

Advanced Care at Home at Scale in an Integrated Health Care System

Arsheeya Mashaw, MD; Eric Johnson, PhD; Eliza Shulman, DO; Rahul Rastogi, MD; Kevin Varner, MS; Joel Womack, MD; and Keith Crowland, MBA

Advanced care at home (ACAH) provides hospital-level care in patients' homes as a full substitute for traditional hospital care, a model commonly referred to as hospital at home.

The ACAH model has been studied for decades.¹⁻⁴ Results of multiple studies demonstrate improved care quality and utilization metrics such as lower readmission rates, lower costs of care, and lower health service utilization.⁵⁻⁸ Prior to the COVID-19 pandemic, ACAH in the United States was mainly implemented in the context of Medicare Advantage and the US Department of Veterans Affairs health care system.⁹ Due to concerns regarding hospital capacity during the pandemic, CMS promulgated the Acute Hospital Care at Home (AHCaH) waiver, which provides a full hospital fee-for-service (FFS) diagnosis-related group payment for ACAH care for Medicare beneficiaries.¹⁰ To date, 304 hospitals in 37 states have obtained the waiver.¹¹ During the COVID-19 pandemic, several ACAH models were initiated quickly, but relatively few programs achieved large scale and some programs focused their efforts on patients with COVID-19.¹²

Although the AHCaH waiver focuses on FFS Medicare beneficiaries, it ignited significant pent-up demand for ACAH that was not limited to FFS. Medicare Advantage plans, especially those in the context of integrated delivery systems, also implemented ACAH. Despite these advantages, ACAH has not been implemented at scale (ie, by increasing census while maintaining quality care) due to multiple barriers including payment and logistic issues.¹³⁻¹⁸

In April 2020, with 4 weeks' notice, Kaiser Permanente of the Northwest (KPNW)—an integrated managed care system in the Portland, Oregon, metropolitan area—in collaboration with Medically Home Group (MHG) developed and initiated an ACAH care model called Kaiser Permanente at Home. This program provides acute hospital-level care at home, treating a diverse set of diagnoses, as a substitute for traditional acute hospital care.

Although there is no agreed-upon definition of scale, for the purposes of this article, the aim of this study was to determine whether it is feasible to scale Kaiser Permanente at Home care in our integrated delivery system by increasing its census in proportion to our staffing and services without sacrificing quality of care.

ABSTRACT

OBJECTIVES: To assess the feasibility of scaling advanced care at home (ACAH) [otherwise known as hospital at home] within an integrated health care delivery system.

STUDY DESIGN: Retrospective cohort study of patients qualified for hospital-level care who were admitted to either ACAH or a traditional hospital.

METHODS: From April 29, 2020, to November 14, 2021, patients requiring hospital-level care received Kaiser Permanente at Home or traditional hospital care. In a subgroup of patients, we compared outcomes for Kaiser Permanente at Home vs traditional hospital care using regression models.

RESULTS: A total of 1005 patients were admitted to Kaiser Permanente at Home. Average daily census (ADC) was intentionally increased over time in stages, from 7.2 to 8.8, then to 12.7. The maximum daily census was 22, with a peak ADC of 16, representing 9% of the total hospital inpatient medicine service census. During this time, there were numeric decreases in Kaiser Permanente at Home escalation rates (17.5% to 10.8%), median length of stay (7.43 days to 5.46 days), and readmission rates (9.79% to 9.24%). A subgroup of Kaiser Permanente at Home patients contributed to the comparative analyses, which showed that patients admitted to Kaiser Permanente at Home were 64% less likely to experience delirium than patients admitted for traditional hospital care [OR, 0.36; 95% CI, 0.15-0.88; $P = .026$]. Comparisons of quality metrics across stages of implementation (readmissions, escalations, length of stay) were inconclusive.

CONCLUSION: In an integrated delivery system, ACAH care can be scaled and can create hospital capacity. However, our data were inconclusive regarding quality throughout scaling due to the small effective sample size, necessitating replication in a larger prospective study with adequate power/precision.

Am J Manag Care. 2023;29(12):e357-e364. doi:10.37765/ajmc.2023.89469

TAKEAWAY POINTS

Advanced care at home (ACAH) (otherwise known as hospital at home) has been demonstrated to provide safe, high-quality hospital-level care in patients' homes. However, scaling this model has been difficult. In the spring of 2020, Kaiser Permanente of the Northwest and Medically Home Group rapidly developed and initiated a model of care called Kaiser Permanente at Home.

- ▶ This is the largest ACAH case series to be reported to date.
- ▶ This study demonstrates achieving scale with a daily peak of 22 patients a day, representing an average daily census of approximately 9% of 2 traditional hospitals' combined internal medicine service census.
- ▶ Demonstration of ACAH at scale could serve to help Congress as it considers extensions of the Acute Hospital Care at Home waiver.

METHODS

Setting: KP System Overview

KP is an integrated nonprofit managed care system. KPNW is 1 of 8 regions within the KP umbrella. KPNW provides care for approximately 636,854 members in northwest Oregon and southwest Washington.

KPNW patients are treated at 1 of 5 regional hospitals, 2 of which are primary locations meant for KP-insured members (referred to in this article as *core hospitals*). Based on the requirements of the CMS AHCAH waiver, Kaiser Permanente at Home admits patients only from the 2 core hospitals and their 2 emergency departments (EDs) in the Portland, Oregon, metropolitan area.

Kaiser Permanente at Home Clinical Model

Kaiser Permanente at Home is a business collaboration between KPNW and MHG, a technology-enabled health care services company that provides a platform and technology to enable acute integrated hospital-level care at home.

The Kaiser Permanente at Home staffing structure utilizes a virtual physician and nurse assigned to each patient. To do this, the physician/nurse teams leverage virtual care technology and in-home service providers to care for their patients (**Table 1**). This combination of technology and in-home providers allows Kaiser Permanente at Home to duplicate any element of a treatment plan required for medical-level admission. In addition, either a paramedic or a nurse provides in-home assessments at least 2 times a day, and a nurse practitioner performs in-home visits every other day (or daily if the clinical scenario dictates). Details of the staffing are noted in **eAppendix A** (eAppendices available at ajmc.com).

In-Home Technology

Every patient is provided with a set of technologies installed at home on admission (**eAppendix B**) consisting of (1) a tablet computer for video visits, contacting a nurse 24/7, and access to the daily patient schedule; (2) a telephone with a direct line to the nursing command center to provide an additional method of communication; (3) wireless-enabled vital sign equipment (blood pressure cuff, pulse oximeter, thermometer, and scale), which uploads results to the

electronic health record; (4) a wireless wide-area network device, which utilizes cell phone signal for internet and creates a redundant power source (in case of a power outage); and (5) an emergency response device attached to the patient's wrist, allowing the patient to press it anywhere in their home to communicate with their virtual nurse.

Electronic Health Record, Documentation, and Communication

Kaiser Permanente at Home has 3 systems to integrate patient care, documentation, charge capture functions, and team communication: (1) the ambulatory module of Epic used to manage all aspects of patient care; (2) Cesia Continuum, the proprietary software created by MHG to gather clinical information and organize and schedule service provider visits; and (3) secure messaging used to communicate patient care needs and orders.

Kaiser Permanente at Home Model Development and Planned Scaling

In the fall of 2019, KPNW partnered with MHG to create and implement an ACAH model. In response to the COVID-19 pandemic, the implementation timeline was accelerated to start within 4 weeks. In March 2020, stakeholders from both KPNW and MHG met daily to develop care plans, flow protocols, and guidelines for admission and treatment. This was followed by detailed live simulations to test all aspects of the care model prior to caring for our first patient. We completed 127 simulations testing all components of Kaiser Permanente at Home over the course of 3 weeks prior to the go-live date.

With a focus on demonstrating safety and scalability, patient census was increased over 3 stages. In addition, at each phase, the physician, nursing, and service provider staff were increased to maintain consistent staffing ratios. From program start (April 29, 2020) to September 2020 (stage 1), the daily census was kept below 10 patients. From October 2020 to February 2021 (stage 2), the daily census cap was limited to 15 patients a day. Finally, in March 2021 (stage 3), physician and nursing staff were adjusted for a maximum daily census of 25 patients a day.

Participants: Screening and Program Eligibility

A detailed description of the admitting and screening process as well as eligibility details is provided in **eAppendix C**. Each day, a Kaiser Permanente at Home nurse reviewed patients currently admitted to the core hospitals and EDs for Kaiser Permanente at Home admission potential. Once a potential patient was identified, they required a social screen done by a Kaiser Permanente at Home nurse and a clinical screen done by a Kaiser Permanente at Home physician (utilizing MCG criteria to ensure inpatient-level admission as well as a clinical safety screen for Kaiser Permanente at Home care). Eligible patients who passed both the social and

TABLE 1. In-Home Service Providers Utilized by Kaiser Permanente at Home

In-home service provider	Details
Paramedic	<ul style="list-style-type: none"> Internal contract to ensure staffing Administers IV medication Provides face-to-face clinical assessments 1-2 times per day on all patients Performs laboratory draws Has i-STAT capability (laboratory results within minutes) Provides urgent visit within 45 minutes, including electrocardiogram, IV fluid bolus, stat medication selection Is available 24/7
Transportation	<ul style="list-style-type: none"> Provides several levels of patient transportation to and from hospital services
Infusion nursing	<ul style="list-style-type: none"> Administers IV medication infusion Also utilized for face-to-face clinical assessments 1-2 times per day for each patient (if not done by the paramedic)
Pharmacy	<ul style="list-style-type: none"> 2 different pharmacy services to ensure redundancy Provide IV medications Outpatient pharmacy utilized for oral medications Pharmacist attends daily team meetings to discuss patient care. Ensure dosing of medications and antibiotic stewardship Are available 24/7
Nurse practitioner	<ul style="list-style-type: none"> Ensures in-person assessment by advanced care provider Generally sees each patient on day 2 and day 4 after the admission date Will also see patients as needed Provides wound care services in conjunction with a virtual wound, ostomy, and continence nurses service
Home health aid	<ul style="list-style-type: none"> Internal contract to ensure staffing Is available 24/7 for the duration of a patient’s Kaiser Permanente at Home admission, if necessary
Mobile imaging	<ul style="list-style-type: none"> Provides mobile x-ray, ultrasound, echocardiogram Is available 24/7
Courier	<ul style="list-style-type: none"> Transports IV and oral medications and laboratory specimens to and from patient homes
Durable medical equipment including oxygen services	Source separate from the home health company that Kaiser Permanente of the Northwest uses
Skilled services	<ul style="list-style-type: none"> Provides physical therapy, occupational therapy, and speech-language pathology
Phlebotomy	<ul style="list-style-type: none"> Performs in-home phlebotomy draws Is available 24/7
Vascular access	<ul style="list-style-type: none"> Provides in-home peripheral IV care and midline or peripherally inserted central catheter line placement Is available 24/7
Medical meals	<ul style="list-style-type: none"> Tailored to medical needs, and delivered fresh daily Duplicated with Instacart food delivery

IV, intravenous.

clinical screens and who consented to Kaiser Permanente at Home treatment were then brought home with medical transportation.

When the patient arrived home, a paramedic set up and tested the technology elements. This was then followed by an admission video visit with the Kaiser Permanente at Home physician and nurse team.

Daily Rounds and Discharge Intervention

Each morning, a huddle was held with team nurses, physicians, nurse practitioners, and a pharmacist. Patients were discussed, and a care plan was developed by the team. The attending physician then performed prescheduled video visits to mirror rounds in the traditional hospital. If a patient required transfer to the traditional

hospital, they were “escalated” back to a KP hospital, if possible. Kaiser Permanente at Home has developed care pathways/algorithms for different escalation scenarios.

Details of the discharge process are listed in [eAppendix D](#). Kaiser Permanente at Home cared for only patients in the acute level of care without a subacute phase. Therefore, the clinical discharge criteria were the same criteria used in a traditional hospital setting. However, in the Kaiser Permanente at Home model, the discharge process can leverage the presence of the care team being in the patient’s home. Medication reconciliation takes advantage of having the patient’s actual medications in hand. The technology was usually removed on the day of discharge.

Study Design

We conducted a descriptive, time-series cohort study for all patients admitted to Kaiser Permanente at Home and followed them through their hospital stay and for 30 days after hospital discharge. We also conducted a comparative cohort study in a subgroup of patients who presented to 1 of the 2 core hospitals and were admitted to either Kaiser Permanente at Home or a core hospital. The comparative study was restricted to stages 2 and 3 of the Kaiser Permanente at Home implementation and to 2 settings: patients who presented to the ED and, separately, patients who were observed on the hospitals' internal medicine floors. In the comparative study, patients were followed through their hospital stay and for 30 days after hospital discharge (see [eAppendix E](#) for reasoning).

The Northwest Permanente Institutional Review Board (IRB) reviewed the details of the study and deemed it quality improvement and thus exempt from IRB review.

Quality Outcomes

Quality metrics included length of stay, 30-day readmission rates, falls with moderate injury, medication errors with injury, escalation rate, equipment safety events with harm, and unanticipated death. *Escalation rate* was defined by patients who were transferred back to the inpatient hospital setting and did not return to Kaiser Permanente at Home care.

Data Collection

All data to build and collect program metrics were extracted from KP HealthConnect (the KP version of Epic) and from MHG's internal records. Kaiser Permanente at Home patient care experience data were collected through a third party as a phone interview using the Hospital Consumer Assessment of Healthcare Providers and Systems survey questions (arranged by MHG) only for patients admitted to Kaiser Permanente at Home directly from the ED. Patient acuity was measured utilizing case mix index (CMI). Although there is some evidence that CMI is a relatively good indicator of disease acuity,¹⁹ KPNW does not capture more stringent comprehensive measures of acuity such as All Patient Refined Diagnosis Related Groups. Delirium was determined via coding and billing data derived from physician documentation of changes in patient cognitive status. Unexpected mortality is not calculated in the traditional hospital population routinely and therefore not reported in results.

Statistical Analysis

The descriptive Kaiser Permanente at Home cohort of 1005 patients was characterized at the time of admission. Kaiser Permanente at Home's average daily census (ADC) and quality outcomes were reported, stratified by 3 stages of implementation, using percentages and means (eg, length of hospital stay). In addition, patient satisfaction data were both descriptive and comparative and could not be adjusted for patient characteristics. Because of this, it was not possible to include these data in the subgroup analysis.

We were able to compare quality outcomes for Kaiser Permanente at Home and conventional hospitals only for a subgroup of patients who presented to 1 of the 2 core KPNW hospitals. The details about the propensity score development, assessment, and regression analyses appear in [eAppendix E](#). Note that CMI and length of stay were considered intermediate variables, as they are calculated at the time of hospital discharge.

RESULTS

Patient Characteristics and Health Care Use

As noted in [Table 2](#), between April 29, 2020, and November 14, 2021, 1005 patients were admitted to Kaiser Permanente at Home. The proportion of patients admitted to Kaiser Permanente at Home from the ED varied between 20% and 25% across implementation stages. The ADC increased from 7.2 to 12.7 from stage 1 to stage 3 of implementation. The highest monthly ADC was noted to be 16, and the maximum patients on a daily census was 22. During the study period, the ADC of the hospital medicine service in the traditional hospital varied from 165 to 207 between both core hospitals. During the month in which the Kaiser Permanente at Home ADC was 16, the internal medicine ADC was 182.

The median length of stay for Kaiser Permanente at Home patients admitted from the ED decreased in a steady fashion from 7.43 days in stage 1 to 5.46 during stage 3. Readmission rates for Kaiser Permanente at Home patients went from 11.52% during stage 2 to 9.24% in stage 3. Overall, 13.2% of patients were escalated and completed their admission in traditional hospital care; this rate decreased across each stage of implementation from 17.5% to 10.8%.

Quality Outcomes and Care Experience

As noted in [Table 2 \(B\)](#), Kaiser Permanente at Home and traditional hospital patients (at our core hospitals) gave an overall hospital rating of 78 vs 75, respectively (out of 100). "Willingness to recommend hospital" scores were 78 vs 76, respectively. In the Kaiser Permanente at Home group, falls with moderate injury had a rate of 1.06 per 1000 patient-days (6 total), and medication errors with injury were noted to be 0.53 per 1000 patient-days (2 total). There was 1 unanticipated death and 2 equipment safety events in the Kaiser Permanente at Home group. There were no catheter-associated urinary tract infection or central line-associated bloodstream infection events.

Readmission rates, length of stay, and delirium rates were compared across stages among 911 patients' first Kaiser Permanente at Home admission. There were 79 observed 30-day readmissions; the OR comparing stage 2 vs stage 1 was 1.09 (95% CI, 0.53-2.26). The OR for readmissions comparing stage 3 vs stage 1 was 0.808 (95% CI, 0.42-1.54).

There were 13 observed delirium events; the OR comparing stage 2 vs stage 1 was 0.22 (95% CI, 0.02-2.13). The OR for delirium comparing stage 3 vs stage 1 was 0.71 (95% CI, 0.19-2.65).

The length of stay across the 3 stages appeared to decrease as ADC was increased, with stage 2 admissions lasting on average 2.06 fewer

days (95% CI, -2.95 to -1.17; $P < .0001$) and stage 3 admissions lasting on average 3.11 fewer days (95% CI, -3.88 to -2.35; $P < .0001$).

Diagnoses Treated

Several diagnoses were managed with Kaiser Permanente at Home (Table 3). The most common diagnoses were congestive heart failure exacerbation, COVID-19 pneumonia, cellulitis, urinary tract infection/pyelonephritis, respiratory illnesses, and other diagnoses not typically treated in the ACAH model.

Comparative Findings From Subgroups

Table 4 (A) shows the distribution of patient characteristics for the subgroup of patients who were admitted to Kaiser Permanente at Home from the ED (n = 59) and their controls (n = 1738) admitted to traditional hospital care. Table 4 (B) shows the subgroup of patients admitted to Kaiser Permanente at Home from the internal medicine floor (n = 218) and their controls (n = 5344) admitted to traditional hospital care. For subgroup 4a, the Charlson Comorbidity Index score was imbalanced and required adjustment in the regression models. For subgroup 4b, Charlson Comorbidity Index, ED visits, and days in hospital were imbalanced and required adjustment in the regression models.

Patients admitted to Kaiser Permanente at Home from the ED experienced a similar risk of 30-day readmission as the patients admitted to a conventional hospital (OR, 0.95; 95% CI, 0.42-2.13; $P = .89$) (Table 5 [A]). Patients admitted to Kaiser Permanente at Home from the internal medicine floor also experienced a similar risk of 30-day readmission as patients admitted to a traditional hospital (OR, 0.93; 95% CI, 0.59-1.47; $P = .75$) (Table 5 [B]). Across both settings, 29 Kaiser Permanente at Home patients were readmitted. The pooled OR for readmission was 0.95 (95% CI, 0.63-1.39; $P = .73$).

Patients admitted to Kaiser Permanente at Home from the ED were numerically less likely to experience delirium than patients admitted to a conventional hospital (OR, 0.62; 95% CI, 0.15-2.63; $P = .52$) (Table 5 [A]). Patients admitted to Kaiser Permanente at Home from the internal medicine floor were significantly less likely to suffer delirium than patients admitted to a

TABLE 2. Characteristics of Patients in the Kaiser Permanente at Home Program Between April 29, 2020, and November 14, 2021

A. Utilization metrics		
Metric	Kaiser Permanente at Home n = 1005	
Patients admitted during each phase		
Stage 1: April 29, 2020, to September 2020 (5 months)	143	
Stage 2: October 2020 to February 2021 (5 months)	217	
Stage 3: March 2021 to patient 1005's admittance (11/14/21) (8.5 months)	645	
Patients admitted from ED vs transfer from medical floor	ED admits	Medical floor
Stage 1	25% (36)	75% (107)
Stage 2	20% (43)	80% (174)
Stage 3	23% (148)	77% (497)
Median (SD) length of stay in days, subgroup of patients admitted from ED		
Overall	5.46 (4.03)	
Stage 1	7.43 (6.51)	
Stage 2	6.24 (5.35)	
Stage 3	5.46 (4.03)	
Overall mean (SD) length of stay in days	5.64 (4.38)	
Overall mean (SD) length of stay prior to Kaiser Permanente at Home admit in days	1.84 (1.55)	
Readmission rates		
Overall	9.95%	
Stage 1	9.79%	
Stage 2	11.52%	
Stage 3	9.24%	
ADC, mean (daily range)		
Stage 1	7.2 (5-13)	
Stage 2	8.8 (5-15)	
Stage 3	12.7 (6-22)	
Peak ADC (September 2021)	16 (12-21)	
Escalation to hospital admit, n (%)		
Overall	132 (13.2%)	
Stage 1	25 (17.5%)	
Stage 2	38 (17.5%)	
Stage 3	70 (10.8%)	
B. Quality data		
Patient experience scores out of 100	Kaiser Permanente at Home	Core hospital
Overall hospital rating	78	75
Willingness to recommend hospital	78	76
Falls with moderate injury, n (rate per 1000 patient-days)	6 (1.06)	
Medication errors with injury (including adverse drug reactions), n (rate per 1000 patient-days)	2 (0.53)	
Equipment safety events with harm, n (%)	2 (0.2%)	
CAUTI/CLABSI, n (%)	0 (0%)	
Unanticipated death, n (%)	1 (0.01%)	

ADC, average daily census; CAUTI, catheter-associated urinary tract infection; CLABSI, central line-associated bloodstream infection; ED, emergency department.

CLINICAL

TABLE 3. Diagnoses Treated by Kaiser Permanente at Home During Study

Diagnosis	% of patients
Congestive heart failure	29.4%
COVID-19 pneumonia	20%
Cellulitis	14.1%
Urinary tract infection/pyelonephritis	8%
Pneumonia	7.2%
Chronic obstructive pulmonary disease exacerbation	4%
Sepsis	3%
Bacteremia	1.7%
Inflammatory bowel disease flare	1.4%
Hyponatremia	1.2%
Neutropenic fever	1.1%
Other diagnoses	9%

conventional hospital (OR, 0.25; 95% CI, 0.08-0.80; $P = .02$) (Table 5 [B]). When we pooled the ORs, the risk of delirium was reduced by 64% (OR, 0.36; 95% CI, 0.15-0.88; $P = .026$).

Patients admitted to Kaiser Permanente at Home from the ED stayed in the hospital 1.41 days longer than patients admitted to a conventional hospital (mean difference, 1.41; 95% CI, 0.14-2.68; $P = .03$).

Kaiser Permanente at Home patients had a slightly lower acuity (CMI) than traditional hospital patients for the subgroup triaged from the ED (mean, 1.61 vs 2.01; standardized mean difference [SMD] = -0.242). In contrast, the acuity was equivalent for the Kaiser Permanente at Home patients triaged from the internal medicine floor and traditional hospital patients (1.51 vs 1.63; SMD = 0.007).

DISCUSSION

To our knowledge, this analysis involved the largest number of patients studied in an ACAH program and is the first study to demonstrate that ACAH can be quickly launched and scaled. Similar to prior studies of ACAH, patient care experience and quality were comparable between ACAH and traditional hospital care. Furthermore, all ACAH patients met MHG criteria for inpatient hospital admission, and patients admitted from the internal medicine floor had balanced clinical acuity (CMI) between groups.

Kaiser Permanente at Home was launched over the course of 4 weeks to help our system create hospital capacity in the context of the COVID-19 pandemic by leveraging the strengths of 2 organizations (KP and MHG). We note that compared with other ACAH models initiated quickly during the pandemic, our model was not specific to caring for patients with COVID-19.¹² Instead, we created hospital capacity by providing hospital-level care in patients' homes for a variety of diagnoses. In addition, we were able to safely scale the Kaiser Permanente at Home census, with a monthly ADC high of 16 during this study, representing 9% of our core hospitals' internal medicine census. Therefore, the implications of this study reach far beyond the COVID-19 pandemic and position the ACAH model

TABLE 4. Propensity Score–Matched Group Data

A. Patients triaged from the ED into Kaiser Permanente at Home (n = 59) or traditional hospital admission (n = 1738)		
Characteristic	Kaiser Permanente at Home (n = 59)	Standardized difference after propensity score
In propensity score		
Age in years	64.8	-0.06
Age categories in years		N/A
< 65	44.1%	
65-75	32.5%	
76-85	20.3%	
> 85	3.4%	
CCI score ^a	3.4	0.13
ED visits ^a	1.95	0.06
LN days in hospital ^a	1.45	-0.08
Not in propensity score		
Female	47.5%	0.01
Non-White race	13.6%	-0.20
Case mix index	1.61	-0.2420
B. Patients triaged from the internal medicine floor into Kaiser Permanente at Home (n = 221) or traditional hospital admission (n = 5344)		
Characteristic	Kaiser Permanente at Home (n = 221)	Standardized difference
In propensity score		
Age in years	63.5	-0.05
Age categories in years		N/A
< 65	49.3%	
65-75	19.0%	
76-85	22.6%	
> 85	9.0%	
CCI score ^a	4.3	0.13
ED visits ^a	1.96	-0.13
LN days in hospital ^a	1.34	-0.18
Not in propensity score		
Female	51.8%	-0.04
Non-White race	19.5%	0.05
Case mix index	1.51	0.0070

CCI, Charlson Comorbidity Index; ED, emergency department; N/A, not applicable.

^aCCI is a modernized version of the original score that has been reweighted and does not include age. ED and days in hospital include visits from the prior 6 months. Days in hospital was log transformed.

of care as a safe solution for hospital capacity barriers such as the rapidly growing population 65 years and older driven by aging baby boomers.^{20,21}

Implementing Kaiser Permanente at Home in stages facilitated controlled growth of the ACAH program with strong attention to quality and safety. Ongoing quality improvement work focused on

TABLE 5. Propensity Score–Matched Group Quality Data

A. Crude incidence of clinical outcomes and propensity score–adjusted ORs and 95% CIs among patients triaged from the ED into Kaiser Permanente at Home or traditional hospital admission			
Outcome	Kaiser Permanente at Home (n = 59)	Traditional hospital (n = 1738)	Adjusted OR (95% CI) and P
30-day readmission, n (%)	7 (11.9%)	215 (12.4%)	0.95 (0.42-2.13); P = .89
Delirium, n (%)	2 (3.4%)	104 (6.0%)	0.62 (0.15-2.63); P = .52
B. Crude incidence of clinical outcomes and propensity score–adjusted ORs and 95% CIs among patients triaged from the internal medicine floor into Kaiser Permanente at Home or traditional hospital admission			
Outcome	Kaiser Permanente at Home (n = 218)	Traditional hospital (n = 5344)	Adjusted OR (95% CI) and P
30-day readmission, n (%)	22 (10.1%)	597 (11.2%)	0.93 (0.59-1.47); P = .75
Delirium, n (%)	3 (1.4%)	342 (6.4%)	0.25 (0.08-0.80); P = .02

ED, emergency department.

ensuring reliable, safe clinical processes, including team communication, information transfer, and integrated supply chain and logistics. Notably, as the program matured, numerical changes in readmission rates, escalation rates, and length of stay decreased as the ADC increased.

The escalation rates were higher in our study than those reported in prior studies of ACAH^{4,8} but similar to others.² These escalation rates may have been a result of the higher illness acuity and greater diversity of diagnoses treated in Kaiser Permanente at Home than other ACAH models studied. For example, although a low escalation rate was reported by Levine et al,⁸ they noted as a limitation that “patients were carefully selected for lower risk for clinical deterioration.” Similarly, Leff et al⁴ reported a much lower escalation rate, but their study was limited to 4 diagnoses. In this context of higher illness acuity and greater diversity of diagnoses, the authors would like to note that with Kaiser Permanente at Home’s layer of technology, logistics, and supply chain, we were able to escalate all patients safely and effectively and had 0.1% unexpected mortality. In addition, the escalation rates improved over time, which most likely reflects the program’s ongoing quality improvement processes; however, further study is necessary.

The Kaiser Permanente at Home group’s length of stay was longer than that of the comparison population and longer than length-of-stay data noted in other ACAH studies.^{4,8} There are several possible reasons that our data differ from previously reported ACAH data regarding length of stay and readmission rates.^{4,8} As discussed earlier, these differences were most likely due to the higher acuity treated with Kaiser Permanente at Home. In addition, the focus on safety in light of the very aggressive ramp-up likely contributed to these differences, as evidenced by a decreasing length of stay and readmission rates over the 3 phases.

Finally, as noted in previous studies of ACAH outcomes,⁴ we also saw significantly lower delirium rates among Kaiser Permanente at Home patients compared with the cohort population. As Leff et al noted, this suggests that the care environment can play a significant role in a patient’s recovery.⁴ However, we also note that our data did not include acuity of delirium.

Limitations

This study has several limitations. This was not a randomized controlled study; it was an observational one. Also, our data were insufficient to reliably compare falls and medication errors with those in the comparison population. Although stage-specific comparative analyses between Kaiser Permanente at Home and traditional hospital care would be ideal, we had to pool findings across stages to achieve adequate precision; stage-specific analyses would be so imprecise that they would not inform decision-making.

Moreover, the study was performed in a single health system in a single geographic region among patients insured by KP, which may limit generalizability of the results. In addition, patient satisfaction data were not generated the same way as for the hospitals, which could affect true outcomes.

CONCLUSIONS

Kaiser Permanente at Home can be implemented at scale for acute medical illness requiring hospital-level care as an alternative to traditional hospital care. In this study, the imprecise comparisons in the small subgroup are unable to support equivalence for quality outcomes. Because of this, they establish the potential for a future adequately powered randomized control trial to study quality outcomes in ACAH at higher scale than previous studies. Finally, the lack of metrics to describe effect on hospital capacity minimizes the ability to measure the impact of capacity created. It will also be important to duplicate these results in a nonintegrated health care setting. ■

Acknowledgments

The authors would like to acknowledge Mary Giswold, MD; Farah Pakseresht; David Mosen; Jillian Croslin; Melissa Blanchard; Andrew Ball; Erik Hansen; Sadie Paez; John Kendrick; Nita Pecos; Alex Gerace; Chris Koppenhafer; T. K. Tandy; Kela Edvalson; Naomi Loo; and John Kendrick.

Author Affiliations: Northwest Permanente PC, Hillsboro, OR (AM), Portland, OR (EJ, RR, KV), and Clackamas, OR (JW); Medically Home Group (ES), Boston, MA; Kaiser Foundation Health Plan of the Northwest (KC), Portland, OR.

Source of Funding: This project was funded by Kaiser Foundation Health Plan of the Northwest and Northwest Permanente PC and launched in collaboration with Medically Home Group.

Author Disclosures: Dr Mashaw, Dr Johnson, Dr Rastogi, Mr Varner, and Dr Womack are employed by Northwest Permanente, which collaborates with Kaiser Foundation Health Plan and Medically Home Group to admit patients to Kaiser Permanente at Home and evaluate the program. Dr Shulman is an employee at Medically Home Group. Mr Crowland is employed by Kaiser Permanente, the organization implementing the model of care being studied.

Authorship Information: Concept and design (AM, ES, RR); acquisition of data (ES, KV, KC); analysis and interpretation of data (AM, EJ, KC); drafting of the manuscript (AM, EJ, ES, RR, KV, KC); critical revision of the manuscript for important intellectual content (AM, EJ, ES, JW); statistical analysis (EJ); administrative, technical, or logistic support (AM, RR, KV, JW); and supervision (AM, JW).

Address Correspondence to: Arsheeya Mashaw, MD, Northwest Permanente PC, 2875 NE Stucki Ave, Hillsboro, OR 97124. Email: arsheeya.mashaw@kp.org.

REFERENCES

- Leff B, Burton L, Bynum JW, et al. Prospective evaluation of clinical criteria to select older persons with acute medical illness for care in a hypothetical home hospital. *J Am Geriatr Soc*. 1997;45(9):1066-1073. doi:10.1111/j.1532-5415.1997.tb05968.x
- Federman AD, Soones T, DeCherrie LV, Leff B, Siu AL. Association of a bundled hospital-at-home and 30-day postacute transitional care program with clinical outcomes and patient experiences. *JAMA Intern Med*. 2018;178(8):1033-1040. doi:10.1001/jamainternmed.2018.2562
- Leff B. Defining and disseminating the hospital-at-home model. *CMAJ*. 2009;180(2):156-157. doi:10.1503/cmaj.081891
- Leff B, Burton L, Mader SL, et al. Hospital at home: feasibility and outcomes of a program to provide hospital-level care at home for acutely ill older patients. *Ann Intern Med*. 2005;143(11):798-808. doi:10.7326/0003-4819-143-11-200512060-00008
- Shepperd S, Iliffe S, Doll H, et al. Admission avoidance hospital at home. *Cochrane Database Syst Rev*. 2016;9(9):CD007491. doi:10.1002/14651858.CD007491.pub2
- Shepperd S, Iliffe S. Hospital at home versus in-patient hospital care. *Cochrane Database Syst Rev*. 2005;3(3):CD000356. doi:10.1002/14651858.CD000356.pub2
- Shepperd S, Doll H, Angus RM, et al. Avoiding hospital admission through provision of hospital care at home: a systematic review and meta-analysis of individual patient data. *CMAJ*. 2009;180(2):175-182. doi:10.1503/cmaj.081491
- Levine DM, Ouchi K, Blanchfield B, et al. Hospital-level care at home for acutely ill adults: a randomized controlled trial. *Ann Intern Med*. 2020;172(2):77-85. doi:10.7326/M19-0600
- Cryer L, Shannon SB, Van Amsterdam M, Leff B. Costs for 'hospital at home' patients were 19 percent lower, with equal or better outcomes compared to similar inpatients. *Health Aff (Millwood)*. 2012;31(6):1237-1243. doi:10.1377/hlthaff.2011.1132
- Acute Hospital Care at Home. CMS. Accessed April 20, 2021. <https://qualitynet.cms.gov/acute-hospital-care-at-home>
- Acute Hospital Care at Home resources. Updated November 10, 2023. Accessed November 2, 2022. <https://qualitynet.cms.gov/acute-hospital-care-at-home/resources>
- Sitammagari K, Murphy S, Kowalkowski M, et al. Insights from rapid deployment of a "virtual hospital" as standard care during the COVID-19 pandemic. *Ann Intern Med*. 2021;174(2):192-199. doi:10.7326/M20-4076
- Wong JB, Cohen JT. Hospital care at home: better, cheaper, faster? *Ann Intern Med*. 2020;172(2):145-146. doi:10.7326/M19-3714
- Cheng J, Montalto M, Leff B. Hospital at home. *Clin Geriatr Med*. 2009;25(1):79-91. vi. doi:10.1016/j.cger.2008.10.002
- Siu AL, Zimbroff RM, Federman AD, et al. The effect of adapting hospital at home to facilitate implementation and sustainment on program drift or voltage drop. *BMC Health Serv Res*. 2019;19(1):264. doi:10.1186/s12913-019-4063-8
- Brody AA, Arbaje AI, DeCherrie LV, Federman AD, Leff B, Siu AL. Starting up a hospital at home program: facilitators and barriers to implementation. *J Am Geriatr Soc*. 2019;67(3):588-595. doi:10.1111/jgs.15782
- Chua MSC, Ko SQ, Lai YF, Lim YW, Shorey S. Perceptions of hospital-at-home among stakeholders: a meta-synthesis. *J Gen Intern Med*. 2022;37(3):637-650. doi:10.1007/s11606-021-07065-0
- Leong MQ, Lim CW, Lai YF. Comparison of hospital-at-home models: a systematic review of reviews. *BMJ Open*. 2021;11(1):e043285. doi:10.1136/bmjopen-2020-043285
- Mendez CM, Harrington DW, Christenson P, Spellberg B. Impact of hospital variables on case mix index as a marker of disease severity. *Popul Health Manag*. 2014;17(1):28-34. doi:10.1089/pop.2013.0002
- Bazzoli GJ, Brewster LR, Liu G, Kuo S. Does US hospital capacity need to be expanded? *Health Aff (Millwood)*. 2003;22(6):40-54. doi:10.1377/hlthaff.22.6.40
- Song Z, Ferris TG. Baby boomers and beds: a demographic challenge for the ages. *J Gen Intern Med*. 2018;33(3):367-369. doi:10.1007/s11606-017-4257-x

Visit ajmc.com/link/89469 to download PDF and eAppendix

Advanced Care at Home at Scale in an Integrated Health Care System: eAppendices

eAppendix A. Staffing Model

Kaiser Permanente at Home Core Staff	Notes
Physician	<ul style="list-style-type: none"> • Hospitalist physicians employed by NW Permanente Physician Group • These physicians are Hospitalists who have had Kaiser Permanente at Home training and do both normal traditional hospital care as well as Kaiser Permanente at Home • 2 physicians staffed per day <ul style="list-style-type: none"> - Physician A maintains 14:1 patient to physician ratio when rounding - Physician B maintains 7:1 ratio on patients that they round on while admitting patients to Kaiser Permanente at Home (typically 3-5 admissions daily) • Physician orientation is 5 days of rounding in led by the Kaiser Permanente at Home Medical Director with orientation checklist and manual. • Physicians maintain skills by rounding for at least 5 days a month on the Kaiser Permanente at Home service. • Total Kaiser Permanente at Home physician pool is kept at a number such that all physicians can round a minimum of 5 days/month for Kaiser Permanente at Home • Kaiser Permanente at Home physicians attend 2 team meetings per month focused on ACAH topics such as virtual physical exam techniques, escalations, etc
Brick-and-mortar Admitting Hospitalist	<ul style="list-style-type: none"> • Hospitalist admitting shift embedded in the larger core hospital • This hospitalist is trained in doing Kaiser Permanente at Home admissions (including clinical screening techniques) • Admits patients in the ED to Kaiser Permanente at Home from 12-10pm. If no Kaiser Permanente at Home patients available this attending admits to the brick-and-mortar hospital as usual. • These physicians have all volunteered to do this shift and to get specific training to do Kaiser Permanente at Home admissions.
Virtual Nurse	<ul style="list-style-type: none"> • These nurses are specifically trained to do virtual ACAH nursing care • Patient to nurse ratio is based on complexity of patients • Typical patient to nurse ratio is (4 or 5):1
Nurse Practitioner	<ul style="list-style-type: none"> • Staffing is kept such that NPs can see all patients on day 2 and 4 and then if necessitated by patient care issues • Responsible for basic wound care • Supervised by Kaiser Permanente at Home attending physician

eAppendix B. Picture of Tech Setup Installed at Each Patient Home



eAppendix C. Admission Components

Kaiser Permanente at Home Admission Components	Details
Initial screen:	<p>Patients are eligible for Kaiser Permanente at Home if they:</p> <ul style="list-style-type: none"> • Were insured by KP • lived in a set geographic catchment area defined by ability for 911 response, as well as service provider access • met inpatient clinical criteria (using MCG™ criteria) • Based on the requirements of the CMS AHCaH waiver, eligible patients were admitted only from the emergency department or inpatient medical ward.
Clinical Screening Criteria	<ul style="list-style-type: none"> • Takes into account an initial conversation between ED or Hospital Medicine attending (who has been treating patient) with the Kaiser Permanente at Home admitting physician • There are no limits to diagnoses based on the clinical screen. However, there are specific exclusion criteria for specific diagnoses created in conjunction with subspecialties within the NWKP organization • The clinical screen is a detailed stepwise analysis which focuses on the attending physician’s ability to demonstrate that patients care plan, clinical safety, and needs can be duplicated in the ACAH setting. • The Clinical screen also ensures that the patient meets inpatient (not observation) level care utilizing MCG criteria as a standard.
Social screening	<ul style="list-style-type: none"> • Performed by a Kaiser Permanente at Home nurse over the phone with the patient or caregiver • Questions focus on safety criteria for a home setting appropriate for care. ie: home structurally sound, appropriate for temperature control, adequate hygiene, running water, safe psychosocial environment, including locked guns and restrained pets • Although, patient caregivers are important stakeholders and give input into the Social Screen, caregiver support is NOT required – our model offers Home Health Aids for as long as required by the patient or family such that they are monitored during the entirety of admission (sometimes 24 hours for the duration of admission).
Admission Process	<ul style="list-style-type: none"> • If a patient was ultimately admitted to Kaiser Permanente at Home, a hospitalist at the core hospital (ED or floor) performs a full admission H&P prior to the patient going home. • Once tech setup and initial assessment are finished by the admitting paramedic and nurse, the physician does an admission video visit which includes med/rec with patient’s medications on hand.
Patient consent	<ul style="list-style-type: none"> • Patient consent is signed on a form scanned into patient chart

EMR transparency and documentation	<ul style="list-style-type: none">• Once patient is admitted to Kaiser Permanente at Home, a banner on their chart notifies that the patient is currently admitted.• All progress notes from acute Kaiser Permanente at Home admission are visible by any clinical team member in patient's chart and identified by the Kaiser Permanente at Home department name.• Discharge summary forwarded to all care team providers upon discharge.
--	--

eAppendix D. Discharge Components

Kaiser Permanente at Home Discharge Components	Details
Discharge Criteria	<ul style="list-style-type: none"> • Because Kaiser Permanente at Home does not have a subacute phase, discharge criteria used by Kaiser Permanente at Home physicians are the same as used in the traditional hospital setting.
Medication reconciliation	<ul style="list-style-type: none"> • During the day of discharge video visit a final medication list is reviewed by the attending physician with the patient or caregiver.
Patient discharge information	<ul style="list-style-type: none"> • A final discharge medication list is provided to the patient on day of discharge • Discharge information and patient education are also provided in the form of an after visit summary on day of discharge
Social Determinants of Health	<ul style="list-style-type: none"> • Patients are screened for needs in social determinants of health during their Kaiser Permanente at Home admission. • Upon discharge a referral is made to Kaiser “navigators” who are specially trained staff who utilize Kaiser and community resources in order to attempt to address SDOH needs. <ul style="list-style-type: none"> - Navigators are specially trained staff who are able to address SDOH needs by utilizing both KP and community resources.
PCP follow up	<ul style="list-style-type: none"> • A follow up with patient’s PCP is scheduled within 5 days of DC • DC summary forwarded to PCP and treatment team providers

eAppendix E. Details of Propensity Score Matched Data Analysis and Results

For a subgroup of patients, we compared the cohort admitted to Kaiser Permanente at Home with the cohort admitted for traditional hospital care. To reduce confounding in the comparison, we developed separate propensity scores for each setting: patients who presented to the emergency department at a core hospital; and patients who were admitted from the internal medicine floor at a core hospital (1). We excluded stage 1 patients from the propensity scores and comparisons because experts have demonstrated that the earliest patients to receive any intervention do not reflect subsequent clinical equipoise.[2] Propensity Score variables included: age, Charlson comorbidity index, the number of emergency department visits in the preceding six months, and the total days hospitalized in the preceding six months We used logistic regression to develop the propensity scores (ie, the propensity of admission to Kaiser Permanente at Home). [3] For the first propensity score (emergency department), the propensities allowed us to form four groups with sufficient overlap between cohorts. For the second propensity score (internal medicine floor), the propensities allowed us to form seven groups with sufficient overlap between cohorts. Those groups, defined by their propensities for admission, served as indicator variables in the regression analyses. We controlled for the propensity score. [3].

To assess how successfully the propensity scores balanced patient characteristics across the cohorts we calculated the standardized mean differences[1]. When a characteristic was imbalanced (standardized difference >0.1), we adjusted for the characteristic in addition to the propensity score to reduce residual confounding. Although race (White vs non-White) was not in the propensity score, we adjusted all analyses for race.

To compare the incidence of 30-day readmission between Kaiser Permanente at Home and traditional hospitalization, we fit two logistic regression models that adjusted for the setting-specific propensity score, race, and any characteristics that were imbalanced (eg, Charlson comorbidity score). The adjusted odds ratios for Kaiser Permanente at Home from those logistic regressions estimated the comparative incidence of readmission. We pooled those setting-specific odds ratios using a fixed-effects meta-analysis to obtain a more precise summary estimate.[4]

To compare the incidence of delirium between Kaiser Permanente at Home and conventional hospitalization we followed the same statistical procedures described above for 30-

day readmission (ie, setting-specific logistic regressions with subsequent pooling by meta-analysis).

To compare the length of stay between Kaiser Permanente at Home and conventional hospitalization, we fit one linear regression model that adjusted for the emergency department setting's propensity score, race and any characteristics that were imbalanced. We did not compare length of stay for the internal medicine floor setting because only a fraction of the length of stay occurred during Kaiser Permanente at Home. The adjusted mean difference for Kaiser Permanente at Home from the linear regression model estimated the comparative length of stay.

CITATIONS:

1. Webster-Clark M, Sturmer T, Wang T, et al. Using propensity scores to estimate effects of treatment initiation decisions: state of the science. *Stat Med* 2021;40:1718-35.
2. Shin H, Schneeweiss S, Glynn RJ, Patorno E. Evolving channeling in prescribing SGLT-2 inhibitors as first-line treatment for type 2 diabetes. *Pharmacoepidemiology Drug Safety* 2022;31:566-76.
3. Sturmer T, Wyss R, Glynn RJ, Brookhart MA. Propensity scores for confounder adjustment when assessing the effects of medical interventions using nonexperimental study designs. *J Intern Med* 2014;275:570-80.
4. Harris RJ, Bradburn MJ, Deeks JJ, Harbord RM, Altman DG, Sterne JA. Metan: fixed- and random-effects meta-analysis. *Stata J* 2008;8:3-28.