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Characterization of the Post-Acute Care Disposition of COVID-19 Patients in an Academic Healthcare Setting in Atlanta, Georgia, USA

By

Peter Kiiza
Master of Public Health

Global Epidemiology

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Dr Ben Lopman
Committee Chair

_______________________________________ [Member's signature]
[Dr Sarah DeCaro]
Committee Member

_______________________________________ [Member's signature]
[Dr Colleen Kraft]
Committee Member

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By

Peter Kiiza

Bachelor of Medicine and Bachelor of Surgery
Gulu University
2012

Thesis Committee Chair: Dr Ben Lopman, PhD, MSc

An abstract of
A thesis submitted to the Faculty of the
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Abstract

Characterization of the Post-Acute Care Disposition of COVID-19 Patients in Academic Healthcare Setting in Atlanta, Georgia, USA

By Peter Kiiza

Background: There is a dearth of information regarding post-acute care (PAC) dispositions among hospital discharged COVID-19 patients. Providing post-acute care to COVID-19 patients, demands specific patient needs be well-characterized to guide holistic care and equitable resource allocation.

Methods. We conducted an 18-month retrospective cohort study for COVID-19 patients discharged from four acute care hospitals within Emory HealthCare Network, Atlanta, GA. We reviewed electronic medical records (EMRs) at 3 time points (i.e., April 22, 2020, May 07, 2020, and October 21, 2021). EMRs of patients discharged from the same hospitals in 2018 and 2019 were extracted for comparison. Both clinical and sociodemographic variables were abstracted. Primary and secondary outcomes of interest were post-acute care dispositions and death. Means (standard deviations), and frequencies and percentages were computed for continuous and categorical variables respectively. Polytomous logistic regression was used to assess associations between the exposures (COVID-19, gender, study year) and PAC disposition (either as a 7-or 3-level) outcome. Logistic regression assessed death as an outcome. Statistical analyses were conducted in R.

Results: There were 680, 994 and 7646 patients at the 1st, 2nd and 3rd EMR encounters respectively. Overall, mean (standard deviation) age was 58.5 (1.8) years, 50.8% female and 54.1% Black. 7.0% died, 70.0% and 84.7% of the participants had home self-care and outpatient services respectively, as their PAC disposition outcomes at end of study. During the early phase of the pandemic, hospital discharged COVID-19 survivors were less likely to die (odds ratio [OR] 0.48, confidence interval [CI] 0.25-0.95) as compared to non-COVID-19 patients. Additionally, COVID-19 diagnosis did not influence whether patients received facility-based or outpatient services (OR: 0.82, CI [0.48-1.40]). Female survivors were less likely to die (OR: 0.55, CI [0.41-0.73]) or receive facility-based services (OR: 0.76, CI [0.63-0.91]). COVID-19 diagnosis or year of study did not significantly impact odds of death when historical controls (patients discharged in 2018-19) were compared to COVID-19 survivors (OR: 0.97, CI [0.84-1.12]).

Conclusion: Home self-care services constituted the major PAC disposition, death and facility-based services were common among male COVID-19 survivors, and a COVID-19 diagnosis or year of study had no substantiative impact on mortality.

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INTRODUCTION

The SARS-CoV-2 pandemic has placed increased demands on hospital resources, requiring hospitals to redistribute staffing, shift and open physical units, and obtain additional equipment to accommodate the surge of COVID-19 patients, many of whom have been critically ill. Likewise, as the pandemic accelerated in early 2020, concerns about post-acute care surge capacity were raised, highlighting the need not only to expand availability of post-acute care resources but also the need to organize and distribute these resources in such way as to avoid COVID-19 transmission within post-acute care facilities[1-3].

As the acute hospital care for COVID-19 hospitalized patients continued to improve due to a growing knowledge base, advent of newer efficacious therapeutics and improved treatment guidelines etc., the number of COVID-19 survivors being discharged with new disabilities inevitably soared. Despite all this experience of treating COVID-19 patients in the past 2-3 years, little is known about the post-acute care needs of COVID-19 survivors at global and national levels [4].

According to the Center for Medicare/Medicaid Services, post-acute care is defined as "care that is provided to individuals who need additional help recuperating from an acute illness or serious medical procedure [5]." The paucity in knowledge and research interests for COVID-19 post-acute care pales in comparison to other relatively rare hospital conditions which surprisingly have many more studies evaluating their readmission and post-discharge care needs [6-8]. Thus, establishing the factors that are associated with hospital readmission or the post-acute hospital needs of COVID-19 survivors at national jurisdictions would help draw attention to efforts that seek to improve post-acute COVID-19 care outcomes globally.

The early COVID-19 response by the USA was hampered by fragmented and incoherent public health measures (varying mask mandates, social distancing guidelines and stay at home orders etc.) instituted by states and within states, a lack of centralized federal response plan, and in some instances local politics had more sway than proven health measures at the time [9, 10].
Healthcare policymakers, payers, and post-acute care providers must rapidly adjust for these exigencies. Having access to recent data on actual post-acute care needs for these patients is key to judicious decision-making. Currently there is limited information documenting post-acute care disposition in patients that have so far required hospitalization for COVID-19.

A systematic review assessing the frequency of long COVID-19 (post-acute COVID-19 syndrome) among 5440 COVID-19 patients in 25 observation studies noted that up to 80% (range 4.7% -80%) of COVID patients had some sort of long-COVID-19 symptoms 3-24 weeks after hospital discharge, and the most common symptoms/complaints documented were chest pain (approximately 90%), general malaise, difficulty breathing, and cough and sputum production (59%). Risk factors such as advanced age, female sex, clinical status at discharge, comorbidities, and oxygen needs at hospital admission and during hospital stay, were associated with long COVID-19 [11].

To the best of our knowledge, there is only one large study that has characterized the post-acute care needs of COVID-19 survivors in Atlanta following acute-hospital discharge [12]. However, this study had a follow up period of 1 month and did not explore the risk factors associated with mortality, hospital readmission and the type of post-acute disposition facility. Our retrospective cohort study seeks to answer these questions within the context of Atlanta, Georgia and for a follow up period of 18 months. The objective of this study is to describe the post-acute care dispositions by site and by home health resources ordered for patients admitted with COVID-19 to four acute-care hospitals within an academic healthcare system in Atlanta, Georgia.

Chapter 1

Global Burden of COVID-19 cases and related Post-Acute Care Challenges

Since January 2020, coronavirus disease (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has been the leading infectious cause of hospitalizations and deaths worldwide [13]. The weekly epidemiologic update on COVID-19 from the World Health Organization (WHO) as of March 22, 2022, estimated that 468 million cases and 6 million deaths globally were due to COVID-19 [14]. This staggering number of cases and deaths has overwhelmed national health systems and pushed some to the brink of collapse [15]. As nations worldwide scrambled to stem the deleterious effects of COVID-19 on their healthcare systems, preparedness and response efforts focused mainly on readying the acute care hospitals and facilities to meet the surge in COVID-19 related admissions [16]. However, guidance and investment in post-acute care has been underwhelming in many jurisdictions worldwide [17].

Meanwhile, the characterization of the acute presentation of COVID-19 (with the commonest symptoms being fever, shortness of breath and cough) has been well documented [15]. In addition, the evolution of symptoms, prognosis, treatment and the hospital outcomes of COVID-19 are well delineated in various literary works [11]. Few studies have documented the long-term sequalae of COVID-19 and the associated post-acute care dispositions COVID-19 survivors utilize in the short and long-terms [4, 11, 18].

An early COVID-19 registry study from the UK with over 47,000 previously hospitalized patients reported a readmission and death rate of 30% and 12.3% respectively among those previously discharged with multiorgan failure [19]. Furthermore, 2 longitudinal studies of COVID-19 hospital discharged survivors conducted in China and Russia stated that 53-76% of the individuals had persistent symptoms (mostly fatigue and respiratory symptoms) at 6-8 months of follow up that required the attention of post-acute healthcare systems [20, 21]. However, limited data on the global and national post-acute care disposition pathways of COVID-19 patients exist to enable robust planning and investment for the clinical and non-clinical management of COVID-19 survivors [1]. Our observational study aims to characterize the post-acute care dispositions among COVID-19 patients in Atlanta, Georgia, USA.

Post-acute care and COVID-19 globally.

Global patterns and estimates for the demand of post-acute care services among COVID-19 survivors have not been firmly established [1]. This critical gap at the global level is fueled in part by limited data on post-acute care discharge dispositions and long term follow up studies of COVID-19 survivors at national jurisdictions [2]. Without a better understanding of the post-acute care needs of COVID-19 survivors, health policy experts and local health authorities and ministries cannot adequately allocate logistics for these post-acute care services within their areas of influence.

Several reasons have been fronted for this lack of data on a global scale to inform health policy and care for COVID-19 survivors at regional and national levels. First, post-acute care for COVID-19 patients is variable and dependent on how the health system of the country was organized before the COVID-19 pandemic. Second, the case has been made that SARS-CoV-2, the virus that causes COVID-19 is novel, and that COVID-19 was only declared a public health emergency of international concern by the WHO just 2 years ago [22]. Third, it is plausible that national surveillance systems intended to track the trajectory of COVID-19 hospital discharged survivors were overwhelmed by the lack of staff as healthcare workers had to tend to the surge of COVID-19 patients seeking acute care and conduct contact tracing [23]. However, this should not be the case since post-acute data from disease outbreaks of closely related coronaviruses (within the same family) such as the severe acute respiratory syndrome (SARS-CoV) or Middle East respiratory syndrome coronavirus (MERS-CoV), which share relatively similar acute and post-acute hospital clinical sequalae are well documented [24, 25].

Various studies tracking the long-term effects or sequalae of COVID-19 among COVID-19 survivors in China reported that 20% of hospitalized patients developed cardiac injury (persistent tachycardia, arrhythmias, cardiac insufficiency, myocarditis and declines in ejection fractions etc.); 36% had neurological deficits and complications such as altered levels of consciousness, anosmia and agnosia, viral encephalitis, polyneuropathies and posterior reversible encephalopathy; and psychological effects to include anxiety, depression, post-traumatic stress disorder and premorbid psychiatric illness [26, 27]. These identified COVID-19 sequalae among survivors' demand attention and will require healthcare workers, local authorities, and healthcare policy makers to ensure that post-acute dispositions within their areas have the requisite capacity and skills to meet this demand. However, data on what post-acute care services that these patients require and the factors associated with what kind of care they do access remains limited at a global level.

COVID-19 in the USA.

As of April 1st, 2022, the United States had reported over 80 million cases of COVID-19 with close to 980,000 related deaths, accounting for the largest number of cases and deaths worldwide [28]. The USA has a death rate of 297.5 per 100,000, which is currently among the highest for any industrialized nation worldwide [29]. The early COVID-19 response by the USA was hampered by fragmented and incoherent public health measures (varying mask mandates, social distancing guidelines and stay at home orders etc.) instituted by states and within states, a lack of centralized federal response plan, and in some instances local politics had more sway than proven health measures at the time [9, 10].

Additionally, the COVID-19 response in the USA was derailed by chronic underfunding of local public health systems, high out-of-pocket spending ($1,125 per capita), limited health coverage i.e., close to 10% of the USA population is uninsured and about half of the USA population are dependent on their employers for health insurance and were at risk of becoming uninsured as employers countrywide scaled down operations because of the economic effects of COVID-19 [30]. To compound all this, 33% of adults in the USA were more likely to delay or forego medical care in 2016 due to the associated health costs which was also rampantly reported during the start of the COVID-19 pandemic and may have affected early health seeking behavior [30].

Since the first case of COVID-19 was reported in the USA on January 20, 2020, trends in the 7-day moving averages of cases have peaked thrice i.e., the highest so far was on January 15, 2022 (806,350 cases), then on September 1, 2021 (164,514 cases) and January 1, 2021 (approximately 230,000 cases) [31]. In comparison, the 7-day moving average of deaths has had 4 peaks with the highest in around January 2021 (3,420 deaths) and with the other 3 peaks around April 2020, September 2021 and February 2022 [32]. The 7-day moving averages of hospitalizations follows a similar pattern as that of the deaths, but only that the peak hospitalization average was witnessed in January 2022 [33]. There has been a general decline among hospitalized COVID-19 patients who required intensive care unit (ICU) admission or invasive mechanical ventilation (IMV), and those who succumbed to the disease. Data from the CDC website shows that across these 3 variables, the highest percentage of IMV or ICU need was 20-35% in March 2020 and slowly declined to less than 20% in February 2022, with a slight peak around August to September 2021 [33].

Whereas data depicting trends of COVID-19 patients in nursing homes is available at the national level in the USA, data on the COVID-19 hospital discharges is not widely available on the national health authorities' websites [34]. Additionally, systematic tracking at the national level of the post-acute care services that COVID-19 survivors utilize during recovery and rehabilitation period is not available to guide relevant health policy recommendations or resource allocations. Although several cohort studies that have tried to fill this gap have been documented, they fall short of being limited in context i.e., have shorter duration of follow up periods (less than year), only follow up survivors that are within their healthcare networks and don't take stock of the post-acute dispositions COVID-19 survivors utilize and the associated risk factors [16, 17, 35-42]. Therefore, local and federal health authorities should incentivize studies that seek to answer these questions as a means of creating a representative database to guide policy on the management of COVID-19 survivors during the post-acute hospital recovery phase.

COVID-19 cases in Atlanta, Fulton County and Georgia.

Georgia state is in the southern part of the USA, and it sits on a land area of 57.701 square miles with a total population of 10.7 million people. The median age is 36.9 years (USA median age is 38.2 years), 13.9% of its population is above 65 years and a total

13.0% of the entire population is uninsured [43]. Atlanta is the largest city in Georgia with a land area of 135.7 square miles, and it is in both Fulton (90% of Atlanta) and Dekalb (10% of Atlanta) Counties. The current population of Atlanta stands at 498,715 people, median age is 33.2 years (14% is above 65 years) and 10.6% of the population has no health insurance [44].

The first two documented cases of COVID-19 in Georgia state were from Fulton county and were reported on February 29, 2020 [45], since then, and as of April 1, 2022, the state of Georgia has reported over 1,938,336 cases and 31,097 confirmed deaths [46]. The trends of COVID-19 cases and deaths in Fulton County mirror those observed in the state of Georgia. For example, both the 7-day moving average of confirmed cases has witnessed 4 peaks since the pandemic started i.e., the highest peak of cases for the Georgia state was around January 08, 2022 (16,000 cases) and the highest 7-day moving average for cases in Fulton County was on Dec 30, 2022 (1,600 cases reported) [46]. The other 7-day moving average peaks for both Fulton County and Georgia state were in Aug 2021-Sep 2021, Dec 2019-Jan 2021 and Jul 2020-Aug 2020 [46].

The 7-day average of the number of new COVID-19 hospital inpatients (both adult and pediatric patients) in Georgia, shows 3 major peaks i.e., January 12, 2021 (805 inpatients), August 28, 2021 (796 inpatients) and January 14, 2022 (797 patients) and with a small spike in admissions around August 20, 2020 (363 inpatients). Similarly, the 7-day deaths per 100,000 of the population of Georgia, has 1 minor-and 4-major peaks that closely lag the 7-day hospital inpatient numbers [47]. The highest peak of the 7-day death rate per 100, 000 people was around January 20, 2021, at 9.18, while the other peaks in order of highest death rates were around September 2021-October 2021, January 2022-February 2022, August 2020-September 2020 and April 2020-June 2020 respectively [32]. Data from the CDC and Georgia Department of Public Health (GDPH) show that the COVID-19 cases, deaths and inpatient hospital admissions in Fulton County and Georgia state are currently showing a downward trend [32, 45-48].

As observed earlier with the national data trends of COVID-19 cases, deaths, inpatient hospital admissions and nursing homes, similar data are available at the Georgia state level. However, data tracking the COVID-19 hospital discharges and post-acute care dispositions within Atlanta city, Fulton County and Georgia state, is not readily available on the GDPH websites or in the current literature [45-47]. Moreover, few cohort studies or local health authorities if any, are tracking County level trends of the post-acute care services that COVID-19 survivors utilize during the recovery and rehabilitation period within Georgia state [12]. To the best of our knowledge, there is only one large study that has characterized the post-acute care needs of COVID-19 survivors in Atlanta following acute-hospital discharge [12]. However, this study had a follow up period of 1 month and did not explore the risk factors associated with mortality, hospital readmission and the type of post-acute disposition facility. Our retrospective cohort study seeks to answer these questions within the context of Atlanta, Georgia and for a follow up period of 18 months.

Epidemiology and current therapeutics for SARS-CoV-2

SARS-CoV-2 belongs to the family *Coronaviridae* and genera beta coronavirus that infect humans together with MERS-CoV, SARS-CoV, HCoV-HKU1 and HCoV-OC43 [24]. The SARS-CoV genome encodes for 4 proteins namely spike (S), membrane (M), envelope (E) and nucleocapsid (N). This polymorphic enveloped virus has a diameter of about 60-140 nm and consists of a spike (S) protein (S) that is 150 kDa protein [25]. The S protein and its receptor binding protein help facilitate attachment of the virion to the host cell. Additionally, the surface of this S protein utilizes 14 amino acid residues to bind to the angiotensin-converting enzyme 2 (ACE2) and then use ACE2 as one of their receptors to bind to host cell surfaces [49, 50]. It has been postulated that the furin-like cleavage site in SARS-CoV-2 that facilitates S protein priming maybe responsible for the increased efficiency and spread of the SARS-CoV-2 as compared to other similar beta-coronaviruses [51]

SARS-CoV-2 virus has over 85% similarity to the bat's (bat-SL-COVZC45) coronavirus, a possible indication that the SARS-CoV-2 virus could have originated from the bats SARS-CoV and MERS-CoV [52, 53]. The SARS-CoV virus is highly transmissible, and it can remain viable for up to 2 hours in the air. Early estimates of the observed basic reproductive number (Ro), case fatality rate and symptom profile at the start of the COVID-19 pandemic, mirrored those observed with seasonal influenza (SI) as compared to MERS and SARS, i.e., the Ro for SARS, MERS, Seasonal Influenza and COVID-19 was 2-5, 0.3-0.8, 1.3-1.8, and 1.4-3.8 respectively, while the CFR for SARS, MERS, SI and COVID-19 was 35%, 9%, 0.1% and 0.2-3.8% respectively [53].

The incubation period for COVID-19 is between 4-14 days and the mainstay route of transmission is via respiratory droplets, and airborne transmission is possible if aerosolizing procedures are being conducted [54]. Debate favoring other mechanisms of transmission to include airborne, fecal-oral route, vertical transmission, contact with open mucous membranes such as the conjunctival is still ongoing [25, 55, 56]. All age groups are vulnerable to infection, but severe disease is more pronounced in the elderly, and among those with comorbidities and immunosuppressing conditions such as diabetes, chronic kidney disease and individuals on immunosuppressants etc. Asymptomatic individuals or those still incubating, have the potential to transmit the disease [57].

The clinical spectrum of COVID-19 ranges from an asymptomatic infection to severe disease with multisystem failure requiring intensive care unit services [58]. Most COVID-19 infected individuals do not show symptoms or if they do, the symptoms are mild and may not require hospitalization. For those who present to hospital, a systematic review of 41,409 COVID-19 patients in 23 countries revealed that the 6 most common symptoms at presentation were fever (58.7%), cough (54.5%), dyspnea (30.8%), malaise (29.8%), fatigue (28.2%) and sputum secretion (25.3%) [59]. For COVID-19 patients that required hospital admission, a metanalysis of 13,893 COVID-19 patients, showed a case fatality 11.5 % (95% CI:7.7-16.9) in those not requiring ICU whereas it was 40.5% (95% CI: 31.2-50.6) among those who were admitted to the ICU [60].

As of March 2022, the definitive treatment for COVID-19 remains elusive with treatment protocols mainly focused on supportive therapy and symptomatic treatment of patients. However, the WHO made strong recommendations for use of the following medications in COVID-19 patients with severe or critical disease: corticosteroids, IL-6 receptor blockers such as tocilizumab and sarilumab and Janus kinase (JKI) inhibitors such as baricitnib [61]. And conditional recommendations for the following drugs among non-severe COVID-19 patients: molnupiravir (contraindicated among pregnant and lactating women, and children); sotrovimab among those with the highest risk of admission; and casirivimab-imdevimab (neutralizing monoclonal antibodies) among those with the highest risk of hospitalization and in settings where viral genotyping can be done to confirm a susceptible SARS-CoV-2 variant [62].

Risk factors for the need of post-acute care disposition facilities

Age and sex as risk factors: in a case series describing the outcomes of 5700 COVID-19 patients admitted to 12 hospitals within the Northwell Health system in New York state between March 1, 2020, to April 4, 2020, indicated that readmission rates to acute care facilities, proportions of patients discharged to post-acute care facilities and mortality rates were comparatively greater among individuals in higher age groups (10-year age intervals), with the risk for each outcome increasing by age group after the age of 20 years. Although the researchers noted a limitation of a short follow up time (i.e., median 4.5 days [IQR 2.4-8.1]), males were more likely than females to succumb to COVID-19 in this study population [63].

In a cross-sectional study conducted at the 60-day post-discharge point among 2217 adult COVID-19 survivors affiliated to one of the 38 Michigan hospitals on the Mi-COVID data registry, found that non-white patients accounted for more than half of hospital readmissions (n = 144, 55%) while most deaths following discharge were among white patients (n = 153, 21.5%) majority of whom were discharged via palliative care. Being black was associated with re-hospitalization, financial distress and mental health issuses, i.e., black patients were more unlikely to visit a physician during the follow-up period and had the longest delays in resuming work (average 35.5 days) [64].

Comorbidities, race and residential status as risk factors: findings from a 30-day post hospitalization retrospective cohort study of 1344 COVID-19 survivors by Kingery et al., found that older age (HR 1.01 per year [95% CI 1.00–1.02]), diabetes (HR 1.54 [1.06–2.23]), undomiciled status (5.13 [2.83-9.30] and the need for dialysis (HR 3.78 [2.23–6.43]) at the index presentation were associated with risk for rehospitalization when a multivariable Cox proportional hazard regression analysis was conducted [65]. These same researchers further stated that among these COVID-19 survivors from a quaternary hospital in New York city, older age (HR 1.09 [1.06-1.12]), Asian race (2.68

[1.17-6.14]), hypertension (3.46 [1.31-8.82]), diabetes mellitus (1.98[0.99-3.99]), chronic kidney disease (2.93[0.89-9.66] and active malignancy (3.40[1.49-8.82]) were associated with death within the 30-day period following hospital discharge [65].

Stam H.J. et al, in their call for action for more robust care to patients with COVID-19 post intensive care syndrome (PICS), identified several risk factors associated with PICS such as age and prior comorbidities (hypertension, obesity, diabetes, coronary artery disease and stroke etc.); ICU admission, sedation and mechanical ventilation duration periods; and complications to include delirium, hypoxia, sepsis and glucose dysregulation [66]. Furthermore, they stated that long term sequalae of PICS to include physical complications: neuropathies, paresis, severe fatigue, dyspnea and impaired lung function; cognitive deficits to memory, spatial, vision, psychomotor response and impulsivity; and psychological and psychiatric conditions: anxiety, depression and post-traumatic stress disorder all require careful attention and caretakers of these survivors should be informed about the expectations [67].

Additionally, approximately 30% of patients with a history of PICS were incapable of going back to work while a quarter of them required full time care takers by 1-year after ICU discharge [68]. This proportion of patients experiencing or recovering from PICS is bound to increase as the cases of COVID-19 rise, therefore, it pertinent that public health policy experts devote additional funds to improving and scaling up post-acute care services.

Furthermore, in a cross-sectional study looking at 2217 patients of COVID-19 discharged from 38 select hospitals in the Michigan Mi-COVID 19 initiaitive, Robinson-Lane et al., noted that at the 60-day post hospital discharge period, 11.8% required readmissions, 13% had died and 3.3% still required extended care facilities [64]. Similarly, a study by Chopra et al. reported rehospitalization levels of 15.1% among their COVID-19 survivors at the 60 day follow-up period [18]. Another cohort of 1344 COVID-19 patients discharged from either the emergency department (ED) or acute care of 2 hospitals in New York City during the 1st peak of the COVID-19 outbreak in the USA (study dates March 3, 2020, to May 15, 2020), found that 16.5% of them had returned to an ED, 9.8% were re-admitted, and 2.4% had died within 30 days following discharge. With the median (IQR) times (days) from discharge to return to an ED, re-hospitalization and death, being 6 days (2–16), 5.4 days (2–14) and 9 days (5–15) respectively [65]. The statistics of patients mentioned in these studies, warrant a keener look and appropriate descriptions of the post-acute hospital dispositions for COVID-19 patients, and may help espouse what patients deserve as part of their care.

Post-acute health services in the USA and Georgia

Post-acute care facilities in the USA play a significant role in the care of discharged individuals who may require either skilled or unskilled nursing attention for their full rehabilitation or long-term care or end of life of care. These post -acute care services include skilled nursing facilities (SNFs), home health agencies (HHAs), inpatient rehabilitation facilities (IRFs), home health services (HHS), hospice care (HC), intermediate care facilities (ICFs), and long-term acute care hospitals (LTACHs).

HHAs recruit the services of skilled health care professionals who then offer home-based care to patients with medical conditions or disabilities; IRFs offer medical rehabilitation services aimed at restoring functional independence among patients with infirmities sustained from injuries or medical conditions or recovering from surgery [69]; HHS are required by patients who are home bound but require the intermittent services of SNFs, physical therapy, speech-language pathology, occupational therapy and are under the care of a doctor [70]; HC is offered to individuals that are terminally ill or who choose comfort or hospice care instead of curative care or Medicare-covered treatment for their illness, and this kind of care can be administered from home, a nursing or an inpatient facility [71]; ICFs are a form of long term care facilities that provide non-continuous nursing and supportive care to those with developmental challenges on the advice of a physician; LTACHs offer a similar level of hospital care to medically complex patients who have been hospitalized for 25 days or more [72]; and SNFs offer skilled nursing care to patients who often don't require hospital level care services [1, 73].

Health care delivery in the USA lies within the jurisdiction of states and local healthcare authorities, which when were faced with the surging numbers of COVID-19 cases, instituted disparate control measures to protect their health care systems from being overwhelmed. Subsequently, this lack of uniformity in the health policies and measures to contain the surge of COVID-19 cases by states, fueled in part by local political pressure and perspectives and a neglect of established evidence-based guidelines resulted into inconsistences in the guidance offered to post-acute care health facilities. For example, some states recommended that all acute-hospital discharged patients be transferred to post-acute care facilities irrespective of their COVID-19 status, while other local health authorities barred post-acute care providers from admitting any of these patients[1]. These variabilities in public health recommendations by local authorities need to be streamlined so that discharged patients have a clear pathway to what facilities they need to access.

Rationale

Improvement in care transitions remains a national priority for the USA, but the rising costs of post-acute hospital care were already slowing progress in this area prior to this COVID-19 pandemic [74]. As the increase in the number of COVID-19 cases continued to exert immense pressure on the quality and capacity of acute and post-acute hospital care services that patients needed, limitations to include inadequate hospital beds, lack of PPE and essential medical supplies, financial constraints, knowledge gaps and an overwhelmed health workforce etc., led to triage systems in these care facilities to rationing care (to include access to ICUs, oxygen therapy, dialysis, ECMO etc.). Patients or survivors who were deemed more likely to benefit the most from the available scarce health care services were prioritized [74].

Moreover, in the early phases of the COVID-19 pandemic in the USA, 1 out of every 4 COVID-19 documented deaths in the country was from residents of nursing homes (NHs), yet residents account for only 0.5% of the total USA population [3]. The funding mechanisms of NHs are heavily reliant on an increased admission rates of Medicare eligible short term post-acute hospital patients, which helps offset the lower than market cost reimbursements from Medicaid's long-term residents [3]. The COVID-19 pandemic has not only deprived NHs of these Medicare clients (due to the reduced number of referrals and fewer elective procedures being conducted at hospitals), but it has also exposed the logistical and structural deficits that plague most nursing homes in the USA.

Furthermore, patients who end up going to post-acute facilities may receive inadequate social care from the staff or even their loved ones, as COVID-19 restrictions may necessitate individuals to socially distance, limit visitors to 1-2 per week, reduce contact time with the survivors and mask mandates [3]. To further compound this dire situation, the baseline high acute care hospital costs incurred by COVID-19 survivors in addition to the control measures instituted to limit the spread of COVID-19, economically disempowered large sections of patients and their care takers as they transitioned to post-acute hospital care.

The current solid evidence points to the fact that a significant proportion of COVID-19 survivors develop long-COVID-19 symptoms that require some form of post-acute hospital care for their short- or long-term rehabilitation. This juxtaposed with the limited data on the post-acute care dispositions of COVID-19 survivors at the global, national and state levels, warrants the initiation of long follow up studies to understand the needs of COVID-19 survivors once they leave the hospital. Examining the risk factors associated with the various care pathways COVID-19 survivors choose to pursue after their discharge from acute hospital settings would not only guide resource allocation to various post-acute care facilities but also inform clinical and public health recommendations for the care COVID-19 survivors in the short and long term. Therefore, we conducted a retrospective cohort study with the primary objective of characterizing the type of health facilities or services utilized by COVID-19 survivors discharged from four acute care hospitals under Emory HealthCare in Atlanta, Georgia. Secondly, we compared the mortality and the associated sociodemographic factors of COVID-19 survivors during the 2020-2021 follow up period versus patients discharged from acute care hospitals during the financial years of 2018 and 2019. Descriptive statistics (to include frequencies, percentages, means and medians) of the sociodemographic factors, post-acute care facilities utilized, and mortality are reported. Polytomous logistic regression models of the correlates of post-acute disposition as either a 7-level outcome (expired, home health services, home self-care, short term hospital, long term care hospital, skilled nursing facility, and others) or as a 3-level outcome (outpatient services, facility-based services and expired) are presented. Finally, a logistic regression model was used to identify factors associated with death among COVID-19 survivors during the follow up period.

Chapter 2: Methods

Study sites.

This study was conducted at 4 hospitals under the umbrella of the Emory Healthcare (EHC) network, Emory University. EHC consists of 11 hospitals, 1 clinic, 250 provider sites, and it is the largest academic health system in Atlanta, serving over half a million people in Georgia [75]. It boasts of over 2800 physicians in 70 subspecialities; and is the largest clinically integrated network in the state of Georgia, USA [75]. The 4 hospitals involved in this study include Emory University Hospital (EUH), Emory Saint Joseph's Hospital (ESJH), Emory Johns Creek Hospital (EJCH) and Emory University Hospital Midtown (EUHM).

EUH is a quaternary adult care facility with over 751 licensed-and 120 intensive care unit (ICU)-beds [75]. The ESJH, is in the northern metro Atlanta area, and it specializes in robotic surgery for valve repair and cardiac rehabilitation among other services. [75]. The EJCH, is a comprehensive facility with emergency medicine, a women center, and adult and neonatal ICUs [75]. Finally, EUHM, is a tertiary teaching and care facility with over 529 licensed-and 86 ICU beds[75].

Study design

We conducted an 18-month retrospective observational study for participants who were discharged from any one of the 4 hospitals mentioned above. Patients who were admitted and received care from any one of the hospital units such as from emergency rooms, intensive care units and in-patient wards etc. The cohort study was granted approval from Emory University review board and given that the data required for this study were de-identified clinical information used for routine patient care, the study was classified as posing minimal risk to patients and thus the need for informed consent was waived. The study period run from April 22, 2020, to October 25, 2021, with the goal of characterizing the post-acute care dispositions and associated factors that favored their utilization among COVID-19 patients discharged from the 4 study acute care hospitals within in Atlanta, Georgia.

Study population

We included patients who were discharged from an acute care hospital and whose main reason for hospital admission was COVID-19 illness during the period February 26th, 2020, and May 05th, 2020. A similar cohort of patients who required acute care hospital admission for other reasons other than COVID-19 and discharged from the 4 study hospitals during the study period were included to help compare post-acute care disposition pathways to those had survived COVID-19. Additionally, patients who were discharged from the 4 study hospitals during the financial years of 2018 and 2019 were included to this study to guide comparisons of post-acute care dispositions between the pre-pandemic period to that of the pandemic period.

Inclusion criteria

We included all patients with a laboratory confirmed COVID-19 infection, and who required acute-care hospital admission for their COVID-19 illness at one of the 4 study sites. Additionally, patients must have been at least 14 years of age and had been admitted for a minimum of 24 hours within any of the 4 acute-care hospital settings. Furthermore, we included only patients who survived their COVID-19 illness or were in their recuperation phase or had met the discharge or referral criteria from any one of 4 study sites at the time of their acute-care hospital discharge. Only primary COVID-19 post-acute hospital admissions were considered as eligible.

Exclusion criteria

We excluded patients who met the following criteria: (1) pregnant mothers; and (2) those residing outside of Georgia and whose follow up was deemed impractical (i.e., had missing data on identifiers such as age, race, gender, admission and discharge dates and post-acute care disposition etc.).

Data collection and management

Trained, and experienced hospital staff extracted clinical data from patient charts, electronic medical records and platforms hosted by the 4-study acute-care hospitals at three different time points. The first time point was on April 22, 2020 (for participants admitted on March 04, 2020, and discharged in April 2021), the second data extraction took place on May 07, 2022 (for participants admitted on February 22, 2020, through May 04, 2020), and the final one was on October 25, 2021 (for participants admitted on March 03, 2020 and discharged on October 21, 2021). Patient data were de-identified up to the level required for data analysis and thereafter stored in an encrypted format with access limited to only approved study personnel. The de-identified data used for the analysis are available in Appendix A. Extracted data included the following: hospital admission, discharge and coding dates; type of hospital unit and acute care hospital participant was admitted to; health insurance status; gender, age at admission and race; hospital unit from which patient was discharged from; post-acute care facility that patient was admitted to; length of stay in the hospital; principal diagnosis together with the primary ICD-10 code; Medicare Severity Diagnosis Related Groups (MS DRG) [76]; total census days; and discharge fiscal year.

Data cleaning and coding process.

Data cleaning and the coding process involved grouping health insurance status under 3 categories i.e., government (*Champus, Managed Care, Medicaid, Medicare, Govermental, Medicare/Medicaid etc.*), commercial (*Blue Cross, Commercial and all associated variations*), self-pay and others [77]. Race of the participants was according to pre-fixed categories and in alignment with USA census standardized race categories [42]. According to the utilization frequencies of the post-acute care (PAC) disposition facilities observed in our study, we grouped PAC under the 7 most common categories i.e., expired, home health services, home self-care, short term hospital, long term care hospital, skilled nursing facility, and others (*hospice-med facility, left against medical advice, intermediate care facilities, other rehab facilities, to law enforcement and to a psychiatric hospital*). Following a similar study [6], post-acute care dispositions was grouped as out-patient services (*i.e., home health services; home self-care; hospice-home; left against medical advice (ama); and to court/law enforce etc*.) or facility based services (*intermediate care facilities; long and short term care hospitals; skilled nursing facilities, hospice-medical facilities; other rehabilitation facilities; to psychiatric hospital; still admitted; and discharged or transferred to another facility*). The acute-care hospital unit where the participant was discharged from was grouped as either ICU or non-ICU. A detailed description of how the variables were coded is provided for in Appendix B

Outcomes

Our primary outcome of interest was to determine what health services or facilities COVID-19 survivors utilized during the 18-month follow up period following their acute hospital discharge. The secondary outcome of the study was mortality at the 18-month study follow up period. Additionally, comparisons between the odds of mortality and post-acute care discharge dispositions during the COVID-19 pandemic (i.e., 2020, 2021) and the pre-COVID-19 pandemic years (i.e., 2018, 2019) were assessed.

Study Research Questions

Our research team set out to answer the questions listed below.

Questions assessing the primary outcome (post-acute care disposition) of the study:

1. a. Did the post-acute care (PAC) disposition differ by the patient's principal diagnosis at the time of acute-care hospital discharge during the early phase of the pandemic? We used a 7-level category to describe the post-acute care disposition outcomes.
   b. Did the PAC disposition differ by the patient's principal diagnosis at the time of acute-care hospital discharge during the early phase of the pandemic? We used a 3-level categorization to describe the post-acute care disposition outcome.

   Rationale for questions 1a and 1b*: to assess whether the post-acute care hospital dispositions of patients in Atlanta, GA, differed by their COVID-19 status during the early phase of the COVID-19 pandemic (May 07, 2020). And to test whether there any differences between the 7-and 3-level categorizations of the outcome.*

2. Does the PAC disposition at the 18-month study follow up time differ by gender among COVID-19 survivors? We used a 3-level categorization to describe the PAC disposition outcome.

***Rationale for questions** 2: to assess whether COVID-19 survivor's gender at the time of acute hospital discharge was associated with a particular post-acute care disposition outcome at the 18 month follow up period.*

3. a. Do the odds of PAC disposition among COVID-19 discharged patients during the 18-month follow up period of 2020-2021 differ from the odds of PAC disposition among discharged patients in the financial years of 2018-2019? We used a 7-level categorization to describe the PAC disposition outcome.

   b. Do the odds of PAC disposition among COVID-19 discharged patients during the 18-month follow up period of 2020-2021 differ from the odds of PAC disposition among discharged patients in the financial years of 2018-2019? Using a 3-level categorization for the PAC disposition outcome.

   ***Rationale for questions 3a and 3b**: to assess whether the PAC dispositions of patients in Atlanta, GA, differed by their COVID-19 status during the pre-pandemic years (2018, 2019) vs. the pandemic years (2020, 2021).*

Questions assessing the secondary outcome (odds of death) of the study:

4. Do the odds of death among COVID-19 survivors discharged from acute-care hospitals differ by gender at the end of the 18-month study follow up period?
   ***Rationale for questions 4**: to assess whether COVID-19 survivor's gender at the time of acute hospital discharge was associated with the odds of death at the 18 month follow up period.*

5. Do the odds of death among COVID-19 survivors discharged from acute-hospital during the 18-month follow up period of 2020-2021 differ from the odds of death among acute-care hospital discharged patients in the financial years of 2018 and 2019?

   Rationale for question 5: to assess whether the odds of death among acute-care hospital discharged COVID-19 survivors in Atlanta, GA during the pandemic years (2020, 2021), differed from the odds of death among acute-care hospital discharged patients during the pre-pandemic years (2018, 2019).

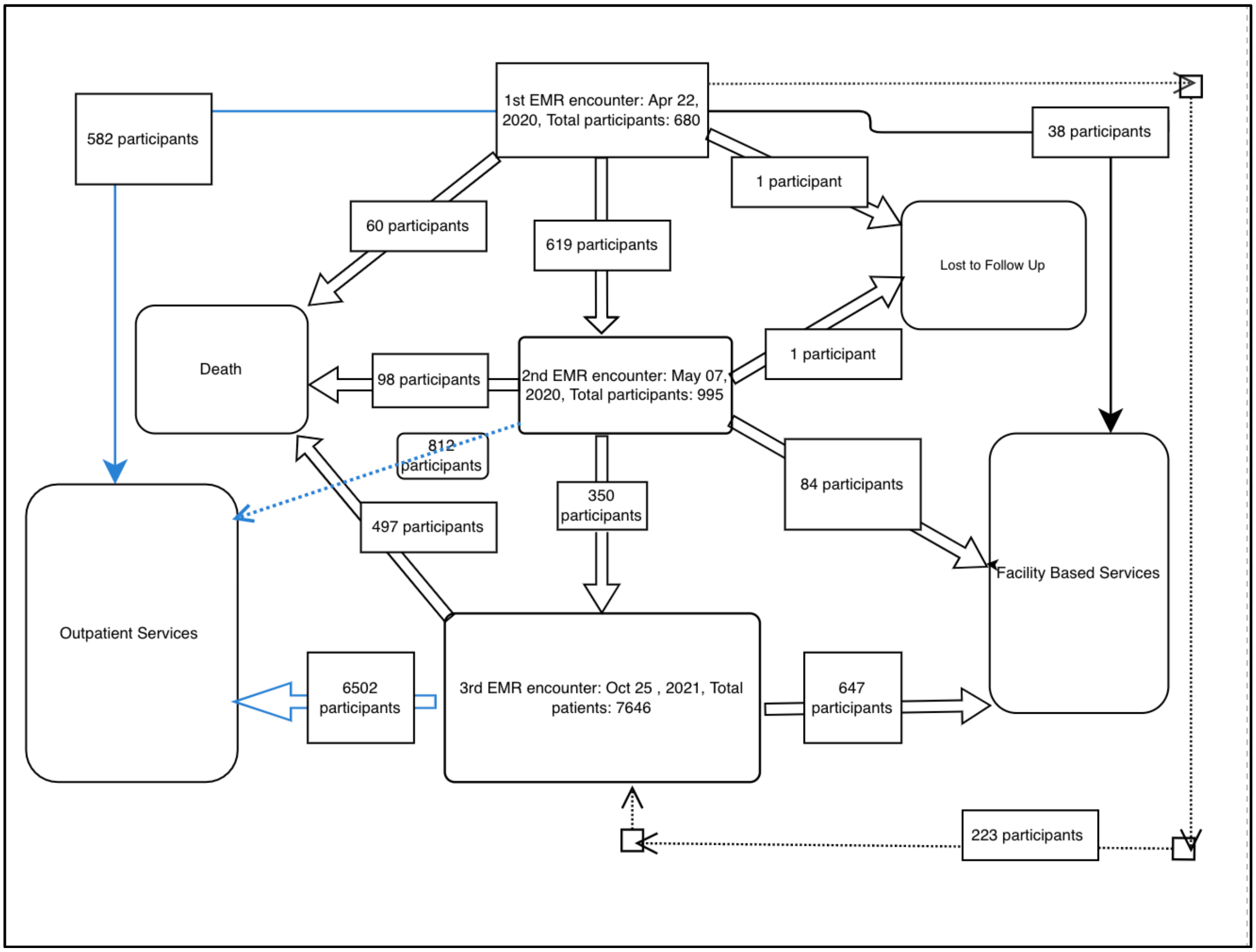
Statistical Analysis

Descriptive statistics were used to describe the sociodemographic characteristics (age, race, gender, health insurance status) and the clinical variables (length of hospital stay, comorbidities, principal diagnosis, acute-care hospital and the corresponding unit that a participant was discharged from, and post-acute disposition status) of the participants at each of the 3 time points during the follow up period and for comparable acute-care hospital discharge patients in the financial years of 2018 and 2019 cohorts. Means (standard deviations) and medians (range) were computed for continuous variables, and frequencies and percentages were calculated for categorical variables. Pearson Chi-

Squared tests and independent t- tests were used to compare for any differences between categorical and continuous variables respectively and where applicable. The odds of the post-acute dispositions were evaluated using polytomous logistic regression models after treating the various levels of the post-acute care outcome as nominal variables. The first set of the polytomous logistic regression (PLR) models assessed post-acute care disposition as a 7-level outcome with home health services as the referent group at both the 2nd (1-month) and 3rd electronic medical record (EMR) encounters (18-month). The 7-levels of the post-acute care disposition in these sets of models were as follows (i) expired, (ii) home health services, (iii) home self-care, (iv) short term hospital, (iv) long term care hospital, (vi) skilled nursing facility, and (vii) others. The second set of polytomous regression models assessed the post-acute care dispositions as a 3-level outcome to include out-patient services, facility-based services and death during the 18 month follow up period. From the literature review above, we considered the following variables age, gender, race, acute care hospital unit that participant was discharged from, health insurance status, diagnosis and comorbid conditions as possible covariates, to examine their impact on post-acute-care disposition and odds of mortality. A logistic regression model was used to assess the secondary outcome of mortality at the end of the 18-month study follow up. Alternatively, the odds of mortality for acute-care hospital discharged COVID-19 survivors were compared with the odds of mortality among patients were discharged from similar acute care hospitals for the financial years of 2018 and 2019. The effect of a COVID-19 survivor's gender on the PAC disposition (as 3-level outcome) was assessed for using both adjusted and crude polytomous logistic regression models. Comparisons of PAC disposition between the COVID-19 survivors during the 2020-2021 follow up period (at the 18-month study point) and PAC dispositions of patients discharged during the financial years 2018 and 2019 were made using a polytomous logistic regression (PLR) model. Crude and adjusted odds and odds like ratios were computed and were applicable the models were adjusted for age, race, gender, health insurance status, hospital discharging unit, principal diagnosis and comorbid conditions. The models used for this analysis are available in Appendix C. All statistical analyses were conducted using version 4.1.1 of the R programming language (R Project for Statistical Computing: R Foundation). Statistical significance was defined as P (α), 2-sided and was set at 0.05.

Results

Figure 1: Diagram showing the post-acute disposition of patients at 3 different encounters.



Our study cohort reviewed electronic medical records (EMR) for the post-acute care (PAC) disposition of discharged patients at the 3 distinct time points. There were 680, 994 and 7646 patient observations at the first, second and third EMR encounters respectively (see figure 1). 619 patient observations were found in both 1st and 2nd encounters, 350 were in both the 2nd and 3rd EMR encounters, and 223 participants were found in the 1st and 3rd EMR encounters. Two participants were lost to follow up, one from each of the first two encounters. Outpatient services when using a 3-level outcome, were the most common PAC disposition outcome across the 3 EMR encounters. Home self-care was the predominant post-acute care disposition in all the 3 EMR encounters when a 7-level outcome was used. Further details of the post-acute care dispositions at each EMR encounter are presented in Table 1.

The overall mean age (standard deviation) of the participants was 58.5 (1.8) years, as compared to 54.5 (17.1), 56.1 (17.7) and 59.2 (16.6) for the 1st, 2nd, and 3rd EMR encounters respectively. Less than 1% of the participants in all the three EMR encounters were 17 years or younger, with the rest of the categories (i.e., 18-49, 50-64 and above 65 years) being roughly of similar sizes. About half of the participants were female in all the 3 encounters (overall, 50.8% of total number of participants were female). Majority of the participants across the 3 encounters were African American (and 54.1% overall) while 30.8% of the participants were White, and 10.8% were of an unknown race (Table 1).

90% of all the participants were from 3 acute care hospitals (i.e., 31.9% from Emory University Hospital Midtown [EUHM], 29.9% from Emory Saint Joseph's Hospital [ESJH] and 27.0% from Emory University Hospital [EUH])—See Table 1. Post-acute care disposition to Home Self Care (HSC) was the most common (averaging 70.0%) across all the 3 encounters, and in a distant second place was Home Health Services (HHS) [12.7%]. The overall mortality rate was 7%, and it was less than 10% in all the 3 encounters, with the highest being 9.9% in the second EMR encounter (6.5% and 8.8% in the 3rd and 1st EMR encounters respectively). Majority of the patients were not discharged via intensive care units (93.2%) and less than 60% of all participants had a length of hospital stay less than 7 days. Approximately 85% of the acute-care hospital discharged participants had out-patients services as their post-acute care disposition outcome as compared to only 8.3% who required facility-based services.

Furthermore, the majority (78.1%) of patients utilized government affiliated health insurance schemes, with that proportion increasing by each subsequent EMR encounter, while the proportion of those under self-pay gradually declined (from 14.1% in the 2nd encounter to 3.1% in the 3rd encounter). The proportion of participants under commercially affiliated health insurance systems remained relatively similar throughout the study period (see Table 1 for details).

When the 1st encounter was categorized by the post-acute care disposition (i.e., death, outpatient services and facility-based services)—see Table 1 in the Appendix D, the mean age of those who died was 71.1 (14.5), 64.9 (17.1) years for those who required facility-based services and 52.1 (16.1) for those who required outpatient services. A similar trend was observed with age-categories, with the majority (73%) of those who died being more than 65 years. Generally, the older a COVID-19 survivor was, the more likely they would die or need facility-based services.

As compared to other categories within their groups, male COVID-19 survivors, African Americans, patients discharged from Emory University Hospital Midtown (EUHM), patients admitted to the ICU, and COVID-19 survivors who had comorbidities or had a lengthy stay at the acute hospital, were more likely to either die or require facility-based services. A similar trend was observed in the second and 3rd EMR encounters (see Tables 2A-2C and Table 3 in the Appendix D, and Table 2 below). Additionally, in the second EMR encounter, the outcomes of death, facility-based and out-patient services were highest among those who had government affiliated health insurance (80.6%, 85.4%, and 70.3% respectively) among COVID-19 survivors. A similar observation was obtained in the 3rd EMR encounter (see Table 2 below and Table 3 in Appendix D).

Comparisons of the PAC disposition, volume of discharged patients by acute care hospital, and health insurance utilization among COVID-19 discharged patients in 2020-21 and non-COVID-19 patients in the financial years 2018-2019 are represented in figures 2 and 3, and Table 5 in the Appendix D. All acute-care hospitals witnessed an increase in the volume of patients discharged from their facilities in terms of absolute numbers (see Table 5 in Appendix D). However, in terms of proportions of patients discharged Emory Johns Creek Hospital (EJCH) and Emory University Hospital (EUH) saw a decline, while Emory Saint Joseph's Hospital (EJSH) and Emory Hospital Midtown (EUHM) experienced an increase the percentage of patients discharged over the 3–4-year period (2018-2021)–see Table 5 in the Appendix D.

Among the PAC dispositions (using a 7-level outcome), Figure 2, Home Self Care had 3.3 times increase in the number of patients accessing their services in 2020-2021 as compared to 2018 (5276 vs 1586) and had a 69.0% share of total PAC dispositions for the financial years 2020-21. All the other PAC disposition (death inclusive) outcomes' relative percentages declined from 2018 to 2019 (Table 5 in Appendix D, and Table 3 below). However, the absolute number of discharged patients who had death or home health services as their PAC disposition outcome increased over the years (2018 through to 2021).

In Figure 3, both outpatient services and death as PAC disposition outcomes increased in number although percentage wise, most patients in 2020-21 had outpatient services as their PAC disposition outcome (85.0%). However, the number of discharged patients ending up at facility-based services dropped significantly (by more than 2.5 times) over the years (i.e., 1622 [32.2%] and 1853 [33.8%] in 2018 and 2019 respectively to 647 [8.5%] in 2020-21)–see Table 5 in Appendix D and Table 3 below.

85.6% of the post-acute discharged patients utilized government affiliated health insurance systems as compared to 11.3% who utilized commercial health insurance systems and 3.1% who were able to meet their own health insurance costs during the financial years 2020-21. Apart from government affiliated health insurance systems, all the other insurance systems experienced a decline in usage from 2018- to 2021 (i.e., commercial health insurance status declined from (1622) 63.8% in 2018 to (647) 11.3% in 2020-21). A similar decline was observed among individuals who were under self-pay [i.e., 335 (6.7%) in the FY 2018 to 237 (3.1%) in the FY 2020-21]—see Tables 4A-4B and Table 5 in Appendix D.

The Pearson's Chi-squared test for the differences in the volume of acute care hospital discharged patients between 2018-2019 and 2020-2021 was statistically significant (p value < 0.01). Similarly, meaningful observations were obtained for the differences in PAC disposition (as 7-level outcome and as a 3-level outcome) and health insurance status between patients discharged in 2018-19 versus COVID-19 patients discharged in 2020-2021 (see Table 3 below).

Finally, when the data for the 3 EMR visits were categorized by gender (see Table 6 in Appendix D), the mean and median ages between female and male participants was quite similar across the 3 EMR encounters [overall mean(sd), 58.6 (17.5) years among females; and 58.9 years (16.0) among males]. All the 2 study participants who were between 0-17 years of age were female. Overall, more males than females died during the PAC disposition follow up period (males:358 [7.8%] vs females: 297 [6.3%]), and proportionally, more males than females required facility-based services during their PAC disposition (males: 406 [8.9%] vs females:363 [7.7%]).

Table 1: Showing the demographics of participants at each of the 3 encounters

	1st encounter (N=680)	**2nd encounter (N=994)**	**3rd encounter (N=7646)**	**Overall (N=9320)**
Age				
Mean (SD)	54.5 (17.1)	56.1 (17.7)	59.2 (16.6)	58.5 (16.8)
Median [Min, Max]	55.0 [14.0, 99.0]	57.0 [14.0, 101]	59.0 [18.0, 104]	59.0 [14.0, 104]
Age categories				
0-17	1 (0.1%)	1 (0.1%)	0 (0%)	2 (0.0%)
18-49	264 (38.8%)	360 (36.2%)	2142 (28.0%)	2766 (29.7%)
50-64	210 (30.9%)	301 (30.3%)	2610 (34.1%)	3121 (33.5%)
65+	205 (30.1%)	332 (33.4%)	2894 (37.8%)	3431 (36.8%)
Gender				
Female	355 (52.2%)	499 (50.2%)	3882 (50.8%)	4736 (50.8%)
Male	325 (47.8%)	495 (49.8%)	3764 (49.2%)	4584 (49.2%)
Race				
African American or Black	452 (66.5%)	641 (64.5%)	3953 (51.7%)	5046 (54.1%)
American Indian or Alaskan Native	1 (0.1%)	2 (0.2%)	17 (0.2%)	20 (0.2%)
Asian	22 (3.2%)	34 (3.4%)	270 (3.5%)	326 (3.5%)
Caucasian or White	146 (21.5%)	222 (22.3%)	2501 (32.7%)	2869 (30.8%)
Multiple	1 (0.1%)	3 (0.3%)	29 (0.4%)	33 (0.4%)
Unknown, Unavailable or Unreported	58 (8.5%)	91 (9.2%)	859 (11.2%)	1008 (10.8%)
Native Hawaiian or Other Pacific Islander	0 (0%)	1 (0.1%)	17 (0.2%)	18 (0.2%)

	1st encounter (N=680)	2nd encounter (N=994)	3rd encounter (N=7646)	Overall (N=9320)
Acute-care hospital participant was discharged from				
EJCH	52 (7.6%)	64 (6.4%)	932 (12.2%)	1048 (11.2%)
ESJH	140 (20.6%)	207 (20.8%)	2437 (31.9%)	2784 (29.9%)
EUH	240 (35.3%)	369 (37.1%)	1906 (24.9%)	2515 (27.0%)
EUHM	248 (36.5%)	354 (35.6%)	2371 (31.0%)	2973 (31.9%)
Post-acute care disposition facility				
EXPIRED	60 (8.8%)	98 (9.9%)	497 (6.5%)	655 (7.0%)
HOME HEALTH SERVICE	48 (7.1%)	83 (8.4%)	1049 (13.7%)	1180 (12.7%)
HOME SELF CARE	527 (77.5%)	719 (72.3%)	5276 (69.0%)	6522 (70.0%)
HOSPICE-HOME	4 (0.6%)	7 (0.7%)	101 (1.3%)	112 (1.2%)
INTERMED CARE FACILITY	1 (0.1%)	1 (0.1%)	5 (0.1%)	7 (0.1%)
LEFT Against Medical Advice	3 (0.4%)	3 (0.3%)	74 (1.0%)	80 (0.9%)
LONG TERM CARE HOSP	1 (0.1%)	3 (0.3%)	89 (1.2%)	93 (1.0%)
SHORT TERM HOSPITAL	23 (3.4%)	29 (2.9%)	68 (0.9%)	120 (1.3%)
SKILLED NURSING FAC	13 (1.9%)	45 (4.5%)	343 (4.5%)	401 (4.3%)
HOSPICE-MED FACILITY	0 (0%)	1 (0.1%)	58 (0.8%)	59 (0.6%)
OTHER REHAB FACILITY	0 (0%)	5 (0.5%)	61 (0.8%)	66 (0.7%)
D/XFR CANCR OR CHILD	0 (0%)	0 (0%)	18 (0.2%)	18 (0.2%)
DISCH/XFR TO OTHER	0 (0%)	0 (0%)	1 (0.0%)	1 (0.0%)
STILL A PATIENT	0 (0%)	0 (0%)	1 (0.0%)	1 (0.0%)
TO COURT/LAW ENFORCE	0 (0%)	0 (0%)	1 (0.0%)	1 (0.0%)
TO PSYCHIATRY HOSPITAL	0 (0%)	0 (0%)	3 (0.0%)	3 (0.0%)
Post-acute care disposition by type of services				
EXPIRED	60 (8.8%)	98 (9.9%)	497 (6.5%)	655 (7.0%)
Facility Based Services	38 (5.6%)	84 (8.5%)	647 (8.5%)	769 (8.3%)
Out-patient Services	582 (85.6%)	812 (81.7%)	6502 (85.0%)	7896 (84.7%)
Acute-care hospital Unit participant was discharged from				
ICU	58 (8.5%)	85 (8.6%)	491 (6.4%)	634 (6.8%)
non-ICU	622 (91.5%)	909 (91.4%)	7155 (93.6%)	8686 (93.2%)
Health Insurance				
Not reported	680 (100%)	0 (0%)	0 (0%)	680 (7.3%)
Commercial	0 (0%)	121 (12.2%)	866 (11.3%)	987 (10.6%)
Government	0 (0%)	733 (73.7%)	6543 (85.6%)	7276 (78.1%)

	1st encounter (N=680)	2nd encounter (N=994)	3rd encounter (N=7646)	Overall (N=9320)
Self-Pay	0 (0%)	140 (14.1%)	237 (3.1%)	377 (4.0%)
Length of stay				
Mean (SD)	4.72 (4.91)	5.72 (6.95)	7.66 (9.06)	7.23 (8.67)
Median [Min, Max]	3.00 [1.00, 29.0]	3.00 [1.00, 55.0]	5.00 [1.00, 126]	4.00 [1.00, 126]
Length of stay categories				
0-1	246 (36.2%)	374 (37.6%)	591 (7.7%)	1211 (13.0%)
2-7	295 (43.4%)	374 (37.6%)	4818 (63.0%)	5487 (58.9%)
8-14	98 (14.4%)	149 (15.0%)	1293 (16.9%)	1540 (16.5%)
15+	41 (6.0%)	97 (9.8%)	944 (12.3%)	1082 (11.6%)

Table 2: Characteristics of patients on the 3rd encounter (18-month point) by the post-acute care disposition

	EXPIRED (N=497)	Facility Based Services (N=647)	Out-Patient Services (N=6502)	Overall (N=7646)
age				
Mean (SD)	71.3 (14.7)	70.1 (14.6)	57.2 (16.2)	59.2 (16.6)
Median [Min, Max]	72.0 [26.0, 104]	72.0 [19.0, 103]	57.0 [18.0, 104]	59.0 [18.0, 104]
Age Categories				
0-17	0 (0%)	0 (0%)	0 (0%)	0 (0%)
18-49	44 (8.9%)	56 (8.7%)	2042 (31.4%)	2142 (28.0%)
50-64	107 (21.5%)	144 (22.3%)	2359 (36.3%)	2610 (34.1%)
65+	346 (69.6%)	447 (69.1%)	2101 (32.3%)	2894 (37.8%)
Gender				
Female	224 (45.1%)	320 (49.5%)	3338 (51.3%)	3882 (50.8%)
Male	273 (54.9%)	327 (50.5%)	3164 (48.7%)	3764 (49.2%)
Race				
African American or Black	243 (48.9%)	371 (57.3%)	3339 (51.4%)	3953 (51.7%)
Asian	17 (3.4%)	21 (3.2%)	232 (3.6%)	270 (3.5%)
Caucasian or White	194 (39.0%)	217 (33.5%)	2090 (32.1%)	2501 (32.7%)
Multiple	2 (0.4%)	1 (0.2%)	26 (0.4%)	29 (0.4%)
Native Hawaiian or Other Pacific Islander	2 (0.4%)	0 (0%)	15 (0.2%)	17 (0.2%)
Unknown, Unavailable or Unreported	39 (7.8%)	37 (5.7%)	783 (12.0%)	859 (11.2%)
American Indian or Alaskan Native	0 (0%)	0 (0%)	17 (0.3%)	17 (0.2%)
Post-Acute Care Disposition				
EXPIRED	497 (100%)	0 (0%)	0 (0%)	
D/XFR CANCR OR CHILD	0 (0%)	18 (2.8%)	0 (0%)	18 (0.2%)
DISCH/XFR TO OTHER	0 (0%)	1 (0.2%)	0 (0%)	1 (0.0%)

	EXPIRED (N=497)	Facility Based Services (N=647)	Out-Patient Services (N=6502)	Overall (N=7646)
HOSPICE-MED FACILITY	0 (0%)	58 (9.0%)	0 (0%)	58 (0.8%)
INTERMED CARE FAC	0 (0%)	5 (0.8%)	0 (0%)	5 (0.1%)
LONG TERM CARE HOSP	0 (0%)	89 (13.8%)	0 (0%)	89 (1.2%)
OTHER REHAB FACILITY	0 (0%)	61 (9.4%)	0 (0%)	61 (0.8%)
SHORT TERM HOSPITAL	0 (0%)	68 (10.5%)	0 (0%)	68 (0.9%)
SKILLED NURSING FAC	0 (0%)	343 (53.0%)	0 (0%)	343 (4.5%)
STILL A PATIENT	0 (0%)	1 (0.2%)	0 (0%)	1 (0.0%)
TO PSYCH HOSP	0 (0%)	3 (0.5%)	0 (0%)	3 (0.0%)
DISASTER ALT SITE	0 (0%)	0 (0%)	1 (0.0%)	1 (0.0%)
HOME HEALTH SERVICE	0 (0%)	0 (0%)	1049 (16.1%)	1049 (13.7%)
HOME SELF CARE	0 (0%)	0 (0%)	5276 (81.1%)	5276 (69.0%)
HOSPICE-HOME	0 (0%)	0 (0%)	101 (1.6%)	101 (1.3%)
LEFT AMA	0 (0%)	0 (0%)	74 (1.1%)	74 (1.0%)
TO COURT/LAW ENFORCE	0 (0%)	0 (0%)	1 (0.0%)	1 (0.0%)
Acute Care Hospital				
EUHM	170 (34.2%)	239 (36.9%)	1962 (30.2%)	2371 (31.0%)
EJCH	46 (9.3%)	45 (7.0%)	841 (12.9%)	932 (12.2%)
ESJH	121 (24.3%)	135 (20.9%)	2181 (33.5%)	2437 (31.9%)
EUH	160 (32.2%)	228 (35.2%)	1518 (23.3%)	1906 (24.9%)
Discharging Unit in the Acute Care Hospital				
ICU	359 (72.2%)	114 (17.6%)	18 (0.3%)	491 (6.4%)
non-ICU	138 (27.8%)	533 (82.4%)	6484 (99.7%)	7155 (93.6%)
Health Insurance Status				
Commercial	94 (18.9%)	88 (13.6%)	684 (10.5%)	866 (11.3%)
Government	392 (78.9%)	557 (86.1%)	5594 (86.0%)	6543 (85.6%)
Self-Pay	11 (2.2%)	2 (0.3%)	224 (3.4%)	237 (3.1%)
Length of Stay				

	EXPIRED (N=497)	Facility Based Services (N=647)	Out-Patient Services (N=6502)	Overall (N=7646)
Mean (SD)	16.5 (13.2)	19.0 (17.0)	5.85 (5.69)	7.66 (9.06)
Median [Min, Max]	13.0 [1.00, 108]	14.0 [1.00, 126]	4.00 [1.00, 74.0]	5.00 [1.00, 126]
Length of Stay Categories				
0-1	12 (2.4%)	30 (4.6%)	549 (8.4%)	591 (7.7%)
2-7	126 (25.4%)	157 (24.3%)	4535 (69.7%)	4818 (63.0%)
8-14	128 (25.8%)	147 (22.7%)	1018 (15.7%)	1293 (16.9%)
15+	231 (46.5%)	313 (48.4%)	400 (6.2%)	944 (12.3%)

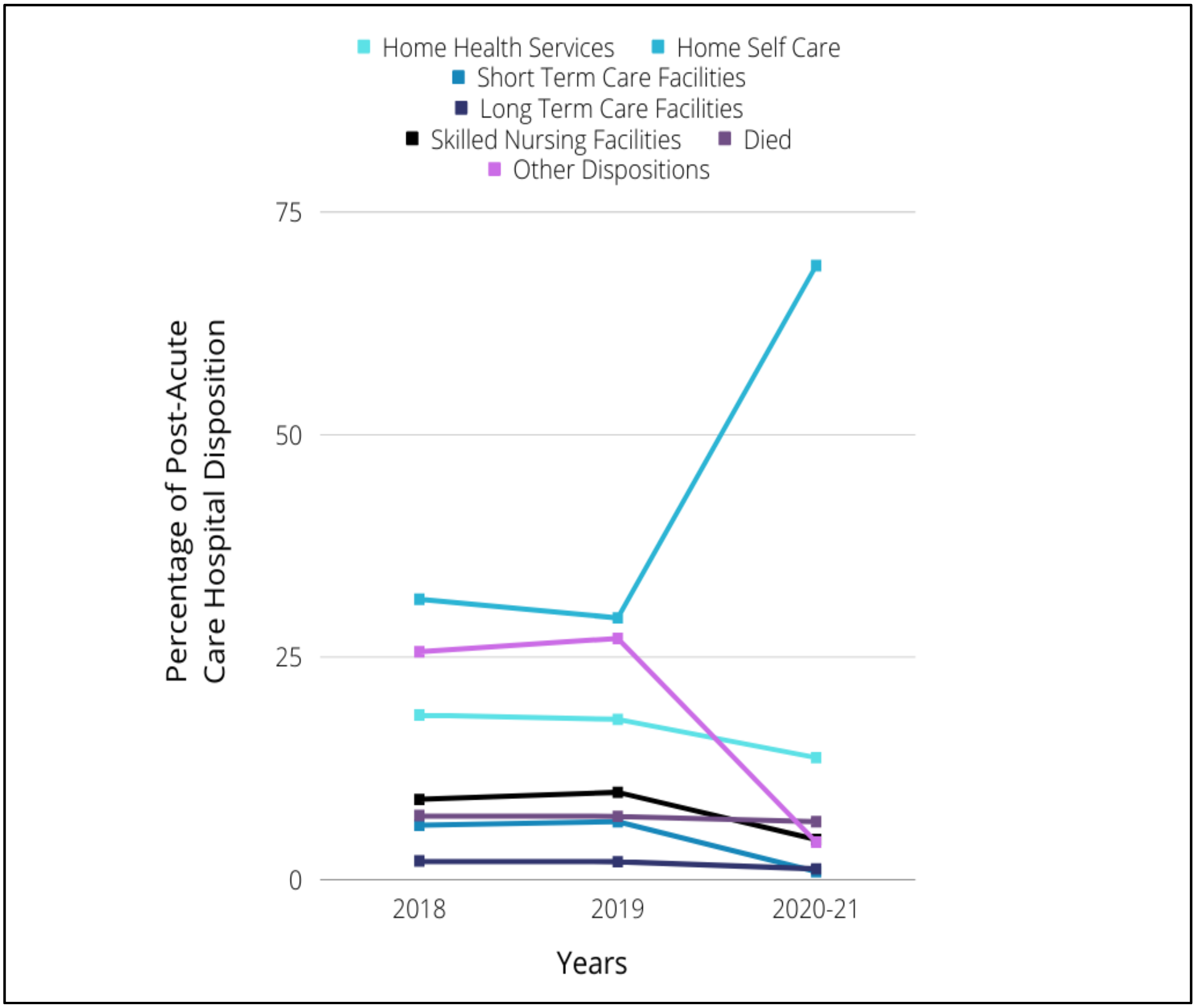


Figure 2: Post-Acute Care Disposition by study years 2018, 2019 and 2020-21

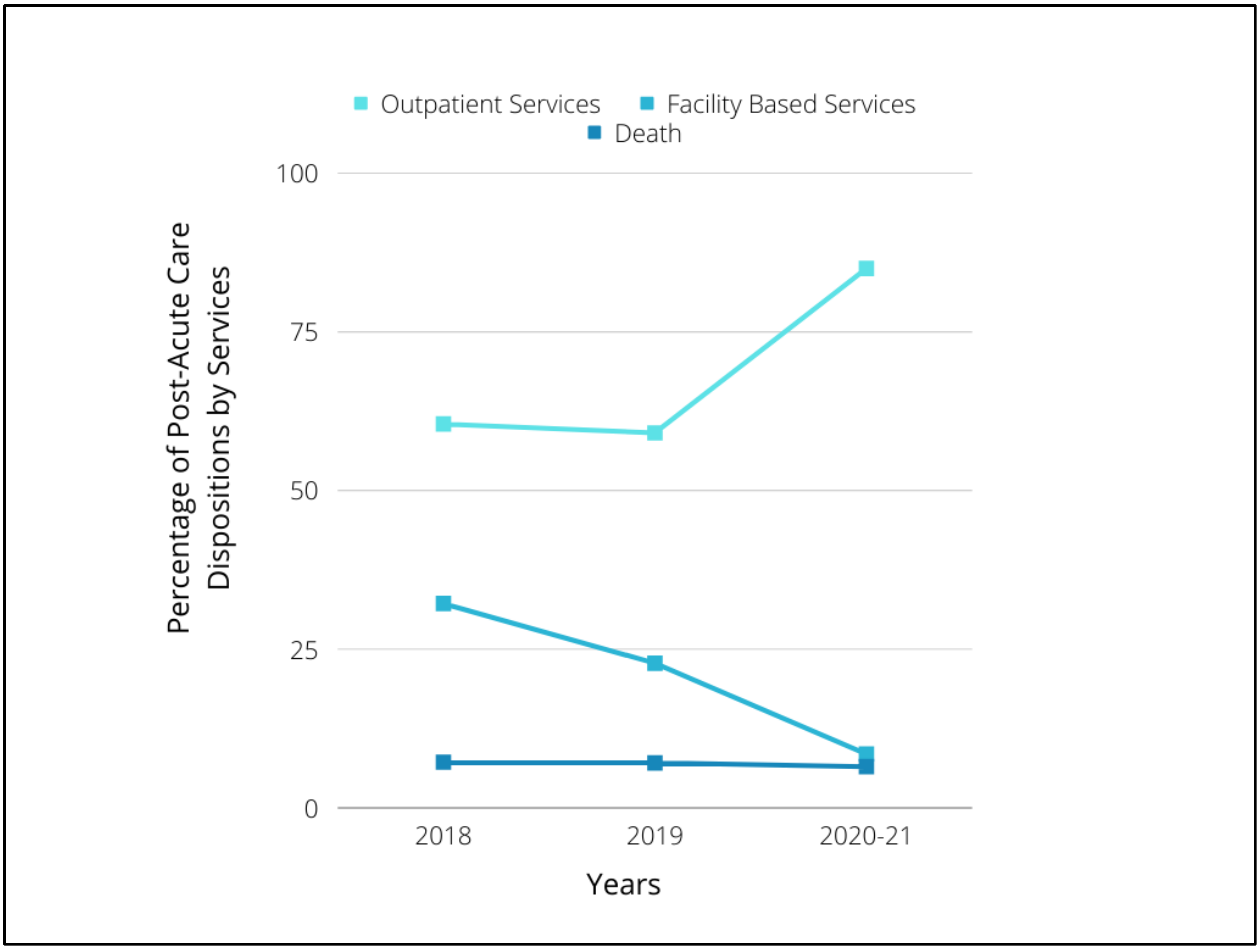


Figure 3: Post-Acute Care Disposition of services by study years 2018, 2019 and 2020-21

Table 3: Comparisons of Post-Acute Care Dispositions, Health Insurance Consumptions and Acute Care Hospitals Utilized between the Years 2018/2019 and 2020/2021

	2018-2019 (N=10520)	2020-2021 (N=7646)	Overall (N=18166)	p-value
Acute Care Hospital Utilized in Atlanta				<0.001
0- EJCH	1637 (15.6%)	932 (12.2%)	2569 (14.1%)	
1-ESJH	2333 (22.2%)	2437 (31.9%)	4770 (26.3%)	
2-EUH	3429 (32.6%)	1906 (24.9%)	5335 (29.4%)	
3-EUHM	3121 (29.7%)	2371 (31.0%)	5492 (30.2%)	
Post-Acute Care Disposition				<0.001
Home Health Services	1921 (18.3%)	1049 (13.7%)	2970 (16.3%)	
Home Self Care	3200 (30.4%)	5276 (69.0%)	8476 (46.7%)	
Short Term Hospitals	665 (6.3%)	68 (0.9%)	733 (4.0%)	
Long Term Care Hospitals	219 (2.1%)	89 (1.2%)	308 (1.7%)	
Skilled Nursing Facilities	987 (9.4%)	343 (4.5%)	1330 (7.3%)	
Expired	756 (7.2%)	497 (6.5%)	1253 (6.9%)	
Others (hospice, left AMA,	2772 (26.3%)	324 (4.2%)	3096 (17.0%)	
Post-Acute Care Disposition services				<0.001
Out-patient services	6289 (59.8%)	6502 (85.0%)	12791 (70.4%)	
Facility-based facilities	3475 (33.0%)	647 (8.5%)	4122 (22.7%)	
Death	756 (7.2%)	497 (6.5%)	1253 (6.9%)	
Health Insurance Utilized				<0.001
Government	2648 (25.2%)	6543 (85.6%)	9191 (50.6%)	
Commercial	6814 (64.8%)	866 (11.3%)	7680 (42.3%)	
Self-Pay	715 (6.8%)	237 (3.1%)	952 (5.2%)	
Others	343 (3.3%)	0 (0%)	343 (1.9%)	

[1] n (%)

[2] Pearson's Chi-squared tests.

Primary Outcome

Question 1a: Did the odds of post-acute care (PAC) disposition differ by the patient's principal diagnosis (COVID-19) at acute-care hospital discharge during the early phase of the pandemic?

Table 4a: Adjusted and crude estimates of the effect of COVID-19 diagnosis on PAC disposition (as a 7-level outcome).

Post-Acute Care Disposition (7-level outcome)	Adjusted Model			Crude Model		
	COVID-19 Diagnosis Odds Ratio	95% Confidence Intervals (CI)	P-value	COVID-19 Diagnosis Odds Ratio	95% Confidence Intervals (CI)	P-value
Home Self Care	0.58	0.35 - 0.96	0.03	0.67	0.42 - 1.07	0.10
Short Term Care Fac	0.22	0.08 - 0.66	<0.01	0.28	0.11 - 0.70	<0.01
Long Term Care Fac	0.20	0.02 - 2.66	0.22	0.31	0.03 - 3.60	0.35
Skilled Nursing Fac	1.04	0.47 - 2.31	0.92	1.24	0.59 - 2.69	0.56
Expired	0.29	0.13 - 0.64	<0.01	0.36	0.20 - 0.67	<0.01
Other facilities*	0.35	0.12 - 1.06	0.06	0.34	0.12 - 1.01	0.05

Reference group for post-acute care disposition and COVID-19 diagnosis were Home Health Services and not having a non-COVID-19 diagnosis respectively. Other facilities* refer to hospice-med facility, left against medical advice, intermediate care facilities, other rehab facilities, to law enforcement and to a psychiatric hospital etc.

In an adjusted polytomous logistic model with 7 levels of the PAC disposition outcome during the early phases of the pandemic (May 07, 2020), COVID-19 survivors as compared to non-COVID-19 patients, were more likely to receive care from home health services than from home self-care and short-term care facilities (STCFs). For example, the odds of having a post-acute care disposition via home-self-care services or STCFs [vs. post-acute care disposition by home health services] among COVID-19 survivors was 0.58 and 0.22 times respectively, the corresponding odds among non-COVID-19 discharged patients during the 2 month follow up encounter period. There were no significant differences in the odds of having a post-acute disposition via long term care facilities (LTCFs), skilled nursing facilities (SNFs) and other post-acute disposition facilities [vs. post-acute care disposition by home health services] among COVID-19 survivors as compared to non-COVID-19 discharged patients during the same follow up period (see Table 4a above).

In the unadjusted model, only the odds of post-acute care disposition to STCFs were statistically different and lower [i.e., odds ratio 0.28, CI (0.11- 0.70), p<0.01] than odds of post-acute care disposition to home health services among COVID-19 survivors as compared to non-COVID-19 discharged patients during this follow up period. Furthermore, the odds of death as a post-acute care hospital disposition outcome among COVID-19 versus non COVID-19 discharged patients, were statistically significant (in both the adjusted and crude models) and lower than the odds of post-acute care hospital disposition via home health services [adjusted and crude odds ratio (OR): OR 0.29, CI (0.13 - 0.64), p value <0.01 and OR 0.36, CI(0.20 – 0.67), p value <0.01, respectively].

Question 1b: Does the post-acute care disposition differ by the patient's principal diagnosis (COVID-19) at the time of acute-care hospital discharge during the early phase of the pandemic?

Table 4b: Adjusted and crude estimates of the effect of COVID-19 diagnosis on PAC disposition (as a 3-level outcome)

Post-Acute Care Disposition (3-level outcome)	Adjusted Model			Crude Model		
	COVID-19 Diagnosis Odds Ratio	95% Confidence Intervals (CI)	P-value	COVID-19 Diagnosis Odds Ratio	95% Confidence Intervals (CI)	P-value
Facility-based services	0.82	0.48 - 1.40	0.47	0.86	0.55 - 1.34	0.50
Death	0.48	0.25 - 0.95	0.04	0.52	0.34 - 0.80	<0.01

Reference group for post-acute care disposition and COVID-19 diagnosis were out-patient services and not having a COVID-19 diagnosis respectively.

In Table 4b above, both the adjusted (controlling for age, gender, race, discharging unit, comorbidities and health insurance status) and crude estimate showed that, the odds [adjusted OR vs crude OR were OR:0.82, CI(0.48 – 1.40), p value 0.47 vs. OR: 0.86, CI(0.55 - 1.34), p value 0.50, respectively] of receiving facility-based services among acute-care hospital discharged COVID-19 survivors as compared to non-COVID-19 discharged patients were not statistically different from receiving out-patient services. Conversely, the odds of death as the PAC disposition outcome (versus outpatient-based services as the PAC disposition outcome) among COVID-19 survivors discharged from an acute-care hospital using the adjusted and crude models, were 0.48 and 0.52 times the odds of the corresponding non-COVID-19 patients respectively. The odds of death as a PAC disposition outcome among acute-care hospital discharged COVID-19 survivors versus non-COVID-19 discharged patients were statistically significant and lower than out-patient services as a PAC outcome in both the crude and adjusted models [i.e., OR 0.52 CI (0.34 – 0.80), p value <0.01 and OR 0.48, CI (0.25 – 0.95), p value 0.04, respectively].

Question 2: Does the post-acute care disposition at the 18-month study follow up time differ by the patient's gender among COVID-19 survivors?

Table 5: Crude and adjusted estimates for the effect of gender on the PAC disposition

Post-Acute Care Disposition (3-level outcome)	Adjusted Model			Crude Model		
	Gender (Female) Odds ratio	95% Confidence intervals (CI)	P-value	Gender (Female) Odds ratio	95% Confidence intervals (CI)	P-value
Facility-based services	0.76	0.63 - 0.91	<0.01	0.93	0.79 - 1.09	0.36
Death	0.55	0.41 - 0.73	<0.001	0.78	0.65 - 0.93	<0.01

The reference groups are out-patient services and males for PAC disposition and gender variables respectively

The odds of PAC disposition by facility-based services (versus PAC disposition by out-patient services) among females was 0.76 times the corresponding odds for males in the fully adjusted model. Controlling for the variables (age, race, acute care hospital, hospital discharging unit and health insurance status)—Table 5, females as compared to men, were less likely to have facility-based services as their PAC disposition [OR: 0.76, CI (0.63 – 0.91), p value <0.01]. However, the effect of gender on PAC disposition was statistically insignificant when gender was used alone in the model [OR: 0.93, CI (0.79 – 1.09), p value 0.36]. Contrary, the odds of the PAC disposition being death (versus PAC disposition being out-patient services) among female COVID-19 survivors for the adjusted and crude models, was 0.55 and 0.78 times the corresponding odds among male COVID-19 survivors during the 18-month follow up period. In both models, female COVID-19 survivors as compared to male COVID-19 survivors, were less likely to die during the 18 month follow up period [adjusted and crude estimates were OR: 0.55, CI (0.41 – 0.73), p value <0.001 and OR:0.78 CI (0.65 – 0.93), respectively].

Question 3a: Do the odds of PAC disposition among COVID-19 discharged patients during the 18-month follow up period of 2020-2021 differ from the odds of PAC disposition among discharged patients in the financial years of 2018-2019?

Table 6a: Crude and adjusted estimates for the effect of COVID-19 on the PAC disposition during 2020-21 vs PAC dispositions among discharged patients for the financial years 2018, 2019.

Post-Acute Care Disposition (7-level outcome)	Adjusted Model			Crude Model		
	COVID-19 Diagnosis Odds ratio	95% Confidence intervals (CI)	P-value	COVID-19 Diagnosis Odds ratio	95% Confidence intervals (CI)	P-value
Home Self Care	2.89	2.58 – 3.24	<0.001	3.02	2.77 – 3.30	<0.001

Short Term Care Fac	0.15	0.11 – 0.20	<0.001	0.19	0.14 – 0.24	<0.001
Long Term Care Fac	0.51	0.38 – 0.70	<0.001	0.74	0.57 – 0.96	0.02
Skilled Nursing Fac	0.48	0.40 – 0.57	<0.001	0.64	0.55 – 0.73	<0.001
Expired	1.13	0.95 – 1.34	0.17	1.20	1.05 – 1.38	<0.01
Other facilities*	0.16	0.13 – 0.18	<0.001	0.21	0.19 – 0.25	<0.001

Reference group for post-acute care disposition and COVID-19 diagnosis were Home Health Services and not having a non-COVID-19 diagnosis respectively. Other facilities* refer to hospice-med facility, left against medical advice, intermediate care facilities, other rehab facilities, to law enforcement and to a psychiatric hospital etc.

In both the adjusted PLR model (which controlled for acute-care hospital and health insurance status) and the crude model, the odds for PAC disposition of any category (vs. the PAC disposition by home health services) among COVID-19 survivors were lower than the corresponding odds among non-COVID-19 discharged patients except for those who died or those whose PAC was home self-care (see table 6a above). Both models yielded statistically significant values for skilled nursing facility, other facilities and short- and long-term care services (Table 6a). The odds for PAC disposition by home self-care (versus PAC disposition by home health services) among COVID-19 survivors while using the adjusted and crude PLR models, was 2.89 and 3.02 times the corresponding odds for non-COVID-19 discharged patients, with all values being statistically significant. Conversely, the odds of PAC disposition being death (vs. PAC disposition by home health services) among COVID-19 patients was 1.13 times the corresponding odds among non-COVID patients, a result which was not statistically significant [OR: 1.13, CI (0.95 – 1.34), p value 0.17)]. However, in the crude model, the odds of death as a PAC disposition outcome (vs. home health services) among COVID-19 discharged persons were 1.20 times the corresponding odds among non-COVID-19 discharged patients, a value which was statistically significant [OR 1.2, CI (1.05 – 1.38), p value <0.01].

Question 3b: Do the odds of PAC disposition among COVID-19 discharged patients during the 18-month follow up period of 2020-2021 differ from the odds of PAC disposition among discharged patients in the financial years of 2018-2019? Using a 3-level categorization for the PAC disposition outcome.

Table 6b: Crude and adjusted estimates for the effect of COVID-19 on the PAC disposition (3-level outcome) during 2020-21 vs PAC dispositions (3-level outcome) among discharged patients for the financial years 2018, 2019.

Post-Acute Care Disposition (3-level outcome)	**Adjusted Model**			**Crude Model**		
	COVID-19 Diagnosis	95% Confidence	P-value	COVID-19 Diagnosis	95% Confidence	P-value

	Odds ratio	intervals (CI)		Odds ratio	intervals (CI)	
Facility-based services	0.15	0.13 – 0.17	<0.001	0.18	0.16 - 0.20	<0.001
Death	0.65	0.56 - 0.75	<0.001	0.64	0.56 - 0.71	<0.001

The reference groups are out-patient services and non-COVID-19 for the post-acute care disposition and COVID-19 diagnosis variables respectively.

Both the adjusted and unadjusted odds of either facility-based services or death as PAC dispositions (versus outpatient services as a PAC disposition) among COVID-19 discharged patients followed up for 18 months during 2020-2021 period, were meaningfully lower than the odds among non-COVID-19 patients in the financial years 2018 and 2019 (see Table 6b). For example, in the adjusted PLR model (controlled for acute care hospital and health insurance status), the odds of facility-based services as a PAC disposition (vs. home health services) among COVID-19 survivors was 0.15 times the corresponding odds among non-COVID-19 patients for the year 2018-2019, which result was statistically significant [i.e., OR: 0.15, CI (0.13 – 0.17), p value < 0.001)]. Similar statistically significant results of the odds for facility-based services or death vs outpatient services among COVID-19 survivors as compared to non-COVID-19 patients were obtained in the crude and adjusted models for facility-based services and death respectively.

Secondary Outcome

Question 4: Do the odds of death among COVID-19 survivors discharged from acute-care hospitals differ by gender at the end of the 18-month study follow up period?

Table 7: Crude and adjusted estimates for the effect of gender on the odds of death among COVID-19 survivors during the 18 month follow up period.

Model Type	**Outcome (Mortality)**	**Gender (female)** Odds like ratios	**95% Confidence intervals (CI)**	**p-value**
Full model	Death	0.62	0.47 - 0.82	<0.001
Crude	Death	0.78	0.65 - 0.94	<0.01
Observations 7646, R^2 Tjur =0.001				

The reference group for outcome was patients whose outcome was either out-patient services or facility-based services, and the reference group for the gender was male COVID-19 survivors discharged from acute care hospitals.

A logistic regression model was fitted to estimate the crude and adjusted estimates of the effect of gender on the odds of death among COVID-19 survivors followed up for 18 months during the pandemic years of 2020 and 2021. After controlling for age, race, entity, discharging unit from the acute care hospital (ICU vs. non-ICU), and length of stay, the odds of death among female COVID-19 survivors was 0.62 times the corresponding odds among male COVID-19 survivors [CI (0.47 – 0.82), p value <0.001].

Generally, female COVID-19 survivors who had been discharged from acute care hospitals were less likely to die as compared to their male counterparts during the 18-month follow up in both the adjusted and crude models [OR: 0.78, CI (0.65 – 0.94), p value <0.01]— see Table 7 above .

Question 5: Do the odds of death among COVID-19 survivors discharged from acute-hospital during the 18-month follow up period of 2020-2021 differ from the odds of death among acute-care hospital discharged patients in the financial years of 2018 and 2019?

Table 8: Crude and adjusted estimates for the effect of COVID-19 status or year of study (pre-pandemic vs pandemic years) on the odds of death among acute hospital discharged patients.

Model Type	Outcome (Mortality)	COVID-19 diagnosis	95% Confidence intervals (CI)	p-value
		Odds ratios		
Full model	Death	0.97	0.84 - 1.12	0.68
Crude	Death	0.90	0.80 - 1.10	0.73
Observations 7646, R^2 Tjur =0.001				

The reference group for outcome was patients whose outcome was either out-patient services or facility-based services, and the reference group for the COVID-19 diagnosis was individuals with no COVID-19.

After controlling for health insurance status and the acute discharging facility, the odds of death among COVID-19 survivors discharged from acute-care facilities was 0.97 times the odds among patients discharged from acute care hospitals in pre-pandemic years [CI (0.84 – 1.12), p value <0.68]. This effect of a COVID-19 diagnosis on the odds of death among COVID-19 survivors discharged from acute care hospitals was not attenuated in the unadjusted models [OR: 0.90, CI (0.80 – 1.10), p value 0.73)]. Year of study and the COVID-19 diagnosis were found to be highly collinear and therefore in the fully adjusted model, one of them was dropped. Generally, the effect of COVID-19 diagnosis or year of study did not seem to have a meaningful effect on the odds of death (see table 8 above).

Discussion

Principal findings

In this open retrospective cohort study, we found that home self-care and outpatient-based services were the most common post-acute care disposition outcomes for both COVID-19 survivors and non-COVID-19 patients discharged from 4 acute-care hospitals in Atlanta, Georgia during the pandemic (2020-21)-and pre-pandemic years of 2019-2020. Furthermore, being a male COVID-19 survivor was associated with increased odds of death and admission to facility-based services following hospital discharge. Additionally, we found that during the early phases of the COVID-19 pandemic, it was more likely for COVID-19 survivors versus non-COVID discharged patients to require outpatient services than to die or require facility-based services during the follow up period. However, when the effect of COVID-19 diagnosis or year of study on mortality among COVID-19 survivors and historical controls (i.e., acute care patients discharged in 2018 and 2019), it was found to be insignificant.

Limitations

It is noteworthy that our study had the following limitations. First, although we adjusted for comorbidities and complications in our analysis, we did not document the treatment that COVID-19 survivors received during their hospital admission. This could potentially introduce bias on what PAC disposition patients end up in. Secondly, this was an open retrospective cohort study that involved electronic medical records with no contact to study participants or substitute decision makers to verify any missing data or any new diagnoses. Additionally, we could not independently corroborate any wrongly inputted data (misclassification bias). Third, we did not factor in the effect of public health measures such as vaccination campaigns, infection control mandates at these post-acute care facilities and any public health policies or by laws that may have affected the admission criteria of COVID-19 survivors to post-acute care facilities. Fourth, we did not control for the effect of the dominant COVID-19 strain that was in circulation during our study period. Differences in the circulating COVID-19 strain could have impacted COVID-19 case numbers which in turn, affected acute hospital COVID-19 discharge polices; and the COVID-19 strain by itself could dictate the resultant or COVID-19 sequalae which in turn affect the patient's post-acute care disposition trajectory. Fifth, we did not have did not have access to the baseline acute care hospital admission assessments for COVID-19 survivors. Lack of these data could result into uncontrolled confounding, as the differences observed in PAC disposition outcomes may not be attributable to COVID-19-related illness/sequalae. Finally, we did not factor in the available bed capacity in the post-acute care facilities, rates of healthcare worker COVID-19 infections at these facilities and number of functional post-acute care facilities at the various time points during the study.

Strengths and weaknesses

Like previous studies that examined post-acute care disposition of COVID-19 survivors or non-COVID-19 patients[18, 19, 40, 65, 78], increasing age of the participants, lengthy hospital stays, a history of comorbidities, being African American (as compared to other racial groups), and having been admitted to an ICU were associated with both death and the need for facility-based services during the post-acute care period.

Contrary to our expectations and prior literature on this subject[11, 19], there was a significant decline in the utilization of facility-based services as a PAC disposition outcome (when considered as a 3-level outcome) among COVID-19 survivors during the 2020-21 financial years as compared to non-COVID-19 patients for the financial years of 2018 and 2019 i.e., facility-based service as a PAC disposition outcome was 32.2% and 33.8% in 2018 and 2019 respectively, but it dropped to only 8.5% in the pandemic years of 2020-21. However, when this observation was tested in both the fully adjusted and crude polytomous logistic regression models during the early phase of the pandemic (2nd EMR encounter), the effect of a COVID-19 on PAC disposition outcome (other than death) was attenuated. However, apart from the PAC outcomes of death and short-term care facilities which were meaningfully lower than facility-based services or home health services (either when PAC was considered as a 7- or 3-level outcome) among COVID-19 survivors than non-COVID patients, the rest of the outcomes were non-significant in both full and crude models (Tables 4A and 4B).

When the PAC disposition outcomes were compared between COVID-19 patients discharged from acute care hospitals in the pandemic years of 2020-21 to non-COVD-19 patients discharged from acute care hospitals in the pre-pandemic years (2018-2020), all PAC disposition (either 7- or 3 level) outcomes were statistically significant and lower than the odds of having home health services or outpatient services except for death (i.e., when a 7-level outcome PAC disposition was used)– see Tables 6A-B and Table 8. In the unadjusted model used in Table 6A, COVID-19 survivors were more likely to die (versus having home health services as their PAC disposition outcome) during the follow up period as compared non-COVID-19 discharged patients in the financial years of 2018-2019.

This observation of mortality presents a significant departure from what we had initially observed when similar comparisons were made during the early phase of the COVID-19 pandemic, and when the PAC disposition outcome was tested as a binary outcome (i.e., death vs outpatient services and facility-based services), year of study (involving historical controls) or COVID-19 diagnosis were not meaningfully associated with the odds of death. Our study results to some extent, agree with what was observed in a 2022 large cohort study conducted in England, UK, that followed 24, 763 post-discharge COVID-19 survivors, 123, 362 general population controls and 16,058 influenza controls for utmost 1 year, and found that overall risk of death or re-hospitalisation was higher among discharged COVID-19 patients than the other controls (fully adjusted hazard ratio 2.22, 2.14 to 2.30, $p < 0.001$)[79].

Gender as a predictor for PAC disposition outcomes was assessed using both crude and adjusted polytomous logistic regression models among COVID-19 survivors only

(Table 5) at the 18 month follow up study period. And it was observed that in the fully adjusted model, the male gender was significantly associated with both death and facility-based services (1.82 and 1.3 times, respectively) as compared to female COVID-19 survivors. The effect of gender on having facility-based services as the PAC disposition outcome among COVID-survivors was attenuated when gender was used alone in the model. However, this effect persisted for death as a PAC disposition outcome in the crude model—see Table 5. Similarly, when the effect of gender on PAC disposition was tested among COVID-19 survivors during pandemic years (2020-21) versus non-COVID-19 patients discharged from acute care facilities during the pre-pandemic years of 2018-2019, the male gender was significantly associated with death and PAC disposition via facility-based services for both adjusted and unadjusted models, which study findings don't stand in agreement with previous studies [11, 15, 78, 80].

Possible implications for clinicians and policy makers of these study findings.

Although this study was conducted in Atlanta, it presents key take always for global audiences that may not have well-structured post-acute care systems to handle COVID-19 survivors following acute-care hospital discharge. Enumerating the discharge disposition of a representative sample of COVID-19 patients, facilitates evidence based-decision making that enables public health and policy authorities to apportion resources and attention to areas that require remediation.

In this study, most COVID-19 survivors ended up with home self-care or outpatient services as their post-acute care disposition. A growing body of evidence suggests that acute hospital discharged COVID patients are at risk of developing COVID-19 complications that require close attention. Therefore, public health practitioners, clinicians and all relevant authorities should draft specifically targeted messages to guide COVID-19 survivors whose PAC disposition outcome is home self-care on how to identify any danger signs and symptoms related to COVID-19 sequalae. Second, findings from this study argue the case that local governments and health authorities should invest in rehabilitation services and/or allocate more resources to home health staffing and physical resources to these facilities since they receive the bulk of the patients. Third, public health authorities should implement and facilitate referral pathways for COVID-19 survivors who maybe at home (home self-care) or under outpatient services but require to quickly access medical services at facility-based units. Fourth, we observed that male COVID-19 survivors had an increased odds for death or being admitted to facility-based services, reasons as to why male COVID-19 survivors carry this increased risk, should be investigated and appropriate interventions instituted by the clinicians and public health authorities. Fifth, public health authorities and local governments in Atlanta and globally could invest more resources in increasing the number of individuals that are eligible for government health insurance schemes or health subsidies as most of our study participants (COVID-19) survivors required government affiliated health insurance schemes to pay their medical bills, and we noted that there was a significant reduction in both commercial and self-pay health insurance users among the COVID-19 survivors. Sixth, COVID-19 survivors presented with mixed results for the odds of death in this study, therefore, further studies should be conducted, preferably those that have longer follow up times and that maintain some form of contact with the COVID-19 survivors or their substitute decision makers to ensure data collected are accurate. This initiative would guide the creation of future post-acute COVID-19 care data collection tools and storage databases to be used in similar disease pandemics or large outbreaks. Finally, recommendations arising from quantifying the post-acute care needs of COVID-19 patients in Atlanta will help provide a guidance template for health care planners in resource-limited settings globally who may not have astutely collected data on their COVID-19 patients post-acute disposition needs to anticipate what their patients lack to tailor appropriate health recommendations and resources investments applicable to their settings.

In conclusion, our study found that home self-care services constituted the major post-acute care disposition that COVID-19 survivors and non-COVID-19 patients utilized following hospital discharge; the PAC outcomes of death and facility-based services were more common among male COVID-19 survivors; increasing age was associated with death and facility-based services; participants that utilized government affiliated health insurance schemes were more likely to require facility based services or have death as their post-acute care disposition, and the proportion of patients who required government affiliated health insurance increased from 2018 through to 2021; there was a sharp decline in the use of facility-based services in the pandemic years as compared to the pre-pandemic years; and last but least, the odds of death as a post-acute care disposition were associated with COVID-19 diagnosis during the early phases of the pandemic but remain debatable when comparisons are made with patients who were discharged in the pre-pandemic years.

Unanswered questions and future research.

1. How does gender affect mortality or the trajectory of COVID-19 survivors after discharge from an acute care facility?
2. How have public health interventions aimed at controlling COVID-19 such as vaccination mandates, mask mandates and social distancing etc. affected the post-acute care disposition of COVID-19 patients in various counties in Georgia?
3. How did public health or politically driven by-laws issued at various times during the pandemic affect the post-acute care disposition of COVID-19 patients?
4. What were effects of the various circulating dominant strains of COVID-19 on the post-acute care disposition of COVID-19 survivors?
5. Has the risk profile for mortality or hospital readmission among COVID-19 survivors changed during the pandemic and is this risk profile similar across various counties in Georgia, or states in the USA or globally?
6. Why did COVID-19 survivors appear to have reduced odds of death during the follow up periods in the early phases of the pandemic and why did this "protective effect" if any, appear to wane with time?

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