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ORIGINAL RESEARCH

Beyond the COVID-19 Pandemic: Budget Impact Analysis of Remote Healthcare Delivery for Hypertension and Diabetes Mellitus Management in Thailand

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Purpose: The COVID-19 pandemic disrupted healthcare services globally, necessitating innovative care delivery models for non-communicable diseases. Remote healthcare pathways, including telehealth with pharmacy at home (PAH) and deferred care (DC), emerged as potential solutions for managing stable hypertension (HT) and diabetes mellitus (DM) patients. This study aims to estimate the budget impact of implementing PAH and DC compared to usual care (UC) for HT and DM patients in Thai tertiary care hospitals from the government perspective.

Methods: A retrospective budget impact analysis was conducted using data from July-December 2021 (COVID-19 period) and July-December 2022 (new normal period). The study included stable patients from 35 tertiary care hospitals in Thailand. Direct medical costs were obtained from administrative databases and national costing studies. Multivariate log-linear regression models estimated conditional costs, controlling for patient characteristics. The analysis compared baseline scenario (UC only) versus alternative scenario (UC+PAH+DC). Sensitivity analyses were performed using 95% confidence intervals and ±20% population variations.

Results: The alternative scenario demonstrated lower total budgets in both periods. During COVID-19, total costs were 12.23 versus 12.94 million USD (baseline), yielding 0.71 million USD in savings. In the new normal, costs were 11.93 versus 12.54 million USD (baseline), generating 0.61 million USD in savings. Cost-saving ratios were 0.06 USD and 0.05 USD per dollar allocated during the COVID-19 and new normal periods, respectively. Sensitivity analyses confirmed robustness across parameter variations.

Conclusion: PAH and DC pathways represent economically advantageous alternatives, demonstrating cost savings from the government perspective. These findings support implementing remote healthcare delivery in resource-constrained settings, though comprehensive evaluations incorporating societal and patient perspectives are warranted. The findings are based on extrapolation-based results and should be interpreted with caution due to variability in parameters including adoption rates of PAH/DC, unit costs applied, patient numbers, retrospective design, bundled interventions, and the savings ratio.

Keywords: budget impact analysis, telehealth, remote healthcare delivery, non-communicable diseases, COVID-19, cost

Introduction

The COVID-19 pandemic has significantly impacted individuals with non-communicable diseases (NCDs), as continuous medical care was required.[1] Healthcare service availability has been globally disrupted due to the pandemic, resulting in a decline in healthcare visits, hospital admissions, diagnoses, and treatments.[2–6] NCDs were responsible for

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approximately 71% of global deaths, with the majority occurring in low- and middle-income countries in 2022.[7] In Thailand, 75% of all deaths were attributed to NCDs in 2021.[8] The four leading causes of NCD-related mortality worldwide included cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes mellitus (DM).[7,8] In 2020, healthcare services for conditions such as hypertension (HT), asthma, DM, and cancer were notably disrupted among 168 WHO member countries.[6] HT and DM were significant contributors to the NCD burden in Thailand. In 2019, HT and DM were estimated to account for 1.75% and 3.13% of annual deaths, respectively.[9] In 2024, the incidence and prevalence of HT were reported at 1.38% and 24.7%, while DM had an incidence rate of approximately 0.7% and a prevalence of 5.6%.[10] The average outpatient service cost per visit was 964 THB for HT and 1,312 THB for DM, with total costs of 1,436.7 and 1,344.0 million THB, respectively. These estimates were derived from data collected from 40 hospitals participating in the Phase 1 Cost per Case Analysis Project in Thailand, covering four fiscal years (2018–2021). The analysis was conducted from the provider perspective, based on a total of 29,895,693 service visits available for analysis.[11]

Restricted access to healthcare during the pandemic has had a negative impact on treatment outcomes for patients with NCDs. Additionally, adverse health effects have been exacerbated by pandemic-related factors, including reduced physical activity, dietary limitations, and decreased social interactions.[4,12,13] Moreover, changes in clinical practices for NCDs management and shifts in patient behavior have been observed due to the COVID-19 pandemic.[1–6,12,13] Various policies have been implemented worldwide to control the spread of COVID-19 while maintaining healthcare services.[3,4,6,14,15] In Thailand, multiple policies have been adopted by the large hospitals since the start of the COVID-19 pandemic, including telehealth along with the pharmacy at home (PAH) and the deferred care (DC).[6] These programs not only contribute to controlling the spread of COVID-19 and sustaining essential healthcare services but also alleviate the burden on limited resources such as human resources, financial support, and medical supplies. Remote healthcare delivery is particularly suitable in countries with limited resources. PAH and DC were forms of remote healthcare delivery that represented an integration of service models which were previously implemented separately. These included telehealth, pharmacy at home by postal delivery, and deferred follow-up care. Originally, each of these service models was implemented independently to improve patient convenience, reduce overcrowding in healthcare facilities, reduce waiting times, address provider time constraints, and enhance access to care for patients in remote areas. Their prior use increased healthcare providers' confidence in reintegrating these models during emergency situations. These models were commonly applied to clinically stable patients with HT and DM, two of the most burdensome NCDs. Remote healthcare delivery in HT and DM patients was feasible through home-based devices such as blood pressure monitors and glucometers. Furthermore, standardized clinical practice guidelines supported remote management of these conditions by providing clear clinical indicators, structured medication adjustment protocols, and appropriate procedures for remote counseling and lifestyle guidance.[16] Moreover, these care pathways were implemented specifically for clinically stable patients, thereby minimizing potential risks associated with disease progression or complications. The integration of telehealth into both the pharmacy at home and deferred care enabled timely follow-up and allowed healthcare providers to intervene promptly in the event of any concerning symptoms or clinical changes.[6]

Telehealth was investigated in previous studies prior to the COVID-19 pandemic. It was reported to reduce healthcare service costs and patients' out-of-pocket expenses.[17] Healthcare service costs included equipment, building supplies, and wages, while out-of-pocket expenses covered transportation, meals, and accommodation. A systematic review of cost-effectiveness analysis (CEA) found that telehealth was claimed to be cost-effective.[18] The CEA of the pharmacy at home by postal delivery in Thailand relative to the schizophrenic patients at Suanprung hospital between 2009 and 2010 from the societal perspective was analyzed. The study found that after seeing a physician, patients received the pharmacy at home by postal delivery, the total cost was approximately half that for patients who received drugs in person (12,765 THB versus 24,028 THB). Furthermore, patients who received pharmacy at home by postal delivery had a higher probability of continuing to receive prescribed medication without recurring symptoms than patients who received drugs at the outpatient department (0.57 and 0.51, respectively). The Incremental Cost-Effectiveness Ratio (ICER) was calculated by dividing the difference in total costs by the difference in probability of continuing to receive prescribed medication without recurring symptoms. The study found the ICER was −187,716.67 THB per patient who continued to receive prescribed medication with no recurring symptoms.[19] Gaining one more patient in the pharmacy at home program by postal delivery who continues to receive prescribed medication without recurring symptoms could save 187,716.67 THB compared to a patient who received drugs at the outpatient department.[19] For DC, there is currently no published study evaluating the economic outcomes. Guidance from the United States Centers for Disease Control and Prevention provided useful insights regarding deferred care during the COVID-19 pandemic. Deferred care was recommended for routine primary and specialty care, management of well-controlled chronic conditions, routine screenings for asymptomatic conditions, and deferral of elective procedures may be deferred when necessary. However, the outcomes of deferred care depend on individual patient conditions and the duration of the delay.[20] This study contributes new evidence by evaluating integrated care models for HT and DM patients, which have not previously been assessed from an economic perspective. In particular, no prior studies have examined the budget impact of the model in the Thai healthcare context.

To our knowledge, this is the first study in Thailand to estimate the budget impact of PAH and DC for patients with HT and DM, which were implemented during the COVID-19 period and continuing into the new normal period. These periods were selected to capture differences in healthcare delivery during the pandemic and the subsequent transition to the new normal, in line with Thailand's official COVID-19 timeline.[21] Thailand's healthcare system is primarily funded by the government.[22] Therefore, this study adopted the government perspective to reflect real-world decision-making and budget allocation. This information is useful for strengthening the resilience of health systems by informing resource planning for potential future transitions from normal to crisis situations. In addition, these programs have been implemented during normal periods to enable healthcare providers to manage other important tasks. Consequently, the budget impact observed during crises and normal periods is expected to differ, reflecting changes in resource allocation according to shifting healthcare priorities. The findings of this study can serve as a reference for resource-limited countries to plan and manage budgets to enhance the efficiency of healthcare service delivery in both crises and normal situations.

Materials and Methods

Study Design and Scope

This study is a retrospective estimating the budget impact of PAH, DC, and usual care (UC) programs for stable HT or DM patients in tertiary care in Thailand. Tertiary care in this study referred to regional hospitals operated under the Ministry of Public Health, each with a capacity of more than 500 beds.[23,24] There are 35 such hospitals in Thailand.

Data were gathered using a cost of illness (COI) approach. The study covered two periods: July 2021 to December 2021 and July 2022 to December 2022, which were selected to represent COVID-19 and new normal periods, respectively. The study period was divided in accordance with the timeline of the COVID-19 situation in Thailand, as stated in the official announcement by the National Health Security Office published in the Royal Gazette. The pandemic officially began in January 2020 and continued through several waves until July 2022, after which COVID-19 was reclassified as endemic, effective from July 1, 2022.[21] Costs were reported in the United States dollar (USD), based on the exchange rates announced by the Bank of Thailand on December 30, 2021 (1 USD = 33.59 THB) and December 30, 2022 (1 USD = 34.73 THB).[25] This study received ethics approval from the Human Research Ethics Committee of Saraburi Hospital (EC040/2566). The committee waived the requirement for individual informed consent based on the following justifications: (1) the retrospective nature of the study posed minimal risk to participants, (2) obtaining consent from all patients would be impracticable due to the large sample size and extended time period, and (3) the research could not reasonably be carried out without access to the medical records. To protect patient privacy, all identifying information was removed from the dataset, and unique study codes were assigned to each case. Data access was restricted to the research team, and all data handling procedures complied with institutional confidentiality policies. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable local regulations governing medical research.

The definitions and operational characteristics of the PAH and DC pathways are as follows:[6]

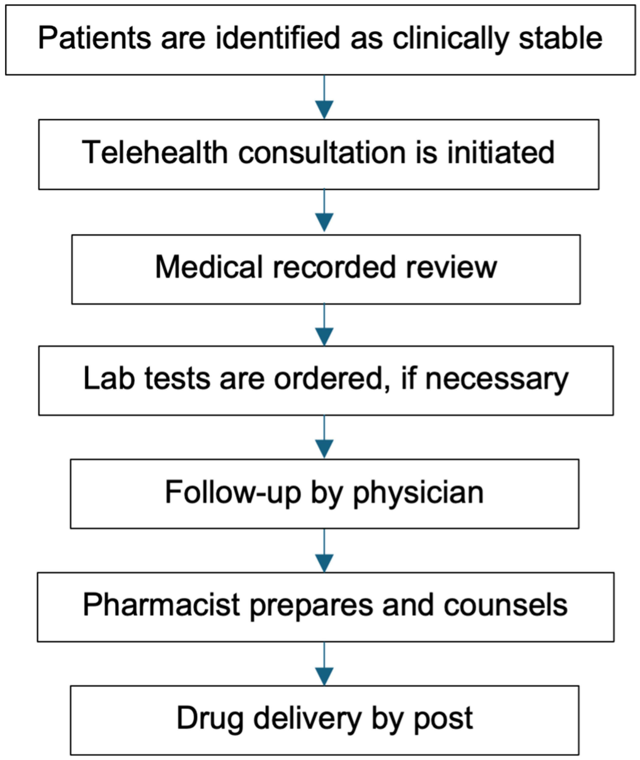

Figure 1 The workflow of PAH pathway.

PAH Pathway

PAH was a remote healthcare delivery model that integrated telehealth with medication delivery by postal service. Eligible patients were those with stable clinical conditions, approved by both healthcare providers and the patients. Medications requiring special handling such as liquids, injectables, refrigerated drugs, and chemotherapy agents were excluded. The service began with a telehealth initiated either by nurses or upon patient request via telephone. Upon enrollment, medical records were reviewed, and laboratory tests were ordered if necessary. Laboratory investigations were conducted at any facility that was convenient and accessible to the patient. Follow-up consultations were conducted by physicians via telephone. Hospital pharmacists reviewed prescriptions, prepared medication packages, and contacted patients for counseling. Medications were delivered via postal service, with delivery costs paid by patients either at a fixed rate or based on weight and distance. The workflow of the PAH pathway is shown in Figure 1.

DC Pathway

DC was a remote healthcare delivery model combining telephone-based telehealth with delayed in-person follow-up. Implementation of this program required mutual agreement between healthcare providers and patients. Eligible patients were those with stable symptoms and an adequate supply of medication at home. The workflow of the DC pathway is shown in Figure 2.

Data Collection

Secondary data were derived from administrative databases at a single tertiary care hospital, the unit cost per disease analysis phase 1 and year 2 of the Thai Case Mix Centre (TCMC),[26] and the Health Data Center service of the Ministry of Public Health.[10] Data in this study were obtained from HT and DM patients identified during two study periods. Inclusion criteria included patients without complications and with an unchanged medication regimen for at least six months. HT and DM patients meeting these criteria were defined as stable patients. Finally, stable patients were assigned to each care pathway. The workflow of patient selection and assignment to care pathway is shown in Figure 3.

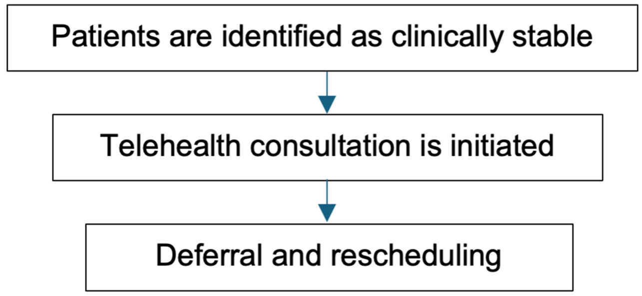

Figure 2 The workflow of DC pathway.

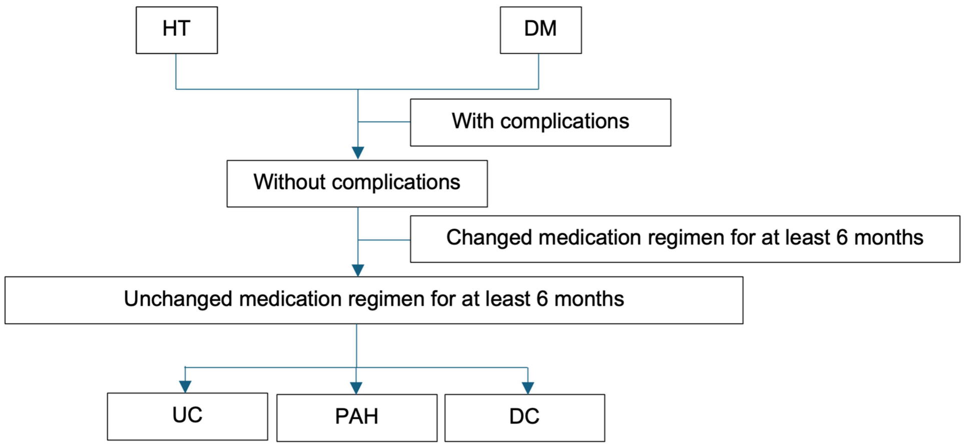

Figure 3 The workflow of patient selection and assignment to care pathway.

Direct medical costs included the cost of treatment and cost of care pathway. Cost of treatment comprises medication, diagnostic, general, and laboratory services. Cost of treatments was obtained from administrative databases at a single tertiary care hospital. The cost of care pathway was estimated using standard costing guidelines and activity-based frameworks, which relied on empirical data and an accounting approach to determine direct and overhead costs. The cost of care pathway was obtained from the report of TCMC and single tertiary care hospital. Table 1 presents the cost components and their sources.

The data on the number of target populations were obtained from the national database covering 35 tertiary care hospitals, provided by Health Data Center service of the Ministry of Public Health.[10]

Data Analysis

Budget Impact Analysis (BIA)

The framework of budget impact in this study follows Health Technology Assessment guidelines of Thailand and ISPOR Task Force on Good Research Practices.[27,28] It estimates the difference in the total budget between UC only (baseline

Table 1 Components of Cost Analysis

Costs	Sources
Direct medical cost	
Treatment costs, including medication, diagnostic, general, and laboratory investigation	Single tertiary care hospital
Service organization costs for PAH, DC and UC	Single tertiary care hospital and TCMC[26]

Abbreviations: PAH, telehealth along with pharmacy at home; DC, telehealth along with deferred care; UC, usual care; TCMC, the Thai Case Mix Centre.

scenario) and total budget of UC+PAH+DC (alternative scenario). This study estimates the budget impact from the government perspective. The total budget for each scenario is calculated as the conditional cost multiplied by the number of target populations.

The conditional cost was estimated using a multivariate log-linear regression model, controlling for potential confounders related to patient characteristics in a single tertiary care hospital across two study periods. Separate models were fitted for each period to assess contextual cost differences. The potential confounders included comorbidities (≤2 disease, and >2 disease), sex (male, and female), age (<60, and ≥60), medical benefit scheme (Universal coverage, Social security scheme, Civil service medical benefits scheme, and other), polypharmacy (yes, and no), body mass index (<25 kg/m^2, and ≥25 kg/m^2), and history of COVID-19 infection (yes, and no).[2,29–34] Polypharmacy was defined as the concurrent use of five or more medications. The regression coefficients of direct medical cost were exponentiated to obtain predicted cost values for each care pathway, which represented the conditional cost.

There are 35 tertiary care hospitals in Thailand, all of which were included in identifying the target population of HT and DM patients with stable symptoms. The number of target population was estimated using a national database covering all 35 tertiary care hospitals across all regions of Thailand.[10] This aligns with previous study showing that the PAH and DC programs were most commonly implemented in tertiary care hospitals following a similar model of care.[6] Finally, stable patients were assigned to each care pathway proportionally based on the observed prevalence rates derived from the single tertiary care hospital. These rates represent the proportion of stable patients who received each care pathway.

The data analysis was performed using Microsoft® Excel for Mac, Version 16.95.3. The details of the input parameters are listed in Table 2.

Sensitivity Analysis

This study applied a deterministic one-way sensitivity analysis, using a 95% confidence interval (CI) of the conditional cost and varying the target population estimates by ±20%, as listed in Table 2.

Table 2 Input Parameters of BIA

Variables	Input Parameters	References
The number of target population		
Total number of stable HT and DM patient in 35 tertiary care hospitals in Thailand (COVID-19)	305,430	National database[10]
Total number of stable HT and DM patient in 35 tertiary care hospitals in Thailand (new normal)	318,931	National database[10]
Prevalence rate of UC (COVID-19)	0.821	Single tertiary care hospital
Prevalence rate of PAH (COVID-19)	0.087	Single tertiary care hospital
Prevalence rate of DC (COVID-19)	0.092	Single tertiary care hospital
Prevalence rate of UC (New normal)	0.905	Single tertiary care hospital
Prevalence rate of PAH (New normal)	0.035	Single tertiary care hospital
Prevalence rate of DC (New normal)	0.060	Single tertiary care hospital

(*Continued*)

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Table 2 (Continued).

Variables	Input Parameters	References
Conditional cost (USD)		
Conditional cost of UC (COVID-19)	42.33	Single tertiary care hospital
Conditional cost of PAH (COVID-19)	55.46	Single tertiary care hospital
Conditional cost of DC (COVID-19)	5.30	Single tertiary care hospital
Conditional cost of UC (New normal)	39.33	Single tertiary care hospital
Conditional cost of PAH (New normal)	46.18	Single tertiary care hospital
Conditional cost of DC (New normal)	3.08	Single tertiary care hospital
95% CI for the conditional cost (USD)		
95% CI of conditional cost for UC (COVID-19)	38.70–45.87	Single tertiary care hospital
95% CI of conditional cost for PAH (COVID-19)	47.26–63.80	Single tertiary care hospital
95% CI of conditional cost for DC (COVID-19)	4.55–6.15	Single tertiary care hospital
95% CI of conditional cost for UC (New normal)	36.69–42.20	Single tertiary care hospital
95% CI of conditional cost for PAH (New normal)	38.95–54.73	Single tertiary care hospital
95% CI of conditional cost for DC (New normal)	2.67–3.57	Single tertiary care hospital

Abbreviations: HT, hypertension; DM, diabetes mellitus; UC, usual care; PAH, telehealth along with pharmacy at home; DC, telehealth along with deferred care; CI, confidence interval; USD, United States dollar.

Results

Budget Impact Analysis (BIA)

The BIA demonstrated that the alternative scenario required a lower total budget compared to the baseline scenario in both the COVID-19 and new normal periods. In the COVID-19 period, the total annual cost was 12.94 million USD in the baseline scenario and 12.23 million USD in the alternative scenario, resulting in a budget impact saving of 0.71 million USD. In the new normal period, the total annual cost was 12.54 million USD in the baseline scenario and 11.93 million USD in the alternative scenario, representing a budget impact saving of 0.61 million USD. These findings indicate that implementing the alternative care pathways could reduce government healthcare expenditures under both periods. Detailed results are presented in Table 3.

Sensitivity Analysis

The ranges reflecting the sensitivity of the calculations are listed in Table 4. Two types of sensitivity analyses were conducted. First, the conditional cost was varied based on their 95% CI. Second, the target population was varied by ±20%. The sensitivity analysis demonstrated that variations in the conditional cost had minimal effects on the overall direction and magnitude of the budget impact. The alternative care pathways consistently resulted in lower total budget

Table 3 Budget Impact Analysis

Scenario	Annual cost (million USD) separated by care pathways			
	UC	PAH	DC	Total
COVID-19				
Baseline scenario	12.94	-	-	12.94
Alternative scenario	10.61	1.47	0.15	12.23
Budget impact				0.71
New normal				
Baseline scenario	12.54	-	-	12.54
Alternative scenario	11.35	0.52	0.06	11.93
Budget impact				0.61

Abbreviations: UC, usual care; PAH, telehealth along with pharmacy at home; DC, telehealth along with deferred care; USD, United States dollar.

Table 4 Sensitivity Analysis

Scenario	Ranges of annual cost (million USD)			
	UC	PAH	DC	Total
1.Vary conditional cost				
COVID-19				
Baseline scenario	11.83–14.02	-	-	11.83–14.02
Alternative scenario	9.71–11.51	1.26–1.70	0.13–0.17	11.10–13.38
Budget impact				0.64–0.73
New normal				
Baseline scenario	11.71–13.46	-	-	11.71–13.46
Alternative scenario	10.59–12.18	0.43–0.61	0.05–0.07	11.07–12.86
Budget impact				0.60–0.64
2. Vary target population				
COVID-19				
Baseline scenario	10.34–15.51	-	-	10.34–15.51
Alternative scenario	8.49–12.74	1.18–1.77	0.12–0.18	9.79–14.69
Budget impact				0.55–0.82
New normal				
Baseline scenario	10.03–15.05	-	-	10.03–15.05
Alternative scenario	9.08–13.61	0.41–0.62	0.05–0.07	9.54–14.30
Budget impact				0.49–0.75

Abbreviations: UC, usual care; PAH, telehealth along with pharmacy at home; DC, telehealth along with deferred care; USD, United States dollar.

Table 5 Cost Saving

Cost allocation	Cost saving
COVID-19	
12.23 million USD	0.71 million USD
1 USD	0.06 USD
New normal	
11.93 million USD	0.61 million USD
1 USD	0.05 USD

estimates compared to the baseline scenario across both study periods, with savings ranging from 0.64 to 0.73 million USD during the COVID-19 period and 0.60 to 0.64 million USD during the new normal period. A similar trend was observed under the population variation, with savings ranging from 0.55 to 0.82 million USD in the COVID-19 period and 0.49 to 0.75 million USD in the new normal period. These findings support the robustness and reliability of the budget impact results under plausible fluctuations in key parameters.

Cost Saving

The findings from this study indicate that the total budget of the alternative scenario was lower than that of the baseline scenario. In addition, the analysis demonstrated the cost savings of the alternative care pathways. In both periods, the implementation of the alternative care pathways yielded cost savings of 0.06 and 0.05 USD per every 1 USD allocated, respectively, in the COVID-19 and new normal periods (Table 5).

Discussion

A study in Thailand highlighted that the main reasons for disruptions in NCD services were insufficient staff and the closure of certain services provided by healthcare facilities. The study also recommended that, during a public health crisis, affordable and widely available digital technologies should be used to ensure that patients have continuous access to care. Additionally, alternative services, such as mobile medical laboratories, medication delivery, and medical refills at drug stores, could have enhanced the consistent monitoring of laboratory results and the use of prescribed medications.[16] In this study, the PAH and DC were forms of remote healthcare delivery. These care pathways operated under the same criteria, including stable symptoms, physician approval, and patient consent. Additionally, for the DC, patients had to have an adequate supply of medication at home. Liquid, injectable, refrigerable, or chemotherapy drugs were not permitted in PAH. Access to these services required not only the fulfillment of clinical criteria but also a shared decision-making process between healthcare professionals and patients. The medical histories of the enrolled patients were sent to physicians. Laboratory tests were required for patients and could be obtained at the most convenient healthcare unit. The DC program ended when appointments were postponed. Medication delivery began after the medication history and laboratory tests had been reviewed by the doctor. Pharmacists contacted the patients by phone to provide counseling. Medications were delivered via a postal service.[6]

The total budget of the PAH and DC pathways at tertiary care hospitals in Thailand during the COVID-19 period was 1.47 and 0.15 million dollars per year, respectively. In the new normal period, the total budget of the PAH and DC pathways decreased to 0.52 and 0.06 million dollars per year, respectively. Based on the analysis, the alternative scenario was more cost saving than the baseline scenario. Among the care pathways in the alternative scenario, the DC pathway provided the highest savings. The cost savings of the DC pathway might be because there was no further medication cost as the patient already had medication at home. Consequently, no additional costs were incurred from pharmacy operations. A previous study provided evidence that telehealth intervention was beneficial in reducing healthcare service costs and patients' out-of-pocket expenses.[17] Additionally, a systematic review of cost-effectiveness analyses concluded that telehealth was considered a cost-effective service.[18] Similarly, the study on the pharmacy at home service using postal delivery also showed it to be cost-effective.[19] This program has been widely implemented in the US, with up to

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one-third of medications for chronic illnesses being delivered by the postal service.[35] However, the dispensing system in the US differs from that in Thailand. In the US, medication delivery by the postal service typically began only after a physician had issued a prescription, and patients were responsible for contacting a pharmacy store to deliver their medications. In Thailand, medication delivery by the postal service was the responsibility of the hospital pharmacy department. In Thailand, a study on the delivery of psychiatric medications by postal service also demonstrated effectiveness and cost savings. However, the methodology and population used in these studies differed from those used in this study. Patients were required to visit a physician at the hospital. However, they did not need to wait for medication at the pharmacy department. This approach could help reduce the waiting time for drug dispensing.[19] During the COVID-19 period, the PAH and DC were implemented in Thailand to reduce patient visits to healthcare facilities. These programs represented two integrated approaches: one combining telehealth with a pharmacy at home service by postal delivery, and the other involving deferred follow-up care. This contrasts with previous studies that examined these interventions in isolation. Moreover, the population in this study consisted only of patients with HT or DM, which differed from psychiatric patients and might have led to outcomes that differed from those reported in previous studies.

This study demonstrates the cost implications in terms of the budget impact. Understanding these costs is essential for resource management. PAH and DC, which are newly developed care pathways, emerged during the COVID-19 period. In crisis situations, the use of both PAH and DC is crucial for preventing the spread of COVID-19, sustaining healthcare services, and alleviating the burden of limited resources. However, these care pathways have also been implemented in normal situations, enabling healthcare professionals to address other important issues. Therefore, it is essential to emphasize the importance of careful budget allocation planning. The budget allocated for PAH and DC during the COVID-19 period was twice as high as that in the new normal period. Additionally, every 1 USD allocated to PAH and DC reduced healthcare expenditures from the government perspective during the COVID-19 and the new normal periods by approximately 0.06 and 0.05 USD, respectively. Therefore, in the new normal period, the implementation of PAH and DC is beneficial as they can effectively reduce the government's financial burden. Although the PAH and DC pathways reduced healthcare costs, the previous study in Thailand identified several implementation challenges related to remote healthcare delivery. One key issue was the limited digital literacy among older adults, which continues to prevent many patients from independently using these care models. Consequently, family or community caregivers are often required to assist with technology use. Additionally, technological infrastructure varies by healthcare facility level. Tertiary care hospitals are generally better equipped to adopt telehealth systems, whereas primary and secondary care hospitals face challenges due to limited service areas and poor internet accessibility. Furthermore, health information systems remain fragmented, making it difficult to share patient data across hospitals. This hinders the continuity of care, particularly for patients with chronic conditions.[16]

This study had several limitations. The long-term clinical impact was not assessed, which limited the ability to calculate cost consequences. This limitation might have led to an underestimation of the budget impact and an overestimation of cost savings. Reassessing and incorporating the cost consequences would provide more accurate data. Additionally, several variables were used in the cost calculation based on reference values. The findings were derived from extrapolation-based results and should be used with caution. Several key parameters including the adoption rates of PAH/DC, unit costs applied, patient numbers, retrospective design, bundled intervention, and savings ratio, may vary under real world conditions.

Future studies are recommended to further strengthen the evidence base regarding the effectiveness and economic value of alternative care pathways. A longitudinal study with a minimum follow-up period of 2–3 years should be conducted to evaluate long-term clinical outcomes and assess the sustainability of cost savings. In addition, a comprehensive cost-effectiveness analysis is warranted to determine the economic value of each care pathway. Comparative analyses of patient adherence and treatment outcomes across different care pathways would also help identify factors contributing to optimal disease management. Furthermore, future research should assess patients' digital health literacy and explore its impact on the effectiveness and accessibility of remote healthcare delivery. Importantly, future studies should adopt broader perspectives such as societal and patient viewpoints to provide a more holistic understanding that can better inform health policy. Finally, the scalability of the PAH and DC pathways should be evaluated across various healthcare settings, including primary and secondary care to inform broader policy implementation.

Conclusion

This budget impact analysis demonstrates that PAH and DC pathways for stable HT and DM patients in Thai tertiary care hospitals result in significant cost savings from the government perspective. During both the COVID-19 and the new normal period, the alternative scenario required lower total budgets compared to the baseline scenario, generating savings of 0.71 and 0.61 million USD, respectively. For every 1 USD allocated to these alternative care pathways, the health system saved 0.06 USD during COVID-19 and 0.05 USD during the new normal period. These findings suggest that PAH and DC pathways are economically advantageous and can help alleviate the financial burden on government healthcare expenditures while maintaining quality care for chronic disease patients. However, the results should be interpreted cautiously given the extrapolation-based methodology, reliance on reference values and varying real-world parameters. Future research should examine perspectives beyond government costs, including societal and patient viewpoints to provide a more comprehensive economic evaluation. Additionally, longitudinal studies are needed to assess long-term clinical outcomes, cost-effectiveness, and the feasibility of implementing these care pathways across various levels of the healthcare system.

Abbreviations

PAH, telehealth along with pharmacy at home; DC, telehealth along with deferred care; UC, usual care; HT, hypertension; DM, diabetes mellitus; CEA, cost-effectiveness analysis; ICER, the incremental cost-effectiveness ratio; BIA, budget impact analysis; COI, cost of illness; NCDs, non-communicable diseases; USD, United States dollar; CI, confidence interval; TCMC, the Thai Case Mix Centre.

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Disclosure

The author(s) report no conflicts of interest in this work.

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