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ORIGINAL RESEARCH

Impact of the Home-Based Medical Integrated Program on Health Outcomes and Medical Resource Utilization in Home Healthcare Patients in Taiwan

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Purpose: The home-based medical integrated program (HMIP) is a novel model for home healthcare (HHC) in Taiwan, initiated in 2016 to enhance care quality. However, the outcomes of this program on health outcomes and medical resource utilization in HHC patients remain unclear. Thus, we conducted this study to clarify it.

Patients and Methods: The authors utilized the Taiwan National Health Insurance Research Database to identify HHC patients who received HMIP and those who did not between January 2015 and December 2017. A retrospective cohort study design was used. Convenience sampling was employed to select patients who met the inclusion criteria: being part of the HHC program and having complete data for analysis.

Results: A total of 4982 HHC patients in the HMIP group and 10,447 patients in the non-HMIP group were identified for this study. The mean age in the HMIP group and non-HMIP group was 77.6 years and 76.1 years, respectively. Compared with the non-HMIP group, the HMIP group had lower total medical costs for HHC, fewer outpatient department visits and lower medical costs, lower medical costs for emergency department visits, fewer hospitalizations, and a lower mortality rate (34.6% vs 41.2%, $p<0.001$).

Conclusion: The HMIP is a promising model for improving care quality and reducing medical resource utilization in HHC patients. While this suggests that the non-HMIP model should be replaced, it's important to note that both non-HMIP and HMIP models currently coexist. The HMIP may serve as an important reference for other nations seeking to improve care quality and reduce medical resource utilization in their own HHC systems.

Keywords: home-based medical integrated plan, health outcomes, medical resource utilization, Taiwan

Introduction

The global demographic shift towards an aging population poses significant challenges for all countries, including low- and middle-income countries, due to the accelerating pace of population aging and the projected doubling of the proportion of the world's population over 60 years by 2050.[1] In Taiwan, the percentage of older adults in the population exceeded 14% in 2018, has risen to 16.2% in 2021, and is projected to reach 20% by 2025.[2] This aging population is also

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accompanied by a declining total fertility rate from 5.75 in 1960 to 0.87 in 2022, which increases the burden of care on families for older adults with chronic and complex conditions.[3] This care burden may lead to decreased care quality, reduced national productivity, increased social problems, and higher costs for medical resources, ultimately straining national health insurance and security.[4]

Home healthcare (HHC) offers continuous and convenient care for disabled patients in Taiwan, where HHC services have been reimbursed by the National Health Insurance (NHI) program since 1995.[5] The main services include nursing visits (one visit every two weeks) and physician visits (one visit every two months), with physicians only allowed to perform assessments but not prescribe or treat patients.[5] The main functions of this HHC model include changing nasogastric tubes, urinary catheters, and tracheostomy tubes, as well as providing care for chronic wounds.[5] However, many disabled patients and their families face challenges in going to hospitals for medications and treatments.[5] Therefore, in 2016, Taiwan NHI upgraded the HHC model to the Home-based Medical Integrated Plan (HMIP)[6] (Figure 1). This change aims to encourage physicians to provide care outside of hospitals, expand options for seeking medical assistance, and promote changes in patients' health-seeking behavior.[6,7] The HMIP is initiated by two major sources: hospital discharge planning and community referral.[6,8] The healthcare provider evaluates the patient who fits the HMIP criteria and decides on enrollment after shared decision-making with the patient and families.[6,8] Because polypharmacy and potential inappropriate medication are major problems in Taiwan, agreement on medication reconciliation by a physician is an absolute criterion for entering HMIP.[6,8] The physician visits the patient at least once every three months.[8] The HMIP model focuses on integrating health literacy, rehabilitation, home-based medical care, home-based nursing, community palliative care, and end-of-life care, while building community resource networks and

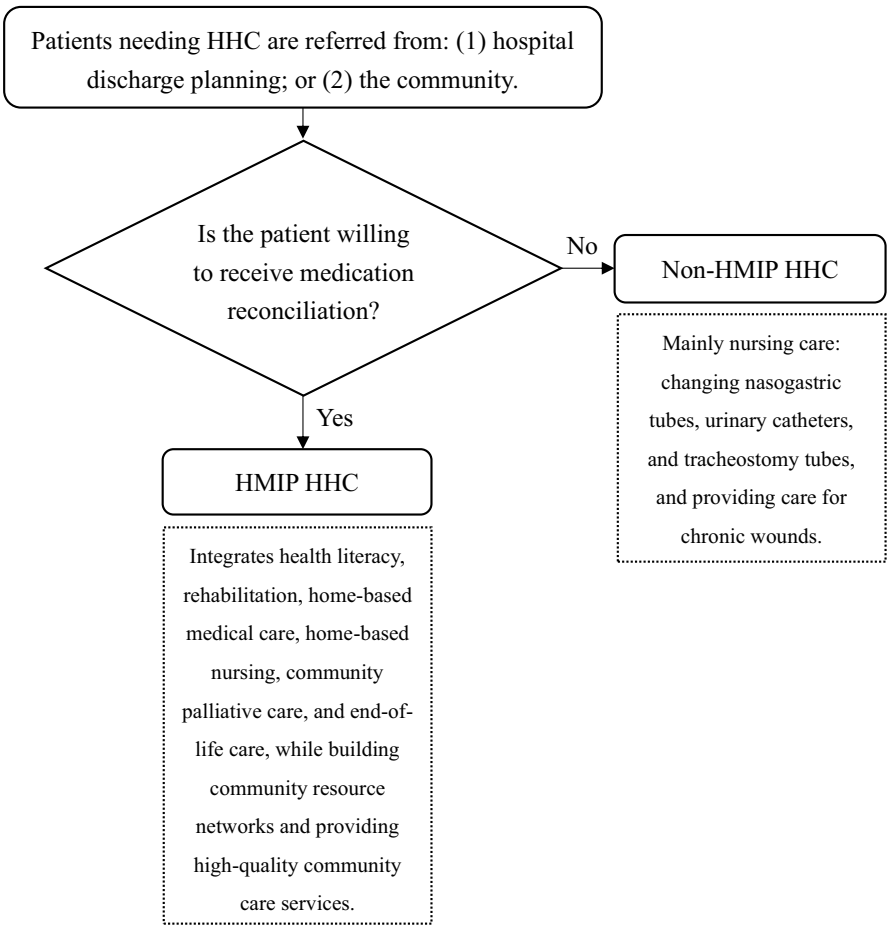

Figure 1 Flowchart of the difference between HMIP HHC and non-HMIP HHC in Taiwan.
Abbreviations: HMIP, Home-based Medical Integration Program; HHC, home healthcare.

providing high-quality community care services, which is different from the previous non-HMIP model.[8] We used the keywords "home-based medical integrated program", "home healthcare", "care quality", "health care interventions", and "Taiwan" in PubMed and Google Scholar; however, there were no studies about the impact of the HMIP program on patients' health outcomes and medical resource utilization. Therefore, we conducted this study to clarify this issue.

Materials and Methods

Data Source

Due to the requirement of long-term follow-up data, we have opted to utilize the Taiwan National Health Insurance Research Database (NHIRD) for this study. The NHIRD, known for its comprehensive coverage of nearly 100% of the population in Taiwan[9], is a reputable and sizable source of biomedical research material. Over the years, it has been extensively employed in numerous biomedical research studies, with a substantial number of 4473 articles published in PubMed between 1996 and 2017 based on this database.[10] These publications have provided valuable references for clinical care, underscoring the reliability and utility of the NHIRD.

Study Design, Setting, and Participants

We identified patients who participated in HHC from the NHIRD between January 2015 and December 2017 (Figure 2). Since the HMIP began in 2016, we identified all patients with HMIP from the Taiwan NHIRD between January 1, 2017 and December 31, 2017 as the HMIP group. The HMIP program consists of three service stages.[11] The first stage is home-based primary care, where physicians conduct home visits.[11] Eligible patients for home-based primary care services should be living at home, have clear healthcare needs, and face difficulties accessing healthcare due to disability or disease, including dementia.[11] The second stage is known as home-based primary care plus, aims to provide additional skilled nursing care to homebound patients.[7,11] Nurse visits are added to physician visits in this stage.[7,11] The third stage is home-based palliative care, which aims to provide end-of-life care for patients diagnosed with serious illnesses.[11] Since the first stage does not include nurse visits and the third stage is focused on end-of-life care, we included data from the second stage of HMIP for the study group, whose population was like the HHC patients prior to implementing HMIP.

The non-HMIP group consisted of all HHC patients between January 1, 2015 and December 31, 2015. For our analysis, we included variables such as age, sex, and primary diagnosis. We excluded patients without outcome, those who resided in nursing homes, or those who participated in hospice home care. We identified the following common primary diagnoses in the HHC, including dementia (International Classification of Diseases, 9th Revision, Clinical

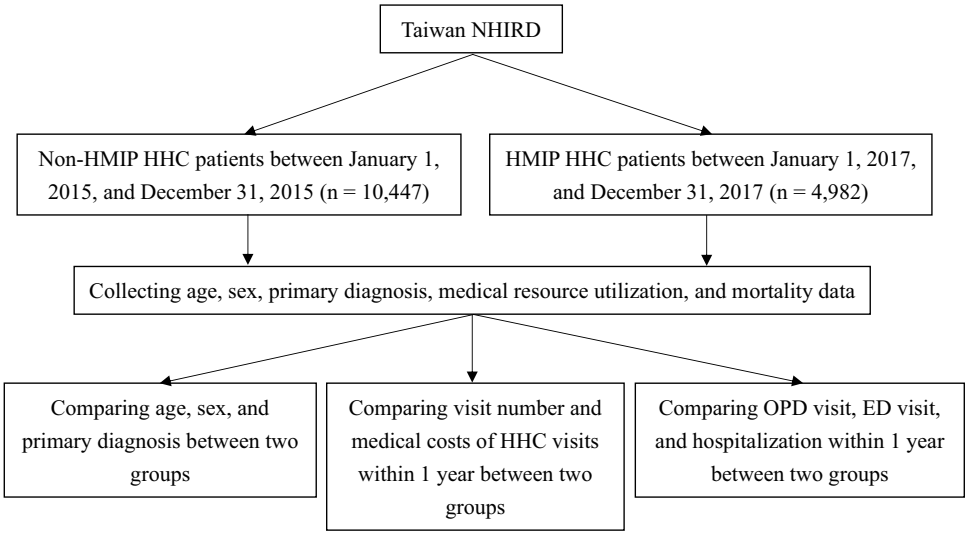

Figure 2 Flowchart of this study.
Abbreviations: NHIRD, National Health Insurance Research Database; HMIP, Home-based Medical Integration Program; HHC, home healthcare; OPD, outpatient department; ED, emergency department.

Modification [ICD-9-CM] codes 290.0, 290.1, 290.2, 290.3, 290.8, 290.9, 294.8, 294.9, 310.1), cerebrovascular disease (ICD-9-CM codes 438), hypertension (ICD-9-CM codes 401.0, 401.1, 401.9), type 2 diabetes (ICD-9-CM code 250.1, 250.9, 357.2, 362.0, 366.4, 583.8), ischemic stroke (ICD-9-CM code 433, 434), other cerebrovascular disease (ICD-9-CM code 046.3, 348.3, 435.9, 436, 437), parkinsonism (ICD-9-CM code 332.0), hypertensive heart disease (ICD-9-CM code 402.0, 402.1, 402.9), and non-traumatic intracerebral hemorrhage (ICD-9-CM code 431). The primary diagnosis was considered positive if it was documented in at least one hospitalization or in at least three ambulatory care visits.

Outcome Measurements

We conducted a follow-up of the two groups to compare the following outcomes within a 1-year period: HHC visit number and associated medical costs, outpatient department (OPD) visit number and medical costs, emergency department (ED) visit number and medical costs, hospitalization number and medical costs, and mortality. As our objective was to investigate the impact of HHC, higher numbers of OPD visits, ED visits, and hospitalizations were considered as poor outcomes.

Ethical Statements

The study was conducted in accordance with the ethical principles of the Helsinki Declaration and was approved by number 11009-E02 from the Institutional Review Board of Chi Mei Medical Center on September 3, 2021. Informed consent was waived due to the anonymous nature of the data, with subjects being unidentifiable prior to analysis, and in accordance with applicable regulations. Because this was a retrospective study using de-identified data, there was no provision for patient withdrawal or continuation.

Statistics

Based on the distributional characteristics of the continuous variables, we performed appropriate statistical tests to compare the differences between the two groups. For normally distributed continuous variables, we utilized Student's *t*-test, while for non-normally distributed continuous variables, we used the Wilcoxon rank-sum test to test for differences in distribution between the non-HMIP and HMIP groups. Furthermore, we employed Pearson's chi-square test to assess differences in distribution for categorical variables such as sex, age, and primary diagnoses between the two groups. All statistical analyses were conducted using SAS 9.4 for Windows (SAS Institute, Cary, NC, USA). A significance level of p-value less than 0.05 (two-tailed) was considered statistically significant.

Results

A total of 4982 patients with HMIP and 10,447 patients without HMIP were included in this study (Table 1 and Supplementary Figure 1). The mean age ± standard deviation of the HMIP group was higher than that of the non-HMIP group (77.6 ± 11.4 vs 76.1 ± 13.4 years, p<0.001). Female patients were predominant in both groups. Most patients in both groups were aged ≥65 years (86.2%−89.0%). Compared to the non-HMIP group, the HMIP group had higher rates of primary diagnoses of dementia (22.4% vs 19.2%, p<0.001), hypertension (30.8% vs 23.5%, p<0.001), type 2 diabetes (26.3% vs 12.7%, p<0.001), ischemic stroke (13.7% vs 9.1%, p<0.001), other cerebrovascular disease (6.6% vs 4.6%, p<0.001), Parkinsonism (6.1% vs 4.4%, p<0.001), and hypertensive heart disease (6.5% vs 3.1%, p<0.001).

In comparison to the non-HMIP group, the HMIP group had a higher number of total HHC visits (8.4 ± 5.3 vs 7.1 ± 4.6, p<0.001), which included nurse visits (7.4 ± 4.5 vs 7.0 ± 4.6, p<0.001) and physician visits (3.5 ± 2.6 vs 2.4 ± 1.7, p<0.001) (Table 2). However, the total medical cost of HHC was lower in the HMIP group compared to the non-HMIP group (27,644.1 ± 39,238.8 New Taiwan Dollars [NTD] vs 53,241.0 ± 131,260.4 NTD, p<0.001).

In comparison to the non-HMIP group, the HMIP group had a lower number of OPD visits (17.8 ± 15.8 vs 19.3 ± 16.8, p<0.001) and a lower total medical cost of OPD visits (51,222.7 ± 90,851.9 NTD vs 57,162.0 ± 227,307.1 NTD) (Table 3). The ED visit number was not significantly different between the two groups. However, the HMIP group had a lower total medical cost of ED visits than the non-HMIP group (14,879.9 ± 16,894.0 NTD vs 16,138.8 ± 18,956.2, p<0.001). The hospitalization rate was lower in the HMIP group compared to the non-HMIP group (2.2 ± 1.9 vs 2.4 ±

Table 1 Comparing Age, Sex, and Primary Diagnosis Between Non-HMIP and HMIP HHC Patients

Variable	Non-HMIP (n = 10,447)	HMIP (n = 4982)	*p*-value*
Age			
Mean ± standard deviation	76.1 ± 13.4	77.6 ± 11.4	<0.001
<65, n (%)	1442 (13.8)	544 (10.9)	<0.001
≥65, n (%)	9005 (86.2)	4438 (89.0)	
Sex, n (%)			
Male	5045 (48.2)	2327 (46.7)	0.066
Female	5402 (51.7)	2655 (53.2)	
Primary diagnosis, n (%)			
Dementia	2011 (19.2)	1120 (22.4)	<0.001
Cerebrovascular disease	2421 (23.1)	863 (17.3)	<0.001
Hypertension	2456 (23.5)	1535 (30.8)	<0.001
Type 2 diabetes	1329 (12.7)	1312 (26.3)	<0.001
Ischemic stroke	957 (9.1)	684 (13.7)	<0.001
Other cerebrovascular disease	485 (4.6)	331 (6.6)	<0.001
Parkinsonism	465 (4.4)	306 (6.1)	<0.001
Hypertensive heart disease	332 (3.1)	325 (6.5)	<0.001
Non-traumatic ICH	383 (3.6)	207 (4.1)	0.139

Notes: *Pearson's chi-square test for categorical variables, and Student's *t*-test and Wilcoxon test for continuous variables were employed for data analysis.
Abbreviations: HMIP, Home-based Medical Integration Program; HHC, home healthcare; ICH, intracranial hemorrhage.

Table 2 Comparing Visit Number and Medical Costs of HHC Visits Within 1 Year Between Non-HMIP and HMIP HHC Patients

Variable	Non-HMIP (n = 10,447)	HMIP (n = 4982)	*p*-value
Total visit number	7.1 ± 4.6	8.4 ± 5.3	<0.001
Number of nurse visit	7.0 ± 4.6	7.4 ± 4.5	<0.001
Number of physician visit	2.4 ± 1.7	3.5 ± 2.6	<0.001
Total medical cost (NTD)	53,241.0 ± 131,260.4	27,644.1 ± 39,238.8	<0.001
Average of medical cost per visit (NTD)	6005.8 ± 11,046.6	3184.9 ± 2734.1	<0.001

Notes: Data were presented as mean ± standard deviation. *Pearson's chi-square test for categorical variables, and Student's *t*-test and Wilcoxon test for continuous variables were employed for data analysis.
Abbreviations: HMIP, Home-based Medical Integration Program; HHC, home healthcare.

Table 3 Comparing OPD Visit, ED Visit, and Hospitalization Within 1 Year Between Non-HMIP and HMIP HHC Patients

Variable	Non-HMIP (n = 10,447)	HMIP (n = 4982)	*p*-value*
OPD			
Visit number	19.3 ± 16.8	17.8 ± 15.8	<0.001
Total medical cost	57,162.0 ± 227,307.1	51,222.7 ± 90,851.9	0.023
Average of medical cost per visit	2866.3 ± 5406.1	2742.6 ± 3625.8	0.099
ED			
Visit number	2.8 ± 2.8	2.8 ± 2.6	0.712
Total medical cost	16,138.8 ± 18,956.2	14,879.9 ± 16,894.0	<0.001
Average of medical cost per visit	6106.6 ± 5420.5	5844.0 ± 5466.8	0.021

(*Continued*)

Table 3 (Continued).

Variable	Non-HMIP (n = 10,447)	HMIP (n = 4982)	*p*-value*
Hospitalization			
Number	2.4 ± 1.8	2.2 ± 1.9	0.003
Total medical cost	16,234.2 ± 18,402.6	24,437.85± 514,789.1	0.371
Average of medical cost per hospitalization	6997.0 ± 5506.3	7137.12± 11,188.7	0.504
Mortality	4309 (41.2)	1724 (34.6)	<0.001

Notes: Data were presented as mean ± standard deviation or n (%). *Pearson's chi-square test for categorical variables, and Student's *t*-test and Wilcoxon test for continuous variables were employed for data analysis.
Abbreviations: OPD, outpatient department; ED, emergency department; HMIP, Home-based Medical Integration Program; HHC, home healthcare.

1.8, p=0.003), with no significant difference in the total medical cost of hospitalization between the two groups. Following a one-year follow-up period, the group receiving the HMIP intervention exhibited a lower mortality rate compared to the non-HMIP group (34.6% vs 41.2%, p<0.001).

Discussion

This study demonstrated that the HMIP group was older and had a higher prevalence of chronic diseases compared to the non-HMIP group. However, the total medical cost of HHC, the number of OPD visits and associated medical costs, the medical cost of ED visits, hospitalization rate, and mortality were significantly lower in the HMIP group.

One possible explanation for these findings is that the HMIP provides physician-led treatment and care integration from hospital to community, which may be lacking in the non-HMIP group.[6] In the previous HHC model (ie, non-HMIP group), home visits by physicians were limited to medical assessments only.[6] This limitation not only failed to provide practical assistance to the public, but also posed challenges for patients with mobility issues or difficulties in visiting hospitals.[6] On the other hand, the HMIP model enables physicians to step out of their "ivory tower" and offers the public more options to seek medical assistance, potentially leading to changes in patients' health-seeking behavior.[6] The home-based concept that underlies the medical service system is deeply rooted in the community and establishes an integrated model of community medical care.[6] Timely job handover confirmation with the connecting team and providing patients with continuous-care services prior to discharge through the discharge-planning service and the connection with the connecting team are critical issues in ensuring seamless care.[6]

The HMIP is a kind of home-based medical care, which has become a crucial service model in developed countries to improve accessibility to health care and provide person-centered care for these homebound patients.[11–13] Home-based medical care is known to reduce hospitalizations and ED visits, improve quality of life, and decrease the cost of health care.[11,14,15] In Taiwan, the HMIP services covered by NHI reimbursement include medication prescriptions, procedures, and laboratory tests across all three stages.[11] There is no fixed upper limit on the frequency of visits, which is determined based on the clinical condition of each patient, but physicians are required to conduct home visits at least once every 2 months for each patient.[11] Home care physicians are allowed to conduct visits for up to eight different patients per day, with a maximum of 180 home visits per month.[11] Patients receiving HMIP services are required to copay 5% of the actual cost of each visit unless they qualify for exemption.[11] Transportation costs for healthcare workers traveling to patients' homes are also incurred.[11] Additionally, full-time telephone consultations are available for patients and their caregivers included in the program, providing continuous care and strong support, which could potentially explain the better outcomes observed in this study.[11]

In our research, we utilize the expenses covered by the Taiwan NHI as a means of indicating the medical expenses incurred by the patient. The Taiwan NHI is a healthcare insurance program offers comprehensive coverage to nearly 100% of Taiwan's population.[16] It provides affordable access to healthcare services with small co-payments required by most clinics and hospitals.[9,17] The program includes copayments for outpatient visits and hospital services, as well as coinsurance for inpatient care.[16] Due to its wide coverage, the Taiwan NHI is commonly used to represent medical costs in previous studies.[18–20] In this study, we also utilize it to represent medical expenses, but it is important to note that the direct medical expenses paid by the Taiwan NHI were the only costs considered. Other associated costs, such as indirect and opportunity costs to patients, including

employment fees for caregivers and out-of-pocket expenses for medications, nutrition, and medical equipment, were not factored in. Further research that includes all associated costs would be necessary to evaluate the results more accurately.

There are two reasons that the non-HMIP and HMIP programs coexist in HHC in Taiwan. First, there was no scientific evidence to support which program was better before. This study provides solid evidence that HMIP is more beneficial than non-HMIP, which could help our government promote HMIP further. Second, some patients refuse to enter HMIP because it requires medication reconciliation. In Taiwan, some patients are still accustomed to visiting many specialists for multiple medications.[21,22]

The main strength of this study is its utilization of nationwide claims data to examine various medical resources, including visit numbers and costs of HHC, OPD, and ED, hospitalization rates, and mortality. This data could help the Taiwanese government promote HMIP further. However, there are several limitations to consider. Firstly, the HMIP group only included stage 2 patients to match the background of the non-HMIP group, which may not fully capture the overall picture of HMIP. Secondly, the study did not analyze the clinical service content of HMIP, such as medication reconciliation or continuity of care, which could provide insights into the root causes of the observed better outcomes. Third, patient- or caregiver-reported outcomes, which are important for evaluating the effectiveness of these services, were not available in the database used for this study. Fourth, sociodemographic data that may affect the outcomes was unavailable in this study. Therefore, further research is warranted, including studies that encompass stage 1 and stage 3 HMIP patients, incorporate analysis of clinical service content, and include patient- or caregiver-reported outcomes and sociodemographic data.

Conclusion

This study revealed that despite the HMIP group being older and having a higher prevalence of chronic diseases compared to the non-HMIP group, the total medical cost of HHC, the number of OPD visits and associated medical costs, the medical cost of ED visits, hospitalization rate, and mortality were significantly lower in the HMIP group. One possible explanation for these findings is that HMIP offers physician-led treatment and care integration from hospital to community, which may be lacking in the non-HMIP group. Based on the findings of this study, it is recommended to replace the non-HMIP group with HMIP for HHC in Taiwan. This model could also serve as a valuable reference for other nations. However, further research is needed, including studies that encompass stage 1 and stage 3 HMIP patients, incorporate analysis of clinical service content, and include patient- or caregiver-reported outcomes.

Abbreviations

HHC, home healthcare; NHI, National Health Insurance; HMIP, home-based medical integrated program; NHIRD, National Health Insurance Research Database; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; OPD, outpatient department; ED, emergency department; NTD, New Taiwan Dollars.

Data Sharing Statement

The data used in this study were obtained from the Taiwan NHIRD, which is managed by the National Health Insurance Administration of Taiwan. However, due to data access restrictions and privacy concerns, the NHIRD is not available for request by external parties. Researchers interested in accessing similar data for their own studies are encouraged to contact the National Health Insurance Administration directly for information on data availability and access procedures.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

All authors report no competing interests in this work.

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