

# Evaluation of a Hospital-in-Home Program Implemented Among Veterans

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The hospital is the traditional place to provide acute care. However, hospitalizations can be costly and may lead to further deterioration in health status among the elderly.<sup>1-4</sup> The Hospital-in-Home (HIH) model offers an alternative approach to traditional hospital services.<sup>5-8</sup> At the core of the HIH model is the goal of delivering hospital-level care to patients who have developed an acute episode that typically would require inpatient services, but who are medically stable enough to be treated at home.<sup>7-9</sup> The common conditions that have been managed through HIH include congestive heart failure, chronic obstructive pulmonary disease, community-acquired pneumonia, and cellulitis.<sup>7,8,10-13</sup> The HIH model has been associated with superior patient outcomes, such as reduced risks of delirium, improved functional status, improved satisfaction among patients and their family members, reduced mortality, reduced readmissions, and significantly lower costs.<sup>5,6,12,14-22</sup> These studies vary in research design (eg, randomized trial or observational studies), study populations (eg, patients with different conditions in a variety of healthcare settings), and contrasting study methods and study outcomes.

Despite promising findings, however, the HIH model has not been widely implemented in the United States. One of the barriers to the adoption of this model is the misalignment of financial incentives among patients, payers, and providers under the traditional fee-for-service payment system.<sup>7</sup> Such disincentives may not be applicable to integrated healthcare delivery systems that are responsible for discrepancies in the costs and care of defined populations, such as managed care, accountable care, and the Veterans Health Administration (VHA) healthcare systems.<sup>7</sup>

The Veterans Affairs (VA) health system is America's largest integrated healthcare system. Its highly integrated medical delivery system aligns both financial incentives and quality care delivery, and thus is motivated to promote an HIH model. In 2010, the VA Office of Geriatrics and Extended Care (GEC) community-based transformational (T-21) programs piloted the HIH model as an alternative to inpatient services. One of the HIH programs was implemented at the VA Pacific Islands Health Care System

## ABSTRACT

**OBJECTIVES:** To examine the outcomes (ie, costs, hospitalizations, and mortality) associated with a Hospital-in-Home (HIH) program implemented in 2010 by the Veterans Affairs (VA) Pacific Islands Healthcare System in Honolulu, Hawaii.

**STUDY DESIGN:** Retrospective cohort study.

**METHODS:** We obtained medical information for veterans who were enrolled in the HIH program in Honolulu, Hawaii, between 2010 and 2013. For purposes of comparison, we also gathered VA data to identify a cohort of hospitalized veterans in Honolulu who were eligible for, but not enrolled in, the HIH program. Using VA administrative data, we extracted a set of individual-level variables at baseline to account for the differences between program enrollees and comparators. In total, 99 HIH program enrollees and 322 unenrolled veterans were included. We identified 3 sets of outcome variables: total costs of care related to the index event (ie, HIH services for enrollees and hospitalizations for comparators), hospitalizations, and mortality after discharge from the index event. We used a propensity score-matching approach to examine the difference in related outcomes between enrollees and comparators.

**RESULTS:** The average medical cost was \$5150 per person for veterans receiving HIH services, and \$8339 per person for veterans receiving traditional inpatient services. The difference was statistically significant ( $P < .01$ ). There was no statistically significant difference in mortality or hospitalization rates after the index event.

**CONCLUSIONS:** This study provides evidence of the potential benefits of a model that delivers acute care in patients' homes. Considering the emergence of accountable healthcare organizations, interest in broader implementation of such programs may be worthy of investigation.

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(VAPIHCS) in Honolulu, Hawaii. This program is unique in that it does not have its own acute care hospital, and instead relies on the Tripler Army Medical Center (TAMC) in Honolulu, to provide inpatient care to its veterans. A steady flow of resources is transferred from the VA to the Department of Defense to reimburse the Army as veterans receive inpatient care from the TAMC, making the financial incentive for the implementation of the HIH program apparent at the VAPIHCS. The aim of our study was to evaluate the costs and related outcomes of this program. It was conducted as an operationally requested quality improvement project that was exempt from Institutional Resource Board review. Approval to publish these results was obtained from the GEC.

## METHODS

### The Honolulu HIH Program

When the VAPIHCS implemented the HIH program in September of 2010, the main targeted conditions included heart failure, pneumonia, chronic obstructive pulmonary disease, and cellulitis. To recruit patients, the HIH program staff made repeated and frequent visits to the TAMC and the VA Ambulatory Care Center in Honolulu. The HIH staff communicated with hospitalists, medical residents, discharge planners, and social workers at the TAMC, as well as VHA providers, nurses, and other staff at the facility, and maintained a close working relationship with a home-based primary care (HBPC) facility whose staff would refer eligible patients. A pamphlet was developed with basic information regarding the HIH program and outlining the patient referral process.

One of the components of the Honolulu HIH program was the substitutive model (ie, it provided hospital-equivalent care in the veteran's home for those who would have otherwise been hospitalized). The requirement to enroll in the program was that the veteran was living at home and had 1 of the required admitting diagnoses. Veterans were referred to the HIH program from outpatient clinics and the VA HBPC, and were screened by physicians or registered nurses for appropriate diagnoses to ensure that care could be safely provided in the home. Once admitted to the program, veterans received required intravenous (IV) infusions, respiratory treatments, laboratory tests, x-rays, and wound care in the home. They also received daily nursing and physician visits, as needed, and had 24-hour access to an on-call geriatrician. Although no specific age limit was imposed in this study, the HIH program is listed under geriatrics service, and all of the physicians covering HIH are geriatric-trained physicians.

HIH staff ordered and delivered required supplies and medications, scheduled medical transportation, and coordinated care to

## TAKEAWAY POINTS

We evaluated a Hospital-in-Home (HIH) program implemented in Honolulu, Hawaii. Using Veterans Affairs administrative data and a propensity score-matching approach, this study provided further confirmation of the potential benefits of this new care delivery model.

- ▶ The costs of HIH services were 38% less than that of comparable inpatient hospitalizations.
- ▶ There were no statistically significant differences in postdischarge hospitalization rates or mortality between HIH enrollees compared with veterans who were not enrolled in the program.
- ▶ With the reform of Medicare payment models and the emergence of accountable care organizations, there may be more interest in implementing HIH programs.

meet the medical needs of veterans, their families, and caregivers. The HIH nursing staff took calls during duty hours on weekends and holidays, and worked with an outside pharmacy to provide all needed IV medications. Veterans were discharged from the program once symptoms improved; ultimately, they transitioned to their usual primary care providers (PCPs) or HBPC, if necessary. A discharge summary was placed in the Computerized Patient Record System, the patient's Patient Aligned Care Team was notified, and follow-up care appointments were made with the PCP.

**Data source.** To evaluate the program, we (the GEC Data Analyses Center) followed specific steps. First, basic information was requested from the HIH program director to identify veterans who received care through this program. Social security number (SSN), date of birth, and gender were used to obtain the veteran's identifier number (ie, scrambled SSN) used in the VA data systems. Dates of HIH program enrollment and disenrollment were also used to define the "active" period within the program and to establish both the program pre-enrollment phase prior to the trial, and the follow-up period following the program's completion.

Data were then obtained from multiple VA administrative sources via the VA's Corporate Data Warehouse. Specifically, data included vital status file, enrollment file, patient file, patient treatment file, outpatient file, Ward file, pharmacy file, inpatient treating specialty file, and fee-basis file from January 1, 2007, to September 30, 2013. These files contained demographic information (ie, age, gender, and race), VA enrollment status, and information about VA-provided services or VA-paid services, including the *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)* codes, dates of service, medication use, and the costs of VA-provided and VA-purchased services. These VA data were linked by individually scrambled SSNs and compiled chronologically into a single file to track veterans' utilization of health services.

### Study Populations

The study population included HIH enrollees who were admitted to the Honolulu HIH program from a noninstitutional location (eg, outpatient clinics or home) between September 2010 and June 2013, and they were compared with a group of veterans who were

not enrolled in the program, but were comparable to the enrollees. To identify potential comparators for the study, we used administrative data to include veterans who were not enrolled in the HIH program, but who were admitted to the TAMC for inpatient services from a noninstitutional location between January 2008 and September 2012 in Honolulu, Hawaii. We did not include nonenrollee veterans who had hospitalizations in fiscal year 2013 (FY13) as controls due to the concern of potential bias. Because of the expansion of the program, it is likely that the program enrolled most of the eligible veterans in FY13. Thus, those who were not enrolled during the same time period could be quite different from those who were enrolled. We then identified the primary diagnosis associated with hospital admissions and selected patients whose primary diagnosis was among the set of admission conditions stipulated for HIH enrollees. Furthermore, we identified the diagnosis-related group (DRG) and identified select hospital admissions with low-weight medical DRGs, with the assumption that the HIH enrollees did not have complications. This resulted in the 99 program enrollees and 322 nonenrolled veteran comparators who were identified for the study.

### Analyses

Three sets of outcome variables were evaluated. The first outcome was the total cost of care, including inpatient, outpatient, or pharmacy costs, incurred during the index event. These services were either provided by the VA (ie, DSS data) or paid for by the VA (ie, TAMC-provided inpatient services were captured on fee-for-service files). The duration of the index event referred to the time between the admission and discharge dates of HIH services for enrollees and hospitalizations for nonenrollees. Costs were adjusted to 2013 dollars by the Consumer Price Index. The second set of outcomes included the incidence of 30- and 90-day hospitalizations after the discharge of the index event. The third set of outcomes entailed 30-, 90-, and 180-day mortality after the veteran had been discharged from the index event.

Based on VA administrative data, we extracted a set of individual-level variables at baseline (ie, the admission of the index event) to account for the potential differences between program enrollees and comparators. These variables included individual sociodemographic characteristics (eg, age, gender, race, and VA priority status that determined eligibility for Priority group 1 [veterans with 50% or more service-connected disabilities that precluded employment]), prior VA healthcare utilization (eg, number of inpatient events and total VA-paid costs in the 3, 6, and 12 months prior to the index event). In addition, we utilized VA claims data to obtain the ICD-9-CM codes recorded within the 1-year period prior to the admission of the index event, and identified a set of chronic conditions for each veteran. We also calculated the number of different drug classes used by the veterans within 1 year prior to the index event. We categorized the number of drug classes into 3

groups, including fewer than 5 drug classes (lower 25th percentile), 5 to 10 drug classes, and more than 10 drug classes (upper 25th percentile), to allow for the potential nonlinear relationship between the number of drug classes and outcomes. These individual-level characteristics could be correlated with the outcomes and, thus, the differences in each factor between enrollees and other subjects were considered.

We used a propensity score-matching approach to examine the difference in related outcomes between enrollees and controls. Specifically, a logistic regression was first estimated to predict the probability of HIH enrollment, based on individual factors we identified at the baseline, as described previously. After obtaining the probabilities, nonenrollees were matched to program enrollees based on the enrollee's probability of enrollment. (We used a radius-matching approach and required nonenrollees' probabilities of enrollment to be within the radius of 0.01 of the enrollees' probabilities). The outcomes were then compared between the 2 groups of veterans with matched probabilities. If there were multiple matched nonenrollees to 1 enrollee, the average difference in outcomes was calculated. The average treatment effect on the treated (ATT) population which represents the average difference in outcomes between the enrollees and matched nonenrollees) was then estimated by averaging over the unit-level treatment effects across matched pairs. The standard errors for the difference in outcomes (ATT) were obtained by a bootstrapping approach with 1000 iterations. The propensity score-matching process was performed by a STATA procedure, PSMATCH2. All the analyses were performed in STATA version 13 (StataCorp; College Station, Texas) and SAS version 9.3 (SAS Institute Inc; Cary, North Carolina).

## RESULTS

The average age of enrollees was 73 years. As expected, the majority of veterans were admitted for pneumonia, congestive heart failure, diabetes, urinary tract infection, or cellulitis. The remaining veterans were admitted for management of other heart conditions (eg, chronic ischemic heart disease), kidney conditions (eg, pyelonephritis), or infections (eg, osteomyelitis). Similarly, approximately 90% of nonenrollees were hospitalized with a primary diagnosis of cellulitis, pneumonia, urinary tract infection, and heart failure. The DRG weights of these hospitalizations varied between 0.6176 and 0.9938 for nonenrollees. On average, the LOS of HIH services was 9.24 days for enrollees and 6.21 days for inpatient events.

**Table 1** presents a comparison of individual characteristics between enrollees and nonenrollees before and after propensity score matching. Individual characteristics were reasonably balanced through the propensity score-matching approach, with the average age being 73 years for enrollees and 74 years for comparators. About 95% of enrollees and 97% of the comparators were male. The prevalence of chronic conditions for the 2 groups was similar,

**TABLE 1.** Comparison of Individual Characteristics Between Enrollees and Nonenrollees Before and After Propensity Score Matching

Characteristic	Before Matching			After Matching		
	HIH Enrollees (n = 99)	Nonenrollees (n = 322)	P	HIH Enrollees (n = 91)	Nonenrollees (n = 322)	P
Median age, years	73.32	68.56	.001	72.8	73.8	.579
Priority 1 status	39.39%	38.51%	.871	39.6%	34.2%	.459
White	40.40%	48.14%	.177	41.8%	37.9%	.598
Male	92.93%	97.20%	.052	94.5%	96.8%	.449
Cancer diagnosis	31.31%	19.25%	.011	29.7%	29.4%	.971
Diabetes	49.49%	40.37%	.108	48.4%	51.1%	.714
CHF	37.37%	19.57%	.000	34.1%	32.7%	.851
Other heart conditions	45.45%	38.51%	.218	44.0%	42.2%	.810
COPD	33.33%	23.29%	.045	31.9%	31.6%	.965
Renal disease	24.24%	13.04%	.007	20.9%	22.6%	.777
Cognitive problem	20.20%	13.04%	.079	20.9%	22.9%	.743
Number of prescribed medications (5-9)	39.39%	48.45%	.114	42.9%	44.0%	.873
Number of prescribed medications (≥10)	40.40%	21.74%	.000	35.2%	32.0%	.657
Any acute inpatient events in 90 days prior to index date	15.15%	14.29%	.831	24.17%	24.14%	.996
Any acute inpatient events in 91-182 days prior to index date	11.11%	11.80%	.851	13.19%	11.18%	.745
Any acute inpatient events in 183-365 days prior to index date	10.10%	18.32%	.053	18.68%	22.57%	.682
Total amount of medical costs in 90 days prior to index date	\$17,339	\$10,214	.001	\$15,976	\$14,175	.557
Total amount of medical costs in 91-182 days prior to index date	\$10,261	\$7976	.187	\$9956	\$9307	.793
Total amount of medical costs in 183-365 days prior to index date	\$18,471	\$12,719	.052	\$16,510	\$15,444	.799
Admission from HBPC	17.17%	8.39%	.012	16.5%	17.5%	.853

CHF indicates congestive heart failure; COPD, chronic obstructive pulmonary disease; HBPC, home-based primary care.

with approximately 24% of both enrollees and comparators experiencing an inpatient event within 90 days of the index event. Overall, the comparators were not sicker than enrollees, and the likelihood of overestimating the effect of the HIH program would be small.

Eight enrollees could not be matched with a nonenrollee veteran, and therefore, were not included in the propensity score-matched population. The unmatched enrollees seemed to be sicker than the other enrollees at baseline. For example, on average, they were 7 years older than the other enrollees and had more comorbidities. They also incurred higher healthcare costs prior to the index event than the other enrollees (data were not presented in the table).

The comparison of the outcomes between enrollees and comparable nonenrollees after the propensity score matching (ie, the ATT population) is shown in [Table 2](#). The HIH program was associated with a 38% reduction in costs compared with an inpatient event. The average cost for HIH services per enrollee was \$5150, and the average cost of an inpatient stay among the comparators was

\$8339 per person. The difference, \$3189 (38.2%), was statistically significant ( $P < .01$ ). The differences in the 30-day and 90-day rehospitalization rates after discharge were not statistically significant (ie, the 30-day rehospitalization rate was 14.3% for enrollees and 12.6% for the comparators;  $P = .75$ ), and the 90-day rehospitalization rate was 16.5% for program enrollees and 21.4% for comparators;  $P = .38$ ). The 30-, 90- and 180-day mortality rates were 6.6%, 11.0%, and 13.2%, respectively, for enrollees, and 6.2%, 14.1%, and 19.7%, respectively, for comparators. These differences were not statistically significant.

## DISCUSSION

The growing population of aging veterans and the increasing demand for inpatient services present a challenge to the VA health-care system. This study evaluated an HIH program implemented among veterans in Honolulu, Hawaii. It was an observational study, and the identification of the comparison group and evaluation of

**TABLE 2.** Comparators of Outcomes Between Enrollees and Nonenrollees Before and After Propensity Score Matching

Outcomes		HIH Enrollees (n = 91)	Nonenrollees (n = 322)	Difference (SE) <sup>a</sup>	P
Costs of medical episodes <sup>b</sup>	Unmatched	\$5403	\$7312	-\$1909 (586.76)	.001
	ATT after matching	\$5150	\$8339	-\$3189 (831.63)	.000
Proportion of veterans who were hospitalized within 30 days of discharge	Unmatched	14.1%	9.9%	4.2%	.24
	ATT after matching	14.3%	12.6%	1.7% (0.052)	.75
Proportion of veterans who were hospitalized within 90 days of discharge	Unmatched	16.2%	21.4%	-5.3%	.254
	ATT after matching	16.5%	21.4%	-4.9% (0.056)	.381
30-day mortality after discharge	Unmatched	7.1%	4.3%	2.7%	.276
	ATT after matching	6.6%	6.2%	0.4% (0.037)	.913
90-day mortality after discharge	Unmatched	11.1%	8.1%	3.0%	.351
	ATT after matching	11.0%	14.1%	-3.1% (0.047)	.510
180-day mortality after discharge	Unmatched	14.1%	11.8%	2.3%	.536
	ATT after matching	13.2%	19.7%	-6.5% (0.054)	.231

ATT indicates average treatment effect on the treated population; HIH, Hospital-in-Home; SE, standard error.

<sup>a</sup>The SEs for the differences in outcomes after matching (ATT) were obtained by bootstrapping strategy with 1000 iterations. We did not provide SEs for the unmatched categorical outcomes.

<sup>b</sup>Veterans Affairs (VA) costs of index inpatient event for comparators, including VA-paid outpatient and inpatient services, VA-provided outpatient and inpatient services, and drug costs.

the outcomes were based on administrative data. A propensity matching approach was applied to account for the potential differences between the enrollees and the comparison group. Although the study population and the study approach were different from previous studies,<sup>11,12,14,23,24</sup> the findings were consistent in that we found that the HIH program provided hospital-equivalent care to eligible patients at a lower cost. Unlike some of the similar programs,<sup>13,14</sup> the VAPIHCS did not operate an inpatient hospital, and so, creating the program required diligence in planning the care and the provision of special services to be developed from the beginning, including a comprehensive set-up of medical equipment, supplies, and personnel. Many managed care organizations are in a similar position as the VAPIHCS in that they are based in physician groups rather than health systems that operate hospitals, and it is reassuring that a nonhospital can successfully implement an HIH program.

We followed the HIH enrollees and the veterans chosen as comparators following their discharge from the HIH program or hospital, and did not find any statistically significant differences in mortality or rehospitalizations. On the other hand, it is likely that we underestimated the positive outcomes associated with the HIH program. For older adults, hospitalizations are associated with a high risk of adverse events (AEs), such as delirium, falls, and nosocomial infections.<sup>1-3,19,25</sup> These hospital-acquired AEs not only lead to impairment in patients' health status, but can also be costly.<sup>26</sup> Providing acute services at a patient's home, when possible, is a logical way to limit these negative outcomes, and has been found to be associated with better functional status and better quality of life (QOL) compared with those who received hospital inpatient care.<sup>15,22</sup>

The HIH model is well aligned with the goal to deliver patient-centered care, and the HIH team identifies each veteran's specific needs and provides high-quality care to accommodate them in a uniquely personal setting: the veteran's residence. Veterans can benefit from support of family members while receiving hospital-equivalent services, which could potentially improve QOL and general welfare.

The HIH model also has the potential to reduce the extent of care discontinuity occurring during an acute episode. For example, instead of sending a veteran to TAMC, the Honolulu HIH staff collaborates with HBPC staff, geriatric healthcare providers, and primary and specialty care staff to provide necessary services in patients' homes. Such collaboration and coordination facilitates the exchange of information among healthcare providers and ensures that appropriate medical measures are administered to veterans during and after participation in the program.

**Limitations**

However, these findings should be interpreted with caution. Unfortunately, we were not able to assess change in veterans' functional or cognitive status due to a lack of available data. In addition, we were not able to compare an individual's satisfaction level with their experience with the HIH program versus hospitalizations. We are also likely to have underestimated the positive outcomes of HIH programs as we only selected hospitalizations with low-weight DRGs, and it is likely that the HIH program provided care to patients with more complicated diagnoses.<sup>27</sup> Furthermore, the propensity score-matching approach only accounted for observed factors. This was not a randomized trial, and therefore, it is likely

that there were some unobserved differences between enrollees and comparators that could have confounded the effect of the HIH program on outcomes. For example, the severity of individual conditions at admission—which can be related to costs, rehospitalizations, and mortality—may not be completely captured by administrative data. If this is the case, our findings may be biased. However, we have accounted for critical individual-level factors. Furthermore, based on the observed characteristics between enrollees and nonenrollees at baseline, nonenrollees did not seem to be sicker than enrollees, making the likelihood of overestimating the benefits of HIH services low. Last, we only investigated the costs incurred within the VA system. It is possible that veterans in both groups differentially used non-VA-paid services, such as Medicare or Medicaid, which were not captured by our study. ■

## CONCLUSIONS

Earlier studies have demonstrated the success and promise of the HIH model. This program demonstrated that it was possible to build a program without a hospital, and provided a useful example to managed care systems wishing to develop such a cost-effective program. With Medicare payment reform (eg, accountable care organizations) and incentives for providers to administer more efficient care, there may be pronounced interest in implementing programs, such as HIH, more broadly.

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