



## REVIEW ARTICLE



# Fundamentals of healthcare delivery science for the non-health systems scientist: the final step in translational research for late-life psychiatric and neurocognitive disorders

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This perspective describes why and how Healthcare Delivery Science (HDS) is the stage of translational science research necessary to answer the vexing question of clinical research: “Why is it that what we know works is frustratingly difficult to translate or ‘scale’ to real-world clinical practice?” Our patients with late-life psychiatric and neurocognitive disorders (PNCs) are managed in the specialty mental health, general health and long-term care service sectors, and over their lifetimes often require complex, multifaceted and coordinated evidence-based interventions that span all three healthcare sectors to optimize their quality of life and functioning. This perspective defines core principles of HDS and summarizes key implementation and dissemination research methods to further understanding of translational research challenges in real-world settings and to facilitate their widespread dissemination. The importance of Learning Health Systems, especially Age-Friendly Health Systems, as real-world research laboratories, is also reviewed. Importantly, translation of evidence-based interventions across service sectors and large diverse patient populations requires skilled interdisciplinary teams. We characterize existing and projected geriatric professional workforce trends necessary to meet the population health service demands and will offer strategies to ensure success in the growth of the workforce that is required. Selected examples of HDS research are presented that have shown dissemination and translational promise, including a review of the “naturalistic” observational study example associated with private equity investment in the specialty mental health and long-term care service sectors. Finally, HDS’s “value proposition” is offered to support the proposition that discovery science priorities could also be shaped from HDS evidence.

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## INTRODUCTION

The lament for many clinical and health services investigators is the questions: “Why is it that what we know works is frustratingly difficult to translate or ‘scale’ to real-world clinical practice.” As applied to patients with late-life psychiatric and neurocognitive disorders (PNCs) the task is daunting. The purpose of this commentary is to present an overview of healthcare delivery science for scientists or clinicians who may be unfamiliar with its foundations, and how this research domain enables the translation of neuroscience advances into routine clinical practice.

Late-life PNCs patients are among the most difficult patient populations managed across the specialty mental health, general health and long-term care service sectors. Many have significant co-morbid medical illnesses, often complicated by troublesome behavioral symptoms that require time, effort and specific expertise in behavioral interventions by direct care providers and/or their families. Problematic social determinants of health (social isolation, poverty, healthcare access limitations, etc.) create

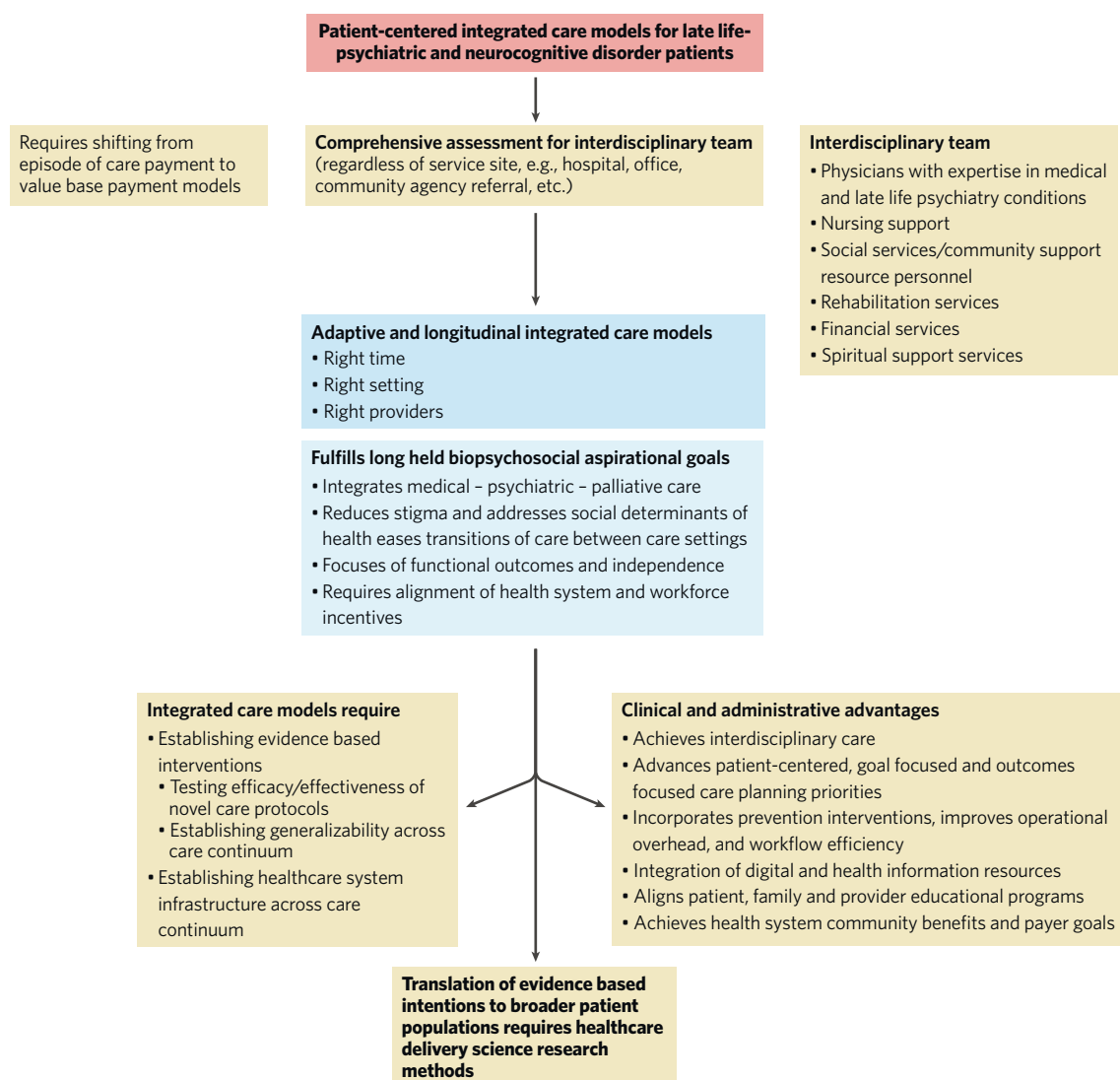
additional treatment complexity, stress and burden for family caregivers, professional providers and healthcare systems. We submit that late-life PNCs patients are among most complex patients within all of healthcare.

A primary treatment goal for geriatric mental health professionals is enhancing functional capacity and quality of life older patients with late-life PNCs. Best practices have shown that interdisciplinary care teams and person-centered evidenced based interventions (EBIs), based upon high quality clinical science research, or “discovery science,” are necessary to achieve optimal health outcomes for our complex patients [1]. But extrapolating EBI to large diverse populations in different health settings and sectors require tailoring to meet cultural and psychosocial values of diverse patient populations; and evidence that interventions can be scaled in a cost-effective manner. Bridging the “know-do” gap (we know what works but cannot get it done to “scale”) requires approaches that understand and systematically address the many challenges of scaling EBIs to broader and more diverse

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**Fig. 1 Achieving patient-centered integrated care for diverse populations with late-life psychiatric and neurocognitive disorders requires interdisciplinary teams that deliver comprehensive assessments and adaptive, evidence-based care across services and settings.** Implementing effective patient-centered interventions in various healthcare environments relies on Healthcare Delivery Science Research Methods.

populations across different healthcare settings and sectors. These research questions are the provenance of Healthcare Delivery Science (HDS) [2, 3].

As illustrated in Fig. 1, multiple components present challenges in the translation of “what we know works” to more diverse populations. Each element may contribute to inefficient, fragmented, or costly EBI practice variation leading to suboptimal patient (or population health) outcomes.

Integrated care models are straightforward in concept but challenging to implement in practice. HDS is the scientific discipline that characterizes the complexity of healthcare delivery in real-world settings; barriers to implementation and dissemination of EBIs to broad and diverse patient populations; and applies specific research methods to test innovations designed to optimize EBI implementation and effectiveness within and across different settings. An overarching aim of HDS is achieving the value proposition of the “Quadruple Aim of Healthcare”: improving their care experiences, enhancing population health, reducing per capita costs of care, and improving the well-being of the healthcare team [4, 5].

#### HOW THIS COMMENTARY IS ORGANIZED

We begin with a case example illustrating the numerous practical challenges in addressing the needs of individuals with these disorders in care delivery (Box 1). Thereafter we provide an overview the fundamentals of HDS for late-life PNCDs.

- What is healthcare delivery science?
- Why are “Learning Health Systems” and “Age-Friendly Health Systems” necessary to translate EBI discoveries to larger and more diverse patients?
- What are prior examples of healthcare services research and systems interventions for late-life PCNDs?
- How do current and future interdisciplinary geriatric workforce shortages hinder broad EBI translation? Reasonable solutions to address these shortages are suggested.
- What are examples of implementation and dissemination science studies for patients with late-life PNCDs?
- What are the future opportunities and directions for research and practice in HDS in completing the translational arc from discovery to delivery science for PNCDs?

**Box 1.** Case Example: Patient-level, Provider-level, and System-level factors illustrating why Late-Life Psychiatric and Neurocognitive Disorders Patients are Complex and Difficult to Manage (OUT – CASE HISTORY)

**Case Example:** Mr. K is an 83-year-old man with hypertension, type 2 diabetes, osteoarthritis, and mild left-sided weakness from a past stroke. His wife noticed growing memory problems, trouble with medication management, and occasional disorientation. His daughter, who lives a plane flight away, reported increased anxiety, social withdrawal, and neglect of daily activities. After cognitive screening by his primary care physician, Mr. K was referred to a neurologist who diagnosed probable vascular dementia based on his diagnostic work-up including an MRI which demonstrated the stroke and periventricular white matter disease. A benzodiazepine anxiolytic was prescribed for anxiety, but further pharmacological and cognitive/behavioral assessments were not made due to a lack of local psychiatrist, geriatric psychiatrist, or neuropsychology resources in his community.

Over the next year, Mr. K's physical condition worsened, leading to a fall and hospitalization. During this hospital stay, he developed a hyperactive delirium treated with low doses of aripiprazole that was discontinued upon discharge. Home health services began but were discontinued after two months because Medicaid benefits lapsed. His agitation and suspiciousness increased, resulting in several emergency room visits. In addition to the aripiprazole, after his last emergency room visit, he was provided with the serotonin re-uptake inhibitor, citalopram, and given low doses of trazodone for sleep. He was discharged without referrals to general psychiatric services and/or coordinated community-care services as few were available in the patient's hometown.

Eventually, Mr. K's declining physical, cognitive, and nutritional status and persistence of neuropsychiatric symptoms led to additional emergency visits and psychiatric hospitalization at a state facility with a geriatric psychiatry unit, but far from the family's home. While his neuropsychiatric symptoms improved with treatment, his physical and functional state continued to worsen. He was transferred to a private equity owned intermediate-care nursing home for long-term care where his basic needs were met, but his quality of life continued to deteriorate.

This case exemplifies the multifaceted challenges encountered at the patient, provider, and system levels within geriatric psychiatry. While some non-clinician readers may suggest that the clinical vignette overstates the complexities related to clinical management, pharmacotherapy, and social determinants to support the importance of HDS in translational science, the case history accurately represents the difficulties involved in caring for older adults with late-life PNCDs—a reality well-recognized by experts in geriatric psychiatry and medicine. Sadavoy described these challenges using the 5-Cs of geriatric mental health care: 1) Complexity, 2) Chronicity, 3) Co-morbidity, 4) Continuity, and 4) Context, which encompasses the environmental, social, and physical aspects of illness in various care settings [6]. A complementary approach that is being promoted by healthcare payer and provider systems consists of care that accommodates the 5-Ms of person-centered care for seniors: 1) identifying what “Matters Most” for the patient; 2) ensuring “Mobility,” vital for health and quality of life; 3) assessing necessary “Medications”; 4) addressing “Mentation” to detect cognitive and affective disorders in late-life; and 5) acknowledging the “Multicomplexity” of older patients, including their chronic conditions and functional limitations [7].

### WHAT IS HEALTHCARE DELIVERY SCIENCE?

Table 1 summarizes key elements and selective terminology used to describe HDS. Its origins arise from concerns raised by the National Academy of Medicine's (formerly the Institute of Medicine) about quality of care in the US healthcare system, practice variation, and building safer and more cost-effective health care delivery systems [8–11].

Healthcare delivery science (HDS) addresses the translational research gap between discovery science (fundamental and clinical trials research) and delivery in actual systems of care to advance real impact for patients, families, and populations. In brief, HDS completes the translational arc that begins from bench to bedside, to achieve impact in the clinic, community, health care system, and population [2, 3]. Internationally, HDS is known as “knowledge translation and integration,” “population health intervention research,” or “scaling-up” research [12]. Important definitions of the core elements and research methods of the discipline have been established.

Table 1 summarizes key terms and several distinct research methodologies used in HDS research. HDS research methodologies use patient generated practice data, identify and address obstacles to adopting best practices, examine barriers among personnel, healthcare system workflows, and work environments that lead to ineffective care and financial inefficiencies, and test

interventions to modify such. These activities contribute to dynamic Learning Health Systems (LHS) focused on quality improvement outcomes [13, 14].

Implementation Science is “...the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practice into routine practice, and, hence, to improve the quality and effectiveness of health services.” [12] Implementation science examines real-world healthcare delivery incentives that enhance population health; seeks to understand and untangle complex interventions; increase equitable healthcare access; reduce healthcare costs; positively influence the operational culture for providers and patients; and examine how new digital tools (including artificial intelligence) to improve patient, provider, and healthcare system outcomes [12, 15–23].

Dissemination science uses proven methods in targeted distribution of information and resources of EBIs to health care professionals, community organizations, policy makers, diverse patient populations, and healthcare systems. In simple terms, this discipline leverages the “push” and “pull” of in knowledge transfer of EBIs using best practices including health information technology, social media, practical guidance materials, and social marketing campaigns. The most challenging target group for dissemination efforts are administrative personnel responsible decisions that require adoption at multiple levels of a healthcare system [12, 20, 24]. Passive methods of knowledge dissemination (publication of consensus statements, mailings, conventional distribution of clinical guidelines etc.) are less effective than using rigorously investigated EBI dissemination methods for a targeted audience of potential adopters [24].

Choosing the appropriate study designs is challenging because of the potential conflicts between rigorous randomized trial design and the realities of busy and understaffed hospital and community health delivery systems with competing priorities. Central to this challenge is conducting research in settings with payment models that inadequately cover the costs of longitudinal care or shifts those costs, e.g., “cost-shifting,” to families because of complex clinical PNCDs symptoms/behaviors, medical comorbidities, and challenging social determinants impacting access to continuing care services [25, 26].

Even when interventions are proved effective, challenges in their dissemination may persist. Lack of healthcare system leadership buy in for geriatric service lines; limited reimbursement for comprehensive wrap around services from Medicare and Medicaid; uneven supply of skilled direct care providers or geriatric specialists (psychiatry, medicine or advanced practice professionals); constrained community social support systems; and social determinants that limit the capability of successfully translating an EBI in this setting [27–32].

**Table 1.** Taxonomy of selected terms and definitions associated with healthcare delivery science methodology.

Healthcare delivery science (HDS) [2, 3]	Advances in implementation research have included developing and measuring adaptations of evidence-based practices to optimize effectiveness, fit, and the specific characteristics of target population within the healthcare systems that deliver those services, e.g., “T-4” translation.
Age-Friendly Health System (AFHS) [35, 36]	Age-Friendly Health Systems promote systems-based models of care that are practically focused on care delivery principles that: <ul style="list-style-type: none"> <li>• Keep healthy older adults healthy</li> <li>• Are proactive in addressing potential health needs</li> <li>• Prevent avoidable harms</li> <li>• Improve care of those with serious illness and at the end of life,</li> <li>• And support family caregivers throughout.</li> </ul>
Evidenced based interventions (EBIs) [1]	Within the healthcare context, evidence-based interventions have demonstrated positive clinical outcomes for patients experiencing a medical illness, and have been historically categorized as: <ul style="list-style-type: none"> <li>• Level 1a – supported by a meta-analysis of more than one randomized controlled trials.</li> <li>• Level 1b – supported by well-controlled and conducted randomized controlled trial.</li> <li>• Level 2a – supported by one or more well designed, executed non-randomized trial or quasi-experimental design.</li> <li>• Level 2b – supported by well-designed case-control or cohort study</li> <li>• Level 3 – supported by case series or correlational studies.</li> <li>• Level 4 – includes expert opinion and well-defined model, theory or expert opinion.</li> </ul>
Learning Health Systems (LHS) [33, 34]	Learning Health Systems are characterized by the following: <ul style="list-style-type: none"> <li>• Real-time access to knowledge: Evidence is readily available to enhance clinical decision-making.</li> <li>• Engaged patient-clinical partnerships: Patients and clinicians work together closely.</li> <li>• Incentives aligned with value: Continuous improvement and waste reduction are rewarded, complemented by transparency in safety, quality, prices, costs, and outcomes of care.</li> <li>• Continuous learning culture: Leadership focuses on improving operations, building provider competencies and skills, and encouraging systems analysis and information feedback loops to promote learning and health system improvement.</li> </ul>
Patient-centered care [37]	Individualized, goal-oriented care plan based on a person’s preference and includes ongoing review of goals and care plan, supported by an interprofessional team; a primary or lead point of contact; active collaboration among healthcare and service providers; continual information sharing and integrated communication; and education and training of provider; where appropriate, the person and those important to the person.
Implementation science research (ISR) [21–29]	Implementation science research (ISR) evaluates the effectiveness of specific strategies to promote the systematic uptake of research findings and other evidence-based practices into routine clinical practice. ISR examines real-world healthcare delivery incentives that enhance population health; seeks to understand and untangle complex interventions; increase equitable healthcare access; reduce healthcare costs; positively influence the operational for providers and patients; examine how new digital tools (including artificial intelligence) to improve patient, provider, and healthcare system outcomes.
Dissemination science research (DSR) [25]	Dissemination science research focuses on identifying and evaluation of communication channels and strategies that spread “Evidence-Based Interventions” (EBIs) to potential adopters who are individuals targeted by a “change agency” to decide about whether to try a practice, program, policy or technology that they perceive to be new (i.e., an innovation).
“Evidence levels” in healthcare delivery science [19] (page 29)[20]	Type 1 Evidence – Etiology or cause of a particular outcome; its magnitude; and whether actions can be modified or prevent the outcome; and could an action. Type 2 Evidence – Focuses on an intervention’s ability to “effect” an outcome using metrics like “cost-effectiveness,” e.g., “bang for your buck.” Type 3 Evidence – Information required to adapt and implement EBIs and includes <ul style="list-style-type: none"> <li>• An understanding of factors or “context” relating to the setting of the intervention.</li> <li>• Whether inferences from one study can be applied to other populations.</li> <li>• The quality and “equity” of the implementation intervention.</li> <li>• The adaptability, replication, scalability and sustainability of intervention across multiple settings and populations.</li> </ul>
Knowledge for action [19](page 30)	Knowledge for action uses “knowledge translation” and “knowledge transfer” in service of improving population health. Knowledge translation refers to processes that synthesize, disseminate or exchange knowledge between “producers” and “users” of knowledge (individuals, organizations) with the goal of improving population health. Knowledge transfer is the process of bidirectional knowledge exchange producers and stakeholders of knowledge.

**Table 1.** continued

Definitions of selected study designs in healthcare delivery science	<p><b>“Pragmatic” Clinical Trials</b> – use clinically relevant alternative interventions that include diverse populations of study and embrace real-world considerations (clinical settings, providers, etc.) that collect data on a broad range of health outcomes and mediators that influence those outcomes [19, 26, 29, 31].</p> <p><b>“Observational Implementation Trials”</b> – take into consideration policy and practice-led implementation processes where insights on barriers, facilitators, and other factors influence the implementation processes [19].</p> <p><b>“Effectiveness Trials”</b> – are conducted in community or organizational settings where EBI interventions are typically delivered by and used by community clinicians. Examples include multiphase trials and <b>Smart, Multiple Assignment Randomized Trials (“SMART”)</b> [19].</p> <p><b>Roll-out Implementation Optimization Designs</b> – assign all groups or sites to eventually receive an intervention, starting at a randomly assigned time. That staggered implementation can both increase acceptability to partners and make best use of limited implementation resources [148, 149].</p> <p><b>“Stepped-Wedged: Trials”</b> – a special rollout of interventions design to sites or individuals in such a manner as all sites/participants receive the intervention by the end of the trial, but the order of the roll out is randomized [19].</p> <p><b>“Emulated” Randomized Clinical Trials</b> – using large observational data sets to mimic an idealized effectiveness clinical trial where the observational data has sufficient clinical information to control confounders that allow “emulation” of randomization. They may be particularly useful when a randomized trial is not feasible, ethical or timely [150, 151].</p>
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**Table 2.** American Geriatrics Society’s eight essential elements of geriatric clinical practice [37].

• Goal-oriented care plan based on the person’s preferences
• Ongoing review of the care plan
• Care supported by interprofessional teams
• One primary or lead point of contact on the healthcare team
• Active coordination among all healthcare and supportive service providers
• Continuous information sharing
• Education and training for providers, and where/when appropriate, the person and those important to the person
• Performance measurements and quality improvement using feedback from the person and caregivers

### WHY ARE “LEARNING HEALTH SYSTEMS” AND “AGE-FRIENDLY HEALTH SYSTEMS” NECESSARY TO TRANSLATE EBI DISCOVERIES TO LARGER AND MORE DIVERSE PATIENTS?

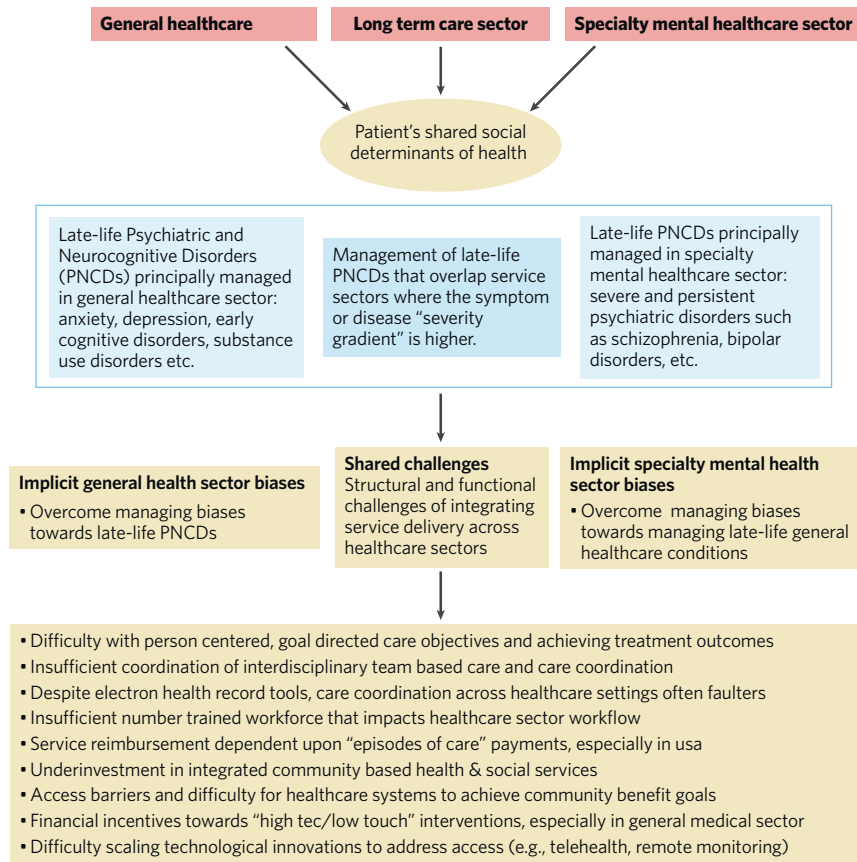
“Learning Health Systems” (LHSs): LHSs are healthcare systems where “science, informatics, incentives, and culture are aligned for continuous improvement and innovation, with best practices seamlessly embedded in the delivery process and new knowledge captured as an integral by-product of the delivery experience” [33, 34]. LHSs directly address the complexity that health professionals and patients are required to navigate in our current healthcare system [34]. Highlighted approaches address organizational and technological environments that are often poorly configured to deliver, monitor outcomes, and improve complex diagnostic and treatment services.

Further, LHSs help patients and families, especially those with late-life PNCDs navigate across service sectors and settings to reduce miscommunication, duplicative services, risk of errors and harm, and low value care related to fragmented services. Improving work-flows, employee engagement, and human resource investments in a LHS to also serves to improve morale and job satisfaction among healthcare professionals faced with competing demands, stress, and administratively burdensome work environments, that lead to moral injury and burnout. Last, LHSs focus on management interventions to advance the promise of “value-based” care as the financial solvency of healthcare systems are threatened as the costs of care continue to increase,

payors cost-shift to patients, and operational margins continue to decline [29, 34].

“Age-Friendly Health Systems:” The American Geriatrics Society’s “Age-Friendly Health System” movement aligns with many LHSs core principles [35, 36]. The initiative was developed in response to the observation that clinical environments for older adults and their families often involve unclear or insufficiently communicated care instructions. This has been associated with challenges in care coordination across various settings, which may result in unnecessary care or adverse outcomes [36]. The Age-Friendly Health System movement is anchored by the American Geriatrics Society’s working definition of person-centered care, e.g., “...the individual’s values and preferences are elicited, and once expressed, guide all aspects of their health care, supporting their realistic health and life goals...(page 16)” [37]. Eight elements of clinical practices are identified and summarized in Table 2.

Alone or in combination, the eight elements of an Age-Friendly Health System are targets for well-designed HDS research where an EBI established by a clinical trial is scaled within a single healthcare system or across several health systems. As detailed in the section “Examples of Implementation and Dissemination Science Interventions” below, incorporating these principles can help to address misaligned incentives, identify appropriate factors to create higher value on quality-of-life measures, and ensure coordinated services between hospital and community-based resources that are tailored to the needs of older adults and their families [35, 36].



**Fig. 2 This figure illustrates the management of late-life psychiatric and neurocognitive disorders within general health, long-term care, and specialized mental health sectors.** Enhancing access and coordination necessitates acknowledging common challenges, addressing sector-specific biases, and ensuring a sustained commitment from healthcare systems to implement changes, even in the face of significant operational obstacles.

### WHAT ARE PRIOR EXAMPLES OF HEALTHCARE SERVICES RESEARCH AND SYSTEMS INTERVENTIONS FOR LATE-LIFE PNCDs?

Descriptive analysis about configuration, capacity, quality, and service integration across healthcare settings and sectors for patients with late-life PNCDs date to the earliest days of geriatric psychiatry. Highlighted were the value of interdisciplinary team care, using functional capacity and quality of life measures as treatment outcomes, and the benefits of longitudinal, person-centered ICMs that bridge healthcare sectors and service settings. Models of nursing home care, systematic reviews of home and community settings, and community care models for older patients with severe mental illnesses were extensively examined [38–53].

Practice based research demonstrated that integrated general health and specialty mental health care sectors, e.g., "collaborative care models," where mental health/substance abuse providers who were co-located in primary care settings led to favorable patient outcomes for management of depressed patients in primary care; and increased referrals for depression, suicide care and prevention, anxiety and substance abuse services. Using integrated care pathways has led to improve antipsychotic pharmacotherapy monitoring and polypharmacy reduction for older patients with late-life schizophrenia [54–57]. And models of care such as "Programs for the All-Inclusive Care for the Elderly" (PACE) have also successfully managed patients with complex geriatric syndromes, including those with PNCDs [58, 59]. Importantly, expert panels have consistently championed the value and further investigation of integrating clinical and health services research efforts within and across healthcare sectors with healthcare policy initiatives for patients with late-life PNCDs [60–72].

Figure 2 outlines the features of delivering person-centered EBI ICMs to individuals with late-life PNCDs, as disease severity increases. It identifies structural and operational barriers—such as limited shared planning, goal setting, outcome tracking, financial incentives, and incompatible EHRs—that hinder coordinated care across general, long-term, and specialty mental health sectors. Improving access to interdisciplinary treatments often requires tailoring for diverse cultural or ethnic groups seeking care in different clinical settings. Integrated services occur along a continuum, from loosely linked to fully integrated infrastructures. Moving from care coordination to integrated system redesign requires deliberate efforts at the clinical, organizational, and systemic levels. Designing effective models demands attention, not only to patient-centered clinical care, but also to availability of workforce, management oversight and governance, healthcare financing, and care network design necessary to sustain longitudinal collaboration [73].

### HOW DO CURRENT AND FUTURE INTERDISCIPLINARY GERIATRIC WORKFORCE SHORTAGES HINDER BROAD EBI TRANSLATION? AND REASONABLE SOLUTIONS TO ADDRESS THESE SHORTAGES

A skilled geriatric-trained workforce is required for healthcare systems to implement, disseminate and sustain those EBI that transform better outcomes for patient populations with late-life PNCDs. A 2008 National Academy of Medicine issued a report summarizing the then-current geriatric workforce in the US and provided recommendations necessary to build and sustain the geriatric workforce of the future to meet future needs of an aging US population [74].

**Table 3.** Estimates of “growth demand” and “adequacy of supply” for US healthcare workforce disciplines who serve patients with late-life psychiatric and neurocognitive disorders<sup>a</sup>.

Discipline	Estimated growth demand between 2022 and 2037 (Percent)	Estimated adequacy of supply in 2037 (Percent)
Physicians		
General internal medicine physicians	18	76
Family physicians	12	73
Geriatric physicians <sup>d</sup>	43	78
Adult psychiatrists <sup>d</sup>	54	43
Nurses/nurse practitioners/physician assistants		
Nurse practitioners	13	176
Psychiatric nurse practitioners	51	120
Physician assistants	12	108
Psychiatric physician assistants	57	86
Registered nurses LTC <sup>b</sup>	138	N/A <sup>c</sup>
Social work		
Mental health and substance abuse social workers	64	93
Healthcare social workers	77	97
Other health professionals disciplines		
Psychologists	50	55
General dentists	8	93
Pharmacists	13	96
Occupational therapists community	14	105
Occupational therapists LTC	32	N/A
Physical therapists community	15	97
Physical therapists LTC	32	N/A
Home health aids	35	N/A
Community health workers	8	N/A
Psychiatric technicians	64	N/A

<sup>a</sup>National Center for Health Workforce Analysis. Workforce Projections Dashboard 2037. Department of Health and Human Services. Washington DC. <https://data.hrsa.gov/topics/health-workforce/workforce-projections> Accessed April 25, 2025.

<sup>b</sup>LTC: Long-Term Care.

<sup>c</sup>N/A: Data insufficient for projection.

<sup>d</sup>Separate subcategories for geriatric psychiatrist “growth and adequacy” data are not available.

Subsequent reports from in 2012 and 2023 continued to document both the shortages in the gerontological workforce, and the urgency to expand the workforce required to accommodate the care needs and expectations for the expanding “baby-boomer” population at risk for needing specialized care [63, 75]. Table 3 summarizes workforce data projections for selected health professions associated with geriatrics care generated from the Health Services Resource Administration’s Healthcare Workforce Projections Dashboard 2037 [76–79]. Except for nurse practitioners, non-psychiatric physician assistants and community occupational therapists, virtually every professional or direct caregiver category finds meaningful gaps between demand and adequacy of provider supply. Further complicating these findings, it is also unclear how trends of an aging healthcare workforce and increasing levels of burnout and job dissatisfaction will further exacerbate the demand/supply provider gaps.

Physician shortages are projected to worsen by mid-century, with a notable lack of geriatric-trained doctors. The supply of board-certified geriatric medicine and geriatric psychiatry physicians is limited [80–81]. In 2018, there were only 2.6 geriatric psychiatrists per 100,000 older adults in the US, and by 2021, 21.2 geriatric medicine specialists per 100,000 [82–84]. As of 2024, just 2441 board-certified geriatric psychiatrists were listed, with unclear numbers practicing general psychiatrists with a geriatric

focus [52, 85]. Geriatric medicine specialists have declined from over 10,200 in 2000 to just over 7100 in 2020, and only 5611 “active” primary care physicians practiced geriatrics in 2022 [86, 87].

Further, geriatric physicians are mainly concentrated in urban areas, and major geographic disparities are found, especially in geriatric psychiatry where availability ranges from 14.1 per 100,000 in Rhode Island to none in Mississippi and North Dakota [32, 82]. International medical graduates are overrepresented in these fields, but declining international medical graduate matriculation, particularly in psychiatry, exacerbates anticipated geriatric psychiatry workforce shortages [31, 88, 89].

The number of trainees entering geriatric physician specialty programs has declined. Table 4 presents data from ACGME fellowship training, indicating that while the number of accredited GP fellowship programs remained steady, fellow enrollment decreased from 100 in 2000–01 to 41 in 2024–25. GM program sponsorship increased slightly, but total fellows declined from 325 to 273 over the same period [90]. The current training pipeline for geriatric psychiatrists and geriatric medicine physicians does not match the increasing population of individuals aged 65 and older in the United States, despite growth in medical school class sizes.

Primary care physicians and general psychiatrists are and will be increasingly expected to provide geriatric care in routine practice.

**Table 4.** Trends in geriatric psychiatry and geriatric medicine ACGMG accredited fellowship training programs: 2001-02 versus 2024-25.

Academic Year	Geriatric psychiatry		Family medicine		Internal medicine	
	Number of programs	Number of fellows	Number of programs	Number of fellows	Number of programs	Number of fellows
2000-01	62	100	23	38	97	325
2024-25	60	41	44	31	118	273

From the Accreditation Council for Graduate Medical Education. ACGME-Accreditation Data System (ADS). Number of Accredited Programs and On-Duty Residents/Fellows for Academic Year by Specialty. <https://apps.acgme.org/ads/Public/Reports/ReportRun>. Accessed April 23, 2025.

With this expectation, then, core training programs should introduce trainees to interdisciplinary geriatric care models. However, current ACGME's Residency Review Committees requirements for psychiatry and internal medicine only require incidental geriatrics exposure, while family medicine mandates at least 100 h or one month with 125 patient encounters [91–93]. These minimal requirements are insufficient, especially as the population as the geriatric population grows over the next few decades.

What is required to address training gaps and workforce development is a reenvisioning of professional development and training. This has been highlighted by multiple National Academy of Medicine reports, specialty societies, advocacy groups, and research findings. Table 5 summarizes various proposals to develop interdisciplinary teams and maintain a capable workforce for patients with late-life PNCDs and are aligned with AFHS movement and the individual 5Ms of geriatric practice [7, 29, 63, 69, 75, 94–100].

Increasing geriatric competencies of all members of interdisciplinary teams enhance their collaborative professional competencies. From the perspective of an individual healthcare system, optimizing the delivery of geriatric services into geriatric clinical services lines that bridge across service sectors and settings should be considered, like what has been achieved in pediatrics or oncology service lines [29]. Service lines create high functioning teams focused on patient-centered care coordination, implementing best practices and promoting teamwork across healthcare settings and service sectors. Importantly, they can serve as laboratories for implementation and dissemination science research activities in real-world settings.

#### EXAMPLES OF IMPLEMENTATION AND DISSEMINATION SCIENCE RESEARCH FOR PATIENTS WITH LATE-LIFE PNCDs?

Systematic reviews of the outcomes of integrated care largely confirm that found evidence of improved quality of care, improved patient satisfaction, and improved access to care were confirmed, but evidence was inconsistent or limited with reference to health costs, and access to primary or specialty care [101, 102]. Table 6 summarizes of selected large-scale US and international implementation, observational and health services trials focusing on integrated care management and outcomes for late-life PNCDs patients [55, 64, 101–121]. A few studies will be discussed in more detail to illustrate challenges faced by investigators.

#### Integrated care models

The complex effectiveness trial “Care Ecosystem Model” for dementia care, implemented at two geographically separate academic medical centers, successfully demonstrated that integrated coordinated dementia care, improved caregiver well-being, reduced emergency visits, and lowered costs [103, 104]. The Program of Research to Integrate Services for Maintenance of Autonomy (PRISMA) model in Quebec improved satisfaction and service continuity by coordinating medical and social care [105]. Australia's Eat Walk Engage program reduced hospital-associated functional decline in older inpatients [106]. Singapore's integrated

memory clinics enhanced early dementia diagnosis and management in primary care [107]. Evidence from both systematic reviews and pragmatic trial shows that integrated care principles can be applied across various systems and cultures.

Large-scale systemwide integration studies, however, are very challenging to conduct and thus outcomes may not be as robust. For example, The US Department of Veterans Affairs health system implemented a specialized patient-centered medical home model for geriatric veterans in 2010 called the Geriatric Patient Aligned Care Team (GeriPACT) [108]. By 2015, only 66 of the 141 VA facilities had enrolled only 60,000 of the estimated 1.5 million veterans over age 65 years who met criteria in GeriPACT services. Regarding mental health integration, just under 43 percent had a mental health provider on the team (28.7 percent – psychiatrist and 23.8 percent – psychologist). When behavioral health providers were present, however, GeriPACT teams were more likely to manage psychosocial, cognitive, and depressive disorders [109].

#### Pragmatic interventional trials

Some studies illustrate the value integrating functional and caregiver-centered outcomes into evaluations but in doing so may also highlight methodological limitations. For example, capturing measures of functional status, caregiver burden, or cognitive trajectories needed for longitudinal analyses may not have psychometric properties sensitive enough to measure subtle but meaningful changes in outcomes, nor contain culturally sensitive quality outcome measures aligned with patient or caregiver values across trial designs [110]. Two recent pragmatic randomized implementation trials highlight this challenge: the Dementia Care (D-CARE) trial and the Indiana Palliative Excellence in Alzheimer Care Efforts (IN-PEACE) trial [111, 112].

D-CARE compared the effectiveness of a health system community-based comprehensive dementia care program to usual care. The IN-PEACE trial evaluated the addition of palliative care to a dementia care program against usual care. Both trials utilized neuropsychiatric inventory (NPI) of “patient” symptoms as a primary outcome measure. Both studies had caregiver outcomes. In D-CARE caregiver strain was assessed as a coprimary outcome. Secondary outcomes included caregiver self-efficacy, distress due to NPI symptoms, depressive symptoms, patient mortality, and hospitalizations. The IN-PEACE trial used secondary outcomes of caregiver strain and depression, along with a “combined measure of emergency visits and hospitalizations.” Both trials failed to show impact on the primary outcome of patient NPI symptoms. The D-CARE study reported improved caregiver self-efficacy, and the IN-PEACE study found a reduction of patient combined emergency visits and hospitalizations.

A commentary on both studies suggested that using NPI as the primary outcome suffered from the variability of NPI symptoms in patient participants during the trials. This variability might have contributed to why the null hypothesis for each trial failed. While NPI symptoms create significant management challenges for caregivers, they greatly vary during the illness' course. A “stepped-wedge” pragmatic trial design was suggested, tailored to patients

**Table 5.** The United States geriatric mental health workforce population health requirements, challenges and offered solutions.

Workforce and policy challenges	Population health requirements	Challenges identified	Offered solutions
Geriatric psychiatry/medicine	There is a significant need for more board-certified geriatric psychiatrists and geriatricians to meet the mental health and SUD needs of the older adult population in the US.	The number of trainees, including IMGs, choosing geriatric psychiatry and medicine has decreased significantly over the last decade.	Increase emphasis on geriatric curriculum in medical schools. Recruit board-certified geriatric psychiatrists and geriatricians as mentors in academic/training programs. Incentivize fellowship training and attending positions in geriatric psychiatry and medicine with significant financial rewards. Make visa waivers for IMGs in fellowship and attending positions easier. Develop mini-fellowships and certificate programs in geriatrics medicine, geriatric psychiatry and SUD physicians interested in treating these disorders. Expand professional societies recruitment of medical students and early career residents to participate in mentorship programs including medical society activities, aging related research opportunities and building network of geriatric focused colleagues.
Advance practice professionals (APPs)	There is a significant need for more APPs with training and board certification in geriatric mental health and SUDs to meet the needs of the older adult population in the US.	Although the number of APPs is steadily growing, those with training and certification in geriatric mental health and SUDs are limited.	Increase emphasis on geriatric curriculum in nursing schools. Recruit trained, board-certified geriatric mental health specialists as mentors in academic/training programs. Incentivize training and specialist positions in geriatric mental health and SUDs with significant financial rewards. Develop mini-fellowships and certificate programs in geriatric mental health and SUD for APPs interested in treating these disorders.
Other health and social support professionals	The number of professionals from allied disciplines (social workers, occupational therapists, physical therapists, counselors) with training and certification in geriatric mental health and SUDs must increase to meet the growing needs of the older adult population in the US.	Despite an increase in the number of these professionals, those with training and certification in geriatric mental health and SUDs are limited.	Increase emphasis on geriatric curriculum in degree and training programs. Recruit trained, certified geriatric mental health specialists as mentors in academic/training programs. Incentivize training and specialist positions in geriatric mental health and SUDs with significant financial rewards. Develop mini-fellowships and certificate programs in geriatric mental health and SUD for professionals interested in treating these disorders.
Family support/education	Due to the shortage of professionals trained and certified in geriatric mental health and SUDs, family caregivers are increasingly providing the necessary care.	Family caregivers often lack expertise, are overextended, and face burnout, leading to suboptimal care and significant emotional, physical, and financial stress.	Provide formal education and training to family caregivers of older adults with mental health and SUDs. Offer financial and other assistance to family caregivers. Provide respite care to prevent caregiver burden and burnout. Enable access to caregiver peer support groups and professional help for those experiencing caregiver burden and burnout.
Non-licensed providers	"Extenders" of care under the supervision of a licensed professional	Require established clinical protocols to guide scope of care guidelines Requires immediate supervision/guidance and direct access to licensed health care professionals	Expanding patient-centered supervision of chronic care services to help relieve family burden. Serve as additional "eyes and ears" for patients requiring constant supervision.
Community-based organizational and workforce needs	Late-life PNCDs populations have difficulty accessing coordinated care services provided by skilled healthcare professionals in community settings	Challenges with organizational integration of services, workforce shortages and availability support services for families	Identify and disseminate evidence-based community-based models of care that are best practices and establish financial value-based payment models from state, Federal and private payers to support and sustain clinical services. Link community-based models of care with hospital healthcare systems to ensure seamless coordination of care services for patients.

Table 5. continued

Workforce and policy challenges	Population health requirements	Challenges identified	Offered solutions
			<p>Under the IRS requirement for not-for-profit health systems to conduct community needs assessments</p> <ul style="list-style-type: none"> <li>• require healthcare systems to conduct community needs assessments and plans of action for older adults that: identify and close gaps in preventive services</li> <li>• address unmet programs needs for late-life PNCDs patients with severe mental illnesses</li> <li>• identify and implement best practices of integrated care models across the care continuum (outpatient, inpatient, long-term care settings) to address the complexity of co-morbid medical/psychiatric illnesses</li> <li>• address unique palliative care needs for late-life PNCDs patients.</li> </ul> <p>Provide appropriate training to support families and caregivers to be “active” advocacy and care provider agents for their patients.</p> <p>Incentivize recruitment and retention of professional and non-licensed care providers through novel value-based payment models.</p> <p>Expand geriatric workforce professionals through better service reimbursement rates, educational financial support and Federal support through programs such as HSRA’s Geriatric Workforce Enhancement Program.</p>
Heath care policy initiatives	Diminish the stigma of late-life PNCDs and expand the geriatric workforce.	Community, state and Federal underinvestment in support of programs for patients with late-life PNCDs	<p>Expand the mandates of the National Institutes of Mental Health, National Institute of Aging, the Agency for Healthcare Research and Quality, and Centers Medicaid and Medicare’s Center for Innovation to jointly coordinate to fund implementation and dissemination programs of research specifically for patients with late-life PNCDs so that best practices can be identified and sustained.</p> <p>Expand resources available through HSRA’s Geriatric Workforce Enhancement Program to include training and support for non-licensed and family caregivers, and expansion of support in secondary education (high schools) and community colleges.</p>

entering the trial when NPI systems were high, and/or using other patient functional symptoms or caregiver measures as primary outcomes where results might have been differed [113].

#### Challenges associated with a nationwide pragmatic trial

The Centers for Medicare & Medicaid Innovation (CMMI) Guiding an Improved Dementia Experience (“GUIDE”) model represents a pragmatic clinical trial in the form of an innovative payment and care delivery initiative designed to promote the implementation of evidence-based, integrated dementia care [122]. The GUIDE model provides a fee for service funding stream to support care models proven to improve clinical outcomes for individuals living with dementia and their caregivers, while simultaneously aiming to reduce overall healthcare costs.

Despite its promise, the real-world implementation of GUIDE has revealed substantial practical and financial challenges for participating healthcare systems, particularly in translating policy design into operational infrastructure. These challenges include workforce demands, reimbursement complexities, care

coordination logistics, and data collection burdens, all of which may limit scalability. Further, GUIDE limits enrollment to individuals diagnosed with a major, but not a mild, neurocognitive disorder, and excludes those individuals on a Medicare Advantage plan.

Nevertheless, GUIDE offers a critical opportunity to apply healthcare delivery science to identify best practices for sustainable implementation across diverse primary care and specialty care settings. In the context of developing an interdisciplinary service line for older adults with complex PNCDs, the GUIDE model serves as a potential prototype for how health systems can align financing, clinical operations, and population health goals to meet the needs of this growing and vulnerable population.

#### Examples of “naturalistic” observational experiments

Recent Federal legislative and Executive Branch actions pose “naturalistic” observational experiments worthy of intense scrutiny. These actions have directly impacted Federal support for

**Table 6.** Selected observational, effectiveness and pragmatic clinical trials examining system level integrated care models for older patients with late-life psychiatric and neurocognitive disorders.

Model	Reference	Target population	Integration level	Setting/Anchor	Scope of services	Patient-Centeredness	Evidence of Effectiveness	Challenges
Program for All-Inclusive Care for the Elderly™ PACE (USA)	Kodner et al. [64] (Review of Outcomes)	Frail elderly aged 55+ eligible for nursing home care, living in community settings.	Full clinical, administrative, and financial integration across acute, primary, and long-term care.	Adult day health centers serve as hubs for services and monitoring.	Medical, rehabilitative, personal care, social support, and housing services if needed.	High - focused on individual care planning and maintaining autonomy and function.	Decreased nursing home admissions, improved patient and caregiver satisfaction, some cost savings reported.	Complex setup, intensive resource investment, issues with scaling up nationally.
System of Integrated Care for Older Persons SIPA (Canadian)	Béland et al. [114]	Community-dwelling elderly needing coordinated health and social services.	Full integration of health and social services under one management structure.	Community organizations linked with hospital and outpatient networks.	Broad range of home care, rehabilitation, preventive, and social services.	High - focused on prioritizing patient goals and community living.	Improved functional outcomes, decreased hospitalizations, better continuity of care.	Inter-organizational coordination, financial risk sharing among partners.
Program of Research to Integrate Services for Maintenance of Autonomy PRISMA (Canadian)	Hébert et al. [106]	Older adults at risk of loss of autonomy due to chronic conditions or frailty.	Primarily coordination between existing services, not full merger.	Primary care physicians and community-based organizations.	Coordination of health, social, and supportive services across levels of care.	High - focused on personalized goals and proactive case management.	Improved access, client satisfaction, and care quality; neutral cost impact.	Slow implementation, reliance on strong local leadership and partnerships.
Eat Walk Engage (Australia)	Mudge et al. [107]	Older adults hospitalized for acute medical conditions.	Intra-hospital coordination; interdisciplinary teamwork within ward settings.	Medical wards with embedded interdisciplinary teams.	Targeted support for mobility, nutrition, and cognitive stimulation during hospitalization.	High - focused on preserving function and preventing delirium through daily activities.	Shorter hospital stays, less functional decline, improved quality metrics.	Dependence on ward culture, leadership engagement, and ongoing staff training.
Walcheren Integrated Care Model WICM (Netherlands)	Looman et al. [115]	Community-dwelling frail elderly	Partial - provider network with coordination	Primary care practices with case managers	Medical, nursing, social care; proactive monitoring	High - focused on personalized care plans	Improved quality of care indicators; unclear cost savings	Coordination complexities; funding mechanisms unclear
Geriatric Resources for Assessment and Care of Elders GRACE (USA)	Counsell et al. [116]	Low-income elderly with complex needs	Coordinated primary care-community care	Primary care practices linked with community resources	Medical, mental health, social support services	High - focused on patient goals and preferences prioritized	Reduced ED visits and hospitalizations among high-risk groups	Resource-intensive; workforce sustainability
Effectiveness of Integrating Suicide Care in Primary Care	Angerhofer Richards, et al. [55]	Middle to older aged adults in primary care setting. Stepped-Wedge Cluster Randomized Trial	Integrated mental health/primary care settings.	Community setting	Practice facilitators, screening, EHR monitoring, for suicide risk assessment and safety planning	High - focused on patient-centered interventions	Safety planning, suicide care higher within the intervention group led to lower suicide attempts and increase treatment for depression and substance abuse	Screening may miss patients at risk for suicide but chose not to report suicidality for fears of overreaction/loss of autonomy.

Table 6. continued

Model	Reference	Target population	Integration level	Setting/Anchor	Scope of services	Patient-Centeredness	Evidence of Effectiveness	Challenges
Integrated neighborhood approach To Support Elderly (Netherlands)	van Dijk et al. [119, 120]	Older adults in urban neighborhoods	Community-level integration	Neighborhood hubs and coordinators	Medical, social support, community activation	High - focused on strong focus on social connectedness and autonomy	No Differences in well-being or Health Related Quality of Life	Lack of effects for integrated neighborhood integrated care highlights complexity of integrated care and support initiatives.
Hospital at Home (USA)	Levine et al. [118]	Older adults with acute medical conditions	Substitutive hospital level care for patients at home.	Patient's home	Acute medical management at home	High - focused on avoiding hospitalizations	Adjusted cost of acute care episode 38% less than hospitalized patients. Fewer laboratory Services Home-care patients were less sedentary Lower re-admission rates.	System redesign for home care Highly selected patients -unsure about generalizability
Helping Older People Experience Success HOPES (USA)	Bartels et al. [122]	Older adults with severe mental illness	Behavioral health-primary care integration	Community mental health centers	Psychiatric care, physical health support, life skills training	High - focused on recovery oriented and functional goals	Improved social functioning, decreased institutionalization	Sustainability, funding streams
Care Ecosystem CARES (USA)	Possin et al. [104], Guterman et al. [105]	People with dementia and their caregivers	Primary care and specialty care linkage	Remote/digital support coordinated with primary care	Medical, social, caregiver support services	High - focused on caregiver and patient goals drive care plans	Reduced emergency department visits; caregiver depression and burden. Secondary analyses demonstrated reduced total costs of care.	Technology adoption, reimbursement models
CaReEcoSystem Primary Care Embedded Dementia Treatment CRESCENT (USA)	Forester et al. [121]	Nurse care managers managing dementia patients. Pragmatic pilot randomized trial	Provision of dementia care training to nurse managers.	Outpatient integrated care management program at an academic medical center	Educational intervention of nurse managers in CRESCENT training modules	High - focused training for nurses and measuring patient outcomes	For patients who nurse manager received intervention, ED utilization was reduced. Nonsignificant reduction in caregiver distress with patient neuropsychiatric symptoms was noted	Targeted training for nurse managers may reduce ED utilization and reduce caregiver distress of neuropsychiatric symptoms.

Table 6. continued

Model	Reference	Target population	Integration level	Setting/Anchor	Scope of services	Patient-Centeredness	Evidence of Effectiveness	Challenges
Geriatric Patient-Aligned Care Teams Study GerIPACT (USA)	Sullivan et al. [110], Moyer et al. [109]	65+ Veterans receiving care in US Veterans Affairs health systems	Medical home model of care	Across outpatient-inpatient settings	Medical, mental health, social services coordination	High - focused on coordinated care services	When behavioral health providers were team members, GeirPACTs were more likely to manage psychosocial, cognitive and psychiatric disorders	Wide variation in both structure and model consistency
Dementia Care Study D-CARE (USA)	Rueben et al. [112]	Pragmatic randomized implementation trial for longitudinal care of dementia patients	Interdisciplinary care team focused on integrated dementia care models and social support across all care delivery sites would be better than usual care.	Health-system vs. community care vs. usual care	Coordinated longitudinal care and interventions for patient Neuropsychiatric symptoms (NPI)	High - focused on patient NPI symptoms and primary caregiver outcome of strain. Secondary outcomes - caregiver self-efficacy, distress, and depression and mortality and hospitalizations	No change in Patient NPI symptoms or other improved caregiver self-efficacy No other positive outcomes	NPI symptoms may not have been the best primary outcome measure to assess. Secondary outcomes may represent better targets
Indiana Palliative Excellence in Alzheimer Care Efforts Trial IN-PEACE (USA)	Sachs et al. [113]	Pragmatic randomized trial to determine whether integrated palliative care at end-of-life reduces dementia symptoms, caregiver distress/depression and ED visits or hospitalization	Integrated palliative care services in community dwelling dementia patients	Community-based intervention	Coordinated palliative care vs. usual care	High - focused on patient NPI and symptom management at end-of-life Secondary outcomes - patient symptoms at end-of-life, caregiver distress, depression, and combined ED and hospitalization events.	No change in patient NPI symptoms. Modest decline in combined ED and hospitalizations events.	NPI symptoms may not have been the best primary outcome to measure. Secondary outcomes may represent better targets.

state management Medicaid funded services, many of which directly support care of patients with late-life PNCDs. Executive Branch orders that downsized personnel and resources of the Agency for Healthcare Research and Quality, the Health Resources and Services Administration, and the Substance Abuse and Mental Health Services Administration will directly impact both healthcare quality research and health professional development relevant to the needs of late-life PNCDs patients and their families. Observational implementation and other quasi-experimental designed studies will be essential to understand the impact of these actions.

A second “naturalistic” experiment in the US has evolved quickly and bares intense scrutiny: the increasing involvement of private equity investment in general hospitals, specialty mental health and substance abuse programs and hospitals, nursing homes and long-term care services, as well as physician practices. Results of this new form of healthcare investment are becoming more evident and will continue to be a major topic for HDS research in the mid-21<sup>st</sup> century [123–127].

Private equity investments are characterized by the following. First, investments are made by non-specialist investors, such as private equity firms and high net worth individuals. Second, investors use minimal personal capital for facility or practice acquisitions but rather rely upon debt financing which is then transferred to the purchased entity. Third, investors restructure the target acquisition through: reducing services for uninsured or underinsured patients; adjusting service pricing (upcoding); increasing service frequency; charging patients with high out-of-network prices when physicians used are not within the patient’s provider network; and selling hard assets like hospital buildings, thereby requiring facilities to pay rent on buildings they once owned. Finally, private equity investors typically sell the acquisition within a short timeframe [127].

The scale of private equity investment is dramatic. In 2021, private equity invested \$206 billion in 1400 US healthcare acquisitions [128]. private equity venture capital firms and real estate investment trusts (REITS), investments in income-producing properties like nursing homes, are aimed at increasing value by improving business operations efficiency and leveraging new debt to access capital necessary for infrastructure improvements (e.g., information systems, operational workflows, etc.), as well as supporting professional recruitment for low-profit margin enterprises [123, 127, 128]. Evidence supporting justification and investment rationale is mixed, with some reviews strenuously disagreeing with private equity marketing aims [129, 130].

At present, large-scaled observational studies using CMS and other data sources are documenting the impact of private investment in the US healthcare. The behavioral health and nursing home industry are targets of interest. Data indicates that private equity ownership for mental health and substance abuse facilities ranged between 6 and 7 percent in 2023, with the highest levels observed in rural and southern states [124, 127]. Investments by private equity firms in nursing homes increased to \$5.3 billion between 2015 and 2021, representing private equity ownership between 5 and 11 percent [125].

Data from large-scale observational studies indicates concerns about declining patient care experiences resultant from private equity acquisitions [130]. Studies have shown an association with increased prices, staffing reductions, variable or decreased quality of clinical care, and poorer patient experiences [127, 131–134]. Specifically, among for Medicare patients, private equity acquisition has been linked to a 25 percent rise in hospital-acquired adverse events such as falls, central line bloodstream infections, and higher rates of surgical site infections, an 11 percent rise in mortality, more emergency department visits, hospitalizations, higher Medicare costs, but similar likelihood of receiving antipsychotic medications, developing pressure ulcers or experiencing server pain [125, 135, 136].

Yet, private equity investment may also present new opportunities to expand integrated care capacity, particularly for those with serious mental illnesses. Organizations such as Author Health show that, with appropriate oversight and quality metrics, private-sector partnerships can enhance access while maintaining efficiency and responsiveness by offering health systems the ability to outsource intricate care delivery, thereby avoiding the expansion of internal bureaucracies and capital investment [137]. Evaluating the outcomes of this investment will require well-designed IS and DS research that assesses scalability and effectiveness for nursing home populations, given the prevalence of late-life PNCDs among residents.

#### **WHAT ARE THE FUTURE OPPORTUNITIES AND DIRECTIONS FOR RESEARCH AND PRACTICE IN HDS IN COMPLETING THE TRANSLATIONAL ARC FROM DISCOVERY TO DELIVERY SCIENCE FOR PNCDs?**

There is currently significant potential for translating fundamental and clinical neuroscience evidence into practical applications. However, there has also been a noticeable decline in public confidence and support for such research. This skepticism towards science, particularly in relation to medically related EBIs, has increased significantly during and after the COVID-19 pandemic, and is thought to be attributable to “science-related populism,” where personal opinions and emotions outweigh scientific facts [138]. Cognitive psychologists attribute this to the clash between fast, intuitive thinking—which may cause errors—and slower, analytical thinking that can override initial judgments [139].

Evidence “skepticism” is also influenced by ideological factors such as social, religious, moral, and political beliefs, which are reinforced by the immediacy of social media and internet access. These platforms can reinforce confirmation biases [139–142]. Despite significant advancements in tools and therapeutics, translational neuroscience is facing challenges. A multi-pronged approach is necessary with one of the most critical components consisting of an effective strategy to clearly demonstrate, communicate, and effect practical, real-life impact of our science, in essence research that is based on IS and DS research methodology.

While we have been extraordinarily successful (and arguably too successful) in generating new scientific journals and populating them with articles for immediate broad electronic dissemination, with few exceptions we have been communicating our research to increasingly smaller audiences of colleagues. Our own metrics of “impact” that lead to professional advancement are measured by research funding, the number of peer-reviewed articles, and the number of citations they generate by other scientists and journals. However, few, if any of these indicators of impact, have meaningful resonance with the average patient whose tax dollars are providing the lion’s share of funding for our scientific work that spans the continuum from basic science, through clinical trials and health services outcomes research, to population health interventions.

The real impact of the translational research continuum is appreciated fullest at the target level of individual patients, family members, communities, health care systems, and populations. This is precisely the mission, rationale, and method at the heart of HDS. Conventional descriptions of translational science focus on research on the myopic focus of “from bench to bedside,” and undersells the capacity of widespread impact and acceptance by the public. A more compelling view of translational research is embracing its full capacity to span bench to bedside, to clinic, to community, to population, and even global. Put succinctly, translational science has true impact when it realizes the promise of bridging “discovery science to delivery science.” This is among the many reasons that infusion of investment and growth of

population health and HDS will directly address the needs of individuals and families affected by complex late-life PNCDs.

There are multiple converging trends providing compelling rationale to advance HDS as an engine for accelerating and enabling high-impact “discovery” neuroscience. There is an undeniable demographic imperative of an aging domestic and global population with escalating numbers of older adults with PNCDs. In addition to constituting the greatest cause of worldwide disability, these conditions will increasingly account for acute, and most importantly, long-term care costs that threaten to overwhelm regional, national, and global health expenditures. In essence, without effective prevention and treatment these trends are financially unsustainable.

Finally, new methods in agile, accelerated, and dynamic research need to be applied that transcend the limitations of fixed research designs in health care delivery science in the context of treatments, systems, and an outer world that is constantly changing. Conventional randomized controlled trials (RCTs) remain the “gold standard” in research that assumes the capacity to hold constant the comparators and to control the context of the experiment. Despite their advantages with respect to *internal* validity, RCTs may present significant limitations in real-world applied health care delivery research with respect to *external* validity. Specific challenges include generalizability to “real-world” providers and patients, potential contamination by other treatments or factors in the natural environment, as well as potential selection bias by often lacking full inclusion of marginalized, disadvantaged, minoritized, or disabled populations of direct relevance to older adults with PNCDs.

Most importantly, healthcare systems, by definition, are constantly changing environments with respect to organization, financing, populations, and services which are beyond the capacity of health care delivery science to control. A variety of novel agile research designs are now being used to address these challenges including quasi-experimental designs, interrupted time series studies, pre-trial micro-simulation modeling, emulated clinical trials, roll-out-implementation optimization designs, and dynamic adaptation methods. These advances not only more realistically adapt to naturally occurring changes in health care systems while maintaining research rigor, but also present efficient, less costly, less incremental and more rapid and generalizable approaches to evaluating outcomes in health care delivery for complex patients such as those with PNCDs [143–151].

There is substantial justification for optimism [152]. Beyond the advancements in fundamental neuroscience and novel treatments, we are concurrently experiencing a remarkable expansion in data science, health technology, and HDS. The application of artificial intelligence is revolutionizing our ability to utilize data to predict, simulate, and identify intricate health conditions with the aim to optimize treatment outcomes. Emulated randomized trials offer the capability to swiftly identify effective therapies at a fraction of the cost associated with conventional clinical trials. Pragmatic randomized clinical trials conducted in real-world healthcare settings evaluate the effectiveness of clinical interventions within complex environments where elements controlled within traditional randomized controlled trials cannot be maintained. Additionally, advances in implementation and dissemination science research within LHSs provide validated methods and technologies that bridge the gap between EBI and their application to achieve practical and significant improvements in population health. Finally, there is an extraordinary opportunity for high-impact translational team science that brings together basic, fundamental, and clinical researchers with health care delivery and implementation scientists working together to bridge discovery to delivery. We stand on the threshold of fully realizing the potential of translational science to effect meaningful change that is understood, appreciated, valued, and supported by public

sponsors, patients, and families – “*from discovery science to delivery science.*”

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## AUTHOR CONTRIBUTIONS

Dr. Colenda was responsible for substantial contributions to the conception and design of the work; and acquisition, analysis, and interpretation of reference material; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. As lead author, Dr. Colenda is accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. In preparation of submission, Microsoft Co-Pilot Pro was used for copy-editing and grammatical clarity. (Microsoft. Copilot (GPT-4) [Large Language Model]. 2025. <https://copilot.microsoft.com>) No sections of this article used AI software to generate original content. Dr. Forester was responsible for substantial contributions to the conception or design of the work; and acquisition, analysis, and interpretation of reference material; drafting the work and revising it critically for important intellectual content; and final approval of the version to be published. Dr. Tampi was responsible for substantial contributions to the conception or design of the work; and acquisition, analysis, and interpretation of reference material; drafting the work; revising it critically for important intellectual content; and final approval of the version to be published. Dr. Tsegaye was responsible for substantial contributions to the acquisition, analysis, interpretation of reference material, drafting the clinical vignette and summary of research studies. Dr. Bartels was responsible for substantial contributions to the conception or design of the work; and acquisition, analysis, and interpretation of reference material; drafting the work; revising it critically for important intellectual content; and final approval of the version to be published.

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## COMPETING INTERESTS

CCC is a financial seed investor in Siftwell.AI, a decision support health informatics start-up company. As of the submission of this article, he has not received compensation due to his status as a seed investor. BPF is a consultant to CVS Health as a member of CVS Health's Pharmacy and Therapeutics Committee. He is a

consultant and receives stock options from Rippl Care and Patina Health. RRT, ST and SJB report no competing interests.

#### **ADDITIONAL INFORMATION**

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