown 19% Comorbidities: CVD: NR CKD: 11% COPD: NR DM: 26% HTN: 38% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 24% (976/3993) Respiratory support Mechanical ventilation or ECMO: 23% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): AKI group 10, no AKI group 7 (P<.001, discharged patients only) Planned time post-hospital: NR Reported time post-hospital (days, median): 21
Chevinsky 2021[109] USA Retrospective Funding: Not reported	Inclusion: Hospitalized for COVID-19 (ICD-10 code) from March 1 to June 30, 2020 Exclusion: Patients with at least 1 encounter preceding index encounter or who died or were pregnant in index encounter	N=27,284 adults for both COVID-19 and Control groups Age (%): COVID-19 group Age 18-39: 9; 40-49: 10; 50-64: 28; ≥65: 53 Control group Age 18-39: 11; 40-49: 9; 50-64: 27; ≥65: 54	COVID-19 severity: NR ICU admission: both groups 40% Respiratory support: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	Controls were hospitalized individuals who did not meet inclusion criteria for COVID-19 and were not diagnosed with COVID-19 during the 4 months after index encounter Patients and controls matched (1:1) based on propensity scores on several confounding variables	Gender (% male): COVID-19 group: 48; Control group: 47 Race/ethnicity: COVID-19 group: White 48%, Black 26%, Asian 2%, Hispanic 13% Control group: White 47%, Black 26%, Asian 2%, Hispanic 14% Comorbidities: NR	Length of hospital stay (days, median): COVID-19 group 6 (range 3, 11); Control group 4 (range 2, 6) Planned time post-hospital (days): 30-120 Reported time post-hospital (days): NR
Chopra, 2020[80] USA Retrospective Funding: Health Insurance industry	Inclusion: Hospitalized with COVID-19 (unclear if confirmed), discharged Exclusion: None reported	N=1250 Age (years, median): 62 Gender (% male): 52 Race/ethnicity: 52% Black, 37% White, 11% Unknown Comorbidities: CVD: 24% CKD (moderate/severe): 23% COPD: 10% DM: 35% HTN: 64% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 13% Respiratory support Mechanical ventilation or ECMO: 6% NIV, HFNC, or CPAP: NR Other: 69% Length of hospital stay (days. median): 5 Planned time post-hospital (days): 60 Reported time post-hospital (days): NR
Collins, 2020[26] USA Retrospective Funding: University	Inclusion: Persons with HIV admitted with COVID-19 (detection of SARS-CoV-2 via RT-PCR) Exclusion: None reported NOTE: study sites included Atlanta Veterans Affairs Medical Center	N=20 Age (years, median): 57 Gender (% male): 65 Race: 85% Non-Hispanic Black, 5% Non-Hispanic White, 5% Non-Hispanic/Multiracial, 5% Hispanic/Latino Comorbidities: CVD: 30% CKD: 25% Chronic lung disease: 30% DM: 45% HTN: 70% Obesity: 30%	COVID-19 severity: NR ICU admission: 30% Respiratory support Mechanical ventilation or ECMO: 15% NIV, HFNC, or CPAP: 15% Other: 25% Length of hospital stay (days, median): 5 Planned/reported time post-hospital (days): 0 (discharge)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Smoking: 50% Current, 10% Former, 40% Never	
Curci, 2020[27] Italy Cross-sectional Funding: None	Inclusion: Consecutive referrals to rehabilitation unit; adults (>18); diagnosis of viral interstitial lung disease (CT); positive for SARS-CoV-2 (RT-PCR); previously hospitalized in ICU; clinical stability (able to perform bedside mobilization without reduction in oxygen saturation below 90%); complete weaning from sedative and antipsychotic drugs Exclusion: Respiratory distress signs; cognitive impairment; need of respiratory support (FiO_2 >60%); need of CPAP devices; signs of cardiovascular instability	N=32* Age (years, mean): 73 Gender (% male): 69 Race: NR Comorbidities: CVD: NR CKD: NR COPD: 6% DM: 19% HTN: 63% Obesity: NR Smoking: 28% *Subgroups 1) FiO_2 ≥21% and <40% (n=13); without oxygen support devices or wearing nasal cannula 2) FiO_2 ≥40% and <60% (n=19); wearing non-rebreather mask, Venturi mask, or oxygen mask	COVID-19 severity: NR ICU admission: 100% Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC or CPAP: NR Other: 47% Length of hospital stay (days, mean): 16.4 (ICU admission to rehabilitation unit) Planned/reported time to rehabilitation unit admission (days): 0 (discharge from ICU)
Daher, 2020[81] Germany Prospective Funding: None	Inclusion: Consecutive patients hospitalized due to COVID-19 (confirmed by RT-PCR) Exclusion: Patients with ARDS who needed mechanical ventilation in the ICU	N=33 Age (years, mean): 64 Gender (% male): 67 Race/ethnicity: NR Comorbidities: CVD: 19% CKD: 22% COPD: 9% DM: 25% HTN: 59% Obesity: NR Smoking: NR	COVID-19 severity: 100% (criteria NR) Symptom onset to hospitalization: 6 days ICU admission: NR Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: NR Other: 82% Length of hospital stay (days, mean): 15 Planned time post-hospital: NR Reported time post-hospital (days, median): 42 (range 48-71)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Daugherty 2021[110] USA Retrospective Funding: Insurance (Research & Development)	Inclusion: Ages 18-65 diagnosed with COVID-19 (SARS-CoV-2); continuous enrollment in the health plan from January 1, 2019 to index date (defined by first of: 1) primary, secondary, or tertiary diagnosis of COVD-19; 2) administrative claims with ICD-10 codes U07.1 or either B34.2 or B97.29 before April 1, 2020; 3) documentation of positive PCR test in outpatient laboratory dataset; or 4) admitted to hospital for COVID-19 (based on diagnostic code)) Exclusion: Positive SARS-CoV-2 antibodies but without documented infection; ICD-10 codes B34.2 or B97.29 on or after April 1, 2020; and admitted to hospital for suspected COVID-19 but missing diagnostic codes Controls were ages 18-65 without COVID-19 (SARS-CoV-2) diagnosis with continuous health plan enrollment from January 1 2019 to randomly assigned month and day drawn from the SARS-CoV-2 infection group (2020 comparator group used for analysis of hospitalized patients) Patients and controls matched (1:1) using propensity scores based on 108 variables	N=21,746 hospitalized (N=18,118 for both COVID-19 and control groups in matched analysis after exclusion if less than index date + 21 days of follow-up); demographics and comorbidities NR for hospitalized subgroup Age (years, mean): NR Gender (% male): NR Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: 13% (n=2933) Respiratory support: NR Length of hospital stay: NR Planned time post-acute infection* (days): 90-180 Reported time post-acute infection* (days, mean): 120 NOTE: post-acute infection defined as index date plus 21 days
Dawson, 2020[143] United Kingdom Prospectively collected/ retrospectively analyzed	Inclusion: Admitted with SARS-CoV-2 (RT-PCR confirmed); referred to Speech and Language Therapy team with clinical signs of dysphagia Exclusion: None reported	N=208 Age (years, mean): 68 Gender (% male): NR Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: 49% (102/208) admitted for ventilatory support Respiratory support Mechanical ventilation or ECMO: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: Not reported			NIV, HFNC, or CPAP: NR Other: 39% (tracheostomy) Length of hospital stay: NR Planned/reported time post-hospital: NR
DeBolt, 2020[43] USA Retrospective case-control Funding: Not reported	Inclusion: Ages 18-50; confirmed (RT-PCR) SARS-CoV-2 infection meeting admission criteria for severe and critical COVID-19; pregnant women were admitted for COVID-19 and not obstetrical indications Exclusion: Inconclusive or negative SARS-CoV-2 laboratory results; comorbidities associated with immunocompromised state (active malignancy, history of transplant or developmental delay, cerebral palsy, trisomy 21 or other aneuploidies) Controls were non-pregnant women of reproductive age admitted for COVID-19	N=38 pregnant cases; 94 non-pregnant controls Age (mean, years) Cases: 35; Controls: 38 (P<.01) Gender (% male): 0 Race/ethnicity Cases: 24% Non-Hispanic White, 18% Non-Hispanic Black, 40% Hispanic, 8% Asian, 0% American Indian or Alaskan Native, 10% Other or Unknown Controls: 10% Non-Hispanic White, 14% Non-Hispanic Black, 37% Hispanic, 9% Asian, 1% American Indian or Alaskan Native, 30% Other or Unknown Comorbidities: CVD: NR CKD: NR COPD: Cases 11%, controls 29% DM: Cases 11%, controls 28% HTN: NR Obesity: NR Smoking: Cases 0%, controls 0%	COVID-19 severity (WHO and Chinese CDC criteria) Severe: 76% Cases; 85% Controls Critical: 24% Cases; 15% Controls (P<.01) ICU admission: 40% Cases; 17% Controls Respiratory support Mechanical ventilation or ECMO: 26% Cases; 11% Controls NIV, HFNC, or CPAP: 29% Cases; 10% Controls Other: NR Length of hospital stay (days, mean): 9 (Cases); 7 (Controls) Planned/reported time post-hospital (days): 0 (discharge)
de Graaf, 2021[111] the Netherlands Prospective Funding: None	Inclusion: All adults (≥18) from geographic region discharged after admission for PCR-confirmed SARS-CoV-2 infection; planned for outpatient clinic after discharge Exclusion: None reported	N=81 Age (years, mean): 61 Gender (% male): 63 Race/ethnicity: NR Comorbidities: CVD: 28% CKD: 11% COPD: 4% DM: 23%	COVID-19 severity: NR ICU admission: 42% Respiratory support Mechanical ventilation or ECMO: 41% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 17

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		HTN: 34% Obesity: NR Smoking: 11%	Planned time post-hospital (days): 42 Reported time post-hospital (days): NR
de Havenon, 2021[146] USA Retrospective Funding: Government	Inclusion: ICD-10 codes for ischemic stroke in discharge diagnoses, comorbid COVID-19 during same hospitalization (identified by ICD code U07.1 [laboratory testing confirmed]) Exclusion: Elective hospital admissions, patients on hospice prior to admission NOTE: included historical controls	N=2086 COVID-19 positive cases, 166,586 pneumonia controls Age category: Cases: 12% 18-50 years; 29% 51-64 years; 29% 65-74 years; 11% 75-79 years; 19% ≥80 years Controls: 11% 18-50 years; 26% 51-64 years; 25% 65-74 years; 12% 75-79 years; 26% ≥80 years Gender (% male): 58 cases, 51 controls Race/ethnicity: Cases: 34% White, 32% Black, 19% Hispanic, 5% Asian, 11% Other/Unknown; Controls: 62% White, 22% Black, 7% Hispanic, 3% Asian, 6% Other/Unknown Comorbidities: CVD: NR CKD: NR COPD: NR DM: 55% cases, 40% controls HTN: 67% cases, 73% controls Obesity: 25% cases, 17% controls Smoking: 5% cases, 16% controls	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 44% cases, 12% controls NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 18 cases, 8 controls Planned/reported time post-hospital (days): 0 (discharge)
De Lorenzo, 2020[82] Italy Part of COVID-BioB study Prospective and retrospective	Inclusion: Age ≥18, admitted to emergency department, confirmed (RT-PCR) SARS-CoV-2, follow-up at designated COVID-19 Outpatient Clinic Exclusion: Admitted for reasons other than COVID-19 who subsequently tested positive for SARS-CoV-2	N=126 (hospitalized patients) Age (years, mean): 61 Gender (% male): 73 Race/ethnicity: 94% European, 6% Hispanic Comorbidities: CAD: 6% CKD: 2% COPD: 2% DM: 14%	COVID-19 severity: NR ICU admission: 3% (4/126) Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: 25% Other: NR Length of hospital stay (days, median): 10

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: None		HTN: 44% Obesity: NR Smoking: NR	Planned time post-hospital: NR Reported time post-hospital (days, median): 22
De Michieli, 2021[112] USA Retrospective Funding: Government	Inclusion: Consecutive adult patients with confirmed COVID-19 diagnosis (RT-PCF); presented to emergency department and/or were admitted Exclusion: No Minnesota Research Authorization form or permission to use records, <18 years, indeterminate PCR results, no hs-cTnT during index hospitalization	N=367 Age (years, mean): 61 Gender (% male): 60 Race/ethnicity: White 66% Comorbidities: CAD: 13% CKD: 21% COPD: 16% DM: 32% HTN: 58% Obesity: 41% Smoking: 36% (current)	COVID-19 severity: NR ICU admission: 28% Respiratory support Mechanical ventilation or ECMO: 16% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 7 Planned time post-hospital (days): 30 Reported time post-hospital (days, median): 49
Dennis, 2021[57] United Kingdom Prospective Funding: Government	Inclusion: Positive for SARS-CoV-2 by RT-PCR (n=62), positive antibody test (n=63), or determined to have COVID-19 by 2 independent clinicians based on symptoms (n=73) Exclusion: Symptoms of active respiratory viral infection; discharged from hospital in last 7 days; contraindications to MRI (metallic implanted devices, claustrophobia)	N=37 (patients hospitalized only) Age (years, mean): 50 Gender (% male): 38 Race/ethnicity: 76% White, 8% South Asian, 5% Black Comorbidities: Previous heart disease: 3% CKD: NR COPD: NR DM: 0% HTN: 5% Obesity: NR Smoking: 65% never, 35% former, 0% current NOTE: 35% were health care workers	COVID-19 severity: NR ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time post-positive test: NR Reported time post positive test (days, median): 105 NOTE: Organ function by patient-reported questionnaires, fasting blood investigations, and multi-organ MRI

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Doher, 2020[145] Brazil Retrospective cohort Funding: None	Inclusion: Age ≥18, confirmed severe COVID-19, admitted to ICU, positive RT-PCR Excluded: CKD on dialysis	N=201 (101 diagnosed with AKI) Age (years, median): 64 (AKI: 73, non-AKI: 60) Gender (% male): 61 (AKI: 66 non-AKI: 56) Race/ethnicity: NR Comorbidities: CAD: 8% (13% AKI, 3% non-AKI) CKD: NR COPD: NR DM: 32% (39% AKI, 25% non-AKI) HTN: 49% (58% AKI, 39% non-AKI) Obesity: NR Smoking: 3% (2% AKI, 4% non-AKI)	Time from symptoms to hospital admission: 6 days (median) COVID-19 severity: NR ICU admission: 100% (inclusion criteria) Respiratory support (at ICU admission) Mechanical ventilation or ECMO: 44% (71% AKI, 17% non-AKI) NIV, HFNC, or CPAP: 61% (64% AKI, 57% non-AKI) Other: NR Length of hospital stay (days, median): 18 AKI, 10 Non-AKI Planned/reported time post-hospital (days): 0 (discharge)
Egol, 2020[58] USA Prospective Funding: None	Inclusion: Hip fracture; positive RT-PCR test before, during, or after (at rehabilitation) hospitalization Exclusion: None reported NOTE: Included comparison data from COVID-19 Suspected and COVID-19 Negative patients	N=17 (COVID-19 positive) Age (years, mean): 82 Gender (% male): 71 Race/ethnicity: 82% White, 0% African American, 12% Hispanic, 6% Asian Comorbidities: CVD: 47% CKD: 24% (renal failure) COPD: 18% DM: 41% HTN: 65% Obesity: NR Smoking: 53% Never, 35% Former, 12% Current	COVID-19 severity: NR ICU admission: 29% Respiratory support Mechanical ventilation or ECMO: 12% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, means): 9.8 Planned time post-hospital (days): 30 Reported time post-hospital (days): NR
El Moheb, 2020[59] USA Retrospective	Inclusion: All patients with confirmed SARS-CoV-2 (RT-PCR) who were intubated and admitted to ICU	N=92 (propensity matched subgroup with COVID-19 ARDS) Age (years, median): 62 Gender (% male): 59	COVID-19 severity: NR ICU admission: 100% (inclusion criteria)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: Not reported	Exclusion: None reported NOTE: analysis was limited to patients whose gastrointestinal complications while hospitalized were previously reported; propensity score matching with to identify comparably ill patients with non-COVID-19 ARDS	Race/ethnicity: NR Comorbidities: CAD: 13% CKD: 20% Chronic lung disease: 29% DM: 37% HTN: 55% Obesity: NR Smoking: 39%	Respiratory support: NR Length of hospital stay (days, median): 24 Planned/reported time post-hospital: NR
Engelen, 2021[113] Belgium Prospective Funding: None	Inclusion: Age 75 or younger and hospitalized with confirmed COVID-19 Exclusion: Residents of medical care facilities, patients with cognitive impairment, or with a clinical frailty scale greater than 5, patients admitted for non-respiratory reasons with incidental finding of SARS-CoV-2 or patients with hospital stay <2 days	N=146 Age (years, mean): 58 Gender (% male): 62 Race/ethnicity: NR Comorbidities: CVD: NR CKD: 20% COPD: NR DM: 29% HTN: 45% Obesity: NR Smoking: 44%	COVID-19 severity: NR ICU admission: 39% Respiratory support Mechanical ventilation or ECMO: 28% NIV, HFNC, or CPAP: NR Other: 88% Length of hospital stay (days, median): 11 Planned time post-hospital (days): 42 Reported time post-hospital (days): NR
Eswaran, 2021[114] USA Retrospective Funding: none	Inclusion: Patients hospitalized with confirmed COVID-19 Exclusion: Patients who died, were discharged to hospice or comfort care, screened positive when hospitalized for an unrelated condition, or were discharged on therapeutic anticoagulation for another indication.	N=447 Age (years, mean): 54 Gender (% male): 51 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: 39% Respiratory support: NR Length of hospital stay (days, mean): 8 Planned time post-hospital (days): 30 Reported time post-hospital (days): NR
Fisher, 2020[28] USA	Inclusion: Age >18 years with COVID-19 test performed upon hospitalization;	N=3,345 (positive for COVID-19; total of 4,610 were eligible and tested	COVID-19 severity: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Retrospective Funding: None	confirmed case of COVID-19 was a positive RT-PCR result Exclusion: Age <18 years; end stage kidney disease; no creatinine values; unknown sex assignment NOTE: included comparison group of patients hospitalized during same time period in 2019	Age (years, mean): 64 Gender (% male): 53 Race: 8% Non-Hispanic White; 36% Non-Hispanic Black, 37% Hispanic; 19% Other Comorbidities: CVD: NR CKD: 12% COPD: NR DM: 27% HTN: NR Obesity: 43% Smoking: NR NOTE: 16% were nursing home residents	ICU admission: 13% Respiratory support Mechanical ventilation or ECMO: 18% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 5 Planned/reported time post-hospital (days): 0 (discharge)
Frija-Masson, 2020[60] France Retrospective Funding: Not reported	Inclusion: Age <85; confirmed SARS-CoV-2 infection (RT-PCR); discharged from hospital; evaluated with pulmonary function tests 30 days after symptom onset as part of routine care Exclusion: Decline to participate; recurrence; patients with ARDS NOTE: 18% (9/50) treated as outpatients	N=50 Age (years, median): 54 Gender (% male): 56 Race: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 16% HTN: 48% Obesity: NR Smoking: 10% active; 18% former	COVID-19 severity: 50% severe (based on CT) ICU admission: 14% (7/50) Respiratory support Mechanical ventilation or ECMO: 2% NIV, HFNC, or CPAP: 8% Other: 50% Length of hospital stay: NR Planned time post-infection (days): 30 Reported time post-infection: NR
Fuglebjerg, 2020[29] Denmark Case series Funding: None	Inclusion: Hospitalized with COVID-19 confirmed by PCR testing Exclusion: Chronic lung diseases or New York Heart Association (NYHA) class II or above	N=26 Age (years, median): 63 (range 29-85) Gender (% male): 62 Race: NR Comorbidities: NR (patients had a median of 1 (non-specified) per patient)	COVID-19 severity: NR ICU admission: 31% Respiratory support Mechanical ventilation or ECMO: 15% NIV, HFNC, or CPAP: NR Other: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
			Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Garrigues, 2020[61] France Prospective, survey Funding: None	Inclusion: Hospitalized in COVID-19 ward; positive SARS-CoV-2 (RT-PCR) and/or typical abnormalities on chest CT Exclusion: Directly admitted to ICU without being hospitalized in COVID-19 unit; deceased, unreachable by telephone, demented, bedridden, non-French speaking	N=120 Age (years, mean): 63 Gender (% male): 63 Race: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 22% HTN: 47% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 20% Respiratory support Mechanical ventilation or ECMO: 12% NIV, HFNC, CPAP: 14% Other: NR Length of hospital stay (days, mean): 13 Planned time post-hospital (days): >100 Reported time post-hospital (days, mean): 111
Goicoechea, 2020[30] Spain Retrospective Funding: Not reported	Inclusion: All patients on maintenance hemodialysis admitted with positive RT-PCR testing for SARS-CoV-2 infection Exclusion: None reported	N=36 (7 were discharged) Age (years, mean): 71 Gender (% male): 64 Race: NR Comorbidities: CVD: 22% CKD: 100% COPD: 19% DM: 64% HTN: 97% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 3% (1/36) Respiratory support Mechanical ventilation or ECMO: 3% (NOTE: all required oxygen supplement therapy; severe comorbidities in 11 patients requiring assisted mechanical ventilation limited invasive measures) NIV, HFNC, CPAP: 67% Other: 33% Length of hospital stay (days, median): 11.4 (discharged patients) Planned/reported time post-hospital (days): 0 (discharge)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Grewal, 2020[31] USA Retrospective Funding: Not reported	Inclusion: Diagnosis of acute ischemic stroke (AIS) (confirmed with MRI or CT); positive for COVID-19 (RT-PCR); divided patients into "COVID" group (initially with COVID-19 symptoms who developed AIS) and "neuro" group (admitted for AIS and tested positive for COVID-19) (NOTE: included control groups of non-COVID-19 AIS patients hospitalized during study time frame and in 2019) Exclusion: None reported	N=13 (6 in "COVID" group, 7 in "neuro" group) Age (years, mean): 62 Gender (% male): 46 Race: 46% Latino, 31% African-American Comorbidities: CAD: 15% CKD: NR COPD: NR DM: 69% HTN: 69% Obesity: 15% Smoking: NR	COVID-19 severity: 8 (62%) severe or critical; 5 (38%) mild or regular ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Gupta, 2021[139] USA STOP-COVID study Cohort Funding: None	Inclusion: Age ≥18; consecutively admitted to ICUs at 67 hospitals, laboratory confirmed diagnosis of COVID-19 Exclusion: History of ESKD NOTE: authors report that 153 of the patients in this study were included in Chan 2020 (above) 7	N=3099 (637 with AKI-RRT, 216 discharged) Age (years, median): 62 Gender (% male): 65 Race/ethnicity: 37% White, 31% Black, 6% Asian, 34% Hispanic, 26% Other/Unknown Comorbidities: CAD: 13% CKD: 67% eGFR <90 ml/min per 1.73 m^2 COPD: 8% DM: 14% insulin dependent, 26% noninsulin dependent HTN: 60% Obesity: NR Smoking: 30% current or former	COVID-19 severity: NR ICU admission: 100% Respiratory support Mechanical ventilation or ECMO: 66% (on ICU admission) NIV, HFNC, or CPAP: 22% Other: NR Length of hospital stay: NR Planned time post-hospital (days): 0 (discharge) Reported time post-hospital (days): 60 after ICU admission
Hall, 2021[115] United Kingdom Retrospective Funding: None	Inclusion: All patients attending the hospital with either a positive PCR for COVID-19 or a clinical radiological diagnosis and had persistent symptoms or required ICU admission	N=200 (179 received inpatient care, 21 discharged directly from the emergency department) Age (years, mean): 55 Gender (% male): 62 Race/ethnicity: NR Comorbidities:	COVID-19 severity: NR, majority were not reported as "critically unwell" ICU admission: 39% Respiratory support Mechanical ventilation or ECMO: 28% NIV, HFNC, or CPAP: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	Exclusion: Patients who died or were not yet discharged. Patients unable to attend clinic for follow-up due to frailty	CVD: NR CKD: NR COPD: 2% DM: 28% HTN: 36% Obesity: 36% Smoking: 15%	Other: 70% Length of hospital stay (days, median): 9 Planned time post-hospital (days): 28-42 Reported time post-hospital: NR
Hamilton, 2020[83] United Kingdom Retrospective Funding: None	Inclusion: Age ≥18, tested positive (RT-PCR) for COVID-19, 4 hospitals Exclusion: Day cases and known hemodialysis patients	N=1032 (210 with AKI) Age (years, median): 71 Gender (% male): 55 Race/ethnicity: 70% White, 11% Asian, 9% Black, 9.3% Mixed/Other/Unknown Comorbidities: CVD: 4% CKD: 14% COPD: 25% DM: 23% without complications, 4% with complications HTN: NR Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission (critical care): 16% (165/1032) Respiratory support Mechanical ventilation or ECMO: 75% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 10 Planned time post-COVID positive admission (days): 30 Reported time post-COVID positive admission (days): NR
Han, 2021[116] China Prospective Funding: Government, university	Inclusion: Severe COVID-19 patients discharged from the hospital Exclusion: NR	N=114 Age (years, mean): 54 Gender (% male): 70 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: 14% DM: 11% HTN: 28% Obesity: 22% Smoking: 14% (history)	COVID-19 severity: 100% severe ICU admission: 9% Respiratory support Mechanical ventilation or ECMO: 21% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 17 Planned time post-disease onset (days): 180 Reported time post-disease onset (days, mean): 175

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Hegde, 2020[44] USA Retrospective case series Funding: None	Inclusion: Age ≥18, laboratory-confirmed COVID-19 (positive for SARS-CoV-2 by RT-PCR), transthoracic echocardiogram performed during hospital stay with features consistent with Takotsubu cardiomyopathy Exclusion: None reported	N=7 Age (years, mean): 71 Gender (% male): 57 Race/ethnicity: NR Comorbidities: CAD: 14% CKD: 14% COPD: NR DM: 71% HTN: 86% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 86% Respiratory support Mechanical ventilation or ECMO: 86% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 18 Planned/reported time post-hospital (days): 0 (discharge)
Hill, 2020[84] USA Retrospective Funding: Not reported	Inclusion: Positive for SARS-CoV-2 (RT-PCR) Exclusion: Indication for heparin bolus was thrombosis of an extracorporeal circuit	N=2748 (2075 survived to discharge) Age (years, mean): NR Gender (% male): NR Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 23% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned time post-hospital : NR Reported time post-hospital (days, mean): 21
Hittesdorf, 2020[140] USA Retrospective Funding: Institution/ Department	Inclusion: Admitted to a provisional ICU, severe COVID-19 (not defined) Exclusion: Incomplete records or follow-up data	N=116 Age (years, mean): 62 Gender (% male): 65 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 43% HTN: 53%	COVID-19 severity: 100% (criteria NR) ICU admission: 100% Respiratory support: Mechanical ventilation: 100% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 60 (survivors)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Obesity: 44% Smoking: NR	Planned time post-hospital (days): 0 (discharge) and 90 Reported time post-hospital: NR
Hu, 2020[45] China Cross-sectional Funding: Government	Inclusion: Patients admitted to a hospital designated to treat patients with SARS-CoV-2, diagnosis of COVID-19 based on WHO guidelines and RT-PCR methods Exclusion: Lack of available blood samples, no CT examination, death	N=76 Age (years, mean): 51 Gender (% male): 45 Race/ethnicity: NR Comorbidities: CVD: 12% CKD: NR COPD: NR DM: 11% HTN: 22% Obesity: NR Smoking: NR	COVID-19 severity: 17% severe, 83% no-severe ICU admission: NR Respiratory support: NR Length of hospital stay (days, median): 14 (18 [severe], 13 [non-severe]) Planned/reported time post-hospital (days): 0 (discharge)
Huang C, 2021[85] China Retrospective and Prospective Funding: Government, University, Foundation	Inclusion: Adults, laboratory confirmed COVID-19, discharged Exclusion: Died before follow-up visit; follow-up would be difficult owing to psychotic disorder, dementia, or readmission to hospital attributed to underlying disease; unable to move freely or immobile before or after discharge; declined participation; unable to be contacted; living outside Wuhan (study city) or in nursing or welfare homes	N=1733 Age (years, median): 57 Gender (% male): 52 Race/ethnicity: NR Comorbidities: CVD: 7% CKD: 2% COPD: 2% DM: 12% HTN: 29% Obesity: NR Smoking: 6% current, 3% former	Time from symptom onset to admission (days, median): 15 COVID-19 severity: NR ICU admission: 4% Respiratory support Mechanical ventilation or ECMO: 1% NIV, HFNC, or CPAP: 6% Other: 68% Length of hospital stay (days, median): 14 Planned time post-hospital (days): 180 Reported time post-hospital (days, median): 153

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Huang L, 2020[62] China Retrospective Funding: Foundation, Government	Inclusion: Consecutive patients referred for CMR due to cardiac symptoms after discharge; previously confirmed with SARS-CoV-2 (RT-PCR); considered recovered by hospital discharge criteria Exclusion: History of CAD or myocarditis; contraindication to gadolinium contrast; CMR image quality not sufficient for analysis	N=26 Age (years, median): 38 Gender (% male): 38 Race: NR Comorbidities: CAD: 0% CKD: 0% COPD: 0% DM: 0% HTN: 8% Obesity: NR Smoking: NR NOTE: also included data from healthy controls (similar age and gender distribution, no CVD or systemic inflammation) who underwent CMR at same hospital	COVID-19 severity: 0 critical, 4 severe, 22 moderate ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 0% NIV, HFNC, or CPAP: 81% Other: NR Length of hospital stay: NR Planned/reported time post-hospital: NR NOTE: Median time from cardiac symptom onset to CMR was 47 days
Huang Y, 2020[63] China Retrospective Funding: Not reported	Inclusion: Age over 18 years; released from hospital over 1 month; confirmed SARS-CoV-2 infection (RT-PCR) Exclusion: Previous history of pulmonary resection, neurological disease, or mental illness; could not be contacted or declined participation	N=57 Age (years, mean): Severe: 53; Non-severe: 44; P=.03 Gender (% male): Severe 71%; Non-severe: 35%; P=.01 Race: NR Comorbidities: CVD: 5% CKD: NR COPD: 0% DM: 7% HTN: 19% Obesity: NR Smoking: 16%	COVID-19 severity: 30% severe, 70% non-severe ICU admission: NR Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: NR Other: 30% Length of hospital stay (days, mean): 21 Planned time post-hospital (days): 30 Reported time post-hospital: NR
Jacobs, 2020[117] USA Prospective	Inclusion: Aged 18 or older; diagnosis of viral RNA PCR-confirmed COVID-19 infection during hospitalization; hospitalization duration of at least three days	N=183 Age (years, median): 57 Gender (% male): 62	COVID-19 severity: 95% mild ICU admission: NR Respiratory support

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: None	Exclusion: Individuals who had expired during or after hospitalization; non-English speakers; and individuals with a documented diagnosis of dementia or delirium	Race/ethnicity: 54% White, 9% Black, 9% Asian, 1% American Indian/Alaskan, 27% other/non-white Comorbidities: CVD: 12% CKD: NR COPD: 4% DM: 28% HTN: 48% Obesity: 49% Smoking: NR	Mechanical ventilation or ECMO: 5% NIV, HFNC, or CPAP: 81% Other: 13% Length of hospital stay (days, median): 7 Planned time post-hospital (days): 35 (±5) Reported time post-hospital: NR
Karaarslan, 2021[118] Turkey Prospective Funding: None	Inclusion: Aged between 18 and 70 years or older and discharged following hospitalization for COVID-19 Exclusion: Individuals who received intensive care unit care during hospitalization	N=300 Age (years, mean): 53 Gender (% male): 60 Race/ethnicity: NR Comorbidities: CVD: 15% CKD: 2% COPD: 2% DM: 28% HTN: 32% Obesity: NR Smoking: 7%	COVID-19 severity: NR ICU admission: None Respiratory support: NR Length of hospital stay (days, mean): 8 Planned time post-hospital (days): 14 and 30 Reported time post-hospital: NR
Katz, 2020[32] USA Retrospective Funding: None	Inclusion: Confirmed SARS-CoV-2 infection (RT-PCR); concurrent stroke diagnosis (stroke symptom onset during COVID-19 illness or onset of COVID-19 symptoms or SARS-CoV-2 positivity within 14 days of stroke symptom onset) confirmed by imaging Exclusion: None reported NOTE: included control group of all stroke patients admitted 1 year earlier between same dates to same hospitals	N=86 Age (years, mean): 67 Gender (% male): 56 Race: 30% White, 31% Black, 12% Asian, 27% Multiracial/other Comorbidities: CVD: NR CKD: NR COPD: NR DM: NR HTN: NR Obesity (BMI ≥30 kg/m^2): 31%	COVID-19 severity: among n=45 testing positive for COVID-19 after stroke symptoms 51% (23/45) had mild COVID-19 symptoms and 29% (13/45) were asymptomatic ICU admission: 51% (critical care admission) Respiratory support Mechanical ventilation or ECMO: 44% NIV, HFNC, or CPAP: 9% Other: 72% Length of hospital stay: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Smoking: NR	Planned/reported time post-hospital (days): 0 (discharge) NOTE: 48% (41/86) had stroke onset during hospitalization for COVID-19
Khalili, 2020[86] Iran Prospective cohort Funding: Not reported	Inclusion: Hospitalized with COVID-19 (confirmed by RT-PCR [76%] or CT findings), included patient with and without diabetes Exclusion: None reported	N=254 (127 with diabetes) Age (years, mean): 66 Gender (% male): 56 Race/ethnicity: NR Comorbidities: CVD: 8% CKD: 8% COPD: 3% DM: 50% HTN: 43% Obesity: NR Smoking: 4% current, 2% former	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 11% NIV, HFNC, or CPAP: 89% Other: NR Length of hospital stay (days, mean): 6 (range 1-60) Planned time post-admission (days): 90 Reported time post-admission: NR
Knights, 2020[137] United Kingdom Retrospective Funding: Not reported	Inclusion: Admitted to hospital with positive COVID-19 test Exclusion: None reported	N=108 Age (years, mean): 69 Gender (% male): 58 Race: White British: 76% Comorbidities: CVD: NR CKD: 6% COPD: 15% DM: 23% HTN: 45% Obesity: 31% Smoking: 44% Ex or current, 56% never NOTE: 10% were care home residents; 21% had a “package of care”	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 8% NIV, HFNC, or CPAP: 24% Other: 55% Length of hospital stay (days, median): 8 [IQR 4-13] Planned time post-admission to study end point (days): NR Reported time post-admission to study end point (days, median): 26

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Li, 2021[119] China Prospective Funding: Government	Inclusion: Patients admitted to the hospital for COVID-19 Exclusion: NR	N=107 Age (years, mean): 66 Gender (% male): 50 Race/ethnicity: NR Comorbidities: CVD: 13% CKD: NR COPD: NR DM: 11% HTN: 41% Obesity: NR Smoking: NR	COVID-19 severity: 55% mild, 45% critical/severe ICU admission: None Respiratory support: NR Length of hospital stay: NR Planned time post-hospital (days): 90-180 Reported time post-hospital (days, median): 93 (mild), 101 (critical severe)
Liotta, 2020[33] USA Retrospective Funding: Not reported	Inclusion: Admitted with COVID-19; diagnosis confirmed by SARS-CoV-2 RT-PCR Exclusion: None reported	N=509 Age (years, mean): 59 Gender (% male): 55 Race: 53% White, 30% Black or African American, 4% Asian, 13% Other/Unknown/Declined Comorbidities: CVD: NR CKD: 11% COPD: NR DM: 30% HTN: 54% Obesity (BMI >30 kg/m^2): 52% Smoking: 28% Current	COVID-19 severity: 26% severe ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 27% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 7 Planned/reported time post-hospital (days): 0 (discharge)
Liu, 2020[141] China Retrospective Funding: Government	Inclusion: Discharged following hospitalization; infected with SARS-CoV-2 (testing details NR) Exclusion: None reported	N=51 Age (years, mean): 47 Gender (% male): 42 Race/ethnicity: NR Comorbidities: CVD: 2% CKD: NR COPD: NR DM: 8%	COVID-19 severity: All 'common' COVID-19 (fever, some respiratory-infection symptoms, pneumonia on radiographic images) ICU admission: NR Respiratory support: NR Length of hospital stay: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		HTN: 14% Obesity: NR Smoking: 6%	Planned time post-hospital (days): 0 (last day before discharge), 14, and 28 Reported time post-hospital (days, median): 19 and 31
Loerinc, 2021[87] USA Retrospective Funding: None	Inclusion: Confirmed SARS-CoV-2 by RT-PCR or ICD-10 code for COVID-19; discharged from hospital Exclusion: Died during index hospital stay, admitted for unrelated reasons and incidentally tested (provider discretion) for COVID-19, discharged to home for end-of-life care with no additional post-discharge needs, transferred from study hospital to outside facility for continued hospitalization	N=310 Age (years, median): 58 Gender (% male): 49 Race/ethnicity: 69% African American, 18% White, 4% Hispanic, 9% Other Comorbidities: CAD: 8% CKD: 19% COPD: 5% DM: 36% HTN: 65% Obesity (BMI ≥30): 45% Smoking: NR	COVID-19 severity: NR ICU admission: 22% Respiratory support Mechanical ventilation or ECMO: 14% NIV, HFNC, or CPAP: NR Other: 70% Length of hospital stay (days, median): 5 Planned time post-hospital (days): 30 Reported time post-hospital: NR
Lovinsky-Desir, 2020[64] USA Retrospective Funding: Government, Foundation	Inclusion: Sequential patients 65 years or younger; positive for severe SARS-CoV-2 (RT-PCR); hospitalized or died in the emergency department Exclusion: None reported	N=1243 (age 21-29 [n=300] and 40-65 [n=943] groups only) Age (years, median): Age 21-39: 31-32 years Age 40-65: 56-58 years Gender (% male): 59 Race: 22% Black, 19% White, 1% Asian, 35% Other (NOTE: race identification declined for some patients) Comorbidities: CVD: NR CKD: NR COPD: 0% (excluded from analysis) DM: NR HTN: NR Obesity: 42% Smoking: 59% Never, 4% Current, 11% Former	COVID-19 severity: 100% severe defined as hospitalization with confirmed positive SARS-CoV-2 PCR result or death in emergency department ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 21% NIV, HFNC, or CPAP: NR Other: 6% (tracheostomy) Length of hospital stay (days, median): 4-6 days Planned/reported time post-hospital: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		(NOTE: smoking status missing for some patients)	
Lv, 2020[88] China Retrospective Funding: University and Government	Inclusion: Patients with laboratory (nucleic acid) confirmed infection with COVID-19 and lung involvement confirmed by chest imaging, improved and discharged Exclusion: Pregnant	N=137 Age (years, mean): 47 Gender (% male): 52 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: 2% DM: NR HTN: NR Obesity: NR Smoking: 4%	COVID-19 severity: 20% (27/137) severe, 80% (110/137) non-severe ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 0% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned time post-hospital (days): 14 Reported time post-hospital: NR
Mathew, 2020[46] India Retrospective Funding: None	Inclusion: COVID-related stroke (*ie,* stroke and positive RT-PCR for SARS-CoV-2), stroke confirmed by CT or MRI of the brain Exclusion: None reported	N=62 Age (years, mean): 56 Gender (% male): 77 Race/ethnicity: NR Comorbidities: CAD: 8% CKD: NR COPD: NR DM: 55% HTN: 62% Obesity: NR Smoking: NR	COVID-19 symptom onset to stroke symptom onset (days, mean): 12.5 COVID-19 severity: NR ICU admission: NR Respiratory support: NR Length of hospital stay (days, mean): 16 Planned/reported time post-hospital (days): 0 (discharge)
Matsunaga, 2020[47] Japan COVIREGI-JP Registry	Inclusion: Positive SARS-CoV-2 test, inpatient treatment Exclusion: Participants in other clinical studies and inclusion in registry deemed inappropriate, refused to participate	N=2638 (number of cases for each parameter varied due to missing data) Age (years, median): 56 (non-severe=52, severe=57) Gender (% male): 59 (non-severe=55, severe=68) Race/ethnicity: 96% Japanese	COVID-19 severity: 68% non-severe; 32% severe ICU admission: 11% (282/2638) (3% of non-severe cases, 26% of severe cases) Respiratory support

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: Government		Comorbidities: CVD: 1% CKD: NR COPD: 2% DM: 3% with complications, 14% without complications HTN: 15% Obesity: 6% Smoking: 14% Current	Mechanical ventilation or ECMO: 8% (2% of non-severe cases; 23% of severe) NIV, HFNC, or CPAP: 4% (2% of non-severe, 11% of severe) Other: NR Symptom onset to hospitalization (days, median): 7 Length of hospital stay (days, median): 15 Planned/reported time post-hospital (days): 0 (discharge)
Mo, 2020[34] China Cross-sectional Funding: Government	Inclusion: Hospital admitted; laboratory confirmed noncritical COVID-19 Exclusion: Critical cases	N=110 Age (years, mean): 49 Gender (% male): 50 Race: NR Comorbidities: CVD: 3% Kidney disease: 2% Lung disease: 3% DM: 8% HTN: 24% Obesity: NR Smoking: 12%	COVID-19 severity: 22% mild, 61% pneumonia, 17% severe pneumonia ICU admission: 0% Respiratory support Mechanical ventilation or ECMO: 0% (critical cases excluded) NIV, HFNC, or CPAP Other: NR Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Monday, 2020[89] USA (Veterans) Retrospective Funding: None	Inclusion: Veterans with laboratory confirmed COVID-19 infection (RT-PCR) Excluded: Civilians admitted to aid local health systems	N=79 Age (years, median): 69 Gender (% male): 94 Race/ethnicity: 90% African American, 9% White, 1% Other Comorbidities: CAD: 35% CKD: 25% COPD: 38%	COVID-19 severity: NR ICU admission: 11% (9/79) directly to ICU; 26% (18/70) were transferred to ICU Respiratory support (highest required) Mechanical ventilation or ECMO: 30% NIV, HFNC, or CPAP: 3% Other: 51%

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		DM: 61% HTN: 92% Obesity: 53% Smoking: 66% (current or former)	Symptoms onset to admission (days, median): 7 Length of hospital stay (days, median): 6 Planned time post-hospital (days): 30 Reported time post-hospital: NR
Morin, 2021[120] (COMEBAC Study Group) France Prospective Funding: Hospital/ University	Inclusion: Adults (>18 years) admitted to a university hospital; survived 4 months after hospital discharge or after ICU discharge; had been hospitalized for >24 hours primarily because of COVID-19; diagnosis of SARS-CoV-2 (RT-PCR) or CT lung scan (or both) Exclusion: Death within 4 months after discharge, persistent hospitalization, end-stage cancer, dementia, nosocomial COVID-19 infection, incidental positive SARS-CoV-2 results during hospitalization for a different medical indication	N=478 Age (years, mean): 61 Gender (% male): 58 Race/ethnicity: NR Comorbidities: CVD: 16% CKD: 11% COPD: 4% DM: 27% HTN: 47% Obesity: 37% Smoking: No 76%, Former 18%, Current 6%	COVID-19 severity: NR ICU admission: 30% Respiratory support Mechanical ventilation or ECMO: 15% (51% of patients in ICU) NIV, HFNC, or CPAP: NR Other: 43 Length of hospital stay (median): 9 days Planned time post-hospital (days): 120 Reported time post-hospital (days, median): 113 for telephone assessment; 125 for ambulatory assessment
Mowla, 2020[48] Multinational Retrospective Funding: None	Inclusion: Adult hospitalized patients with definitive diagnosis of cerebral venous sinus thrombosis (CVST) and confirmed diagnosis of SARS-CoV-2 infection (RT-PCR) or typical symptoms and corresponding findings on chest CT if RT-PCR wasn't available (n=1) Exclusion: None reported NOTE: CVST was attributed to SARS-CoV-2 infection if infection symptoms or diagnosis (whichever came first) occurred	N=13 (COVID-19 group) Age (years, mean): 51 Gender (% male): 39 Race/ethnicity: NR Comorbidities: NR	SARS-CoV-2 detected on same day as CVST presentation (n=2); COVID-19 associated symptoms prior to CVST symptom onset (n=11) COVID-19 severity: 1 with no symptoms, 9 with mild to moderate symptoms, 1 with severe (no severity data for 2 patients) ICU admission: NR Respiratory support: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	between 2 weeks prior to the onset of CVST symptoms and 2 days after hospital admission NOTE: Included historical control group		Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Naar, 2020[49] USA Prospective Funding: Not reported	Inclusion: Severe COVID-19 (RT-PCR confirmed) admitted to ICU Exclusion: None reported	N=206 Age (years, median): 60 Gender (% male): 65 Race/ethnicity: 43% Hispanic or Latino, 28% White (Non-Hispanic),11% Black or African American, 16% Other Comorbidities: CHD: 9% CKD: 13% COPD: 8% DM: 43% HTN: 50% Obesity: NR Smoking: 23%	COVID-19 severity: NR ICU admission: 100% (inclusion criteria) Respiratory support Mechanical ventilation or ECMO: 87% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 19 Planned/reported time post-hospital (days): 0 (discharge)
Nachega, 2020[50] Democratic Republic of the Congo Retrospective cohort Funding: Not reported	Inclusion: All COVID-19 patients admitted; RT-PCR testing was done Exclusion: None reported	N=766 (includes 34 children) Age (years, median): 46 Gender (% male): 66 Race/ethnicity: NR Comorbidities: CAD: NR CKD: 1% Asthma/COPD: 3% DM: 14% HTN: 25% Obesity (self-report): 5% Smoking: NR	COVID-19 severity: 61% Mild, 14% Moderate, 21% Severe, 4% Critical (WHO criteria) ICU admission: 25% (all severe and critical patients) Respiratory support: NR Length of hospital stay (days, median): 13 (for 645 recovered patients) Planned/reported time post-hospital (days): 0 (discharge)
Nemer, 2021[51] USA Retrospective	Inclusion: Positive for SARS-CoV-2 (by RT-PCR), admitted from emergency department to non-ICU bed and subsequently discharged	N=350 Age (years, mean): 64 Gender (% male): 55 Race/ethnicity: NR	COVID-19 severity: NR ICU admission: 14% (48/350)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: None	Exclusion: None reported	Comorbidities: CAD: 16% CKD: 17% COPD: 8% DM: 32% HTN: 66% Obesity: NR Smoking: 28% (current or prior)	Respiratory support Mechanical ventilation or ECMO: 6% NIV, HFNC, or CPAP: 5% Other: 86% Length of hospital stay (days, mean): 6 Planned/reported time post-hospital (days): 0 (discharge)
Nersesjan, 2021[142] Denmark Prospective Funding: Foundation	Inclusion: Age ≥18, admitted to tertiary referral center from the hospital's COVID-19 ICU, COVID-19 intermediate care unit, and the neurological department; positive for SARS-CoV-2 (RT-PCR) except 1 patient with clinical suspicion (later confirmed) Exclusion: None reported NOTE: patients from ICU and intermediate care unit were screened for neurological and psychiatric symptoms during those admissions and evaluated for cognitive status and neurological deficits at discharge; patients from neurological department were screened for suspected neurological complications during/after a COVID-19 infection	N=61 Age (years, mean): 63 Gender (% male): 63 Race/ethnicity: 80% Caucasian, 0% Asian, 1% Middle Eastern, 0% African, 4% Inuit Comorbidities: CAD: 13% CKD: NR COPD: 8% DM: 15% HTN: 15% Obesity: Smoking:	COVID-19 severity: NR ICU admission: 57% Respiratory support Mechanical ventilation or ECMO: 64% NIV, HFNC, or CPAP: 5% Other: 86% Symptom onset to admission (days, mean): 7 Length of hospital stay (days, mean): 30 Planned time post-hospital (days): 90 Reported time post-hospital: NR
Ng, 2020[35] USA Retrospective Funding: Not reported	Inclusion: All adult (age ≥18 years) patients who tested positive for COVID-19 (RT-PCR); hospitalized in 1 of 13 hospitals in a large health system Exclusion: Transferred to hospitals outside the health system; admitted to inpatient obstetric service; end stage kidney disease; prior kidney transplant; <2 serum creatinine levels during admission	N=9,657 (demographic data for 40% [3,854/9,657] who developed AKI while hospitalized; 638 [17%] required KRT) Age (years, medians): KRT: 64 Non-KRT: 71 (P<.001) Gender (% male): KRT: 79 Non-KRT: 58 (P<.001) Race/Ethnicity:	COVID-19 severity: NR ICU admission: KRT: 92%, Non-KRT: 45% (P<.001) Respiratory support Mechanical ventilation or ECMO: KRT: 92%, Non-KRT 41% (P<.001) NIV, HFNC, or CPAP: NR Other: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		KRT: 25% Non-Hispanic White, 22% Non-Hispanic Black, 22% Hispanic Non-KRT: 38% Non-Hispanic White, 21% Non-Hispanic Black, 19% Hispanic (P<.001) Comorbidities (all P<.001): CAD: KRT: 13%, Non-KRT: 18% CKD: KRT: 7%, Non-KRT: 9% COPD: KRT: 6%, Non-KRT: 8% DM: KRT: 48%, Non-KRT: 43% HTN: KRT: 64%, Non-KRT: 69% Obesity: BMI 30 or higher KRT: 45%, Non-KRT: 32% Smoking: KRT: 64% never, 22% current, 14% unknown Non-KRT: 67% never, 23% current, 10% unknown (P<.001)	Length of hospital stay (days, median): KRT: 29; Non-KRT: 12 Planned/reported time post-hospital (days): 0 days (discharge)
Ntaios, 2020[36] Multi-national (Global COVID-19 Stroke Registry) Retrospective Funding: None	Inclusion: Hospitalized with laboratory-confirmed COVID-19 (96% by PCR, 4% by serology) and acute ischemic stroke (NOTE: median delay between initiation of COVID-19 symptoms and stroke onset=7 days [IQR 2-15]) Exclusion: Infected after onset of stroke (NOTE: also included propensity matched group of non-COVID-19 patients from other registries)	N=174 Age (years, median): 71 Gender (% male): 62 Race: NR Comorbidities: CAD: 17% CVD: NR CKD: NR COPD: NR DM: 31% HTN: 68% Obesity: 37% Smoking: 28%	COVID-19 severity: NR ICU admission: 23% (40/174) Respiratory support Mechanical ventilation or ECMO: 16% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned/reported time post-hospital (days): 0 (discharge)
Nugent, 2021[121] USA Retrospective	Inclusion: Tested for COVID-19 by RT-PCR, developed AKI during hospitalization, survived past discharge, did not require dialysis within 3 days of discharge, had ≥1 measurement of serum creatinine as an outpatient post-discharge	N=1612 (182 COVID-19) Age (years, median): 70 (67 COVID-19 group) Gender (% male): 50 (53 COVID-19 group) Race/ethnicity: 40% Black, 41% White, 3% Asian, 17% Other; 22% Hispanic (COVID-19 group)	COVID-19 severity: NR ICU admission: 37% (COVID-19 group) Respiratory support Mechanical ventilation or ECMO: 29% (COVID-19 group)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: Foundation	Exclusion: Age <18 years, determined to have ESKD, received prior kidney transplant, initial creatinine level ≥4 mg/dL	Comorbidities: CVD: NR CKD: 35% (33% COVID-19 group) COPD: 47% (45% COVID-19 group) DM: 52% (64% COVID-19 group) HTN: 89% Obesity: NR Smoking: NR	NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 14 (COVID-19 group) Planned time post-hospital: NR Reported time post-hospital (days, median): 92 (COVID-19 group)
Osikomaiya, 2021[122] Nigeria Retrospective Funding: Government	Inclusion: Discharged from COVID-19 facility based on resolution of symptoms and/or 2 negative RT-PCR SARS-CoV-2 results (at least 24 hrs apart) Exclusion: Potential confounding comorbidities or concurrent infections	N=274 Age (years, mean): 42 Gender (% male): 66 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 3% HTN: 16% Obesity: NR Smoking: NR	COVID-19 severity (WHO): 7% asymptomatic, 51% mild, 39% moderate, 3% severe ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time post-hospital (days): 14 Reported time post-hospital (days, median): 15
Overstad, 2020[52] Norway Retrospective Funding: Not reported	Inclusion: Confirmed (RT-PCR) SARS-CoV-2, included in local quality register for COVID-19 Exclusion: None reported	N=70 Age (years, median): 59 Gender (% male): 67 Race/ethnicity: 60% Norwegian; 40% immigrants Comorbidities: CAD: 30% CKD: 10% COPD/asthma: 16% DM: 24% HTN: NR Obesity: 31% Smoking: NR	Duration of symptoms prior to admission (days, median): 7 COVID-19 severity: 19% critically ill ICU admission: 19% Respiratory support Mechanical ventilation or ECMO: 19% NIV, HFNC, or CPAP: 6% Other: NR Length of hospital stay (days, median): 6

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
			Planned/reported time post-hospital (days): 0 (discharge)
Ozer, 2021[123] Turkey Prospective Funding: NR	Inclusion: Hospitalized with diagnosis of COVID-19 (positive PCR test); admitted to cardiology clinic for 'routine control' Exclusion: Coronary artery disease, heart failure, atrial fibrillation, previous cerebrovascular disease, renal failure, severe COPD, malignancy, poor echogenicity, <18 years of age	N=74 Age (years, mean): 60 Gender (% male): 39 Race/ethnicity: NR Comorbidities: CVD: NR (excluded) CKD: NR (excluded) COPD: NR (severe excluded) DM: 11% HTN: 43% Obesity: NR Smoking: 8%	COVID-19 severity: NR ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time post-hospital: NR Reported time post-hospital (days, mean): 30
Parra, 2020[90] Spain Case-control Funding: None	Inclusion: Laboratory confirmed SARS-CoV-2 infection, admitted and discharged alive Exclusion: Death during 3 weeks following discharge for controls NOTE: Case patients were readmitted within 3 weeks of discharge with clinical presentation related to the infection or its treatment; controls were discharged but not readmitted	N=61 readmitted patients Age (years, median): 67 Gender (% male): 45 Race/ethnicity: NR Comorbidities: CVD: 26% CKD: NR COPD: 20% DM: 23% HTN: 55% Obesity: 10% Smoking: NR	COVID-19 severity: NR ICU admission: 5% Respiratory support: NR Length of hospital stay (days, median): 6 Planned time post-hospital (days): 21 Reported time post-hospital (days, median): 6
Patell, 2020[65] USA Retrospective Funding: Not reported	Inclusion: Age ≥18 years; positive for SARS-CoV-2 (RT-PCR) Exclusion: Hospitalized at time of analysis; discharged without any form of post-discharge contact in hospital medical records; discharged on therapeutic anticoagulation (separate reporting for	N=163 Age (years, median): 58 Gender (% male): 48 Race: 37% White Comorbidities: Heart disease: 12% CKD: 10% Chronic respiratory disease: 22%	COVID-19 severity: NR ICU admission: 26% Respiratory support: NR Length of hospital stay (days, median): 6 Planned time post-hospital (days): 30

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	patients discharged on prophylactic-dose anticoagulation)	DM: 31% HTN: 53% Obesity: NR Smoking: NR	Reported time post-hospital: NR
Paterson, 2020[37] United Kingdom Retrospective case series Funding: Several authors receive funding; not specified if related to this project	Inclusion: Patients referred to COVID-19 neurology/encephalitis and neurovascular multi-disciplinary team meetings; "definite" cases determined with RT-PCR Exclusion: None reported	N=43 (demographic data for 16 with definite COVID-19 diagnosis and discharged) Age (years, mean): 57 Gender (% male): 56 Race: 63% White, 23% Black, 13% Asian Comorbidities: CVD: NR CKD: NR COPD: NR DM: 6% HTN: 38% Obesity: NR Smoking: NR	COVID-19 severity: 19% critical, 19% severe, 63% mild ICU admission: 25% Respiratory support Mechanical ventilation or ECMO: 19% (critical cases, by definition) NIV, HFNC, or CPAP: NR Other: 19% (severe cases, by definition) Length of hospital stay (days, mean): 16.6 (reported for 12 patients) Planned/reported time post-hospital (days): 0 (discharge)
Perry, 2020[53] United Kingdom Retrospective case-control Funding: None	Inclusion: Clinical diagnosis of stroke and tested positive for SARS-CoV-2 within 4 days of admission (or within 4 days of stroke for inpatient strokes) or stroke in patients with clinical suspicion of COVID-19 at time of admission and were found to be SARS-CoV-2 positive at any point during first 10 days of admission Exclusion: Subarachnoid hemorrhage, acquired COVID-19 after stroke, date of stroke onset could not be estimated NOTE: included concurrent control group of patients who were either consistently SARS-CoV-2 negative or never tested because no symptoms or signs of COVID-19	N=86 (COVID-19 group) Age (years, median): 75 Gender (% male): 55 Race/ethnicity: 72% White, 10% Black, 18% Asian, 1% Mixed/Other Comorbidities: NR	For 44 cases with ischemic stroke and known dates of onset of stroke and COVID-19, onset of COVID-19 symptoms occurred a median of 6 days before stroke onset; for 3 patients with intracerebral hemorrhage and known dates, COVID-19 symptoms occurred a median of 4 days after stroke onset COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 8% NIV, HFNC, or CPAP: 1% Other: 43% Length of hospital stay (days, median): 7

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
			Planned/reported time post-hospital (days): 0 (discharge)
Puntmann, 2020[66] Germany Prospective Funding: Government, Industry, Institution	Inclusion: Minimum of 2 weeks post-diagnosis of SARS-CoV-2 by RT-PCR; resolution of respiratory symptoms; negative results on swab test at end of isolation period Exclusion: Recently recovered from COVID-19 and referred for clinical CMR imaging; unwilling to participate; absolute contraindications for contrast-enhanced magnetic resonance study NOTE: included healthy and risk-factor matched control groups	N=100 Age (years, mean): 49 Gender (% male): 53 Race: NR Comorbidities: CVD: 13% CKD: NR COPD: 21% DM: 18% HTN: 22% Obesity: NR Smoking: 22%	COVID-19 severity: 18% asymptomatic, 49% mild/moderate (both recovered at home), 33% severe (required hospitalization) ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 2%, 6% (hospitalized group) NIV, HFNC, or CPAP: 17%, 52% (hospitalized group) Other: 28% (NR for hospitalized group) Length of hospital stay: NR Planned/reported time post-hospital: NR NOTE: median time from diagnosis to CMR was 71 [IQR 64-92] days)
Qin 2021[103] China Prospective Funding: None	Inclusion: Patients hospitalized with PCR-confirmed COVID-19 Exclusion: Patients who died or were lost to follow-up.	N=647 (81 w pulmonary outcomes) Age (years, mean): 58 Gender (% male): 44 Race/ethnicity: NR Comorbidities: CVD: 5% CKD: NR COPD: 6% (listed as chronic respiratory disease) DM: 11% HTN: 30% Obesity: NR Smoking: NR	COVID-19 severity: 51% non-severe, 49% severe ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 40% NIV, HFNC, or CPAP: 16% Other: NR Length of hospital stay (days, mean): 18 (for 81 pulmonary patient subset) Planned time post-hospital (days): 90 Reported time post-hospital: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Raman, 2021[124] United Kingdom Prospective Funding: Government, Foundation	Inclusion: All patients with moderate to severe laboratory COVID-19 (positive SARS-CoV-2) Exclusion: Severe comorbidities (end-stage renal, cardiac, liver, or neurological disease), contradictions to MRI NOTE: included uninfected (negative for SARS-CoV-2 and asymptomatic) controls from the community (not hospitalized), group-matched for age, sex, body mass index, and risk factors	N=58 COVID-19 Age (years, mean): 55 Gender (% male): 59 Race/ethnicity: 22% Black/Asian and minority ethnic groups; 78% White Comorbidities: CAD: 3% CKD: NR COPD: 5% DM: 16% (Type 1 and 2) HTN: 38% Obesity: NR Smoking: 35% Current or ex-smoker	COVID-19 severity: Moderate to severe (inclusion criteria) ICU admission: 36% (21/58) Respiratory support Mechanical ventilation or ECMO: 21% NIV, HFNC, CPAP: 26% Other: 46% Length of hospital stay (days, median): 8.5 Planned time post-hospital (days): 30-180 Reported time post-hospital (days, median): 48
Ramani, 2021[91] USA Retrospective Funding: Not reported	Inclusion: Admitted with COVID-19 (not confirmed), follow-up in post-COVID-19 ICU clinic approximately 6 weeks after discharge Exclusion: None reported	N=28 (attended clinic) Age (years, median): 56 Gender (% male): 61 Race/ethnicity: 25% African American, 57% Hispanic, 14% White, 4% Asian Indian Comorbidities: NR	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 86% NIV, HFNC, CPAP: NR Other: NR Length of hospital stay (days, median): 22 Planned time post-hospital: NR Reported time post-hospital (days, median): 40
Rashidi, 2020[92] Iran Retrospective Funding: Not reported	Inclusion: Hospitalized patients with diagnosis of COVID-19 (RT-PCR [64%] or chest CT scan [36%]) Exclusion: None reported	N=1529 Age (years, median): 56 Gender (% male): 54 Race/ethnicity: NR Comorbidities: CAD: 10%	COVID-19 severity: NR ICU admission: 8% Respiratory support: NR Length of hospital stay: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		CKD: 5% COPD: 10% DM: 18% HTN: 29% Obesity: 14% Smoking: 15%	Planned time post-hospital (days): ≥45 Reported time post-hospital (days, range): 45-55
Rass, 2021[125] Austria Prospective Funding: NR	Inclusion: positive RT-PCR test, hospitalization or outpatient management, age ≥18y Exclusion: age <18 years and patients who died during acute phase of COVID-19	N=135 (103 hospitalized) Age (years, median): 56 Gender (% male): 61 Race/ethnicity: NR Comorbidities: CVD: 40% CKD: 7% COPD: NR DM: 18% HTN: 30% Obesity: NR Smoking: 3% (40% former)	COVID-19 severity (based on type of hospitalization): 23% severe (ICU), 53% moderate (non-ICU), 24% mild (outpatient) ICU admission: 23% Respiratory support Mechanical ventilation or ECMO: 22% NIV, HFNC, or CPAP: NR Other: 50% Length of hospital stay (days, mean): 8 Planned time post-hospital (days): 90 Reported time post-hospital: NR
Remy-Jardin, 2021[126] France Retrospective Funding: None	Inclusion: patients hospitalized with confirmed COVID-19 who had residual respiratory symptoms (*ie*, dyspnea, dry cough) and/or concern on chest radiographic abnormalities and were referred to the department of pulmonology for specialized follow-up. Underwent dual-energy CT angiography (DECTA) Exclusion: Patients with no need for further investigation, received non-contrast CT or single-energy CTA	N=55 Age (years, mean): 60 Gender (% male): 76 Race/ethnicity: NR Comorbidities: CVD: NR CKD: 1% COPD: 5% DM: 16% HTN: 40% Obesity: 35% Smoking: 44%	COVID-19 severity: NR but 42% had “critical respiratory status” (admitted to ICU) ICU admission: 42% Respiratory support Mechanical ventilation or ECMO: 29% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay: NR Planned time post-hospital (days): 90 Reported time post-hospital (days, median): 144 to CT exam

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Richardson, 2020[67] USA Case Series Funding: Government	Inclusion: Consecutive patients at 12 hospitals in an academic health system requiring hospital admission with confirmed SARS-CoV-2 infection (RT-PCR) Exclusion: None reported	N=5,700 (2,081 were discharged) Age (years, median): 63 Gender (% male): 60 Race: African American 23%, Asian 9%, White 40%, Multiracial 29% Comorbidities: CAD: 11% CKD: 5% COPD: 5% DM: 34% HTN: 57% Obesity: 42% Smoking:16%	COVID-19 severity: NR ICU admission (discharged): 4% (82/2081) Respiratory support Mechanical ventilation or ECMO (discharged): 2% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (medians, discharged patients): <18 years (n=32): 2.0 days 18-65 years (n=1,373): 3.8 days >65 years (n=676): 4.5 days Planned time post-hospital: NR Reported time post-hospital (days, median): 4.4
Roberts, 2020[68] United Kingdom Prospective Funding: Not reported	Inclusion: Patients discharged following admission for COVID-19; 6-week follow-up for hospital-associated VTE (HA-VTE) events Exclusion: None reported NOTES: 1) patients received thromboprophylaxis while hospitalized 2) comparison cohort of post-discharge HA-VTE following medical admission in 2019	N=1877 Age (years, mean): NR Gender (% male): NR Race: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: NR (11% [208/1877] admitted to critical care) Respiratory support: NR Length of hospital stay: NR Planned/reported time post-hospital (days): 90
Rodriguez, 2020[54] USA American Heart Association	Inclusion: Age ≥18 years, hospitalized with COVID-19 as diagnosis, discharged with complete data on admission and discharge dates, age, sex, and medical history	N=7,868 Age (years, mean): 61 Gender (% male): 55 Race/ethnicity: 33% Hispanic, 26% non-Hispanic Black, 6% Asian, 35% non-Hispanic White	Time from symptom onset to hospital arrival (days, weighted mean): 5 COVID-19 severity: NR ICU admission: 29%

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
COVID-19 CVD Registry Funding: Industry, Foundation	Exclusion: None reported	Comorbidities: CAD: 9% CKD on dialysis: 4% Pulmonary disease: 19% DM: 37% HTN: 60% Obesity: 39% Smoking: 6%	Respiratory support Mechanical ventilation or ECMO: 22% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, weighted mean): 6 Planned/reported time post-hospital (days): 0 (discharge)
Sachdeva, 2020[69] USA Retrospective Funding: None	Inclusion: Age ≥18 years; end stage kidney disease on chronic peritoneal dialysis; hospitalized with COVID-19 (positive by PCR testing)	N=11 Age (years, median): 54 (<50: 36%; 50-59: 27%; 60-69: 27%; 70-79: 9%) Gender (% male): 27 Race: 9% Hispanic, 45% Non-Hispanic Black; 9% Non-Hispanic White; 36% Other or Unknown Comorbidities: CAD: 9% CKD: 100% COPD: 0% DM: 45% HTN: 91% Obesity (BMI ≥30 kg/m^2): 36% Smoking: 82% Never, 18% Former	COVID-19 severity: NR ICU admission: 27% Respiratory support Mechanical ventilation or ECMO: 27% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, mean): 9 (range 2-23) Planned/reported time post-hospital: NR
Salisbury, 2020[93] United Kingdom Retrospective Funding: Government	Inclusion: Age ≥18 years, SARS-CoV-2 (RT-PCR) Exclusion: Admission <24 hours, VTE diagnosed within first 24 hours after presentation, diagnosed with COVID-19 during hospital stay for other medical conditions	N=152 (subgroup discharged without an indication for therapeutic anticoagulation) Age (years, median): 62 Gender (% male): NR Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU or high dependency unit admission: 16% Respiratory support: NR for subgroup Length of hospital stay (days, mean): 7 Planned time post-hospital (days): 90 Reported time post-hospital (days): 42

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Sami, 2020[94] Iran Prospective Funding: Government, University	Inclusion: Admitted for COVID-19 (RT-PCR or chest CT), discharged Exclusion: Minors	N=490 Age (years, mean): 57 Gender (% male): 61% Race/ethnicity: NR Comorbidities: HTN: 35% CVD/CAD: 14% DM: 28% CKD: 3% COPD: 2% Smoking: 14%	COVID-19 severity: 12% of patients discharged had composite events of mechanical ventilation or ICU admission ICU admission: 8% (overall) Respiratory support: NR Length of hospital stay (days, median): 5 Planned time post-hospital (days): 7, 30, 84, and 365 Reported time post-hospital (days): 7 and 28
Shah, 2020[95] Canada Prospective Funding: Foundation, University	Inclusion: Adults hospitalized with laboratory-confirmed SARS-CoV-2 infection	N=60 Age (years, median): 67 Gender (% male): 68 Race/ethnicity: NR Comorbidities: HTN: 35% DM: 22% CPOD: 13% CAD: 10% CKD: 7%	COVID-19 severity: NR ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 20% NIV, HFNC, or CPAP: NR Other: 78% Length of hospital stay (days, mean): 10 Planned time post-symptom onset (days): 90 Reported time post-symptom onset: NR
Sibilia, 2021[144] Spain Retrospective Funding: None	Inclusion: All patients discharged after hospitalization with COVID-19 Exclusion: NR	N=172 Age (years, mean): 56 Gender (% male): 57 Race/ethnicity: NR Comorbidities: CVD: 14% CKD: NR COPD: 4% DM: 15%	COVID-19 severity: 29% moderate, 71% severe ICU admission: 43% Respiratory support Mechanical ventilation or ECMO: 18% NIV, HFNC, or CPAP: NR Other: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		HTN: 33% Obesity: NR Smoking: 5%	Length of hospital stay (days, mean): 20 Planned time post-hospital (days): 90 Reported time post-hospital (mean, days): 101
Somani, 2020[70] USA Retrospective Funding: Government	Inclusion: Age ≥18 years; laboratory confirmed SARS-CoV-2; admitted and subsequently discharged alive from 5 health system hospitals Excluded: Discharge before April 12, 2020 (all patients had ≥14 day observation for possible readmission); returned <12 hours after discharge; died during index admission	N=2,864 (n=103 returned to hospital; 2,761 did not) Age (years, median): 66 Gender (% male): 58 Race: 4% Asian, 28% Black, 27% Hispanic, 24% White; 17% Unknown/Other NOTE: no differences between groups for Age, Gender, or Race Comorbidities: CAD: 8% CKD: 5% COPD: Returned: 7%; No Return: 3%; P=.035 DM: 15% HTN: Returned: 35%; No Return: 22%; P=.003 Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: Returned: 6%; No Return: 19%; P=.001 Respiratory support Mechanical ventilation or ECMO: Returned: 1%; No Return: 11%; P=.003 NIV, HFNC, or CPAP: Returned 42%; No Return: 49% Other: NR Length of hospital stay (days, median): Returned: 4.7; No Return: 7; P=.006 Planned time post-hospital (days): <14 Reported time post-hospital: NR
Sonnweber 2020[96] Austria Prospective Funding: Foundation, Industry, University	Inclusion: Diagnosis of COVID-19 (RT-PCR and typical presentation), hospitalized or outpatient care with persisting symptoms Exclusion: Unable to attend regular follow-up, rejection of study participation	N=145 (n=133 for second follow-up) Age (years, mean): 57 Gender (% male): 55 Race/ethnicity: NR Comorbidities: CVD: 40% HTN: 30% COPD: 6% DM: 17% CKD: 7% Obesity: NR Smoking: 3%	COVID-19 severity: 75% hospitalized ICU admission: 22% Respiratory support Mechanical ventilation or ECMO: 27% NIV, HFNC, or CPAP: 3% Other: 66% Length of hospital stay: NR Planned time post-diagnosis (days): 60 and 100

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
			Reported time post-diagnosis (days, mean): 63 and 103
Spinicci, 2021[127] Italy Retrospective Funding: University	Inclusion: Patients hospitalized with COVID-19 Exclusion: Discharged >10 weeks, unable to attend clinical visit due to hospitalization or residents in care facilities, patient refusal	N=100 Age (years, median): 68 Gender (% male): 59 Race/ethnicity: NR Comorbidities: CVD: 12% CKD: 7% COPD: 12% DM: 21% HTN: 50% Obesity: 25% Smoking: NR	COVID-19 severity (WHO): 9% mild, 32% moderate, 12% severe, 47% critical ICU admission: 31% Respiratory support Mechanical ventilation or ECMO: 21% NIV, HFNC, or CPAP: 33% Other: 33% Length of hospital stay (days, median): 16 Planned time post-hospital (days): 56 Reported time post-hospital (days, median): 60
Stevens, 2020[97] USA Retrospective Funding: Not reported	Inclusion: Positive for SARS-CoV-2 (RT-PCR), admitted to an ICU, received RRT for AKI Exclusion: ESRD on KRT prior to admission	N=115 Age (years, median): 63 Gender (% male): 73 Race/ethnicity: 32% Black, 23% White, 4% Asian, 23% Multi-racial, 17% NR Comorbidities: CAD: 10% CKD: 28% COPD: 7% DM: 50% HTN: 70% Obesity: 54% Smoking: 8%	Time from symptom onset to presentation (days, median): 6 COVID-19 severity: NR ICU admission: 100% (inclusion criteria) Respiratory support Mechanical ventilation or ECMO: 99% NIV, HFNC, or CPAP: NR Other: NR Length of hospital stay (days, median): 36 Planned time post-hospital: NR Reported time post-hospital (days, median): 29 (from RRT initiation)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Suarez-Robles, 2021[128] France Retrospective Funding; None	Inclusion: Patients discharged for PCR-confirmed COVID-19 Exclusion: subjects who did not consent	N=134 Age (years, mean): 59 Gender (% male): 46 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: 1% Respiratory support Mechanical ventilation or ECMO: NR NIV, HFNC, or CPAP: NR Other: 3% Length of hospital stay: NR Planned time post-hospital (days): 90 Reported time post-hospital: NR
Suleyman, 2020[138] USA Retrospective case series Funding: Not reported	Inclusion: Consecutive adult patients evaluated at 5 hospitals and 9 emergency departments in a health system; confirmed SARS-CoV-2 infection (RT-PCR) Exclusion: Lack of demographic and baseline data	N=355 (hospitalized) (108 discharged home after initial evaluation not reported here) Age (years, mean): 61 Gender (% male): 47 Race: 73% African American Comorbidities: CAD: 16% CKD: 45% COPD: 12% DM: 43% HTN: 73% Obesity: 59% Smoking: 39%	COVID-19 severity: NR ICU admission: 40% Respiratory support Mechanical ventilation or ECMO: General practice unit: 0% (0/234); ICU: 81% (114/141) P<.001 NIV, HFNC< or CPAP: NR Other: NR Length of hospital stay (days, median): General practice unit: 5 [3-7] ICU: 15 [9-23] P<.001 Planned time post-hospital (days): 30 Reported time post-hospital: NR
Taquet, 2021[129] USA Retrospective	Inclusion: Age >10 years, confirmed diagnosis of COVID-19 Exclusion: NR	N=236379 (COVID-19 group) Age (years, mean): 46 Gender (% male): 44	COVID-19 severity: NR ICU admission: 4% (8945/236379)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Funding: University	NOTE: Participants organized into one primary cohort (confirmed diagnosis of COVID-19) and 2 matched control cohorts (diagnosed with influenza and diagnosed with any respiratory tract infection including influenza)	Race/ethnicity: 57% White, 19% Black or African American, 3%Asian, 20% Unknown; 16% Hispanic or Latino Comorbidities: CVD: NR CKD: 7% COPD: NR DM: 16% HTN: 30% Obesity: 18% Smoking: NR	Respiratory support: NR Length of hospital stay: NR Planned time post-hospital (days): 180 Reported time post-hospital: NR
Tomasoni, 2021[130] Italy Cross-sectional Funding: Foundation	Inclusion: Patients with documented clinical recovery and virological clearance after hospitalization for COVID-19 disease (clinical recovery was defined as absence of fever for 48-72 hours and normal oxygen saturation on ambient air with concomitant hospital discharge and virological clearance was defined as presence of 2 consecutive negative nasopharyngeal swabs taken 24-48 hours apart, at least 14 days after clinical recovery) Exclusion: NR	N=105 Age (years, median): 55 Gender (% male): 73% Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR (all patients had interstitial pneumonia at admission) ICU admission: NR Respiratory support Mechanical ventilation or ECMO: 28% (non-invasive or orotracheal intubation) NIV, HFNC, or CPAP: NR Other: 72% (low flow oxygen or none) Length of hospital stay (days, mean): 8 Planned time post-hospital (days): 30-90 Reported time post-hospital (days, median): 46
Tudoran, 2021[131] Romania Prospective Funding: None	Inclusion: Hospitalized for SARS-CoV-2 (RT-PCR) and discharged alive; mild/moderate disease; age <55 years; no history of significant associated cardiovascular pathology or diabetes; cardiologic exam with routine transthoracic echocardiography (TTE) at/near time of admission	N=125 Age (years, median): 47 Gender (% male): 50 Race/ethnicity: NR Comorbidities: CVD: NR CKD: NR COPD: NR	COVID-19 severity: 100% mild/moderate ICU admission: 0% (exclusion criteria) Respiratory support Mechanical ventilation or ECMO: 0% (exclusion criteria) NIV, HFNC, or CPAP: NR Other: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
	Exclusion: Age >55; severe or critical. COVID-19; respiratory insufficiency requiring mechanical ventilation and/or ICU stay during hospitalization; associated medical conditions on TTE as determined by cardiologist	DM: 0% (inclusion criteria) HTN: NR Obesity: 29% Smoking: NR	Length of hospital stay: NR Planned time post-hospital (days): 42-70 Reported time post-hospital: NR
Venturelli, 2021[132] Italy Prospective Funding: Public	Inclusion: Patients aged >18 discharged from the emergency department or admitted wards of the hospital with any condition possibly related to SARS-CoV-2 Exclusion: Asymptomatic pregnant women admitted for delivery and asymptomatic patients found positive to the molecular test admitted for planned procedure for other conditions	N=767 (NOTE: 510 felt recovered) Age (years, mean): 63 Gender (% male): 67 Race/ethnicity: NR Comorbidities: CVD: 10% CKD: NR COPD: 5% DM: 7% HTN: 22% Obesity: 22% Smoking: 4%	COVID-19 severity: NR ICU admission: 9% Respiratory support Mechanical ventilation: 8% NIV, HFNC, or CPAP: 18% Other: 73 Length of hospital stay (days, median): 18 (without ICU admission), 58 (with ICU admission) Planned time post-hospital: NR Reported time post-hospital (days, median): 81
Vizcaychipi, 2020[38] United Kingdom Prospective Funding: None	Inclusion: Admitted to Emergency Department; completed hospital encounter (discharged alive or died) Exclusion: Remained in admitting hospital; transferred to another hospital NOTE: study was designed to evaluate the effect of an electronic medical record alert system on early mortality related to COVID-19	N=1,039 admitted; data for n=939 who completed hospital encounter Age (years, median): 67 Gender (% male): 60 Race: 62% White Comorbidities: CVD: NR CKD: NR COPD: 10% DM: 38% HTN: 53% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: 14.4% (150/1039) Respiratory support: NR Length of hospital stay (days, median): 7 Planned/reported time post-hospital (days): 0 (discharge)

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Vlachou, 2021[98] United Kingdom Retrospective Funding: Not reported	Inclusion: Admitted with positive test for SARS-CoV-2, underwent CT pulmonary angiography (CTPA) because of increasing oxygen requirements or refractive hypoxia, not improving on oxygen, very elevated D-dimer, or tachycardia disproportionate to clinical condition Exclusion: None reported	N=39 Age (years, mean): 62 Gender (% male): 56 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR (100% 'severe' – not defined) ICU admission: NR Respiratory support: NR Length of hospital stay (days, median): 7 Planned time post-hospital (days): 28 Reported time post-hospital: NR
Wang, 2020[71] China Prospective cohort Funding: Government	Inclusion: Confirmed COVID-19 patients discharged from hospital Exclusion: Could not be contacted or refused to participate	N=131 Age (years, median): Non-severe: 38; Severe: 60 (P<.0001) Gender (% male): 45 Race: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 2% HTN: 3% Obesity: NR Smoking: NR	COVID-19 severity: 53% (69/131) severe ICU admission: NR (NOTE: "severe" category did not require ICU admission) Respiratory support: NR Length of hospital stay (days, median): 15 Planned time post-hospital (days): 28 Reported time post-hospital (days, median): 25
Wu, 2021[133] China Prospective Funding: Government	Inclusion: ≥18 years, severe COVID-19 (confirmed with RT-PCR), discharged from hospital Exclusion: History of hypertension, diabetes, cardiovascular disease, cancer, or chronic lung disease (including asthma and COPD) or history of smoking documented at time of hospital admission; required intubation and mechanical ventilation	N=83 Age (years, mean): 60 Gender (% male): 57 Race/ethnicity: NR Comorbidities: see Exclusion CVD: 0% CKD: NR COPD: 0% DM: 0% HTN: 0% Obesity: NR	COVID-19 severity: Severe (inclusion criteria) ICU admission: 0% (exclusion criteria) Respiratory support Mechanical ventilation or ECMO: 0% (exclusion criteria) NIV, HFNC, or CPAP: 55% Other: 45% Length of hospital stay (days, median): 29

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Smoking: 100% never smoked	Planned time post-hospital (days): 90, 180, 270, and 365 Reported time post-hospital (days, median): 98, 189, 275, and 348
Xia, 2020[55] China Retrospective Funding: Not reported	Inclusion: Confirmed COVID-19, hospitalized in regular care inpatient ward	N=282 (mild and moderate COVID-19) Age (years, mean): 48 Gender (% male): 50 Race/ethnicity: NR Comorbidities: CVD: 22% CKD: NR COPD: 2% DM: 11% HTN: NR Obesity: NR Smoking: NR	Time from symptom onset to hospitalization (days, mean): 5 COVID-19 severity: 2% mild, 98% moderate ICU admission: 0% (inclusion criteria) Respiratory support: NR Length of hospital stay (days, mean): 16 Planned/reported time post-hospital (days): 0 (discharge)
Xiong, 2021[99] China Prospective Funding: Not reported	Inclusion: Ages 20-80 years, diagnosed with COVID-19, cured and discharged Exclusion: Severe and complex underlying diseases, receiving invasive treatment, women who were pregnant or breastfeeding NOTE: included control group free of COVID-19, similar demographics, completely quarantined at home for >3 months with little physical work	N=538 (those who completed telephone follow-up from group of 891 discharged) Age (years, median): 52 Gender (% male): 46 Race/ethnicity: NR Comorbidities: CHD: 3% CKD: 2% COPD: 4% DM: 7% HTN: 15% Obesity: NR Smoking: NR	COVID-19 severity: 5% critical, 34% severe, 62% “general” ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time post-hospital: NR Reported time post-hospital (days, median): 97

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
Xu, 2020[72] China Retrospective case series Funding: Government	Inclusion: Adults with confirmed SARS-CoV-2 infections (RT-PCR); critically ill (admitted to ICU, requiring mechanical ventilation or fraction of inspired oxygen concentration ≥60%) Exclusion: Deceased within 48 hours after ICU admission	N=92 (survivors; data from 147 non-survivors not reported here) Age (years, mean): 58 Gender (% male): 58 Race: NR Comorbidities: CVD: 15% CKD: NR COPD: 3% DM: 20% HTN: 45% Obesity: NR Smoking: NR	COVID-19 severity: 100% critically ill ICU admission: 100% Respiratory support Mechanical ventilation or ECMO: 9% NIV, HFNC, or CPAP: 44% Other: INR Length of hospital stay: NR Planned time post-hospital (days): 60 Reported time post-hospital: NR
Yasin, 2021[134] Egypt Retrospective Funding: None	Inclusion: Patients hospitalized with confirmed COVID-19 by nasopharyngeal swab RT-PCR testing who underwent initial CT during hospitalization and follow-up CT after discharge Exclusion: NR	N=210 Age (years, mean): 54 Gender (% male): 71 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: NR ICU admission: 25% Respiratory support: NR Length of hospital stay (days, mean): 16 Planned time post-hospital: NR Reported time post-hospital (days, mean): 42
You, 2020[73] China Case series Funding: None	Inclusion: Laboratory-confirmed COVID-19; pulmonary function test after discharge from hospital Exclusion: None reported	N=18 Age (years, mean): 51 Gender (% male): 56 Race: NR Comorbidities: CVD: NR CKD: NR COPD: NR DM: 6% HTN: 17% Obesity: NR	COVID-19 severity: 67% (12/18) moderate, 28% (5/18) severe, 6% (1/18) critical ICU admission: NR Respiratory support: NR Length of hospital stay (days, mean): 28 Planned time post-hospital: NR

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		Smoking: NR	Reported time post-hospital (days, mean): 40 (to pulmonary function test)
Yu, 2020[74] China Retrospective case series Funding: Government	Inclusion: COVID-19 positive confirmed by pharyngeal swab nucleic acid testing; hospitalized then discharged after treatment; underwent thin-section chest CT scans at least twice while hospitalized and at least once following discharge Exclusion: None reported	N=32 (n=14 fibrosis group, n=18; non-fibrosis group) Age (years, medians): fibrosis group 54; non-fibrosis group 37; P=.008 Gender (% male): 69 Race: NR Comorbidities: CVD: 6% CKD: NR COPD: 3% DM: 6% HTN: 13% Obesity: NR Smoking: NR	COVID-19 severity: NR ICU admission: fibrosis group 35.7% (5/14); non-fibrosis group 0% (0/18); P=.01 Respiratory support: NR Length of hospital stay (days, median): fibrosis group 19.5 [11.5-21.8]; non-fibrosis group 10.0 [6.0-15.3]; P=.001 Planned time post-hospital: NR Reported time post-hospital (days, median): fibrosis group 9 [7-11]; non-fibrosis group 9 [7.8-11.3]
Zhang, 2020[100] China Retrospective Funding: Government	Inclusion: Convalescent patients (recovered from COVID-19) Exclusion: None reported	N=112 (adult group) Age (years, median): 37 Gender (% male): 56 Race/ethnicity: NR Comorbidities: NR	COVID-19 severity: 17% severe, 83% non-severe ICU admission: NR Respiratory support: NR Length of hospital stay: NR Planned time post-hospital (days): 14 Reported time post-hospital: NR
Zhao, 2020[101] China Retrospective Funding: Government	Inclusion: Adults with confirmed SARS-CoV-2 (RT-PCR) Exclusion: Critical COVID-19	N=55 Age (years, mean): 48 Gender (% male): 58 Race/ethnicity: NR Comorbidities: CVD: 4%	COVID-19 severity: 7% mild, 86% moderate, 7% severe ICU admission: NR Respiratory support: Mechanical ventilation or ECMO: 0%

Author, Year Country Study Design Funding	Inclusion/Exclusion Criteria	Baseline Demographic Data	Hospitalization Characteristics Time of Post-hospital Follow-up
		CKD: NR COPD: NR DM: 4% HTN: 11% Obesity: NR Smoking: NR	NIV, HFNC, or CPAP: NR Oxygen: 26% Length of hospital stay (days, mean): 15 Planned time post-hospital (days): 90 Reported time post-hospital: NR
Zhou, 2021[135] China Prospective Funding: None	Inclusion: PCR-confirmed COVID-19 Exclusion: Age <18 years; classified as severe community acquired pneumonia; required invasive or non-invasive ventilatory support; admitted to ICU; history of heart failure	N=97 Age (years, mean): 47 Gender (% male): 54 Race/ethnicity: NR Comorbidities: CAD: 6% CKD: 1% COPD: NR DM: 11% HTN: 25% Obesity: NR Smoking: NR	COVID-19 severity: 100% non-severe ICU admission: 0% (exclusion criteria) Respiratory support Mechanical ventilation or ECMO: 0% (exclusion criteria) NIV, HFNC, or CPAP: 0% (exclusion criteria) Other: NR Length of hospital stay (days, median): 17 Planned time post-hospital: NR Reported time post-hospital (days, median): 11

Abbreviations: AKI=acute kidney injury; ARDS=acute respiratory distress syndrome; ARF=acute respiratory failure; CAD=coronary artery disease; CMR=cardiovascular magnetic resonance; COVID-19, SARS-CoV-2: 2019 novel coronavirus; CPAP=continuous positive airway pressure; CT=computed tomography; CVD=cardiovascular disease: CKD=chronic kidney disease; COPD=chronic obstructive pulmonary disease; DM=diabetes mellitus; ECMO=extracorporeal membrane oxygenation; ELSO=Extracorporeal Life Support Organization; ESKD=end stage kidney disease; FIM=Functional Independence Measurement; hs-CTnT=high-sensitivity cardiac troponin T; HTN=hypertension; ICD=International Classification of Disease; IQR=interquartile range; ICU=intensive care unit; KRT=kidney replacement therapy; MRI=magnetic resonance imaging; PE=pulmonary embolism; POCUS=point-of-care ultrasound; RT-PCR: reverse transcriptase polymerase chain reaction; SpO2=Peripheral Capillary Oxygen Saturation; VTE=venous thromboembolism; WHO=World Health Organization

TABLE 2. STUDY QUALITY APPRAISAL

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Akhtar, 2021[39] Qatar Retrospective	Evaluated all acute stroke admissions	Single site; n=833 (32 COVID-19 positive)	Unclear how modified Rankin Scale was administered	Yes	Little information on COVID-19 severity
Al-Aly, 2021[104] USA (Veterans) Retrospective	Hospitalized cohort within a specific time range	Multisite; n=13,654 (COVID-19 group)		ICD-10 codes	Little information on COVID-19 severity; no information on comorbid conditions but focus was on new onset diagnoses
Al Kasab, 2020[23] USA, South America, Europe Prospective	Consecutive patients meeting eligibility criteria	Multisite; n=13	Unclear how modified Rankin Scale was administered	Yes	No information about comorbidities; little information about hospitalization
Alemanno, 2021[105] Italy Prospective	Clear inclusion; consecutive patients for baseline but not follow-up	Single site; n=87 (56 at 1mo follow-up)	Unclear how outcome measures were administered	Established measures (MoCA, MMSE), but criteria for “deficit severity” unclear	Little information on COVID-19 severity Little patient demographic data No information to explain poor follow-up retention
Alharthy, 2021[24] Saudi Arabia Prospective	Unclear if consecutive patients	Single site; n=89	Unclear how ultrasound was analyzed	Unclear – used point-of-care ultrasound (noted limited evidence supporting its diagnostic utility in COVID-19)	Unclear how subjects were identified for enrollment; limited patient information
Alharthy, 2020[75] Saudi Arabia Prospective	Consecutive patients reviewed for eligibility	Single site: n=171	Unclear how ultrasound was analyzed - authors note that adequate training is required for reliable use	Unclear – authors note ‘scarce data’ on use of ultrasound in COVID-19	Little information on COVID-19 severity

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Anand, 2020[40] USA Retrospective	All patients during study period reviewed for eligibility	Single site; n=74	Unclear who reviewed medical records and whether data were verified	Medical records	Little information on COVID-19 severity
Arab-Zozani, 2020[76] Iran Cross-sectional	'Systematic sampling' to select patients	Single site; n=409	Telephone interviews at 22 +/- 15 days post-discharge	Medical records and telephone interview for EQ-5D-5L	Little information on comorbidities or COVID-19 severity
Atalla, 2020[136] USA Retrospective	Unclear if all patients were reviewed for eligibility	2 sites; n=339 (19 readmitted)	Only captured patients who presented to hospital they were discharged from	Medical records and post-discharge call to patients	Little information on COVID-19 severity
Ayoubkhani, 2021[106] United Kingdom Retrospective	Included all patients with exclusions clearly noted in flow diagram	Multisite (NHS hospitals in England); n=47,780 (COVID-19 group)		ICD-10 codes	Little information on COVID-19 severity
Barbaro, 2020[41] Multi Retrospective cohort	ECMO registry cases – unclear if all patients included in registry	International registry; n=1035	Outcome unclear for 10% (discharged to long-term acute care or unspecified location)	Registry data	Little information on COVID-19 severity; outcomes reported for ARDS cohort
Bellan, 2021[107] Italy Prospective	Contacted all participants discharged	Single site; n=238	Used validated scales and measures	Yes	Little information on COVID-19 severity
Benussi, 2020[25] Italy Retrospective cohort	Included all patients meeting eligibility criteria	Single site ("hub" for acute cerebrovascular diseases); n=56 with COVID-19	Unclear how Stroke Scale was administered	Unclear how stroke was diagnosed; NIH Stroke Scale for assessment	No information on COVID-19 severity
Bhatt, 2021[42] USA Retrospective	Unclear if all eligible patients (authors note limitations of coding)	Multicenter database (over 1000 healthcare entities/health systems); n=8,393 COVID-19	Unclear whether coding was consistent across sites	Database records (ICD-10 codes)	Little information on COVID-19 severity

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Boari, 2021[108] Italy Prospective	Contacted all surviving participants	Single site; n=94	Used validated scales and measures	Yes	Little information on COVID-19 severity and follow-up group
Bowles, 2020[77] USA Retrospective cohort	All patients admitted to home health care following hospitalization	Single home health agency serving 64 hospitals in 1 city; n=1,409	Outcomes assessed by nurse or physical therapist; mandatory assessment	Outcome and Assessment Information Set (OASIS)	No information on COVID-19 severity; results reported by age groups
Brendish, 2020[78] United Kingdom Prospective cohort	Convenience sample – all patients from clinical trial of point-of-care testing for SARS-CoV-2; concurrent comparison group COVID-19 negative	Single site; n=1,054	Unclear how date were extracted from medical records (qualifications/verification)	Medical records	COVID-19 severity (respiratory support) not linked to outcomes
Brosnahan, 2020[79] USA Retrospective	All patients discharged and re-presenting reviewed for eligibility	Single site; n=9 (limited to patients re-presenting to initial hospitalization site)	Broad definition of thrombotic event	Hospital records filtered for presumed events	No information on COVID-19 severity
Casas-Rojo, 2020[56] Spain Retrospective cohort	Consecutive patients	150 hospitals in registry; n=15,111	Unclear how patients were followed for readmission data; unclear if patients may have presented to other hospitals	Electronic data capture system with procedures for verification of data	Little information on COVID-19 severity
Chan, 2021[102] USA Retrospective	Unclear if consecutive patients	5 sites; n=3993 (1835 with AKI while hospitalized; 212 with post-discharge follow-up)	Unclear – AKI defined based on change from baseline creatinine; 63% had missing data and creatinine was imputed; used creatinine from 7 to 365 days prior to admission for others	Yes – dataset	No patient characteristics for the n=212 patients with post-discharge follow-up data

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Chevinsky 2021[109] USA Retrospective	Hospitalized cohort within a specific time range	Multisite (922 hospitals), data from large US health plan; n=27,284 (COVID-19 group)		ICD-10 codes	Little information on COVID-19 severity; no information on comorbid conditions but focus was on new onset diagnoses
Chopra, 2020[80] USA Retrospective	Sites may use pseudo-randomized procedure to select patients for inclusion if unable to abstract all hospitalizations	38 sites; n=1,250	Trained abstractors and surveyors; structured templates; 42% completed for 60 day post-discharge survey	Medical records and telephone survey	Little information on COVID-19 severity
Collins, 2020[26] USA Retrospective	All patients reviewed for eligibility	3 sites; n=20	Yes	Electronic medical records	Little information on COVID-19 severity
Curci, 2020[27] Italy Cross-sectional	Consecutive patients reviewed for eligibility; all eligible included	Single site; n=32	Yes	No spirometry measures	Yes; all patients were admitted to ICU
Daher, 2020[81] Germany Prospective	Consecutive	Singe site; n=33	Trained study team administered questionnaires; echocardiography	Follow-up at pulmonary disease outpatient clinic	Labeled as 'severe' but no information on criteria
Daugherty 2021[110] USA Retrospective	Hospitalized cohort within a specific time range	Multisite, data from large US health plan; n=18,118 (COVID-19)		ICD-10 codes	Little information on COVID-19 severity; no demographic data for hospitalized subgroup
Dawson, 2020[143] United Kingdom Prospectively collected/ retrospectively analyzed	All patients meeting eligibility criteria	Single site; n=208	Length of follow-up not reported	Unclear how readmission or re-presentation was assessed; unclear if patients may have gone to other hospitals	Little patient information; time post-hospital not reported

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
DeBolt, 2020[43] USA Retrospective	Unclear if all pregnant women were reviewed for study eligibility	4 sites; n=38	Unclear how data were abstracted	Electronic medical records	Yes; results also reported separately for 'critical' group
de Graaf, 2021[111] the Netherlands Prospective	All patients in geographic region were eligible	Single site; n=87	Cardiac evaluation by cardiologist; no information about pulmonary function testing	Yes (cardiac and pulmonary function tests)	Accounted for all patients admitted; little information on COVID-19 severity
de Havenon, 2021[146] USA Retrospective	Unclear if all cases during study period included; COVID-19 via ICD code U07.1	312 US Hospitals; n=2,086	Reported "favorable discharge" combining home and acute rehabilitation	Healthcare analytics database	Little information on COVID-19 severity
De Lorenzo, 2020[82] Italy Prospective	Consecutive	Single site; n=185	Multi-disciplinary team	Medical records and outpatient clinical follow-up; mMRC Dyspnea scale, MoCA (cognitive)	Yes; some severity measures included in prediction analyses
De Michieli, 2021[112] USA Retrospective	Consecutive patients; unclear if all were admitted	Multi-site; n=367	Method for obtaining follow-up data not reported	Unclear	Little information on COVID-19 severity; unclear why 7% of survivors not assessed at follow-up
Dennis, 2021[57] United Kingdom Prospective	Unclear if consecutive patients; described population as "low-risk" (*eg*, younger, largely without risk factors, pre-existing disease, or hospitalization) but inclusion criteria don't require that	2 sites; n=37 hospitalized (of n=201 included)	Unclear whether MRI was dual-reviewed; unclear how questionnaires were administered	Validated questionnaires (patient-reported), blood tests, MRI	Unclear how subjects were identified for enrollment; little information on COVID-19 severity; time post-hospital unclear
Doher, 2020[145] Brazil Retrospective cohort	Unclear if all patients were assessed for eligibility	Single site; n=201	Unclear	Medical records or telephone contact	Yes (all ICU patients); unclear if some patients remain hospitalized at end of study period

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Egol, 2020[58] USA Prospective	Consecutive patients	7 hospitals served by a university orthopedic department; n=17	Unclear how patients were followed after discharge	Unclear – source of data not reported	Unclear how many were COVID-19 positive at admission vs during admission
El Moheb, 2020[59] USA Retrospective	All patients meeting eligibility criteria identified; report focused on 141 of 242 (58%) with COVID-19 whose gastrointestinal complications while hospitalized were previously reported; after propensity matching, 92 COVID-19 patients were included	Single site with 13 ICUs; n=92	Unclear – length of follow-up for emergency department readmission not reported	Unclear – source of data not reported	No information about patient disposition at discharge, post-discharge monitoring, or length of follow-up
Engelen, 2021[113] Belgium Prospective	Evaluated all confirmed COVID-19 admissions 75 and younger	Single site; n=146	Yes	Yes	Little information on COVID-19 severity beyond ICU admission
Eswaran, 2021[114] USA Retrospective	Yes	11 sites; n=447	Yes	Yes	No comorbidity information; Little information on COVID-19 severity
Fisher, 2020[28] USA Retrospective	Unclear whether age 18 was included or excluded; not specified if all patients were reviewed for eligibility	3 hospitals in a healthcare system; n=3,345	Yes	Medical records	Disposition of all patients is unclear
Frija-Masson, 2020[60] France Retrospective	Unclear if all patients were reviewed for eligibility	Single site; n=50	Yes	Did not perform CT measures at 30 days	Unclear how 30 days post-symptom onset relates to time post-discharge
Fuglebjerg, 2020[29] Denmark Case series	Consecutive patients reviewed for eligibility; all eligible included	Single site; n=26	Yes	Authors note that clinical implications of hypoxia are not well described in the literature	Little information about comorbidities or COVID-19 severity

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Garrigues, 2020[61] France Prospective, survey	Contacted all eligible patients	Single site; n=120	Telephone questionnaire administered by trained physicians	Some elements of questionnaire were developed by the study authors	Limited information about comorbidities
Goicoechea, 2020[30] Spain Retrospective	All admitted patients on maintenance hemodialysis meeting eligibility criteria	Single site; n=36	No information	Unclear ("worsening or appearance of X-ray pulmonary infiltrates")	No information about patients who were discharged
Grewal, 2020[31] USA Retrospective	All patients admitted meeting eligibility criteria	Single site; n=13	Yes	Yes	Little information about COVID-18 severity
Gupta, 2021[139] USA Cohort	Consecutive	67 hospitals; n=3,099	Data form completed by study personnel; automated and manual data verification protocols	Chart review with standardized data form	Yes (all ICU admissions)
Hall, 2021[115] United Kingdom Retrospective	Clear inclusion, exclusion seems convenience based, only evaluated first 200 patients; patients excluded for frailty may have post-discharge outcomes	Single site; n=200	yes	yes	Little information on COVID-19 severity
Hamilton, 2020[83] United Kingdom Retrospective	All patients during study period meeting eligibility criteria	4 hospitals; n=1,032	Data manually checked for duplicate values	Electronic medical records	Time post-hospital unclear
Han, 2021[116] China Prospective	Unclear how sample was identified	Single site; n=114	Used CT scans and imaging	Yes	Yes
Hegde, 2020[44] USA Retrospective case series	All patients during study period meeting eligibility criteria	4 hospitals; n=7	Unclear who did abstraction and if data were verified	Electronic medical records	Yes

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Hill, 2020[84] USA Retrospective	All patients assessed for eligibility	14 hospitals; n=86	Multiple strategies to query electronic medical records; criteria for confirmation of thrombosis	Electronic medical records; authors note limitations of medical record search	No information on comorbidities; little information on COVID-19 severity
Hittesdorf, 2020[140] USA Retrospective	Unclear if all patients assessed for eligibility	Single site; n=116	Unclear how patients were followed	Yes	Limited information on comorbidities; 100% ICU admission
Hu, 2020[45] China Cross-sectional	Unclear if all patients assessed for eligibility	Single site; n=76	Unclear if artificial intelligence findings were reviewed by clinicians	Unclear – artificial intelligence program for detection of fibrosis	Yes
Huang C, 2021[85] China Retro and Prospective	All patients evaluated for eligibility; many exclusion criteria; stratified disproportional random sampling (according to severity) used to select patients for pulmonary function and imaging	Single site; n=1,733	Follow-up at outpatient clinic with trained physicians; CT mages evaluated by clinicians; interpretation of ultrasound unclear	mMRC dyspnea, EQ-5D-5L, pulmonary function, ultrasound, CT	Yes; outcomes reported by level of severity (oxygen requirement)
Huang L, 2020[62] China Retrospective	Consecutive patients meeting eligibility criteria	Single site; n=26	Yes	Yes	Little information on COVID-19 severity; no information on time post-discharge
Huang Y, 2020[63] China Retrospective	Unclear if all patients were reviewed for eligibility	Single site; n=57	19% (13/70) eligible could not be contacted or declined participation	Yes	Little information on COVID-19 severity
Jacobs, 2020[117] USA Prospective	Contacted all surviving participants, 52% response rate	Single site; n=183	Used validated scales and measures	Yes	Yes

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Karaarslan, 2021[118] Turkey Prospective	Included 300 participants, threshold for analysis	Single site; n=300	Used validated scales and measures, phone interviews	Yes	No information on respiratory outcomes at baseline, little information on COVID-19 severity
Katz, 2020[32] USA Retrospective	All patients meeting eligibility criteria	11 hospitals in a health system; n=86	Yes	Yes – chart review and other databases	Little information on comorbidities
Khalili, 2020[86] Iran Prospective cohort	Unclear if all patients were reviewed for eligibility	Single site; n=254	Unclear how patients were followed	Number of patients discharged alive not reported so readmission only available for total number enrolled	Little information on COVID-19 severity; time post-hospital unclear
Knights, 2020[137] United Kingdom Retrospective	All admitted patients	Single site; n=69 (survivors)	Unclear how post-discharge care needs were captured	Data from electronic and paper medical records; additional information from patients	No information about patients discharged to care home or other; time post-hospital unclear
Li, 2021[119] China Prospective	Reached 44% of eligible participants with 18% inclusion rate	Single site; n=107	Used clinical and laboratory tests	Yes	Little information on baseline characteristics
Liotta, 2020[33] USA Retrospective	Consecutive patients	10 hospitals in a health system; n=509	Modified Rankin Scale scores determined independently by 2 reviewers	Data from electronic medical records (including templates specific to COVID-19), clinical notes, diagnostic studies, and physician-documented diagnoses; modified Rankin Scale	Yes
Liu, 2020[141] China Retrospective	Unclear if all patients were reviewed for eligibility	2 sites; n=51	CT interpreted by 2 experienced radiologists (consensus)	CT	Yes (note: patients had similar level of severity)

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Loerinc, 2021[87] USA Retrospective	All patients assessed for eligibility	Single site; n=310	Data manually collected from notes; training or experience not reported	Unclear – data from physician discharge notes, discharge medication reconciliation, case management and nursing notes at discharge, and post-hospital transition care management notes	Little information on COVID-19 severity
Lovinsky-Desir, 2020[64] USA Retrospective	Sequential patients	2 hospitals in network; n=1243 (n=95 in <21 age group not included - median age 14-15)	Unclear how patients were followed for readmission data	Medical records	Length of follow-up for readmission unclear
Lv, 2020[88] China Retrospective	Consecutive	Single site; n=137	Automated pulmonary function testing system	Electronic medical records	Little information on comorbidities
Mathew, 2020[46] India Retrospective	Consecutive cases	13 hospitals in 1 city; n=62	Unclear how modified Rankin Scale was administered	Unclear	No information on COVID-19 severity
Matsunaga, 2020[47] Japan Registry	Patients entered into registry at discretion of principal investigator	227 sites; n=2638	'Research collaborators' input data to registry; funding for each patient enrolled	Unclear how self-care ability was defined; source of oxygen therapy required and RRT data not reported	Yes
Mo, 2020[34] China Retrospective	Unclear if all patients were reviewed for eligibility	Unclear if single site; n=110	Yes	Lung function tests but no imaging	Yes
Monday, 2020[89] USA (Veterans) Retrospective	All admitted patients	Single site; n=79	Unclear who abstracted data	Electronic medical records	Time post-hospital unclear

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Morin, 2021[120] (COMEBAC Study Group) France Prospective	Unclear if reviewed records of all patients hospitalized during study period for eligibility	Single site; n=478 for telephone assessment; n=177 for clinic assessment (invited based on prior ICU admission or current symptoms during telephone assessment)	Telephone assessment by "medical officer"; independent review of lung CT scans; neuropsychologist for cognitive assessment	Predominantly standard instruments	57% of eligible patients consented to participate in follow-up; reported demographics for those who did not consent were similar
Mowla, 2020[48] Multinational Retrospective	Unclear if all patients were reviewed for eligibility	9 sites in 3 countries; n=13 (other sites invited but had no cases or could not meet timeline)	Unclear how modified Rankin Scale was administered; missing data for 33% (3/9 discharged)	Dual confirmation of cerebral venous sinus thrombosis; medical records	No information on comorbidities; limited information on COVID-19 severity
Naar, 2020[49] USA Prospective	Consecutive patients	Single site; n=206	Unclear	Unclear how RRT status was identified	Little information on COVID-19 severity
Nachega, 2020[50] Democratic Republic of the Congo Retrospective cohort	All admitted patients meeting eligibility criteria	7 sites; n=766	Unclear who abstracted/verified data	Database records	Yes
Nemer, 2021[51] USA Retrospective	All admitted patients meeting eligibility criteria	2 sites; n=350	Unclear who abstracted/verified data	Electronic medical records	Yes
Nersesjan, 2021[142] Denmark Prospective	Consecutive cases	Single site; n=61	Unclear who abstracted/verified data	MoCA and clock drawing tests; electronic medical records	Yes
Ng, 2020[35] USA Retrospective	All admitted patients meeting eligibility criteria	13 hospitals in a health system; n=3,854 (2,771 survivors)	Yes	Data from chart reviews (hospital progress, discharge, and social worker notes)	Yes

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Ntaios, 2020[36] Multi-national Retrospective	Consecutive patients meeting eligibility criteria	28 sites in 16 countries; n=174 (96 survivors)	Unclear how modified Rankin Scale was administered	Global COVID-19 Stroke registry	Yes
Nugent, 2021[121] USA Retrospective	Clear inclusion; consecutive patients	5 hospitals; n=1612 (182 COVID-19 positive)	eGFR calculated using the Chronic Kidney Disease Epidemiology equation	AKI classified into 3 stages according to creatine criteria; cut-offs unclear	No information on COVID-19 severity
Osikomaiya, 2021[122] Nigeria Retrospective	Clear but broad inclusion, unclear exclusion; patients referred to discharge center	Patients referred from 6 isolation facilities; n=274	Limitation of self-reported symptoms	Limitation of self-reported symptoms	Yes; inclusion of COVID-19 severity and comorbidities
Overstad, 2020[52] Norway Retrospective	All admitted patients meeting eligibility criteria	Single site; n=70	Unclear who abstracted/verified data	COVID-19 registry, medical records, electronic charts	Yes
Ozer, 2021[123] Turkey Prospective	Consecutive patients reviewed for eligibility	Single site; n=74	Images reviewed by single cardiologist blinded to study data	Echocardiography	No information on COVID-19 severity
Parra, 2020[90] Spain Case-control	Unclear if all patients assessed for eligibility	Single site; n=61	Unclear – authors note that some patients may have been readmitted at other hospitals	Unclear	Limited information on COVID-19 severity
Patell, 2020[65] USA Retrospective	Consecutive patients meeting eligibility criteria	Single site; n=163	Unclear if all patients were followed	Medical records	Yes
Paterson, 2020[37] United Kingdom Retrospective	Cases referred to COVID team meetings (“selective”)	Single site; n=43 (29 with definite COVID-19)	Unclear	Unclear – little information about source of data	Yes
Perry, 2020[53] United Kingdom Retrospective case-control	Unclear if all patients were reviewed for eligibility	13 sites; n=86	Unclear how modified Rankin Scale was administered	Case report forms from multiple study sites	Limited information on COVID-19 severity

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Puntmann, 2020[66] Germany Prospective	Unselected cohort	Single site; n=100	Yes	Yes	Little information about subgroups of hospitalized patients vs home recovery patients; time post-hospital unclear
Qin 2021[103] China Prospective	Clear, minimal	Single site; n=81	Yes	Yes	Yes
Raman, 2021[124] United Kingdom Prospective	"Unselected cohort"; patients approached by medical team for possible inclusion in study; also noted that all patients assessed for eligibility	Unclear if single site; n=58 COVID-19 and n=30 group-matched controls	Images assessed by multiple specialists independently; questionnaires completed with electronic data capture; training/experience of assessors unclear	Software for MRI image analysis; standard questionnaires for cognitive function and dyspnea; electronic medical records for clinical data	All moderate to severe COVID-19; controls were not hospitalized; no demographic information about the 36 patients excluded
Ramani, 2021[91] USA Retrospective	Appears to include all patients admitted during the study period	Single site; n=28	Patients attended Post-COVID-19 ICU Clinic; little information on how specific outcomes were assessed	MoCA, Quality of Life in Neurological Disorders, pulmonary function	No information on comorbidities; little information on COVID-19 severity
Rashidi, 2020[92] Iran Retrospective	Consecutive cases	3 sites; n=1,529	Interview by trained physician; clinic follow-up if symptomatic	Imaging or ventilation-perfusion scans	Little information on COVID-19 severity
Rass, 2021[125] Austria Prospective	Clear inclusion; consecutive patients	Multisite; n=135 (103 hospitalized)	Neurological evaluation performed by neurological consultants or junior neurologists under supervision of consultants; limitation of self-reported cognitive symptoms	Established measures (MoCA, SS-16) with clear criteria, but no baseline comparator; limitation of self-reported cognitive symptoms	Yes; inclusion of COVID-19 severity and comorbidities

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Remy-Jardin, 2021[126] France Retrospective	Yes	Unclear if single site; n=55	Yes	Yes	Yes
Richardson, 2020[67] USA Case series	All admitted patients meeting eligibility criteria	12 sites; n=5,700	Authors note median follow-up of 4.4 days post-discharge	Yes – electronic medical records	Little information on patients who were discharged
Roberts, 2020[68] United Kingdom Prospective	All events at designated sites (patients may have presented elsewhere during follow-up)	2 sites of 1 hospital; n=1877	No routine contact during follow-up (only captured patients who presented to hospital they were discharged from)	Yes – imaging required	No patient demographic data; little information on COVID-19 severity
Rodriguez, 2020[54] USA Registry	Consecutive patients in American Heart Association COVID-19 Registry meeting eligibility	88 sites; n=7,868	Abstraction/verification unclear	Medical records	Yes
Sachdeva, 2020[69] USA Retrospective	All patients meeting eligibility criteria	13 hospitals of a health system; n=11	Unclear – methods for obtaining follow-up information not specified; unclear if patients may have presented to other hospitals	Yes – electronic and manual chart review	Time post-hospital not reported
Salisbury, 2020[93] United Kingdom Retrospective	Consecutive cases	Single site; n=303	Authors note links with other local hospitals if patients present there with VTE	Electronic medical records; radiographic confirmation	No information on comorbidities; little information on COVID-19 severity
Sami, 2020[94] Iran Prospective	Unclear – “first COVID-19 cases with complete information”	Single site; n=490	Data cross-checked by research team (professionals and clinical faculty)	Telephone follow-up	Yes
Shah, 2020[95] Canada Prospective	Unclear if all assessed for eligibility – “referrals”	Single site; n=60	Unclear – methods not reported	Pulmonary function tests; dyspnea symptoms present/absent	Limited information on COVID-19 severity; time post-hospital unclear

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Sibilia, 2021[144] Spain Retrospective	Unclear	Single site; n=172	Yes	Yes	Yes
Somani, 2020[70] USA Retrospective	Unclear if all patients were reviewed for eligibility	5 hospitals of a health system; n=103	No systematic follow-up; unclear if patients may have presented to other hospitals	Yes – electronic health records	Yes
Sonnweber 2020[96] Austria Prospective	Unclear if all patients were reviewed for eligibility	3 sites; n=145 (74% were hospitalized)	In-person follow-up visits; training of individuals interpreting the test findings is unclear	mMRC dyspnea score, pulmonary function, CT, echocardiography	No information about subset of patients hospitalized; time post-hospital unclear
Spinicci, 2021[127] Italy Retrospective	Clear but broad inclusion; consecutive patients, all patients invited for follow-up	Single site; n=100	Limitation of self-reported symptoms	Limitation of self-reported symptoms	Yes; inclusion of COVID-19 severity and comorbidities
Stevens, 2020[97] USA Retrospective	All patients reviewed for eligibility	Single site; n=115	Data abstraction/verification unclear	Electronic medical record	Yes (100% ICU admissions)
Suarez-Robles, 2021[128] France Retrospective	Yes	Single site; n=134	Patient self-report	Moderate, self-report	Sparse baseline data (no co-morbidity data); Little information on COVID-19 severity
Suleyman, 2020[138] USA Retrospective case series	Consecutive patients	5 sites; n=355 hospitalized patients	Follow-up to 30 days post-discharge	Yes – electronic medical records	Yes
Taquet, 2021[129] USA Retrospective	Evaluated COVID-19 patients using network of electronic records	Multisite; n=236,379	Evaluated outcomes using ICD codes and medical records	Yes	Limited information on COVID-19 severity
Tomasoni, 2021[130] Italy Cross-sectional	Unclear how participants were identified	Single site; n=105	Used validated scales and measures	Yes	Little information on baseline characteristics

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Tudoran, 2021[131] Romania Prospective	All patients hospitalized during study period reviewed for eligibility	Single site; n=125; 182 of 254 eligible patients agreed to participate (57 subsequently ineligible)	"Experienced operator" performed all echocardiographic measurements	Echocardiography	Baseline TTE did not include careful measures of ventricular function so may not have ruled out pre-existing cardiovascular conditions; little demographic data
Venturelli, 2021[132] Italy Prospective	Contacted all participants meeting eligibility	Single site; n=767	Used validated scales and measures	Yes	Yes
Vizcaychipi, 2020[38] United Kingdom Prospective	Consecutive admissions evaluated for eligibility	2 hospitals of 1 institution; n=939	Source of disposition data not reported	Unclear	Limited information on comorbidities and COVID-19 severity
Vlachou, 2021[98] United Kingdom Retrospective	Only patients who underwent CT pulmonary angiography during hospitalization for increasing O2 requirements, refractory hypoxia, elevated D-dimer or tachycardia	Single site; n=39	No information about interpretation or verification of findings	Yes	No information on comorbidities and COVID-19 severity
Wang, 2020[71] China Prospective cohort	Unclear if all patients were reviewed for eligibility	Single site; n=131	Followed every 7 days up to 4 weeks; methods for follow-up data collection unclear	Data obtained by questionnaire	Limited information on comorbidities
Wu, 2021[133] China Prospective	Screened all patients admitted during study period for eligibility	Single site; n=83	Images independently assessed by experienced radiologists; little information about administration of other measures	mMRC for dyspnea; imaging per guidelines	Little information about patients who could not be contacted, declined participation, or withdrew; "severe" COVID but excluded patients receiving mechanical ventilation

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Xia, 2020[55] China Retrospective	Unclear if all patients were reviewed for eligibility	Single site; n=282	CT scans evaluated by radiologists with experience in thoracic imaging evaluation	CT	Yes
Xiong, 2021[99] China Prospective	Patients who were discharged and completed telephone contact (many exclusions); comparison cohort was not hospitalized	Single site; n=538	Post-discharge contact was by experienced clinicians	Self-report of newly diagnosed hypertension	Yes
Xu, 2020[72] China Retrospective case series	Unclear if all patients were reviewed for eligibility	3 sites; n=239 ICU patients	Unclear if follow-up was complete for post-discharge patients	Self-report	Time post-hospital unclear
Yasin, 2021[134] Egypt Retrospective	Clear but minimal	Unclear if single site; n=210	Yes	Yes	Sparse baseline data (no co-morbidity data); little information on COVID-19 severity
You, 2020[73] China Case series	Unclear if study included all or consecutive patients	Single site; n=18	Yes	CT scans not completed at the same time as pulmonary function tests; CT scans reviewed independently by 2 cardiothoracic radiologists blinded to clinical information	Limited information on comorbidities and COVID-19 severity
Yu, 2020[74] China Retrospective case series	Unclear if study included all patients	Single site; n=32	Specific criteria provided for many of the outcomes assessed from CT scan; scans reviewed independently by 3 experienced radiologists	CT	Yes
Zhang, 2020[100] China Retrospective	All patient recovered from COVID-19	Single site; n=134	Imaging findings evaluated by experienced radiologists	CT	No information on comorbidities; limited information on COVID-19 severity

Author, Year Country Study Design	Clear Inclusion Criteria/Consecutive/ Complete?	Adequate Sample Size?	Condition/Outcome Measured in a Standard Reliable Way?	Valid Methods for Identification of the Condition/Outcome?	Adequate Information about Subjects & Setting?
Zhao, 2020[101] China Retrospective	Patients identified through national influenza surveillance system	3 sites; n=55	Images reviewed by 2 radiologists blinded to clinical data; followed ATS-ERS guidelines for pulmonary testing	CT, pulmonary function	Limited information on comorbidities and COVID-19 severity
Zhou, 2021[135] China Prospective	Referrals to Infectious Diseases clinic were invited to participate (also described as consecutive)	Single site; n=97 (only those who attended clinic and completed ECG or echocardiography	Unclear – no information on interpretation of test results	MRI, ECG and echocardiography, CMRI; not all patients completed all follow-up tests (depended on screening test results)	Limited demographic data

Abbreviations: AKI=Acute kidney injury; CT=computed tomography; ECG=electrocardiogram; eGFR=estimated globular filtration rate; mMRC=Modified Medical Research Council Dyspnea Scale; MMSE=Mini Mental State Examination; MoCa=Montreal Cognitive Assessment; MRI=magnetic resonance imaging; TTE=transthoracic echocardiogram

Reference: JBI Critical Appraisal Checklist for Case Series

TABLE 3. PULMONARY OUTCOMES

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
Al-Aly, 2021[104] USA (Veterans) Retrospective Outcomes vs individuals hospitalized with seasonal influenza	NR	NR	NR	**Shortness of breath[a]** HR (adjusted) 1.14 (95%CI 1.04, 1.26) Excess burden per 1000 hospitalized COVID-19 patients at 6 months 13.22 (95%CI 3.68, 21.94) COVID-19 group: N=13,654 Control group (influenza): N=13,997
Alharthy, 2021[24] Saudi Arabia Prospective	NR	NR	NR	**Pleural Effusions at Discharge (Ultrasound)** 1.5% (1/64) (n=64 survivors)
Alharthy, 2020[75] Saudi Arabia Prospective	NR	NR	NR	**Pleural Effusions (Ultrasound)** **2 months** 18.9% (24/127) **4 months** 11.8% (15/127) P=.0001
Ayoubkhani, 2021[106] United Kingdom Retrospective Controls from general population not meeting inclusion criteria for COVID-19; unclear if any were hospitalized at time of study	NR	NR	NR	**Respiratory Disease, new onset events** COVID-19 Group: 21.5% (6085/28,335) Rate per 1000 person-years 538.9 (95%CI 525.5, 552.6) General Population Control Group: 0.8% (240/28,335) Rate per 1000 person-years 19.7 (95%CI 17.3, 22.4) P<.001 between groups **Respiratory Disease, all events** COVID-19 Group: 29.6% (14,140/47,780) Rate per 1000 person-years

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
				770.5 (95%CI 757.8, 783.3) General Population Control Group: 5.4% (2585/47,780) Rate per 1000 person-years 129.1 (95%CI 124.2, 134.2) P<.001 between groups NOTE: study reported increased respiratory disease among those admitted to ICU (data NR)
Bellan, 2021[107] Italy Prospective	NR	NR	**D_{LCO} <80%** 52% (113/219)	**Dyspnea** 6% (13/238)
Boari, 2021[108] Italy Prospective	25% (24/94)	NR	**D_{LCO} <80%** 32% (30/94)	**Dyspnea** 36% (33/91)
Chevinsky 2021[109] USA Retrospective Controls were hospitalized individuals who did not meet inclusion criteria for COVID-19 and were not diagnosed with COVID-19 during the 4 months after index encounter	NR	NR	NR	**Respiratory failure; insufficiency; arrest** vs hospitalized non-COVID-19 control group 1-30 days after discharge OR (adjusted) 3.3 (95%CI 2.6, 4.1) 31-60 days after discharge OR (adjusted) 1.0 (95%CI 0.70, 1.4) 60-90 days after discharge OR (adjusted) 0.93 (95%CI 0.65, 1.3) 90-120 days after discharge OR (adjusted) 0.73 (95%CI 0.47, 1.1) **Pneumonia (except that caused by tuberculosis)** vs hospitalized non-COVID-19 control group 1-30 days after discharge OR (adjusted) 5.5 (95%CI 4.1, 7.5) 31-60 days after discharge

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
				OR (adjusted) 1.3 (95%CI 0.89, 2.0) 60-90 days after discharge OR (adjusted) 0.88 (95%CI 0.53, 1.5) 90-120 days after discharge OR (adjusted) 1.0 (95%CI 0.58, 1.9) N=27,284 for COVID and control groups
Curci, 2020[27] Italy Cross-sectional	NR	NR	NR	**PaO_2/FiO_2 (mmHg)** Mild alteration (300-399): 22% (7/32) Moderate alteration (200-299): 38% (12/32) Severe alteration (<200): 41% (13/32) **Respiratory Supports Needed** None: 13% (4/32) Nasal cannula: 41% (13/32) Oxygen mask: 13% (4/32) Venturi mask: 25% (8/32) Non-rebreather mask: 9% (3/32) **mMRC Dyspnea Scale** Grade 4: 13% (4/32) Grade 5: 88% (28/32)
Daher, 2020[81] Germany Prospective	NR	NR	NR	**Dyspnea (symptom questionnaire)** Admission: 48% (16/33) 6 week follow-up: 33% (11/33)
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a	NR	NR	NR	**New Clinical Diagnoses at 4 months** **Respiratory failure (acute respiratory failure, chronic respiratory failure, interstitial lung disease)** COVID group: 2.60% Non-COVID Control group: 0.19% Risk difference 2.41% (95%CI 1.35, 3.2)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
hospital for COVID-19				**Acute respiratory failure** COVID group: 2.58% Non-COVID Control group: 0.18% Risk difference 2.4% (95%CI 1.67, 3.43) **Chronic respiratory failure** COVID group: 1.53% Non-COVID Control group: 0.05% Risk difference 1.48% (95%CI 0.97, 1.75) **Interstitial lung disease** COVID group: 1.60% Non-COVID Control group: 0.13% Risk difference 1.47% (95%CI 1.14, 1.98) P<.001 for all outcomes N=18,118 for both groups
Dawson, 2020[143] United Kingdom Prospectively collected/ retrospectively analyzed	NR	NR	NR	**New Aspiration Pneumonia** 0% (0/208)
De Lorenzo, 2020[82] Italy Prospective	NR	NR	NR	**mMRC Dyspnea Scale** Mild: 25% (31/126) Moderate: 3% (4/126) Severe: 2% (3/126) Very Severe: 2% (2/126)
Dennis, 2021[57] United Kingdom Prospective	NR	NR	NR	**Deep Breathing Fractional Area Change <31%** 12% (4/34) (n=3 missing data)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
Frija-Masson, 2020[60] France Retrospective	NR	**Pulmonary Function Test Interpretation** Normal: 48% (24/50)	NR	Restrictive pattern: 8% (4/50) Restriction with altered diffusion capacity: 18% (9/50) Altered diffusion capacity only: 26% (13/50)
Fuglebjerg, 2020[29] Denmark Case series Hypoxia and dyspnea elicited by 6-minute walking test Exercise-induced hypoxia: $Sp0_2$ <90% (test terminated)	NR	NR	NR	**Exercise-Induced Hypoxia, % (n/N)** 50% (13/26) NOTE: PE confirmed in 67% (4/6) who underwent further testing SpO_2 <90% was not associated with an increase in subjective dyspnea (Borg scale)
Garrigues, 2020[61] France Prospective, survey	NR	NR	NR	**mMRC Dyspnea Scale Grade 2 or More** 29% (35/120) Ward patients: 28% (27/96) ICU patients: 33% (8/24)
Goicoechea, 2020[30] Spain Retrospective	NR	NR	NR	**"Lung Abnormalities"** 86% (6/7) (Worsening or appearance of X-ray pulmonary infiltrates)
Hall, 2021[115] United Kingdom Retrospective	NR	FVC ≤80% 27% of (16/59) of patients with complete lung function tests TLC ≤70%	NR	**Reduction in mMRC Dyspnea score (range 1 to 5) ≥2 points** 18% (36/200)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
		44% of (26/59) of patients with complete lung function tests Oxygen desaturation ≥4% 20% (34/170) of patients that underwent 6-minute walk test		**Persistent interstitial change (parenchymal abnormality) via CT** 32% (64/200)
Han, 2021[116] China Prospective	"Fibrotic like changes at 6 months" 35% (40/114) De novo in 95% (38/40)	NR	**D_{LCO} <80%** 26% (27/104)	**Dyspnea** 14% (16/114) **Pleural Effusions (CT scan)** 9% (10/114)
Hu, 2020[45] China Cross-sectional	61% (46/76)	NR	NR	NR
Huang C, 2021[85] China Retro and Prospective Scale 3 = No supplemental O_2 Scale 4 = Requiring supplemental O_2 Scale 5-6 = Requiring HFNC, NIV or IMV	NR	**FEV_1 <80% Predicted** Scale 3: 8% (7/89) Scale 4: 2% (4/172); P<.05 vs Scale 3 Scale 5-6: 13% (11/88) **FVC<80% Predicted** Scale 3: 3% (3/89) Scale 4: 1% (1/172) Scale 5-6: 11% (10/88) **FEV_1/FVC <70%** Scale 3: 8% (7/89) Scale 4: 8% (13/172) Scale 5-6: 2% (2/88) **TLC <80% of Predicted** Scale 3: 11% (9/83) Scale 4: 10% (17/165) Scale 5-6: 35% (30/86)	**D_{LCO} <80% Predicted** Scale 3: 22% (18/83) Scale 4: 29% (48/165) Scale 5-6: 56% (48/86); P<.05 vs Scale 3	**mMRC scores ≥1** Overall: 26% (419/1615) Scale 3: 24% (102/425) Scale 4: 26% (277/1079) Scale 5-6: 36% (40/111), P<.05 vs Scale 3 **At Least 1 Abnormal CT Pattern** Scale 3: 52% (49/89) Scale 4: 54% (87/161) Scale 5-6: 54% (50/92)
Huang Y, 2020[63] China Retrospective	7% (4/57)	**FEV_1 <80% Predicted** 9% (5/57) (mild impairment) **FVC<80% Predicted** 11% (6/57) (5 mild impairment, 1 moderate)	**DLCO <80% Predicted** 53% (30/57) (26 mild impairment, 4 moderate) Subgroups	**Respiratory Muscle Strength** Pimax <80% Predicted 49% (28/57) Pemax <80% Predicted 23% (13/57)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
		FEV_1/FVC <80% 44% (25/57) (mild impairment) **TLC <80% of Predicted** 12% (7/57) (6 mild, 1 moderate) Outcomes did not differ by severity of COVID-19	Severe COVID-19: 77% (13/17) Non-severe: 43% (17/40) P=.02	**CT Residual Abnormality** 54% (31/57) Subgroups Severe COVID-19: 94% (16/17) Non-severe: 38% (15/40) P Not Reported **Obstructive Pulmonary Dysfunction** 11% (6/57) **Restrictive Pulmonary Function** 12% (7/57) **Combined Obstructive and Restrictive** 4% (2/57)
Jacobs, 2020[117] USA Prospective	NR	NR	NR	**Dyspnea (persisting from hospital discharge)** 45% (58/128) Or 32% (58/183 enrolled)
Karaarslan, 2021[118] Turkey Prospective	NR	NR	NR	**Dyspnea (2 weeks)** 38% (114/300) **Dyspnea (4 weeks)** 26% (78/300)
Li, 2021[119] China Prospective	NR	NR	NR	**Lesions (incomplete resolution) (CT at 3-6 months)** 72% (44/61)
Liu, 2020[141] China Retrospective	NR	NR	NR	**Ground Glass Opacity (CT)** Discharge: 18% (9/51) First follow-up (~2 weeks): 10% (5/51) Second follow-up (~4 weeks): 10% (5/51) **Consolidation** Discharge: 49% (25/51)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
				First follow-up (~2 weeks): 8% (4/51) Second follow-up (~4 weeks): 2% (1/51)
Lv, 2020[88] China Retrospective	NR	**At 2 Weeks Post-discharge** **IVC<80% Predicted** 81% (111/137) Severe cases: 89% (24/27) Non-severe cases: 79% (87/110) **FVC<80% Predicted** 24% (33/137) Severe cases: 56% (15/27) Non-severe cases: 16% (18/110)	NR	NR
Mo, 2020[34] China Cross-sectional	NR	**FEV_1 <80% Predicted** 14% (15/110) **FVC <80% Predicted** 9% (10/110) **FEV_1/FVC <70%** 5% (5/110) Outcomes above did not differ by severity of COVID-19 **TLC <80% Predicted** 25% (27/110) COVID-19 Severity Subgroups Mild: 17% (4/24) Pneumonia: 21% (14/67) Severe Pneumonia: 47% (9/19) P<.05 overall and for Severe Pneumonia vs Pneumonia or vs Mild	**DLCO <80% Predicted** 47% (51/110) COVID-19 Severity Subgroups Mild: 30% (7/24) Pneumonia: 42% (28/67) Severe Pneumonia: 84% (16/19) P=.001 overall P<.01 for Severe Pneumonia vs Pneumonia or vs Mild	NR
Morin, 2021[120] (COMEBAC Study Group) France Prospective	**Fibrotic Lesions** 19% (33/170) (clinic assessment; median 125 days) Intubated: 36.7% (18/49)	NR	**DLCO <70%** 22% (33/152) (clinic assessment; median 125 days)	**Nijmegen Score (Dysfunctional Breathing=score >22)** 21% (37/177) (clinic assessment; median 125 days) **Dyspnea (new onset during or after hospitalization for COVID-19 and persistent at time of assessment)**

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
	Non-intubated: 12.4% (15/121)			16% (78/478) (telephone assessment; median 113 days) **Abnormal Lung CT scan** 53% (108/171) (clinic assessment; median 125 days) **Persistent GGO** 42% (72/170) (clinic assessment; median 125 days)
Osikomaiya, 2021[122] Nigeria Retrospective	NR	NR	NR	**Dyspnea** 10% (26/274)
Qin 2021[103] China Prospective	**Pulmonary Interstitial damage** (from subset of 45 patients who received chest CT): 71% (32/45)	**TLC <80% Predicted** 10% (8/81) **FVC <80% Predicted** 21% (17/81) **FEV_1/FVC <70%** 4% (3/81) Pulmonary function test results were available for 81 patients (41 non severe and 40 severe patients)	**DLCO <80% Predicted** 54% (44/81)	**Dyspnea** 9% (56/647) **Dyspnea (non-severe)** 7% (26/399) **Dyspnea (severe)** 12% (30/248)
Raman, 2021[124] United Kingdom Prospective Controls were negative for SARS-CoV-2 and asymptomatic; community	**NR**	**FVC <80% Predicted** COVID-19 13% (7/56) Controls 0% (0/28) P=.09 **FEV_1<80% Predicted** COVID-19 11% (6/56) Controls 4% (1/28)	NR	**Dyspnea – mMRC ≥2 (significant breathlessness)** COVID-19 Group 64% (36/56) Control Group 10% (3/29) P<.0001 **Lung Parenchymal Abnormalities** COVID-19 Group 60% (32/53) Control Group

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
dwelling (not hospitalized)		P=.42 Median 1.6 months post-discharge		11% (3/28) P<.0001 **VO_2 Peak <80% of Predicted Maximum** COVID-19 Group 55% (28/51) Control Group 7% (2/27) P<.0001 Median 1.6 months post-discharge
Ramani, 2021[91] USA Retrospective	NR	NR	**Reduced diffusion capacity:** 27% (7/26)	At 40 days (median) Normal lung function: 62% (16/26) Obstructions: 15% (4/26) Restriction: 19% (5/26) Mixed obstruction and restriction: 4% (1/26)
Remy-Jardin, 2021[126] France Retrospective	12.7% (7/55)	NR	NR	**COVID-19 Lung Infiltration ("residual findings") on CT (median of 144 days)** 73% (40/55) **Emphysema (median of 144 days)** 18% (10/55)
Sami, 2020[94] Iran Prospective	NR	NR	NR	**Dyspnea (symptom questionnaire)** Week 1 Non-severe: 22% (86/400) Severe: 19% (10/53) Week 4 Non-severe: 15% (59/400) Severe: 19% (10/52)
Shah, 2020[95] Canada Prospective	NR	**FEV_1/FVC <70%** 11% (7/60)	**Abnormal DLCO** 52% (31/60)	**Dyspnea (present/absent on symptom questionnaire)** At 12 weeks 21% (12/60)

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
				Imaging (CT) **Ground Glass Abnormality:** 83% (50/60) **Reticulation**: 65% (39/60) **Neither:** 12% (7/60)
Sibilia, 2021[144] Spain Retrospective	NR	**FEV <80% Predicted** 25% (43/172) **FVC <80% Predicted** 24% (42/172)	**DLCO <80% Predicted** 57% (98/172)	**Dyspnea** 40% (68/172)
Sonnweber 2020[96] Austria Prospective	NR	**FVC<80% Predicted Normal** 60 days: 27% (34/125) 100 days: 22% (29/132) **FEV_1 <80% Predicted Normal** 60 days: 22% (28/127) 100 days: 22% (30/136) **FEV_1/FVC <70%** 60 days: 4% (5/125) 100 days: 8% (11/138) **TLC<80% Predicted Normal** 60 days: 11% (14/127) 100 days: 11% (15/137) **Lung Function Impaired** 60 days: 42% (53/126) 100 days: 36% (48/133)	**DLCO<80% Predicted Normal** 60 days: 31% (39/125) 100 days: 21% (28/133)	**Dyspnea (assessed by questionnaire [or mMRC])** 60 days: 68% ([2% (3/145; severe; mMRC 3-4] 100 days: 36% [4% (5/133) severe; mMRC 3-4] **Pathological CT findings** **Overall** 60 days: 77% (112/145) 100 days: 63% (84/133) **Ground Glass Opacities** 60 days: 77% 100 days: 63% **Reticulation** 60 days: 58% 100 days: 51% **Consolidations** 60 days: 54% 100 days: 7%
Spinicci, 2021[127] Italy Retrospective	NR	NR	NR	**Dyspnea** 30% (30/100) **Respiratory Failure** (pO2<60 mmHg) **0% (0/100)**

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
Suarez-Robles, 2021[128] France Retrospective	NR	NR	NR	**Dyspnea** 40% (54/134)
Tomasoni, 2021[130] Italy Cross-sectional	NR	NR	NR	**Dyspnea (on-going)** 7% (7/105)
Venturelli, 2021[132] Italy Prospective	NR	NR	**D_{LCO} Reduced** 19% (136/716)	**Dyspnea (overall)** 30% (228/767) **Dyspnea (mild)** 23% (176/767) **Dyspnea (moderate)** 6% (42/767) **Dyspnea (severe/very severe)** 1% (10/767) **Pulmonary Obstruction** 4% (27/716) **Pulmonary Restriction** 12% (85/716)
Wang, 2020[71] China Prospective cohort	NR	NR	NR	**Chest CT Deteriorated** 1-2 weeks post-discharge 5.6% (2/36) (1 with enhanced inflammatory infiltrates, 1 with multiple bilateral GGO) 3-4 weeks post-discharge 0% (0/54) Outcomes did not differ by severity of COVID-19

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
Wu, 2021[133] China Prospective	**Fibrosis** 0% (0/83) at all follow-up	**FVC<80% Predicted** 3 months: 23% (19/83) 6 months: 16% (13/83) 12 months: 11% (9/83) **FEV_1<80% Predicted** 3 months: 30% (25/83) 6 months: 24% (20/83) 12 months: 16% (13/83) **TLC<80% Predicted** 3 months: 27% (22/83) 6 months: 19% (16/83) 12 months: 15% (12/83) **NOTE: no pulmonary function tests at 9 months**	**DLCO<80% Predicted** 3 months: 55% (46/83) 6 months: 54% (45/83) 12 months: 33% (27/83)	**Dyspnea – mMRC** Score of at least 1 (shortness of breath when hurrying on the level or walking up a slight hill) 3 months: 81% (67/83) 6 months: 30% (25/83) 9 months: 12% (10/83) 12 months: 5% (4/83) **Residual Changes on CT** 3 months: 78% (65/83) 6 months: 48% (40/83) 9 months: 27% (22/83) 12 months: 24% (20/83)
Xia, 2020[55] China Retrospective	NR	NR	NR	**CT At Discharge** Residual infiltrates without fibrosis: 82% (233/282) Residual infiltrates and consolidation fibrosis: 14% (39/282)
Yasin, 2021[134] Egypt Retrospective	48% (101/210)	NR	NR	NR
You, 2020[73] China Case Series	22% (4/18) GGO plus pulmonary fibrosis: 61% (11/18) Normal: 6% (1/18) Not available: 11% (2/18)	**VC_{max} <80% Predicted** 17% (3/18) **FEV_1 <80% Predicted** 17% (3/18) **FVC <80% Predicted** 17% (3/18) **FEV_1/FVC <70%** 17% (3/18) Outcomes did not differ by severity of COVID-19	NR	**Ventilation Impairment** Normal: 67% (12/18) Obstructive Ventilatory Impairment: 17% (3/18) Restrictive Ventilatory Impairment: 17% (3/18)
Yu, 2020[74] China	44% (14/32)	NR	NR	NR

Author, Year Country Study Design	Pulmonary Fibrosis % (n/N)	Lung Volume	Diffusion Capacity	Other
Retrospective case series	Pulmonary fibrosis: combination of parenchymal bands, irregular interfaces, coarse reticular pattern, and traction bronchiectasis			
Zhang, 2020[100] China Retrospective	**At 2 weeks** 31% (35/112)	NR	NR	**Chest CT at 2 weeks** Normal: 40% (45/112) Ground glass opacity: 35% (39/112
Zhao, 2020[101] China Retrospective	NR	**Abnormalities:** 26% (14/55) TLC: 7% (4/55) FEV_1: 11% (6/55) FVC: 11%% (6/55)	**DLCO Abnormality:** 16% (9/55)	**CT at 3 months** Ground glass opacity: 13% (7/55)

Abbreviations: DLCO=diffusing capacity of the lung for carbon monoxide; FEV_1 =forced expiratory volume in 1 sec; FVC=forced vital capacity; GGO=ground-glass opacity; HFNC=high flow nasal cannula; IMV=invasive mechanical ventilation; mMRC=modified Medical Research Council; NIV=non-invasive ventilation; NR=not reported; PE=pulmonary embolism; TLC=total lung capacity

[a]Includes participants without history of the outcome in the past one year

TABLE 4. CARDIOVASCULAR OUTCOMES

Author, Year Country Study Design	Imaging	Blood Tests	Other
Al-Aly, 2021[104] USA (Veterans) Retrospective All outcomes vs individuals hospitalized with seasonal influenza	NR	NR	All outcomes vs individuals hospitalized with seasonal influenza **Acute coronary disease**[a] HR (adjusted) 1.29 (95%CI 1.11, 1.5) Excess burden per 1000 hospitalized COVID-19 patients at 6 months 9.36 (95%CI 4.16, 13.86) **Heart Failure**[a] HR (adjusted) 1.19 (95%CI 1.03, 1.39) Excess burden per 1000 hospitalized COVID-19 patients at 6 months 6.31 (95% CI 1.02, 10.88) COVID-19 group: N=13,654 Control group (influenza): N=13,997
Alharthy, 2021[24] Saudi Arabia Prospective	**Pericardial Effusion (Ultrasound) at Discharge** 1.5% (1/64) (n=64 survivors)	NR	NR
Alharthy, 2020[75] Saudi Arabia Prospective	**Pericardial Effusion (Ultrasound)** **2 months** 15.7% (20/127) **4 months** 11.0% (14/127)	NR	NR
Ayoubkhani, 2021[106] United Kingdom Retrospective Controls from general population not meeting inclusion criteria for COVID-19; unclear if	NR	NR	**MACE, new onset events** COVID-19 Group: 2.6% (945/36,130) Rate per 1000 person-years 65.9 (95%CI 61.8, 70.3) General Population Control Group: 0.5% (190/36,130) Rate per 1000 person-years 12.3 (95%CI 10.6, 14.1) P<.001 between groups

Author, Year Country Study Design	Imaging	Blood Tests	Other
any were hospitalized at time of study			**MACE, all events** COVID-19 Group: 4.8% (2315/47,780) Rate per 1000 person-years 126.1 (95%CI 121.0, 131.4) General Population Control Group: 1.8% (855/47,780) Rate per 1000 person-years 42.6 (95%CI 39.8, 45.5) P<.001 between groups NOTE: decreased rate of MACE in patients admitted to ICU
Daher, 2020[81] Germany Prospective	**Echocardiography** LVEF – globally normal Admission: 94% (17/18) 6 week follow-up: 88% (29/33) RVEF – globally normal Admission: 94% (17/18) 6 week follow-up: 94% (31/33) **Pericardial Effusion** 0% (0/33)	NR	NR
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	NR	NR	**New Diagnoses** **Coronary disease overall (MI, acute coronary syndrome, cardiogenic shock)** COVID-19 Group: 1.05% Control Group: 0.18% Risk difference 0.87% (95%CI 0.54, 1.27) P<.001 **Congestive Heart Failure** COVID-19 Group: 1.54% Control Group: 0.20% Risk difference 1.34% (95%CI 0.66, 1.55) P<.001 **Myocarditis** COVID-19 Group: 0.09%

Author, Year Country Study Design	Imaging	Blood Tests	Other
			Control Group: 0.01% Risk difference 0.08% (95%CI -0.06, 0.19) P=1.0 N=18,118 for both groups
de Graaf, 2021[111] the Netherlands Prospective	**Echocardiography** **Abnormal LV function** (LVEF<52%): 22% (18/81) (NOTE: known pre-existing condition for 2 patients)	**Elevated Troponin T (Cardiac Injury)** 19% (15/81)	NR
De Lorenzo, 2020[82] Italy Prospective	NR	NR	**Uncontrolled Blood Pressure Requiring Therapeutic Change** 21% (26/126)
De Michieli, 2021[112] USA Retrospective	NR	NR	**Acute MI** 0% (0/312) (median 49 days follow-up)
Dennis, 2021[57] United Kingdom Prospective	**CMR** **Left Ventricular Ejection Fraction (%)** Impaired (≤51%): 11% (4/37) Normal (>51%): 89% (33/37) **Evidence of Myocarditis** 22%% (8/37)	NR	NR
Eswaran, 2021[114] USA Retrospective	NR	NR	**Non–ST Segment Myocardial Infarction** 0.08% (4/447) Within 30 days
Hall, 2021[115] United Kingdom Retrospective	NR	NR	**Cardiac Causes of Breathlessness** 4% (8/200) or 10% (8/81 with breathlessness) at 4-6 weeks (previously undiagnosed or deterioration of existing problem, included pericarditis, persistent sinus tachycardia, hypertrophic cardiomyopathy and inferior regional wall motion abnormality, atrial septal defect, pulmonary hypertension, left ventricular

Author, Year Country Study Design	Imaging	Blood Tests	Other
			hypertrophy and worsening of pre-existing heart failure)
Huang L, 2020[62] China Retrospective NOTE: of 26 patients tested, 15 (58%) were considered positive based on presence of positive conventional CMR findings (increased myocardial edema ratio [>2.0] (n=7) and/or LGE presence (n=8)) and 11 (42%) were negative	**CMR** **Myocardial Edema** 54% (14/26) 50% (7/14) with positive LGE 50% (7/14) with small pericardial effusion **LGE** 31% (8/26) with focal linear subepicardial and patchy mid-wall LGE (includes 7 patients noted above) Native T1, T2, and ECV values were significantly elevated in recovered COVID-19 patients with positive CMR findings compared with healthy controls Right ventricular ejection fraction, cardiac index, and stroke volume area were decreased in recovered COVID-19 patients with positive CMR findings compared with healthy controls	NR	NR
Morin, 2021[120] (COMEBAC Study Group) France Prospective	**Echocardiography** **LVEF <50% (no patient <40%)** 12% (10/83) (clinic assessment; median 125 days)	NR	NR
Ozer, 2021[123] Turkey Prospective	**LV-GLS above -18% (subclinical myocardial deformation)** 38% (28/74) 57% (16/28) in group with myocardial injury based on troponin level during hospitalization 26% (12/46) in group without myocardial injury	NR	NR

Author, Year Country Study Design	Imaging	Blood Tests	Other
Puntmann, 2020[66] Germany Prospective NOTE: Data for 100 patients; 33% hospitalized	**CMR** **Abnormal Native T1** COVID-19: 73% (73/100) Healthy Controls: 12% (6/50) Risk Factor-matched Controls: 58% (33/57) P<.05 for COVID-19 vs Controls **Abnormal Native T2:** COVID-19: 60% (60/100) Healthy Controls: 12% (6/50) Risk Factor-matched Controls: 26% (15/57) P<.05 for COVID-19 vs Controls **LGE** *Myocardia*l COVID-19: 32% (32/100) Healthy Controls: 0% Risk Factor-matched Controls: 17% (9/57) P<.05 for COVID-19 vs Controls *Pericardial* COVID-19: 22% (22/100) Healthy Controls: 0% Risk Factor-matched Controls: 14% (8/57) **Pericardial Effusion >10 mm** COVID-19: 20% (20/100) Healthy Controls: 0% Risk Factor-matched Controls: 7% (4/57) P<.05 for COVID-19 vs Controls	**Detectable hsTNT (≥3 pg/mL)** COVID-19 71% (71/100) Healthy Controls 22% (11/50) Risk Factor-matched Controls 54% (31/57) P<.05 for COVID-19 vs Controls **Significantly elevated hsTNT (≥13.9 pg/mL)** COVID-19 5% (5/100) Healthy Controls 0% Risk Factor-matched Controls: 0% P<.05 for COVID-19 vs Controls	NR
Raman, 2021[124] United Kingdom Prospective Controls were negative for SARS-CoV-2 and asymptomatic;	**Left Ventricular Function** Normal and comparable between groups (data NR) **Native T1 (Basal Myocardium) >1197 ms (>2 SD from control mean)** COVID-19: 26% (13/50) Controls: 4% (1/28) P=.015	**Abnormal Troponin T** COVID-19 0% Controls 0% Median 1.6 months post-discharge	NR

Author, Year Country Study Design	Imaging	Blood Tests	Other
community dwelling (not hospitalized)	**Native T1 (Mid Myocardium) >1215 ms (>2 SD from control mean)** COVID-19: 8% (4/51) Controls: 0% (0/28) P=.29 **Native T1 (Apical Myocardium) >1275 ms (>2 SD from control mean)** COVID-19: 2% (1/50) Controls: 4% (1/28) P=1.0 **LGE – Myocarditis Pattern** COVID-19: 12% (6/52) Controls: 7% (2/28) P=.47 **LGE - Pericardial Effusion >10 mm** COVID-19: 2% (1/52) Controls: 0% (0/28) P=1.0 Median 1.6 months post-discharge		
Sonnweber 2020[96] Austria Prospective	**Echocardiography** **LVEF (<53%)** 60 days: 3% (4/145) 100 days: 3% (4/134) **Pericardial Effusion** 60 days: 6% (8/145) 100 days: 1% (1/134)	NR	NR
Spinicci, 2021[127] Italy Retrospective	NR	**NR**	**Palpitation** 15% (15/100) **Chest pain** 12% (12/100)
Tudoran, 2021[131] Romania Prospective	**Diastolic Dysfunction** 17% (21/125) **Diastolic Dysfunction and Impaired Left Ventricular Systolic Function** 9% (11/125) Assessed at 6-10 weeks post-discharge	NR	NR

Author, Year Country Study Design	**Imaging**	**Blood Tests**	**Other**
Xiong, 2021[99] China Prospective	NR	NR	**Newly Diagnosed Hypertension** COVID-19: 1% (7/538) Controls: 0% (0/184)
Zhou, 2021[135] China Prospective	**LVEF <50%** 1% (1/97) Median 11 days post-discharge **CMRI (If Elevated Troponin or ECG Abnormality)** No evidence of acute myocarditis	**Troponin >99th Percentile of Upper Limit of Normal** 6% (6/97)	**Atrial Fibrillation (newly detected)** 1% (1/97) **Sinus Bradycardia (<60 bpm) (newly detected)** 28% (27/97) **T Wave Inversion (newly detected)** 8% (8/97) Median 11 days post-discharge

Abbreviations: hsTNT=high-sensitivity Troponin T; LGE=late gadolinium enhancement; LVEF=left ventricular ejection fraction; LV-GLS=left ventricular global longitudainal strain; NR=not reported

[a] Includes participants without history of the outcome in the past one year

TABLE 5. NEUROMUSCULAR OUTCOMES

Author, Year Country Study Design	NIH Stroke Scale	Modified Rankin Scale	Other
Akhtar, 2021[39] Qatar Retrospective	NR	**Good Prognosis** **Score ≤2 at Discharge** COVID-19 Group: 28% (9/32) Concurrent Non-COVID-19 Group: 52% (112/216) Pre-COVID-19 Era Group: 60% (348/585) P=.001	NR
Al-Aly, 2021[104] USA (Veterans) Retrospective All outcomes vs individuals hospitalized with seasonal influenza	Stroke[a] HR (adjusted) 1.30 (95%CI 1.05, 1.6) Excess burden per 1000 COVID-19 persons at 6 months 4.79 (95%CI 1, 7.87)	NR	**Neurocognitive Disorders[a]** Excess burden per 1000 COVID-19 persons at 6 months 16.16 (95%CI 10.40, 21.19) **Memory Problems[a]** HR (adjusted) 1.42 (95%CI 1.23, 1.63) Excess burden per 1000 COVID-19 persons at 6 months 16.59 (95%CI 10.59, 21.84) COVID-19 group: N=13,654 Control group (influenza): N=13,997
Alemanno, 2021[105] Italy Prospective	NR	NR	**MMSE** **Cognitive Deficits (range in effect severity)** Group 1 9% (2/22) mild Group 2 8% (1/12) mild Group 3 35% (7/20) mild to moderate Group 4 50% (1/2) moderate **MoCA** **Cognitive Deficits** Group 1 55% (12/22) Group 2 83% (10/12) Group 3 85% (17/20)

Author, Year **Country** **Study Design**	**NIH Stroke Scale**	**Modified Rankin Scale**	**Other**
			Group 4 100% (2/2)
Al Kasab, 2020[23] USA, South America, Europe Prospective	NR	**"Functional Independence on Discharge"** **Score 0-2** 17% (2/12) NOTE: missing data for n=1 Non-COVID-19 Group 30% (94/316) P=.52 NOTE: missing data for n=129	NR
Benussi, 2020[25] Italy Retrospective cohort	Median (IQR) COVID-19 Group (n=43) 9.0 (1.0-19.0) Non-COVID-19 Group (n=68) 2.0 (0.0-6.8) P=.005	**"Good Outcome"** **Score ≤2 at Discharge** COVID-19 Group: 25.6% (11/43) Non-COVID-19 Group: 70.6% (48/68) P<.001	NR
Bowles, 2020[77] USA Retrospective cohort NOTE: 1302 of 1409 patients had admission and discharge assessments	NR	NR	**Cognitive Function at Home Health Care Admission** Requires prompting: 23% (297/1302) Requires assistance and direction: 6% (76/1302) **Cognitive Function at Home Health Care Discharge** Requires prompting: 10% (130/1302) Requires assistance and direction: 3% (42/1302) **Confusion at Home Health Care Admission** In new and complex situations only: 41% (536/1302) Anytime: 5% (70/1302)

Author, Year Country Study Design	NIH Stroke Scale	Modified Rankin Scale	Other
			Confusion at Home Health Care Discharge In new and complex situations only: 19% (251/1302) Anytime: 3% (38/1302)
Chevinsky 2021[109] USA Retrospective Controls were hospitalized individuals who did not meet inclusion criteria for COVID-19 and were not diagnosed with COVID-19 during the 4 months after index encounter	NR	NR	**Neurocognitive Disorders** vs hospitalized non-COVID-19 control group patients 1-30 days after discharge OR (adjusted) 1.6 (95%CI 1.2, 2.1) 31-60 days after discharge OR (adjusted) 1.2 (95%CI 0.87, 1.7) 60-90 days after discharge OR (adjusted) 1.1 (95%CI 0.77, 1.6) 90-120 days after discharge OR (adjusted) 1.1 (95%CI 0.72, 1.7) N=27,284 for COVID-19 and control groups **Myopathies** 1-30 days after discharge OR (adjusted) 5.9 (95%CI 2.8, 12.4) Not reported at other follow-up intervals N=27,284 for COVID and control groups
Daher, 2020[81] Germany Prospective	NR	NR	**Cognitive Disorders (unclear how defined)** 6 week follow-up: 18% (6/33)
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	Stroke (ischemic and hemorrhagic) COVID Group: 1.12% Control Group: 0.29% Risk difference 0.83% (95%CI 0.4, 1.2) P<.001 N=18,118 for both groups	NR	**New Clinical Diagnoses** **Amnesia/memory difficulty** COVID-19 Group: 2.90% Control Group: 0.43% Risk difference 2.47% (95%CI 1.76, 2.96) P<.001 **Dementia** COVID-19 Group: 0.23%

Author, Year **Country** **Study Design**	**NIH Stroke Scale**	**Modified Rankin Scale**	**Other**
NOTE: this study also reported peripheral neuropathy, encephalopathy, seizure, and Guillain-Barre Syndrome			Control Group: 0.03% Risk difference 0.2% (95%CI 0.07, 0.3) P<.001 **Alzheimer** COVID-19 Group: 0.04% Control Group: 0.0% Risk difference 0.04% (95%CI 0.0, 0.1) P<.001 N=18,118 for both groups
de Graaf, 2021[111] The Netherlands Prospective	NR	NR	**Cognitive Failures Questionnaire (CFQ-25)** (cognitive impairment: score ≥31) 27% (13/48) **Informant Questionnaire on Cognitive Functioning in the Elderly** (cognitive impairment: score >3.31) 26% (10/38)
De Lorenzo, 2020[82] Italy Prospective	NR	NR	**Cognitive Impairment (MoCA<24)** 29% (36/126)
Eswaran, 2021[114] USA Retrospective	Of 9 total vascular thromboembolic events there was 1 ischemic stroke	NR	NR
Garrigues, 2020[61] France Prospective, survey	NR	NR	**Attention Disorder** 27% (32/120) Ward patients: 29% (28/96) ICU patients: 17% (4/24) P=.327 **Memory Loss** 34% (41/120) Ward patients: 38% (36/96)

Author, Year Country Study Design	NIH Stroke Scale	Modified Rankin Scale	Other
			ICU patients: 21% (5/24) P=.194
Grewal, 2020[31] USA Retrospective	Median (IQR) COVID-19 Group (n=13) 11 (4-23) 2020 Comparison Cohort: 3 (2-13) 2019 Comparison Cohort: 4 (1-11)	**"Poor Outcome"** **Score >2 at Discharge** COVID-19 Group: 77% (10/13) 2020 Comparison Cohort: 47% (25/53) 2019 Comparison Cohort: 41% (36/88)	NR
Jacobs, 2020[117] USA Prospective	NR	NR	**Confusion (persisting from hospital discharge)** 43% (16/37) or 9% (16/183 enrolled)
Liotta, 2020[33] USA Retrospective	NR	**Score ≤2 at Discharge** Overall: 71.1% (362/509) No neurological manifestation (during hospitalization): 70.0% (63/90) Any neurological manifestation: 71.4 (299/419) No encephalopathy (during hospitalization): 89.3% (310/347) Encephalopathy: 32.1% (52/162)	
Mathew, 2020[46] India Retrospective	NR	**Score ≤2 at Discharge** 19% (12/62)	NR
Morin, 2021[120] (COMEBAC Study Group) France Prospective	NR	NR	**Q3PC Questionnaire** **Memory Difficulties** 18% (73/416) **Mental Slowness** 10% (42/415) **Concentration Problems** 10% (41/412)

Author, Year Country Study Design	NIH Stroke Scale	Modified Rankin Scale	Other
			(telephone assessment; median 113 days) **Cognitive Complaint (impaired McNair score, reported cognitive symptoms, or both)** 50% (79/159) **Cognitive Impairment (impairment of either MoCA or d2-R score)** 38% (61/159)
Mowla, 2020[48] Multinational Retrospective	NR	**Score ≤2 at Discharge** COVID-19 Group (data available for 10/13 patients) 60% (6/10) Control Group: 77% (44/57) P=.26	NR
Nersesjan, 2021[142] Denmark Prospective	NR	NR	**Stroke after Discharge** 4% (2/45 with 3 month follow-up data) **Encephalopathy after Discharge** 2% (1/45 with 3 month follow-up data) **Peripheral Neuropathy after Discharge** 9% (4/45 with 3 month follow-up data) **Readmission to neurological department** 24% (4/17 readmitted through 3 month follow-up)
Ntaios, 2020[36] Multi-national registry Retrospective	NR	**Severe Disability at Discharge** COVID-19 Group: 51% (49/96 survivors) **Median Score (propensity matched population (n=330)** COVID-19 Group: 4 [IQR 2-6] Matched Group: 2 [IQR 1-4] P<.001	NR
Osikomaiya, 2021[122] Nigeria	NR	NR	**Attention or memory deficit** 5% (14/274)

Author, Year Country Study Design	**NIH Stroke Scale**	**Modified Rankin Scale**	**Other**
Retrospective			
Perry, 2020[53] United Kingdom Retrospective case-control	NR	**Score ≤2 at Discharge** (estimated from plot) COVID-19 Group: 29% Control Group: 46%	NR
Raman, 2021[124] United Kingdom Prospective Controls were negative for SARS-CoV-2 and asymptomatic; community dwelling (not hospitalized)	NR	NR	**MoCA <26 (Abnormal)** COVID-19 Group 28% (16/58) Control Group 17% (5/30) P=.30 (calculated) Median 1.6 months post-discharge **Clinical Assessment of Brain MRI Brain Abnormalities** COVID-19 Group 24% (13/54) Control Group 21% (6/28) P=.79 Median 1.6 months post-discharge
Ramani, 2021[91] USA Retrospective	NR	NR	**Mild Cognitive Impairment MoCA (<26)** 57% (16/28) **Quality of Life in Neurological Disorders** 22% (6/27)
Rass, 2021[125] Austria Prospective	NR	NR	**Diagnoses at 3 Months (not diagnosed before COVID-19)** **Any Neurological Disease** 15% (20/135) **Polyneuropathy/myopathy** 13% (17/135) **Parkinsonism** 1% (1/135)

Author, Year Country Study Design	NIH Stroke Scale	Modified Rankin Scale	Other
			Stroke with Clinical Symptoms 1% (1/135) **Mild Encephalopathy** 2% (2/135) **MoCA** **Cognitive Deficits (score <26)** 23% (29/135) Severe COVID-19:29% (8/31) Moderate COVID-19 30% (20/72) Mild COVID-19 3% (1/32) **Forgetfulness** 25% (30/135) Severe COVID-19 26% (7/31) Moderate COVID-19 24% (16/72) Mild COVID-19 24% (7/32)
Spinicci, 2021[127] Italy Retrospective	NR	NR	**Mental confusion** 10% (10/100)
Tacquet, 2021 USA Retrospective	NR	NR	**Ischemic Stroke (first)** 1.60% (741/46302) **Intracranial Hemorrhage (first)** 0.63% (292/46,302) **Dementia** 1.46% (676/46,302) **Parkinsonism** 0.20% (93/46,302) **Myoneural junction or muscle disease** 1.24% (574/46,302)
Tomasoni, 2021[130] Italy Cross-sectional			**Cognitive deficits (memory disorder, on-going)** 17% (18/105) **MMSE (mild deficits 18-25)** 36% (9/25)

Author, Year **Country** **Study Design**	**NIH Stroke Scale**	**Modified Rankin Scale**	**Other**
			MMSE (pathological <18) 4% (1/25)
Venturelli, 2021[132] Italy Prospective	NR	NR	**Confusion** 5% (23/510) **MoCa (normal)** >99% (302/304) **MoCa (pathologic =0)** <1% (2/304)

Abbreviation: IQR=interquartile range; MMSE=Mini Mental State Examination; MoCA=Montreal Cognitive Assessment; NR=not reported; Q3PC=European AIDS Clinical Society cognitive screening questions

[a] Includes participants without history of the outcome in the past one year

TABLE 6. RENAL OUTCOMES

Author, Year Country Study Design	Acute Kidney Disease	Chronic Kidney Disease	Need for Renal Replacement Therapy	Imaging Findings
Al-Aly, 2021[104] USA (Veterans) Retrospective All outcomes vs. individuals hospitalized with seasonal influenza and including individuals without history of the outcome in past 1 year	**Acute Renal Failure[a]** Excess burden per 1000 COVID-19 persons at 6 months 27.93 (95%CI 20.67, 34.50) **Acute Kidney Injury[a]** HR (adjusted) 1.24 (95%CI 1.1, 1.4) Excess burden per 1000 COVID-19 persons at 6 months 11.21 (95%CI 5.36, 16.43) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997	**CKD[a]** HR (adjusted) 1.35 (95%CI 1.1, 1.65) Excess burden per 1000 COVID-19 persons at 6 months 6.03 (95%CI 2.17, 9.2) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997	NR	NR
Ayoubkhani, 2021[106] United Kingdom Retrospective Controls from general population not meeting inclusion criteria for COVID-19; unclear if any were hospitalized at time of study	NR	**CKD, new onset events at 140 (mean) days** COVID-19 Group: 0.6% (240/41,705) Rate per 1000 person-years 14.6 (95%CI 12.8, 16.6) General Population Control Group: 0.3% (125/41,705) Rate per 1000 person-years 7.2 (95%CI 6, 8.5) **CKD, all events** COVID-19 Group: 1.5% (710/47,780) Rate per 1000 person-years 38.7 (95%CI 35.9, 41.6) General Population Control Group: 0.9% (410/47,780) Rate per 1000 person-years 20.4 (95%CI 18.5, 22.5)	NR	NR

Author, Year Country Study Design	Acute Kidney Disease	Chronic Kidney Disease	Need for Renal Replacement Therapy	Imaging Findings
		NOTE: Similar rates whether admitted to ICU or not		
Chan, 2021[102] USA Retrospective Compared last hospital creatinine with baseline; grouped as recovered or with AKD Stage 1, 2, or 3 Recovered: difference in creatinine ≤0.3; change in % ≤25% Stage 1: difference >0.3 and change >25% and ≤100% Stage 2: change in % >100% and ≤200% Stage 3: change in % >200%	**At Discharge** 35% (291/832)[b] AKD Stage 1: 23% AKD Stage 2: 6% AKD Stage 3: 6% **Follow-up (median 21 [IQR 8-38] days)** Data available for n=77 with AKD at discharge Recovered: 36% (28/77) AKD Stage 1: 33% (25/77) AKD Stage 2: 13% (10/77) AKD Stage 3: 18% (14/77) Data available for n=135 who had recovered at discharge Remain recovered: 86% (116/135) New AKD Stage 1: 10% (14/135) New AKD Stage 2: 2% (3/135) New AKD Stage 3: 2% (3/135)	NR	NR	NR
Chevinsky 2021[109] USA Retrospective Controls were hospitalized individuals who did not meet inclusion criteria for COVID-19 and were not diagnosed with COVID-19 during the 4	Acute and unspecified kidney failure vs hospitalized non-COVID-19 control group patients 1-30 days after discharge OR (adjusted) 1.3 (95%CI 1.0, 1.6) 31-60 days after discharge OR (adjusted) 0.74 (95%CI 0.56, 0.99) 60-90 days after discharge	NR	NR	NR

Author, Year Country Study Design	Acute Kidney Disease	Chronic Kidney Disease	Need for Renal Replacement Therapy	Imaging Findings
months after index encounter	OR (adjusted) 0.67 (95%CI 0.48, 0.92) 90-120 days after discharge OR (adjusted) 0.56 (95%CI 0.39, 0.80) N=27,284 for COVID and control groups			
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	**Kidney injury (acute and chronic)** COVID-19 Group: 3.02% Control Group: 0.79% Risk difference 2.22% (95%CI 1.42, 2.79) **Acute kidney injury** COVID-19 Group: 2.85% Control Group: 0.47% Risk difference 2.38% (95%CI 1.67, 3.11)	**CKD** COVID-19 Group: 2.06% Control Group: 0.70% Risk difference 1.36% (95%CI 0.72, 1.82) P<.001 for both outcomes N=18,118 for both groups	NR	NR
Dennis, 2021[57] United Kingdom Prospective	NR	NR	NR	**Kidney Cortex T1** Normal: 95% (35/37) Impairment: 5% (2/37)
Doher, 2020[145] Brazil Retrospective cohort	NR	NR	**At Discharge (among RRT group, n=34)** 11% (1/9) 34 required RRT during hospitalization; NOTE: 12 died in the hospital, unclear if 9 represents patients discharged by end of study period	NR
Gupta, 2021[139] USA Cohort	NR	NR	**At Discharge** 34% (73/216 discharged) **At 60 Days after ICU Admission** 57% (39/69 alive at day 60) 18% (39/216 discharged)	NR

Author, Year Country Study Design	Acute Kidney Disease	Chronic Kidney Disease	Need for Renal Replacement Therapy	Imaging Findings
Hamilton, 2020[83] United Kingdom Retrospective	NR	NR	**At Discharge** 6% (2/32 who required RRT during hospitalization)	NR
Hittesdorf, 2020[140] USA Retrospective	NR	NR	**At Discharge and 90 Days after Admission** 4% (2/45 who required RRT during hospitalization) 7% (2/27 surviving at 90 days)	NR
Huang C, 2021[85] China Retro and Prospective	NR	NR	NR	**Abnormal morphology (ultrasound)** Scale 3: 0% (0/40) Scale 4: 0% (0/113) Scale 5-6: 0% (0/28)
Matsunaga, 2020[47] Japan Registry	NR	NR	**At Discharge** 1% (16/2431)	NR
Morin, 2021[120] (COMEBAC Study Group) France Prospective	NR	**Persistent Alteration of Kidney Function at 4 Months** 2% (2/95 who had AKI during hospitalization) or 0.4% (2/478 overall)	NR	NR
Naar, 2020[49] USA Prospective	NR	NR	**At Discharge** 11% (5/46 who required RRT during hospitalization) 3% (5/148 who developed AKI) 2 % (5/206 enrolled) NOTE: 3% (7/206) were dialysis-dependent before hospital admission	NR
Ng, 2020[35] USA Retrospective	**At Discharge** **KRT**	NR	**RRT** 92% (33/36) who had not recovered needed RRT at discharge (30.6% [33/108] of	NR

Author, Year Country Study Design	Acute Kidney Disease	Chronic Kidney Disease	Need for Renal Replacement Therapy	Imaging Findings
	17% (108/638) survived; 33% (36/108) had not recovered kidney function **Non-KRT** 52% (1663/3216) survived; 26% (430/1663) had not recovered kidney function		survivors who required hospital RRT) NOTE: 58% (19/33) had underlying CKD on admission	
Nugent, 2021[121] USA Retrospective COVID and non-COVID groups developed AKI during hospitalization	NR	**Kidney Dysfunction Post-Discharge (3-6 months)** 8% (15/182) **Kidney Recovery after Discharge** (rate per 100 patient-days) COVID-19 Group (n=32) 0.95 (0.62, 1.46) Non-COVID Group (n=287) 1.74 (1.51, 2.00) HR (adj): 0.57 (0.35, 0.92); P=.02	NR	NR
Raman, 2021[124] United Kingdom Prospective Controls were negative for SARS-CoV-2 and asymptomatic; community dwelling (not hospitalized)	NR	**Residual Renal Impairment at 2-3 Months (not present prior to COVID-19)** 3% (2/58) NOTES: Outcome NR for control group; 6 patients developed AKI during hospitalization; 2 required RRT	NR	NR
Stevens, 2020[97] USA Retrospective	NR	NR	**At 30 days (median) from RRT Initiation** 8% (9/115) (NOTE: 2 of the 9 had been discharged with dialysis-dependent AKI; others remained hospitalized)	NR

Abbreviations: AKD=acute kidney disease; CKD=chronic kidney disease; IQR=interquartile range; KRT=kidney replacement therapy
[a]Includes participants without history of the outcome in the past one year
[b]Of 1835 with AKI while hospitalized, 832 were discharged; 291 with acute kidney disease

TABLE 7. ENDOCRINE OUTCOMES

Author, Year Country Study Design	Diabetes Mellitus
Al-Aly, 2021[104] USA (Veterans) Retrospective All outcomes vs. individuals hospitalized with seasonal influenza and including individuals without history of the outcome in past 1 year	**Diabetes[a]** HR (adjusted) 1.6 (95%CI 1.36, 1.87) Excess burden per 1000 hospitalized COVID-19 patients at 6 months 21.39 (95%CI 15.1, 26.77) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997
Ayoubkhani, 2021[106] United Kingdom Retrospective Controls from general population not meeting inclusion criteria for COVID-19; unclear if any were hospitalized at time of study	**Diabetes, new onset events** COVID-19 Group: 1.1% (400/36,100) Rate per 1000 person-years 28.7 (95%CI 26, 31.7) General Population Control Group: 0.3% (125/36,100) Rate per 1000 person-years 8.2 (95%CI 6.9, 9.8) P<.001 between groups **Diabetes, all events** COVID-19 Group: 4.9% (2330/47,780) Rate per 1000 person-years 126.9 (95%CI 121.8, 132.2) General Population Control Group: 3.6% (1725/47,780) Rate per 1000 person-years 86.0 (95%CI 82.0, 90.2) P<.001 between groups NOTE: Increased rates of diabetes for patients admitted to ICU
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	**New Clinical Diagnoses** **Diabetes (Type 2)** COVID Group: 3.04% Control Group: 0.83% Risk difference 2.21% (95%CI 1.4, 3.16) P<.001 N=18,118 for both groups

[a] Includes participants without history of the outcome in the past one year
CI=confidence interval; HR=hazard ratio;

TABLE 8. GASTROINTESTINAL OUTCOMES

Author, Year Country Study Design	Imaging Findings	Other Findings
Al-Aly, 2021[104] USA (Veterans) Retrospective Outcomes vs individuals hospitalized with seasonal influenza and including individuals without history of the outcome in past 1 year	**"Gastrointestinal Disorders" (includes dysphagia)[a]** Excess burden per 1000 COVID-19 persons at 6 months 19.28 (95%CI 12.75, 25.13) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997	
Ayoubkhani, 2021[106] United Kingdom Retrospective Controls from general population not meeting inclusion criteria for COVID-19; unclear if any were hospitalized at time of study	**Chronic Liver Disease, new onset** (mean 140 days follow-up) COVID-19 Group: 0.2% (70/46,395) Rate per 1000 person-years 4.0 (95%CI 3.2, 5.1) General Population Control Group: 0.04% (15/46,395) Rate per 1000 person-years 0.9 (95%CI 0.5, 1.4) P<.001 between groups* **Chronic Liver Disease, all events** COVID-19 Group: 0.3% (135/47,780) Rate per 1000 person-years 7.2 (95%CI 6.1, 8.6) General Population Control Group: 0.1% (50/47,780) Rate per 1000 person-years 2.5 (95%CI 1.9, 3.3) *calculated by review authors	
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	**NR**	**Liver Test Abnormality (at 4 months)** COVID-19 Group: 3.30% Control Group: 1.36% Risk difference 1.95% (95%CI 1.06, 2.58) P<.001 N=18,118 for both groups
Dennis, 2021[57] United Kingdom Prospective	**Liver Inflammation (cT1 in ms)** Normal (<784 ms): 76% (28/36) Impaired (≥784 ms): 24% (9/36) Missing data for n=1	
de Graaf, 2021[111] The Netherlands Prospective	NR	**Elevated Liver Enzyme at 1.5 Months** 2% (2/81)
Huang C, 2021[85] China Retro and Prospective	**Abnormal Liver Morphology (ultrasound)** Scale 3: 0% (0/100) Scale 4: 0% (0/185) Scale 5-6: 0% (0/105)	

[a] Includes participants without history of the outcome in the past one year

TABLE 9. HEMATOLOGIC OUTCOMES

Author, Year Country Study Design	Thromboembolism	Hemorrhage	Coagulation Disorder
Al-Aly, 2021[104] USA (Veterans) Retrospective All outcomes vs individuals hospitalized with seasonal influenza and including individuals without history of the outcome in past 1 year	**Thromboembolism[a]** HR (adjusted) 2.26 (95% CI 1.94, 2.64) Excess burden per 1000 hospitalized COVID-19 patients at 6 months 29.77 (95% CI 25.74, 33.24) **Pulmonary Embolism[a]** Excess burden per 1000 COVID-19 persons at 6 months 18.31 (95%CI 15.83, 20.25) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997	NR	**Coagulation Disorder[a]** Excess burden per 1000 COVID-19 persons at 6 months 14.31 (95%CI 10.08, 17.89) COVID-19 Group: N=13,654 Control Group (influenza): N=13,997
Alharthy, 2021[24] Saudi Arabia Prospective	**DVT at Discharge** 12.5% (8/64) (n=64 survivors)	NR	NR
Alharthy, 2020[75] Saudi Arabia Prospective	**DVT** **2 months** 14.2% (18/127) **4 months** 7.1% (9/127)	NR	NR
Brosnahan, 2020[79] USA Retrospective	**Re-presented with Concern for Thrombotic Event** 0.46% (9/1,975) (included DVT, PE, limb ischemia due to coronary thrombosis, acute stroke, rapidly evolving hemodynamic instability with elevated D-dimer at time of presentation)	NR	NR
Chevinsky 2021[109] USA Retrospective Controls were hospitalized individuals who did not meet inclusion criteria for COVID-19 and were not diagnosed with COVID-	**Acute Pulmonary Embolism** vs hospitalized non-COVID-19 control group patients 1-30 days after discharge OR (adjusted) 1.5 (95%CI 1.0, 2.1) 31-60 days after discharge OR (adjusted) 1.4 (95%CI 0.93, 2.1) 60-90 days after discharge OR (adjusted) 1.2 (95%CI 0.72, 1.9) 90-120 days after discharge OR (adjusted) 1.2 (95%CI 0.70, 2.1)	NR	**Coagulation and Hemorrhagic Disorders** vs hospitalized non-COVID-19 control group patients 1-30 days after discharge OR (adjusted) 1.3 (95%CI 1.0, 1.6) 31-60 days after discharge OR (adjusted) 1.3 (95%CI 0.95, 1.7) 60-90 days after discharge OR (adjusted) 0.65 (95%CI 0.46, 0.90) 90-120 days after discharge

Author, Year Country Study Design	Thromboembolism	Hemorrhage	Coagulation Disorder
19 during the 4 months after index encounter	N=27,284 for COVID and control groups		OR (adjusted) 0.66 (95%CI 0.45, 0.97) N=27,284 for COVID and control groups
Daher, 2020[81] Germany Prospective	**Thromboembolic events at 6 weeks** 0% (0/33)	NR	NR
Daugherty 2021[110] USA Retrospective Controls did not have a COVID-19 diagnosis and were not admitted to a hospital for COVID-19	**DVT** (at 4 months) COVID-19 Group: 2.28% Control Group: 0.30% Risk difference 1.99% (95%CI 1.52, 2.46) **PE** (at 4 months) COVID-19 Group: 1.25% Control Group: 0.14% Risk difference 1.11% (95%CI 0.69, 1.39) P<.001 for all outcomes N=18,118 for both groups	NR	**Hypercoagulability** (at 4 months) COVID-19 Group: 3.15% Control Group: 0.37% Risk difference 2.78% (95%CI 2.29, 3.62) P<.001 N=18,118 for both groups
Engelen, 2021[113] Belgium Prospective	**DVT** (asymptomatic, no prophylaxis, 6 weeks post-discharge) 0% (0/146) **PE** (symptomatic, receiving prophylaxis, 6 weeks post-discharge) 1% (1/146)	**Major Bleeding** (6 weeks post-discharge) 0% (0/146) including in 41 patients receiving post-discharge prophylaxis	NR
Eswaran, 2021[114] USA Retrospective	**Total Vascular Thromboembolic Events** (within 30 days) 2% (9/447), 6 were arterial and 3 were venous events. (see cardiovascular and neurologic outcomes) **Pulmonary Embolism** (within 30 days) 1% (3/447)	NR	NR
Hall, 2021[115] United Kingdom Retrospective	**Pulmonary Embolism (at 4-6 weeks)** 2% (4/200) **Lung Infarcts** 1% (2/200)	NR	NR
Hill, 2020[84] USA Retrospective	**VTE** (median follow-up 21 days) 0.14% (3/2075 survivors)	NR	NR

Author, Year Country Study Design	Thromboembolism	Hemorrhage	Coagulation Disorder
	NOTE: authors report 1 additional VTE in patient who was evaluated and discharged		
Huang C, 2021[85] China Retro and Prospective	**DVT of Lower Limbs (ultrasound)** Scale 3: 0% (0/100) Scale 4: 0% (0/185) Scale 5-6: 0% (0/105)	NR	NR
Patell, 2020[65] USA Retrospective	2.5% (4/163) at median of 23 days [IQR 12-33] 1 each: PE, intracardiac thrombus, thrombosed arteriovenous fistula, ischemic stroke Among 13 patients discharged on thromboprophylaxis: no observed thrombotic or hemorrhagic complications	3.7% (6/163) at median of 27 days [IQR 16-31] 2 “major bleeds” (both following falls), 4 “clinically relevant non-major bleeding”	NR
Rashidi, 2020[92] Iran Retrospective	**Acute PE at 45 Days** 0.2% (3/1529) including 1 alive at follow-up who reported potential symptoms and 2 deaths due to pulmonary embolism	NR	NR
Remy-Jardin, 2021[126] France Retrospective	**PE-type Perfusion Defects (median 144 days)** 11% (6/55) or 16.6% (6/36 with perfusion abnormalities) **Detectable Clot** 2% (1/55) (Note: 1 of the 6 patients with perfusion defects had detectable clot)	NR	NR
Roberts, 2020[68] United Kingdom Prospective	**VTE** COVID-19 Group 0.48% (9/1877) at median of 8 days [range 3-33] 2 DVT, 7 PE Control Group (Medical Admissions in 2019) 0.31% (56/18,159) 8 proximal, 10 distal, 5 line-associated upper-limb DVT, 33 PE OR 1.6 (95%CI 0.77, 3.1); P=.2	NR	NR

Author, Year Country Study Design	Thromboembolism	Hemorrhage	Coagulation Disorder
Salisbury, 2020[93] United Kingdom Retrospective	**VTE** (secondary analysis-subgroup [n=152] discharged without an indication for therapeutic anticoagulation and followed for 42 days) 3% (4/152) (all PE, median of 14 days after discharge [range 4-26 days])	**Bleeding** (secondary analysis-subgroup [n=152] discharged without an indication for therapeutic anticoagulation and followed for 42 days) 0% (0/152)	**NR**
Vlachou, 2021[98] United Kingdom Retrospective	**Admitted with PE (post-recovery)** At up to 4 weeks 1% (4/370 enrolled) (NOTE: number discharged alive NR)	NR	NR

Abbreviations: DVT=deep venous thrombosis; IQR=interquartile range; PE=pulmonary embolism
[a] Includes participants without history of the outcome in the past one year

TABLE 10. HEALTHCARE/RESOURCE UTILIZATION OUTCOMES

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Anand, 2020[40] USA Retrospective	NR	Home Without Services: 34% (22/64 discharged) Skilled Nursing Facility: 32% (20/64 discharged) Acute Rehabilitation: 14% (9/64 discharged) Home With Services: 8% (5/64 discharged) Inpatient Hospice: 6% (4/64 discharged) Long-term Acute Care Hospital: 5% (3/64 discharged) Home with Hospice: 2% (1/64 discharged)	NR	NR
Arab-Zozani, 2020[76] Iran Cross-sectional	NR	NR	NR	**Self-care** 88% reported no problems with self-care post-discharge
Atalla, 2020[136] USA Retrospective	5.6% (19/339) Median of 5 days [IQR 3-13] post discharge **Clinical Course During 2nd Admission** Length of Stay: 7 days Intensive Care: 31% NOTE: 3 patients required a third admission	**For 19 Patients Readmitted** Skilled Nursing Facility: 26% (5/19) Home (n=11) or Hotel for COVID+Homeless (n=3): 74% (14/19)	NR	**Reasons for Readmission** Bacterial pneumonia secondary to COVID-19 infection: 21% (4/19) Prolonged COVID-19 Course: 21% (4/19) Psychiatric episodes: 16% (3/19) Metabolic encephalopathy: 11% (2/19) Thrombotic episodes: 11% (2/19) Alcohol intoxication, orthostatic hypotension, gastroenteritis, fall/trauma (1 each): 21% (4/19)
Barbaro, 2020[41] Multi (International Registry)	NR	Home or acute rehabilitation center: 53% (311/588 discharged alive)	NR	NR

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Retrospective cohort		Long-term acute care center or unspecified: 17% (101/588 discharged alive) Another hospital: 30% (176/588 discharged alive) NOTE: a total of 588/1035 were discharged alive		
Bhatt, 2021[42] USA Retrospective	NR	**COVID-19 Patients without History of Heart Failure** Hospice: 4% (4,320/121,813 discharged) Skilled nursing or rehabilitative care: 19% (22,601/121,813 discharged) **COVID Patients with a History of Heart Failure** Hospice: 7% (428/6,357 discharged) Skilled nursing or rehabilitative care: 41% (2,605/6,357 discharged) **Non-COVID Patients with History of Heart Failure (Non-Heart Failure Hospitalization)** Hospice: 4% (4,068/95,556 discharged) Skilled nursing or rehabilitative care: 21% (20,352/95,556 discharged)	NR	NR
Bowles, 2020[77] USA Retrospective cohort	**During Home Health Care (post-discharge)** 10% (137/1409)	NR	NR	NR

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Brendish, 2020[78] United Kingdom Prospective cohort	**Within 30 days** COVID-19 Positive: 10.6% (30/352) COVID-19 Negative: 17.7% (105/702) MD -7.2% [95%CI -11.7, 2.2; P=.0033]	NR	NR	NR
Casas-Rojo, 2020[56] Spain Retrospective cohort	3.9% (573/14,709) Of patients discharged: 4.8% (573/11,928) Not discharged at end of follow-up (after readmission) 0.2% (31/15,150) Of patients readmitted: 5.4% (31/573)	NR	NR	NR
Chopra, 2020[80] USA Retrospective	**Within 60 days** 15% (189/1250)	Home: 78% (975/1250) Skilled nursing or rehabilitation: 13% (158/1250) Doesn't total 100% or 1250	**Oxygen use:** 7% (32/488) **New use of CPAP or other when asleep:** 7% (34/488)	**Primary care follow-up within 60 days** 78% (382/488 who completed follow-up telephone survey) **Home Health Services** 20% (98/488) **Unable to return to normal activity** 39% (188/488)
Collins, 2020[26] USA Retrospective	NR	Home: 65% (13/20) or 81% (13/16 discharged) Nursing facility (permanent residence): 5% (1/20) or 6% (1/16 discharged) Hotel for those with confirmed COVID-19: 10% (2/20) or 13% (2/16 discharged)	NR	NR
Daher, 2020[81] Germany Prospective	NR	NR	**Needing Oxygen Therapy** Admission: 82% (27/33) 6 week follow-up: 3% (1/33)	

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Dawson, 2020[143] United Kingdom Prospectively collected/ retrospectively analyzed	0% (0/208) Length of follow-up NR	NR	NR	NR
DeBolt, 2020[43] USA Retrospective	NR	**Home without Oxygen Requirement** Pregnant: 92% (35/38) Non-pregnant COVID-19 Controls: 85% (77/91 discharged alive) **Skilled Nursing Facility, Long-term Acute Care, or Home with Oxygen Requirement** Pregnant: 8% (3/38) Non-pregnant COVID-19 Controls: 15% (14/91 discharged alive)	NR	NR
de Havenon, 2021[146] USA Retrospective	NR	**Favorable Discharge (Home or Acute Rehabilitation)** COVID-19 group: 34% (707/2,086) Historical controls: 66% (110,546/166,586) P<.001	NR	NR
De Lorenzo, 2020[82] Italy Prospective	NR	NR	NR	**Need for Follow-up** 60% (75/126) (defined as presence at follow-up evaluation of at least 1 of: respiratory rate >20 breaths/min, uncontrolled blood pressure requiring therapeutic change, moderate to very severe dyspnea, malnutrition, or new-onset cognitive impairment)

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
De Michieli, 2021[112] USA Retrospective	**COVID-19 Related** 9.6% (30/312) (median 49 days follow-up)	NR	NR	NR
Egol, 2020[58] USA Prospective	**Within 30 Days** COVID-19 Positive: 11.8% (2/17) COVID-19 Suspected: 7.1% (1/14) COVID-19 Negative: 2.8% (3/107) P=.21	NR	**Post-Acute Rehabilitation** COVID-19 Positive: 90.0% (9/17) COVID-19 Suspected: 84.6% (11/14) COVID-19 Negative: 78.3% (83/107) P=.61	NR
El Moheb, 2020[59] USA Retrospective	**Emergency Department Readmission** 11% (10/92) Matched comparison group of non-COVID-19 ARDS patients: 11% (10/92) Length of follow-up not reported	NR	NR	NR
Fisher, 2020[28] USA Retrospective	NR	**Nursing Home** COVID-19 positive: 14.7% (492/3345) or 23% (492/2142 discharged) COVID-19 negative: 12.8% (152/1265) or 17% (162/950 discharged) RR (total study population): 1.2 (95%CI 1.0, 1.4) Historical control: 14.6% (1436/9859) or 15% (1436/9544 discharged) RR (COVID positive vs control, total study population): 1.0 (95%CI 0.9, 1.1)	NR	NR

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
		Home COVID-19 positive: 49.3% (1650/3345) or 77% (1650/2142 discharged) COVID-19 negative: 62.3% (788/2365) or 83% (788/950 discharged) RR (total study population): 0.08 (95%CI 0.7, 0.8) Historical control: 82,2% (8108/9859) or 85% (8108/9544 discharged) RR (COVID positive vs control, total study population): 0.6 (95%CI 0.57, 0.62)		
Grewal, 2020[31] USA Retrospective	NR	Disposition reported for 10/13 survivors (remaining patients: 2 deaths, 1 unknown disposition) Home: 30% (3/10) (2/6 in 'COVID' group, 1/4 in 'Neuro' group) Acute rehabilitation: 50% (5/10) (3/6 in 'COVID' group, 2/4 in 'Neuro' group) Long-term acute care: 20% (2/10) (1/6 in 'COVID' group, 1/4 in 'Neuro' group)	NR	NR
Hamilton, 2020[83] United Kingdom Retrospective	**Within 30 days** 8% (86/1032)	NR	NR	NR
Huang C, 2021[85] China Retro and Prospective	NR	NR	NR	**Personal care problems** 1% (11/1622)

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Hegde, 2020[44] USA Retrospective case series	NR	Skilled Nursing Facility: 14% (1/7) or 33% (1/3 discharged) Long-term Acute Care: 29% (2/7) or 67% (2/3) discharged	NR	NR
Katz, 2020[32] USA Retrospective	NR	COVID-19 group Home: 29% (25/86) or 45% (25/56 discharged) Rehabilitation: 36% (31/86) or 55% (31/56 discharged) (Additional 30 patients died or in hospice care) Non-COVID-19 group Home: 46% (228/499) or 52% (228/438 discharged) Rehabilitation: 42% (210/499) or 48% (210/438 discharged) (Additional 61 patients died or in hospice care) Overall P<.001	NR	NR
Khalili, 2020[86] Iran Prospective cohort	**Within 90 days of admission** 4% (10/254)	NR	NR	NR
Knights, 2020[137] United Kingdom Retrospective	5.4% (3/56 patients discharged home)	Home: 81% (56/69 discharged) Care Home: 14% (10/69 discharged) Other (not specified): 4% (3/69 discharged)	New “packages of care”: 2.9% (2/69 discharged) New care home placement: 7.2% (5/69 discharged) Increase in mobility aids: 11.6% (8/69 discharged)	NR
Loerinc, 2021[87] USA Retrospective	**Within 30 days** **Emergency department visits:** 7.7% (24/310) with 54% (13/24) attributed to COVID-19	Home: 91% (281/310) Skilled nursing facility: 8% (25/310) State Public Health quarantine facility: 1% (4/310)	**Any home health or oxygen:** 24% (75/310) including physical or occupational therapy: 14% (42/310);	**Recommended follow-up appointments** Primary care: 83% (258/310)

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
	Readmission 5.2% (16/310) with 69% (11/16) attributed to COVID-19		home nursing service: 5% (16/310); new home oxygen therapy: 13% (41/310) **New short-term medications:** 67% (207/310); average of 2.2 new prescriptions per patient **New long-term medications:** 23% (72/310); average of 1.6 per patient	Specialist: 29% (90/310) including nephrology [7% (23/310)] and cardiology [5% (14/310)] **Follow-up bloodwork ordered:** 10% (31/310) **Follow-up radiology ordered:** 7% (21/310)
Lovinsky-Desir, 2020[64] USA Retrospective	Age 21-39 No Asthma: 5% (12/261) Asthma: 10% (4/39) P=.14 Age 40-65 No Asthma: 5% (40/832) Asthma: 5% (5/111) P=1.0	NR	NR	NR
Matsunaga, 2020[47] Japan Registry	NR	Home: 72% (1762/2437 discharged) Long-term care facility: 2% (44/2437 discharged) Transfer to another hospital: 18% (437/2437 discharged) Transfer to non-medical (isolation) facility: 8% (194/2437 discharged)	**Oxygen therapy required**: 8% (182/2430)	**Self-care Ability** Same as before onset of COVID-19: 84% (2045/2425) Worsened: 10% (237/2425) Improved: 4% (106/2425) Unknown: 2% (27/2425)
Monday, 2020[89] USA (Veterans) Retrospective	**Within 30 days of admission** 14% (8/57 discharged alive)	NR	**Home oxygen at discharge** 39% (22/57 discharged alive)	NR

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
Nachega, 2020[50] Democratic Republic of the Congo Retrospective cohort	NR	Transferred to Home Care 2.6% (20/766 enrolled) 3.0 % (20/665 recovered/alive)	NR	NR
Nemer, 2021[51] USA Retrospective	NR	**Home:** 79% (278/350 enrolled) or 85% (278/328 discharged alive) **Subacute facility:** 11% (40/350 enrolled or 12% (40/328 discharged alive) **Hospice:** 2% (8/350 enrolled) or 2% (8/328 discharged alive)	NR	NR
Nersesjan, 2021[142] Denmark Prospective	**At 3 months** 38% (17/45 with 3 month data)	NR	NR	NR
Overstad, 2020[52] Norway Retrospective	4 were readmitted during study period (denominator unclear)	**Home** 74% (52/70) or 83% (52/63 discharged alive) ICU patients: 38% (5/13) or 63% (5/8 discharged alive) Ward patients: 86% (49/57) or 89% (49/55 discharged alive) **Discharged to 24-hour care** 16% (11/70) or 17% (11/63 discharged alive ICU patients: 23% (3/13) or 38% (3/8 discharged alive) Ward patients: 12% (7/57) or 13% (7/55 discharged alive)	NR	NR
Parra, 2020[90] Spain Case-control	4.4% (61/1368) Median time to readmission: 6 days	NR	NR	**Reasons for Readmission** Pneumonia: 56% (34/61)

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
				PE, DVT, or lower limb arterial thrombosis: 16% (10/61) Heart failure: 10% (6/61) Bacterial infection: 7% (4/61) Myocardial acute infarction, acute kidney failure, severe bleeding, diabetes, generalized edema, threatened miscarriage: each 2% (1/61)
Patell, 2020[65] USA Retrospective	7% (12/163)	NR	NR	NR
Paterson, 2020[37] United Kingdom Retrospective	NR	**Patients with Encephalopathy** (n=7 discharged) Home: 86% (6/7) Rehabilitation Unit: 14% (1/7) **Patients with Inflammatory Central Nervous System Syndromes** (n=2 discharged) Home: 100% (2/2) **Patients with Ischemic Stroke** (n=4 discharged) Rehabilitation Unit: 75% (3/4) Stroke Unit: 25% (1/4) **Patients with Peripheral Neurological Syndromes** (n=2 discharged; location NR **Uncharacterized Condition** (n=1 discharged to home)	NR	NR
Richardson, 2020[67] USA Case series	Overall: 2.2% (45/2081) <18 years: 3.1% (1/32) 18-65 years: 1.6% (22/1,373) >65 years: 3.3% (22/676) **Time to Readmission** (median [IQR]) 3 [1.0, 4.5) days	**Facility (eg, nursing home, rehabilitation)** Overall: 5.9% (122/2081) <18 years: 0% (0/32) 18-65 years: 2.0% (28/1373) >65 years: 13.9% (94/676) **Home**	NR	NR

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
		Overall: 94.1% (1959/2081) <18 years: 100% (32/32) 18-65 years: 98% (1345/1373) >65 years: 86% (582/676)		
Rodriguez, 2020[54] USA Registry	NR	**Home:** 74% (4746/6421 discharged) **Hospice:** 3% (192/6421 discharged) **Nursing facility:** 17% (1097/6421 discharged) **Transfer to another hospital:** 5% (317/6421 discharged)	NR	NR
Sachdeva, 2020[69] USA Retrospective	9% (1/9 discharged home) Length of follow-up NR	NR	NR	NR
Somani, 2020[70] USA Retrospective	**Returned for Emergency Care** 3.6% (103/2864) Median 4.5 days **Inpatient Admission** 54.4% (56/103) or 2% (56/3864) overall	NR	NR	**Reasons for Return** Respiratory distress: 50% Chest pain: 6% Other pain: 6% Altered mental status: 5% Falls: 5% Soft tissue infection: 5% **Need for ICU level care** 10.7% (6/56)
Spinicci, 2021[127] Italy Retrospective	10% (10/100)	NR	**Long-term Oxygen Therapy (discharge)** 15% (15/100) **Long-term Oxygen Therapy (2 months)** 5% (5/100)	**Reasons for Readmission** **Cardiac disease (*ie*, heart failure and myocardial infarction)** 5% (5/100) **Infectious diseases** 2% (2/100) **Respiratory symptoms** 1% (1/100)

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
				Neurologic disorders 2% (2/100)
Suarez-Robles, 2021[128] France Retrospective	**Bacterial respiratory infection, pulmonary thromboembolism, exacerbated COPD** 5% (7/134)	NR	Oxygen therapy 3% (4/134)	NR
Suleyman, 2020[138] USA Retrospective case series	**30-day Hospital** Overall: 11.2% (29 cases) General practice unit: 27 cases ICU: 2 cases P<.001 NOTE: among patients initially discharged home from ED, 4% (4/108) were readmitted within 30 days	**Home** General practice unit: 96% (183/191 with known discharge disposition) ICU: 79% (49/62 with known discharge disposition) **Rehabilitation center** General practice unit: 4% (8/191) ICU: 21% (13/62)	NR	**30-day Mortality (includes hospital mortality**) General practice unit: 7% (15/214) ICU: 40% (57/141) P<.001
Vizcaychipi, 2020[38] United Kingdom Prospective	NR	**Home (usual residence)** 92.5% (614/664 discharged alive) **Temporary Home** 2.4% (16/664) **Residential Care Home** 5.1% (34/664)	NR	NR
Wang, 2020[71] China Prospective cohort	1-2 weeks post-discharge 4% (5/131) 3-4 weeks post-discharge 2% (3/131)	**Home Quarantine** 1-2 weeks post-discharge 87% (114/131) 3-4 weeks post-discharge 92% (121/131) **Community Quarantine** 1-2 weeks post-discharge 9% (12/131) 3-4 weeks post-discharge 3% (4/131) **Designated Hospital**	**Oxygen therapy** 1-2 weeks post-discharge 7% (9/131) 3-4 weeks post-discharge 1% (1/131) **Corticosteroids** 1-2 weeks post-discharge 4% (5/131) 3-4 weeks post-discharge 2% (2/131)	**CBC abnormal** 1-2 weeks post-discharge 14% (2/14) 3-4 weeks post-discharge 8% (4/50) Outcomes did not differ by severity of COVID-19

Author, Year Country Study Design	Readmission	Discharge Disposition	Post-discharge Treatment	Other
		1-2 weeks post-discharge 4% (5/131) 3-4 weeks post-discharge 2% (3/131) **Return to Work** 1-2 weeks post-discharge 0% (0/131) 3-4 weeks post-discharge 2% (3/131) Outcomes did not differ by severity of COVID-19	Outcomes did not differ by severity of COVID-19	
Xu, 2020[72] China Retrospective case series	NR	NR	**Oxygen therapy** 6% (5/85) (nasal cannula)	**60-day mortality (overall)** 62% (147/239) NOTE: Predictors included age >65, lymphocyte and platelet count, ARDS, acute cardiac injury, AKI, liver dysfunction, and coagulopathy

Abbreviations: ARDS=acute respiratory distress syndrome; ED=emergency department: ICU=intensive care unit; IQR=interquartile range

APPENDIX D. PRISMA CHECKLIST

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Title page
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Separate document
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	1
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	1
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	3
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4 and Table 1
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	3
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Appendix A
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	3-4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	4 and Table 1
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	5
Summary	13	State the principal summary measures (e.g., risk ratio, difference in	5

measures		means).	
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	N/A
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	N/A
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6 (Figure 2)
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	7 and Appendix C
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	7
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	9-46 and Appendix C
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	N/A
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	N/A
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	N/A
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	46-48
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	48-49
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	52
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Preface

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097