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A hospital-at-home care model innovation: An exploratory study

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The United States Census Bureau projects that by 2030, one in every five Americans will be at retirement age and by 2034, older adults will outnumber children for the first time in US history.[1] In addition, there will be a shortage of 63,720 full-time equivalent RNs in the US by 2030, according to the 2020 HRSA Nurse Workforce Projections.[2] Healthcare leaders face double trouble as the US population ages and both the demand for healthcare services and the rate of retiring nurses increase.[3] This scenario, along with an exodus from the profession, has contributed to the nursing shortage, fueling the need for innovative care models to meet healthcare demands.[4] A survey conducted by AARP found that 76% of respondents age 50 and older would prefer to age and receive healthcare at home.[5] Thus, healthcare is in dire need of an innovative care model, and nurses' holistic patient-centric views on the healthcare system should be a critical part of its development.

Receiving healthcare at home isn't a new phenomenon. Traditional "home care" or skilled nursing care at home has been a service across the world, primarily used for a post-acute episode of care. In the 1930s, physicians made house calls for acute primary care-type illnesses.[6] Leff and colleagues identified the need for alternatives to inpatient hospitalizations, especially for older adults with chronic diseases who present with an acute condition.[7] In a pilot study, these researchers implemented a hospital at home (H@H) program for inpatient hospitalizations and found it was a safe alternative

KATE3155/SHUTTERSTOCK

to a traditional hospitalization for persons age 65 and older who were diagnosed with community-acquired pneumonia, congestive heart failure, chronic obstructive pulmonary disease, and cellulitis.[7] Moreover, an increasing body of literature from Europe supports the efficacy and safety of acute home-based programs.[8] Despite this evidence, there has been minimal adoption or recognition of H@H programs in the US.

In the past decade, several components have increased capabilities for H@H programs. One is advances in technology for remote patient monitoring devices and telehealth, which have improved the safety of monitoring and caring for patients in their homes.[9,10] The other is a waiver under the Centers for Medicare & Medicaid Services' (CMS) Hospital Conditions of Participation, initiated in November 2020, that requires onsite nursing services 24/7 with immediate access to an RN and inpatient reimbursement for H@H programs.[11] This waiver allows hospitals to embrace innovation for acute care services, given rising acute care demands amid the COVID-19 pandemic, an aging population, and a shrinking labor pool.[4]

The aim of this study was to assess the effectiveness of a H@H program compared with a traditional inpatient hospitalization on acute care outcomes, including 30-day readmission rates and length of stay (LOS), for similar populations of patients diagnosed with COVID-19. The two research questions were:

1. What's the difference in 30-day readmission rates between patients with COVID-19 who participated in the H@H program versus a traditional inpatient hospitalization.
2. What's the difference in length of stay between patients with COVID-19 who participated in the H@H program versus a traditional inpatient hospitalization.

Material and methods

Design

This was a descriptive, retrospective comparison study of patients with COVID-19 admitted to either the H@H model or a traditional inpatient hospitalization between May 1, 2021 and March 31, 2022. The researchers sought to determine whether there was a difference in LOS and 30-day readmission rates between the two groups. The Institutional Review Board approved the study prior to the retrospective data collection.

H@H model

The H@H program provides full inpatient hospital services in the home that would otherwise be available and delivered in the traditional hospital environment, as defined by the CMS waiver program.[11] This includes access to hospitalist and specialty physicians, advanced practice providers, skilled therapists, nurses, care coordinators, pharmacists, nutrition services, and lab and radiology services in their home or via telehealth.[11] The H@H program offered by the health system was voluntary and patient participants gave informed consent to be included.

Participants in the H@H program were placed on continuous remote patient monitoring to assess heart rate and oxygen saturation at home. An acute care nurse was responsible for monitoring the heart rate and oxygen saturation levels of the H@H patient 24/7. The physician or advanced practice provider performed at least one in-person or telehealth visit daily. At least twice daily, paramedics conducted in-person home visits that were coordinated with an interdisciplinary telehealth visit that included, but wasn't limited to, the acute care H@H nurse, care coordinator, dietitian, and pharmacist to support the patient's medical needs and help develop the therapeutic assessment and plan. Family was encouraged but not required to participate.

Home care nurses, aides, and therapists were available and coordinated with the acute care H@H nurse for home visits for infusions, wound care, activities of daily living (ADL) assistance, therapy needs, or escalating health concerns with the acute care H@H nurse. The in-home paramedics performed lab work and 12-lead ECGs as ordered by the provider. Mobile chest X-rays were provided in the home, and any diagnostic imaging tests ordered that couldn't be performed in the home (such as computerized tomography or MRI) were scheduled within 24 hours at the nearest hospital facility. Patients were also offered three meals a day based on dietary orders while participating in the H@H program.

Patients admitted to the H@H program were placed in a virtual inpatient bed in the electronic

health record (EHR) at two locations within the health system. This allowed clinicians monitoring the H@H program to track all patients from admission to discharge and retrospectively generate a list of all patients included in the H@H group.

Data collection

Using random sampling, the researchers retrospectively collected data on 64 H@H COVID-19 admissions and 64 traditional inpatient COVID-19 admissions. A list of potential patients was generated from the EHR of a large academic health system. There was a total of 167 H@H COVID-19 admissions and 199 traditional inpatient COVID-19 admissions. The researchers randomized the participant selection for each group using a random number generator; data were then abstracted. The primary investigator trained the abstractor before data abstraction and audited 10% of the records for validation and accuracy of the data collection before completing the abstraction. The primary investigator didn't achieve 80% interrater reliability with the first audit, so additional training and another audit of 10% of the records were completed with 100% interrater reliability achieved.

The researchers used a standardized instrument to collect demographic information (age, insurance), hospital course details (LOS, admitting diagnosis, disposition status, number of nurse visits, oxygen requirements, and 30-day readmission details), and the specific inclusion and exclusion criteria (see *Table 1*). In addition, patients eligible for the H@H group needed to have informed-consent documentation in the EHR. A linking log was used to ensure data anonymity for the data collection to separate the patient identifiers from the data collected.

Table 1: Eligibility criteria for both groups

Inclusion criteria	Exclusion criteria
• ≥17 years of age • Categorized as an "inpatient" via a utilization management review using either the Medicare 2 midnight rule, InterQual, or Milliman care guidelines • COVID-19 is the primary diagnosis • Evaluated and admitted from one of the health system's EDs or inpatient units • Live at home • Independent with ADL or have a caregiver in the home to assist with ADL • Admitted level of care was medical, surgical, or telemetry unit, as indicated on the bed request	• Residents in a skilled nursing, assisted living, long-term care, or inpatient rehabilitation facility • Receiving methadone or had a positive domestic violence screen on admission screening • Domiciled or in police custody • >10 liters of oxygen needed for ambulation or to maintain oxygen saturation of >93% • Creatine 1.5 times baseline or lactate >4 and not resolving on repeat levels • Active cancer, end-stage renal disease, acute myocardial infarction, or acute stroke • Hypotensive and not responsive to I.V. fluids • ICU or stepdown level of care admission requiring ventilator support or bilevel positive airway pressure, or observation status determined by utilization management review

Measures

The researchers measured acute LOS from the date of admission to discharge. For the 30-day readmission rate, they used the CMS definition of any acute hospitalization within 30 days of discharge from the acute care setting for any diagnosis.[12] Other variables included age in years, insurance (commercial, Medicare/Medicaid, self-pay), LOS, admitting diagnosis (diagnosis-related groups), discharge disposition (home, home with home healthcare, inpatient hospital, new home healthcare), number of nurse visits, oxygen requirements (liters), and 30-day readmission details.

Analysis

All analyses were conducted in RStudio version 4.2.1. Researchers conducted *a priori* power analysis in G*Power 3.1 based on statistical parameters of $\alpha = .05$, $\beta = .80$, and a medium effect size of 0.5 in a two-tailed, independent samples *t* test.[13] Based on these parameters, 64 participants in each group were selected to detect statistical significance. Univariate statistics were examined for all variables to evaluate for any outliers, miscodes, and normality. Prior to conducting planned analyses, the researchers tested the assumptions of each associated statistical test (such as homogeneity of variance for the independent samples *t* test) to

determine whether a parametric or nonparametric equivalent test should be used to analyze the data.

Descriptive data include median and interquartile range (IQR) and mean and standard deviation (SD). Researchers compared categorical variables using Fisher's exact test as some of the counts were low, and continuous variables using independent sample *t* test and Wilcoxon Rank sum test. A *P* value 0.05 was considered statistically significant.

Table 2: Participant characteristics (N = 128)

Characteristic	
Insurance provider, n (%)	
Commercial	59 (46.1)
Medicare/Medicaid	66 (51.6)
Self-pay	3 (2.3)
Age	
Median (IQR)	58.0 (45.8, 69.0)
Mean ± SD	56.4 ± 16.0
Medicare Severity-Diagnosis Related Group, n (%)	
177 - Respiratory Infections and Inflammations with MCC	120 (93.8)
178 - Respiratory Infections and Inflammations with CC	3 (2.3)
190 - Chronic Obstructive Pulmonary Disease with MCC	1 (0.8)
191 - Chronic Obstructive Pulmonary Disease with CC	1 (0.8)
193 - Simple Pneumonia and Pleurisy with MCC	3 (2.3)
Length of stay	
Median (IQR)	5.0 (3.0, 6.0)
Mean ± SD	4.9 ± 2.8
RN visit volume	
Median (IQR)	25.0 (17.0, 39.2)
Mean ± SD	30.2 ± 19.2
Rehospitalization within 30 days, n (%)	
No	126 (98.4)
Yes	2 (1.6)
Patient discharge disposition, n (%)	
Home	118 (92.2)
Home w/HHC	1 (0.8)
Inpatient hospital	6 (4.7)
New HHC	3 (2.3)
Oxygen requirement during hospitalization	
Median (IQR)	2.0 (2.0, 3.0)
Mean ± SD	2.8 ± 1.2
Unknown	11

Abbreviations: CC, complication or comorbidity; HHC, home health care; IQR, interquartile range; MCC, major complication or comorbidity; SD, standard deviation

Results

Demographic characteristics of patients admitted with COVID-19

Table 2 describes the demographic and clinical characteristics of the study sample. The overall mean age of patients was 56.4 years (SD, 16.0 years) and 51.6% had either Medicare and/or Medicaid as their primary payor. The overall median (IQR) nurse visit volume was 25 (17.0, 39.2), and could be in-person or virtually in the H@H program, whereas the traditional group was only completed in-person. The nurse visits were defined by any nursing note that was counted within the EHR upon review. The median oxygen requirement was 2 liters for both groups, and the majority of patients in both groups were discharged home.

Comparison analysis of H@H program vs. traditional inpatient hospitalization

No significant differences were observed between H@H and traditional hospitalization groups for age, insurance provider, admitting diagnosis of COVID-19, discharge disposition, RN visit volume, or oxygen requirements (see *Tables 3* and *4*). The median (IQR) age was compared and wasn't significantly different; however, it should be noted that the H@H group was younger (54) than the traditional hospitalized group (60) (see *Table 4*). Median LOS (IQR) was 4 days (3.0, 5.0) for the H@H group compared with 5 days (3.8, 6.0)

Table 3: Participant characteristics compared by admission group analysis using Fisher's exact test

Characteristic	H@H N = 64	Traditional N = 64	*P* value‡
Insurance provider, n (%)			.692
Commercial	28 (43.8)	31 (48.4)	
Medicare/Medicaid	35 (54.7)	31 (48.4)	
Self-pay	1 (1.6)	2 (3.1)	
Medicare Severity-Diagnosis Related Group, n (%)			.496
177 - Respiratory Infections and Inflammations with MCC	58 (90.6)	62 (96.9)	
178 - Respiratory Infections and Inflammations with CC	2 (3.1)	1 (1.6)	
190 - Chronic Obstructive Pulmonary Disease with MCC	1 (1.6)	0 (0.0)	
191 - Chronic Obstructive Pulmonary Disease with CC	1 (1.6)	0 (0.0)	
193 - Simple Pneumonia and Pleurisy with MCC	2 (3.1)	1 (1.6)	
Rehospitalization within 30 days, n (%)			.999
No	63 (98.4)	63 (98.4)	
Yes	1 (1.6)	1 (1.6)	
Patient discharge disposition, n (%)			.486
Home	57 (89.1)	61 (95.3)	
Home w/HHC	1 (1.6)	0 (0.0)	
Inpatient Hospital	4 (6.2)	2 (3.1)	
New HHC	2 (3.1)	1 (1.6)	

‡Fisher's exact test

Abbreviations: CC, complication or comorbidity; HHC, home health care; MCC, major complication or comorbidity

for the traditional hospitalization group, but the difference wasn't statistically significant ($P = .399$) (see *Table 4*). Readmission within 30 days was 1.6% for each group ($P = .999$) (see *Table 3*).

Discussion

This retrospective analysis compared the efficacy of an acute H@H program to a traditional inpatient hospitalization for patients diagnosed with COVID-19 by measuring LOS and the 30-day readmission rate. No significant difference was found in the median LOS between groups, and each group had one 30-day readmission. The findings suggest that an H@H program is a safe and effective way to care for acute medical patients with COVID-19 infection. The H@H program was at least as safe as a traditional hospitalization in two patient groups that were similar in age, admitting diagnosis, oxygen requirements, and discharge disposition.

Although there was no statistically significant difference in LOS, the median was one day shorter for the H@H group compared with the traditional hospitalized group, suggesting that the H@H program might assist in increasing traditional hospital capacity for higher-acuity patients and help to alleviate some of the burden associated with staffing and capacity challenges. Interestingly, the number of RN visits per patient was comparable in both groups (30.4 [SD, 19.1] mean visits for the H@H group and 29.9 [SD, 19.3] mean visits for the traditional hospitalized group) without changes to LOS or 30-day readmission rates. The RN visits conducted in the H@H program were primarily completed via telehealth, suggesting the bigger role telehealth could have in the acute setting among nurses. The hospital group RN visits were all in-person. Although the research team tried to track all the RN visits, there may

have been additional visits or surveillance that wasn't captured in documentation for either group. The researchers didn't track any of the ancillary visits for either group.

As the increasing demand for healthcare services places greater stress on the nursing professional, telehealth might be a safe and effective way to increase efficiency and access to nursing services, both in the traditional acute care setting and by expanding home-based programs. The H@H model described here was a nurse-led team with remote acute care nurses coordinating the activity of a large, interdisciplinary care team that consisted of home health aides, home health RNs, paramedics, NPs, physicians, and pharmacists. We hope that these findings will assist healthcare system and nurse leaders in supporting the safety and efficacy of H@H programs and implementing virtual nurse programs to continue this innovation.

Although there was no statistical significance found, it should be noted that the median age for both groups was below 60 years of age (*Table 4*). Much of the prior literature on H@H programs involved studies of older adults (age 65 and above).[7,8] If the current study's sample was older, there might be a need for additional resources, which warrants further investigation. The prior literature also included study groups primarily composed of older adults with Medicare insurance.[7,8] However, 46.1% of the current study population (48.4% traditional group and 43.8% H@H group) had commercial insurance related to the COVID-19 pandemic and a need to partner with all payors (see *Tables 2* and *3*).

This study wasn't without its limitations. The sample was limited to admitted patients diagnosed with COVID-19 and may not generalize to other patient populations. The sample size was relatively small, though adequately powered, with 64 patients in each group. It would be beneficial to continue the H@H program to further study the impact in larger sample groups. Although the sample was from a large regional health system comprising an academic medical center and smaller community hospitals, including other health systems with H@H programs could improve the strength of the study.

Additionally, the traditional hospitalized group didn't necessarily receive continuous heart rate and pulse oximetry monitoring that the H@H group required. This methodological factor may have confounded the study results. Lastly, this study only looked at LOS and

Table 4: Mean comparison using *t* test

Characteristic	H@H N = 64	Traditional N = 64	*P* value‡
Age			
Median (IQR)	54.0 (42.8, 69.0)	60.0 (48.0, 68.2)	.256
Mean ± SD	54.4 ± 17.2	58.4 ± 14.6	.156
Length of stay			
Median (IQR)	4.0 (3.0, 5.0)	5.0 (3.8, 6.0)	.399
Mean ± SD	4.9 ± 3.1	4.9 ± 2.5	.950
RN visit volume			
Median (IQR)	25.0 (18.0, 39.2)	27.0 (15.0, 38.5)	.875
Mean ± SD	30.4 ± 19.1	29.9 ± 19.3	.894
Oxygen requirement during hospitalization			
Median (IQR)	2.0 (2.0, 3.0)	2.0 (2.0, 4.0)	.377
Mean ± SD	2.6 ± 1.0	2.9 ± 1.3	.181
Unknown	2	9	

‡Wilcoxon rank sum test/Two sample *t* test

Research box

Purpose	To assess the effectiveness of a hospital-at-home (H@H) program on acute care outcomes, including 30-day readmission rates and length of stay (LOS), for patients with COVID-19 compared with a similar patient population admitted for a traditional inpatient hospitalization
Location	A large academic health system based in Cleveland, Ohio
Time frame	May 1, 2021 through March 31, 2022
Population	COVID-19 inpatient admissions
Collection tool	Standardized instrument was used to collect demographic information (age, insurance), hospital course details (LOS, admitting diagnosis, disposition status, number of nurse visits, oxygen requirements, and 30-day readmission details), and the specific inclusion and exclusion criteria
Sample size	There was a total of 167 H@H COVID-19 admissions and 199 traditional inpatient COVID-19 admissions. A random number generator was used to select 64 participants from each group.

30-day readmission rates as outcomes. Other outcomes that could be examined in future research to better understand the impact of H@H programs include hospital-acquired infection rates, falls with injury, 60-day and 90-day readmission rates, and cost analyses.

Implications for nurse leaders

The findings of this study have important implications for payors and healthcare and home care leaders. If acute home-based care continues, it will be critical to prepare and train clinical teams to provide this level of care in the home. The use of telehealth and continuous remote patient monitoring may be a safe and effective way to increase efficiency and access to nursing services, both in the traditional acute setting and in home-based programs.

The growing demand for healthcare services and the shrinking nursing workforce have prompted calls to deliver innovative acute care services. Nurse leaders should answer these calls with innovative care delivery and change management initiatives that improve our workforce capacity and experience. As a nurse-led team, it's as important that our nurses are trained to lead large, interdisciplinary teams. The H@H program is leveraging technology and remote patient monitoring while nurturing the nurse-patient relationship, suggesting that nurse leaders should explore and support this care delivery model.

Bridging the gaps

This study has helped fill important gaps in the literature regarding H@H programs in the US. Our findings identified that H@H is a safe alternative to the traditional acute hospitalization, provided preliminary evidence of the benefits of H@H programs especially on a younger population with an acute illness, and highlighted a future research agenda. Our findings also suggest that the nurse's role in the healthcare team might be shifting with advances in technology, such as remote patient monitoring. We hope these findings will assist healthcare systems, payors, and home care agencies in supporting the safety and efficacy of H@H programs and finding alternative ways to improve access to healthcare. NM

REFERENCES

1. Vespa J, Medina L, Armstrong DM. Demographic Turning Points for the United States: Population Projections from 2020 to 2060. United States Census Bureau. www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf. Accessed September 25, 2023.
2. National Center for Health Workforce Analysis. Nurse Workforce Projections, 2020-2035. 2022. HRSA Health Workforce. https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/Nursing-Workforce-Projections-Factsheet.pdf. Accessed September 25, 2023.
3. American Association of Colleges of Nursing. Fact sheet: nursing shortage. 2022. www.aacnnursing.org/News-Information/Fact-Sheets/Nursing-Shortage. Accessed on May 17, 2022.
4. Boyle P. Hospitals innovate amid dire nursing shortages. 2021. Association of American Medical Colleges. www.aamc.org/news/hospitals-innovate-amid-dire-nursing-shortages.
5. Binette J, Vasold K. 2018 home and community preferences: a national survey of adults ages 18-plus. 2018. AARP. www.aarp.org/research/topics/community/info-2018/2018-home-community-preference.html. Accessed May 17, 2022.

6. Kelly E. The history of physician house calls. 2017. MultiCare Home Health. https://multicarehh.com/history-physician-house-calls. Accessed May 17, 2022.
7. Leff B, Burton L, Guido S, Greenough WB, Steinwachs D, Burton JR. Home hospital program: a pilot study. *J Am Geriatr Soc*. 1999;47(6):697-702.
8. Mogensen CB, Ankersen ES, Lindberg MJ, et al. Admission rates in a general practitioner-based versus a hospital specialist based, hospital-at-home model: ACCESS, an open-labelled randomised clinical trial of effectiveness. *Scand J Trauma Resusc Emerg Med*. 2018;26(1):26.
9. Tuckson RV, Edmunds M, Hodgkins ML. Telehealth. *N Engl J Med*. 2017;377(16):1585-1592.
10. Sensmeier J. Managing health with remote patient monitoring. *Nurs Manage*. 2021;52(11):13-17.
11. Centers for Medicare & Medicaid Services. Acute hospital care at home. 2020. https://qualitynet.cms.gov/acute-hospital-care-at-home. Accessed May 17, 2022.
12. Centers for Medicare & Medicaid Services. Guidance for calculating the plan all-cause readmissions (PCR) measure in the 2019 adult and health home core sets. *Medicaid & CHIP Health Care Quality Measures: Technical Assistance Resource*. 2019. www.medicaid.gov/medicaid/quality-of-care/downloads/performance-measurement/pcr-resource.pdf. Accessed May 17, 2022.
13. Faul F, Erdfelder E, Buchner A, Lang A-G. Statistical power analyses using G*Power 3.1: tests for correlation and regression analyses. *Behav Res Methods*. 2009;41(4):1149-1160.

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This publication was made possible through the support of a statistician, Nirav Patil, MBBS, MPH, who is employed by the Clinical Research Center of University Hospitals Cleveland Medical Center (UHCMC) and the Case Western Reserve University Clinical and Translational Science Collaborative (CTSC) 4UL1TR000439. Its contents are solely the responsibility of the authors and don't necessarily represent the official views of UHCMC or NIH. The authors and planners have disclosed no relevant financial relationships related to this article.

DOI-10.1097/nmg.0000000000000091