Effectiveness of an Integrated Ambulatory Care Program in Health Care and Medication Use in Patients With Multimorbidity and Polypharmacy

Yu-Tai Lo, MD, MS; Mei-Hua Chen, MS; Pin-Hao Chen, MSCP; Feng-Hwa Lu, MD, MS; Chia-Ming Chang, MD; Yi-Ching Yang, MD, MPH

Background and Objectives: Multimorbidity increases risks, such as polypharmacy, inappropriate prescription, and functional decline. It also increases medical care utilization by older adults, placing a burden on health care systems. This study evaluated the effectiveness of an integrated ambulatory care program for health care and medication use in patients with multimorbidity and polypharmacy. **Methods:** We conducted a retrospective clinical review of adults with multimorbidity and polypharmacy who attended an integrated ambulatory care program at a 1193-bed university hospital between July 1 and September 30, 2019. This program involves multidisciplinary teamwork, comprehensive assessments, medication reviews, and case management. Outcomes, including the frequency of outpatient visits, emergency department visits, hospitalizations, chronic prescription medications, potentially inappropriate medications (PIMs), health care costs, and total medical expenditure, were compared before and after the program. **Results:** The mean age of participants (n = 134) at baseline was 74.22 ± 9.75 years. The mean number of chronic diagnoses was 9.45 ± 3.38. Participants included 72 (53.7%) women. At the 1-year follow-up, participants showed a significant decrease in the annual frequency of outpatient visits (19.78 ± 9.98 to 13.90 ± 10.22, $P < .001$), emergency department visits (1.04 ± 1.70 to 0.73 ± 1.40, $P = .029$), and chronic disease medications (10.71 ± 3.96 to 9.57 ± 3.67, $P < .001$) across all age groups. There was also a reduction in the annual number of PIMs (from 1.31 ± 1.01 to 1.12 ± 0.93, $P = .002$) among patients aged 65 years. However, no effects were observed on annual hospitalization, duration of hospital stay, or total health care expenditure, possibly due to the high disease-related treatment cost for certain participants. **Conclusions:** Expanding integrated ambulatory care programs in Taiwan may help patients with multimorbidity reduce their use of outpatient and emergency services, chronic prescriptions, and PIMs.

Key words: health care utilization, integrated care, medication reconciliation, multimorbidity, polypharmacy, potentially inappropriate prescriptions

Multimorbidity, defined as the presence of 2 or more chronic diseases in the same individual, is associated with advanced age and frailty, and its prevalence is expected to increase as the population ages.[1,2] Multimorbidity has profound implications for individuals, health care systems, and economies in rapidly aging societies.[3,4] The treatment of multimorbidity exhausts most health care resources, but yields relatively disappointing health outcomes.[5-7] Modern medical science and evidence-based clinical guidelines tend to focus on single conditions, causing multimorbidity care to be duplicative, disjointed, and even harmful.[8,9] Consequently, older adults with

Author Affiliations: *Departments of Geriatrics and Gerontology (Drs Lo, Lu, Chang, and Yang and Ms M.-H. Chen) and Pharmacy (Mr P.-H. Chen), National Cheng Kung University Hospital, College of Medicine, National Cheng Kung University, Tainan, Taiwan; Department of Family Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan (Drs Lu and Yang); and Department of Medicine & Institute of Gerontology, College of Medicine, National Cheng Kung University, Tainan, Taiwan (Dr Chang).*

Correspondence: *Yi-Ching Yang, MD, MPH, Department of Family Medicine, College of Medicine, National Cheng Kung University, Tainan, Taiwan; Department of Geriatrics and Gerontology, National Cheng Kung University Hospital, Tainan, Taiwan, No. 138, Sheng Li Rd, Tainan City 70403, Taiwan (yiching@mail.ncku.edu.tw).*

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The data and resources were shared with other eligible researchers through established academic channels. The datasets used in this study were obtained from the corresponding authors upon request.

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multimorbidity experience fragmented care, functional decline, increased health care utilization, more prescriptions with adverse events, worse quality of life, and higher mortality.[10,11] To address increasing multimorbidity in the older population, the National Institute for Health and Care Excellence in the United Kingdom and the American Geriatrics Society have developed guidelines, emphasizing that the most important aspect of multimorbidity management is the promotion of coordinated, safe, and high-quality care.[12,13]

Polypharmacy, or the use of multiple medications, is another consequence of multimorbidity.[14] Of older patients (>65 years) living in the community, 37% to 46.6% were found to be taking more than 5 medications.[15,16] The prevalence of polypharmacy is much higher within long-term care facilities: Jokanovic et al.[17] suggested that 91% of residential care patients were taking more than 5 medications, while up to 74% of them were taking more than 9 medications. Although polypharmacy can be appropriate, it places potentially greater treatment burdens on patients and affects their ability to adhere to medication regimens and maintain their quality of life.[18] Additionally, older patients, who are more likely than younger patients to have an increased number of chronic conditions, consume many medicines and are subject to high risks of adverse drug reactions and drug-drug interactions.[14,19,20] Older patients are also at higher risk of receiving a prescription for a medication that is individually associated with a greater risk of harm than benefit, otherwise known as a potentially inappropriate medication (PIM).[4,19,20] A European study found that 22.6% of older adults in the community are prescribed at least 1 medication that is considered inappropriate.[20] As reported by the World Health Organization, inappropriate polypharmacy has become a major public health concern,[21] leading to complications, such as functional decline, falls, and increased hospitalizations, which further burdens the health care system.[19,22]

Providing appropriate care for patients with multimorbidity and polypharmacy can be challenging, given that evidence-based guidelines often focus on single diseases. Recently, most interventions for addressing polypharmacy in older adults living with multimorbidity have been developed with the intention of reducing the number of PIMs (deprescribing) and optimizing appropriate medication prescription through the use of professionals (eg, pharmacists, physicians, or collaboration between pharmacists and physicians), program-based (eg, medication review clinics), decision aids, or computer support systems.[15,23] Although such interventions hold the potential for reducing the burden of medications, the benefits in terms of clinical outcomes, such as health care utilization among patients with multimorbidity and polypharmacy, remain unclear.[15,23-25] Several systematic reviews have investigated the effectiveness of polypharmacy interventions within various settings, including primary care, long-term care, and inpatient care, but drew mixed conclusions.[26-30] In their systematic review, Clarkson et al.[15] found that deprescribing interventions in outpatient clinics can be grouped into those that are physician-led and -implemented, those that are delivered by a multidisciplinary team, or those that are pharmacist-led and physician-implemented. Nevertheless, they also concluded that the evidence for interventions for polypharmacy is scarce in outpatient clinics and recommended that further research be conducted.

Multimorbidity-related polypharmacy and a high number of outpatient clinic visits remain major issues in Taiwan, where health care resources are often consumed without corresponding improvements in outcomes.[31,32] Compared with those of other countries, Taiwanese older adults make, on average, significantly more annual outpatient visits (28.54 visits).[32] Frequent and fragmented use of outpatient services results in polypharmacy and high PIM risk. In Taiwan, 81.1% and 38.1% of the aged population receive more than 5 and more than 10 medications for the treatment of chronic diseases, respectively.[33] Among outpatients, 19.1% of older adult patients had a PIM prescription; the percentage of PIM increased when more than 7 medications were prescribed.[34,35]

In 2019, the National Health Insurance (NHI) administration of Taiwan launched a patient-centered, integrated ambulatory care program to reduce unnecessary utilization of health care resources and negative health outcomes for patients with multimorbidity and polypharmacy.[36] The program encourages and supports hospitals to establish individual integrated ambulatory care services. To date, the impact of this program has not been thoroughly studied. Furthermore, previous interventions addressing polypharmacy in older adults with multimorbidity, in outpatient settings, mainly investigated outcomes such as the reduction of medication burden, while data on outcomes such as change in health care utilization and cost were limited.[15]

To address this gap, we sought to evaluate the impact of an integrated ambulatory care program on health care utilization, and on medication-related and cost-related outcomes among patients with multimorbidity and polypharmacy in a university hospital.

METHODS

Services in the integrated ambulatory care program in the study hospital

The integrated ambulatory care program in our hospital was developed and has been offered in the study hospital since July 1, 2019, for patients who met the following criteria: (1) more than 2 chronic conditions[37]; (2) polypharmacy with 7 medications for chronic disease management; and (3) had consulted more than 2 physicians for their chronic conditions. This hospital-based program involves multidisciplinary teamwork, comprehensive functional assessment, medication review, and case management. The multidisciplinary team that implemented the program consisted of 2 case managers, 38 physicians (20 family medicine doctors, 11 neurologists, 5 geriatricians, and 2 internal

medicine doctors) who were approved by the NHI administration to provide integrated care in an outpatient setting, and 7 pharmacists who were responsible for integrated care and comprehensive medication reviews. During the first treatment session, a case manager conducted a 20- to 30-minute comprehensive assessment, and a pharmacist personally reviewed the patient's medication regimen for 10 to 20 minutes. Information on each medication regimen was retrieved from the NHI MediCloud system of Taiwan, which allows medical professionals to access prescription records provided by various hospitals and clinics.[38] The case manager and pharmacist then cooperated to make recommendations to the patients and caregivers. The physician responsible for the patient's integrated care reconciled the medication regimens according to both the patient's preferences and the multidisciplinary team's recommendations. After the initial service session, patients were followed twice by case managers to ensure that there were no major adverse responses to the adjusted medication regimens that required further evaluations or interventions.

Study design and participants

This study was a preliminary program evaluation that used a case series design. The study was conducted at a 1193-bed university hospital in Taiwan. We enrolled program beneficiaries during the first 3 months after the start of the program (July 1 to September 30, 2019). To evaluate the effectiveness of the complete process of the integrated ambulatory care program and to compare health care and medication use for 1 year before and 1 year after the program, we excluded those who (1) refused further follow-up sessions, (2) were lost to follow-up after the first session, (3) died before completing the 3 sessions, (4) completed 3 sessions but died within the following year, and (5) received no further medical treatment within the following year.

Ethical approval

The study protocol was approved by the Institutional Review Board of the National Cheng Kung University Hospital (A-ER-109-311). Considering the retrospective nature of the study and the de-identification of the data, the institutional review board waived the requirement for obtaining written informed consent from the patients.

Baseline data collection

Baseline data on demographic characteristics, namely, age, sex, and educational status, were collected upon inclusion of the participants (first session). Furthermore, clinical characteristic data were collected, namely, Charlson Comorbidity Index (CCI) scores for comorbidity status,[39] chronic disease diagnoses, comprehensive assessment scores, number of medications, and number of PIMs according to the Beers Criteria for patients 65 years and older.[40] Chronic disease diagnoses included cerebral vascular disease, dementia, diabetes mellitus, mild liver disease, moderate-to-severe liver disease, congestive heart failure, moderate-to-severe renal disease, peptic ulcer disease, myocardial infarction, connective tissue disease, chronic lung disease, and malignancy.

The process of integrating care and deprescribing requires individualization. We considered that understanding every patient's baseline functional and frailty status would help the multidisciplinary team to plan personalized medication regimens. Therefore, we collected baseline data from the comprehensive assessment during the first treatment session, conducted by our case managers. The comprehensive assessment evaluated the activities of daily living, according to the Barthel Index[41]; cognitive function, according to the Short Portable Mental Status Questionnaire (SPMSQ)[42]; frailty, according to the Clinical Frailty Scale (CFS)[43]; mood, according to the 5-item Geriatric Depression Scale (GDS-5)[44]; and nutritional status, according to the Mini Nutritional Assessment–Short Form (MNA-SF).[45] A brief description of the tools used in the comprehensive assessment is shown in Supplemental Digital Content 1, available at: http://links.lww.com/QMH/A116.

A retrospective chart review was conducted to capture the baseline demographics, clinical data, and results of the comprehensive assessment of all participants.

Primary and secondary outcomes

In addition, to change the burden of medications, our study also aimed to explore the benefits of the program in terms of clinical outcomes, such as changes in health care utilization and cost. Therefore, the primary outcomes were changes in health care and medication use, including the number of outpatient clinic visits, emergency department (ED) visits, hospitalizations, chronic prescription medications, and PIMs at 1 year before and 1 year after the program. Secondary outcomes included changes in the annual outpatient care costs, hospitalizations, ED care, and total medical expenditures 1 year before and 1 year after the program.

Taiwan's NHI adopts a single-payer system and mainly uses fee-for-service payment for medical services, examinations, and medications.[46] In this study, we measured the reimbursed payment from the NHI, including general diagnoses and treatment, medical consultations and operations, and related expenses, such as examinations, laboratory tests, anesthesia, prescription medications, supplies, nursing care, hospital rooms, and certain over-the-counter drugs. We did not include out-of-pocket fees in this study.

Data on primary and secondary outcomes were obtained from hospital electronic medical records.

Statistical analysis

Continuous variables are presented as means with standard deviations, and categorical variables are expressed as counts with percentages. Comparisons of variables between different age groups were performed using the χ^2 test or Fisher's exact test for

categorical variables, and the 2-sample *t*-test or the Mann-Whitney *U* test for continuous variables. Comparisons of outcomes between 1 year before and 1 year after the integrated ambulatory program were performed using paired *t* tests. Statistical significance was defined as $P < .05$. All tests were 2-tailed. All statistical analyses were performed using Statistical Package for the Social Sciences software, version 22 (IBM, Armonk, New York).

RESULTS

Between July 1 and September 30, 2019, 159 patients were initially included in the integrated ambulatory care program. After excluding ineligible patients, 134 patients were included in the final analysis (Figure 1). At baseline, participants had a mean age of 74.22 ± 9.75 years (range, 49-94 years). Seventy-two (53.7%) were women, and 29 (21.6%) had no formal education. Participants had a mean CCI score of 3.91 ± 2.46 (range, 0-13) and a mean CFS score of 4.01 ± 1.34 (range, 3-7). The mean number of chronic disease diagnoses per patient was 9.45 ± 3.38, according to the 99 disease categories defined by the Taiwan Ministry of Health and Welfare. Seventy-three participants (54.48%) had 9 or more chronic disease diagnoses. The most common underlying chronic diseases were diabetes (58.21%), diabetes with end-organ damage (54.48%), moderate-to-severe kidney disease (50.75%), gastric ulcers (21.64%), and cerebrovascular disease (21.64%). Eighty-one participants had 10 or more chronic prescription medications (60.4%), and the mean number of chronic disease prescription medications was 10.71 ± 3.98 (range, 3-26). Among participants 65 years and older, 90 were treated with PIM (79.6%), and the mean number of PIMs was 1 ± 1.01 (range, 0-4). Table 1 shows the baseline demographic and clinical characteristics of study participants.

The results of the baseline comprehensive assessment differed significantly between the age groups (Table 2). Participants 85 years and older had lower Barthel index scores ($P < .001$), lower MNA-SF scores ($P = .007$), higher CFS scores ($P < .001$), and higher SPMSQ scores ($P = .007$) than did those younger than 85 years, indicating a greater dependence on daily activities and increased malnutrition, frailty, and cognitive impairment. However, participants 85 years and older had significantly lower PIM treatment rates than did participants aged 65 to 74 years and 75 to 84 years ($P = .012$) (Table 2).

Fifty-four participants underwent pharmacist consultation, and 40 received therapeutic interventions as part of the medication review service (Table 3). The most common topics addressed during counseling interventions were administration (31.5%), dietary considerations (31.5%), oral inhalation techniques (14.8%), and anticoagulation precautions (13%). The most common reasons for therapeutic intervention were inappropriate dosage or frequency (35%), lack of indications (30%), and duplicate prescriptions (22.5%).

One year after completion of the 3 sessions, participants across all age groups experienced average reductions in annual outpatient visits ($P < .001$), visits to the ED ($P = .029$), and the number of chronic prescriptions ($P < .001$) of 5.88 ± 7.26, 0.31 ± 1.64, and 1.13 ± 2.46, respectively. Participants 65 years and older experienced a mean reduction in PIM of 0.19 ± 0.82 ($P = .002$). Reductions in annual hospitalization and length of hospital stay, outpatient care costs, hospital care costs, ED care costs, and total medical expenditure were also observed after the end of the

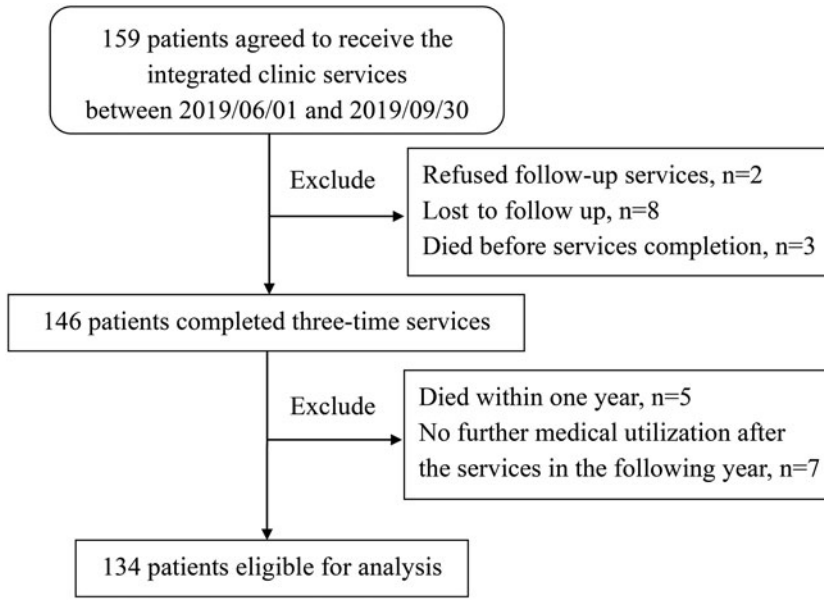

Figure 1. Flowchart of study participant selection.

Table 1. Baseline Sociodemographic and Clinical Characteristics of Study Participants (n = 134)

Variables	Mean ± SD or n (%)
Sociodemographic characteristics	
Age, y	74.2 ± 9.75
Range (min-max)	49-94
Sex	
Female	72 (53.7)
Male	62 (46.3)
Education status	
No formal education	29 (21.6)
Primary school	42 (31.3)
Junior high school	22 (16.4)
Senior high school	21 (15.7)
College/university	16 (11.9)
Postgraduate and above	4 (3)
Clinical characteristics	
Charlson Comorbidity Index	3.91 ± 2.46
Clinical Frailty Scale score	4.01 ± 1.34
Barthel Index	81.72 ± 26.21
5-item Geriatric Depression Scale score	0.83 ± 1.26
Short Portable Mental Status Questionnaire	1.17 ± 2.12
Mini Nutrition Assessment-Short Form	11.56 ± 2.57
Number of chronic prescription medications	10.71 ± 3.98
Number of chronic prescription medications ≥ 10	81 (60.4)
Number of potentially inappropriate medications[a]	1.42 ± 1.01
Prescribed potentially inappropriate medications[a]	90 (79.6)
Number of chronic diseases	9.45 ± 3.38
Diabetes	78 (58.21)
Diabetes with end-organ damage	73 (54.48)
Moderate-to-severe renal disease	68 (50.75)
Peptic ulcer diseases	29 (21.64)
Cerebral vascular diseases	29 (21.64)
Chronic pulmonary diseases	19 (14.18)
Dementia	18 (13.43)
Cancer	18 (13.43)
Congestive heart failure	17 (12.69)
Myocardial infarction	2 (1.49)
Connective tissue diseases	1 (0.75)

[a]Applied only to those 65 years and older.

integrated ambulatory care service program; however, no significant effects were found (Table 4).

We noted a high standard deviation in outpatient care costs, both 1 year before the program and 1 year after the program. The descriptive analysis showed that 7 participants had extremely high outpatient care costs (>100 000 new Taiwan dollar [NTD]) in the year before the program, the year after the program, or both. The reasons for the extremely high outpatient care costs are detailed in Supplemental Digital Content 2, available at: http://links.lww.com/QMH/A117. After excluding these 7 participants (n = 127), average costs of annual outpatient care (NTD) for 1 year before the program and 1 year after the program were 32 998.24 ± 16 735.74 and 26 610.31 ± 15 791.35, respectively, and the reduction in the annual outpatient care cost was statistically significant ($P < .001$). Nevertheless, no significant reductions were found in hospital care costs, ED care costs, and total medical expenditure after excluding the 7 participants (see Supplemental Digital Content 3, available at: http://links.lww.com/QMH/A118).

We also performed statistical analysis to compare primary and secondary outcomes before and after the program between groups divided by the numbers of chronic disease prescription medications and the results of the comprehensive assessment measured at baseline, to identify potential factors associated with the effectiveness of the program (see Supplemental Digital Contents 4-1 to 4-3 available at http://links.lww.com/QMH/A119). Participants with 10 or more medications were more likely to reduce the number of chronic disease prescription medications (12.95 ± 3.37 to 11.22 ± 3.51) than were participants with fewer than 10 medications (7.28 ± 1.77 to 7.06 ± 2.20) at 1 year after the program ($P < .001$). In addition, participants with 10 or more medications were more likely to reduce the number of PIMs (1.69 ± 1.02 to 1.29 ± 0.95) than were participants with fewer than 10 medications (0.98 ± 0.83 to 0.98 ± 0.83) 1 year after the program ($P < .01$). Although all variables presented reduction in participants with 10 or more medications (n = 81) and in participants with fewer than 10 medications (n = 53) after the program (Figure 2), changes in the number of outpatient clinic visits, ED visits, hospitalizations, annual outpatient care costs, hospitalizations, ED care, and total medical expenditures were not statistically significantly different between the 2 groups.

Participants with a GDS-5 score of 1 or more were more likely to show a reduced number of annual outpatient department visits (22.17 ± 10.27 to 14.78 ± 11.11) than were participants having a GDS-5 score = 0 (17.95 ± 9.46 to 13.09 ± 9.50), by 1 year after the program ($P < .043$). Participants with an abnormal MNA-SF score (<12), indicating a risk of malnutrition, were more likely to show a reduced number of annual ED visits (2.00 ± 2.27 to 1.17 ± 1.92) than were participants with a normal MNA-SF score (0.53 ± 0.99 to 0.49 ± 0.56), by 1 year after the program ($P < .026$). Comparing primary and secondary outcomes

Table 2. Baseline Clinical Characteristics of Patients Who Received Integrated Ambulatory Care Services, by Age Group

	Age Group				
Variables	**<65 (n = 21) Mean ± SD or n (%)**	**65-74 (n = 48) Mean ± SD or n (%)**	**75-84 (n = 48) Mean ± SD or n (%)**	**≥85 (n = 17) Mean ± SD or n (%)**	***P***
Age, y	58.81 ± 5.11	69.79 ± 2.29	80.19 ± 3.12	88.88 ± 2.62	. . .
Male sex	13 (61.9)	20 (41.7)	23 (47.9)	6 (35.3)	.341
Charlson Comorbidity Index	3.95 ± 1.94	3.85 ± 2.41	4.38 ± 2.62	2.71 ± 2.52	.121
Number of chronic diseases	8.43 ± 2.86	8.92 ± 3.44	10.23 ± 3.35	10.00 ± 3.54	.104
Barthel Index	93.10 ± 18.67	89.27 ± 19.89	79.79 ± 23.97	51.76 ± 33.49	<.001
					<.001
Independent, 100	16 (76.2)	24 (501.0)	10 (20.8)	1 (5.9)	
Mildly to moderately dependent, 61-99	4 (19.0)	20 (41.7)	28 (58.3)	6 (35.3)	
Severely to totally dependent, 0-60	1 (4.8)	4 (8.3)	10 (20.8)	10 (58.8)	
Clinical Frailty Scale score	3.48 ± 1.12	3.60 ± 1.09	4.23 ± 1.33	5.24 ± 1.48	<.001
5-item Geriatric Depression Scale score	0.95 ± 1.24	0.69 ± 1.21	0.77 ± 1.26	1.25 ± 1.44	.444
					. . .
No depression, <2	15 (71.4)	39 (81.3)	43 (89.6)	12 (75.0)	
Suspected depression, ≥2	6 (28.6)	9 (18.8)	5 (10.4)	4 (25.0)	
	0.14 ± 0.36	0.83 ± 1.79	1.65 ± 2.40	2.13 ± 2.75	.007
Short Portable Mental Status Questionnaire					. . .
Normal, ≤2	21 (100)	45 (93.8)	37 (77.1)	11 (68.8)	
Mild cognitive impairment, 3-4	0	1 (2.1)	5 (10.4)	3 (18.8)	
Moderate cognitive impairment, 5-7	0	1 (2.1)	3 (6.3)	1 (6.3)	
Severe cognitive impairment, 8-10	0	1 (2.1)	3 (6.3)	1 (6.3)	
Mini Nutrition Assessment-Short Form	12.38 ± 1.77	11.96 ± 2.09	11.44 ± 2.75	9.76 ± 3.33	.007
					. . .
Normal, ≥12	14 (66.7)	34 (70.8)	32 (66.7)	7 (41.2)	
Risk of malnutrition, 8-11	7 (33.3)	12 (25.0)	9 (18.8)	5 (29.4)	
Malnutrition, ≤7	0	2 (4.2)	7 (14.6)	5 (29.4)	
Number of chronic disease medications, mean	9.00 ± 2.35	10.75 ± 4.17	11.60 ± 4.38	10.18 ± 3.23	.083
Number of chronic disease medications ≥10	11 (52.4)	30 (62.5)	32 (66.7)	8 (47.1)	.439
Number of potentially inappropriate medications	. . .	1.52 ± 0.97	1.48 ± 0.99	0.94 ± 1.09	.105
Prescribed potentially inappropriate medications	. . .	41 (85.4)	40 (83.3)	9 (52.9)	.012

between groups divided by age (≥75 years vs <75 years), Barthel index (independent vs dependent), and CFS (score ≥4 vs 3) showed no statistically significant difference between the groups.

DISCUSSION

To the best of our knowledge, no previous study has explored a hospital-based multidisciplinary integrated ambulatory care program that included physicians from various specialties. In this study, we present preliminary empirical results on the impact of implementing such an integrated ambulatory care program in Taiwan, including results pertaining to PIM prescriptions, and health care use and cost among participants with multimorbidity and related polypharmacy. We showed that, at the 1-year follow-up, participants had a significant decrease in the annual frequency of outpatient visits, ED visits, chronic disease medications, and the number of PIM.

Excessive outpatient clinic visits among patients with multimorbidity are a major problem in Taiwan. Our finding that the annual number of outpatient clinic visits by participants was reduced by 5.88 after

Table 3. Summary of Pharmacist Counseling and Interventions

Variables	n (%)
Pharmacist counseling topics (n = 54)	
Administration	18 (33.3)
Dietary considerations	12 (22.2)
Oral inhalation techniques	8 (14.8)
Anticoagulation precautions	7 (13.0)
Adherence	7 (13.0)
Administration (route and preparation) techniques	4 (7.4)
Lifestyle modification	2 (3.7)
Insulin injection techniques	2 (3.7)
Adverse drug events	2 (3.7)
Nasal spray techniques	1 (1.9)
Therapeutic intervention reasons (n = 40)	
Dosage or frequency	14 (35.0)
No indication	12 (30.0)
Duplication of prescriptions	9 (22.5)
Adverse drug events	4 (10.0)
Monitoring parameters	4 (10.0)
Drug-drug interactions	3 (7.5)
Route or dosage form	1 (2.5)
More appropriate drug of choice recommendations	1 (2.5)

completing the 3-session integrated ambulatory care program suggests that the program can reduce the unnecessary use of outpatient services. The significant reduction in outpatient visits after the program was not surprising, since a major goal of the intervention was to prevent fragmented care. Additionally, we found a significant reduction in participants' annual number of ED visits after the program. Kang et al.[47] pointed out that older people with multimorbidity were more susceptible to adverse drug event-related ED visits and that 15.3% of adverse drug event-related ED visits were preventable. Our finding that the number of chronic disease medications and of PIM reduced significantly after the program may prevent some adverse drug event-related ED visits and therefore reduce the number of annual ED visits.

We observed that annual numbers of outpatient clinic and ED visits were lower after participants had completed the integrated ambulatory care program, which was consistent with the results of previous studies.[48,49] However, previous cohort studies investigating the effects of integrated outpatient services on health care use have revealed a significant reduction in the number of hospitalizations, a result that was not replicated in the present study. An explanation could be that the average number of hospitalizations among our participants was less than 0.5 annually. Thus, our study may be underpowered in detecting this outcome. Further research with a larger sample size or participants with a higher risk for admission (eg, participants just discharged from the hospital) is required to determine the effect of the program on the prevalence of hospitalization among patients with multimorbidity and related polypharmacy.

Polypharmacy is typically defined as the intake of 5 or more medications daily.[19] Although such a scenario is not necessarily inappropriate, patients with polypharmacy are at a high risk of being prescribed PIMs.[14] In this study, the mean number of chronic prescriptions per patient was 10.71, and 79.6% of the older participants (n = 90) had at least 1 PIM prescription at the baseline evaluation, confirming a high prevalence of inappropriate polypharmacy among study participants. We noticed that numbers of chronic prescription medications and PIMs were more likely to be reduced by 1 year after the program in participants prescribed 10 or more medications than in participants prescribed fewer than 10 medications. This finding may not be surprising, since a higher number of medications at baseline may also involve a greater opportunity for deprescription.

Our finding that numbers of chronic prescriptions and PIMs were lower at 1 year after the program was consistent with those of previous studies.[48,50] Nevertheless, the studies of Wei et al.[48] and Bosch-Lenders et al.[50] did not analyze whether prescription regimens after integration were appropriate, as we did in this study. Unutmaz et al.[51] noted that the prevalence of polypharmacy and PIM prescriptions could be reduced by using a comprehensive geriatric assessment that included the Screening Tool of Older People's Potentially Inappropriate Prescriptions and the Screening Tool to Alert to Right Treatment criteria in older people. However, their study did not evaluate the long-term effects of the altered treatment plan.[51]

Results of previous studies investigating the association between outpatient-based integrated care programs and health care costs were inconclusive. The study of Reiss-Brennan et al.[49] observed that patients who received primary care from an integrated team-based care service received lower total payouts from the health care system in the United States. Wei et al.[48] reported that an integrated geriatric outpatient clinic at their hospital had reduced annual costs of outpatient care and hospitalization by the time of the 1- and 2-year follow-ups; however, the authors did not document the effects of the clinic on overall health expenditure and annual emergency care costs.[48] Fishman et al.[52] noted that, although older adults in a patient-centered medical home clinic reported less use of emergency services and inpatient admissions for ambulatory care at the 12-month and 21-month follow-ups, the number of outpatient clinic visits, ED visits, inpatient admissions, and total costs were not significantly reduced.[52] Our findings of a lack of significant reduction in the overall medical expenditure or annual costs of outpatient care, hospitalizations, and ED care at the 1-year follow-up were consistent with those of Fishman et al.[52]

Table 4. Comparison of Outcomes 1 Year Before and After Integrated Ambulatory Care Program Services (n = 134)

	Previous Year Mean (SD)	1 y Later Mean (SD)	*P*
Annual outpatient department visits	19.78 (9.99)	13.90 (10.22)	<.001
Annual emergency department visits	1.04 (1.70)	0.73 (1.40)	.029
Annual hospitalizations	0.49 (0.90)	0.37 (0.85)	.186
Length of hospital stay, d/y	3.89 (9.77)	2.86 (7.65)	.271
Number of chronic prescription medications	10.71 (3.98)	9.57 (3.67)	<.001
Number of PIM (only for those ≥65 y)	1.42 (1.01)	1.17 (0.92)	.002
Cost of annual outpatient care (NTD)	43 989.76 (60 059.18)	38 794.04 (64 809.53)	.209
Cost of annual emergency care (NTD)	6 468.31 (14 708.85)	6 056.36 (14 994.55)	.763
Cost of annual hospitalization (NTD)	30 981.09 (97 780.53)	21 686.69 (58 762.18)	.277
Annual health care expenditures (NTD)	79 939.16 (126 414.58)	64 537.08 (98 581.60)	.128

Abbreviations: NTD, new Taiwan dollar; PIM, potentially inappropriate medication.

Given that the annual frequency of outpatient visits and the number of medications were significantly reduced in our participants by 1 year after the program, it was surprising that the cost of annual outpatient care was not significantly reduced in the year after the program. A possible explanation for this null finding is the variation and complexity among the program participants, making the outpatient cost beyond the control of the program. When we excluded the 7 participants with extremely high outpatient costs from the analysis, the reduction in outpatient cost was significant. Examining the medical records of these 7 participants, we noticed that they suffered from severe medical complexity, requiring high-cost medicines, treatments, or examinations. Specifically, 3 of these patients were taking very expensive medicines to treat their chronic diseases (2 before and during the program, 1 before the program). Two of them were end-stage renal disease patients who underwent outpatient dialysis treatment (1 peritoneal dialysis and 1 hemodialysis) after entering the program. One of them suffered from severe retinal problems and received outpatient-based retinal laser therapy just 1 day before the program and continued the treatment after the program. The remaining patient suffered from cancer recurrence in the year before the program and received frequent image evaluation and oncology clinic visits (see Supplemental Digital Content 2, available at: http://links.lww.com/QMH/A117). Future studies investigating the cost outcomes for older patients with multimorbidity should consider the effect of disease complexity.

Although we did not find a significant decrease in the annual outpatient cost 1 year after the program, the average annual outpatient cost reduction was 5195.72 NTD per participant. We did not measure costs related to out-of-pocket payments, transportation costs, earnings forgone or productivity losses as a result of treatment, or time spent during informal caregiving in our study. With an annual reduction of 5.88 outpatient clinic visits after completing the program, it is likely certain that costs related to transportation, earnings forgone or productivity losses, and time during informal caregiving were saved after the program.

Limitations

This study had several limitations, signifying the need for caution when interpreting our findings. First, because of its case series study design, this study did not have a comparison group. The differences between before and after the intervention may have been affected by personal factors known to influence health care use, such as self-efficacy, self-management skills, disease complexity, and care preferences. Second, the retrospective data did not cover changes in recipient function (eg, falls, mood, and cognitive and functional capacities) or patient-related outcome measures, which may help strengthen the value of the case series. Third, we did not consider health care use at other medical facilities because we could only access the medical records of this study hospital. Fourth, this study was conducted among patients from a single university hospital, and our findings may not be generalizable to patients receiving health services from other institutions. Finally, a high follow-up rate is imperative for a case series study and the follow-up rate in this study was only 84% (134/159). Besides participants who died during the program (n = 8) and participants who did not utilize medical care in the year after the program (n = 7), we excluded 10 participants who refused further follow-up sessions (n = 2) and those who were lost to follow-up (n = 8) after the first session. Even though our case managers did contact the 2 participants who refused further follow-up and wished to reschedule appointments, they preferred to forego further services. The case managers were unable to contact the 8 participants who were lost to follow-up because of incorrect telephone numbers or a lack of response to 3 phone calls.

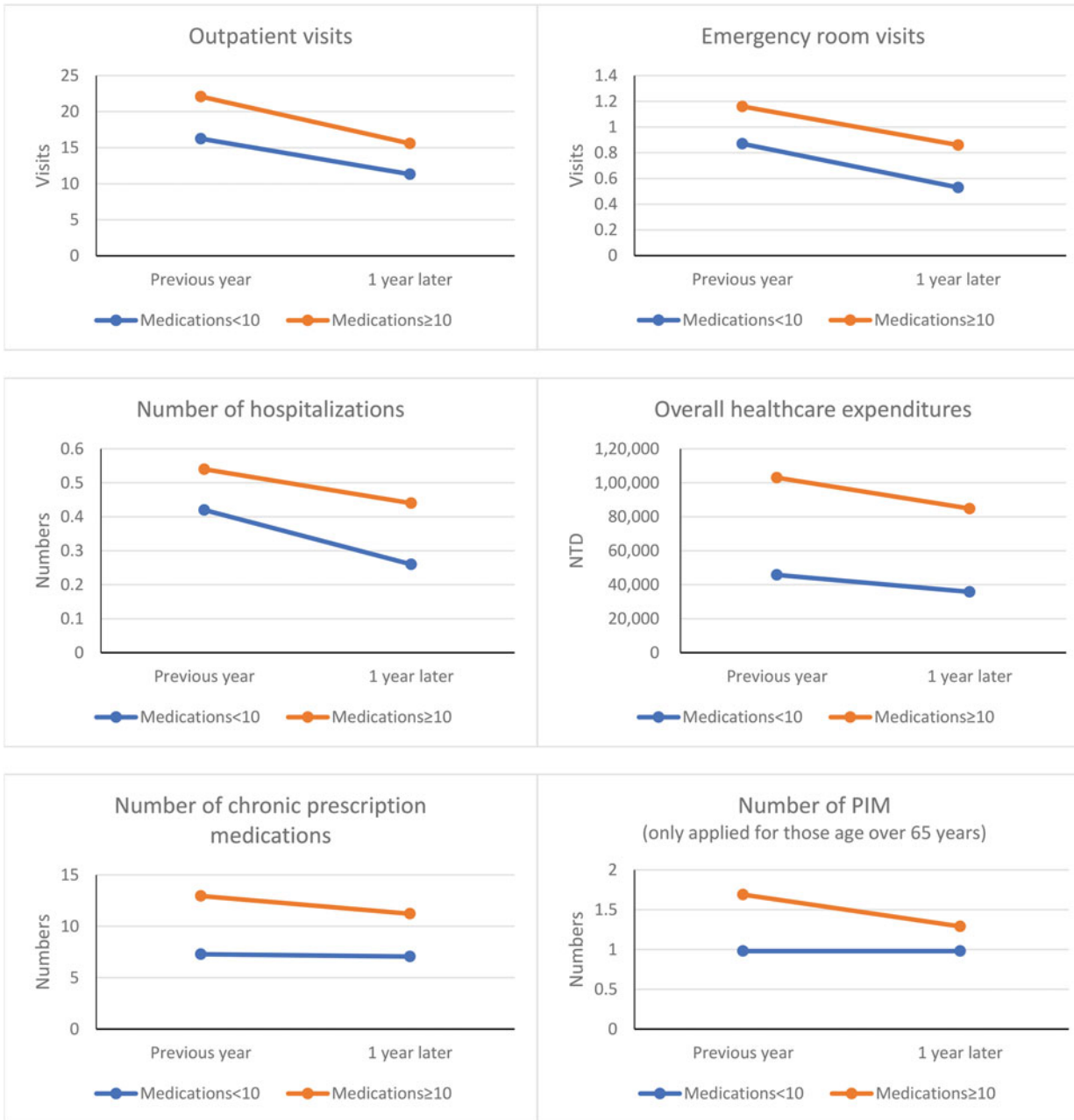

Figure 2. Comparison of changes in the number of outpatient clinic visits, emergency department visits, hospitalizations, chronic prescription medications, potential inappropriate medication (PIM), and total health expenditures 1 year before and after the integrated ambulatory care program between participants with 10 or more (n = 81) or fewer than 10 (n = 53) chronic prescription medications. This figure is available in color online (www.qmhcjournal.com).

Strengths

Despite the limitations, the strengths of the present study included its evaluation of long-term outcomes (1 year after program completion) and the comprehensive medication review conducted by pharmacists using the NHI MediCloud system, with assessment for PIM prescriptions for all participants 65 years and older. In this way, we were able to include and help the most at-risk population. For intervention addressing polypharmacy in older adults living with multimorbidity, it is critical to make individualized decisions with clinical judgment based on each patient's functional status and preferences of care. We measured various functional aspects, including frailty, nutrition status, cognitive function, daily activities, and mood at the first session, to facilitate tailored care for each participant.

Our integrated ambulatory care program included physicians from many different specialties, while most previous programs mainly involved geriatricians. However, despite the increasing population of older adults with multimorbidity, the geriatric workforce capacity has actually decreased.[53] On the other hand, specialist

clinics, such as general medicine, internal medicine, and neurology clinics, are likely to encounter patients with polypharmacy and multimorbidity due to advancing age.[15] With the help of case managers and pharmacists, physicians with different specialties were able to perform deprescribing and promote integrated care for their patients. Through our program, these physicians gained knowledge about PIMs and skills of medication reconciliation that are important in the care of older adults with polypharmacy and multimorbidity. These physicians then applied their expertise to improve clinical practice. The positive preliminary results obtained in this study can serve as a reference for other countries that wish to develop integrated care for older adults with multimorbidity and with a limited number of geriatricians. In addition, our study results can serve as a reference for future studies aiming to elucidate the influence of outpatient-based interventions on health care and prescription-related outcomes in patients with multimorbidity and related polypharmacy.

CONCLUSIONS

A hospital-based multidisciplinary integrated ambulatory care program reduced the annual frequency of outpatient visits, ED visits, number of chronic disease medications, and PIM at the 1-year follow-up. Excluding patients with exceptional medical needs, the program also potentially achieved significant overall cost reduction for outpatient services.

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