EXHIBIT I

post-operative survival of patients with abdominal aortic aneurysm: a prognostic factor review and meta-analysis of time-to-event data. *Eur J Vasc Endovasc Surg*. 2019;58: 190-198.

5. Juszczak MT, Taib B, Rai J, et al. Total psoas area predicts medium-term mortality after lower limb revascularization. *J Vasc Surg*. 2018;68:1114, e1111-1125.

6. Mamane S, Lok W, Girgis M. Psoas muscle area in healthy adults: effect of normal aging and derivation of reference values. *J Frailty Ageing*. 2018;7:61-91.

7. Kim DH, Afilalo J, Shi SM, et al. Evaluation of changes in functional status in the year after aortic valve replacement. *JAMA Intern Med*. 2019;179:383-391.

8. Collaborators GBDB. Burden of disease in Brazil, 1990-2016: a systematic subnational analysis for the global burden of disease study 2016. *Lancet*. 2018;392:760-775.

9. Perez-Sousa MA, Pozo JD, Cano-Gutierrez CA, Izquierdo M, Ramirez-Velez R. High prevalence of probable sarcopenia in a representative sample from Colombia: implications for geriatrics in Latin America. *J Am Med Dir Assoc*. 2020;22(4):859-864.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

Data S1. Supporting Information.

Health equity in Hospital at Home: Outcomes for economically disadvantaged and non-disadvantaged patients

INTRODUCTION

Hospital at Home (HaH) has been demonstrated to be effective in a variety of settings and patient populations.[1,2] However, it is unknown whether HaH is feasible or effective for socioeconomically disadvantaged patients. Our aim is to determine whether HaH services were received by disadvantaged patients, and if so, whether effectiveness differs for patients depending on socioeconomic status (SES) using two indicators of SES.

METHODS

Patient selection

In a previous Center for Medicare and Medicaid Innovation (CMMI) demonstration of HaH, we recruited patients aged ≥18 years with fee-for-service Medicare or coverage from a private insurer that contracted for HaH services.[1] Patients with Medicaid were dually eligible or had Medicaid Managed Care. All participants required inpatient admission for medical diagnoses from one of four New York City hospitals from November 2014 through August 2017. Patients were ineligible if they required intensive care, surgery, or telemetry monitoring. Additionally, program eligibility required a suitable home environment. Participation in HaH consisted of acute, hospital-level care at home and a 30-day period of post-acute transitional care. Control patients were identified using identical eligibility criteria, but either chose traditional inpatient care instead of HaH, were admitted to inpatient units on nights and weekends when HaH was unavailable, or were admitted before HaH was implemented at one hospital.

Analysis

Primary outcomes and subgroups were selected prior to conducting the analysis. Primary outcomes were duration of acute hospital-level length of stay (LOS), 30-day all-cause hospital readmissions, and 30-day all-cause emergency department (ED) visits not leading to hospitalization. We examined whether primary outcomes differ for subgroups using two indicators of SES: (1) Medicaid enrollment status; (2) binary SES residential indicator (i.e., whether patient lived in public housing[3] or a census block group where 20% or more of the households had incomes below the federal poverty level). We compared outcomes of HaH and control patients within subgroups. To limit potential bias from nonrandom assignment to HaH, we used entropy balancing weighted regression. Models for Medicaid status subgroups were adjusted for

age, race and ethnicity, education, ADL impairment, and general health; models for the SES residential indicator were only adjusted for age, race, and ethnicity due to cell size limitations. Standard errors were adjusted for clustering of HaH admissions among individual patients.

RESULTS

A total of 477 hospital episodes across 443 unique subjects were included in this analysis (289 [60.6%] HaH and 188 [39.4%] controls). Medicaid status and low SES residential indicator were prevalent at similar rates in the two groups: 41.9% in HaH vs. 39.4% in controls had Medicaid ($p = 0.59$); 55.0% of HaH and 60.8% of controls were associated with the low SES residential indicator ($p = 0.18$). The Medicaid and the low SES residential indicator had substantial but incomplete overlap; 42.7% of those linked to the low SES residential indicator did not have Medicaid status, and 18.7% of those linked to the higher SES residential indicator had Medicaid.

Primary outcomes by subgroups are shown in Table 1. Unadjusted and adjusted analyses demonstrate that the duration of acute care was shorter in HaH compared with hospital inpatient controls regardless of SES. The 30-day ED revisits not leading to hospitalization were significantly reduced in patients with Medicaid (AOR 0.28, 95% CI 0.09, 0.88; $p = 0.03$) favoring HaH. There were no other statistically significant differences in hospital readmission and ED revisit outcomes between HaH and controls. However, the point estimates favored HaH (see Figure 1) except in the case of 30-day ED revisits in the non-Medicaid subgroup.

DISCUSSION

There is a dearth of research on issues related to healthcare equity in the provision of HaH.[4] This is important to address now, as the model is expanding due to Medicare's Acute Hospital Care at Home waiver for hospital reimbursement for the duration of the pandemic.[5,6] Our data suggest that HaH is feasible for economically disadvantaged patients and that these patients may even have greater benefit from HaH. We hypothesize that better outcomes for low SES patients may result from the ability of HaH providers to directly observe and provide care to patients in their homes, where they can address social determinants of

TABLE 1 Raw and adjusted patient outcomes among Hospital at Home patients and inpatient controls, stratified by socioeconomic status and by Medicaid status

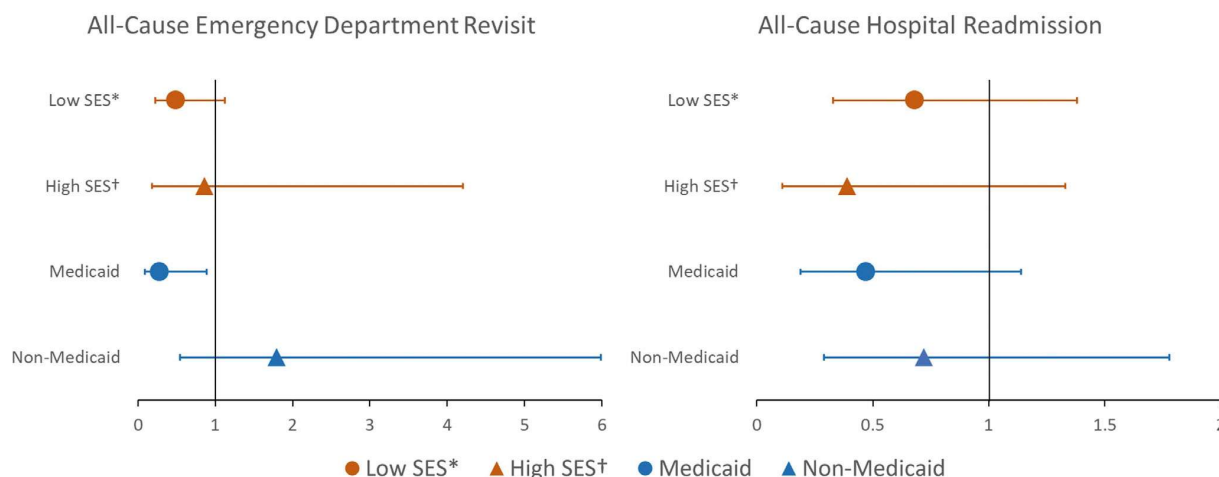| Subgroup	n	Acute length of stay		All-cause hospital readmission		All-cause emergency department revisit	
		Raw	Adjusted[a]	Raw	Adjusted[a]	Raw	Adjusted[a]
		Mean (SD)	Difference	30-day rate (%)	Odds Ratio (CI)	30-day rate (%)	Odds ratio (CI)
Low SES[b]							
Hospital at Home	159	3.17 (2.30)[e]	1.97[e]	13.21	0.68 (0.33, 1.38)	6.92	0.49 (0.22, 1.12)
Inpatient control	115	5.05 (2.94)		17.39		13.91	
High SES[c]							
Hospital at Home	130	3.26 (1.87)[e]	1.92[e]	5.38[d]	0.39 (0.11, 1.33)	4.62	0.86 (0.18, 4.20)
Inpatient control	73	5.64 (3.21)		15.07		6.85	
Medicaid							
Hospital at Home	121	3.33 (2.46)[e]	2.85[e]	9.92	0.47 (0.19, 1.14)	4.96[d]	0.28 (0.09, 0.89)[d]
Inpatient control	74	5.81 (3.74)		20.27		16.22	
Non-Medicaid							
Hospital at Home	168	3.13 (1.82)[e]	1.59[e]	9.52	0.72 (0.29, 1.78)	6.55	1.79 (0.54, 5.99)
Inpatient control	114	4.94 (2.46)		14.04		7.89	

[a]Adjusted for patient mix based on age and race/ethnicity in analysis of SES, and adjusted for patient mix based on age, sex, education, race/ethnicity, ADL impairment, and general health in analysis of Medicaid status.
[b]Low SES defined as either living in NYCHA housing or a neighborhood with >20% poverty.
[c]High SES defined as neither living in NYCHA housing nor a neighborhood with >20% poverty.
[d]Statistically significant at the 0.05 level.
[e]Statistically significant at the 0.01 level.

DHNotice00717

All-Cause Emergency Department Revisit

All-Cause Hospital Readmission

● Low SES* ▲ High SES† ● Medicaid ▲ Non-Medicaid

* Low SES defined as either living in NYCHA housing or a neighborhood with >20% poverty
† High SES defined as neither living in NYCHA housing nor a neighborhood with >20% poverty

FIGURE 1 Distribution of adjusted odds ratios comparing the outcomes of hospital at home patients to controls in four subgroups. Adjusted for patient mix based on age and race/ethnicity in analysis of low and high socioeconomic status (SES). Adjusted for patient mix based on age, sex, education, race/ethnicity, activities of daily living impairment, and general health in analysis of Medicaid status

health (e.g., food insecurity, medical equipment needs, management of chronic diseases in real-world situations). Study limitations include the use of retrospective data and proxy indicators of SES status, and limited ability to adjust for potential confounders due to cell size constraints. More research on HaH and healthcare equity needs to be performed, including routine measurement of multiple dimensions of SES, to better understand how this expanding model of care supports these populations.

CONFLICT OF INTEREST

Dr. Leff serves as a clinical advisor to Medically Home, Dispatch Health, and the Chartis Group. He serves as a volunteer member of the Humana Multidisciplinary Advisory Board. In the early 2000s, Dr. Leff developed Hospital at Home technical assistance tools that were licensed by Johns Hopkins to several entities and, as a result of these license agreements, both the University and its inventors received royalty income; there has been no royalty income for several years. Dr. Leff's arrangements and relationships have been reviewed and approved by the Johns Hopkins University in accordance with its conflicts of interest policy. Dr. Leff serves as a consultant to the Kenes Group as a member of the planning committee of the World Hospital at Home Congress. Drs. Siu, DeCherrie, and Leff are leaders of the Hospital at Home Users Group, which focuses on Hospital at Home technical assistance and is supported by grants from the John A. Hartford Foundation. Dr. DeCherrie is a full-time employee of the Medically Home Group. Dr. Siu, Mr. Zhao, Mr. Bollens-Lund, Ms. Lubetsky, Ms. Schiller, Dr. Saenger, Dr. Ornstein, and Dr. Federman are full-time employees of the Icahn School of Medicine, which in turn has an ownership interest in a joint venture with Contessa Health, a venture that manages acute care services provided to patients in their homes through prospective bundled payment arrangements. No authors have a personal financial interest in the joint venture.

AUTHOR CONTRIBUTIONS

Study concept and design: Siu, Federman, DeCherrie, Ornstein, Leff. Acquisition of subjects and/or data: Siu, Zhao, DeCherrie, Lubetsky, Schiller, Federman. Analysis and interpretation of data: All authors. Preparation of manuscript: All authors.

SPONSOR'S ROLE

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Albert L. Siu MD, MSPH[1,2]
Duzhi Zhao MS[1]
Evan Bollens-Lund MA[1]
Sara Lubetsky MS[1]
Gabrielle Schiller MPH[1]
Pamela Saenger MD, MPH[1]
Katherine A. Ornstein PhD, MPH[1]
Alex D. Federman MD, MPH[3]
Linda V. DeCherrie MD[1,4]
Bruce Leff MD[5]

[1]*Brookdale Department of Geriatrics and Palliative Medicine, Icahn School of Medicine at Mount Sinai, New York, New York, USA*
[2]*Geriatric Research, Education, and Clinical Center, James J. Peters Department of Veterans Affairs Medical Center, Bronx, New York, USA*
[3]*Division of General Internal Medicine, Department of Medicine, Icahn School of Medicine at Mount Sinai, New York, New York, USA*
[4]*Medically Home, Boston, Massachusetts, USA*
[5]*Division of Geriatric Medicine, Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland, USA*

Correspondence
Albert L. Siu, MD, MSPH, Brookdale Department of Geriatrics and Palliative Medicine, Icahn School of Medicine at Mount Sinai, One Gustave Levy Place, Box 1640, New York, NY 10029, USA.
Email: albert.siu@mssm.edu

ORCID
Evan Bollens-Lund https://orcid.org/0000-0002-8402-7635

REFERENCES

1. 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
2. Augustine MR, Siu AL, Boockvar KS, DeCherrie LV, Leff BA, Federman AD. Outcomes of Hospital at Home for older adults with and without high levels of social support. *Home Healthc Now.* 2021;39(5):261-270. doi:10.1097/nhh.0000000000000980
3. Yim B, Howland RE, Culp GM, Zhilkova A, Barbot O, Tsao TY. Disparities in preventable hospitalizations among public housing developments. *Am J Prev Med.* 2019;56(2):187-195. doi:10.1016/j.amepre.2018.08.019
4. Leff B, DeCherrie LV, Montalto M, Levine DM. A research agenda for hospital at home. *J Am Geriatr Soc.* 2022;70(4):1060-1069. doi:10.1111/jgs.17715
5. Levine DM, DeCherrie LV, Siu AL, Leff B. Early uptake of the Acute Hospital Care at Home Waiver. *Ann Intern Med* Dec 2021;174(12):1772–1774. doi:10.7326/m21-2516
6. Clarke DV, Olson DP, Adams D, Wolfe AJ, Fleisher LA. Acute Hospital Care at Home: the CMS waiver experience. *NEJM Catal Innov Care Deliv.* 2021. https://catalyst.nejm.org/doi/full/10.1056/CAT.21.0338

Transitioning an in-person geriatric memory clinic to a virtual care model for rural primary care clinics

INTRODUCTION

Dementia is a leading cause of disability and dependency among older adults, with an estimated 6.2 million Americans affected in 2021 and $355 billion in direct care costs.[1] Experts recommend management of less-complex patients in primary care and more complex patients by geriatricians.[2–4] However, shortages in the geriatric

workforce make access challenging, particularly in rural communities.[5] Virtual care via video conferencing is a promising strategy for addressing specialist shortages while improving access.[6–8] These models have been examined in select populations including veterans,[9] but have not been studied using a team-based approach. Our memory clinic located in the Charlotte metropolitan region is a geriatrician-led, team-based clinic dedicated to diagnosis and management of dementias.[8] Our prior research identified several program strengths, including the team-based approach to enhance care

PERSPECTIVES IN HOSPITAL MEDICINE

Journal of
Hospital Medicine
Society of Hospital Medicine

Health equity and Hospital at Home programs

Anupama Goyal MD, MPH, MBA [ID] | Stephanie Taylor MD, MSc

Division of Hospital Medicine, University of Michigan, Ann Arbor, Michigan, USA

Correspondence
Anupama Goyal, MD, MPH, MBA, Division of Hospital Medicine, University of Michigan, F-4309 UH-South, Unit 4, Ann Arbor, MI 48109-5220, USA.
Email: anugoyal@med.umich.edu

INTRODUCTION

With widespread evidence of health disparities challenging healthcare delivery, health systems, communities, and policymakers, must address how to manage a diversifying population requiring complex and costly healthcare. Both patients and health systems desire to optimize time at home and avoid hospital-associated complications. Many health systems have developed Hospital at Home (HaH) innovations designed to avoid or reduce hospital days.[1] These programs have demonstrated shorter length of stay, lower mean cost of care, and higher patient satisfaction compared to brick-and-mortar hospitalization.[2]

Research has shown that patients admitted in HaH versus traditional brick-and-mortar hospitals have similar baseline characteristics (age, sex, race/ethnicity, health literacy, and health status) with HaH programs demonstrating a slightly higher percentage of elderly, predominantly White males, with a higher burden of functional impairment and comorbid illnesses.[3,4] Recently published national level data of 5132 patients who received care in a HaH program also demonstrated that 41.7% of the patients were 80 years or older, 44% were females, and 85.2% were Whites, with a mean household income of $83,932. Overall, Black or Latino patients had similar outcomes (e.g., mortality during HaH admission or 30 days after discharge; 30 days after discharge readmission rates, or skilled nursing facility use) as compared to patients in the program with disability and dual eligibility.[5] Siu et al. also suggest that HaH programs may be beneficial for economically disadvantaged patients (Medicaid status and low socioeconomic residential indicators), given the ability to directly observe and provide care to patients in their homes.[6]

Some programs have turned attention to equitable access to HaH. However, there is a paucity of literature on how best to implement and evaluate hospital care at home programs through a health equity lens, and experts have explicitly recommended the development of an equity framework for HaH.[4,7] Importantly, innovations such as HaH programs that are developed with equity in mind may not be equitably implemented if contextual barriers and preferences experienced by diverse patient populations are unaddressed. Inequitable implementation can create or perpetuate health disparities. In this paper, we provide a framework for the "equitable implementation" of HaH programs.

IMPROVING THE EQUITABLE IMPLEMENTATION OF HAH

Data from nonrandomized trials suggests that acceptance rates of HaH programs are similar in Black and Hispanic patients as compared to White patients. However, a greater proportion of patients who refused participation in a HaH program had a family member who helped them in their activities of daily living.[8] One study's findings did not suggest disparities in enrollment into HaH based on sociodemographic characteristics, but 16% of their HaH-eligible patients declined the program because the emergency department or other clinicians declined despite the home hospitalist desiring the patient in the program.[5] Bruce et al. also demonstrated that patient and family satisfaction scores with hospital care at home were comparable with those in traditional brick-and-mortar, except that advanced patient age was associated with lower satisfaction with discharge procedures.[3] These patient and provider contexts that limit HaH acceptance need to be proactively and equitably addressed during HaH program implementation to ensure both parties feel comfortable with support and care delivery in HaH.

Health equity refers to a state of equal opportunity to attain one's full health potential regardless of socially determined circumstances. Health inequities manifest across racial, ethnic, and

DHNotice00720

socioeconomic lines due to structural disadvantages (e.g., access to healthcare) and discriminatory behaviors (e.g., gender bias).[9] "Equitable implementation" describes the provision of evidence-based innovations in a fair manner that leads to improved outcomes for all recipients.[10] Usual hospital care suffers from health inequities and efforts to address these have led to the adoption of actionable frameworks that lead to organizational and clinical practice change to create more equitable health systems.[11] To reduce health disparities, it is vital that HaH programs adopt an equitable implementation framework to meet the needs and preferences of marginalized populations.

GUIDING THE WAY FORWARD: HEALTH EQUITY IMPLEMENTATION AND HEALTHCARE DISPARITIES FRAMEWORKS

Framed in an implementation science approach, HaH is an evidence-based practice to be implemented.[12] The health equity implementation framework (HEIF) (Figure 1) provides a guide for equitable implementation of HaH by identifying equitable implementation determinants (i.e., barriers or facilitators). The HEIF categorizes the most salient implementation determinants as interacting factors:

clinical encounter, innovation, recipients, context, and societal influence. The central domain of this framework is the clinical encounter (where HaH is discussed and delivered) and is connected to the innovation (HaH) itself. Patients, providers, and other recipients interact with HaH and are directly influenced by culturally relevant factors. The clinical encounter is influenced by two domains of context: an inner circle representing local, organizational, and health system context, and an outer circle representing societal context (e.g., economies, physical structures, and sociopolitical forces). To the right, facilitation indicates the importance of addressing, not just identifying, determinants.[13] The anticipated result of the HEIF application is successful program implementation and improvement in health equity.

In parallel to the HEIF, the Healthcare Disparities Framework (HCDF) delineates three phases of health disparities research (detection, understanding, and reduction or elimination), with each phase framed according to the clinical encounter and patient, provider, and health system factors.[13] Ideally, the two frameworks can be used iteratively, with implementation guided by the HEIF followed by evaluation and improvements guided by the HDCF. Applying both HEIF and HDCF to HaH will have multiple implications on program design, implementation, and evaluation.
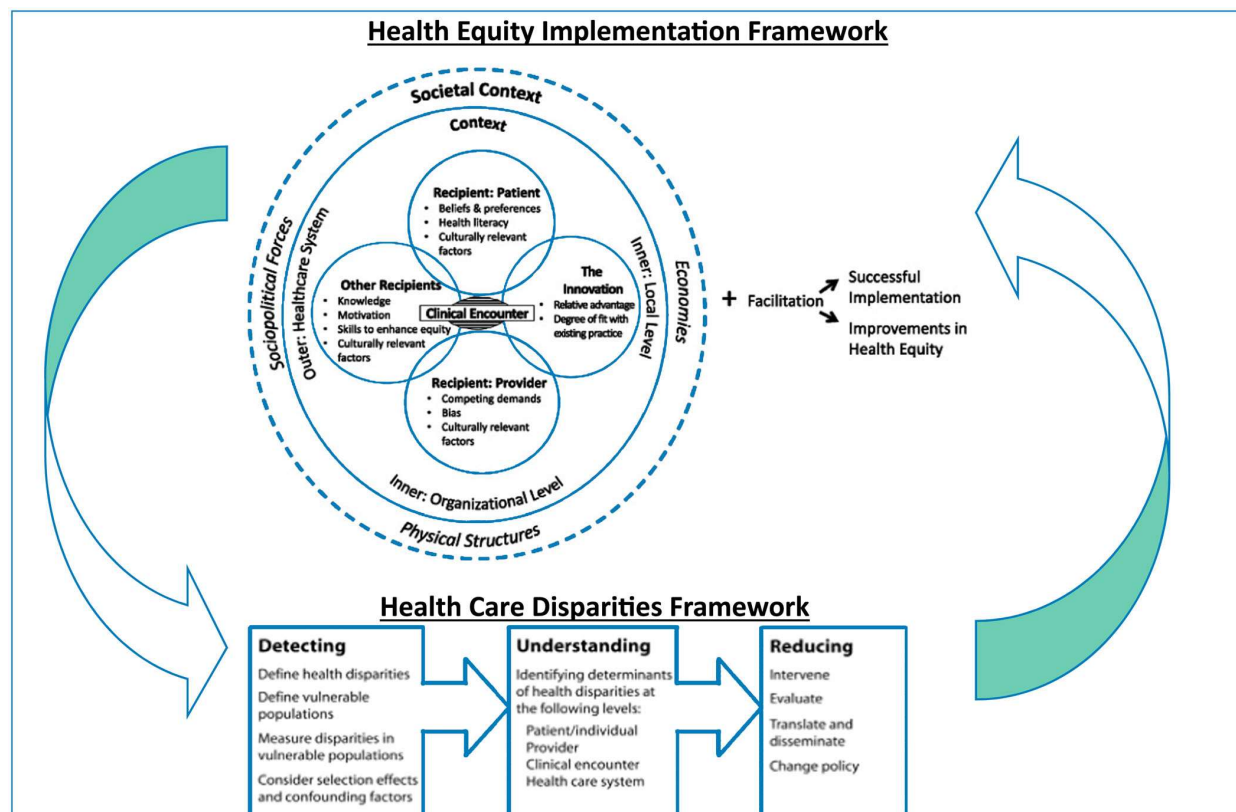

FIGURE 1 Iterative process of equitable implementation guided by the HEIF and HCDF. HCDF, healthcare disparities framework; HEIF, health equity implementation framework.

First, the implementation of HaH must take a health equity perspective at the patient level. Literature suggests that disadvantaged or minoritized groups have the same acceptance rates for HaH as compared to other groups—an opt-in model that respects patients' preferences regardless of race or ethnicity. However, little is known about their beliefs and preferences regarding these programs. For example, research suggests low acceptance rates of home health services (another opt-in model) by Black patients, potentially due to personal attitudes toward home-based care or poor understanding of publicly reported quality information compared with their White and higher-income counterparts.[14] Levine et al. demonstrated that 10% of their eligible patients declined HaH due to perceptions of their homes being "nontherapeutic living environments." They recommend interventions focused on lowering the stigma of a "nontherapeutic living situation" and in turn increasing acceptance of hospital care at home programs.[5] Interventions like these would be especially beneficial in the marginalized groups. Thus, deliberate efforts should be made to elicit and align with these patient beliefs.

Most health promotion interventions focus on changing patient preferences, but a patient-level equitable implementation must differentiate between patient preferences that are grounded in cultural traditions from those that are linked to modifiable perceptions or even misleading information (that may arise from unequal access to healthcare information). HaH programs should engage their local community partners to ensure cultural relevance related to matters of caregiving, and privacy, are integrated in the program. For example, some HaH programs have collaborated with local community paramedics to provide in-person home visits to their patients.[15,16] This collaboration provides an opportunity to better meet the needs of structurally marginalized communities where paramedics can help advise if the home setting appears unsafe and link patients or caregivers with social services and agencies (such as food banks and employment agencies) in the community. However, assessing and treating for social determinants should be integrated into front-line paramedics' scope of practice.[17]

Second, although health systems across the nation have received an extension of the Center for Medicare (CMS) Acute Hospital at Home waiver, adoption of HaH by state Medicaid programs has been slow. Currently, only about eight states Medicaid program reimburse health systems for HaH.[18] The lack of provision of HaH to Medicaid patients is an important sociopolitical force that requires continued policy reform and engagement with key stakeholders to provide HaH opportunities equitably in communities with limited income and resources.

Third, to address provider-level equity influences, HaH programs must identify and mitigate biases in offering and providing HaH. Although, not specific to HaH, prior work has demonstrated that Blacks are less likely to be referred to home health programs at discharge from the hospital.[11] HaH programs should develop robust processes for eliminating bias in patient selection, including cultural competence in tailoring communication about the program. Additionally, providers should guard against implicit age-related biases toward elderly populations' ability to competently use technology (e.g., smartphones, wearable patient monitoring devices, or tablets to

TABLE 1 Examples of developing or modifying innovations in HaH across HEIF domains.

HEIF domain	Determinants of equitable implementation	Equitable implementation strategy	Outcomes
Clinical encounter	Communication about HaH with patients with different cultures or languages	- Training to improve cultural competency, mitigate bias - Investment in multilingual program media, integration of translation services within technology used to interface with clinicians	*Implementation* - Reach: Proportion of patients offered HaH representative of target population across race, ethnicity, and other groups - Adoption: Proportion of patients accepting HaH representative of the target population across race, ethnicity, and other groups
Innovation	Acceptability of HaH among marginalized groups	- Preimplementation elicitation of beliefs, values, and preferences across diverse sociocultural perspectives - Incorporate the adaptability of the HaH program to fit the sociocultural context	*Effectiveness* - Increased hospital-free days among population subgroups - Low mortality and hospital readmission among population subgroups - Patient and caregiver satisfaction among population subgroups
Recipients	Patient beliefs about the benefits and risks of care delivery through HaH	- Community engagement - Culturally tailored media and education materials	
Inner and outer context	System-level practices, policies, processes, and resources prioritizing equitable HaH implementation	Empanel an equity advisory board including community members to guide decisions, monitor outcomes, and propose ideas for improvement	
Societal context	Social, economic, and neighborhood needs	Integration of HaH programs with community resources to address social needs	

Abbreviations: HaH, Hospital at Home; HEIF, health equity implementation framework.

virtually connect to providers).[19] Studies have shown not only a clear need for training but also troubleshooting with the use of Bluetooth-enabled blood pressure devices and smartphones among limited English-proficient elderly Asian low-income populations.[20] Rather than assume older adults cannot manage the technology associated with HaH, programs should provide digital health assistance processes that help elderly or non-English speaking patients navigate technology to their advantage, both while within the program and follow-up visits—an approach adopted for telehealth during the COVID 19 pandemic.[21] Finally, artificial intelligence technology models that select patients by predicting success based on clinical and social factors must be monitored for the introduction or perpetuation of biases against marginalized populations. For example, Satyabatra et al. used a predictive model based on a set of clinical and social factors that determined the enrollment of patients in their HaH program. Their predictive model auto-excluded patients with a "mental illness flag" in their electronic medical record (e.g., schizophrenia).[22]

Fourth, HaH programs should consider structural inequities that threaten equitable implementation. Structural inequities refer to disparities in wealth, health, and other resources and outcomes that result from political and economic systems that privilege some while disadvantaging others. The relationship between structural inequities and health is often framed in terms of social determinants of health (SDOH), such as economic stability, access to healthcare, and neighborhood and community context.[23] HaH programs must include plans for eliciting, under-standing, and addressing these SDOH to ensure equitable implementation. An example of structural inequities relevant to equitable delivery of hospital care at home is the relative lack of technological accessibility in disadvantaged neighborhoods or rural settings due to poor internet or cellular service.[24] As per the 2020 Federal Communications Commission's report, 22.3% of Americans in rural areas and 27.7% of Americans in Tribal lands lack coverage from fixed terrestrial 25/3 Mbps broadband, as compared to only 1.5% of Americans in urban areas.[25] The capability of immediate on-demand remote audio connectivity with a HaH team member for a HaH patient is a key requirement of the CMS waiver.[26]

CONCLUSION

HaH is a rapidly growing care delivery model that has the potential to improve the quality, value, and experience of acute care. However, the growth of HaH should follow the advice of legendary basketball coach John Wooden to "Be quick, but don't hurry" when it comes to planning for equitable implementation. Integrating implementation science with HaH innovations through the Health Equity Implementation Frame-work provides a guide for the development, implementation, and evaluation of HaH programs that support all populations (Table 1).

ORCID
Anupama Goyal http://orcid.org/0000-0003-2992-2183

REFERENCES

1. Leff B, Montalto M. Home hospital-toward a tighter definition. *J Am Geriatr Soc*. 2004;52(12):2141. doi:10.1111/j.1532-5415.2004. 52579_1.x
2. 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. *Can Med Assoc J*. 2009;180(2):175-182. doi:10.1503/cmaj.081491
3. Leff B, Burton L. Hospital at home: feasibility and outcomes of a program to provide hospital-level care at home for acutely ill older patients. *Ann Int Med*. 2005;143(11):798-808. doi:10.7326/0003-4819-143-11-200512060-00008
4. Levine DM, OuchiKei 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
5. Levine DM, Souza J, Schnipper JL, Tsai TC, Leff B, Landon BE. Acute hospital care at home in the United States: the early national experience. *Ann Intern Med*. 2024;177(1):109-110. doi:10.7326/M23-2264
6. Siu AL, Zhao D, Bollens-Lund E, et al. Health equity in hospital at home: outcomes for economically disadvantaged and non-disadvantaged patients. *J Am Geriatr Soc*. 2022;70(7):2153-2156. doi:10.1111/jgs.17759
7. Levine DM, Paz M, Burke K, Schnipper JL. Predictors and reasons why patients decline to participate in home hospital: a mixed methods analysis of a randomized controlled trial. *J Gen Intern Med*. 2022;37(2):327-331. doi:10.1007/s11606-021-06833-2
8. Leff B, Burton L, Mader S, et al. Satisfaction with hospital at home care. *J Am Geriatr Soc*. 2006;54(9):1355-1363. doi:10.1111/j.1532-5415.2006.00855.x
9. Health Equity. Center for Disease Control and Prevention. https://www.cdc.gov/healthequity/whatis/index.html
10. Woo B, DuMont K, Metz A. *Equity at the Center of Implementation*. Center for the Study of Social Policy; 2019. https://cssp.org/2019/12/implementation-equity/
11. Yakusheva O, Lee K. Racial and ethnic disparities in home health referral among adult Medicare patients. *Med Care*. 2024;62(1):21-29. doi:10.1097/MLR.0000000000001945
12. Curran GM. Implementation science made too simple: a teaching tool. *Implement Sci Commun*. 2020;1:27. doi:10.1186/s43058-020-00001-z
13. Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. *Am J Public Health*. 2006;96(12):2113-2121. doi:10.2105/AJPH.2005.077628
14. Fashaw-Walters SA, Rahman M, Gee G. Out of reach: inequities in the use of high-quality home health agencies. *Health Aff*. 2022;41(2):247-255. doi:10.1377/hlthaff.2021.01408
15. Beresford L. Hospital at Home: A New Frontier for Community Paramedics. Accessed May 5, 2023. https://www.hmpgloballearning network.com/site/emsworld/feature-story/hospital-home-new-frontier-community-paramedics
16. Abrashkin KA, Washko J, Zhang J, Poku A, Kim H, Smith KL. Providing acute care at home: community paramedics enhance an advanced illness management program—preliminary data. *J Am Geriatr Soc*. 2016;64(12):2572-2576. doi:10.1111/jgs.14484

DHNotice00723

17. Allana A, Pinto A. Paramedics have untapped potential to address social determinants of health in Canada. *Healthc Policy*. 2021;16(3): 67-75. doi:10.12927/hcpol.2021.26432

18. Raths D. Hospital at Home Programs Seek Medicaid Participation. Healthcare Innovation. https://www.hcinnovationgroup.com/policy-value-based-care/medicare-medicaid/article/53072888/hospital-at-home-programs-seek-medicaid-participation

19. Jarva E, Oikarinen A, Andersson J, et al. Healthcare professionals' perceptions of digital health competence: a qualitative descriptive study. *Nurs Open*. 2022;9(2):1379-1393. doi:10.1002/nop2.1184

20. Him E-H, Stolyar A, Lober W. Challenges to using an electronic personal health record by a low-income elderly population. *J Med Internet Res*, 2009;11(4):e44.

21. Lee G, Chang A, Pal A, Tran TA, Cui X, Quach T. Understanding and addressing the digital health literacy needs of low-income limited English proficient Asian American patients. *Health Equity*. 2022;6: 494-499. doi:10.1089/heq.2022.0045

22. Pati S, Thompson GE, Mull CJ, et al. Improving patient selection and prioritization for hospital at home through predictive modeling. *AMIA Annu Symp Proc*. 2022;2022:856-865.

23. Social Determinants of Health. Offices of Disease Prevention and Health Promotion. https://health.gov/healthypeople/priority-areas/social-determinants-health

24. Broadband Equity: Addressing Disparities in Access and Affordability. Testimony From Asian Americans Advancing Justice. https://www.advancingjustice-aajc.org/sites/default/files/2021-05/2021.05.06%20E%26C%20Broadband%20Disparities%20Testimony.pdf

25. Federal Communications Commission. 2020 Broadband Deployment Report April 2020. https://docs.fcc.gov/public/attachments/FCC-20-50A1.pdf

26. Acute Hospital Care at Home Program. Approved List of Hospitals as of 4/5/2021. Center for Medicare Services, Hospital at Home Program. https://www.cms.gov/files/document/covid-acute-hospital-care-home-program-approved-list-hospitals.pdf

NC Medicaid's Early Experience with a Hospital at Home Program During the Public Health Emergency

Arianna Keil, Ryan Fair, Wendy Qi, Sam Thompson, Shannon Dowler

During the COVID-19 pandemic, the Centers for Medicare & Medicaid Services allowed hospitals to rapidly receive Hospital at Home status to alleviate the inpatient bed burden; NC Medicaid allowed this model during the Delta surge and subsequently completed an evaluation of the outcomes for Medicaid members.

During the COVID-19 public health emergency (PHE), NC Medicaid allowed approved hospital facilities or systems to provide acute hospital care at home [1]. Originally a program designed for the Medicare population, offering coverage of care provision for significant illness outside of traditional inpatient settings is one example of how Medicaid programs across the country rapidly evolved to meet the challenges of the pandemic. Historically, transitioning to new models can take public payors many years for public to adopt. Previous studies examining outcomes for populations cared for using a "Hospital at Home" (HaH) model have shown either favorable results or no significant differences in readmission rates, length of stay, and emergency department (ED) visits as compared with populations served by traditional inpatient hospitalization [2–6]. To guide policy planning, NC Medicaid partnered with an external quality review organization, Health Services Advisory Group, to examine whether these outcomes were consistent among beneficiaries receiving HaH services.

The analysis compared 240 NC Medicaid HaH claims (associated with 234 beneficiaries) from March 2021 to August 2022 with a comparison group of 240 NC Medicaid claims for traditional inpatient hospitalization. The groups were matched on beneficiary age, gender, race, ethnicity, COVID-19 diagnosis, and Chronic Illness and Disability Payment System risk model score using propensity score matching. Measures included average length of stay (LOS), all-cause 30-day readmission, ED visit within 30 days after discharge, and primary care provider (PCP) follow-up visit within 30 days after discharge. Measure data sources included both administrative (final adjudicated paid claims) as well as ancillary data sources (identifiers associated with claims hospitals reported as being for HaH services). For the HaH group, over 94% of the ancillary data sources identified claims from a single hospital system. The comparison group included inpatient claims from the same hospital systems, with similar diagnosis codes found in the HaH claims.

Demographics of the HaH group reflected 70% women with an average age of 44 years, while the average age for men was 48 years; 53% of the HaH cohort identified as Black, 42% White, and 82% non-Hispanic or Latino. The sample had more women and Black participants than the general NC Medicaid population, which is 57% women, 38% Black, 57% White, and 83% non-Hispanic or Latino. Half of the general NC Medicaid population is aged less than 21 years (Table 1).

As compared with the matched cohort, PCP follow-up visits within 30 days occurred at a significantly higher frequency in the HaH group (52.1% for HaH group versus 42.5% for comparison group). The small HaH population limited its statistical power to detect other significant differences, including ED visits within 30 days (13.8% for HaH group versus 8.3% for comparison group) and all-cause 30-day readmissions (12.9% for HaH group versus 10.0% for comparison group). Average LOS appeared similar for both groups (7.9 days for HaH, 8.2 days for comparison group).

In conclusion, as compared with the general NC Medicaid population, more women beneficiaries and Black beneficiaries were served by the HaH program as reflected by claims

TABLE 1.
Demographics of HaH Group and General NC Medicaid Population

	HaH Group	General NC Medicaid Population
Average Age	44 y. for women	50% aged 0-20 y.
	48 y. for men	
Female Gender	70%	57%
Black Race	53%	38%
Non-Hispanic or Latino Ethnicity	82%	83%

DHNotice00725

from predominately one hospital system during March 2021–August 2022. Compared with matched claims, the HaH group was significantly more likely to follow up with their PCP. Average LOS for both groups was approximately eight days. Small sample sizes limited statistical power; no significant difference was seen in other metrics.

Discussion

As compared with previous HaH studies looking at populations other than Medicaid beneficiaries, these results appear less favorable overall. Although beneficiaries participating in HaH were significantly more likely to follow up with their PCP, it is not clear whether patients in this cohort were motivated to see their PCP due to improved symptoms and/or desire to be compliant, or due to lack of symptom resolution or worsening symptoms. Higher (although not statistically significant) percentages of ED visits and all-cause readmissions in the HaH group may support the theory that PCP visits occurred more frequently in this group due to the latter. Patients receiving HaH supports in this analysis were approximately 30 years younger than those in another study examining outcomes among HaH participants in a Medicare/private insurance population [4], so the less favorable results are particularly surprising. One might expect that people who are healthier overall might be selected for HaH as compared with inpatient care. If studies involving older people (who generally are less healthy than younger people) demonstrate more favorable or neutral outcomes on ED follow-up and readmissions with HaH care, younger individuals might be expected to have even more favorable outcomes. Instead, these data suggest the opposite.

Medicaid is a safety-net program offering health care benefits to vulnerable populations. The majority of individuals are eligible for Medicaid benefits due to low income. Low-income individuals, by definition, have fewer financial resources. This often translates into fewer social resources, reduced housing quality and stability, and reduced access to health-related resource needs (such as healthy food, ready transportation, and safe communities). These factors may contribute to the less favorable results for Medicaid HaH participants as compared with HaH participants covered by Medicare or commercial insurance. If Medicaid is a proxy for generally lower income and less access to other supports needed to promote recovery from illness, it is possible that this population may benefit from traditional inpatient hospitalization more than those covered by other insurance products. Perhaps time spent in a safe hospital setting with easy access to meals and social support provided by clinical care team members offers Medicaid beneficiaries in particular a distinct advantage in promoting recovery from illness.

NC Medicaid and other state Medicaid programs began to offer coverage for HaH services during the COVID-19 pandemic, when there was a real and immediate need to free up hospital beds for patients requiring inpatient care and monitoring. Many states stood up field hospitals at some point during the PHE in response to overwhelming numbers of people with severe symptoms from COVID-19 infection. Clinical care team members were spread exceptionally thin and the physical and emotional demands on this workforce were considerable. As the pandemic wore on, in addition to the demands of direct patient care, clinical care team members also were often lightning rods for patient and family member frustration and stress. This stress came from many sources: income disruption, limited social interactions, confusing (and sometimes conflicting) guidance from public health authorities, masking requirements, and concerns about COVID-19 vaccine side effects. There also was significant concern around viral contagion; early in the PHE, it was not clear how the virus spread, but one effective intervention for reducing viral transmission was physical distancing between people. The HaH program offered participating individuals greater physical distancing (reducing viral exposure in those with non-COVID-19 diagnoses and reducing transmission for those with COVID-19 diagnoses), reduced health care workforce burden, and increased hospital bed availability for severely ill patients.

It was also not clear why the distribution of women and Black beneficiaries in the HaH program differed from the distribution of women and Black beneficiaries in the overall Medicaid population. Possible explanations include perceived higher levels of compliance among women as compared with men, perhaps leading health care providers to consider women to be generally lower risk for this type of lower-touch care [7]. Black beneficiaries may have been perceived to have greater available social supports than White beneficiaries, making them more appropriate for this model of care [8]. Conversely, higher numbers of Black beneficiaries and women beneficiaries in the HaH group may also reflect a pattern of race and gender bias, where White beneficiaries and male beneficiaries were prioritized to receive the more resource-intensive intervention of traditional inpatient care. For the future, it may be informative to look at the proportion of women and Black beneficiaries in the HaH program in the context of the population of patients with an inpatient admission and overall population or catchment area served by specific hospital systems.

The analysis described in this article does not provide insight into how beneficiaries were identified to receive care through the HaH model versus traditional inpatient care. Presumably, with matched diagnoses and chronic disease states, these factors played less of a role. It is possible that the factors that led clinical care teams to recommend HaH for one person and traditional inpatient care for another were influenced by unconscious bias. Future studies examining criteria used by clinical care teams to identify subpopulations of Medicaid beneficiaries for whom HaH care is appropriate would be valuable. These criteria ideally would include not only clinical elements, but also specific social and demographic factors that might influence decision-making.

DHNotice00726

A HaH model shifts a significant portion of the caregiving responsibility to family members or friends, and this burden must be acknowledged. Longer term, clear, evidence-based selection factors linked to favorable outcomes for the HaH model are needed. The need for such criteria in the Medicaid population appears particularly apparent, given the limited research on use of this model in this unique and financially vulnerable population.

This analysis is limited by its relatively small sample size, as well as its focus on administrative data. Although such data are readily available to state Medicaid programs, administrative data often do not prioritize clinical accuracy. Diagnoses as reflected by ICD-10 codes, for instance, tell only a portion of a patient's story. The nuances and complexity of patient care and factors contributing to selection of a HaH model of care over inpatient care delivery for an individual patient, or reasons for PCP follow-up visits within 30 days after discharge, are often not reflected in administrative data. For example, smoking history recorded within an electronic health record may factor into clinical decision-making about the appropriateness of HaH care but not be reflected consistently in administrative data. The analysis is also limited by its data from predominately one hospital system. It is not clear whether other systems would provide HaH services in a manner that would improve outcomes for this population.

After extensive study, review, and stakeholder discussions, NC Medicaid made the decision to cover HaH until December 31, 2024, when the Center for Medicare & Medicaid Services (CMS) waiver flexibility is scheduled to end. The program is currently pursuing a follow-up analysis with improved identification of HaH claims (ancillary data are no longer required to facilitate claims identification). There is particular interest among NC Medicaid leadership in examining whether HaH programs delivered during or after the PHE, such as NC Medicaid's, relied more on virtual monitoring of HaH patients as compared with earlier programs with superior outcomes. As the model matures with more experience and more health systems participating, it is the expectation that outcomes should improve to meet those seen in other studies.

Conclusion

Providing HaH coverage during the pandemic offered advantages of greater physical distancing for HaH participants and freed up hospital beds and hospital care team members to serve severely ill patients. Coverage for such services also reflected the changing landscape of Medicaid programming. While not overwhelming, early evidence seems to suggest that as compared with people covered by Medicare or commercial insurance, the Medicaid population may benefit more from traditional inpatient care over HaH care, despite being decades younger on average than the Medicare population. Very low-income individuals, such as those qualifying for Medicaid benefits due to income eligibility, may have limited at-home supports needed to promote recovery from serious illnesses. Suggested areas of future study include evidence-based selection criteria for HaH care for Medicaid members, examination of HaH outcomes across different hospital systems, and possibly examination of the impact of provision of non-medical but health-related resources (such as healthy food) on outcomes for HaH participants. As additional research is done in this area, the program will continue to assess its value for beneficiaries. **NCMJ**

Arianna Keil, MD Chief Quality Officer, NC Medicaid, Raleigh, North Carolina.
Ryan Fair, BS Senior Executive Director, Health Services Advisory Group, Inc., Phoenix, Arizona.
Wendy Qi, PhD, MPH Data Scientist, Health Services Advisory Group, Inc., Phoenix, Arizona.
Sam Thompson, MSW Deputy Director, Program Evaluation, NC Medicaid, Raleigh, North Carolina.
Shannon Dowler, MD, FAAFP, CPE Chief Medical Officer, NC Medicaid, Raleigh, North Carolina.

References
1. Approved Facilities/Systems for Acute Hospital Care at Home. CMS. Updated January 18, 2024. Accessed January 25, 2024. https://qualitynet.cms.gov/acute-hospital-care-at-home/resources
2. Cai S, Laurel P. Evaluation of a hospital-in-home program implemented among veterans. *Am J Manag Care.* 2017;23(8):482–487. https://www.ajmc.com/view/evaluation-of-a-hospital-in-home-program-implemented-among-veterans
3. Echevarria C, Gray J, Hartley T, et al. Home treatment of COPD exacerbation selected by DECAF score: a non-inferiority, randomised controlled trial and economic evaluation. *Thorax.* 2018;73(8):713–722. doi: 10.1136/thoraxjnl-2017-211197
4. 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
5. Levine DM, Ouchi K, Blanchfield B, et al. Hospital-level care at home for acutely ill adults: a pilot randomized controlled trial. *J Gen Intern Med.* 2018;33(5):729–736. doi: 10.1007/s11606-018-4307-z
6. Walsh D, Ledford C, Lyon M, Shiver S, Wilkins T, Furno M. Clinical outcomes of a newly instituted hospital at home program during the COVID19 pandemic. *Ann Fam Med.* 2023;(Suppl 1): 3883. Doi: 10.1370/afm.21.s1.3883
7. Otterbring T, Festila A. Pandemic prevention and personality psychology: Gender differences in preventive health behaviors during COVID-19 and the roles of agreeableness and conscientiousness. *J Safety Science Resilience.* 2022;3(1):87–91. doi: 10.1016/j.jnlssr.2021.11.003
8. Saulsberry L. Medicare Beneficiaries of Color More Likely to Rely on Unpaid Informal Caregivers for Home Health. *To the Point* (blog), Commonwealth Fund. Published January18, 2023. Accessed January 22, 2024. https://www.commonwealthfund.org/blog/2023/medicare-beneficiaries-color-more-likely-rely-unpaid-informal-caregivers-home-health

DHNotice00727

Healthcare on the brink: navigating the challenges of an aging society in the United States

Check for updates

Charles H. Jones ✉ & Mikael Dolsten ✉

The US healthcare system is at a crossroads. With an aging population requiring more care and a strained system facing workforce shortages, capacity issues, and fragmentation, innovative solutions and policy reforms are needed. This paper aims to spark dialogue and collaboration among healthcare stakeholders and inspire action to meet the needs of the aging population. Through a comprehensive analysis of the impact of an aging society, this work highlights the urgency of addressing this issue and the importance of restructuring the healthcare system to be more efficient, equitable, and responsive.

The United States is undergoing a demographic and health transformation that will have profound implications for its healthcare system and society. The population is aging at an unprecedented rate, with the baby boomer generation, defined as those born between 1946 and 1964, reaching retirement age and living longer than ever before. According to the U.S. Census Bureau, by 2030, all baby boomers will be older than 65, leading to about one in every five residents being retirement age[1]. This shift poses a dual challenge for the healthcare system: how to meet the increasing and complex healthcare needs of the elderly, and how to ensure that the system is prepared and equipped to provide quality and equitable care for this growing segment of the population.

The implications of this demographic shift are far-reaching. The healthcare system, as currently structured, is underprepared for the onslaught of demands this aging population will impose[2]. The system is also fragmented, inefficient, and costly, with gaps in coordination, quality, and access. Moreover, the system does not adequately address the social determinants of health, such as income, education, housing, transportation, and social support, that impact the health outcomes and health behaviors of the older adults[3–5]. Nor does it sufficiently engage the older adults and their caregivers in the planning and delivery of care or leverage the potential of community-based and home-based care models, which can improve the access, quality, and affordability of care for the elderly[6].

However, the challenge does not end there. There is a growing shortage of healthcare providers, which means that the supply and availability of qualified and skilled healthcare professionals, such as physicians, nurses, pharmacists, clinical social workers and technicians, is insufficient and inadequate to meet the demand and need of the population. This phenomenon is even more pronounced in low- and middle-income countries, as well as in the rural and remote areas within the U.S. According to the World Health Organization (WHO), the global health workforce was 43.5 million in 2018, and is projected to grow to 53.9 million by 2030, but still falls short of the estimated demand of 80 million by 2030, resulting in a global

shortfall of 18 million health workers, mostly in low- and middle-income countries[7]. In the U.S., a study by the Association of American Medical Colleges (AAMC) predicts a shortage of up to 139,000 physicians by 2033[8]. The shortage of healthcare providers has significant implications for the health sector, as it affects the access, quality, and cost of healthcare, as well as the health outcomes and satisfaction of the population.

As such, the U.S. is facing a healthcare paradox[9]. On one side, there is an aging population with increasing healthcare needs, and on the other, there is a strained healthcare system grappling with workforce shortages, capacity challenges, and fragmentation. Addressing this paradox requires innovative solutions, policy reforms, and a commitment to restructuring the healthcare system to be more efficient, equitable, and responsive to the needs of its aging citizens.

Although many of these issues may be front-of-mind for geriatrics specialists, many other stakeholders in the eldercare system likely do not understand the full scale of challenges brought on by a rapidly aging populace or may underestimate their preparedness for the resulting changes. This was seen in a recent survey of stakeholders in adult vaccine market, which represents a sector critical in the eldercare industry[10]. When presented with the projected rise of adult vaccines, a trend driven largely by the needs of the aging population, stakeholders across the market were unaware of the associated complexities and anticipated minimal challenges in adopting expanded vaccine schedules[10]. While vaccines represent only a portion of the eldercare market, it is reasonable to believe that this lack of a holistic understanding applies to all sectors in the eldercare industry.

This paper aims to stimulate dialogue and collaboration among the healthcare stakeholders, and to inspire action and innovation to address the needs and aspirations of the aging population. To accomplish this, this work will provide a comprehensive and critical analysis of the impact and implications of an aging society to highlight the importance and urgency of this issue.

Pfizer, 66 Hudson Boulevard, New York, New York 10018, USA. ✉e-mail: charles.jones@pfizer.com; mikael.dolsten@pfizer.com

DHNotice00728

Rising tide of healthcare needs: increasing demand and complexity of care

The U.S. population is aging rapidly because of two interrelated factors: the aging of the baby boomer generation, and the increase in life expectancy. The baby boomer generation constitutes the largest cohort in the U.S. history, with about 73 million members[11]. As this cohort reaches retirement age, the share of the population that is 65 and older will increase significantly, from 17% in 2022 to 21% in 2030, and to 23% in 2050 (Fig. 1A)[12]. By 2050, the number of Americans aged 65 and older will increase by 40%, from 58 million in 2022 to 82 million in 2050.

The aging population, particularly those over 85 years old, presents new challenges for the medical system. This will be the fastest growing segment, tripling in size from 6.5 million in 2022 to 17.3 million in 2050, a number comparable to the current population of New York state[13]. These elderly adults often suffer from multiple and complex health conditions, including age-related diseases that affect their heart, brain, and immune system. However, the medical system lacks the experience and expertise to effectively treat these diseases and provide specialized, personalized care for this vulnerable group. The increase in the share and size of the older population will have implications for the demand and supply of healthcare and social services, as well as for the economic and fiscal stability of the nation.

One of the main drivers of the increased healthcare demand and utilization among the elderly is the high prevalence of multiple chronic conditions (MCCs), which are defined as having two or more chronic diseases that last at least a year and require ongoing medical attention or limit activities of daily living[14,15]. According to the Centers for Disease Control and Prevention (CDC), 88% of older adults have at least one MCC, and 60% have at least two (Fig. 1B). These include common conditions such as hypertension, arthritis, heart disease, cancer, diabetes, and chronic kidney disease. MCCs are associated with increased mortality, disability, functional decline, and reduced quality of life. Moreover, they pose significant challenges to healthcare provision and management, as they require complex and coordinated care across multiple settings and providers. A study by Machlin et al. (2019) found that among Medicare beneficiaries aged 65 and older, those with MCCs accounted for 94% of total healthcare expenditures in 2010, compared to 6% for those without MCCs[16]. The average annual expenditure per person was $21,342 for those with four or more MCCs, $13,272 for those with three MCCs, $9176 for those with two MCCs, and $5865 for those with one MCC. These figures contrast sharply with the $2025 spent for those without any MCC.

The high prevalence of MCCs among the elderly is expected to persist or even increase in the future, as it is closely linked to the increase in life expectancy. As people live longer, they are more likely to develop and accumulate chronic diseases over time, especially if they have risk factors such as age-related physiological changes, environmental exposures, lifestyle behaviors, genetic predispositions, and social determinants of health. For example, a study by Crimmins and Beltrán-Sánchez[17] found that the increase in life expectancy in the U.S. between 1998 and 2008 was accompanied by an increase in the number of years spent with MCCs, especially among the elderly[17]. The study estimated that the average number of years spent with MCCs increased from 7.2 to 8.6 for men aged 65 and older, and from 10.0 to 11.3 for women aged 65 and older. Therefore, the aging population will face a higher burden of chronic diseases and a lower quality of life in the coming decades. Making matters worse, the health and longevity of the next wave of aging people may also be affected by new external triggers, such as obesity, processed food intake, microbiome changes, climate change, pandemics, and pollution, which can have diverse and unpredictable impacts on different individuals. These triggers can also change the health behaviors and healthcare access of the elderly.

Another challenge that arises from the medication requirements of the aging population is polypharmacy, which is defined as the concurrent use of five or more medications[18]. Individuals aged 65 and over account for over a third of all prescribed medications in the U.S.[19]. However, polypharmacy can have negative consequences, such as increased risk of drug interactions, adverse drug events, medication non-adherence, and medication errors. These can lead to poor outcomes, such as reduced effectiveness, increased morbidity and mortality, and decreased quality of life. Therefore, polypharmacy necessitates careful medication management and monitoring, as well as regular medication reviews and deprescribing when appropriate. A study by Qato et al.[20] found that among U.S. adults aged 65 and older, the prevalence of polypharmacy increased from 31.4% in 1999-2000 to 35.8% in 2011-2012, and the prevalence of potentially inappropriate medication use increased from 8.7% to 10.0%[20]. The study also found that polypharmacy was associated with higher rates of emergency department visits and hospitalizations[20].

The economic implications of the aging population for the healthcare sector are profound, as they affect not only the healthcare spending and
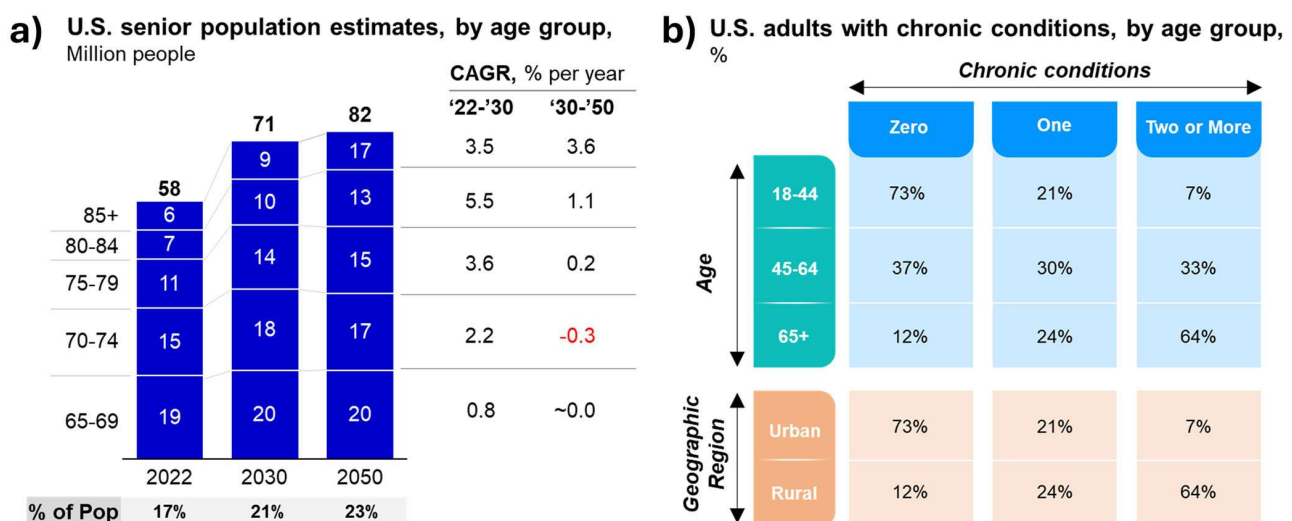

Fig. 1 | Growth of senior population and chronic disease burden. This figure illustrates the expected growth of the senior population and the associated increase in chronic disease burden. Raw data sourced from "2023 National Population Projections Tables: Main Series", which utilizes official estimates of resident population on July 1, 2022 as the base for projecting the U.S. population from 2023 to 2100 (panel **a**) and Boersma, et al., "Prevalence of Multiple Chronic Conditions Among U.S. Adults, 2018" (panel **b**).

DHNotice00729

Table 1 | Challenges and impacts of workforce dynamics in healthcare

Factor	Implication	Notable Statistics
The aging of the healthcare workforce itself, leading to increased retirements and reduced working hours.	• The system will face a significant loss of experience and expertise, as well as a reduced availability of workers.	• According to the Health Resources and Services Administration, about a third of the current registered nurses are over 50 years old, and about half of the current physicians are over 55 years old[82,83].
The insufficient supply of new entrants into the healthcare professions, due to limited educational capacity, high attrition rates, and low retention rates.	• The system will face a shortage of qualified and skilled workers, as well as a lack of diversity and representation in the workforce. • The supply of new healthcare graduates will continue to be constrained by the limited capacity of educational institutions, the high costs and debts of education, and the competitive and demanding nature of the professions[82–84].	• According to the American Association of Colleges of Nursing, U.S. nursing schools turned away more than 75,000 qualified applicants in 2018 due to faculty shortages, insufficient clinical sites, and budget constraints[85]. • According to the AAMC, U.S. medical schools have increased their enrollment by 31% since 2002, but this is still not enough to meet the projected demand for physicians[85].
The uneven distribution of the healthcare workforce across geographic regions, specialties, and settings, resulting in shortages in rural and remote areas, primary care and geriatric care, and community-based and home-based care.	• The system will face disparities and gaps in access and quality of care for different populations, especially the elderly, who often have multiple and complex needs. • The distribution of healthcare workers will become even more skewed towards urban and affluent areas, leaving rural and remote areas with fewer and less accessible providers[83,84].	• According to the Health Resources and Services Administration, about 60 million Americans live in areas with a shortage of primary care providers, and about 77 million Americans live in areas with a shortage of mental health providers[86]. • According to the American Geriatrics Society, there are only about 7,300 certified geriatricians in the U.S., which is far below the estimated need of 30,000 by 2030[87].
The increased workload and stress of the healthcare workers, leading to burnout, dissatisfaction, and turnover	• Attrition of healthcare provider could increase leading to overall reduction in available staff.	• According to a survey by the American Nurses Association, more than half of the nurses reported feeling overwhelmed by their work, and more than a third reported feeling emotionally exhausted[88]. • According to a survey by the Medscape, more than 40% of the physicians reported feeling burned out, and more than 10% reported feeling depressed[89].

resource utilization, but also the healthcare workforce, the healthcare quality, and the healthcare innovation. According to the Congressional Budget Office, the federal spending on major health programs for the elderly, such as Medicare and Medicaid, will increase from 6.6% of gross domestic product (GDP) in 2020 to 9.2% of GDP in 2050[21]. This projected growth is presumably driven by the older age segments differing healthcare utilization patterns and the increasing complexity of care. Specifically, it is estimated that adults aged 65+ visits doctors 20% more frequently than younger adults and experience a threefold increase in hospitalization rates[22]. This increased utilization and complexity of care drives increased spending as reported in a 2019 Kaiser Family Foundation study that found Medicare spending for beneficiaries aged 65 to 74 averages $7566, which nearly doubles to $16,145 for those aged 85 and older[23].

The rising tide of healthcare needs due to an aging population is multifaceted, encompassing increased service utilization, higher prevalence of chronic diseases, escalated healthcare spending, and complex medication management. This scenario places unprecedented demands on the healthcare system, calling for innovative approaches in care delivery, financial planning, and resource allocation. Adapting to these changes requires a concerted effort from healthcare providers, policymakers, and stakeholders to ensure that the system is not only responsive but also sustainable in meeting the evolving needs of an aging society. Therefore, it is imperative to recognize and discuss the impact this evolution will have on the demand for healthcare professionals, such as physicians, nurses, pharmacists, and specialists in geriatrics, who will be the critical in providing adequate and appropriate care for the elderly with complex medical needs.

The overburdened healthcare landscape: healthcare delivery challenges

The demand for healthcare workers is expected to outpace the supply, resulting in a projected deficit of 1.2 million registered nurses and 121,900 physicians by 2030[8,21]. The healthcare workforce shortage is driven by several factors, such as the aging of the workforce itself, the insufficient supply of new entrants, the uneven distribution across regions and specialties, and the increased workload and stress of the workers. These factors

are summarized in Table 1, along with their implications and notable statistics.

The shortage of healthcare providers will have a ripple effect on the entire healthcare system, affecting the quality, accessibility, and affordability of care. Physician shortages lead to increased mortality, reduced preventive care, and higher healthcare spending[24]. Moreover, the shortage of physicians creates a competitive environment for talent, where healthcare providers vie for the limited pool of available professionals. This competition may result in sector consolidation, where larger and more affluent providers acquire or merge with smaller and less profitable ones, creating economies of scale and scope. However, this consolidation may also have negative consequences, such as reduced competition, increased market power, and higher prices[25].

Appropriate staffing and labor supply are necessary for delivering care, but they are not sufficient without adequate resources and infrastructure. However, the current system is not well prepared to handle the increase in volume and complexity of care, resulting in overcrowding, wait times, delays, cancellations, and rationing of care. Some of the factors that contribute to this resource gap include:

- The state and performance of care delivery. The U.S. infrastructure is in bad shape and needs more investment and improvement, as a 2017 report by the American Society of Civil Engineers gave it a D+ grade[26]. The system wastes about $750 billion, or 30% of its spending, every year on unnecessary or excessive costs, fraud, and other inefficiencies[27]. It also has high variation in the quality and results of care across different providers, places, and regions, which can lead to too much, too little, or improper use of services[28]. For instance, a report by the Dartmouth Atlas Project showed that Medicare spending per beneficiary ranged by more than three times across regions, and that more spending did not mean better quality or satisfaction[29].
- The lack and imbalance of beds. The U.S. has seen a decline in the number of hospital beds per person from 4.5 in 1980 to 2.4 in 2018, reflecting the move from inpatient to outpatient care and the attempts to save costs and enhance efficiency. However, this trend also implies that there is less excess capacity to cope with fluctuations in demand, such as during pandemics, disasters, or seasonal variations.

DHNotice00730

Furthermore, the allocation of beds across states and regions is unequal, creating differences in access and quality of care for various populations[30]. For example, the states with the lowest number of beds per person are Nevada (1.8), Oregon (1.8), and Washington (1.9), while the states with the highest number of beds per person are South Dakota (4.1), North Dakota (4.0), and West Virginia (3.8)[31].

- The inadequacy and inefficiency of technology. The U.S. healthcare system is lagging behind in the adoption and use of information and communication technology (ICT), such as electronic health records (EHRs), telemedicine, and health information exchange (HIE), which can improve the quality, safety, and coordination of care, as well as reduce the costs and errors of care[32]. According to a 2023 report by the Organisation for Economic Co-operation and Development (OECD), the U.S. only hit the threshold of EHR use in 90% of physician offices, medical specialist offices, hospitals, and emergency rooms in 2021[33]. Although the U.S. joins 17-21 other countries that, depending on the setting, have achieved this milestone, it is one of the four countries that did not report having a mandated system in place[33]. As a result, access to records is inconsistent and may require use of multiple portals to view all of a patient's medical data, impeding benefits that may be observed through shared medial data across practices[33]. For example, analysis of EHRs have supported efforts to predict risk of conditions such as gestational diabetes[34] and postpartum depression[35] as well as to evaluate medical trends during the COVID-19 pandemic[36–38]. The large volume of data used in such efforts has generated interest for the application of machine-learning, particularly deep learning, to parse through complex and multivariate relationships identifiable within patient records[39–41]. Despite the potential, there are various concerns that arise with the digitization and availability of such records, such as breaches through cyber-attacks[42]. Finding avenues to address such concerns regarding patient privacy will be an important step towards realizing the benefits from advances in EHRs and their analysis to identify health trends.

The resource gap in the U.S. healthcare system will have serious consequences for the health and well-being of the population, especially the elderly, who are more vulnerable and dependent on the availability and quality of care. A study by the Commonwealth Fund found that the U.S. ranked last among 11 high-income countries in the health outcomes and experiences of older adults, with the highest rates of mortality, disability, hospitalizations, and unmet needs[43]. Moreover, the resource gap will have implications for the innovation and competitiveness of the U.S. healthcare sector, as it will limit the ability and opportunity to develop and implement new and better ways of delivering and improving care, such as digital health, precision medicine, and artificial intelligence (AI)[44].

The U.S. healthcare system is facing a supply crisis, as it is unable to meet the rising and complex needs of the aging population. The system is suffering from a shortage of labor and a constraint of resources, resulting in a capacity gap that affects the efficiency, equity, and quality of care. Addressing this crisis requires a strategic and comprehensive approach that involves increasing the quantity and quality of the healthcare workforce, enhancing the availability and accessibility of the healthcare resources, and improving the performance and productivity of the healthcare delivery. Achieving these goals requires collaboration and coordination among the healthcare providers, policymakers, and stakeholders, as well as a commitment and investment in the healthcare sector.

The fragmentation and disparity in healthcare provision: access challenges and the "rich-poor divide"

The U.S. healthcare system is facing a challenge not only in meeting the demand and supply of healthcare, but also in ensuring that the healthcare is accessible and affordable for all segments of the population, especially the elderly, who often face barriers and difficulties in obtaining and utilizing the care they need. The system is characterized by fragmentation and disparity, meaning that the healthcare provision is divided and disconnected across different providers, payers, and settings, and that the healthcare outcomes and experiences vary widely across different groups, regions, and conditions. These features of the system create inefficiencies, inequities, and inconsistencies in the access and quality of care, which can have negative impacts on the health and well-being of the population.

The fragmentation of the U.S. healthcare system stems from the lack of a universal and integrated system of healthcare coverage and delivery, which leads to gaps and overlaps in the coordination, continuity, and comprehensiveness of care[45]. The system is composed of multiple and competing payers, such as private insurers, public programs, and self-pay individuals, each with their own eligibility criteria, benefit packages, payment mechanisms, and administrative rules. This creates a complex and confusing landscape for the consumers and the providers, who have to navigate through different and often conflicting policies, procedures, and requirements. Moreover, the system is composed of multiple and independent providers, such as hospitals, clinics, physicians, nurses, pharmacists, and others, each with their own practice patterns, quality standards, and information systems. This creates a siloed and disjointed landscape for the delivery and management of care, which can result in duplication, fragmentation, and gaps in the care process.

The fragmentation of the U.S. healthcare system has significant implications for the access and quality of care, especially for the elderly, who often have multiple and complex needs that require coordinated and comprehensive care across different settings and providers. The fragmentation can lead to poor outcomes, such as increased errors, complications, readmissions, and costs, as well as reduced satisfaction, trust, and adherence[46]. For example, a study by Pham et al.[47] found that among Medicare beneficiaries aged 65 and older, those who had four or more chronic conditions and saw 10 or more physicians had twice the rate of preventable hospitalizations than those who saw two or fewer physicians[47]. Moreover, the fragmentation can lead to unmet needs, such as delayed or foregone care, as well as increased burden, such as out-of-pocket expenses, transportation difficulties, and caregiving responsibilities[48]. For example, among Medicare beneficiaries aged 65 and older, 15% reported having trouble getting timely appointments, 12% reported having trouble getting needed tests or treatments, and 9% reported having trouble getting needed medications[49].

The disparity in the U.S. healthcare system stems from the unequal and unfair distribution of healthcare resources, opportunities, and outcomes across different groups, regions, and conditions, which leads to gaps and differences in the access, quality, and affordability of care[50]. The system is influenced by various factors, such as income, education, race, ethnicity, gender, age, geography, and disability, that affect the health status and health behaviors of the population, as well as the availability and utilization of healthcare services. These factors create a diverse and heterogeneous landscape for the consumers and the providers, who face different and often disproportionate challenges and barriers in obtaining and delivering care. Moreover, the system is influenced by various policies, programs, and practices, such as reimbursement rates, quality measures, and incentives, that affect the allocation and distribution of healthcare resources, such as workforce, facilities, equipment, and technology. These policies, programs, and practices create a dynamic and complex landscape for the payers and the policymakers, who must balance and align the competing and conflicting interests and objectives of the healthcare stakeholders.

As the demand for healthcare services increases due to the aging population, and the supply of healthcare workers and resources remains insufficient and inadequate, a new form of fragmentation and disparity is emerging in the U.S. healthcare system: the rich-poor divide. This refers to the phenomenon where the affluent and urban areas attract and retain more and better healthcare professionals and facilities, while the poor and rural areas are left with fewer and worse healthcare options. This creates a vicious cycle, where the rich areas have more access and quality of care, and the poor areas have less access and quality of care, leading to further widening of the health and economic gaps between them.

One of the factors that contributes to this new form of fragmentation and disparity is the market-driven and competitive nature of the U.S. healthcare sector, where healthcare providers are motivated by financial incentives and rewards to work in areas and specialties that offer higher compensation and recognition. This creates a situation where the supply of healthcare workers is skewed towards the areas and specialties that have more demand and resources, such as urban and affluent areas, and specialty and subspecialty care. Conversely, the supply of healthcare workers is scarce in the areas and specialties that have less demand and resources, such as rural and remote areas, and primary and geriatric care. This results in a mismatch between the needs and the availability of the healthcare workforce, which affects the access and quality of care for different populations.

One of the examples that illustrates this new form of fragmentation and disparity is the rise of travel nurses, who are registered nurses with advanced training and certification in various specialties, and work on a temporary or contract basis in different locations and settings. These nurses are in high demand, as they can fill the gaps and shortages of anesthesiologists (i.e., travel nurse anesthetist) or other nurse specialists, who are often concentrated in urban and academic centers. Moreover, these nurses are well compensated, as they can earn significantly higher salaries and benefits than regular nurses and have more flexibility and autonomy in choosing their assignments and schedules. However, these nurses also contribute to the fragmentation and disparity of the healthcare system, as they tend to work in areas and settings that offer more opportunities and rewards, such as affluent and urban areas, and private and specialty hospitals. This leaves the areas and settings that have less opportunities and rewards, such as poor and rural areas, and public and primary care facilities, with fewer and less qualified healthcare workers, which affects the access and quality of care for the populations they serve.

Addressing the challenge of fragmentation and disparity in the U.S. healthcare system requires a holistic and integrated approach that involves improving the coordination and continuity of care, enhancing the equity and inclusivity of care, and ensuring the affordability and sustainability of care. Achieving these goals requires collaboration and coordination among the healthcare providers, payers, policymakers, and stakeholders, as well as a commitment and investment in the healthcare sector.

Interventions, policy reform, and global comparison

As the number of individuals living into their 80s, 90s and beyond increases dramatically, focus has shifted from extending lifespan to enhancing the quality of these additional years. This approach, known as 'delayed aging,' has encompassed investments in technology and policies that increase the number of years lived without the accumulation of chronic conditions and other side effects of aging. Achieving this would result in the compression of morbidity, meaning that chronic illnesses would be concentrated into a shorter period towards the end of life. This shift would not only have an impact on the general health of the population, would also have a positive financial impact. For example, a 2013 study conducted by Goldman et al. estimated that wide-spread delayed aging would save the U.S. $7.1 trillion by 2060.

The emerging field of geroscience is central to increasing the number of healthy years in older populations. This discipline seeks to understand the relationship between aging and age-related diseases, aiming to mitigate the latter by targeting the biological processes of aging itself[51]. A key strategy involves identifying biomarkers and risk factors, such as socioeconomic and lifestyle choices, that predict disease development in later life (Table 2). Technological advancements have enabled the aggregation of large multi-Omics datasets and longitudinal medical records from diverse patient groups and different aging tissues[52]. These include blood, brain, muscle, heart, liver, joint, skeleton, fat, among others. For example, the Accelerating Medicines Partnership®'s (AMP®'s) Alzheimer's Disease program has used a multi-omic analyses of molecular data from human brain samples to identify over 500 unique drug candidate targets[53]. This wealth of information offers an unprecedented opportunity to leverage AI methodologies to decipher unique patient markers and identify potential interventions.

Once these risk factors are identified, researchers can develop interventions that correct or mitigate them. These include addressing issues such as immune aging, chronic low-grade tissue inflammation, obesity, mitochondrial age-related insufficiency, and brain proteinopathies[54]. For instance, clinical studies with new targeted immune agents aim to rejuvenate the aging immune system using immune aging biomarkers as surrogate endpoints[55]. The hope is that restoring immune health could translate to beneficial downstream effects on the vascular, heart, brain, and kidney systems. The advent of the GLP-1 drug class (e.g., Semaglutide and Tirzepatide), which not only have the potential to prevent obesity-related diseases later in life, also offers a promising avenue for the reversal of metabolic aging and may even promote DNA repair in neurodegenerative diseases[56]. Maintaining muscle function is also crucial, particularly in the context of aging or chronic conditions like sarcopenia[57]. Insights into muscle augmenting factors and the ability to mobilize and differentiate muscle stem cells present critical areas for promoting healthy aging[58]. Bioengineering, including the development of exoskeletons for spinal injury patients, offers potential solutions for maintaining ambulation during aging[59].

Future interventions may include longitudinal analyses of genome integrity and maintaining DNA fidelity systems. Reducing the accumulation of somatic mutations, which correlate with aging of bone marrow[60], myeloid cell dysplasia (clonal hematopoiesis)[61], vascular wall dysfunction[62], and blood cancers[63], could be possible. The first successful trials in gene therapy and gene editing have shed new light and promise on human disease, suggesting that restoring the integrity of the human genome and cell systems may increasingly be within our technological reach. This could expand to restore function in autoimmune and fibrotic diseases, further underscoring the transformative potential of geroscience and technology in improving healthcare for the elderly.

As the field of geroscience advances, there is a significant risk that these innovations may predominantly benefit those with substantial resources, further exacerbating the 'rich-poor' divide in eldercare and highlighting one type of inequity that tomorrow's elderly may face. There is already evidence that compression of morbidity may be due more to socioeconomic factors than biological determinants[64,65]. However, we do not yet know what other challenges these future generations may face. New and emerging socioeconomic factors and factors associated with marginalized groups in younger populations will have a yet unknown impact on tomorrow's elderly. The shifting healthcare requirements of younger demographics, characterized by factors such as the increase in gender-affirming care, escalating mental health issues, and substance misuse, including opioids, are likely to affect the future landscape of elderly care in ways that are currently unknown. The opioid crisis, as elaborated in Barbara Kingsolver's *Demon Copperhead*, serves as an illustration of how prevalent health and societal challenges can have significant long-term impacts on public health and healthcare systems[66]. This narrative, which mirrors the broader societal problem of substance abuse, underscores the importance of incorporating equity as a fundamental factor in healthcare policy decisions. Ensuring that healthcare improvements, including those emerging from geroscience, are accessible to all, irrespective of their socioeconomic status, is vital to prevent further exacerbation of the economic disparity in eldercare.

To this end, the U.S. has launched policy reforms over the last two decades aimed at securing equitable healthcare for its senior citizens. These measures seek to confront salient challenges in the accessibility, quality, and financial viability of services catering to the elderly. The expansion of Medicaid under the Affordable Care Act (ACA), enacted in 2010, serves as a cornerstone of these initiatives, enhancing Medicaid's scope to encompass superior benefits, cost reductions, and improved eldercare[67]. Significantly, the ACA reducing the Medicare Part D prescription drug "donut hole," or drug coverage gaps, improving preventive care with no cost-sharing. Additional initiatives, such as Medicare Advantage, aim to improve eldercare coordination by allowing Medicare beneficiaries to enroll in managed care plans (Medicare Advantage). Medicare Advantage, for example, enrolled over 30.8 million individuals in 2023 alone, and now represent over 50% of all seniors on Medicare[68].

DHNotice00732

Table 2 | Diagnostic biomarkers for age-related diseases and their implications for clinical practice

Diagnostic Risk Factor(s)	Select Biomarkers	Change with Age	Physiological Impact	Associated Diseases	Testing	Use in Medicine	Ref
Chronic Inflamm. (Inflamm-ageing)	CRP; IL-6; TNF-α; IL-1β	Increase	Leads to system inflamm. causing tissue damage, altered immune response, and increase risk of ASCVD.	CV diseases; Frailty; Dementia; CKD; DM; Cancer; Depression; Sacropenia	Blood tests; High Sensitivity CRP Test	Utilized currently	90
Metabolic Health (Glucose Metabolism, Hyperglycemia)	Fasting glucose; HbA1c; Insulin levels	Dysreg.	Impairs glucose utilization, leading to hyperglycemia and contributing to vascular damage and insulin resistance.	CV disease; Cognitive decline; T2D; Metabolic syndrome	Blood tests (HbA1c, glucose testing, insulin assay)	Utilized currently	91
Muscle Function (Sarcopenia)	Muscle mass; Grip strength; Gait speed; DEXA	Decrease	Reduces skeletal muscle strength and function, impairs mobility and increases fall risk	Sarcopenia; Frailty; Increased risk of falls and hospitalization; Decreased mobility and independence	Physical assessments; DXA; CT; MRI; BIA	Utilized currently	92
Cachexia/Obesity	BMI; Waist CIR; Body comp.	Varies	Alters metabolic regulation, increases mechanical load on joints, and contributes to systemic inflamm.	Diabetes; CV diseases; Osteoarthritis; Sleep apnea; Certain cancers (e.g., breast, colon); Surgical Risks and complications	Physical measurement; DXA; BIA	Utilized currently	93
Immune Aging Fingerprint	Immunophenotyping; Senescent cell markers; CD28null T cells	Immune Dysreg.	Leads to decreased immune surveillance and increased prevalence of senescent cells contributing to tissue dysfunction.	Increased susceptibility to infections; Autoimmune disorders; Cancer; Reduced VE	Flow cytometry; SA-β-gal staining; Immuno-phenotyping	Soon to be diagnostic	94
Genetic Risk Factors	Genetic poly-morphisms; SNPs	Stable but influence disease risk	Influences metabolic pathways and immune responses, predisposing individuals to various chronic conditions.	Metabolic syndrome; CV diseases; Alzheimer's disease; Certain cancers; Response to medications (pharmacogenomics)	Genetic screening; SNP arrays	Exploratory	95,96
Microbiome	Microbial comp.; SCFA profiles	Changes with diet, anti-biotic usage	Affects gut barrier function, systemic inflamm., and nutrient metabolism.	GI disorders; Metabolic dysregulation (e.g., obesity, diabetes); Autoimmune diseases; Mood disorders	16 S rRNA gene sequencing; Metagenomic sequencing	Exploratory	90
Telomere Length	Telomere length	Shortens	Shortening of telomeres is associated with cellular aging and increased risk of age-related diseases.	CV diseases, various cancers; OP; Diabetes; Increased risk of mortality	Quantitative PCR; Telomere length analysis	Exploratory	97
Oxidative Stress Markers	MDA; 8-OHdG; Antioxidant capacity	Increases	Causes cellular damage and contributes to the aging process and development of age-related diseases.	NDDs; CV diseases; Cancer; AMD	Blood tests; ELISA; Spectro-photometry	Exploratory	98
Vitamin D Levels	25-hydroxy-vitamin D	Varies with exposure and intake	Influences bone health, immune function, and has been linked to a lower risk of several chronic diseases.	OP; CV diseases; T2D; MS; Depression; Certain Cancers	Blood tests (25-hydroxy-vitamin D assay)	Exploratory	99

8-OHdG 8-hydroxy-2′-deoxyguanosine, *AMD* age-related macular degeneration, *ASCVD* atherosclerotic cardiovascular disease, *BIA* bioelectrical impedance analysis, *BMI* body mass index, *CIR* circumference, *CKD* chronic kidney disease, *comp.* composition, *CPR* C-reactive protein, *CT* computed tomography, *CV* cardiovascular disease, *DEXA* dual-energy x-ray absorptiometry, *DM* diabetes mellitus, *Dysreg.* dysregulation, *ELISA* enzyme-linked immunosorbent assay, *GI* gastrointestinal disease, *HbA1c* hemoglobin A1C, *IL* interleukin, *MDA* malondialdehyde, *MRI* magnetic resonance imaging, *MS* multiple sclerosis, *NDDs* neurodegenerative diseases, *OP* osteoporosis, *PCR* polymerase chain reaction, *Ref* references, *SA-β-gal* senescence-associated β-galactosidase, *SCFA* short chain fatty acids, *SNPs* single nucleotide polymorphisms, *T2D* Type 2 diabetes, *TNF-α* tumor necrosis factor-α, *VE* vaccine efficacy.

DHNotice00733

As components of the patient protection models, accountable care organizations (ACOs) have also exhibited efficacy in enhancing care coordination, leading to improved patient outcomes and decreased costs. A 2021 report from the Centers for Medicare & Medicaid Services (CMS) asserts that ACOs yielded $17.7 billion in gross savings and $6.5 billion in net savings for Medicare between 2021 and 2022, while also improving the quality of care[69]. Alongside these models, enhancements in Long-Term Care and Support Services through the expansion of home and community-based services (HCBS) via Medicaid have substantially widened access to personalized long-term care[70,71]. These services are aimed at facilitating elderly individuals to 'age in place'[72]. In 2019 alone, Medicaid HCBS expenditures amounted to $162 billion, highlighting a sustained trend towards increased investment in services that promote autonomy and dignity for the elderly[73]. Additionally, this represents a cost-effective approach to long-term care by minimizing dependence on more costly institutional care settings.

Internationally, countries have adopted diverse strategies to address the healthcare needs of their aging populations. Japan and Germany, for example, both emphasize integrated care models and insurance-based solutions, like Germany's statutory health insurance complemented by long-term care insurance[74,75] and Japan's Long-Term Care Insurance[76]. However, Japan, as one of the world's oldest populations, faces unique challenges in sustaining its healthcare workforce[77]. In an attempt to compensate for this, this country has positioned itself at the forefront of automating elder care including the development of technologies such as 'care robots,' to improve the quality of care in nursing homes[78]. Similar to Japan, Singapore has also implemented technological healthcare solutions for its aging population, investing in improving telemedicine, remote health monitoring apps, wearable wellness technology, and smart home solutions (e.g., fall detect sensors) to facilitate independent living and reduce the burden on the healthcare system[79]. This country is currently second in the word in terms of highest life expectancy, compared with the U.S. at 48[80]. Sweden, number 20 on that list[80], is internationally recognized as a model for eldercare. It is another country that heavily focuses on 'aging in place' by providing heavily funded care through municipal taxes and government grants[81].

Conclusion

It is often said that there is always tomorrow, implying that we can postpone our actions and decisions to a later date. However, this sentiment cannot hold true anymore when it comes to the care of the aging population. For us to have a prosperous tomorrow, we must begin planning and actioning today. The aging of the population is not a distant or hypothetical scenario, but a present and inevitable reality. We cannot afford to wait and see what happens. We must act and change what happens today. We have the potential and the responsibility to create a better and brighter future for the elderly and for ourselves. The question is: will we?

Data availability

No datasets were generated or analyzed for this manuscript.

References

1. Bureau, U. C. Older Population and Aging. *United States Census Bureau* https://www.census.gov/topics/population/older-aging.html (2023).
2. Chamie, J., Berkman, L., Hayutin, A. M., Smith, J. P. & Hoeksema, M. J. *Why Population Ageing Matters: A Global Perspectives* (Center for Migration Studies, 2007).
3. CDC. Equitably Addressing Social Determinants of Health and Chronic Diseases, *CDC* https://www.cdc.gov/chronicdisease/healthequity/social-determinants-of-health-and-chronic-disease.html?CDC_AA_refVal=https%3A%2F%2Fwww.cdc.gov%2Fchronicdisease%2Fprograms-impact%2Fsdoh.htm (2022).
4. Lopes, L., Montero, A., Presiado, M., Liz H. Americans' Challenges with Health Care Costs. *KFF* https://www.kff.org/health-costs/issue-brief/americans-challenges-with-health-care-costs/ (2023).
5. Chetty, R. et al. The association between income and life expectancy in the United States, 2001-2014. *JAMA* **315**, 1750–1766 (2016).
6. He, Y., Wei, B. & Li, Y. The impact of using community home-based elderly care services on older adults' self-reported health: fresh evidence from China. *Front. Public Health* **11**, 1257463 (2023).
7. WHO. Global Health Workforce statistics database. *WHO* https://www.who.int/data/gho/data/themes/topics/health-workforce (2023).
8. Dall, T. et al. The Complexities of Physician Supply and Demand: Projections From 2018 to 2033. *AAMC* https://www.aamc.org/system/files/2020-06/stratcomm-aamc-physician-workforce-projections-june-2020.pdf (2020).
9. Gurwitz, J. H. The paradoxical decline of geriatric medicine as a profession. *JAMA* **330**, 693–694 (2023).
10. Jones, C. H., Jenkins, M. P., Adam Williams, B., Welch, V. L. & True, J. M. Exploring the future adult vaccine landscape—crowded schedules and new dynamics. *npj Vaccines* **9**, 27 (2024).
11. Staff, A. C. 2020 Census Will Help Policymakers Prepare for the Incoming Wave of Aging Boomers. *United States Census Bureau* https://www.census.gov/library/stories/2019/12/by-2030-all-baby-boomers-will-be-age-65-or-older.html#:~:text=The%202020%20Census%20will%20provide,on%20America's%20population%20age%20structure.%E2%80%9D&text=Born%20after%20World%20War%20II,will%20turn%2074%20next%20year (2019).
12. 2023 National Population Projections Tables: Main Series. *United States Census Bureau* https://www.census.gov/data/tables/2023/demo/popproj/2023-summary-tables.html (2023).
13. QuickFacts: New York. *United States Census Bureau* https://www.census.gov/quickfacts/fact/table/NY/PST045223 (2023).
14. Davis-Ajami, M. L., Lu, Z. K. & Wu, J. Multiple chronic conditions and associated health care expenses in US adults with cancer: a 2010–2015 Medical Expenditure Panel Survey study. *BMC Health Serv. Res.* **19**, 1–10 (2019).
15. Goodman, R. A., Posner, S. F., Huang, E. S., Parekh, A. K. & Koh, H. K. Peer reviewed: defining and measuring chronic conditions: imperatives for research, policy, program, and practice. *Prev. Chronic Dis.* **10**, E66 (2013).
16. Machlin, S. R. & Soni, A. Health care expenditures for adults with multiple treated chronic conditions: estimates from the Medical Expenditure Panel Survey, 2009. *Prev. Chronic Dis.* **10**, E63 (2013).
17. Crimmins, E. M. & Beltrán-Sánchez, H. Mortality and morbidity trends: is there compression of morbidity? *J. Gerontol. B: Psychol. Sci. Soc. Sci.* **66**, 75–86 (2011).
18. Masnoon, N., Shakib, S., Kalisch-Ellett, L. & Caughey, G. E. What is polypharmacy? A systematic review of definitions. *BMC Geriatr.* **17**, 1–10 (2017).
19. Cohen, R. A. & Boersma, P. Strategies used by adults aged 65 and over to reduce their prescription drug costs, 2016-2017. *NCHS Data Brief* **335**, 1–8 (2019).
20. Qato, D. M., Wilder, J., Schumm, L. P., Gillet, V. & Alexander, G. C. Changes in prescription and over-the-counter medication and dietary supplement use among older adults in the United States, 2005 vs 2011. *JAMA Intern. Med.* **176**, 473–482 (2016).
21. The 2020 Long-Term Budget Outlook. *Congressional Budget Office* https://www.cbo.gov/system/files/2020-09/56516-LTBO.pdf (2020).
22. Health, United States, 2014: With Special Feature on Adults Aged 55–64. *National Center for Health Statistics* https://www.cdc.gov/nchs/data/hus/hus14.pdf (2015).
23. Cubanski, J., Neuman T., Griffin, S., and Damico, A. Medicare Spending at the End of Life: A Snapshot of Beneficiaries Who Died in 2014 and the Cost of Their Care. *KFF* https://www.kff.org/medicare/issue-brief/medicare-spending-at-the-end-of-life/ (2016).

24. Zhang, X., Lin, D., Pforsich, H. & Lin, V. W. Physician workforce in the United States of America: forecasting nationwide shortages. *Hum Resour Health* **18**, 8 (2020).
25. Gaynor, M. & Town, R. *the Impact of Hospital Consolidation—update* (The Synthesis Project, Robert Wood Johnson Foundation, 2012).
26. 2017 Infrastructure Report Card. *ASCE* https://www.infrastructurereportcard.org/wp-content/uploads/2016/10/2017-Infrastructure-Report-Card.pdf (2017).
27. McGinnis, J. M., Stuckhardt, L., Saunders, R. & Smith, M. *Best care at lower cost: the path to continuously learning health care in America* (National Academies Press, 2013).
28. Wennberg, J. E., Fisher, E. S. & Skinner, J. S. Geography and the debate over medicare reform: A reform proposal that addresses some underlying causes of Medicare funding woes: geographic variation and lack of incentive for efficient medical practices. *Health Affairs* **21**, W96–W112 (2002).
29. The Dartmouth Atlas of Health Care. *Dartmouth Atlas Project* https://www.dartmouthatlas.org/ (2024).
30. Hospital Beds per 1,000 Population by Ownership Type. *KFF* https://www.kff.org/other/state-indicator/beds-by-ownership/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D (2022).
31. Health Care Resources: Hospital Beds. *OECD* https://data.oecd.org/healtheqt/hospital-beds.htm (2020).
32. Adler-Milstein, J. & Jha, A. K. HITECH Act drove large gains in hospital electronic health record adoption. *Health Aff* **36**, 1416–1422 (2017).
33. Slawomirski, L. et al. Progress on implementing and using electronic health record systems. *OECD* https://www.oecd.org/publications/progress-on-implementing-and-using-electronic-health-record-systems-4f4ce846-en.htm (2023).
34. Artzi, N. S. et al. Prediction of gestational diabetes based on nationwide electronic health records. *Nat. Med.* **26**, 71–76 (2020).
35. Amit, G. et al. Estimation of postpartum depression risk from electronic health records using machine learning. *BMC Pregnancy Childbirth* **21**, 630 (2021).
36. Wood, A. et al. Linked electronic health records for research on a nationwide cohort of more than 54 million people in England: data resource. *BMJ* **373** (2021).
37. Wang, Q. Q., Kaelber, D. C., Xu, R. & Volkow, N. D. COVID-19 risk and outcomes in patients with substance use disorders: analyses from electronic health records in the United States. *Mol. Psychiatry* **26**, 30–39 (2021).
38. Collaborative, O. et al. OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients. *MedRxiv* https://doi.org/10.1101/2020.05.06.20092999 (2020).
39. Ayala Solares, J. R. et al. Deep learning for electronic health records: a comparative review of multiple deep neural architectures. *J. Biomed. Inform.* **101**, 103337 (2020).
40. Li, Y. et al. BEHRT: transformer for electronic health records. *Sci. Rep.* **10**, 7155 (2020).
41. Huang, S.-C., Pareek, A., Seyyedi, S., Banerjee, I. & Lungren, M. P. Fusion of medical imaging and electronic health records using deep learning: a systematic review and implementation guidelines. *NPJ Digit Med.* **3**, 136 (2020).
42. Keshta, I. & Odeh, A. Security and privacy of electronic health records: Concerns and challenges. *Egypt Inform. J.* **22**, 177–183 (2021).
43. Osborn, R., Doty, M. M., Moulds, D., Sarnak, D. O. & Shah, A. Older Americans were sicker and faced more financial barriers to health care than counterparts in other countries. *Health Aff.* **36**, 2123–2132 (2017).
44. Topol, E. J. High-performance medicine: the convergence of human and artificial intelligence. *Nat. Med.* **25**, 44–56 (2019).
45. Shortell, S. M. & McCurdy, R. K. Integrated health systems. *IKMS* **8**, 369–382 (2009).
46. O'Malley, A. S. & Rich, E. C. Measuring comprehensiveness of primary care: challenges and opportunities. *J. Gen. Intern. Med.* **30**, 568–575 (2015).
47. Pham, H. H., Schrag, D., O'Malley, A. S., Wu, B. & Bach, P. B. Care patterns in Medicare and their implications for pay for performance. *NEJM* **356**, 1130–1139 (2007).
48. Komisar, H. *The Effects of Rising Health Care Costs on Middle-Class Economic Security*, https://www.aarp.org/pri/topics/health/coverage-access/impacts-of-rising-healthcare-costs-AARP-ppi-sec.html (2013).
49. Shi, L., Regan, J., Politzer, R. M. & Luo, J. Community Health Centers and racial/ethnic disparities in healthy life. *Int J Health Serv* **31**, 567–582 (2001).
50. Braveman, P. & Gruskin, S. Defining equity in health. *JECH* **57**, 254 (2003).
51. Kennedy, B. K. et al. Geroscience: linking aging to chronic disease. *Cell* **159**, 709–713 (2014).
52. Babu, M. & Snyder, M. Multi-omics profiling for health. *Mol Cell Proteomics* **22**, 100561 (2023).
53. Alzheimer's Disease. *NIH* https://www.nih.gov/research-training/accelerating-medicines-partnership-amp/alzheimers-disease (2021).
54. Tenchov, R., Sasso, J. M., Wang, X. & Zhou, Q. A. Aging Hallmarks and progression and age-related diseases: a landscape view of research advancement. *ACS Chem Neurosci* **15**, 1–30 (2024).
55. Tran Van Hoi, E. et al. Biomarkers of the ageing immune system and their association with frailty—a systematic review. *Exp. Gerontol.* **176**, 112163 (2023).
56. Wilbon, S. S. & Kolonin, M. G. GLP1 receptor Agonists—effects beyond obesity and diabetes. *Cells* **13**, 65 (2024).
57. Grevendonk, L. et al. Impact of aging and exercise on skeletal muscle mitochondrial capacity, energy metabolism, and physical function. *Nat. Commun.* **12**, 4773 (2021).
58. Sousa-Victor, P., García-Prat, L. & Muñoz-Cánoves, P. Control of satellite cell function in muscle regeneration and its disruption in ageing. *Nat. Rev. Mol. Cell Biol.* **23**, 204–226 (2022).
59. Kapsalyamov, A., Hussain, S. & Jamwal, P. K. State-of-the-art assistive powered upper limb exoskeletons for elderly. *IEEE Access* **8**, 178991–179001 (2020).
60. Patel, N., Dulau-Florea, A. & Calvo, K. R. Characteristic bone marrow findings in patients with UBA1 somatic mutations and VEXAS syndrome. *Semin. Hematol.* **58**, 204–211 (2021).
61. Park, S. J. & Bejar, R. Clonal hematopoiesis in cancer. *Exp. Hematol.* **83**, 105–112 (2020).
62. Revêchon, G., Merino, L. G., Machtel, P. & Eriksson, M. Somatic mutations in vascular wall function and age-associated disease. *Eur. Heart J.* **44**, 4208–4210 (2023).
63. Feusier, J. E. et al. Large-scale identification of clonal hematopoiesis and mutations recurrent in blood cancers. *Blood Cancer Discov.* **2**, 226–237 (2021).
64. House, J. S., Kessler, R. C. & Herzog, A. R. Age, socioeconomic status, and health. *Milbank Q.* **68**, 383–411 (1990).
65. Rowe, J. W. & Berkman, L. Decompression of morbidity and the workforce. *Nat. Aging* **2**, 3–4 (2022).
66. Kingsolver, B. *Demon Copperhead* (Harper, 2022).
67. The Affordable Care Act: A Stronger Medicare Program in 2012. *CMS* https://www.cms.gov/apps/files/medicarereport2012.pdf (2013).
68. Ochieng, N., Biniek, J. F., Freed, M., Damico, A., Neuman, T. Medicare Advantage in 2023: Enrollment Update and Key Trends. *KFF* https://www.kff.org/medicare/issue-brief/medicare-advantage-in-2023-enrollment-update-and-key-trends/ (2023).

DHNotice00735

69. ACOs & Cost Savings. *NAACOS* https://www.naacos.com/acos-and-cost-savings#:~:text=ACOs%20and%20Cost%20Savings,savings%2C%20according%20to%20CMS%20data. (2022).
70. Home- and Community-Based Services. *CMS* https://www.cms.gov/training-education/partner-outreach-resources/american-indian-alaska-native/ltss-ta-center/information/ltss-models/home-and-community-based-services (2023).
71. Chidambaram, P., Burns, A., Rudowitz, R. Who Uses Medicaid Long-Term Services and Supports? *KFF* https://www.kff.org/medicaid/issue-brief/who-uses-medicaid-long-term-services-and-supports/ (2023).
72. *Aging in Place: Growing Older at Home. NIH* https://www.nia.nih.gov/health/aging-place/aging-place-growing-older-home#resources (2023).
73. Burns, A., Mohamed, M., Watts, M. O. M. Pandemic-Era Changes to Medicaid Home- and Community-Based Services (HCBS): A Closer Look at Family Caregiver Policies. *KFF* https://www.kff.org/medicaid/issue-brief/pandemic-era-changes-to-medicaid-home-and-community-based-services-hcbs-a-closer-look-at-family-caregiver-policies/ (2023).
74. Wienecke, D. How does Germany care for the elderly? *Medium* https://dietrichwienecke.medium.com/how-does-germany-care-for-the-elderly-c394425a2e07 (2023).
75. Busse, R., Blümel, M., Knieps, F. & Bärnighausen, T. Statutory health insurance in Germany: a health system shaped by 135 years of solidarity, self-governance, and competition. *Lancet* **390**, 882–897 (2017).
76. Yamada, M. & Arai, H. Long-term care system in Japan. *Ann. Geriatr. Med. Res.* **24**, 174–180 (2020).
77. Okamoto, S. & Komamura, K. Towards universal health coverage in the context of population ageing: a narrative review on the implications from the long-term care system in Japan. *Arch. Pub. Health* **80**, 210 (2022).
78. Wright, J. Inside Japan's long experiment in automating elder care. *Technology Review* https://www.technologyreview.com/2023/01/09/1065135/japan-automating-eldercare-robots/ (2023).
79. Koh, S. Tech-Assisted Healthcare: Revolutionizing Senior Care in Singapore. *Medium* https://medium.com/@koh.siag.lan/tech-assisted-healthcare-revolutionizing-senior-care-in-singapore-8fc53241d83a (2024).
80. Country Comparisons—Life expectancy at birth. *CIA* https://www.cia.gov/the-world-factbook/field/life-expectancy-at-birth/country-comparison/ (2024).
81. Lorenzoni, L. Case Study—Sweden. *Organization for Economic Co-operation and Development* https://extranet.who.int/kobe_centre/sites/default/files/pdf/Sweden_draft_rev-2.pdf (2021).
82. Auerbach, D. I. & Staiger, D. O. How fast will the registered nurse workforce grow through 2030? Projections in nine regions of the country. *Nurs. Outlook* **65**, 116–122 (2017).
83. Supply and Demand Projections of the Nursing Workforce: *2014-2030*. *National Center for Health Workforce Analysis* https://bhw.hrsa.gov/sites/default/files/bhw/nchwa/projections/NCHWA_HRSA_Nursing_Report.pdf (2017).
84. State Physician Workforce Data Report. *AAMC* https://www.aamc.org/data-reports/workforce/report/state-physician-workforce-data-report (2019).
85. Nursing Shortage Fact Sheet. *AACN* https://www.aacnnursing.org/News-Information/Fact-Sheets/Nursing-Shortage (2022).
86. Health Workforce Shortage Areas. *HRSA* https://data.hrsa.gov/topics/health-workforce/shortage-areas (2024).
87. Geriatrics Workforce Enhancement Program. *HRSA* https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/funding/geriatrics-workforce-enhancement-programs-2019.pdf (2019).
88. American Nurses Association Well-Being Initiative. *ANA* https://www.nursingworld.org/practice-policy/work-environment/health-safety/disaster-preparedness/coronavirus/what-you-need-to-know/the-well-being-initiative/ (2019).
89. Medscape National Physician Burnout & Suicide Report 2020: The Generational Divide. *Medscape* https://www.medscape.com/slideshow/2020-lifestyle-burnout-6012460 (2020).
90. Ferrucci, L. & Fabbri, E. Inflammageing: chronic inflammation in ageing, cardiovascular disease, and frailty. *Nat. Rev. Cardiol.* **15**, 505–522 (2018).
91. Chia, C. W., Egan, J. M. & Ferrucci, L. Age-related changes in glucose metabolism, hyperglycemia, and cardiovascular risk. *Circ. Res.* **123**, 886–904 (2018).
92. Lena, A., Coats, A. J. S. & Anker, M. S. Metabolic disorders in heart failure and cancer. *ESC Heart Fail* **5**, 1092–1098 (2018).
93. Martin, L. et al. Cancer cachexia in the age of obesity: skeletal muscle depletion is a powerful prognostic factor, independent of body mass index. *J. Clin. Oncol.* **31**, 1539–1547 (2013).
94. Tchkonia, T., Zhu, Y., Van Deursen, J., Campisi, J. & Kirkland, J. L. Cellular senescence and the senescent secretory phenotype: therapeutic opportunities. *JCI* **123**, 966–972 (2013).
95. Dominguez, L. J. & Barbagallo, M. The biology of the metabolic syndrome and aging. *Curr. Opin. Clin. Nutr. Metab. Care* **19**, 5–11 (2016).
96. Guo, Y. et al. Plasma proteomic profiles predict future dementia in healthy adults. *Nat. Aging* **4**, 247–260 (2024).
97. Rizvi, S., Raza, S. T. & Mahdi, F. Telomere length variations in aging and age-related diseases. *Curr. Aging Sci.* **7**, 161–167 (2014).
98. Liguori, I. et al. Oxidative stress, aging, and diseases. *Clin. Interv. Aging* **13**, 757–772 (2018).
99. Meehan, M. & Penckofer, S. The role of vitamin D in the aging adult. *J. Aging Gerontol.* **2**, 60–71 (2014).

Acknowledgements

Author contributions

C.H.J. conceptualized the publication, developed the outline, researched sources, drafted and edited the manuscript, and provided strategic input. M.D. provided strategic insights, edited the manuscript, and provided research source material.

Competing interests

The authors declare no competing non-financial but declare the following Competing Financial Interests: C.H.J. and D.M. report that they are employees of Pfizer Inc. and may hold stock or stock options in the company.

Additional information

Correspondence and requests for materials should be addressed to Charles H. Jones or Mikael Dolsten.

Reprints and permissions information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

DHNotice00736

ADDRESSING HEALTH-RELATED SOCIAL NEEDS IN HOSPITAL AT HOME THROUGH SYSTEMATIC, IN-PERSON ASSESSMENT & REFERRAL TO COMMUNITY HEALTH NAVIGATORS

Gregory D Snyder[1], MD, MBA, Arsheeya Mashaw[2], MD, Chloe Eustache, RN[1]

[1]Medically Home Group Inc., United States of America, [2] Kaiser Permanente Northwest, Advanced Care at Home, United States of America

INTRODUCTION

Hospital at Home (HaH) is well positioned to address social drivers of health (SDOH). Kaiser Permanente Northwest (KPNW) and Medically Home Group evaluated the impact of administering an additional systematic assessment of in-home SDOH risk (Figure 1) during a home visit early in the HaH stay to supplement an existing virtual, pre-admission survey of home safety & needs.

KPNW's HaH population

KPNW is an integrated hospital system in Portland, Oregon that implemented HaH in 2020 with Medically Home Group and has served over 3,200 patients.

METHODOLOGY

Pre-protocol

Assessment

- Pre-admission telephonic assessment of patients' homes & in-home needs done by virtual HaH nurses through a Social Stability Tool (SST).

Referrals

- Virtual HaH nurse referred patients to Community Health Navigators as needed

SDOH protocol (initiated April 2022)

Assessment

- Standard pre-admission, telephonic assessment
- **Additional 4-domain SDOH assessment (see Figure 2)** administered in-person in the home during day 2 of the HaH admission

Referral

- Any SDOH-risk identification triggered CHN referral. CHNs set SDOH risk-mitigation goals and tasks towards completion of goals

Table 1. Comparison of baseline (pre-protocol) and SDOH protocol assessment & referrals

SDOH ASSESSMENT

Financial Strain

How hard is it for you to pay for the very basics: food, housing, medical care, and heating?

In the past 12 months:

Food Insecurity

- You worried that your food would run out before you got the money to buy more?
- The food you bought just didn't last and you didn't have the money to get more?

Transportation

- Has lack of transportation kept you from medical appointments or from getting medications?
- Has lack of transportation kept you from meetings, work, or from getting things needed for daily living?

Housing Stability

- Was there a time when you were not able to pay mortgage/rent on time?
- How many places have you lived?
- Was there a time when you did not have a place to sleep or slept in a shelter (including now)?

Figure 1. Questions asked of patient during in-home assessment by SDOH domain

DEMOGRAPHICS

One-third of patients were over age 75, half were women, and a majority were White, insured by Medicare.

The total KPNW HaH patients during the trial was 1,787.

Age:	
• <65	697 (39.0%)
• 65 to 75	499 (27.9%)
• <76	591 (33.2%)
Sex:	
Female	911 (51.0%)
Race/ Ethnicity:	
• White	1515 (84.8)
• Non-White	272 (15.2%)
Insurance Type:	
Commercial Insurance	549 (30%)
Medicaid	155 (9%)
Medicare	1083 (61%)

Table 2. Demographics of patients in trial

PROTOCOL RESULTS

Prior to implementation of the SDOH protocol, there were 1389 HaH episodes; 96 (7.7%) had a CHN referral. In the SDOH protocol period, of 322 HaH episodes 60 (18.6%) had a CHN referral.

All CHN referrals were reviewed for task completion status by the CHN within 1-month of referral. In the pre-protocol period, completion rate was 77%; in the protocol phase completion rate was 80%.
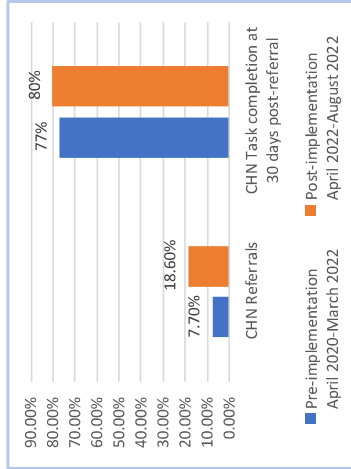

Figure 2. CHN Referrals & task completion at 30 days post referral pre protocol and during the SDOH protocol period

CONCLUSION

Implementing standardized in-home SDOH evaluation in KP at Home yielded higher CHN referral rates; this maintained high levels of task completion for SDOH needs. An in-home protocol to assess and address SDOH in HaH is more effective in supporting SDOH referrals than virtual, pre-admission evaluation alone.