


# Care Need Combinations for Dementia Patients with Multiple Chronic Diseases

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**Purpose:** The purpose of this study was to find care need combinations for dementia patients with multiple chronic diseases and their caregivers.

**Patients and Methods:** A cross-sectional study was conducted with 83 patients who had multiple chronic diseases. Variables from patients included age, gender, severity of clinical dementia rating, feeding, hypnotics, mobility, getting lost, mood symptoms, and behavioral and psychological symptoms. Moreover, 26 types of care needs were included in this study. The Apriori algorithm was employed to first identify care need combinations and then to find the relationships between care needs and variables from dementia patients with multiple chronic diseases.

**Results:** Six rules were generated for care need combinations. Four care needs could be formed as a basic care need bundle. Moreover, two additional care needs could be added to provide a wider coverage for patients. In the second stage, 93 rules were found and categorized into three groups, including 2, 6, and 28 general rules with support of 30% but less than 40%, 20% but less than 30%, and 10% but less than 20%, respectively. When the support value is 10% but less than 20%, more variables from patients were found in rules which help the dementia collaborative care team members provide tailor-made care need bundles.

**Conclusion:** Four basic care needs were social resources referral and legal support (Care (1)), drug knowledge education (Care (3)), memory problem care (Care (5)), and fall prevention (Care (8)). Besides, disease knowledge education (Care (2)) and hypertension care (Care (16)) were frequent unmet needs in this specific population. Moreover, care for the mood of the caregiver (Care (11)) should be considered especially in dementia patients with preserved ambulatory function or with symptoms of hallucination. The collaborative care team should pay more attention to those care needs when assessing this specific population.

**Keywords:** multiple chronic diseases, care need, dementia, dementia collaborative care team, Apriori algorithm

## Introduction

Population aging is happening worldwide. By 2030, Asia will contain up to 60% of the world's older adults aged 60 years or above and 50% of the world's oldest-old.<sup>1</sup> The number of older people in Taiwan has grown rapidly in the past decades, with the percentage of the population over the age of 65 years increasing from 6.8% in 1992 to 16.9% in 2022.<sup>2</sup> Dementia is a neurodegenerative illness strongly associated with aging. The prevalence of all-cause dementia and mild cognitive impairment were 8.04% and 18.76%, respectively, in Taiwanese people aged 65 years or above in 2013.<sup>3</sup> Dementia is still incurable; therefore, appropriate care intervention to satisfy the unmet needs of people living with dementia (PLWD) and their caregivers is important.<sup>4,5</sup>

Black et al<sup>6</sup> found that more than 95% of PLWD and caregivers have one or more unmet needs. The most common needs for PLWD were safety needs, meaningful activities, legal issues/concerns, and nursing or pharmacological treatment and care. On the other hand, the most common needs for caregivers were memory disorder education, care

skills and knowledge of resources, caregiver's mental health, and access to informal support.<sup>6–9</sup> Decreased levels of unmet needs were associated with better outcomes in both PLWD and their care partners.<sup>7</sup> Case managers in collaboration with primary physicians have a pivotal role in identifying and addressing the needs of the patient–caregiver dyad.<sup>4</sup> A systematic review showed that case managers and primary care providers partnership models effectively improved the severity of neuropsychiatric symptoms, as well as caregiver burden, distress, and mastery.<sup>10</sup>

Grouping frequent care needs makes the work of dementia case managers more efficient. A previous report from our dementia collaborative team revealed five care needs as a basic care need bundle when a patient with dementia was first diagnosed, including appropriate scheduling of activities, regular outpatient follow-up treatment, introduction and referral of social resources, referral to family support groups and care skills training, and health education for dementia and behavioral and psychological symptoms of dementia (BPSD).<sup>11</sup> More than 40% of PLWD and their caregivers needed care involved in the basic bundle. In male patients with vascular cognitive impairment, care for the mood of the caregiver was the sixth care need which should be addressed in addition to the basic care need bundle.<sup>12</sup> To further help elementary case managers make an appropriate regular assessment, our case manager-based dementia collaborative team adjusted the unmet needs and defined when and how to use those needs since September 2020, ie, care need 2.0 (Table 1). Our team arranged a face-to-face assessment every 6 months including cognition, function, living status, home environment, and behavior and psychological symptoms of the patient, as well as the stress, mood, and preference of the caregiver in order to elucidate their unmet needs. Case managers then performed monthly follow-up by phone to check if the unmet needs were satisfied.

Multiple chronic diseases increased the risk of dementia in older adult; therefore, PLWD were always accompanied with multimorbidity.<sup>13</sup> Eighty-three percent of PLWD had two or more chronic comorbid conditions, which increased the care load and complicated caregivers' transition experiences.<sup>14,15</sup> PLWD with multiple chronic conditions had a more rapid progression and worse outcomes than those with fewer conditions.<sup>16</sup> PLWD with co-occurring chronic conditions also negatively impacted hospitalization, emergency department visit, mortality, institutionalization, and functional outcomes.<sup>17,18</sup> Caregivers usually experienced worse health conditions, decreased social life, and higher responsibility while taking care of PLWD with multiple chronic conditions.<sup>15</sup> Successful strategies in caring for PLWD and their caregivers would rely on not only clinical treatments but also evaluation of the whole-person including addressing the combination of dementia and multimorbidity.<sup>19</sup> No literatures have been found to focus on the care needs of caregivers and PLWD with multiple chronic diseases. The aim of the present study was to find the combination of care needs in PLWD with multiple chronic diseases and their care partners.

## Patients and Methods

Patients who were diagnosed with dementia at the memory clinic of Changhua Christian Hospital and used care need 2.0 from September 2020 to July 2021 were enrolled in this study. The diagnosis of dementia for each patient was based on clinical dementia rating (CDR) scale by a clinical psychologist.<sup>20</sup> The clinical trial was approved by the Institutional Review Board of Changhua Christian Hospital (CCH IRB 160615). The need for informed consent was waived by the Institutional Review Board of Changhua Christian Hospital because this study used a retrospective study design. All data were recorded in the electronic medical chart with the highest confidentiality and compliance with the Declaration of Helsinki. Initially, there were 176 patients who used care need 2.0 as shown in Table 1 but only 83 patients who had multiple chronic diseases. In this study, when a patient had two or more chronic diseases from a list of hypertension, diabetes, hyperlipidemia, cerebrovascular disease, cardiovascular disease, chronic kidney disease, anemia, and hearing impairment, then the patient had multiple chronic diseases.

Variables such as age, gender, and the severity of clinical dementia rating for each patient were summarized in Table 2. In addition, the follow-up information for patients including feeding, hypnotics, mobility, getting lost, mood symptoms, and behavioral and psychological symptoms are provided in Table 3. Nearly 60% of the patients were aged 75–84 years, and the percentage of female patients were slightly higher than that of male patients. Hypertension, hyperlipidemia, diabetes, and hearing impairment were the top four chronic diseases among the patients. Moreover, nearly 50% of the patients had a very mild dementia. On the other hand, the majority of the patients could feed independently (89.2%), did not need to use hypnotics (75.9%), could walk independently (56.6%), and did not get lost

**Table 1** Care Needs Addressed by Changhua Christian Hospital

Category	Number	Description	Selected When	Need are Considered as Fulfilled When
Long term care resources	1	Social resources referral and legal support	If PLWD or caregivers ask social resources or legal support such as disability card, day-care facilities, or guardianship	PLWD and/or caregivers can at least partially understand how to apply the resources
Specific care of dementia	2	Disease knowledge education	If PLWD and caregivers ask education information about dementia, such as prevention and disease course	PLWD and/or caregivers can illustrate more than 3 types of disease knowledge or caring skills from health education manual
	3	Drug knowledge education	If PLWD and caregivers ask pharmacological treatment of dementia	PLWD and/or caregivers can illustrate more than 3 types of medication effects/side effects
	4	Disorientation care	If CDR disorientation has a subscale $\geq 2$	Caregivers can illustrate more than 3 methods to deal with disorientation
	5	Memory problem care	If CDR memory has a subscale $> 0$	Caregivers can illustrate more than 3 methods to deal with memory problems
	6	BPSD care	Any symptom has detected through neuropsychiatric inventory	Caregivers can illustrate more than 3 methods to deal with BPSD
	23	Care of communication problem	If PLWD or caregivers declare decreased ability on language communication	PLWD and/or caregivers can illustrate more than one method to facilitate communication
Safety issues	7	Driving evaluation and suggestion	If PLWD is still driving or riding a motorcycle	PLWD can express more than one risk factor related to unsafe driving/riding, and PLWD or caregivers can illustrate more than one alternative transportation choice
	8	Fall prevention	If PLWD needs assistance to walk or has a history of fall	PLWD and/or caregivers can illustrate more than 3 methods to prevent fall, and PLWD can use at least one kind of assistive devices
	9	Adjusting home environment safety	If any event of indoor safety concern has been recorded (eg, overcooked or burning)	PLWD and/or caregivers can illustrate more than 3 methods to maintain home safety. Number of accident events is recorded at each assessment
Care of general problems	10	Social interaction problem care	If PLWD has social withdrawal or inappropriate social behaviors	PLWD has more than 4 times of proper social activities per month (either passive or active)
	12	Maintenance of activity of daily living	If a patient's activity of daily living is impaired	Caregivers at least partially understand the importance and try to maintain independent ADL of the patient
	13	Nutrition care	If the patient has an abnormal nutritional assessment (evaluating patient's oral intake ability and recent body weight change)	Caregivers can illustrate more than 3 kinds of methods to maintain suitable nutritional status
	15	Adequate sleep and rest	If PLWD has poor sleep quality	PLWD can maintain good or fair strength in the morning

(Continued)

Table I (Continued).

Category	Number	Description	Selected When	Need are Considered as Fulfilled When
Care of specific symptoms	14	Dizziness care	If PLWD complains about dizziness	PLWD states dizziness getting better. Number of accident events due to dizziness is recorded at each assessment
	16	Hypertension care	If PLWD has a history of hypertension	PLWD and/or caregivers can notice the goal of blood pressure and illustrate more than 3 methods to prevent hypertension
	17	Hypotension care	If PLWD has a history of hypotension	PLWD and/or caregivers can illustrate more than 3 methods to prevent hypotension
	18	Hearing impairment care	If PLWD has a hearing problem	PLWD and/or caregivers can use more than one assistive device or alternative method to receive information
	19	Stool incontinence care	If PLWD has stool incontinence	Caregivers can illustrate more than two methods to help the patient
	20	Urine incontinence care	If PLWD has urine incontinence	Caregivers can illustrate more than 3 methods to help the patient
	21	Diarrhea care	If PLWD has diarrhea	Caregivers can illustrate more than 3 methods to improve diarrhea
	22	Constipation care	If PLWD has constipation	Caregivers can illustrate more than 3 methods to improve constipation
	24	Dysphagia care	If PLWD has dysphagia	Caregivers can illustrate more than 3 care tips to prevent choking
	25	Pain care	If PLWD has an abnormal pain score	PLWD and/or caregivers can illustrate more than 2 methods to alleviate pain
	26	Care of impaired skin integrity	If PLWD has impaired skin integrity	PLWD and/or caregivers can illustrate more than 3 kinds of methods to repair the skin
Caregiver support	11	Care for the mood of the caregiver	If a caregiver presents with depressive mood (screen by CES-D) or a high Zarit's burden interview score	Caregivers can notice more than 3 methods or resources to alleviate stress

**Abbreviations:** CDR, clinical dementia rating; ADL, activity of daily living; CES-D, Center for Epidemiologic Studies-Depression Scale; BPSD, behavioral and psychological symptoms of dementia.

**Table 2** Demographic Variables of Dementia Patients with Multiple Chronic Diseases

Variables		Frequency	Percentage	Data Type
Age	<65 years	6	7.2	1
	65–74 years	10	12.1	2
	75–84 years	49	59.0	3
	≥85 years	18	21.7	4
Gender	Female	42	50.6	0
	Male	41	49.4	1
Multiple chronic diseases	Hypertension	65	78.3	1: With the disease; and 0: without the disease
	Diabetes	30	36.1	
	Hyperlipidemia	44	53.0	
	Cerebrovascular disease	16	19.3	
	Cardiovascular disease	9	10.8	
	Chronic kidney disease	13	15.7	
	Anemia	28	33.7	
	Hearing impairment	30	36.1	
Severity of CDR	Very mild dementia	41	49.4	0
	Mild dementia	24	28.9	1
	Moderate dementia	12	14.5	2
	Severe dementia	6	7.2	3

(60.2%). The highest frequency in mood symptoms was anger (22.9%) followed by dysthymia (15.7%), depression (14.5%), and emotional lability (14.5%). Finally, the highest frequency in behavioral and psychological symptoms was delusion (22.9%) followed by hallucination (14.5%). It is worth to note that the presence of BPSD was evaluated by psychologists or trained nursing case managers, and most of the BPSD listed in the neuropsychiatric inventory were recorded. Other abnormal behaviors frequently observed in dementia patients such as wandering, pathological crying or laughing, cursing others, akathisia, and akinesia were noted by trained nursing case managers. The frequencies of 26 care needs used among 83 dementia patients with multiple chronic diseases are summarized in Table 4, where social resources

**Table 3** Follow-Up Variables of Dementia Patients with Multiple Chronic Diseases

Variables		Frequency	Percentage	Data Type
Feeding	Independent	74	89.2	0
	Feed by others	8	9.6	1
	On nasogastric tube	1	1.2	2
Hypnotics	No use	63	75.9	0
	Fair response	13	15.7	1
	Poor response	7	8.4	2
Mobility	Independent	47	56.6	0
	Assistance needed	19	22.9	1
	Wheel-bound	17	20.5	2
	Bedridden	0	0	3
Getting lost	Never getting lost	50	60.2	0
	Tend to get lost	23	27.7	1
	History of getting lost	10	12.1	2

(Continued)

**Table 3** (Continued).

Variables		Frequency	Percentage	Data Type
Mood symptoms	Pathological crying or laughing	0	0	1: with the symptom; and 0: without the symptom
	Phobia	1	1.2	
	Dysthymia	13	15.7	
	Depression	12	14.5	
	Anxiety	5	6.0	
	Worry	1	1.2	
	Anger	19	22.9	
	Irritability	10	12.0	
	Emotional lability	12	14.5	
	Apathy	4	4.8	
Behavioral and Psychological symptoms	Agitation	0	0	1: with the symptom; and 0: without the symptom
	Akathisia	2	2.4	
	Wandering	0	0	
	Screaming	0	0	
	Curse	0	0	
	Pacing	0	0	
	Shadowing	0	0	
	Aggression (verbal/body)	4	4.9	
	Disinhibition	2	2.4	
	Akinesia	3	3.6	
	Nighttime behavior	4	4.8	
	Aberrant motor behavior (stereotype)	0	0	
	Delusion	19	22.9	
	Hallucination	12	14.5	
	Misidentification	0	0	

referral and legal support (Care 1), disease knowledge education (Care 2), care for the mood of the caregiver (Care 11), memory problem care (Care 5), fall prevention (Care 8), and adjusting home environment safety (Care 9) were the care needs with top 6 frequencies. In the present study, only 18 of 26 care needs were used due to a smaller sample of size for dementia patients with multiple chronic diseases.

**Table 4** Frequencies of 26 Care Needs Used Among 83 Dementia Patients with Multiple Chronic Diseases

Care Need	Frequency	Percentage in Terms of 83 Patients
1. Social resources referral and legal support	70	84.34
2. Disease knowledge education	39	46.99
3. Drug knowledge education	16	19.28
4. Disorientation care	11	13.25
5. Memory problem care	20	24.10
6. BPSD care	11	13.25

(Continued)

**Table 4** (Continued).

Care Need	Frequency	Percentage in Terms of 83 Patients
7. Driving evaluation and suggestion	7	8.43
8. Fall prevention	18	21.69
9. Adjusting home environment safety	18	21.68
10. Social interaction problem care	6	7.23
11. Care for the mood of the caregiver	25	30.12
12. Maintenance of activity of daily living	16	19.28
13. Nutrition care	3	3.61
14. Dizziness care	2	2.41
15. Adequate sleep and rest	2	2.41
16. Hypertension care	13	15.66
17. Hypotension care	0	0
18. Hearing impairment care	0	0
19. Stool incontinence care	0	0
20. Urine incontinence care	0	0
21. Diarrhea care	0	0
22. Constipation care	0	0
23. Care of communication problem	3	3.61
24. Dysphagia care	0	0
25. Pain care	0	0
26. Care of impaired skin integrity	6	7.23

The purpose of this study was to find the care need combinations for PLWD with multiple chronic diseases. Studies such as Jhang et al<sup>11,12</sup> showed that the Apriori algorithm was an effective approach to identify care need bundles for PLWD by revealing statistical correlation through setting up support, confidence, and lift. Therefore, this study employed the Apriori algorithm to find care need bundles for PLWD with multiple chronic diseases. The support, confidence, and lift are defined below.<sup>21-24</sup> The support of an association rule  $A \Rightarrow B$  calculates the percentage of transactions containing both A and B in the database depicted in Equation (1):

$$\text{Support } (A \Rightarrow B) = P(A \cap B) = \frac{\text{number of transactions containing both A and B}}{\text{total number of transactions}} \quad (1)$$

The confidence of the association rule  $A \Rightarrow B$  evaluates the accuracy of the rule by computing the percentage of transactions containing A and also containing B simultaneously in the database depicted in Equation (2):

$$\text{Confidence } (A \Rightarrow B) = P(B|A) = \frac{P(A \cap B)}{P(A)} = \frac{\text{number of transactions containing both A and B}}{\text{number of transactions containing A}} \quad (2)$$

Lift measures if the correlation of A and B is to be independent or dependent depicted in Equation (3). If a lift is equal to 1, A and B are independent and no rule will be generated containing either event. If a lift is greater than 1, A and B are positively dependent.

$$\text{Lift}(A, B) = \frac{P(A \cap B)}{P(A)P(B)} \tag{3}$$

The Apriori algorithm in IBM SPSS Modeler 14.1 was applied. Data type for each variable was defined by the numerical values as shown in Tables 2 and 3. In addition, each care need used a two-point scale. If a care need was applied, a value of 1 was assigned. If not, a value of 0 was given. This study had twofold. The first stage was to find care need combinations. Therefore, 26 care needs were the input variables for both antecedents and consequents. In the second stage, the purpose was to find care need combinations along with the associations of variables listed in Tables 2 and 3. Specifically, the input variables for antecedents included age, gender, and CDR from Table 2 and feeding, hypnotics, mobility, getting lost, 10 types of mood symptoms, and 15 types of behavioral and psychological symptoms from Table 3. Moreover, 26 care needs were the input variables for both antecedents and consequents. The minimum support, confidence, and lift values based on the suggestions from Jhang et al<sup>11,12</sup> were set to 10%, 90%, and greater than 1, respectively.

## Results

In the first stage, there were six rules generated as shown in Table 5. Memory problem care (Care (5)) was associated with social resources referral and legal support (Care (1)). In addition, fall prevention (Care (8)) was associated with Care (1). The higher support value indicated the more frequent the care need combinations were from the database. Thus, Care (1), Care (3), Care (5), and Care (8) could be bundled together to form a basic care need combination for dementia patients with multiple chronic diseases when support was set to greater than 19%. In addition to these four care needs, disease knowledge education (Care (2)) and hypertension care (Care (16)) could be implemented to provide a more comprehensive combination if needed.

In the second stage, there were 80 rules generated with the support values ranging from 10% to less than 40%. In order to show the rules in a practical viewpoint, these rules were classified into three groups, namely 30% to less than 40%, 20% to less than 30%, and 10% to less than 20%. For each group, general rules were summarized based on the similarities of rules. In Table 6, there were three rules which could be further summarized into two general rules with 30% to less than 40%. The first general rule indicated that a patient with very mild dementia who did not use hypnotics would require social resources referral and legal support (Care (1)) regardless if the patient’s feeding was independent. The second general rule containing only one rule showed that a patient who did not use hypnotics but required disease knowledge education (Care (2)) needed Care (1).

**Table 5** Six Rules in the First Stage of the Study

Rule No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
1	Care (5): Memory problem care	Care (1): Social resources referral and legal support	24.10	90.00	1.07
2	Care (8): Fall prevention		21.69	100	1.19
3	Care (3): Drug knowledge education		19.28	93.75	1.11
4	Care (2): Disease knowledge education Care (5): Memory problem care		12.05	100	1.19
5	Care (2): Disease knowledge education Care (16): Hypertension care		10.84	100	1.19
6	Care (2): Disease knowledge education Care (8): Fall prevention		10.84	100	1.19



**Table 6** Two General Rules with Support of 30% but Less Than 40%

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
1	CDR: Very mild dementia Hypnotics: No use	Care (1): Social resources referral and legal support	37.35	90.32	1.07
	CDR: Very mild dementia Feeding: Independent Hypnotics: No use		36.15	90.00	1.07
2	Care (2): Disease knowledge education Hypnotics: No use		30.12	92.00	1.09

Table 7 summarizes 10 rules which were categorized into 6 general rules with the support of 20% but less than 30%. To further explain the meanings of these general rules, the second and third general rules consisting of four and two rules, respectively, were illustrated. The second general rule showed that a patient who could get lost would require social resources referral and legal support (Care (1)) no matter whether the patient could feed independently, did not use hypnotics, or both. The third general rule indicated that a male patient with very mild dementia who did not use hypnotics would need Care (1) regardless if the patient's feeding was independent.

Eighty rules with the support value of 10% but less than 20% were further summarized into 28 general rules as shown in Table 8. The lower support value indicated the less frequent in the database. However, these rules were still important for certain groups because of high confidence values. In fact, more demographic variables were appeared in general rules. For instance, the term "65–74 years old" was found in general rule 19. That is, if a patient whose age was 65–74 years,

**Table 7** Six General Rules with Support of 20% but Less Than 30%

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
1	Care (2): Disease knowledge education Feeding: Independent Hypnotics: No use	Care (1): Social resources referral and legal support	26.51	90.91	1.08
2	Getting lost: Tend to get lost		27.71	95.65	1.13
	Feeding: Independent Getting lost: Tend to get lost		25.30	95.24	1.13
	Hypnotics: No use Getting lost: Tend to get lost		22.89	94.74	1.12
	Feeding: Independent Hypnotics: No use Getting lost: Tend to get lost		20.48	94.12	1.12
3	Gender: Male CDR: Very mild dementia Hypnotics: No use		25.30	90.48	1.07
	Gender: Male CDR: Very mild dementia Feeding: Independent Hypnotics: No use		25.30	90.48	1.07
4	Care (5): Memory problem care		24.10	90.00	1.07
5	Care (8): Fall prevention		21.69	100	1.19
6	Mobility: Wheel-bound		20.48	94.12	1.12

**Table 8 28** General Rules with Support of 10% but Less Than 20%

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
1	Care (3): Drug knowledge education	Care (1): Social resources referral and legal support	19.23	93.75	1.11
	Care (3): Drug knowledge education Feeding: Independent		19.23	93.75	1.11
	Care (3): Drug knowledge education Mobility: Independent		16.87	92.86	1.10
	Care (3): Drug knowledge education Feeding: Independent Mobility: Independent		16.87	92.86	1.10
	Care (3): Drug knowledge education CDR: Very mild dementia		12.05	100	1.19
	Care (3): Drug knowledge education CDR: Very mild dementia Feeding: Independent		12.05	100	1.19
	Care (3): Drug knowledge education Feeding: Independent Hypnotics: No use Mobility: Independent		10.84	100	1.19
	Care (3): Drug knowledge education Hypnotics: No use		10.84	100	1.19
	Care (3): Drug knowledge education Feeding: Independent Hypnotics: No use		10.84	100	1.19
	Care (3): Drug knowledge education Hypnotics: No use Mobility: Independent		10.84	100	1.19
2	Care (11): Care for the mood of the caregiver Feeding: Independent Hypnotics: No use	18.08	93.33	1.11	
3	Care (2): Disease knowledge education Age: 75–84 years Hypnotics: No use	18.08	93.33	1.21	
	Care (2): Disease knowledge education Age: 75–84 years Feeding: Independent Hypnotics: No use	15.66	92.31	1.10	
	Care (2): Disease knowledge education Age: 75–84 years Gender: Male Hypnotics: No use	13.25	90.91	1.08	
4	Care (2): Disease knowledge education Gender: Male Hypnotics: No use	16.87	92.86	1.10	
	Care (2): Disease knowledge education Gender: Male Feeding: Independent Hypnotics: No use	13.25	90.91	1.08	
	Care (2): Disease knowledge education Gender: Male Hypnotics: No use Mobility: Independent	12.05	90.00	1.07	
	Care (2): Disease knowledge education Gender: Male Feeding: Independent Hypnotics: No use Mobility: Independent	12.05	90.00	1.07	

(Continued)

**Table 8 (Continued).**

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
5	Care (2): Disease knowledge education Hypnotics: No use Mobility: Independent	Care (1): Social resources referral and legal support	13.25	90.91	1.08
	Care (2): Disease knowledge education Feeding: Independent Hypnotics: No use Mobility: Independent		13.25	90.91	1.08
6	Care (8): Fall prevention Feeding: Independent		16.87	100	1.19
	Care (8): Fall prevention Hypnotics: No use		15.66	100	1.19
	Care (8): Fall prevention Getting lost: Never getting lost		13.25	100	1.19
	Care (8): Fall prevention Feeding: Independent Hypnotics: No use		12.05	100	1.19
	Care (8): Fall prevention Age: 75–84 years		10.84	100	1.19
	Care (8): Fall prevention Feeding: Independent Getting lost: Never getting lost		10.84	100	1.19
7	Care (2): Disease knowledge education Care (8): Fall prevention		10.84	100	1.19
8	Care (2): Disease knowledge education Care (16): Hypertension care		10.84	100	1.19
	Care (2): Disease knowledge education Care (16): Hypertension care Hypnotics: No use		10.84	100	1.19
	Care (2): Disease knowledge education Care (16): Hypertension care Feeding: Independent	10.84	100	1.19	
	Care (2): Disease knowledge education Care (16): Hypertension care Feeding: Independent Hypnotics: No use	10.84	100	1.19	
9	Mood symptoms: Depression	14.46	100	1.19	
	Feeding: Independent Mood symptoms: Depression	14.46	100	1.19	
10	CDR: Very mild dementia Mobility: Assistance needed	14.46	100	1.19	
	CDR: Very mild dementia Feeding: Independent Mobility: Assistance needed	14.46	100	1.19	
11	Age: ≥85 years Mobility: Assistance needed	12.05	90.00	1.07	
	Age: ≥85 years Feeding: Independent Mobility: Assistance needed	12.05	90.00	1.07	
	Age: ≥85 years CDR: Very mild dementia	10.84	100	1.19	

(Continued)

**Table 8** (Continued).

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
12	Care (2): Disease knowledge education Mobility: Assistance needed	Care (1): Social resources referral and legal support	12.05	90.00	1.07
	Care (2): Disease knowledge education Feeding: Independent Mobility: Assistance needed		12.05	90.00	1.07
13	Getting lost: History of getting lost		12.05	100	1.19
	Feeding: Independent Getting lost: History of getting lost		12.05	100	1.19
14	Care (2): Disease knowledge education Getting lost: Tend to get lost		16.87	100	1.19
	Care (2): Disease knowledge education Hypnotics: No use Getting lost: Tend to get lost		14.46	100	1.19
	Care (2): Disease knowledge education Feeding: Independent Getting lost: Tend to get lost		14.46	100	1.19
	Care (2): Disease knowledge education Feeding: Independent Hypnotics: No use Getting lost: Tend to get lost		12.05	100	1.19
15	Gender: Male Getting lost: Tend to get lost		14.46	100	1.19
	Gender: Male Feeding: Independent Getting lost: Tend to get lost		12.05	100	1.19
	Gender: Male Hypnotics: No use Getting lost: Tend to get lost		10.84	100	1.19
16	Mobility: Independent Getting lost: Tend to get lost		14.46	91.67	1.09
	Feeding: Independent Mobility: Independent Getting lost: Tend to get lost		14.46	91.67	1.09
	Hypnotics: No use Mobility: Independent Getting lost: Tend to get lost		13.25	90.91	1.08
	Feeding: Independent Hypnotics: No use Mobility: Independent Getting lost: Tend to get lost		13.25	90.91	1.08
17	Age: 75–84 years Getting lost: Tend to get lost		12.05	100	1.19
18	CDR: Mild dementia Getting lost: Tend to get lost	14.46	91.67	1.09	
	CDR: Mild dementia Feeding: Independent Getting lost: Tend to get lost	12.05	90.00	1.07	
	Care (2): Disease knowledge education CDR: Mild dementia Getting lost: Tend to get lost	10.84	100	1.19	

(Continued)

**Table 8 (Continued).**

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
19	Age: 65–74 years	Care (1): Social resources referral and legal support	12.05	90.00	1.07
20	CDR: Moderate dementia		14.46	91.67	1.08
	CDR: Moderate dementia Feeding: Independent		13.25	90.91	1.08
21	CDR: Moderate dementia Mobility: Independent		10.84	100	3.32
	CDR: Moderate dementia Feeding: Independent Mobility: Independent		10.84	100	3.32
22	Care (2): Disease knowledge education Care (5): Memory problem care		12.05	100	1.19
	Care (2): Disease knowledge education Care (5): Memory problem care Age: 75–84 years		10.84	100	1.19
23	Care (16): Hypertension care CDR: Very mild dementia		Care (5): Memory problem care	12.05	90.00
	Care (16): Hypertension care CDR: Very mild dementia Hypnotics: No use	12.05		90.00	3.74
	Care (16): Hypertension care CDR: Very mild dementia Feeding: Independent	12.05		90.00	3.74
	Care (16): Hypertension care CDR: Very mild dementia Feeding: Independent Hypnotics: No use	12.05		90.00	3.74
24	Behavioral and Psychological symptoms: Hallucination Feeding: Independent	Care (11): Care for the mood of the caregiver	13.25	90.91	3.02
25	Behavioral and Psychological symptoms: Hallucination Hypnotics: No use	Care (1): Social resources referral and legal support	10.84	100	1.19
26	CDR: Very mild dementia Care (2): Disease knowledge education Hypnotics: No use		12.05	100	1.19
	CDR: Very mild dementia Care (2): Disease knowledge education Feeding: Independent Hypnotics: No use		12.05	100	1.19
	CDR: Very mild dementia Care (2): Disease knowledge education Age: 75–84 years Hypnotics: No use		10.84	100	1.19
	CDR: Very mild dementia Care (2): Disease knowledge education Age: 75–84 years Feeding: Independent Hypnotics: No use	10.84	100	1.19	
27	Age: 75–84 years Hypnotics: Fair response	Care (2): Disease knowledge education	13.25	90.91	1.94

(Continued)

**Table 8** (Continued).

No.	Antecedent	Consequent	Support (%)	Confidence (%)	Lift
28	Care (2): Disease knowledge education Mobility: Wheel-bound	Care (1): Social resources referral and legal support	13.25	100	1.19
	Mobility: Wheel-bound Getting lost: Never getting lost		13.25	90.91	1.08
	Hypnotics: No use Mobility: Wheel-bound		13.25	90.91	1.08
	Age: 75–84 years Mobility: Wheel-bound		12.05	100	1.19
	Care (8): Fall prevention Mobility: Wheel-bound		10.84	100	1.19

the patient needed social resources referral and legal support (Care (1)). By the same token, “75–84 years old” was found in general rules 3, 6, 17, 22, 26, 27, and 28. For instance, if a patient whose age was 75–84 years had a fair response for hypnotics, this patient needed disease knowledge education (Care (2)) based on 27th general rule. For the patient whose age was  $\geq 85$  years, Care (1) would be needed when the patient needed assistance in mobility regardless of feeding independently or had very mild dementia. For 23rd general rule, when the patient with very mild dementia who needed hypertension care (Care (16)) would require memory problem care (Care (5)) regardless of hypnotics, feeding, or both. It is worth to note that 24th general rule had care for the mood of the caregiver (Care (11)), which was not included in the basic care need combinations. This rule depicted that a patient would require Care (11) when hallucination and feeding independently were incurred simultaneously for the patient.

Setting a lower support value enabled the dementia collaborative care team members to find more rules containing more care needs as well as variables such as age, gender, and the severity of dementia. In doing so, care team members could be easily to identify what care need combinations should be provided for a particular dementia patient. In contrast, rules with higher support values indicated that more PLWD with multiple chronic diseases would need care need bundles. In fact, there would be a trade-off between a higher or lower support value. In our study, if the support value was reduced from 10% to 5% with the confidence of 90% and lift  $>1$ , there were 2720 rules available. Obviously, these rules might be complicated in practical uses because several smaller groups of PLWD with multiple chronic diseases might need a wide variety of care needs. These rules might become less valuable for care team members to put into practice.

## Discussion

This study found a care need bundle combining four care needs for PLWD with multiple chronic diseases and their caregivers. They were social resources referral and legal support (Care (1)), drug knowledge education (Care (3)), memory problem care (Care (5)), and fall prevention (Care (8)). In addition to the basic care need bundles, disease knowledge education (Care (2)) and hypertension care (Care (16)) were also frequent care needs in PLWD with multiple chronic diseases. In patients with dementia and preserved ambulatory function or with the symptom of hallucination, care for the mood of the caregiver (Care (11)) should be considered as a frequent unmet need.

A previous study in Germany found the most frequent unmet need in PLWD was “nursing treatment and care”, in which “mobility limitation/risk of fall” and “daycare and ambulant care” were the two most common needs.<sup>8</sup> The second and third common unmet needs were “social counseling and legal support” and “pharmaceutical treatment and care.” Studies in the United States using Johns Hopkins Dementia Care Needs Assessment disclosed memory disorder education, care skills and knowledge of resources, legal issues/concerns, caregiver mental health, and access to informal support were most prevalent unmet needs for care partners of PLWD.<sup>7</sup> For community-living PLWD, home/personal safety, general health care, and maintenance of daily activities were the most frequent unmet needs.<sup>9</sup> Both groups also demonstrated that “diagnosis of dementia” was a common need in community-residing individuals with dementia.<sup>6,8,25</sup> The present study used a scientific method to combine four care needs for both PLWD and their caregivers as a care need

bundle. The four domains included frequent care needs listed in previous literatures. On the other hand, “diagnosis of dementia” was not considered as an unmet need because participants in this study have been diagnosed as dementia patients by neurology or psychiatric specialists.

Hypertension care (Care (16)) was a frequent care need in the present study because 78.3% of PLWD with multiple chronic diseases had hypertension. Hypertension was also the most common comorbid in PLWD as well as in a geriatric population with multiple chronic conditions.<sup>18,26</sup> Sufficient evidence showed that moderate-to-severe cognitive impairment had no impact on hypertension medication use in PLWD with co-occurring hypertension.<sup>17</sup> In mild dementia patients treated with anti-hypertensive medications, the rate of adverse health events was higher compared with the randomized controlled trials of anti-hypertensive medications.<sup>27</sup> Appropriate blood pressure goal setting and prevention of medication related side effects were important in PLWD with hypertension.

Compared with our previous reports, the care needs were adjusted from 15 to 26 items by six categories.<sup>11,12</sup> Similar care needs in the basic care need bundle for all dementia population and PLWD with multiple chronic diseases included disease education, care skills training, and referral of social resources.<sup>11</sup> Fall prevention should be included into a basic care need bundle in patients with vascular dementia as well as with multiple chronic diseases.<sup>11</sup>

Care for the mood of the caregiver (Care (11)) should be taken into consideration as an unmet need in multimorbidity dementia patients especially for whom had hallucination or had dementia with preserved ambulatory function. Caregivers of PLWD with multiple chronic conditions experienced a high caregiving load, taken on responsibility for managing multiple complex conditions, and felt worse healthy condition.<sup>15</sup> Previous studies also found caregiver’s mental health was a frequent unmet needs,<sup>7,25</sup> which was also an element included in the basic care need bundle for male patients with vascular cognitive impairment.<sup>12</sup> Preserved ambulatory function or neuropsychiatric symptoms were associated with a high caregiving burden.<sup>21,26</sup> Our previous report also found caregivers who cared for patients with moderate Alzheimer’s disease experienced severe depression.<sup>23</sup> Dementia care team should watch for caregiver’s mental health and provide suitable education or support group to relieving their stress.

Multimorbidity was often accompanied with frailty, polypharmacy, and dementia.<sup>28,29</sup> Hung et al<sup>30</sup> found that the comprehensive geriatric assessment guided multidisciplinary interventions (including physical therapy, psychotherapy, pharmacist education, and social resources linkage) were effective to improve frail severity, physical function, and depressive and nutritional status in elderly (45% with dementia). Appropriate intervention toward frail status and polypharmacy maybe also a solution to deal with this complex population.

The strength of this study was forming a care need bundle through combining care needs in a specific population through a scientific method. No studies have been found to discuss the unmet needs, especially for PLWD with multimorbidity. Another strength was the precise selection of care needs through a proper evaluation and shared decision-making between care teams and PLWD and their caregivers. Elementary dementia case managers could efficiently catch the care focus by using the result identified by our study.

There were some study limitations in this study. First, only eight chronic diseases were included into analysis. Some of the comorbidities frequently co-occurring in PLWD such as arthritis, heart failure, pulmonary diseases, cancers, and mood disorders were not collected in our database.<sup>18</sup> Because of fewer chronic diseases listed into counting, the study participants were supposed to contain at least three kinds of chronic conditions. Second, there was no universal approach to set up support and confidence values in order to generate association rules when applying the Apriori algorithm. In general, a higher confidence value, say 90% or above, is typically recommended when a conditional probability is applied to study the associations of attributes. In contrast to confidence, setting a higher support value would reduce the number of rules that might result in missing some essential rules with low frequencies. Obviously, there is a trade-off between either higher or lower support values. In this study, we displayed the results by using different intervals of support values to balance this condition. Third, the present study did not include caregiver’s characteristics, which may also influence the choice of care needs. Fourth, the study sample was relatively small and may not represent the true needs of the target population. Also, the study only included patients newly diagnosed of dementia, the care needs in the following period may change.

## Conclusion

Four basic care need combinations for PLWD with multiple chronic diseases and their caregivers found in this study were social resources referral and legal support (Care (1)), drug knowledge education (Care (3)), memory problem care (Care (5)), and fall prevention (Care (8)). Disease knowledge education (Care (2)) and hypertension care (Care (16)) were also frequent unmet needs in this specific population. Care for the mood of the caregiver (Care (11)) should be considered especially in PLWD with preserved ambulatory function or with the symptom of hallucination. The collaborative care team should pay more attention to those care needs when assessing this specific population.

## Data Sharing Statement

According to our hospital's regulation, individual de-identified data should pass both the Research and Development Committee and Institutional Review Board (IRB). Researchers should write a research proposal and apply a clinical trial for the IRB of our hospital. All data listed in the present manuscript can be obtained through email if both committees agree the application.

## Disclosure

Kai-Ming Jhang, Wen-Fu Wang, Yu-Ching Cheng, and Yu-Chen Tung are co-first authors for this study. The authors report no conflicts of interest in this work.

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