COVID-19 Post-hospitalization Health Care Utilization: A Living Review

February 2022

VA | U.S. Department of Veterans Affairs
Veterans Health Administration
Health Services Research & Development Service

WHAT'S NEW

Updated November 15, 2021
Search current as of February 4, 2021
This update revises findings from our report published in August 2021. The review includes studies from an updated search and now includes 19 cohort studies, including 1 national VA study, that provide the best available evidence. We conclude that a substantial proportion of adults with COVID-19 post-hospitalization required continued care in a skilled nursing or rehabilitation facility or utilized home health services post-discharge. However, short-term readmission rates were modest. These data suggest that health care systems will need long-term care, home health, and rehabilitation capacity to support patients' needs following discharge.

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The findings and conclusions in this document are those of the author(s) who are responsible for its contents and do not necessarily represent the views of the Department of Veterans Affairs or the United States government. Therefore, no statement in this article should be construed as an official position of the Department of Veterans Affairs. No investigators have any affiliations or financial involvement (eg, employment, consultancies, honoraria, stock ownership or options, expert testimony, grants or patents received or pending, or royalties) that conflict with material presented in the report.

PREFACE

The VA Evidence Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted health care topics of importance to clinicians, managers, and policymakers as they work to improve the health and health care 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, interface with stakeholders, and address urgent evidence needs. 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.

This topic was developed in response to a nomination by Joe Francis MD, Chief Improvement and Analytics Officer for the Office of the Under Secretary for Health for the purpose of informing national VA planning efforts to support Veterans after hospital discharge for COVID-19. The scope was further developed with input from Operational Partners (below), the ESP Coordinating Center, the review team, and the technical expert panel (TEP). The ESP consulted several technical and content experts in designing the research questions and review methodology. In seeking broad expertise and perspectives, divergent and conflicting opinions are common and perceived as healthy scientific discourse that results in a thoughtful, relevant systematic review. Ultimately, however, research questions, design, methodologic approaches, and/or conclusions of the review may not necessarily represent the views of individual technical and content experts.

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Operational Partners

Operational partners are system-level stakeholders who help ensure relevance of the review topic to the VA, contribute to the development of and approve final project scope and timeframe for completion, provide feedback on the draft report, and provide consultation on strategies for dissemination of the report to the field and relevant groups.

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The Coordinating Center sought input from external peer reviewers to review the draft report and provide feedback on the objectives, scope, methods used, perception of bias, and omitted evidence (see Appendix D for disposition of comments). Peer reviewers must disclose any relevant financial or non-financial conflicts of interest. Because of their unique clinical or content expertise, individuals with potential conflicts may be retained. The Coordinating Center works to balance, manage, or mitigate any potential nonfinancial conflicts of interest identified.

TABLE OF CONTENTS

Abstract **1**
Background **2**
Key Question **3**
Methods **3**
Search Strategy 3
Inclusion/Exclusion Criteria 3
Screening Process 4
Data Collection 4
Risk of Bias Assessment 5
Synthesis 5
Living Review 6
Peer Review 6
Results **7**
Key Question: Among adults hospitalized with COVID-19 and discharged, what is the prevalence of short-term (< 3 months) and long-term (≥ 3 months) health care use? 9
Key Points 9
Study Characteristics 10
Discharge Disposition Status 20
Hospital Readmission and Emergency Department Utilization 22
Figure 4. Hospital Readmission and ED Utilization Reported Across Studies 23
Surveillance 23
Risk of Bias 24
Discussion **27**
Our Findings in Context with Other Studies and Evolving Literature 29
Clinical and Policy Context 29
Applicability 30
Limitations in Body of Evidence 30
Limitations of Review 31
Knowledge Gaps/Key Unanswered Questions/Next Steps for Research 31
Conclusions **32**
References **33**
Appendix A. Search Strategies **38**
Appendix B. GRADE Terminology **40**
Appendix C. Peer Review Disposition **41**
Appendix D. Excluded Studies **47**

TABLES

Table 1. Eligibility Criteria 3
Table 2. Evidence Profile (n = 19) 8
Table 3. Study Characteristics 11
Table 4. GRADE Evidence Profile: Unselected Populations 28
Table 5. Evidence Gaps and Future Research 31

FIGURES

Figure 1. PRISMA Literature Flow Diagram[29] 7
Figure 2. Pattern of Discharge Disposition Status for Patients Hospitalized with COVID-19 20
Figure 3. Discharge Disposition Status Reported Across Studies 22
Figure 4. Hospital Readmission and ED Utilization Reported Across Studies 23
Figure 5. Risk of Bias Ratings for Included Studies 25
Figure 6. Risk of Bias Assessment Across Included Studies 26

ABSTRACT

Objectives: SARS-CoV-2 (COVID-19) was declared a pandemic by the World Health Organization in March 2020. At its peak, more than 26 of every 100,000 adult Americans were hospitalized for COVID-19. The objective for this review was to determine short- and longer-term health care utilization following a COVID-19-related hospitalization.

Methods: We followed standard systematic review methodology adapted for living reviews. Living reviews are continually updated, incorporating new evidence as it becomes available. In conjunction with an expert medical librarian, we originally searched MEDLINE, Embase, and the Covid-19 Portfolio server from NIH iCite. For this update, we searched MEDLINE (via Ovid) through February 4, 2021 and conducted surveillance through December 10th, 2021. Eligible studies reported on hospital discharge disposition or post-acute care utilization in adults hospitalized for COVID-19. We abstracted relevant study characteristics and outcomes, assessed risk of bias using existing measures, and used GRADE to assess the certainty of evidence. We synthesized eligible studies narratively.

Results: We identified 19 eligible cohort studies (132,004 patients) conducted in Europe, Asia, and the United States that reported infections incurred early in the pandemic. Surveillance resulted in no significant changes to the outcomes. Based on median values from the included studies, participants were 62 years of age; 30% White, 26% Black, 27% Hispanic, 4% Asian, and 10% other racial/ethnic groups; and stayed 7.8 days in hospital. The pre-hospitalization living situation was reported infrequently. Risk of bias was assessed as low in 12 studies, unclear in 5 studies, and high in 2 studies. Although most patients were discharged home, a substantial proportion were discharged to a skilled nursing facility (median 14.1%; range 8.1% to 19.8%; n=7 studies). For those discharged home (median 80.9%; n=13), home health services were commonly utilized (median 24.2%, n = 3), and were highest in studies that defined these services broadly. A small portion of patients were discharged to hospice (median 3.2%, n=4). Discharge to rehabilitation facilities was reported infrequently, was aggregated with other disposition status, and these composite outcomes varied across studies. After discharge, a median of 4.9% of patients (n=8 studies; range 2.0% to 19.9%) were readmitted to the hospital and a median of 3.6% (n=3; range 3.2% to 7.4%) had an emergency department visit. A VA study using national data reported the highest rate of readmission (19.9%), although this study collected readmission rates for longer than most other studies. Respiratory distress, thrombotic episodes, and COVID-19 were the most common reasons for readmission. Other outcomes were reported infrequently. Study heterogeneity precluded meta-analysis, and the certainty of evidence was moderate.

Conclusions: A substantial proportion of adults with COVID-19 post-hospitalization required care in a skilled nursing or utilized home health services post-discharge. However, short-term readmission rates were modest, and we were unable to assess patients' pre-hospitalization living situation (home, nursing home, *etc*). These data suggest that health care systems will need post-acute care services, including home health services and rehabilitation capacity to support patients' needs following discharge. These conclusions are tempered by moderate certainty of evidence, changes in the dominant COVID-19 variants, and evolving treatment approaches.

BACKGROUND

SARS-CoV-2 (COVID-19) was declared a pandemic by the World Health Organization in March 2020.[1] Early research efforts focused on identifying the virus's clinical manifestations and optimizing treatment approaches to reduce the mortality rate.[2] These efforts made substantial advances that improved the survival rate,[3] thus increasing the number of survivors who may be suffering from sequelae of COVID-19 illness. COVID-19 has a variety of presentations ranging from asymptomatic infection to severe acute respiratory distress with multiple organ failure, and in some instances, to chronic long-COVID symptoms.[2,4-6] Severe illness that leads to hospitalization is more common in older patients and those with underlying conditions.[7] These are also the patients more likely to be higher health care users and to experience functional limitations.[8,9]

Studies performed early in the pandemic found that a substantial proportion of patients hospitalized with COVID-19 experience persistent symptoms up to 6 months after discharge, including residual weakness, reduced aerobic capacity, pain, joint stiffness, confusion, nausea, and fatigue.[10-14] These symptoms have been correlated with reduced physical function and disability leading to increased health care need in patients with acute respiratory distress syndrome (ARDS), a common symptom of COVID-19.[15-17] Past research has shown that hospitalizations are associated with declines in physical function, increased utilization of post-acute care, falls, and short-term mortality in a variety of patients and diagnoses.[18-20]

Physical function is the ability to perform activities of daily living (ADLs) and to reside in the community independently.[21] Patients hospitalized with COVID-19 are at risk for functional impairments due to the symptoms of COVID-19 combined with the decline in function that commonly occurs during and after hospitalization. Early research suggests that COVID-19 causes functional impairments most often linked to dysfunction of the nervous and pulmonary systems.[11-14] Those declines in physical function may lead to increased health care utilization resulting from reduced functional independence and inability to perform ADLs.

As of August 2021, prior to the emergence of Omicron, over 35 million Americans have been infected with SARS-CoV-2.[22] Given the incomplete uptake of COVID-19 vaccinations, the emergence of SARS-CoV-2 variants, and the potential for vaccinations to wane in effectiveness, a large number of Americans are at risk for long COVID or important functional impairment, particularly following more severe illness requiring hospitalization. Patients with ongoing health care and rehabilitation needs could further stress the US health care system.[18-20,23-27] Currently there is limited understanding of how COVID-19 influences patients' outcomes after discharge from hospitalization, including the frequency and duration of post-acute services and health care needs related to functional limitations or impairments.

The primary objective of this living review is to determine the prevalence of short-term (< 3 months) and long-term (≥ 3 months) health care utilization in adults discharged after COVID-19 hospitalization. Understanding how COVID-19 hospitalizations influence patients' downstream medical use can assist health systems, including the VA, and rehabilitation departments in preparing to care for these patients. Treatment to reduce functional impairments targeting the symptoms correlated with hospitalization for COVID-19 have the potential to improve patient's quality of life and avoid adverse health outcomes including rehospitalization as observed in other patients after hospitalization with non-COVID-19 diagnoses.[18-20,27]

KEY QUESTION

The key question (KQ) for this review is:

Among adults hospitalized with COVID-19 and discharged, what is the prevalence of short-term (< 3 months) and long-term (≥ 3 months) health care use?

METHODS

This is the first update to a living review requested by national VA operations leadership that is managing COVID-19 clinical care procedures and policies. We developed a protocol in conjunction with our operations partners using methodology adapted from existing guidance on rapid reviews.[28] We registered our protocol with PROSPERO (CRD42020215229). We followed PRISMA 2020 reporting guidelines for systematic reviews.[29]

SEARCH STRATEGY

We conducted the search of this living review in MEDLINE (via Ovid) and Embase (via Elsevier) databases on September 2, 2020. The MEDLINE (via Ovid) search was updated February 4, 2021 (Appendix A). Search strategies were developed with an expert librarian (SC) and utilized both database-specific subject headings and keywords. We also reviewed posted evidence syntheses on PROSPERO for recent and ongoing reviews related to COVID-19 and the bibliographies of published reviews.[30-32] To identify emerging literature, we adapted our search strategy for preprint server collections from the NIH iCite COVID-19 Portfolio.[33] Searches were not limited by date or language. We consider this a major update to the original report which was based on a literature search through September 2020. For surveillance we 1) conducted a search for other systematic reviews (December 10, 2021), 2) reviewed the bibliography of reviews published since our search date for eligible studies, and 3) incorporated the reviews and any larger, eligible primary studies into our results and discussion.

INCLUSION/EXCLUSION CRITERIA

Study selection was based on the eligibility criteria listed in Table 1. For this update, we limited studies to those with n ≥ 200 to prioritize studies with more precise estimates of outcomes. We also excluded studies limited to patients with a specific clinical condition (*eg*, post-transplant) who were hospitalized for COVID-19 because of their narrow focus. We contacted authors for additional information when the study description was insufficient to determine eligibility.

Table 1. Eligibility Criteria

Study Characteristic	Inclusion Criteria	Exclusion Criteria
Population	Adults hospitalized with a diagnosis of COVID-19 (*ie*, SARs-CoV-2)	• Animal studies • Pediatric populations • Simulated patients • Patients with specific conditions (*eg*, post-transplant)

Study Characteristic	Inclusion Criteria	Exclusion Criteria
Exposure	Diagnosis of COVID-19, defined as laboratory confirmed cases, laboratory or clinical diagnosis if ≥ 80% were laboratory confirmed, or ICD-10 codes	• All other illness, including other SARS infections
Comparator	None	None
Outcomes	Prevalence of post-acute care health care services such as skilled nursing facility, inpatient rehabilitation, occupational therapy, physical therapy, primary care, emergency room/urgent care, home health; and durable medical equipment use (*eg*, walkers) post-acute hospitalization	• Mental health status • Mental health care needs
Setting	Post-acute hospital setting (*eg*, skilled nursing facility, home, emergency department, outpatient setting)	None
Timing	Post-discharge window through longest outcome assessment	Pre-discharge status
Countries	OECD[a] countries	Non-OECD countries
Designs[b]	• Cross-sectional studies with n ≥ 200 • Retrospective or prospective cohort studies with n ≥ 200	• Case-control • Case reports • Case series • Guidelines • Narrative reviews • Systematic or mapping reviews • Qualitative studies • Other designs not suited to assessing prevalence

[a] Organization for Economic Co-operation and Development (2019) includes Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.
[b] We took a best-evidence approach and prioritized inclusion of comparative prevalence studies.

SCREENING PROCESS

We used DistillerSR (Evidence Partners, Manotick, Ontario, Canada), a web-based software, to screen titles and abstracts for identified citations, then full-text articles for inclusion. Citations were screened by 2 reviewers at both the title-and-abstract and full-text levels. At title and abstract, if either reviewer included the citation, it was passed along to full text. At full text, both reviewers had to agree on inclusion or exclusion. Disagreements were discussed and resolved at full team meetings or by a third reviewer. At all steps of eligibility determination, investigators maintained an open dialogue to clarify eligibility criteria.

DATA COLLECTION

We collected the following study characteristics: author/year, location, clinical setting, study date, number of patients, patient characteristics, the highest level of care received, the occurrence of intubation during hospitalization, duration of hospitalization, medical comorbidities (*eg*,

underlying pulmonary or cardiac disease, obesity, diabetes). We then abstracted outcomes including hospital discharge disposition (*eg*, to home, rehabilitation facility or palliative care), discharge services (*eg*, home oxygen and other durable medical equipment, home health care), and post-discharge medical utilization (*eg*, emergency department visits, hospital readmission). For studies reporting outcomes for all hospitalized patients, we extracted data only for those discharged alive, excluding those who died during hospitalization or who remained hospitalized.

RISK OF BIAS ASSESSMENT

Risk of bias (ROB) assessment was done independently by 2 investigators. Disagreements were resolved by consensus after discussion between the 2 investigators or, when needed, by arbitration of a third investigator.

For this update, we assessed ROB for each study using a modified Joanna Briggs Institute (JBI) checklist for cohort studies. We adopted this checklist because it was a better fit to the identified studies than the ROB instrument (*ie*, Leboeuf-Yde and Lauritsen) used in the original report.[34,35] The JBI tool consists of 11 items that address exposure and outcome measurement, strategies to address confounding, adequacy of follow-up and the appropriateness of statistical analyses. We adapted this checklist to add an item addressing participant sampling and by adding guidance specific to COVID-19 studies. When assessing the representativeness of the study population, we considered age, sex, comorbidity rates, and indicators of COVID-19 severity (*eg*, proportion requiring ICU care). Considering these criteria, we assigned a summary risk of bias score (low, moderate, or high) to individual studies.

SYNTHESIS

We developed summary tables for data from the primary studies to evaluate the similarity in designs and study populations and to describe the pattern of outcomes reporting. Because we extracted summary data from studies (*eg*, mean age) and did not have access to the primary data, we describe study characteristics for the median study (*eg*, the median average age reported across studies). We include new data on all outcomes except for home oxygen use, where no new data were reported. When studies reported prevalence estimates without 95% confidence intervals (95% CI), we calculated the 95% CI using the Wilson method utilizing the numerator and denominator counts.[36] Next, we determined the feasibility of quantitative synthesis (*ie*, meta-analysis) to estimate summary effects. We planned to aggregate outcomes when there were at least 3 studies with the same outcome but concluded that studies were too heterogeneous for meaningful meta-analysis. Studies varied importantly by illness severity (*eg*, oxygen requirement, intensive care unit stay), and patients' comorbid medical conditions. Further, 1 large study[37] included data from ~25% of US hospitals and we could not confirm that these data did not overlap with data reported in other studies.

We narratively synthesized studies, reporting medians and the range of values for eligible outcomes. We emphasized evidence from higher-quality studies with more precise estimates of effect and data from VHA hospitals because of their relevance to our stakeholders. A narrative synthesis focuses on documenting and identifying patterns in outcome effects across conditions and interventions. We analyzed potential reasons for inconsistency in treatment effects across studies by evaluating differences in the study population, outcome definitions, and ROB.

We computed a certainty of evidence using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.[38] A summary rating of high, moderate, low, or very low certainty of evidence was assigned after discussion by 2 investigators. Although the GRADE process typically assigns an initial rating of low certainty of evidence to estimates from observational designs, GRADE allows for, and we used, an initial rating of moderate certainty because observational designs are the best match to our study questions. Key GRADE terminology is defined in Appendix B.

LIVING REVIEW

This is the first report update from this living review. We plan to update our review approximately every 3 months through August 2022, or until our conclusions are supported by moderate certainty of evidence and we do not expect new evidence to substantially change our conclusions. Our data synthesis plan may change if future evidence allows. Surveillance was conducted by searching for other relevant systematic reviews or large studies that fit our criteria. Surveillance findings are indicated in the results.

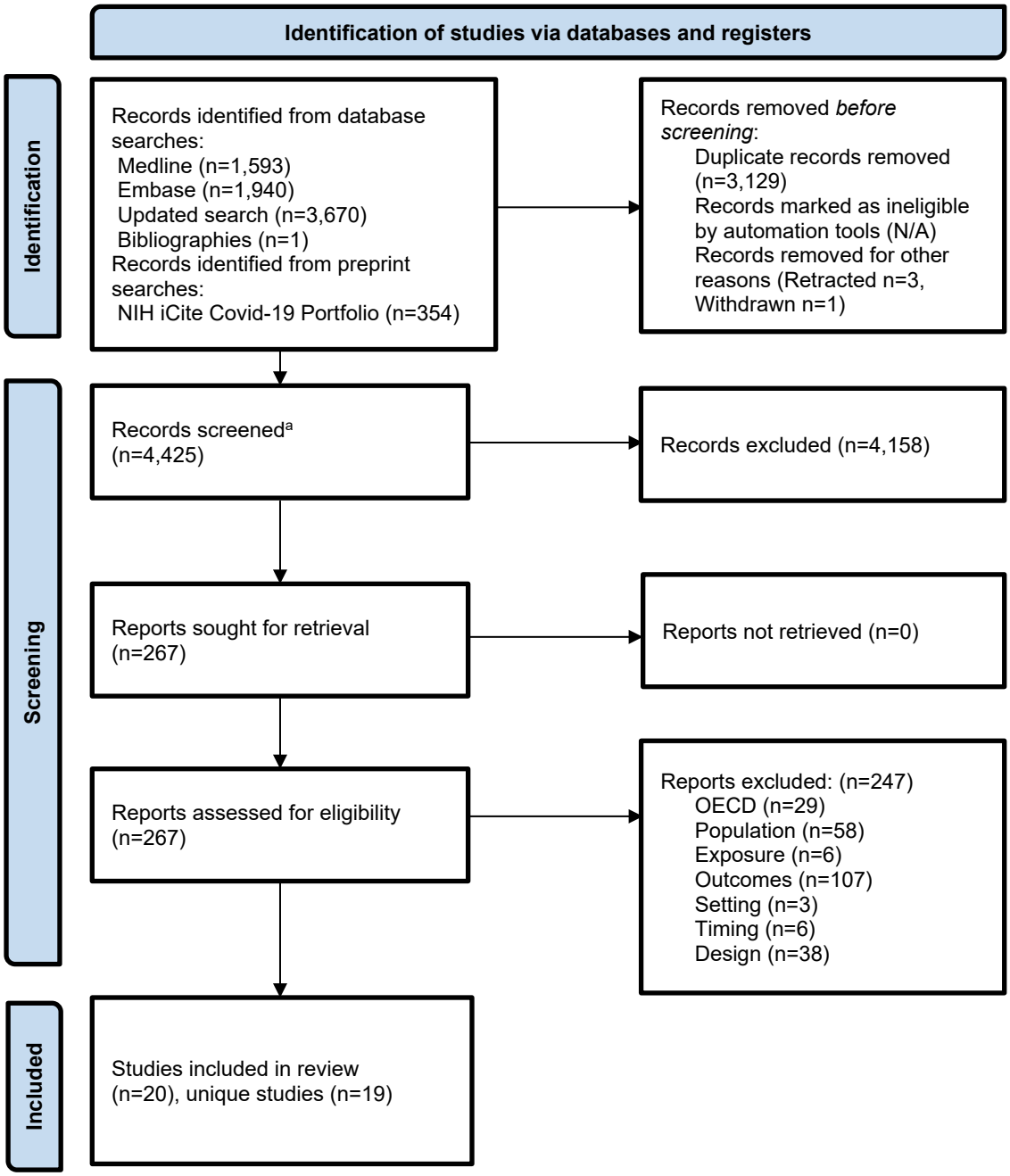
PEER REVIEW

A draft version of this report was reviewed by technical experts and clinical leadership. A transcript of their comments and our responses is in Appendix C.

RESULTS

We identified 4,425 articles through searches of MEDLINE (via Ovid), Embase, and the NIH iCite COVID-19 Portfolio server (Figure 1). After applying inclusion and exclusion criteria to titles and abstracts, 267 articles remained for full-text review. Of these, 19 unique studies were retained for data abstraction and 247 were excluded (Appendix D). All studies were cohort studies conducted in the United States, Europe, or Asia; 18 were retrospective, and 1 was a prospective cohort study. One study was conducted in the VA.

Figure 1. PRISMA Literature Flow Diagram[29]



[a] Search results from Medline (1,531), Embase (581), updated Medline search (1,967), manually identified (1), and preprints (345) were combined.

The 19 eligible studies (Table 2) reported on cohorts hospitalized early in the COVID-19 pandemic. Enrolled patients were generally older adults (median age 62; range 55 to 70) and most frequently male (median 44% female; range 5% to 78%). Comorbidities associated with poor outcomes when reported to occur are as follows: hypertension 41%, obesity 36%, and diabetes mellitus 27%. The proportion receiving intensive care varied from 7% to 54.8%, and 1 additional study was limited to patients who were tracheally intubated[39] suggesting important differences in illness severity across studies. Discharge disposition and hospital readmission were the most commonly reported outcomes.

None of the identified studies measured longer-term health care utilization (*ie,* ≥ 3 months) after discharge. Nine studies reported on over 1,000 patients, and 1 low ROB study conducted by the CDC[37] reported on >100,000 patients, yielding precise estimates for reported outcomes. One study reported readmission rates from the Department of Veterans Affairs Health Care System.[40]

Table 2. Evidence Profile (n = 19)

Study Characteristic	Results
Study designs[a]	
• Prospective cohort	1 study
• Retrospective cohort	18 studies
Countries	USA: 14 studies Europe: 3 studies Asia: 2 studies
Patients enrolled, total Median (range)	132,004 1062 (200, 106543)
Enrollment timing	
• By May 31, 2020	16 studies
• By July 20, 2020	3 studies
Major eligibility criteria	
• Hospitalization[b]	17 studies
• Survived to discharge	1 study
• IMV	1 study
Patient characteristics[c]	
• Mean age (median study, range)	62 (56, 70) (16 studies)
• Female % (median study, range)	44.1% (4.9%, 78.2%)
• Race % (n=14) (median study, range)	White: 30% (11%, 54%) Black: 26% (7%, 87%) Hispanic: 27% (4%, 68%) Asian: 4% (1%, 13%) Other: 10% (3%, 31%)
• ICU stay % (median study, range)	21.6% (7%, 100%) (16 studies)
• Length of stay (median study days, range)	7.8 (5, 17) (16 studies)
• Common comorbidities (median, range)	

Study Characteristic	Results
○ Hypertension	41.3% (4%, 76.7%) (15 studies)
○ Obesity	35.8% (1%, 93%) (11 studies)
○ Diabetes mellitus	26.5% (2%, 43.9%) (16 studies)
○ Immunocompromised	2.9% (0.6%, 13%) (6 studies)
○ Chronic kidney disease	9.9% (0.6%, 29.5%) (12 studies)
Follow-up duration for hospital readmission (days)[d]	Median 30 (range 14 to 62) (7 studies)
Outcomes reported	
• Discharge disposition: Home	14 studies
• Discharge disposition: SNF	8 studies
• Discharge disposition: Hospice	4 study
• Readmission	8 studies
• ED visit	3 studies
• Home health	3 studies
• Mobility aids	1 study
• Other	12 studies
Risk of bias	12 studies low 5 studies unclear 2 studies high

[a]Includes studies classified as "observational".
[b]One study[41] included ambulatory (5.7%) or hospitalized (94.3%) patients.
[c]Studies report medians/means for the study participants; thus, we report the median (IQR) of these average values.
[d]Eight studies report hospital readmission but only 7 reported the follow-up duration.
Abbreviations. ED = emergency department; IMV=invasive mechanical ventilation; ICU = Intensive care unit; SNF = Skilled Nursing Facility

KEY QUESTION: Among adults hospitalized with COVID-19 and discharged, what is the prevalence of short-term (< 3 months) and long-term (≥ 3 months) health care use?

Key Points

- Nineteen cohort studies, conducted early in the pandemic, reported on 132,004 patients discharged after hospitalization for COVID-19.
- Most patients were discharged home, but a substantial proportion of patients were discharged to either a skilled nursing facility (median 14.1%; range 8.1% to 19.8%) or rehabilitation facility. Discharge to rehabilitation facilities was reported in aggregate with other disposition statuses, and thus rates for rehabilitation facilities alone are not available.
- Home health care services were used commonly after discharge (median 24.2%; range 11.5% to 24.7%), but the services varied importantly across studies and were highest in studies that defined these services broadly. After discharge, 4.9% (range 2.0% to 19.9%) of patients were readmitted to the hospital during a median of 30-day (range 14 to 62) follow-up. A VA study using a national database reported a high 60-day readmission rate (19.9%).

- After discharge, 3.6% (range 3.2% to 7.4%) of patients had an emergency department visit.

Study Characteristics

To contextualize the reported outcomes and understand their applicability to current cohorts, we examined studies for detailed descriptions of illness severity and treatment regimens in addition to patient demographics, comorbidities, and level of care. These data were inconsistently reported. The median proportion of patients intubated was 13.0% (range 5.1% to 100%), but extracorporeal membrane oxygenation use, supplemental oxygen use, and efficacious drug treatments such as remdesivir, convalescent plasma, and monoclonal antibodies were reported infrequently. Six studies reported use of systemic steroids, ranging from 8.8% to 78.1%. Detailed study characteristics are reported in Table 3.

Table 3. Study Characteristics

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
Atalla, 2021[42] EHR: 1 hospital USA	Retrospective cohort N=339; 279 Dates: 3/1/2020-4/19/2020	Hospitalized PCR Positive COVID-19	Median Age: 61 (IQR 49 to 74) Women: 43.7% Race: White: 42.8% Black: 16.2% Hispanic: 37.2% Asian: 1.2% Other: 2.7% Admitted from SNF: NR	CKD: 10.6% DM2: 33.3% BMI>30: 39.8% HTN: 45.4% Immunocompromised: NR	ICU: 33% Intubated: 18.9%	-Hospital readmission to same hospital (30 days after discharge)	Low risk of bias Funding: None reported Conflicts: None reported
Bahl, 2020[43] EHR: 8 hospitals in regional system USA	Retrospective cohort N=1,461; 1,134 Dates: 3/1/2020-3/31/2020	Hospitalized PCR Positive COVID-19	Median Age: 59 (IQR 45 to 70) Women: 48% Race: White: 27.1% Black: 65.2% Hispanic: NR Asian: 1.4% Other: 6.3% Admitted from SNF: NR	CKD: 3.7% DM2: 26.7% BMI>30: 59.7% HTN: 48.6% Immunocompromised: 0.6%	ICU: 14.4% Intubated: 7.9%	-Skilled nursing facility -Discharged home -Hospice (At discharge)	Low risk of bias Funding: None reported Conflicts: None reported
Donnelly, 2021[40] VA Corporate Data Warehouse: 132 VA hospitals	Retrospective cohort N=1,775; 1,775 Dates: Admitted 3/1/20-6/1/2020	Hospitalized Diagnosed during hospitalization or -14 to +7 days following hospitalization	Median Age: 70 (IQR 62 to 76) Women: 4.9% Race: White: 43.8% Black: 50.2% Hispanic: NR Asian: NR	CKD: NR DM2: NR BMI>30: NR HTN: NR Immunocompromised: NR	ICU: 22.3% Intubated: 5.1%	-Hospital readmission to VA hospitals (60 days after discharge)	Low risk of bias Funding: VA HSR&D Conflicts: None appear pertinent

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
USA			Other: 6.0% Admitted from SNF: NR				
Fernandes, 2021[44] Discharge summaries (unstructured free text): 2 hospitals USA	Retrospective cohort N=1,737; 1,494 Dates: 3/10/2020-6/30/2020	Hospitalized Positive COVID-19 test	Median Age: 62 (18.2 SD) Women: 45.4% Race: White: 44.6% Black: 16.4% Hispanic: 4.0% Asian: 3.9% Other: 31.0% Admitted from SNF: NR	CKD: NR DM2: NR BMI>30: NR HTN: NR Immunocompromised: NR	ICU: NR Intubated: NR	-Inpatient rehabilitation -Skilled nursing facility -Discharged home (At discharge)	Low risk of bias Funding: Glenn foundation for Medical Research and American Federation for Aging Research; American Academy for Sleep Medicine, Football Players Health Study, Department of Defense through subcontract Conflicts: None reported
Frontera, 2021[45] Prospectively collected data using case report forms, EHR review,	Retrospective cohort N=4,491; 3,489 Dates: 3/10/2020-5/20/2020	NA PCR Positive COVID-19	Mean Age: 64 (Not calculable) Women: 41.9% Race: White: 47.1% Black: 15.7% Hispanic: NR Asian: 7%	CKD: 11.1% DM2: 26.2% BMI>30: NR HTN: 38.1% Immunocompromised: NR	ICU: 21.8% Intubated: 22%	-Acute inpatient rehab or subacute rehab -Skilled nursing facility	High risk of bias Funding: NIH grants and University of Pittsburgh CTSI award

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
ICD10 codes: 4 hospitals USA			Other: 30.2% Admitted from SNF: NR			-Discharged home -Long-term acute care hospital (At discharge)	Conflicts: None reported
Fumagalli, 2020[46] Electronic chart: 2 hospitals Italy	Retrospective cohort N=516, 314 Dates: 2/22/2020-4/10/2020	Hospitalized PCR Positive COVID-19	Mean Age: 64 (12 SD) Women: 34.3% Race: NR Admitted from SNF: NR	CKD: NR DM2: 27.8% BMI>30: NR HTN: 29.6% Immunocompromised: NR	ICU: NR Intubated: 10.9%	-Skilled nursing facility -Discharged home (At discharge)	Unclear risk of bias Funding: None reported Conflicts: None reported
Hyman, 2020[39] EHR: 5 hospitals USA	Retrospective cohort N=755; 234 Dates: 1/30/2020-4/30/2020	NR PCR Positive COVID-19	Median Age: 65 (IQR 56 to 72) Women: 36% Race: White: 19.7% Black: 23.6% Hispanic: 29.8% Asian: 5% Other: 21.9% Admitted from SNF: NR	CKD: 9.2% DM2: 23.7% BMI>30: 49.5% HTN: 33.1% Immunocompromised: NR	ICU: 100.0% Intubated: 100.0%	Skilled nursing facility -Discharged home -Discharged to other/unknown (At discharge)	Low risk of bias Funding: Institute for Critical Care Medicine, Icahn SOM Mt Sinai, NY Conflicts: None reported
Jeon, 2020[41] Claims data: All hospitals	Retrospective cohort N=7,590; 7,157	Hospitalized (94.3%) or ambulatory 5.7%	Categorical Age: 0-19: 431 20-39: 2629 40-64: 3165 >=65: 1365	CKD: 0.6% DM2: 8% BMI>30: NR HTN: 12.7%	ICU: NR Intubated: NR	-Hospital readmission to any hospital (Timepoint NR)	Unclear risk of bias Funding:

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
Korea	Dates: before 5/15/2020	Laboratory confirmed COVID-19 from the Korea CDC	Women: 59.2%% Race: NR Admitted from SNF: NR	Immunocompromised: NR			A grant from Kyung Hee University and a grant from the Korean Health Technology R&D Project through the Korean Health Industry Development Institute (KHIDI), funded by the Ministry of Health and Welfare, Republic of Korea Conflicts: None reported
Johnson, 2020[47] Cleveland Clinic research data registry: Any of 11 hospitals in health care system USA	Retrospective cohort N=312; 290 Dates: Discharged by 6/10/2020	Hospitalized Positive COVID 19 test	Mean Age: 69.6 (14.1 SD) Women: 45.8% Race: White: 45.8% Black: 41% Hispanic: NR Asian: NR Other: 5.1% Admitted from SNF: NR	CKD: NR DM2: NR BMI>30: NR HTN: NR Immunocompromised: NR	ICU: 54.8% Intubated: NR	-Discharged home -Hospice -Skilled nursing facility or rehab (At discharge)	High risk of bias Funding: None reported Conflicts: None reported

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
Lavery, 2020[37] Premier Healthcare Database (EHR and administrative data): 865 medical facilities USA	Retrospective cohort N=126,137; 106,543 Dates: 3/2020-7/2020	Hospitalized ICD10 U07.1 (COVID-19-Virus identified) or B97.29	Categorical Age: age<18: 0.9% 18-49: 24.7% 50-64: 28.1% 65-74: 20.2% >=75: 26% Women: 47.9% Race: White: 39% Black: 23.2% Hispanic: 21.3% Asian: 2.9% Other: 10.3% Admitted from SNF: 4.7%	CKD: 21.0% DM2: 27% BMI>30: 27% HTN: NR Immunocompromised: NR	ICU: 15% Intubated: 13%	-Skilled nursing facility -Discharged home -Home health -Hospice -Hospital readmission to same hospital (60 days after discharge)	Low risk of bias Funding: CDC Conflicts: None reported
Loerinc, 2021[48] EHR: 1 hospital USA	Retrospective cohort N=310; 310 Dates: 3/26/2020-4/21/2020	Hospitalized PCR Positive COVID-19	Median Age: 58 (Range 23 to 99) Women: 51.0% Race: White: 18.4% Black: 69.0% Hispanic: 3.9% Asian: NR Other: 8.7% Admitted from SNF: NR	CKD: 18.7% DM2: 18.7% BMI>30: 44.5% HTN: 64.5% Immunocompromised: 3.8%	ICU: 21.6% Intubated: 13.5%	-Skilled nursing facility -Discharged home -Home health -ED visit -Hospital readmission to same hospital (30 days after discharge)	Low risk of bias Funding: None reported Conflicts: None reported

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
Matsunaga, 2020[49] Nationwide inpatient registry:277 health care facilities Japan	Observational N=2,638; 2,000 Dates: 3/2/2020-7/7/2020	Hospitalized Positive COVID-19 test	Median Age: 56 (IQR 46 to 71) Women: 41.1% Race: NR Admitted from SNF: NR	CKD: NR DM2: 16.7% BMI>30: 5.5% HTN: 15.0% Immunocompromised: 3.7%	ICU: 10.7% Intubated: 8.4%	-Discharged home -Long-term care facility	Unclear risk of bias Funding: Health and Labor Sciences Research Grant Conflicts: Reported but not relevant
Parra, 2020[50,51] EHR: 1 hospital Spain	Retrospective cohort N=1368; 1368 discharged Dates: 2/26/2020-4/20/2020	Hospitalized Laboratory confirmed COVID-19	Median Age: 64 (IQR 54 to 75) Women: 36% Race: NR Admitted from SNF: NR	CKD: NR DM2: 2% BMI>30: 1% HTN: 4% Immunocompromised: 2%	ICU: 7% Intubated: NR	-Readmission to same hospital (3 weeks after discharge)	Unclear risk of bias Funding: None reported Conflicts: One author reported advisory for Gilead and educational activity for MSD, outside the submitted work
Roberts, 2020[51] EHR and data registry: 2 hospitals within health care system	Retrospective cross-sectional N=230; 230 Dates: 1/1/2020-4/30/2020	Hospitalized Positive test via ICD10 COVID	Median Age: 61.9 (NR) Women: 78.2% Race: White: 16.1% Black: 16.1% Hispanic: 67.8% Asian: NR	CKD: NR DM2: 33.5% BMI>30: 19.6% HTN: 46.5% Immunocompromised: NR	ICU: 27.4% Intubated: 48.3%	-Discharged home -Skilled nursing facility or rehab (At discharge)	Low risk of bias Funding: None reported Conflicts: None reported

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
USA			Other: NR Admitted from SNF: 19.5%				
Rodriguez-Nava 2021[52] Data source not described: 1 hospital USA	Retrospective cohort N=313; 200 Dates: 3/1/2020-5/25/2020	Hospitalized PCR Positive COVID-19	Median Age: 66.5 (IQR 56 to 75) Women: 44.8% Race: White: 32.5% Black: 33% Hispanic: 16% Asian: 8.5% Other: 9.9% Admitted from SNF:	CKD: 6.1% DM2: 43.9% BMI>30: 35.8% HTN: 67.5% Immunocompromised: 1.9%	ICU: 23.6% Intubated: 15.1%	-Discharged home -Hospice -Long-term acute care center (At discharge)	Low risk of bias Funding: None reported Conflicts: None reported
Shah, 2020[53] EHR: 3 hospitals in community health system USA	Retrospective cohort N=522; 430 discharged Dates: 3/2/2020-5/6/2020	Hospitalized PCR Positive COVID-19	Median Age: 60 (IQR 50 to 70) Women: 61% Race: White: 10.7% Black: 87.2% Other: NR Admitted from SNF: NR	CKD: 13.50% DM2: 39.3% BMI>30: 93% HTN: 76.7% Immunocompromised: 13%	ICU: 12.1% Intubated: 7.4%	-Discharged home -Discharged SNF (At discharge)	Low risk of bias Funding: None reported Conflicts: None reported
Somani, 2020[54] EHR: 5 hospitals USA	Retrospective cohort N=2864; 2864 discharged Dates: 2/27/2020-4/12/2020	Hospitalized PCR Positive COVID-19	Median Age: 65.9 (IQR 55 to 77) Women: 42% Race: White: 23.8% Black: 28.4% Hispanic: 27.3% Asian: 4.0% Other: 13.6%	CKD: 5% DM2: 15% BMI>30: NR HTN: 23% Immunocompromised: NR	ICU: 18.5% Intubated: 10.3%	-Readmission to any of 5 hospitals -ED visit (14 days after discharge)	Unclear risk of bias Funding: NIH Conflicts: Yes (Renalytix AI and Pensieve Health; Consulting fees

Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
			Admitted from SNF: NR				from AstraZeneca, Reata, GLG Conulting, BioVie, Goldfinch bio; Monogram Orthopedics)
Vilches-Moraga, 2020[55] Data source not reported: Network of 12 UK and 1 Italian site Italy and UK	Observational N=831; 831 Dates: 2/27/2020-6/10/2020	Hospitalized Positive COVID-19 test or clinical diagnosis based on signs, symptoms and supporting radiology (per author 5.5% of participants)	Age < 65 y.o.: 37.9% Women: 44.4% Race: NR Admitted from SNF: 7.8%	CKD: 29.5% DM2: 24.7% BMI>30: NR HTN: 47.9% Immunocompromised: NR	ICU: NR Intubated: NR	-Skilled nursing facility - Discharged home -Home health -Intermediate care -Residential care -Sheltered care (At discharge)	Low risk of bias Funding: None reported Conflicts: None reported
Yeo, 2021[56] EHR: 1 hospital USA	Retrospective cohort N=1,062; 1,062 Dates: 3/13/2020-4/9/2020	Hospitalized PCR Positive COVID-19	Mean Age: 56.5 (16.6 SD) Women: 40.5% Race: White: 18.4% Black: 7.3% Hispanic: 46% Asian: 13.2%	CKD: 6.3% DM2: 25.8% BMI>30: 34.4% HTN: 41.3% Immunocompromised: NR	ICU: NR Intubated: NR	-Discharged home -Skilled nursing facility or rehab -ED visit (Median 62 days (IQR 55, 68)	Low risk of bias Funding: None reported Conflicts: None reported

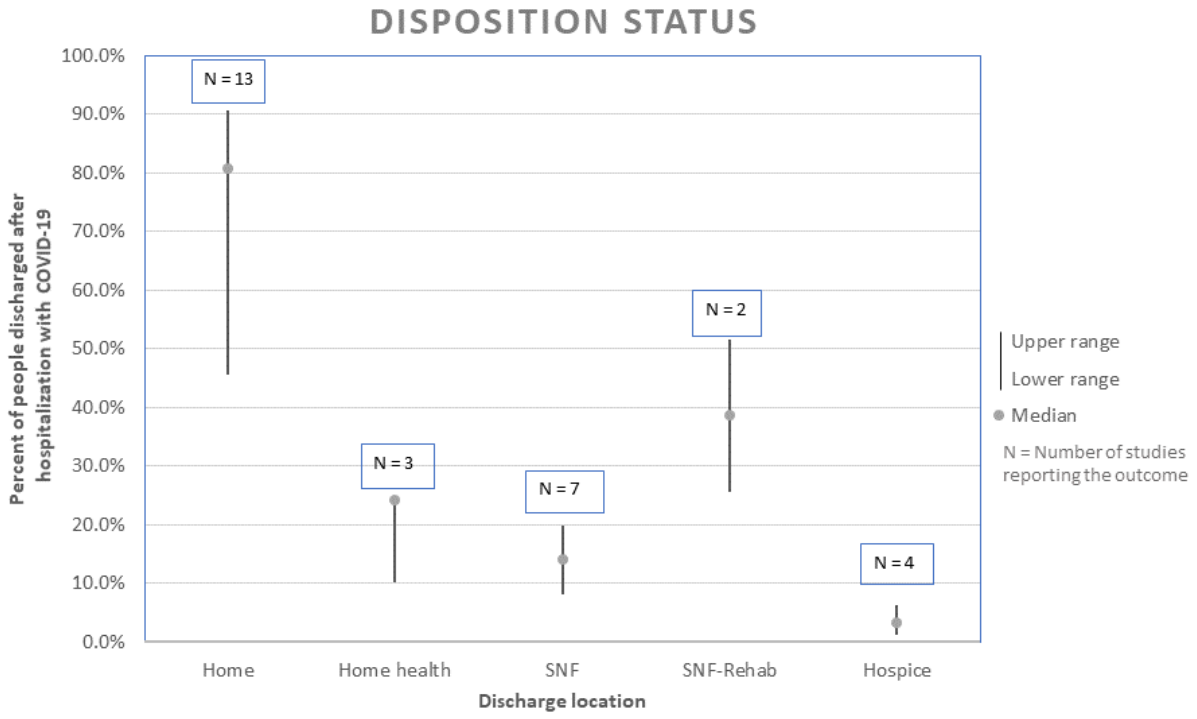
Study Data Source Country	Cohort Study N Enrollment Dates	Eligibility Criteria	Demographics	Comorbidities (%)	Level of care: ICU % Intubated %	Outcomes (Timing)	Risk of Bias Funding Conflicts
			Other: 15.1% Admitted from SNF: NR			-Hospital readmission to same hospital (Median 62 days (IQR 55, 68)	

[a] Comorbidity reported for entire sample, not only those with a known discharge status.
Abbreviations: BMI=body mass index; CKD=chronic kidney disease; D/C=discharged; DM2=diabetes mellitus type 2; ED=emergency department; EHR=electronic health record; HTN=hypertension; ICU=intensive care unit; IQR=interquartile range; NHLBI=National Heart, Lung, and Blood Institute; NIH=National Institutes of Health; NR=not reported; ROB=risk of bias; SNF=skilled nursing facility; y.o.=years old

Discharge Disposition Status

Figure 2 shows the overall discharge disposition pattern. Almost all studies reported discharge to home, with fewer studies reporting other dispositions. Discharge to palliative care was not reported by any study, but discharge to hospice was reported in 4 studies. The only study conducted in the VHA did not report disposition status.

Figure 2. Pattern of Discharge Disposition Status for Patients Hospitalized with COVID-19



The most common disposition was discharge home; 13 studies reported this outcome.[37,43-49,51-53,55,56] The percentage of patients discharged home differed substantially from 45.5% to 90.6% (median = 80.9%) (Figure 3). We examined studies with exceptionally high or low discharge to home rates to explore study design features (*eg*, eligibility criteria) or patient characteristics that could be associated with this outcome. Some variability was explained by differences in outcome definition. For example, the largest study[37] reported discharge to home separately from discharge to home with home health services while other studies included those discharged with home health services in the discharge to home status. Studies that had low discharge to home rates[47,55] had the longest length of stay or restricted those eligible to older adults or those with frailty. Three studies reported post-hospitalization home health services.[37,48,55] The percentage of patients discharged with these services ranged from 11.5% to 24.7% (median 24.2%). A multicenter European study reported the highest use of home health services (24.7%); over one-half of the patients had mild frailty prior to admission as assessed by the Clinical Frailty Scale.[55] We included discharge to "intermediate care" in this study,[55] as their definition of services received was consistent with home health care. The rate of home health use in Loerinc et al included any home service: physical therapy/occupational therapy (13.5%), nursing care (5.2%), and/or home oxygen (13.2%), with some patients receiving more than 1 service (totals

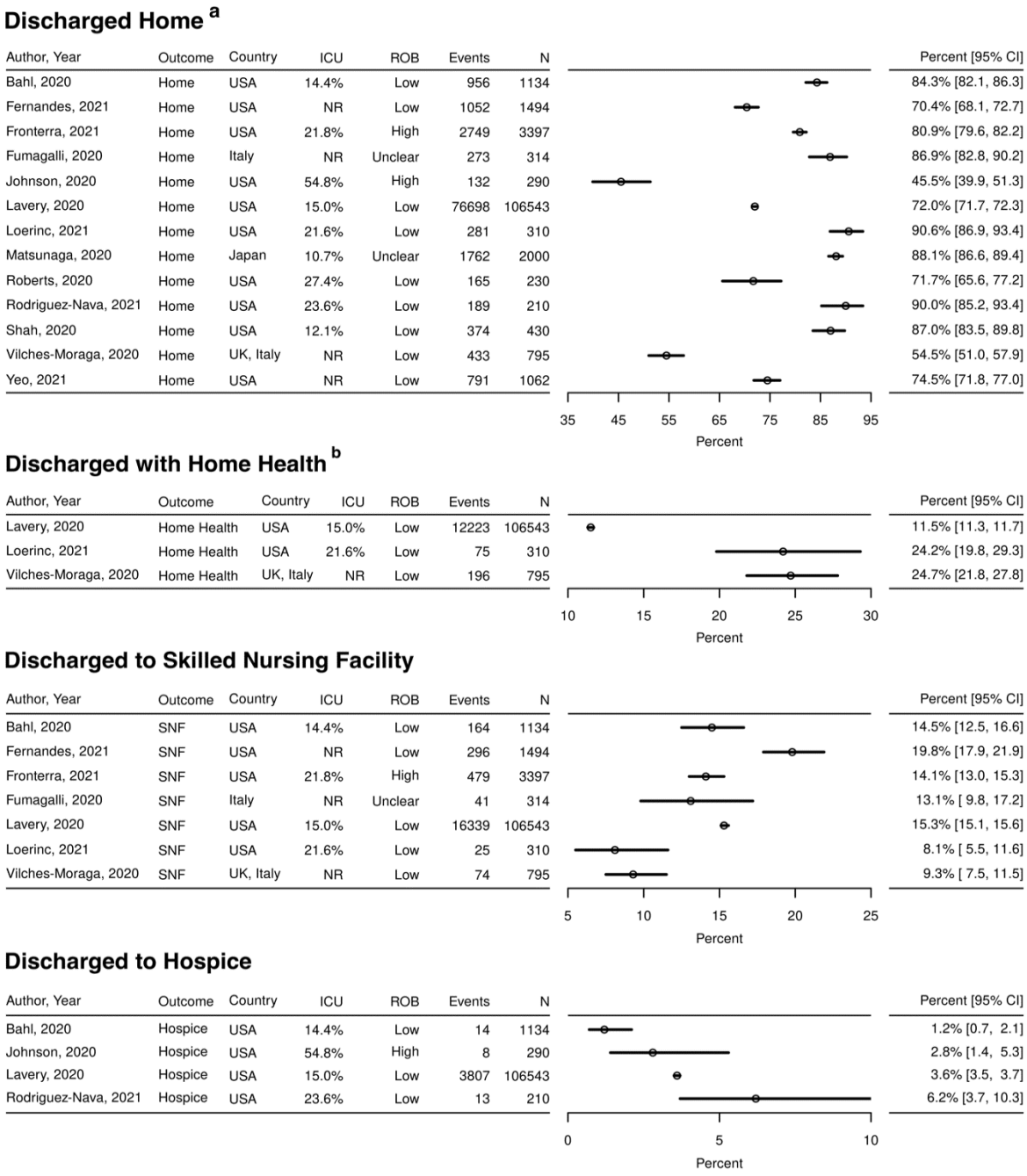
>24.2%).[48] Other studies reporting this outcome did not explicitly include home oxygen or durable medical equipment use.

Seven studies reported the number of patients discharged to a skilled nursing facility,[37,43-46,48,55] with the percentage ranging from 8.1% to 19.8% (median 14.1%). We included "nursing care" reported by Vilches-Moraga,[55] as their definition of services received was consistent with the level of care received at a skilled nursing facility. Two studies reported the composite category of patients discharged to a skilled nursing or rehabilitation facility (SNF-rehab).[47,56] The number of patients utilizing SNF-rehab after discharge was substantial, ranging from 25.5% to 51.7% (median 38.6%). Several other studies reported on discharge dispositions similar to skilled nursing facilities or rehab but were treated separately due to their definition or grouping of the outcome. Roberts[51] reported discharges to "SNF, another acute care institution, inpatient rehab, long-term care hospital," and Matsunaga[49] reported discharges to "long-term care facility".

Four studies reported rates of discharge to hospice care. The percentages of patients receiving this care were relatively low ranging from 1.2% to 6.2% (median 3.2%).[37,43,47,52]

One study[39] that included only high severity patients—those requiring endotracheal intubation—was analyzed separately. Hyman[39] reported the second lowest rate of patients discharged home (51.7%), comparable to the study limited to patients evaluated by a physical therapist and who had a high hospital length of stay.[47] Other disposition status for this high severity study were: discharge to a skilled nursing facilities (47.2%), or other/unknown (5.6%).

Figure 3. Discharge Disposition Status Reported Across Studies



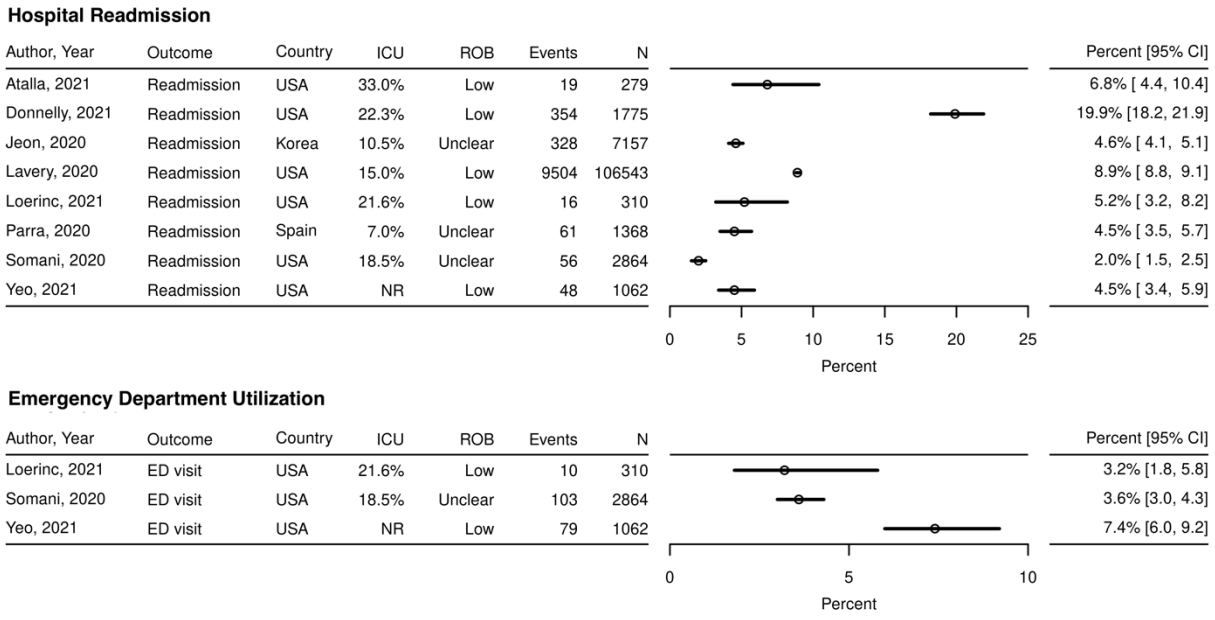
[a] Discharged home plot shows combined discharge and discharge to home health data for Lavery et al.[37]
[b] Discharged to home health plot shows combined home health and discharged to intermediate care for Vilches-Moraga et al.[55]

Hospital Readmission and Emergency Department Utilization

Eight studies,[37,40-42,48,50,54,56] including 1 from the VHA,[40] reported the proportion of patients who were readmitted to the hospital after an index COVID-19 hospitalization. The percentage of patients readmitted to the hospital ranged from 2.0% to 19.9% (median 4.9%; Figure 4). Readmission outcomes were assessed from 14 to 60 days; 1 study[56] followed patients longer

(median 62 days, IQR 55 to 68). The highest readmission rate (19.9%) was reported in a VA study using 60-day outcome data from 132 VA hospitals. The most common readmission diagnosis in Veterans in this cohort were COVID-19 (30.2%), sepsis (8.5%), pneumonia (3.1%), heart failure (3.1%). The COVID-19 survivors had lower readmission rates than matched Veteran survivors of pneumonia (26.1% vs 31.7%, p = 0.006) and heart failure (13.9% vs 8.8%; p < 0.001). Four other studies reported reasons for readmission with varying degrees of granularity.[42,48,54,56] Generally, these studies found that respiratory distress, thrombotic episodes and COVID-19 were the principal readmission diagnoses. The largest study,[37] reporting from 865 US medical facilities, also reported a readmission rate higher than the median study (8.9%). Like the VA study, this study reported 60-day readmission rates, which likely contributes to the higher rate. Emergency room admission was reported in 3 studies (n=4,236 patients) ranging from 3.2% to 7.4% (median 3.6%).[48,54,56]

Figure 4. Hospital Readmission and ED Utilization Reported Across Studies



Surveillance

Our surveillance methods identified another systematic review protocol[57] and 2 other systematic reviews[31,32] that were published addressing COVID-19 hospital readmissions. Although both reviews conducted searches more recently than our report (March 2021 and August 2021), neither identified any additional studies meeting our eligibility criteria. In addition to these systematic reviews, we identified 2 large studies that examined rehospitalization in patients before the Delta wave, published after our search date, that are relevant to our research question.

The first study examined the rate of organ dysfunction after COVID-19 hospitalization while also collecting readmission rates using claims data.[58] The authors found that 29.4% of patients were readmitted out of 47,780 individuals hospitalized for COVID-19 in the UK at a mean of 140 days follow-up. To compare their results to the VA study described above, authors restricted follow-up to 60 days and found a readmission rate of 23%, similar to the 19.9% readmission rate reported by Donnelly.[40] The second study, by Verna et al,[59] examined factors related to 30-day

COVID-19 readmission and inpatient mortality in almost 30,000 patients drawn from claims data in 40 states. Authors found that of all patients hospitalized for COVID-19, only 3.6% of patients were readmitted.

Risk of Bias

The overall ROB assessment along with the 12 domain criteria are summarized in Figures 5 and 6. Twelve studies[37,39,40,42-44,48,51-53,55,56] were rated low ROB, 5 studies[41,46,49,50,54] were unclear ROB,[54] and 2 studies[45,47] had high ROB. Two studies, reported as either a research letter[40] or a Morbidity and Mortality Weekly Report,[37] lacked some of the detail of full-length journal publications. The approach to population sampling and follow-up were frequently considered to be sources of bias because of concerns about representativeness of study populations and loss to follow-up. Specifically, we assessed ROB as elevated when studies collected data from a single hospital. Similarly, we assessed ROB as elevated when studies had incomplete follow-up or did not report the numbers lost to follow-up, did not address missing data, or did not report adequate follow-up times for the readmission or ED use to occur. Since these studies were non-comparative, some elements of the JBI checklist, such as confounding factors, were not applicable.

Figure 5. Risk of Bias Ratings for Included Studies

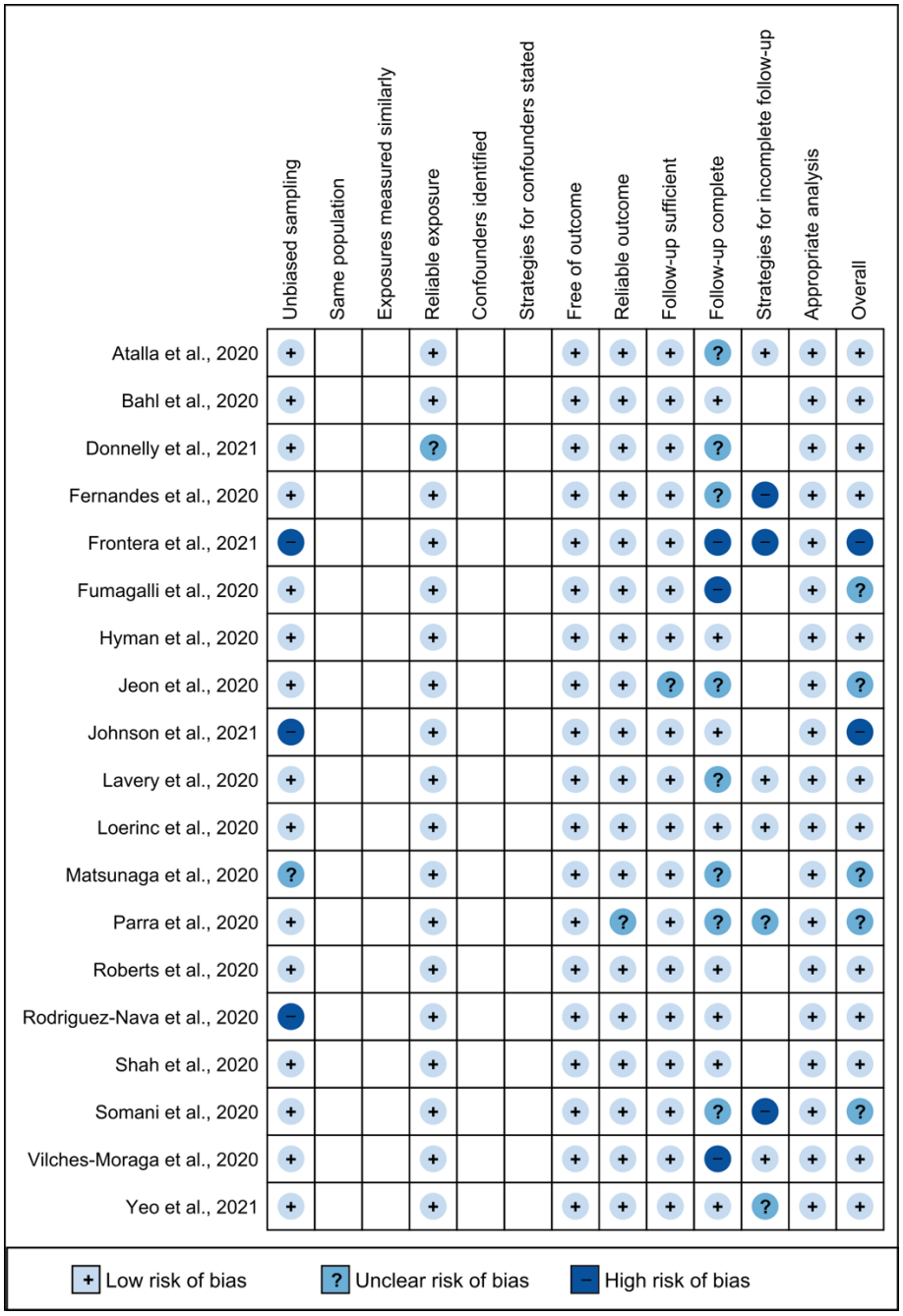
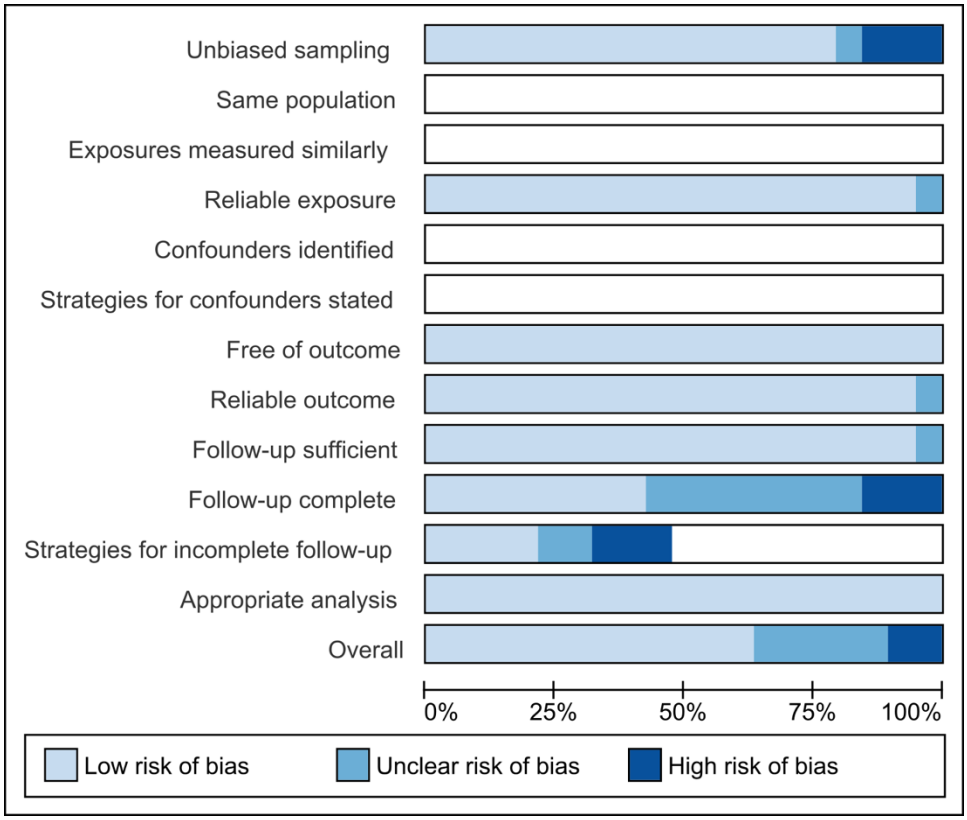


Figure 6. Risk of Bias Assessment Across Included Studies



DISCUSSION

Most patients hospitalized with COVID-19 were discharged home without post-hospitalization rehabilitation services or skilled nursing care. However, a substantial minority were discharged to a skilled nursing facility, a rehabilitation center, or home with home health services. Short-term hospital readmission rates were modest but lower than typically observed for common debilitating medical illnesses such as congestive heart failure[60] or pneumonia, another acute infectious illness.[61] Respiratory distress, thrombotic episodes, and COVID-19 were the most common reasons for readmission. A national VA study had the highest readmission rate, suggesting Veterans may be at greater risk of readmission compared to non-Veterans, although hospitalization was tracked for a longer period than most other included studies. This study did not measure readmissions to non-VA hospitals, suggesting that readmissions rates may have been higher than reported. Veterans using the VHA also tend to be male, older, and have more comorbidities, predisposing them to higher risk of rehospitalization.[7-9] Veterans and other higher-risk patients may require ongoing monitoring or tailored rehabilitation and medical care plans post-discharge to reduce their risk of rehospitalization. Health care systems, particularly the VA, will need post-acute care services, including home health and rehabilitation capacity to support patients' needs following discharge and to reduce rehospitalization rates.

Other outcomes, including oxygen and durable medical equipment use, were reported infrequently, and no studies reported utilization at longer-term time points (*ie*, longer than 3 months after discharge). Each study enrolled patients early in the pandemic. Three of the studies were conducted in Europe, which experienced high rates of COVID-19 early in the pandemic compared to the United States.[62] Treatments (corticosteroids, remdesivir, patient positioning) were poorly reported and have advanced since the studies included in this report—and will continue to advance with time. Similarly, there was marked heterogeneity in patient comorbidities, reasons for readmission, factors associated with readmission, and follow-up time frames across studies. Over the course of the pandemic, improved knowledge about COVID-19 treatments including new antiviral development, vaccinations, and patient management have likely reduced hospital length of stay and improved survivorship. Increased survivorship has the potential to lead to an increased need for post-acute health care, but more recent studies are needed.

Since the publication of our original report, the number of studies has increased substantially and so have our ratings of the certainty of evidence. Certainty of evidence is rated moderate to high for all outcomes except home health and home oxygen (Table 4). Two outcome categories (palliative care and mobility aids) were not reported. Inconsistency was a concern for some outcomes due to unexplained variability in the outcomes reported. The small number of studies did not support statistical analysis for publication bias.

Table 4. GRADE Evidence Profile: Unselected Populations

Outcome	Number of Studies (Patients)	ROB/Quality	Inconsistency	Indirectness	Imprecision	Publication Bias	Median Effect Size/Outcome (Range)	Certainty of the Body of Evidence
Discharged home	13 (118,301)	Not serious	Serious	Not serious	Not Serious	Undetected	Median 80.9% (45.5%, 90.6%)	⊕⊕⊕◯ Moderate
Home health	4 (107,648)	Not serious	Serious	Not serious	Not Serious	Undetected	Median 24.2%; (11.5%, 24.7%)	⊕◯◯◯ Low
Home oxygen	1 (310)	Not serious	Not Serious	Not serious	Serious	Undetected	NA	⊕◯◯◯ Low
Skilled nursing facility	7 (114,079)	Not serious	Not Serious	Not serious	Not Serious	Undetected	Median 14.1% (8.1%, 19.8%)	⊕⊕⊕⊕ High
Hospice	4 (108,117)	Not serious	Not serious	Not serious	Not serious	Undetected	Median 3.2% (1.2%, 6.2%)	⊕⊕⊕⊕ High
Readmission to hospital	8 (121,358)	Not serious	Serious	Not serious	Not Serious	Undetected	Median 4.9% (2.0%, 19.9%)	⊕⊕⊕◯ Moderate
ED visits	3 (4,236)	Not serious	Not serious	Not serious	Serious	Undetected	Median 3.6% (3.2%, 7.4%)	⊕⊕⊕◯ Moderate

OUR FINDINGS IN CONTEXT WITH OTHER STUDIES AND EVOLVING LITERATURE

Since our original report, another systematic review protocol[57] and 2 other systematic reviews[31,32] were published addressing COVID-19 hospital readmissions. The reviews failed to meet many of the AMSTAR-2 quality criteria and did not identify additional studies that met our eligibility criteria. In contrast, our review adheres closely to the AMSTAR-2 quality criteria and the PRISMA 2020 reporting guidelines.[29] Our literature surveillance also identified 2 large studies published after our search date that are relevant to our research question. These 2 studies add to the growing literature exploring outcomes after COVID-19 hospitalization but only explore rehospitalization rates. If these data had been included in our summary estimates, they would have affected median outcomes minimally (≤ 0.03%).

CLINICAL AND POLICY CONTEXT

COVID-19 hospitalization leads to the use of common post-acute medical services. Our review suggests that health systems should plan for a measurable demand for post-acute care in a skilled nursing or rehabilitation facility, around 14% of patients. Since these care facilities house many of our most vulnerable patients, policies to avoid introduction of COVID-19, including introduction by those transferred from hospital, will need careful attention. Relatively low readmission rates are good news since hospitals have been near or at capacity during "peak COVID-19" (November 2020 to February 2021). Further, readmission for other illnesses is associated with higher mortality rates than the index hospitalization, making prevention of readmissions a priority. The one VA-specific study we identified[40] found a higher rate of hospital readmission, suggesting that the VA may face a larger portion of patients being readmitted compared to the civilian population.

High rates of medical utilization after COVID-19 hospitalization can lead to increased health care costs. Although not an objective for this review, some studies attempted to identify patient factors related to outcomes. In the VA study,[40] older age was associated with readmission in an analysis that did not control for other risk factors. In the large CDC study,[37] discharge to a SNF or requiring home health services were independently associated with readmission. Older age, and certain chronic medical comorbidities, were also associated with higher readmission rates. A published systematic review protocol (PROSPERO CRD42021232324)[57] aims to identify factors related to readmission after an index hospitalization. If studies identify a consistent set of risk factors for readmission or develop a predictive model, it could help health systems target resources to those at highest risk and intervene to prevent readmission. The VA and other health systems should consider treatments after hospitalization to address COVID-related symptoms and potentially reduce avoidable health care utilization and rehospitalization. Interventions including but not limited to home health care, medication, assistive devices, and respiratory, physical, or occupational therapy could reduce the risk of future medical utilization including rehospitalizations. For example, ample evidence suggests that exercise-based interventions focused on functional limitations can reduce rehospitalization rates in other patients, which may translate to patients who have suffered from a COVID-19 hospitalization.[18-20,27]

APPLICABILITY

Of the included studies, 15 were conducted in the United States, 3 in Europe, and 2 in Asia with health systems generally applicable to our health system. While the health systems are generally similar, variability in availability of resources due to a range of factors such as insurance, infrastructure, and COVID-19 infection rates are likely to affect service utilization across different health systems. We identified 1 VA study that reported 60-day readmission rates higher than other studies.[40] This study's cohort examined Veterans who were hospitalized for COVID-19 and appeared to have similar characteristics to other Veteran cohorts.[7-9] Compared to the other studies included, the VA study had older patients, a higher rate of comorbidities, and a much higher rate of male patients—all characteristics associated with hospitalization and likely part of the reason for the disparity in rehospitalization rates between Veterans and other patient populations.[7-9] The VA serves a population with higher comorbidities who may have greater needs post-hospitalization. As a result, some of the included studies may not be fully generalizable to the VA population.

These studies were all conducted early in the pandemic. COVID-19 treatments and patient management strategies have evolved since then including the development and implementation of vaccines and anti-viral medications, which might affect our outcomes in uncertain ways (*eg*, some might have milder illness and less need for services, others who might have died will now survive and potentially need higher-level services after discharge). At the time these studies were performed, staffing shortages were common and the delivery of home-based care was abruptly changing. The use of telehealth, visiting staff, and mobile phone applications for support rapidly expanded, which, depending on availability of resources, could impact home health use post-discharge. In addition, decisions to admit and/or transfer to SNF-rehab facilities are partially dependent upon bed availability, which may have been more limited than usual when these studies were conducted. The median age of enrolled patients was 62, and 44.1% were women. Since the VA serves a higher proportion of men, and men tend to have worse COVID-19 outcomes, results from these studies may be skewed to better outcomes than we might observe in Veterans.

LIMITATIONS IN BODY OF EVIDENCE

Cohort studies are the appropriate design to address our question. However, we noted a few common design limitations, including that most studies were retrospective designs, samples may not have been representative of the overall population of patients hospitalized for COVID-19 infection, and utilization outcomes were short term. Few studies reported the proportion of patients admitted from a SNF or other supported care living arrangements (*eg*, assisted living). Readmission and ED visit outcomes were typically captured only if the patient returned to the discharge hospital; thus, these rates may be systematically underestimated. Misclassification of disposition status is also possible if studies did not use consistent definitions to classify health care institutions (*eg*, as a skilled nursing facility). There was significant variability in studies' reporting of outcomes, and often patient characteristics or outcomes of interest were not reported. For example, discharge to skilled curing facilities, Hispanic and Asian race, and some comorbidities were frequently not reported. Some outcomes of interest were addressed infrequently (*eg,* home health) or not at all (*eg,* durable medical equipment). Further, it is possible that outcomes may vary depending on vaccination status, but these studies occurred prior to the first COVID-19 vaccine approval.

LIMITATIONS OF REVIEW

This is a currently evolving literature and we only captured studies from early cohorts (*eg*, patient enrollment occurred between March and July 2020). Given that this is a nascent field, searching and identifying eligible studies is challenging because disposition status is often reported in studies designed for other purposes. It is possible that we may have missed some potentially relevant studies as a result, and our search is current only through February 2021. In addition, GRADE ratings were developed for reviews and guidelines that examine alternative management strategies or interventions and are not ideally suited to non-comparative studies. Also, GRADE ratings are more challenging to make in the absence of summary estimates from meta-analysis. Although we applied the GRADE concepts to evaluate the certainty of evidence, these ratings should be considered somewhat cautiously.

KNOWLEDGE GAPS/KEY UNANSWERED QUESTIONS/NEXT STEPS FOR RESEARCH

Organized by PICOTS, we outline knowledge gaps and study designs to address these gaps (Table 5). In addition, the VHA now has substantial experience with COVID-19. The VHA could address key gaps in knowledge by using its talented HSR&D investigators and sophisticated databases to build on the study by Donnelly et al[40] and examine a broader array of outcomes in Veterans cared for in the VHA. Although beyond the scope of this review, our estimates of post-acute care service needs could be used to project post-acute care services needed for the VA population. Operational partners also identified a need to understand if the post-hospital needs for patients with COVID-19 differed in quantity, duration, or mix of services than matched patients hospitalized for non-COVID-19 indications.

Table 5. Evidence Gaps and Future Research

Evidence Gap	Reason	Type of Studies to Consider
Population		
• Samples with newer variants of SARS-CoV-2 • Samples with current guideline concordant care, including those with breakthrough infections	Insufficient Information	• Cross-sectional • Prospective cohort • Retrospective cohort
Interventions		
• Studies did not consistently report medication/treatment used during hospitalization, including dosage • Studies did not report rehabilitation services provided during hospitalization • Few studies specified the type, frequency, and dose of home-based health services post-hospitalization	Insufficient Information	• Cross-sectional • Prospective cohort • Retrospective cohort
Comparators		
N/A		
Outcomes		
• Limited information on functional outcomes at the time of discharge	Insufficient Information	• Cross-sectional • Prospective cohort • Retrospective cohort

Evidence Gap	Reason	Type of Studies to Consider
• No information on the duration of stay or outcomes of patients discharged to health care institutions (*eg*, skilled nursing facility) • Emphasis was on short-term utilization • Incomplete recording for several studies • Only 1 study reported use of physical or occupational therapy services post-discharge		
Setting		
• All enrollment time periods occurred early in the pandemic	Insufficient Information	• Cross-sectional • Prospective cohort • Retrospective cohort

CONCLUSIONS

There is substantial and growing research exploring the rates of health care utilization after hospitalization for COVID-19. There is moderate-certainty evidence that after COVID-19 hospitalization a substantial portion of patients will require further medical care and services including hospice, rehospitalization, skilled nursing or rehabilitation facility admission. Although the certainty of evidence is lower, about 1 in 8 patients will require home health care. Reassuringly, short-term readmission rates appear modest, although they were higher in 1 national study of Veterans. These findings strongly suggest that policy makers and health systems should prepare rehabilitation, home health, and medical services for patients after hospitalization for COVID-19.

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APPENDIX A. SEARCH STRATEGIES

Database: MEDLINE (via Ovid, MEDLINE
Original Search date: 9/2/2020

Search Set	Search Strategy	Results
#1 *COVID-19 terms*	Coronavirus/ or Coronavirus Infections/ or Betacoronavirus/ or (coronavirus or coronaviruses or coronaviridae or coronavirinae or "corona virus" or "corona viruses" or betacoronavirus or betacoronaviruses or betacoronaviridae or betacoronavirinae or SARS-CoV or SARScov or SARS-CoV-2 or SARS-CoV2 or sarscov2 or SARS2 or COVID-19 or "COVID 19" or COVID19 or 2019nCov or 2019-nCoV or nCov or "CoV 2" or CoV-2 or COV2).ti,ab,kw. or ((wuhan or hubei or huanan) and ("severe acute respiratory" or pneumonia or pnemonias or pneumoniae)).ti,ab,kw.	64,292
#2 *Discharge terms*	Patient Discharge/ or (discharge or discharged or post-acute or postacute or post-covid or postcovid or "post covid").ti,ab,kw. or ((post or following or after or aftercare) adj2 (inpatient or inpatients or hospital or hospitalization or hospitalisation or ICU or "intensive care" or "critical care" or CCU or stepdown or "step down")).ti,ab,kw.	278,912
#3 *Functional outcome terms*	((function or functions or functional or functioning) adj2 (outcome or outcomes or sequelae or impairment or impairments)).ti,ab,kw.	75,064
#4	2 or 3	349,713
#5	1 and 4	1,676
#6	limit 5 to yr="2019 -Current"	1,593

Search update: 2/4/2021
Ovid MEDLINE(R) ALL 1946 to February 01, 2021

Search Set	Search Strategy	Results
#1 *COVID-19 terms*	Coronavirus/ or Coronavirus Infections/ or Betacoronavirus/ or (coronavirus or coronaviruses or coronaviridae or coronavirinae or "corona virus" or "corona viruses" or betacoronavirus or betacoronaviruses or betacoronaviridae or betacoronavirinae or SARS-CoV or SARScov or SARS-CoV-2 or SARS-CoV2 or sarscov2 or SARS2 or COVID-19 or "COVID 19" or COVID19 or 2019nCov or 2019-nCoV or nCov or "CoV 2" or CoV-2 or COV2).ti,ab,kw. or ((wuhan or hubei or huanan) and ("severe acute respiratory" or pneumonia or pnemonias or pneumoniae)).ti,ab,kw.	113,469
#2 *Discharge terms*	Patient Discharge/ or (discharge or discharged or post-acute or postacute or post-covid or postcovid or "post covid").ti,ab,kw. or ((post or following or after or aftercare) adj2 (inpatient or inpatients or hospital or hospitalization or hospitalisation or ICU or "intensive care" or "critical care" or CCU or stepdown or "step down")).ti,ab,kw.	291,211
#3 *Functional outcome terms*	((function or functions or functional or functioning) adj2 (outcome or outcomes or sequelae or impairment or impairments)).ti,ab,kw.	78,589
#4	2 or 3	365,286
#5	1 and 4	3,753
#6	limit 5 to yr="2019 -Current"	3,670

Database: Embase (via Elsevier)
Original search date: 9/2/2020
Note: search from the Results page

Search Set	Search Strategy	Results
#1	'coronaviridae'/de OR 'coronavirinae'/de OR 'betacoronavirus'/de OR 'sars-related coronavirus'/exp OR 'severe acute respiratory syndrome coronavirus 2'/exp OR 'coronavirus infection'/exp OR 'coronavirus disease 2019'/exp OR coronavirus:ti,ab,kw OR coronaviruses:ti,ab,kw OR coronaviridae:ti,ab,kw OR coronavirinae:ti,ab,kw OR 'corona virus':ti,ab,kw OR 'corona viruses':ti,ab,kw OR betacoronavirus:ti,ab,kw OR betacoronaviruses:ti,ab,kw OR betacoronaviridae:ti,ab,kw OR betacoronavirinae:ti,ab,kw OR 'sars cov':ti,ab,kw OR sarscov:ti,ab,kw OR 'sars cov 2':ti,ab,kw OR 'sars cov2':ti,ab,kw OR sarscov2:ti,ab,kw OR sars2:ti,ab,kw OR 'covid 19':ti,ab,kw OR covid19:ti,ab,kw OR 2019ncov:ti,ab,kw OR '2019 ncov':ti,ab,kw OR ncov:ti,ab,kw OR 'cov 2':ti,ab,kw OR cov2:ti,ab,kw OR ((wuhan:ti,ab,kw OR hubei:ti,ab,kw OR huanan:ti,ab,kw) AND ('severe acute respiratory':ti,ab,kw OR pneumonia:ti,ab,kw OR pnemonias:ti,ab,kw OR pneumoniae:ti,ab,kw))	72,947
#2	'hospital discharge'/exp OR discharge:ti,ab,kw OR discharged:ti,ab,kw OR 'post acute':ti,ab,kw OR postacute:ti,ab,kw OR 'post-covid':ti,ab,kw OR 'post covid':ti,ab,kw OR postcovid:ti,ab,kw OR ((post OR following OR after OR aftercare) NEAR/2 (inpatient OR inpatients OR hospital OR hospitalization OR hospitalisation OR icu OR 'intensive care' OR 'critical care' OR ccu OR stepdown OR 'step down')):ti,ab,kw	498,829
#3	'functional outcome'/exp or ((function or functions or functional or functioning) NEAR/2 (outcome or outcomes or sequelae or impairment or impairments)):ti,ab,kw	111,561
#4	#2 OR #3	602,420
#5	#1 AND #4	2,231
#6	#5 AND (2019:py OR 2020:py OR 2021:py)	1,940

APPENDIX B. GRADE TERMINOLOGY

Certainty of evidence: the extent to which one can be confident that the true effect of an intervention lies on one side of a specified threshold, or within a chosen range.

Inconsistency: refers to unexplained heterogeneity of results.

Imprecision: In general, results are imprecise when studies include relatively few patients and few events and thus have a wide confidence interval (CI) around the estimate of the effect.

Directness: Direct evidence consists of research that directly compares the interventions which we are interested in, delivered to the populations in which we are interested, and measures the outcomes important to patients. Authors of systematic reviews and guideline panels making recommendations should consider the extent to which they are uncertain about the applicability of the evidence to their relevant question.

Terminology cited from the GRADE Handbook.[63]

APPENDIX C. PEER REVIEW DISPOSITION

Reviewer Number	Comment	Response
Are the objectives, scope, and methods for this review clearly described?		
3	Yes	
5	Yes	
7	Yes	
8	Yes	
10	Yes	
12	Yes	
13	Yes	
Is there any indication of bias in our synthesis of the evidence?		
3	No	
5	No	
7	No	
8	No	
10	No	
12	No	
13	No	
Are there any published or unpublished studies that we may have overlooked?		
3	No	
5	No	
7	Yes - Ayoubkhani D, Khunti K, Nafilyan V, Maddox T, Humberstone B, Diamond I, et al. Post-covid syndrome in individuals admitted to hospital with covid-19: retrospective cohort study. The BMJ. 2021;372:n693.	Acknowledged, thank you.
8	No	
10	No	
12	No	
13	No	

Additional suggestions or comments can be provided below.		
3		
5	This review is an excellent update to the previous version. I have only minor comments: 1. Figure 2 is a bit hard to read without zooming in very closely. It would be useful to have this in a higher quality format.	We were able to replace with a higher quality image.
	2. Bottom of page 19 - the word "ranged" was repeated twice in the last paragraph.	Thank you. Corrected.
	3. It might be beneficial to include an appendix with descriptions of the GRADE criteria (e.g. what do "indirectness" and "inconsistency" mean in the context of the GRADE criteria?). Perhaps there is a table or checklist in the source material that would explain these concepts to readers who are not familiar with the criteria.	We added an appendix that defines the key GRADE terms.
7	Some Comments: Thank you for this thorough review of evidence on hospital readmissions among those hospitalized for COVID. The methods are clearly laid out with sufficient details about the inclusion and exclusion criteria. I expect to cite this review in an upcoming paper we are revising on a related topic.	Acknowledged, thank you.
	I share below some areas for clarification and possible editing: 1. For the summary of the studies in the table and text, I think it is important to clarify for each of the included studies whether they assessed readmissions at any institution or whether it was limited to the original institution. Some studies included ascertainment of hospital readmissions across multiple sites or systems of care (e.g., Jeon, et al; Matsunaga et al) , whereas others were limited to within one system or one database. Among the US studies for example, in the Donnelly study readmissions to VA hospitals were assessed, however readmissions outside of the VA health system were not included, such as under Medicare covered care. Similarly, even for the large CDC study (Lavery, et al) the readmissions ascertained were limited to those occurring in the one of the 865 healthcare institutions that comprised the Premier database.	The study characteristics table has been updated with the number of hospitals reported in each study. For studies reporting readmissions, we added details to the table about how readmissions data was collected (*eg,* same hospital, any of 5 hospitals). We also highlight incomplete ascertainment of readmission and ED visits as a limitation of the literature
	2. Another aspect to clarify for each of the included studies is whether the data source was truly electronic health records or a data warehouse or repository that included electronic health records. This distinction is important because individual electronic health records are a different source of information than a set of curated electronic health records (i.e., as in a warehouse or repository). For example, in the Donnelly study it is relying on the electronic health record data that is contained in the large national CDW. Similarly, it is the case in the Hyman et al study that while in Table 3 it is listed as “EHR” for the data source, in fact they appeared to have	Details about the data source have been added to the study characteristics table when reported by the literature.

	relied on the large corpus of information in EPIC information system across five hospitals in the Mount Sinai health system. I also think that explicating the data source in more detail matters because it speaks to the ability of the research community to be able to summarize this important information. The access to such stores of information has made it possible for most of these studies to get to a publishable form in a relatively short timeframe. The availability of data in curated repositories in these health systems has made it possible to report on such outcomes quickly.	
	3. On the other hand, it is surprising that the only study that used claims data was the one reported from Korea. No US studies included in this review appeared to have relied on health insurance claims data and no studies from Europe relied on multi-institutional health system data. Given the wealth of information for example in the UK National Health System, I am surprised that there is not one study addressing hospital readmission. One study by Ayoubkhani et al 2021 (Ayoubkhani D, Khunti K, Nafilyan V, Maddox T, Humberstone B, Diamond I, et al. Post-covid syndrome in individuals admitted to hospital with covid-19: retrospective cohort study. The BMJ. 2021;372:n693.) conducted in the UK was included in another systematic review, although it was not accepted for publication until March 15, which was after the ESP cut-off date. Given that this review will be appearing after some other systemic reviews that went beyond Feb 2021, it is important to emphasize this cutoff for the search in the discussion and limitations. This is also important because I suspect that more US studies relying on large datasets from insurance claims, which have likely been delayed by insurer billing adjudications, will be appearing in the next several months.	We now discuss and cite related systematic reviews. We also reviewed the bibliographies of these reviews for additional eligible studies; none were identified. The section, “Limitations of Review” has been revised to clearly identify the Feb 2021 search date as a limitation. We also have added text in the discussion regarding the Ayoubkhani et al 2021 study and its use of claims data.
	4. One other aspect that I think should be mentioned in the discussion is the potential for misclassification of discharge disposition and possibly hospital readmissions as well. It seems possible that there may be differences across countries and even across US health systems whether a health care institution is an acute care facility or a rehabilitation center or a long-term care facility. In other words, were individuals readmitted for acute care rather than a rehabilitation or long-term care facility? If this definition of a hospital readmissions was not consistent across studies/countries, then deriving a hospital readmission rate could be misleading. In the end, that people initially hospitalized with COVID still needed additional care beyond that which could be offered at their home is what is important.	Thank you for this observation. We now address this limitation in the discussion.
	5. By now you may be aware of the recent review published in the Journal of Emergency Medicine which included 29 US studies. While the inclusion/exclusion criteria differed from the current ESP review, it might be worth acknowledging in the ESP review. It seems the biggest difference was that the current ESP review excluded studies that focused on specific conditions and included studies beyond	Thank you. Yes, we are aware of this review, 1 additional review, and a published protocol. They are now cited and discussed.

	the Feb 2021 cut-off of the ESP review. (See: Ramzi ZS. Hospital readmissions and post-discharge all-cause mortality in COVID-19 recovered patients; A systematic review and meta-analysis. Am J Emerg Med. 2021 Nov 6;51:267-279. doi: 10.1016/j.ajem.2021.10.059. Epub ahead of print. PMID: 34781153; PMCID: PMC8570797)	
8	Objective is to determine short-term and long-term health care (hc) utilization in adults after discharge both short -term and long-term (>= 3 months). Of note, none of the studies that met study inclusion criteria measured long-term health care utilization.	Acknowledged.
	Methods in the full text are clear and excellent. Table 1 on page 3 and 4 is clear. The Outcomes study characteristics are well-suited to the objective of studying health care utilization The Setting in Table 1 does not list locations of residence other than home or skilled nursing facility (SNF), for example, assisted living facility and residential care; however, it provides the settings that is does list as examples rather than as a comprehensive list. The method for assessing Risk of Bias is good.	Acknowledged.
	Results. Table 2 page 9 line 10 reports Follow-up duration, reporting 7 studies. It is not clear if these means that only 7 studies provided follow-up information? Without follow-up information, how can health care utilization be determined?	Many studies reported only the disposition status and did not report longitudinal outcomes (*ie*, ED visits, hospital readmission). Eight studies reported hospital readmission, but only 7 specified the follow-up duration. We changed the study characteristic descriptor and added a footnote to the table to clarify this point.
	Table 2 Outcomes reported line 16 reported 8 studies reported Readmission, and only 3 studies reported ED visits, and only 3 studies reported use of home health.	The data reported in Table 2 is correct and consistent with the data reported in the results and Figures 3 and 4.
	Key Points page 9 lines 42-44 report percents of patients discharged to SNF and mentions rehabilitation facility but does not report the percent.	Discharge to rehabilitation facilities was reported in aggregate with other disposition statuses, and thus rates for rehabilitation facilities alone are not available. The text has been modified to clarify this point.
	Discussion. Page 23 lines 14 -25. In addition to stating (appropriately) the possibility that Veterans may be at more risk for readmission than non-Veteran patients, it should also be made clearer that the follow-up period for Veterans was longer than for most other studies, which would allow for capture of more re-admissions. The	Discussion revised to reiterate that the VA study used a longer follow-up period.

	report notes appropriately the reasons that Veterans may be at higher risk (age, male, comorbidities).	
	Discussion. Page 23 lines 32 – 50. The review appropriately notes that there have been changes in treatments and potential increases in survivorship, and this good result may lead to a need for additional post-acute care.	Acknowledged.
	Re any possibly overlooked publications? We do not have complete knowledge of all publication in this area so hard to say. This is a forced choice question with binary response options and cannot submit the review without answering. Anything published since feb 2021 was not reviewed. It seems likely that there have been relevant publications since then that would have been found in a search and considered for inclusion.	Acknowledged. We took steps to identify any missed publications, identify and discuss any large studies published since Feb 2021, and emphasize the potential for missed studies as a limitation.
	Summary comments: The overall methods are excellent. It is helpful to have the list of studies together with the characteristics of the studies.	Thank you.
	Unfortunately the limits of the published studies limit the extent to which the results can be used for health care system planning. Despite the large number of individuals included in the studies taken together, very few studies reported on key outcomes of importance for planning health care resources for post-acute care for a large health care system. For example, none of the studies reported long-term (>=3 months) follow-up, including what percent of patients admitted from home/community and discharged to SNF became SNF-long stayers, and how that compares with other acute care admissions from home/community. The question remains unanswered whether patients acutely hospitalized with COVID-19 will require substantially more long-term outpatient and inpatient care than patients of similar age and comorbidity who are acutely hospitalized for other conditions.	We identified one large UK study, published after our search was completed, that reports longer-term outcomes. This study has been summarized briefly in the discussion.
	As the review notes in the section on Knowledge Gaps page 26 Lines 45-50, VHA could examine a number of the key questions in more detail using VHA data. Table 5 on pages 26 – 27 points the way to future studies.	Acknowledged.
10	This was quite well done!! Proper registration w/ PROSPERO; PRISM-guided methods; GRADE recommendations; assessment of ROB; acknowledgement of limitations.	Acknowledged, thank you.
	The open question of course is what is the breadth and depth of post-COVID disability and how do we plan for it. Did any of these studies look at the duration and outcomes of non-home hospital disposition? Ideally these studies would give us a sense of what proportion of patients who, prior to COVID hospitalization, lived at home but following COVID hospitalization required prolonged rehabilitation (however that might be defined) or who could no longer live safely at home. You	No, studies did not report the duration or outcomes of patients discharge to SNF, rehabilitation centers and other health care institutions. We've added this idea to the future research section.

	might identify this as a limitation of the available data / make a recommendation that future studies capture these longer-term outcomes	
12	wondering why % use of home health isn't mentioned on pg 1 line 30-31 or page 9 line 46? In both of these sections, rates of admission to long term care and readmission rates are mentioned. Pg 17 lines 34-35 does mention this; admittedly there was a large variation. I admit to looking forward to finding this info!	The rates of home health utilization has been added to the abstract and key points.
13	This is a well written and thorough synthesis of evidence of post covid-10 health care utilization. This update includes 3 additional articles since the last review. Recommendations remain the same.	Acknowledged.

APPENDIX D. EXCLUDED STUDIES

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Abrashkin, 2021[1]		X					
Al Kasab, 2020[2]				X			
Albani, 2021[3]				X			
Alcázar-Navarrete, 2020[4]							X
Allenbach, 2020[5]				X			
An, 2021[6]	X						
Andersen, 2021[7]				X			
Andrenelli, 2020[8]							X
Anthonius Lim, 2020[9]							X
Arnold, 2020[10]		X					
Azar, 2020[11]				X			
Banda, 2020[12]		X					
Bangash, 2020[13]							X
Bassi, 2020[14]				X			
Bellan, 2021[15]				X			
Belli, 2020[16]		X					
Benussi, 2020[17]				X			
Berdahl, 2020[18]		X					
Bhattacharya, 2020[19]	X						
Bickton, 2021[20]							X
Blazey-Martin, 2020[21]				X			
Bolotova, 2020[22]		X					
Borgen, 2020[23]							X
Borobia, 2020[24]				X			
Bowles, 2020[25]		X					

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Bravata, 2021[26]						X	
Burn, 2020[27]				X			
Calles, 2020[28]				X			
Candan, 2020[29]							X
Cantador, 2020[30]				X			
Cao, 2020[31]	X						
Caramello, 2020[32]		X					
Carlucci, 2020[33]				X			
Ceravolo, 2020[34]							X
Chamorro-de-Vega, 2021[35]				X			
Chang, 2020[36]				X			
Chen, 2020[37]			X				
Chen, 2020[38]				X			
Chen, 2020[39]	X						
Chew, 2020[40]				X			
Chilimuri, 2020[41]				X			
Chinnadurai, 2020[42]				X			
Choron, 2020[43]				X			
Christie, 2020[44]		X					
Cobb, 2020[45]				X			
Corsi, 2020[46]				X			
Curci, 2020[47]						X	
Curci, 2020[48]							X
d'Alessandro, 2021[49]				X			
Daher, 2021[50]		X					
Dang, 2020[51]				X			
Davido, 2020[52]							X

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
de Havenon, 2021[53]		X					
de Havenon, 2020[54]		X					
De Lorenzo, 2020[55]				X			
Demeco, 2020[56]							X
Dhakal, 2020[57]		X					
Dhelr, 2020[58]		X					
Dillon, 2020[59]				X			
Docherty, 2020[60]				X			
Duan, 2020[61]	X						
Durmus, 2020[62]				X			
Dziewas, 2020[63]		X					
Eastin, 2020[64]	X						
Ebert, 2020[65]				X			
Emmerson, 2020[66]				X			
Enzmann, 2020[67]				X			
Ettman, 2020[68]		X					
Falvey, 2020[69]							X
Ferrando, 2020[70]				X			
Field, 2020[71]						X	
Filardo, 2020[72]				X			
Flatharta, 2020[73]		X					
Fond, 2020[74]			X				
Forlano, 2020[75]				X			
Fried, 2020[76]				X			
Frija-Masson, 2020[77]				X			
Fuglebjerg, 2020[78]				X			
Garrigues, 2020[79]					X		

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Gluckman, 2020[80]		X					
Goertz, 2020[81]				X			
Goicoechea, 2020[82]				X			
Gonzalez-Castro, 2020[83]							X
Gordon, 2020[84]			X				
Grasselli, 2020[85]				X			
Grasselli, 2020[86]				X			
Grutters, 2020[87]							X
Gupta, 2020[88]				X			
Gustavson, 2020[89]							X
Gutenbrunner, 2020[90]		X					
Gutiérrez Rodríguez, 2020[91]				X			
Ha, 2020[92]	X						
Hagg, 2020[93]		X					
Halpin, 2020[94]				X			
Hayek, 2020[95]				X			
Hernandez-Biette, 2020[96]		X					
Hewitt, 2020[97]				X			
Higgins, 2020[98]		X					
Huang, 2020[99]	X						
Huang, 2020[100]				X			
Imam, 2020[101]				X			
Ito, 2021[102]				X			
Jacobs, 2020[103]		X					
James, 2020[104]		X					
Javanian, 2021[105]	X						
Jehi, 2020[106]		X					

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Jiang, 2020[107]							X
Jiang, 2020[108]				X			
Kemp, 2020[109]		X					
Kilaru, 2020[110]		X					
Kim, 2020[111]							X
King, 2020[112]				X			
Kissling, 2020[113]							X
Klok, 2020[114]							X
Knights, 2020[115]		X					
Knopp, 2020[116]				X			
Kundi, 2020[117]				X			
Kurth, 2020[118]							X
Larsson, 2021[119]		X					
Laszkowska, 2020[120]				X			
Leigh, 2020[121]				X			
Leijte, 2020[122]			X				
Lendorf, 2020[123]		X					
Lenka, 2020[124]				X			
Levine, 2020[125]				X			
Li, 2020[126]		X					
Li, 2020[127]				X			
Li, 2020[128]	X						
Li, 2020[129]	X						
Liotta, 2020[130]				X			
Liu, 2020[131]		X					
Liu, 2020[132]				X			
Liu, 2020[133]	X						

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Long, 2020[134]							X
Lopez-Barbeito, 2020[135]		X					
Ludwig, 2020[136]				X			
Magro, 2021[137]				X			
Mahale, 2020[138]	X						
Maldonado, 2020[139]		X					
Mallow, 2020[140]				X			
Mandal, 2020[141]				X			
Mandora, 2021[142]		X					
Mangia, 2021[143]				X			
Marbach, 2020[144]		X					
Marengoni, 2020[145]						X	
Martinez-Garcia, 2020[146]				X			
McDonough, 2020[147]		X					
McLoughlin, 2020[148]				X			
McWilliams, 2021[149]		X					
Mei, 2020[150]				X			
Mendes, 2021[151]		X					
Mendez, 2020[152]				X			
Michel, 2020[153]							X
Mishra, 2020[154]				X			
Mo, 2020[155]				X			
Mody, 2020[156]			X				
Mohamed Hussein, 2020[157]				X			
Moreno-Perez, 2021[158]				X			
Morgan, 2021[159]							X
Negrini, 2021[160]							X

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Network, 2021[161]				X			
Nie, 2021[162]	X						
Nusair, 2020[163]				X			
O'Brien, 2020[164]				X			
Ogedegbe, 2020[165]				X			
Palich, 2021[166]		X					
Pancera, 2020[167]							X
Paranjpe, 2020[168]				X			
Patel, 2020[169]					X		
Pellaud, 2020[170]						X	
Pinto, 2020[171]		X					
Poussardin, 2020[172]				X			
Puchner, 2021[173]				X			
Rahmani, 2020[174]	X						
Ramani, 2020[175]							X
Ramos-Araque, 2021[176]		X					
Rashidi, 2020[177]	X						
Rasidovic, 2020[178]		X					
Reforma, 2020[179]		X					
Renelus, 2020[180]				X			
Rivera-Izquierdo, 2020[181]				X			
Rivera-Lillo, 2020[182]							X
Rodriguez-Garcia, 2021[183]		X					
Rokadiya, 2020[184]							X
Rosen, 2020[185]				X			
Roth, 2020[186]							X
Rovere Querini, 2020[187]				X			

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Russell, 2020[188]		X					
Sagarra-Romero, 2020[189]			X				
Sakai, 2020[190]						X	
Sami, 2020[191]	X						
Santeusanio, 2021[192]		X					
Sauvant, 2020[193]							X
Schiavone, 2021[194]				X			
Scialpi, 2020[195]							X
Sharma, 2020[196]	X						
Sharma, 2020[197]		X					
Sharp, 2020[198]		X					
Shaw, 2020[199]							X
Shi, 2020[200]				X			
Sigfrid, 2020[201]				X			
Simpson, 2020[202]							X
Singh, 2020[203]		X					
Snipelisky, 2020[204]				X			
Sohn, 2020[205]				X			
Soleimani, 2020[206]	X						
Somani, 2020[207]				X			
Song, 2020[208]				X			
Spruit, 2020[209]							X
Sun, 2020[210]							X
Temperoni, 2021[211]		X					
Thomson, 2020[212]					X		
Thornton, 2020[213]		X					
Torres-Castro, 2021[214]							X

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Townsend, 2020[215]		X					
Uyaroglu, 2020[216]				X			
Vallecillo, 2020[217]		X					
van den Borst, 2020[218]		X					
Vanhems, 2021[219]				X			
Vitacca, 2020[220]				X			
Vizcaychipi, 2020[221]				X			
Wang, 2020[222]				X			
Wang, 2020[223]	X						
Wang, 2020[224]	X						
Wang, 2020[225]	X						
Wang, 2020[226]				X			
Weerahandi, 2020[227]		X					
Wilson, 2020[228]							X
Wu, 2020[229]				X			
Wu, 2020[230]				X			
Xing, 2020[231]				X			
Xu, 2020[232]	X						
Yan, 2020[233]	X						
Yan, 2020[234]				X			
Yang, 2020[235]		X					
Yang, 2020[236]				X			
Yang, 2020[237]				X			
Ye, 2021[238]							X
Yu, 2020[239]	X						
Yue, 2020[240]	X						
Zhang, 2020[241]				X			

Study	Exclusion Reason						
	Not OECD	Not population	Not exposure	Not outcome	Not setting	Not timing	Not design
Zhang, 2020[242]	X						
Zhang, 2020[243]	X						
Zhao, 2020[244]				X			
Zheng, 2020[245]		X					
Zhong, 2020[246]	X						
Zuccaro, 2021[247]				X			

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