REVIEW

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Sustaining Health Outside of Hospitals: Home Infusion Therapy for Value-Based Long-Term Care

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ABSTRACT Home infusion therapy (HIT) is a value-based healthcare delivery model where patients receive intravenous medications with home health services (HHS) outside the hospital. Our objective was to provide a comprehensive review of HIT services, tracing its historical development and examining its current role as a critical component of healthcare delivery worldwide. We evaluated peer-reviewed papers and online resources on HIT and HHS, published in English from 1959 to May 2025. Our review supports HIT services globally for three reasons: advance long-term care for the aging population, decrease antimicrobial resistance, and improve healthcare affordability, efficiency and access with continuation of post-acute complex care. The US has pioneered and dominated this field of HIT since 1970's, providing affordable, safe, effective and convenient services to patients, especially those requiring long-term care. While Canada, Europe, and Australia have offered HIT services, many other countries, including low- and middle-income countries (LMICs), provide limited to absent HIT services due to lack of regulations, experience, knowledge and training. HIT is viewed as a cost-effective alternative to hospital care, and payers have generally accepted higher home-based charges as long as they remain below inpatient costs. The strategic roadmap to safe and cost-effective HIT implementation must include provisions for a robust regulatory framework; competitive reimbursement structures to foster scalability; accreditation and certification standards to ensure patient safety; and access with modern technologies and digital transformation. Both HIT and HHS offer a safe, effective, and economical alternative to inpatient care. Policy reforms that initiate or expand coverage and streamline provider entry can strengthen this growing industry while improving patient outcomes and system-wide efficiency.

KEY WORDS: Outpatient Parenteral Antibiotic Therapy, Antibiotic Resistance, Home Infusion Therapy, Global Health

INTRODUCTION

The current global trend of longevity among the elderly population marks a great need for affordable healthcare for the aging population. Aging is a significant risk factor for many chronic diseases, including cancer, cardiovascular diseases, diabetes, and neurodegenerative disorders. Furthermore, older adults often have multiple chronic conditions, requiring complex treatment plans that are usually long-term with subsequent increase in healthcare costs. Based on 2020 US Census, there has been an increase of 15.5 million people aged 65 years or older since 2010[1]. Outside of the US using data from the World Health Organization, there were 1 billion people aged 60 years or older in 2020; by 2050, it is predicted to increase to 2.1 billion, nearly doubling in size within 25 years[2]. Notably, two-thirds of the predicted population for 2050 reside in low- and middle-income countries (LMICs) [2]. This revealing data underscores the urgent need to address healthcare resource utilization in a cost-effective manner, including care outside the hospital to mitigate cost and risks associated with hospitalization (i.e., antimicrobial resistance and hospital-acquired infections).

Home infusion therapy (HIT) is within a home health service (HHS) used to deliver medications intravenously or subcutaneously outside of a hospital[3]. Outside a hospital can encompass a patient's home, a skilled nursing facility, an infusion center or clinic. Offering HIT services under the coordinated care of healthcare professionals outside a hospital makes it cheaper, more convenient, and safer for patients. As such, HIT aligns seamlessly with value-based healthcare by improving patient outcomes, enhancing care experiences, and reducing overall healthcare costs—core tenets of this model. By shifting infusion services from hospitals to infusion centers and the home, patients with chronic or complex conditions can receive timely, individualized treatment in a comfortable setting, which often leads to better adherence, fewer adverse drug events (ADEs), and reduced hospital readmissions. In fact, one study of 5,395 patients reported 3.67% hospital admission and 0.37% requiring HIT discontinuation, with the lowest rate of ADE in elderly patients[4]. A systematic review of 13 studies confirmed these results, with comparable ADEs between HIT and medical setting infusions[5].

The elderly population, which is affected by a variety of concurrent chronic diseases, can greatly benefit from long-term personalized care. Other high-risk populations with conditions like cancer, infections, or autoimmune disorders also require long-term care for their complex diseases[6]. In rural areas, hospitals are less accessible with potential dire consequences from delay in healthcare on long-term patient health outcomes[7]. Home infusion services advance quality of care in these populations by supporting post-hospitalization continuity of care that focus on functional independence and the resumption of normal living. It enables proactive, coordinated management across healthcare providers while controlling costs by avoiding unnecessary acute care utilization. Furthermore, HIT services can protect patients from the risks of receiving care in hospitals since prolonged hospitalization increases the risk to antimicrobial resistance and potentially life-threatening hospital-acquired infections. In stabilized patients, these risks can be mitigated by utilizing HIT and HHS. As health systems

increasingly prioritize outcomes and cost-effectiveness, HIT coupled to HHS emerge as a critical strategy for delivering high-quality, patient-centered long-term care.

Our objective for this work was to provide a comprehensive review of HIT and HHS, tracing its historical development and examining its current role as a critical component of healthcare delivery in different countries. Our review explored the evolution of clinical practices, regulatory frameworks, and technological innovations that have shaped the field, particularly in the US with extensive published data and experience. Our paper also highlighted the benefits, challenges, and sustainability of this model, underscoring the relevance and potential applicability of HIT in different countries, particularly Association of Southeast Asian Nations (ASEAN) including LMICs, where this model has not yet established, to offer insights to inform policy development, healthcare planning, and capacity building in diverse healthcare systems.

METHODS

To identify references in this narrative review related to the history and existing infrastructure for HIT and HHS, we searched online databases, including PubMed and Embase, for publications in English from 1959 to June 2025. The key words used in our searches were: home infusion therapy, outpatient parenteral antibiotic therapy (OPAT), home health, intravenous (IV) infusion, infusion center, antimicrobial resistance, total parenteral nutrition (TPN), and different regions US, Canada, Europe, Australia, and ASEAN. We excluded online resources that exclusively represented IV hydration. As this article was a review based solely on existing published information, approval from an ethics committee was not required.

RESULTS

Home infusion therapy exemplifies the principles of value-based healthcare by improving patient outcomes, enhancing patient experience with safety and convenience, and ensuring cost-effective care delivery. In contrast to traditional inpatient or facility-based infusion services, HIT enables patients to continue medically necessary IV therapies in the comfort of their homes, thereby reducing hospitalization and institutional care costs while maintaining clinical outcomes. There are three critical factors that underscore the importance of developing and offering HIT and HHS in diverse health systems and countries: antimicrobial resistance, need and cost.

Antimicrobial Resistance

The 2023 National and State Healthcare-Associated Infections (HAI) Progress Report by the US Centers for Disease Control and Prevention showed that one of every 31 hospitalized patients experienced at least one HAI[8]. HAIs are defined as infections that develop within 48 to 72 hours after admission to any healthcare facility; this term has been used interchangeably with nosocomial infections. Notably, HAIs are often caused by multidrug-resistant organisms (MDROs), including vancomycin-resistant *Enterococcus*, methicillin-resistant *S. aureus*, and carbapenem-resistant *A. baumannii*, *P. aeruginosa* and *Enterobacterales*. These pathogens pose a significant concern in the intensive care and oncology units, where patients are vulnerable due to compromised immune systems, invasive devices and procedures, and exposure to environmental factors[9]. The therapeutic options for these highly resistant pathogens are scarce, and sometimes no effective antimicrobial agent is available, especially in LMICs[10].

The concern for antimicrobial resistance and HAIs is not restricted to the US. The World Health Organization estimated that 1 in 10 patients globally are affected by HAIs, with higher rates in LMICs[11]. An estimated 136 million cases of HAIs resistant to antibiotics occur worldwide every year based on a large survey of 99 countries[11]. These HAIs caused by MDROs are associated with increased hospital stays, complications, costs and mortality[12]. With over 63% of HAIs caused by MDROs, the global mortality attributed to antimicrobial resistance was approximately more than 5 million deaths in 2019[12]. Older age has been reported as an independent risk factor for in-hospital mortality in critically-ill patients with nosocomial bacteremia caused by multidrug-resistant Gram-negative bacteria[13]. In Europe, the 9 million annual HAIs led to 25 million extra hospital days and surplus cost of 13-24 billion euros[12].

Hospitalization itself, especially if prolonged and recent within the past 90 days, is a risk factor for HAIs caused by MDROs[14]. Strikingly, patients with long-term illnesses, including the elderly population, who are repeatedly hospitalized are at even greater risk for resistant HAIs and may even contract multiple HAIs throughout their hospitalizations[15,16]. In LMICs with hospital-centric care, prolonged hospitalization may be potentially preventable if outside of hospital care, like HIT, was available to ensure continuity of post-acute care and access to critical IV medications.

Major US professional societies have issued guidelines for institutional antimicrobial stewardship programs (largely hospitals) with the goal to prevent and reduce the spread of MDROs[15,16].The leadership role of senior care pharmacists within the interprofessional team is critical to achieve goals of antimicrobial stewardship programs[14]. Applying these principles of antimicrobial stewardship to inform international policies to control the spread of MDROs is important in every country. HIT as a healthcare delivery model that minimizes hospitalization to prevent antimicrobial resistance is well established in the USA. However, HIT should be explored as an alternative model to deliver safe and effective healthcare in other countries, especially in LMICs, to adopt low-cost policies without necessarily having to implement costly isolation protocols or impose additional contact precautions recommended to combat antimicrobial resistance.

Bridging Hospital to Home: Need for Post-Acute Continuity of Care

Home infusion therapy is beneficial to patients who require long-term IV treatment, such as those with chronic illnesses and infections requiring weeks to months of treatment. Having these patients receive therapy at a hospital would increase their risk of acquiring antibiotic-resistant HAI. Avoiding hospitalization in clinically stable patients would be beneficial to the patients' health and recovery, in addition to convenience offered by HIT for patients and their families. For example, a patient may only need HIT service once a day or week. Seeking service at an outpatient infusion center, clinic or home eliminates the patient's risk of contracting a HAI and alleviates the burden on the hospital system, allowing more beds to sick patients who need acute medical attention.

In HIT, patients typically begin infusion therapy in the hospital and transition to home-based self- (or family-supported) administration, with post-discharge guidance and education provided by home-based clinical teams and home health administrators. To ensure patient continuity of care and safety, healthcare providers offering integrated services—including drug compounding, delivery, and clinical support—are better positioned to meet patient needs efficiently. A comprehensive list of medications administered within HIT, categorized by disease state and drug class, and types of HHS are provided in Tables 1 and 2.

A HIT pharmacy provides infusion therapies (e.g., IV, subcutaneous, intrathecal, epidural) to: specialty pharmacy services; ambulatory infusion center services; home health nursing; private duty nursing; respiratory equipment and clinical respiratory services; hospice services; home medical equipment and supplies (with or without oxygen service); and enteral products and supplies[3]. An indispensable component of HIT is medication preparation and use through home infusion pharmacies that require pharmacists. In addition to preparing medications under sterile environment, pharmacists assess a medication's indication, confirm accurate dosing, and ensure drug safety through close patient monitoring[3]. Inappropriate drug dosing may lead to life-threatening consequences; for example, drugs with narrow therapeutic index like vancomycin require appropriate drug dosing and monitoring by clinical pharmacists to prevent acute kidney injury[17].

Through OPAT, vancomycin, with appropriate therapeutic drug monitoring by clinical pharmacists, has been safely used to treat cellulitis, osteomyelitis and endocarditis at home[17]. Clinical pharmacists write drug guidelines specific to HIT to ensure their safe use in the home setting, leveraging published national provisions for OPAT[18]. The pharmacy prepares sterile drug compounding, outside hospitals, for home delivery. While the role of the pharmacists is vital, nursing services are integral to train and educate the patient and caregivers; assess the condition of the home for safe drug administration; educate on side effects; and visit routinely for lab draw and IV catheter assessment with dressing change.

In addition to OPAT, clinical pharmacists are integral to the safe and effective use of TPN in patients' own homes which facilitate their recovery while minimizing exposure to HAI. The HIT services for patients receiving TPN (that has been shown to improve life expectancy) are sterile drug product compounding, home delivery, availability of a nurse for an initial home visit and 24-hr emergency backup, and reimbursement management.

TABLE 1. MEDICATIONS ADMINISTERED WITHIN HOME INFUSION THERAPY BY DISEASE STATE AND DRUG CLASS[1].

Disease State	Drug Class	Common Drugs
Infectious Diseases	Beta-lactam Antibiotics	Ampicillin/Sulbactam, Ceftriaxone, Cefazolin, Ertapenem, Meropenem, Oxacillin, Piperacillin/Tazobactam, Ceftazidime/Avibactam, Ceftolozane/Tazobactam
	Glycopeptides	Vancomycin
	Lipopeptides	Daptomycin
	Aminoglycosides	Tobramycin, Amikacin
	Antifungals (Azoles, Echinocandins)	Fluconazole, Voriconazole, Micafungin
Oncology	Antimetabolites	5-Fluorouracil, Methotrexate
	Alkylating Agents	Cyclophosphamide
	Supportive (Antiemetics, Fluids)	Ondansetron, Granisetron, Zoledronic Acid, Normal Saline, Dextrose 5%
	Opioids	Morphine, Fentanyl, Hydromorphone
Autoimmune Disorders	Biologics	Infliximab, Rituximab, Tocilizumab, Abatacept
	Corticosteroids	Methylprednisolone
Gastrointestinal Disorders	Parenteral Nutrition	Custom Amino Acids, Lipids, Dextrose, Electrolytes
Heart Failure	Inotropic Therapy	Milrinone, Dobutamine
Immunodeficiency	Immunoglobulin Therapy	Intravenous Immunoglobulin, Subcutaneous Immunoglobulin
	Hydration/Electrolyte Therapy	Normal Saline, Dextrose 5%, Potassium Chloride, Magnesium Sulfate
Neurological Conditions	Immunoglobulins	Intravenous Immunoglobulin, Subcutaneous Immunoglobulin
	Corticosteroids	Methylprednisolone
	Monoclonal Antibodies	Natalizumab, Ocrelizumab
Pain / Palliative Care	Opioid Analgesics	Morphine, Hydromorphone, Fentanyl

[1]Some medications, especially if dosed once daily, weekly or monthly and those for oncology, autoimmune disorders, immunodeficiency and monoclonal antibodies, is preferably administered at an infusion center or clinic to ensure patient safety. Home environment for safe drug administration should be assessed thoroughly prior to initiating home infusion therapy.

TABLE 2. SERVICES OFFERED BY HOME HEALTH AGENCIES[1].

Chronic Disease Management
Home Health Aide Services
Hospice Care
Medical Social Services
Medication Management and Infusion Therapy
Nutritional Support
Occupational
Therapy
Palliative Care
Personal Care
Services
Physical Therapy
Post-Stroke Rehabilitation (Occupation, Physical, and Speech Therapies)
Post-Surgical Care
Rehabilitation Services, including Dementia and Alzheimer's Care
Respiratory Therapy
Skilled Nursing
Care
Speech Therapy
Telehealth and Remote Patient Monitoring
Wound Care Management

[1]The following services are provided by home infusion pharmacy: home medical equipment and supply services, pharmacy services.

Cost Savings Through Value-Based Care

Both HIT and HHS offer value-based healthcare because they are more cost effective than care in a hospital[19]. Value-based care recognizes that each patient is unique and can experience improved health outcomes through personalized, patient-centric care. In fact, many hospice patients desire home-based treatment to avoid hospitalization during the terminal phase of illness. Recognized by the US Department of Health and Human Services and Centers for Medicare & Medicaid Services (CMS), HIT aligns with value-based care to reinforce the core tenets of patient outcomes, care experience and affordability[5,19].

The cost savings benefit both insurers (including public and private) as well as patients since oftentimes, patients must pay out-of-pocket for long-term care services. Payers have generally accepted higher home-based charges as long as they remain below inpatient costs. Historically, the cost savings from HIT enticed US public and private insurers to expand coverage to include TPN for all patients in the 1980s and eventually led to hospitals creating their own HIT services[1]. Based on a recent review of six studies, the cost savings from HIT versus inpatient care ranged from $40,460 to $81,559 (up to $120,500 for inotrope therapy) per patient, or $122 to $161.40 per day[20]. HIT costs were significantly lower than medical setting infusion costs, with savings between $1,928 and $2,974 per treatment based on a systematic review of 13 studies[5]. By program, cost savings have ranged from 18 to 75% for OPAT and 60 to 76% for TPN[21]. Remarkably, one recent study that modeled OPAT using Medicare data showed a cumulative 5-year savings of nearly $3 billion in 2023 healthcare dollars[20].

Regulatory Framework and Reimbursement

Regulatory framework for operating HIT pharmacies and HHS, like home health agencies, varies depending on the country and local jurisdiction. For the US, there are federal, state and local requirements, including certification and accreditation standards, in addition to general business and operational requirements (Table 3). Additional regulations must be met for licensing HIT pharmacy services that incorporate medication compounding (including waste management) and clinical pharmacy. Specific for HIT in which drug administration can occur at infusion centers and homes, the preparation of IV drugs must comply to very strict protocols to protect patients' health and safety. Any drug contamination may lead to ADEs, particularly infection. The US Pharmacopeia (USP) issues regulatory standards 797 (Pharmaceutical Compounding of Sterile Preparations) and 800 (Hazardous Drugs Handling in Healthcare Settings) for sterile compounding, which is the standard for compounded sterile IV drug preparation. The American Society of Health-System Pharmacists provides guidelines on HIT practices, adhering to laws and regulations set forth by the federal and state agencies (Table 3).

TABLE 3. FEDERAL AND STATE LICENSURE REQUIREMENTS FOR HOME INFUSION PHARMACY AND HOME HEALTH AGENCY IN THE UNITED STATES

Type	Federal	State	Accreditation and Compliance
Home Infusion Therapy (including Pharmacy)[1,2]	Enrollment with Medicare program and Durable Medical Equipment, Prosthetics Orthotics and Supplies National Provider Identifier and Medicare/Medicaid billing numbers Registration with the Drug Enforcement Administration for handling controlled substances	Home Infusion Therapy License (if applicable in your state) State Board of Pharmacy License Sterile Compounding License (required in many states if compounding infusion medications) Out-of-State Pharmacy License (if shipping across state lines)	Pharmacy Compounding Accreditation Board National Association of Boards of Pharmacy's verification for multistate operations US Pharmacopeia 797 and 800 compliance for sterile and hazardous compounding Accreditation Commission for Health Care, Utilization Review Accreditation Commission, or The Joint Commission accreditation is often required for third-party payer contracting
Home Health Agency[1,2,3]	Medicare Certification via the Centers for Medicare & Medicaid Services (Needed if billing Medicare) National Provider Identifier is required for all health care providers billing insurance	Department of Health or equivalent. Each state has its own requirements for: • Administrator credentials • Clinical supervision (e.g., RN on staff) • Background checks • Policies and procedures • Home visits	Accreditation Commission for Health Care requires submission of policies & procedures, a preliminary review, and an unannounced survey Community Health Accreditation Program focuses on community-based care and holds the Centers for Medicare & Medicaid Services deeming authority for home health services The Joint Commission offers Home Care Accreditation, including home health, and is recognized by Medicare and state licensing authorities

[1]Highly recommended: Waiver for Clinical Laboratory Improvement Amendment (if conducting lab tests like blood glucose monitoring), telehealth certification (if offering remote monitoring or virtual visits), infection control training and documentation for staff.

[2]Business & operational requirements include: professional staff (registered nurse, pharmacist supervision depending on state rules), business license by city, tax identification number from the Internal Revenue Services, state tax permit (if applicable), professional liability insurance (malpractice and general), workers' compensation insurance, compliance documentation for Health Insurance Portability and Accountability Act, and compliance for employee safety according to the Occupational Safety and Health Administration, National Institute for Occupational Safety and Health, and Environmental Protection Agency.

[3]Recommended accreditations for quality and safety by the Community Health Accreditation Partner, the Accreditation Commission for Health Care, and The Joint Commission.

Federal policy has significantly positioned the growth of the HIT industry in the US. Early decisions—such as Medicare coverage for home nutrition (1977) and the prospective payment system for inpatient services (1983)—helped establish HIT as a viable, cost-effective alternative to hospital care[22]. Expanding Medicare coverage to include a broader range of HIT transformed this industry, with steady growth of HIT due to favorable reimbursement structures that have enabled providers to deliver services at lower cost than inpatient care while maintaining strong margins. The CMS is a US federal agency that administers, oversees and manages the payment of healthcare services and goods, including Medicare and Medicaid. Specific to HIT and home health agencies, CMS administers a separate prospective payment system that reimburses a predetermined, fixed amount for a service derived from a classification system. The elements required for HIT reimbursable by CMS include the drug, equipment (e.g., infusion pump), supplies (e.g., tubing and catheters) and clinical services.

Technological Innovations

With the expansion of innovative point-of-care technologies worldwide, including smart pumps, wearable infusion devices, remote and continuous monitoring systems, and telemedicine, HIT and home-based services have become a popular healthcare delivery modality for its efficiency and convenience[23,24]. These technological advancements show promise in enhancing safety, improving patient adherence, and expanding healthcare access. Smart and portable infusion pumps equipped with drug libraries specific for home use now offer dose error reduction systems, wireless connectivity, and remote monitoring capabilities that allow providers to track infusion accuracy[25]. In addition, remote patient monitoring and telehealth platforms provide continuous oversight of patient's health status (e.g., vital signs), and infusion-related complications[19,23,26]. These tools enable real-time clinical decision-making and reduce the burden on caregivers and in-person visits, making therapy more efficient and patient-centered.

Countries with Existing Home Infusion Therapy US, Canada, Europe, and Australia

Home infusion therapy services are currently available in the US, Canada, Europe, and Australia. HIT services in these countries vary, with the US delivering very comprehensive HIT services (Tables 1 and 2). In fact, HIT first began in the US in the 1970's when patients were discharged from a private hospital but still required IV TPN[22]. The expansion of HIT was incited by Medicare coverage in 1977 for home TPN solutions and related supplies[22]. This led to the creation of Home Health Care of America two years later[22]. It was a provider of all things home infusion including medical equipment, nursing services, and infusion supplies, and subsequently served as a catalyst for the expansion of drug infusion therapy from hospital to home[22]. The HIT industry experienced significant growth in the 1980s at a rate of about 30% per year, with the inclusion of therapies such as antimicrobials, hydration, and pain management coupled to Medicare policy changes, the introduction of diagnosis-related groups, and a preference to reduce hospital stays[22]. The 1990s represented a shift toward structured HIT programs, supported by both public health initiatives and private sector involvement. Today, HIT services in the US are widely available with ~ 1,500 pharmacies serving over 3.2 million patients each year and 11,353 active home health agencies[27,28]. HIT services provide post-acute continuity of care from hospital to home, and are highly cost-effective for patients with chronic diseases who require long-term care (e.g., cancer and elder care) that can drain the healthcare system resources[29]. Furthermore, HIT is patient-centered, offering comfort and convenience to patients and family members, while reducing the risk of antibiotic-resistant HAI.

The global trend of aging population coupled to the rising chronic diseases have increased the demand for cost-effective modalities—like HIT—in Canada, Europe, and Australia, as well[2,29]. The evolution of HIT in Canada since the 1970s paralleled that of the US, targeting the elderly and individuals with disabilities[30]. In 1980s, HIT services for pediatric patients became prevalent with evident benefits in cost savings and improved quality of life[31]. From 1990s to today, HIT services have expanded, inclusive of OPAT clinics for cellulitis, osteomyelitis

and other infections leading to decrease in cost, emergency department visits, and hospital readmission[32,33]. Policymakers even incentivized infectious diseases physicians to OPAT through fee-for-service payment[34].

In Europe, HIT emerged during the 1980s with TPN services. By the 1990s, the scope of HIT expanded to OPAT, hydration, and pain management to reduce hospitalization and associated costs[5,35]. Today, HIT therapy is an integral part of healthcare delivery in many European countries, like United Kingdom, France, Spain, Germany, Belgium and The Netherlands, offering patients the convenience of receiving complex treatments in the comfort of their homes, even for rare diseases[5,23,25,36–38].

In Australia, HIT was established through their universal healthcare program Medicare since the 1980s largely for OPAT services that have received high patient satisfaction[39]. Since the 2000s, public health initiatives further supported more structured programs for children and adults[40]. A prominent barrier for HIT in Australia is access, with limited locations in remote rural regions. This obstacle faced by Australia, presents a significant challenge faced by LMICs, which contribute to hospital burden, antimicrobial resistance and HAI.

Opportunities for Home Infusion Therapy in ASEAN

Accessibility to HIT in ASEAN, including LMICs, are currently limited but is projected to experience inevitable growth due to increasing awareness, medical technology and healthcare cost containment in the rising elderly population with long-term chronic diseases. Infusion drug compounding is currently hospital-based, with limited community pharmacy participation. In certain parts of Asia including Singapore, Japan, Taiwan, Thailand, Malaysia and China, HIT services for TPN and/or OPAT were initiated in the 1990s and 2000s; however, comprehensive documentation detailing the exact timelines and adoption rates is limited especially outside of Singapore[41–49]. **In fact,** the progression of HIT across Asia is not as extensively documented as in North America or Europe, with a reported missed opportunity in Asia where 5 of 162 facilities (3%) outside of Singapore provided OPAT services[46].

Based on a meta-analysis of 20 randomized controlled trials with 3,100 participants, hospital-at-home (HaH) programs prevented hospital admission by providing acute-care level treatments, for a limited time only, at home under the supervision of healthcare professionals[50]. Initiated in France in 1957, HaH was adopted in the US for patients who refused hospitalization, not because of hospital burden or as a replacement for acute hospital care due to safety concerns[51]. Parenteral medications are administered in both HIT and HaH care models; however, HaH is short-term care that largely serves patients with chronic obstructive pulmonary disease, stroke and acute medical conditions in geriatric patients, whereas HIT provides long-term care for various medical conditions after hospitalization in patients with the need for continuity of post-acute complex care[50,51]. Furthermore, the benefits of HaH may be limited for geriatric patients in preventing later hospitalizations up to 12 months and mortality at 6 months [50].

As a form of HaH program, the Ministry of Healthcare Transformation in Singapore launched Mobile Inpatient Care at Home (MIC@Home) that partners with local public hospitals to provide inpatient services at homes to reduce hospital burden[52,53]. MIC@Home incorporates IV therapies, medication counseling and dispensing, as well as telehealth and home visits by doctors, nurses and pharmacists, with reimbursable cost by classification as "inpatient" care. The cost-effectiveness of HaH modality should be further studied as decentralization of care can increase professional labor cost.

Cancer patients may require long-term care that includes palliative care for pain relief, TPN for nutritional support, and hospice for end-of-life care, positioning HIT services ideal for home treatments. A growing area of interest pertains to HIT services for cancer patients, particularly in Singapore, Japan, Taiwan and Thailand, to address palliative care and in light of the growing number of biopharmaceuticals developed for subcutaneous administration facilitating home use[36,54,55]. In Taiwan, the National Health Insurance provides partial coverage for home-based services such as IV infusions, wound care, and chronic disease management, leveraging digital health tools (e.g., electronic medical records, LINE-based teleconsultation, and smart medication management tools) to serve the aging and rural communities[56]. In Thailand, senior living facilities have emerged for aging population, with potential for these centers to integrate HIT and HHS. In addition, "daycares" have emerged to address cancer care due to urgent need during the COVID-19 pandemic[57]. Notably, routine administration of chemotherapeutic agents at home is generally not recommended due to safety concerns and wastage of high-cost drugs[58,59]. However, their recommendation for a controlled environment and experienced personnel to manage potential complications during and after infusion of chemotherapy can be

achieved at infusion centers that avoid hospitalization. In rural regions, access to hospital remains limited due to geographic barriers, uneven distribution of healthcare resources, and a shortage of specialized medical personnel especially trained nurses.

The aesthetic and wellness industries are popular in Asia, promoting IV nutrient and vitamin therapy services for hydration, detoxification, immunity and longevity at clinics and spas in South Korea, Japan, Malaysia, Thailand, Taiwan, and Vietnam. Initiating HIT in ASEAN can build upon this existing infrastructure and public familiarity. Regulation has not been enacted for these industries in ASEAN and the US despite its accessibility even through medical tourism[60]. However, the FDA issued a warning, with support from major pharmacy societies, on the increased risk of severe infection and adverse events from lack of sterile compounding of these IV products, coupled to untrained personnel[61,62]. As such, by enhancing the regulatory frameworks and reimbursement models along with creating a foundation of trained personnel to ensure patient safety, these countries can transition from wellness-oriented, elective IV care to clinically-driven HIT services that support sustainable healthcare delivery.

The gross national income per capita in LMICs ranges from $1,146 to $14,005[63]. In LMICs, medication infusions are only accessible in hospitals, where parenteral drug compounding may not be performed under strict regulations for sterile conditions. For example in the LMIC of Vietnam, neonatal intensive care units across 55 provinces have highly variable practices in parenteral nutrition preparation and care delivery, with inconsistencies to US and European guidelines due to the absence of standardized protocols[64]. In addition, antibiotic misuse has catapulted antimicrobial resistance in Vietnamese young children and geriatric patients[65,66]. While antimicrobial stewardship programs are flourishing in hospitals, antibiotic consumption without a prescription continues to contribute to the high prevalence of antibiotic resistance in the community settings throughout Vietnam and other LMICs[67,68].

DISCUSSION

The need for HIT initiation and expansion in ASEAN reflects a broader global trend toward patient-centered care and the decentralization of healthcare services to address cost-effective care for the aging population within an era of rapid technological advancement, including artificial intelligence. A robust framework must be instituted to protect patient safety and cost-effectiveness of HIT services (Table 4). To expedite the initiation and growth of HIT, it is prudent to engage experienced experts who can provide clinical, operational, and regulatory guidance. These experts may include healthcare professionals with experience in parenteral nutrition or infectious diseases, skills in sterile compounding and infusion protocols, and trained in home care and catheter management. International consultants from regions with established HIT can offer valuable insights into best practices, risk mitigation, and implementation strategies. Collaborating with academic institutions, professional societies, and global health organizations can further help build a core team capable of training local staff, advising on infrastructure development, and supporting policy design. Their expertise ensures a safe, efficient, and scalable launch of HIT services.

To build capacity for HIT in diverse healthcare systems and countries without existing infrastructures, the regulatory barriers must be resolved to permit infusions at home by trained and qualified personnel (including nurses certified for home health), establish sterile compounding policies and procedures, and provide competitive reimbursement policy to cover the costs of care by public and private insurances at rates lower than that of hospital care[69]. Attractive reimbursement structures invigorate providers to offer services at rates below hospital charges yet maintain strong profit margins, encouraging market entry and improving patient access, especially important for rural regions and LMICs.

Successful upscale of patient-centric HIT for long-term success and sustainability requires: effective governance requires stakeholder engagements, expansion of reimbursable services, collaborative partnerships between public and private sectors for financing, adequate staffing with clear roles and responsibilities, workforce optimization to decrease labor cost, and accreditation and certification to ensure commitment to quality, safety and compliance with regulations[52,70]. The credentialing of healthcare staff through training and preferably certification specific to home-based care is a crucial process to ensure consistency, continuous quality improvement and integration of new drugs and technologies into care. The shortage of trained personnel, especially nurses, worldwide augments the complexity of staff requirements[35,71,72].

TABLE 4. FRAMEWORK FOR INITATING HOME INFUSION THERAPY IN EMERGING HEALTHCARE SYSTEMS.

Component	Description	Key Stakeholders	Training & Standards
Regulatory Framework	Legalize and regulate home infusion therapy and medication compounding	Ministry of Health, drug regulatory agencies, lawmakers	Develop national guidelines; adopt international standards (e.g., USP 797 and 800)
Licensing and Accreditation	Establish criteria for licensing home infusion pharmacies, and home health services	Health bureaus, accreditation bodies, hospital administration	Create inspection checklists and accreditation pathways for home infusion providers
Clinical Protocols and Guidelines	Standardize patient selection, infusion protocols, and emergency procedures	Clinical societies, hospitals, pharmacists	Train healthcare teams in protocol-based care, central line care, and adverse event management
Multidisciplinary Teams	Form care teams including physicians, nurses, pharmacists, dietitians, and home health workers	Hospitals, home health agencies, nursing associations	Develop team-based training programs and case simulations
Supply Chain & Logistics	Set up cold chain systems, parenteral nutrition compounding, and home delivery infrastructure	Pharmaceutical companies, logistics firms, infusion pharmacies	Train on storage, handling, and aseptic preparation; quality control standards
Telehealth Integration	Implement remote monitoring, follow-up, and emergency triage	Telemedicine vendors, information technology departments, clinicians	Training on digital platforms, patient monitoring protocols, and data security
Patient and Caregiver Education	Design structured education on infusion management, catheter care, and troubleshooting	Nurses, case managers, education departments	Develop multilingual materials, hands-on sessions, and 24/7 helpline support
Insurance and Financing	Include home infusion in public/private insurance benefit packages	Health insurers, government payers, economic planning agencies	Conduct cost-effectiveness analyses; establish reimbursement codes and bundled payments
Data Collection & Research	Build national registry for outcomes, complications, and utilization trends	Academic institutions, public health agencies	Train teams in data collection, registry management, and quality improvement analytics

CONCLUSION

Expansion of HIT and HHS in ASEAN, with strong public health infrastructure and aging population, offers a timely opportunity to decentralize care, lower system costs, and meet the complex needs of long-term care patients with technology-enhanced models and healthcare workforce shortage. A robust regulatory framework and reimbursement structure with appropriate accreditation and certification standards are essential to ensure the safety, quality, and effectiveness of HIT and HHS. These processes validate compliance to best practices and commitment to continuous improvement to ensure patient safety.

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