Article

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Application and Effect Evaluation of an NDB Theory-Guided Stepwise Feeding Strategy in Patients With Dementia-Related Feeding Difficulties

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Abstract

Background: Dementia is a common neurocognitive disorder in older adults and is often accompanied by feeding difficulties, which pose significant challenges for caregivers. According to the Need-Driven Dementia-Compromised Behavior (NDB) theory, such behaviors can be understood as expressions of unmet needs influenced by individual and environmental factors. Stepwise feeding strategies have been proposed as a practical approach to support feeding in patients with dementia. This study aims to evaluate the associations between an NDB theory-guided stepwise feeding strategy and clinical outcomes in patients with dementia-related feeding difficulties.

Methods: This retrospective study included 96 patients with dementia-related feeding difficulties secondary to dementia who were treated at our hospital between July 2019 and December 2021. Based on the nursing care documented in medical records, patients were divided into a conventional care group (n = 58) and an NDB theory-guided stepwise feeding group (n = 38). The primary outcome was the Edinburgh Feeding Evaluation in Dementia (EdFED) score. Secondary outcomes included nutritional status [body mass index (BMI), hemoglobin (Hb), and albumin (ALB)], immune indicators [immunoglobulin G (IgG), immunoglobulin M (IgM), immunoglobulin A (IgA), and cluster of differentiation 4 (CD4)/cluster of differentiation 8 (CD8) ratio], and adverse events (coughing, aspiration, and aspiration pneumonia). All data were extracted from medical records before and after the 10-week observation period.

Results: Baseline characteristics were comparable between the two groups ($p > 0.05$). Compared with baseline, BMI, Hb, and ALB levels increased in both groups after the 10-week observation period (all $p < 0.05$). Higher post-treatment values were observed in the NDB theory-guided stepwise feeding group than in the conventional care group (all $p < 0.05$). Similarly, lower post-treatment EdFED scores and a lower documented incidence of feeding-related adverse events were observed in the NDB theory-guided stepwise feeding group than in the conventional care group (all $p < 0.05$). Post-treatment immune indicator levels were also higher in the NDB theory-guided stepwise feeding group than in the conventional care group (all $p < 0.05$).

Conclusions: The NDB theory-guided stepwise feeding strategy was associated with more favorable post-treatment nutritional indicators, exploratory immune-related laboratory indicators, lower EdFED scores, and improved exploratory immune-related laboratory indicators in patients with dementia-related feeding difficulties. Further prospective studies are needed to confirm these observations.

Keywords

dementia; feeding behavior; nutritional status; deglutition disorders

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Introduction

Dementia, characterized by progressive cognitive impairment and behavioral disturbances, is one of the most common geriatric conditions [1,2]. The major clinical subtypes include Alzheimer's disease, which accounts for approximately 60–70% of dementia cases, vascular dementia, which accounts for approximately 15–20% of cases, and mixed dementia, which is also commonly observed in older adults [3]. Affecting millions worldwide, dementia typically presents as impairments in memory, language, problem-solving, and other cognitive abilities. Research indicates that the average global life expectancy rose above 70 years in 2021, and the population over 64 years old now exceeds the number of children under five, continuing to grow [4]. The global population is aging rapidly, and data analysis predicts that the number of dementia patients worldwide will increase from 57.4 million in 2019 to 152.8 million by 2050, with two-thirds of these cases occurring in low- and middle-income countries [5]. This poses a significant challenge to public health systems worldwide.

Eating is a fundamental human activity, and changes in diet can affect physical, emotional, and social aspects of life [6]. Dementia-related feeding difficulties often cause significant distress for patients and their caregivers [7]. Patients with dementia frequently experience varying degrees of feeding difficulties due to cognitive decline, executive dysfunction, and physiological deterioration of the digestive system. These difficulties include loss of appetite, impaired food recognition, problems with chewing and swallowing, and changes in feeding habits [8,9]. Such changes not only impact patients' physical health, leading to malnutrition, weight loss, decreased overall quality of life, aspiration, pneumonia, and even death [10,11], but also impose a considerable burden on caregivers [12]. Approximately 70% of patients in long-term care facilities exhibit feeding difficulties [13].

The Need-Driven Dementia-Compromised Behavior (NDB) model emphasizes a patient-centered approach, viewing the behaviors of dementia patients as expressions of unmet needs [2]. In this study, the NDB model served as the theoretical framework for understanding dementia-related behavioral symptoms. The stepwise (also referred to as graded or structured) feeding strategy represents the practical implementation of this framework in clinical care. Rather than representing separate interventions, these terms describe different aspects of the same approach, with the NDB model guiding individualized and need-based feeding support. Compared with general stepwise feeding approaches, the NDB-based strategy emphasizes identifying unmet needs and tailoring interventions to individual patients, thereby providing a more patient-centered approach. This framework provides valuable insights into understanding the behavioral and psychological symptoms of dementia, such as dementia-related feeding difficulties. One of the common feeding strategies used in clinical practice is the stepwise feeding approach, which simplifies the feeding process and provides structured support to promote patient autonomy, enhance the dining experience, and ensure nutritional intake. Previous research has shown that organized feeding interventions can significantly improve the nutritional status of dementia patients and enhance their quality of life [11].

This study aims to investigate and evaluate the associations between a stepwise feeding strategy guided by the NDB model and clinical outcomes in patients with dementia-related feeding difficulties. By providing a novel feeding strategy for both patients and caregivers, the goal is to improve patients' nutritional status and overall quality of life while also reducing the burden on caregivers.

Materials and Methods

Research Subjects

The clinical data of 126 patients with dementia-related feeding difficulties secondary to dementia who were admitted to The General Hospital of the Southern Theater Command of the People's Liberation Army of China from July 2019 to December 2021 were retrospectively analyzed using anonymized routinely collected clinical records.

Inclusion criteria: (1) A diagnosis of dementia according to established clinical criteria [Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)], including Alzheimer's disease, vascular dementia, and mixed dementia. (2) The Mini-Mental State Examination (MMSE) [14] was used as a screening tool to describe cognitive status, and a score of < 24 was considered suggestive of cognitive impairment according to commonly used clinical screening thresholds. The diagnosis of dementia was based on established clinical diagnostic criteria rather than on the MMSE score alone. (3) Oral feeding. (4) Presence of feeding difficulties, including behaviors such as reduced appetite, impaired food recognition, impaired chewing or swallowing, or loss of self-feeding ability, as documented in clinical records. (5) Age 60 years or older. (6) Complete clinical data.

Exclusion criteria: (1) Diagnosis of other types of mental disorders. (2) Patients in the acute phase of serious physical illnesses (e.g., severe infections, advanced malig-

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nancies, or organ failure). (3) Feeding difficulties caused by conditions other than dementia, such as acute infections, gastrointestinal disorders, or other neurological diseases.

Of these, 30 patients were not included in the final analysis: 24 did not meet the inclusion criteria, including 18 patients with incomplete clinical data, and 6 patients had other conditions that could affect feeding, such as gastrointestinal diseases or acute infections. Ultimately, 96 patients were included in the final analysis. Patients were retrospectively divided into two groups based on the type of nursing care documented in their medical records: 58 patients were assigned to the conventional care group and 38 patients were assigned to the NDB theory-guided stepwise feeding group.

All patients were admitted during the same study period (July 2019 to December 2021) and were managed within the same hospital setting. Ethical approval was obtained prior to data extraction and analysis. All patient data were anonymized prior to analysis.

Treatment Methods

The conventional care group received routine feeding care according to standard clinical practice. This typically included provision of regular hospital meals with balanced nutrition, assistance with feeding as needed, and monitoring of food intake. Feeding frequency and timing followed standard ward schedules (e.g., three meals per day), and caregivers provided basic support such as prompting, positioning, and supervision during meals. According to medical records, patients in the NDB theory-guided stepwise feeding group received the treatment for a fixed duration of 10 weeks. Patients in the conventional care group were observed over the same 10-week period.

NDB theory-guided stepwise feeding strategy: The treatment consisted of the following components implemented in routine clinical practice:

(1) Team-based care: A multidisciplinary nursing team was established, and staff received training on NDB principles and feeding support techniques. The training was delivered through bedside instruction, demonstration during meals, and brief feedback based on observed feeding performance. The content included patient-centered communication, recognition of unmet needs, safe positioning, verbal cueing, pacing of feeding, food texture adjustment, and management of feeding-related behavioral symptoms. Because the study was retrospective, caregiver competency was not evaluated using a formal standardized scale; however, relevant training and bedside guidance were documented in routine nursing records when available.

(2) Environmental modification: The dining environment was optimized by reducing noise, improving lighting, and using high-contrast tableware to facilitate food recognition and enhance patient attention during meals.

(3) Individualized assessment and NDB-guided care: Patients' cognitive status, feeding ability, and behavioral symptoms were assessed to identify unmet needs according to the NDB framework. Feeding strategies were adjusted based on these individualized assessments.

(4) Stepwise feeding support: Feeding assistance was provided progressively according to patient ability, starting with easily manageable food textures (e.g., soft or semi-solid diets) and advancing as tolerated. Caregivers provided verbal cues, physical guidance, and individualized support to promote patient participation. Progression between feeding stages was based on clinical tolerance rather than a fixed schedule. Patients were considered suitable for a higher level of self-feeding or more advanced food texture when they were able to complete meals with fewer prompts, maintain attention during meals, tolerate the current food texture without obvious coughing or choking, and show no documented aspiration-related symptoms. If coughing, choking, fatigue, refusal to eat, prolonged mealtime, or reduced intake occurred, the feeding stage was maintained or stepped back, and additional assistance or texture modification was provided.

(5) Food selection and nutritional support: Diets were adjusted according to patients' chewing and swallowing abilities, with attention to balanced nutritional intake. Nutritional adequacy was supported through routine meal provision and monitoring of intake as recorded in clinical practice. Nutritional monitoring was mainly based on routine clinical documentation, including daily meal intake, tolerance of prescribed food texture, body weight-related records, and laboratory indicators such as hemoglobin (Hb) and albumin (ALB) when available. Nurses recorded feeding performance, meal completion, need for assistance, and feeding-related adverse events during routine care. Formal adherence assessment was not prospectively designed; therefore, adherence to individual components was inferred from nursing documentation rather than quantified using a standardized checklist.

(6) Ongoing monitoring and adjustment: Patients' feeding performance and intake were regularly documented, and care strategies were adjusted accordingly to maintain safety and nutritional support.

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To improve the reproducibility of the treatment description, the operational procedures were further summarized according to routine nursing records. At the start of care, each patient's cognitive status, feeding ability, swallowing-related symptoms, food recognition, self-feeding capacity, and behavioral responses during meals were assessed by the nursing team. Based on these assessments, patients received stepwise feeding support ranging from verbal prompting and environmental cueing to partial physical assistance and full feeding assistance when necessary. The level of support was adjusted according to the patient's meal completion, tolerance of food texture, coughing or choking episodes, attention during meals, and ability to participate in self-feeding.

Caregivers and nursing staff were instructed to use patient-centered communication, simplified verbal cues, appropriate positioning, slow feeding pace, and observation of swallowing safety during meals. Nutritional intake and feeding tolerance were documented during routine care, including meal completion, food texture tolerance, coughing, aspiration-related symptoms, and adverse events. Because this was a retrospective study, formal adherence scoring and standardized competency evaluation of caregiver training were not available; this limitation has been acknowledged.

The NDB framework was reflected in practice by identifying and addressing individual unmet needs that may underlie feeding difficulties, thereby guiding adaptive feeding strategies. As this was a retrospective study, the treatment was implemented as part of routine care rather than according to a strictly standardized protocol, and adherence to each component was not formally quantified. The intensity and frequency of each component may have varied among patients based on individual needs and clinical judgment.

Assessment of Nutritional Status

Nutritional status data were extracted from medical records. Body mass index (BMI) values recorded within three days before and after the 10-week observation period were collected: ($\text{BMI} = \frac{\text{Weight(kg)}}{\text{Height(m)}^2}$). In addition, previously documented laboratory results were reviewed, including Hb and serum ALB levels measured from fasting venous blood samples. Hb was measured using an automated hematology analyzer (Sysmex XN-1000, Sysmex Corporation, Kobe, Japan), and serum ALB was measured using an automated biochemical analyzer (Cobas 8000, Roche Diagnostics, Basel, Switzerland), according to standard laboratory procedures. In addition to primary exposure and outcome variables, demographic and clinical data were extracted from medical records. These included age, gender, disease duration, dementia subtype (e.g., Alzheimer's disease, vascular dementia, or mixed dementia), and comorbid conditions such as hypertension, diabetes, and cardiovascular diseases. These variables were collected as part of routine clinical documentation and were used to describe baseline characteristics and assess comparability between groups.

Assessment of Immune Factors

Immune-related data were retrospectively extracted from medical records. Laboratory results recorded within three days before and after the 10-week observation period were reviewed, including immunoglobulin G (IgG), immunoglobulin M (IgM), and immunoglobulin A (IgA) levels. These immune-related indicators were included only when they were available within the predefined assessment window as part of routine clinical testing. Patients with acute infections or serious acute physical illnesses were not included in the final analysis according to the eligibility criteria. However, because this was a retrospective study, infection status during follow-up was not prospectively or uniformly assessed. These parameters were measured using enzyme-linked immunosorbent assay (ELISA) with an automated immunoassay analyzer (Cobas e 601, Roche Diagnostics GmbH, Mannheim, Germany), according to standard laboratory procedures. Additionally, data on T-cell subpopulations, including cluster of differentiation 4 (CD4) and cluster of differentiation 8 (CD8), were obtained from medical records. These indicators were measured using flow cytometry with automated analyzers in the hospital's central laboratory. The CD4/CD8 ratio was calculated based on the recorded values. All laboratory measurements were performed as part of routine clinical practice using certified equipment and standardized quality control procedures.

Assessment of Feeding Difficulties

Information on the types and possible causes of dementia-related feeding difficulties was retrospectively extracted from routine clinical and nursing records during the 10-week observation period. The reviewed records included documented mealtime observations, feeding performance, appetite and food intake, food recognition, chewing or swallowing-related symptoms, communication during meals, self-feeding ability, and caregiver or nursing notes on feeding-related behaviors. Based on these records, feeding difficulties were categorized as loss of appetite, overeating or repeated eating, impaired food recognition, communication-related feeding difficulty, or loss of self-

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feeding ability. Possible causes were summarized according to the documented clinical and nursing descriptions. No additional prospective interviews or standardized cause-specific assessment tools were used. The degree of feeding difficulties was evaluated using the Edinburgh Feeding Evaluation in Dementia (EdFED) scale. In this study, the EdFED score was used as the primary outcome measure. The EdFED scale [15] was used to assess the severity of feeding difficulties. The scale comprises three dimensions: patient behavior-obstinacy/aversion and passivity (7 items), nursing interventions (3 items), and an indicator of feeding difficulty (1 item), with a total of 11 items. Each item is scored based on the frequency of feeding difficulties observed during patient meals: 0 points for never, 1 point for sometimes, and 2 points for often, with a total possible score of 22 points. Higher scores indicate greater severity of feeding difficulties. The Cronbach's α coefficient for the simplified Chinese version of the scale is 0.90.

Adverse Events

Adverse event data were extracted from medical records. The incidence of adverse events, including coughing, aspiration, and aspiration pneumonia, was summarized based on documented clinical records during the 10-week observation period.

Outcome Definition

The primary outcome measure was the total EdFED score. The primary analysis focused on the comparison of post-treatment EdFED scores between groups. Secondary outcomes included nutritional status indicators, including BMI, Hb, and ALB, and documented adverse events. Immune-related laboratory indicators, including IgG, IgM, IgA, and the CD4/CD8 ratio, were included as exploratory outcomes because they were available in routine clinical records and may reflect general health status in older patients. These indicators were not considered primary mechanistic endpoints, and their clinical interpretation was limited.

Statistical Analysis

Statistical analyses were performed using SPSS 20.0 (IBM Corp., Armonk, NY, USA). Normally distributed continuous data are presented as mean $\pm$ standard deviation and were analyzed using paired *t*-tests for within-group comparisons and independent-samples *t*-tests for between-group comparisons. Non-normally distributed data are presented as median (minimum, maximum) and were analyzed using the Wilcoxon signed-rank test for within-group comparisons and the Mann-Whitney *U* test for between-group comparisons. Between-group comparisons after the observation period were based on post-treatment values. Categorical data are presented as [n (%)], and comparisons between the two groups were conducted using the chi-square test. All statistical tests were two-sided, and a p value of < 0.05 was considered statistically significant.

Results

General Data Analysis

Between the two groups of patients, no statistically significant differences were observed in general demographic data (all $p > 0.05$, Table 1).

Types and Causes of Dementia-Related Feeding Difficulties

Based on the clinical records, dementia-related feeding difficulties were classified into five main categories: loss of appetite, overeating or repeated eating, impaired food recognition, communication-related feeding difficulty, and loss of self-feeding ability. Loss of appetite was documented in 28 patients (29.17%) and was commonly associated with unfamiliar hospital environments, reduced taste perception, medication effects, oral discomfort, pain, fatigue, anxiety, or depressive symptoms. Overeating or repeated eating was documented in 22 patients (22.92%) and was mainly related to memory impairment and reduced recognition of satiety. Impaired food recognition was documented in 26 patients (27.08%) and referred to difficulty identifying food or understanding how to eat because of cognitive decline. Communication-related feeding difficulty was documented in 20 patients (20.83%) and referred to difficulty expressing hunger, thirst, food preferences, or discomfort because of aphasia or impaired communication. Loss of self-feeding ability was documented in 16 patients (16.67%) and was mainly associated with apraxia, sensory decline, impaired coordination, or motor dysfunction (Table 2).

Comparison of Nutritional Status

After the 10-week observation period, BMI, Hb, and ALB values were higher than baseline values in both groups. Post-treatment BMI, Hb, and ALB values were higher in the NDB theory-guided stepwise feeding group

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Table 1. General demographic data of the two groups [$\bar{x} \pm s$, n(%)].

Items	Conventional care group (n = 58)	NDB theory-guided stepwise feeding group (n = 38)	t/χ^2	p
Gender			0.115	0.734
Male	30 (51.72%)	21 (55.26%)		
Female	28 (48.28%)	17 (44.74%)		
Age	73.90 ± 7.36	76.79 ± 7.46	1.873	0.064
Marital status			0.025	0.875
Married	33 (56.90%)	21 (55.26%)		
Divorced/Widowed	25 (43.10%)	17 (44.74%)		
Education level			1.071	0.585
Elementary or below	17 (29.31%)	15 (39.47%)		
Middle school	30 (51.72%)	17 (44.74%)		
College or above	11 (18.97%)	6 (15.79%)		
Disease duration			0.954	0.621
< 1 year	13 (22.41%)	8 (21.05%)		
1~3 years	29 (50.00%)	16 (42.11%)		
> 3 years	16 (27.59%)	14 (36.84%)		
Chronic disease			1.171	0.279
Yes	24 (41.38%)	20 (52.63%)		
No	34 (58.62%)	18 (47.37%)		
Disease type			0.428	0.807
Alzheimer's disease	28 (48.28%)	19 (50.00%)		
Vascular dementia	17 (29.31%)	9 (23.68%)		
Mixed dementia	13 (22.41%)	10 (26.32%)		

NDB, Need-Driven Dementia-Compromised Behavior.

Table 2. Analysis of types and causes of dementia-related feeding difficulties.

Type	Description	Distribution [n (%)]
Loss of appetite	Reduced willingness or desire to eat, possibly related to unfamiliar hospital environments, unpalatable food, medication effects, oral or dental problems, pain, fatigue, anxiety, or depressive symptoms.	28 (29.17%)
Overeating or repeated eating	Excessive or repeated food intake, possibly related to memory decline, forgetting that a meal has already been eaten, or impaired recognition of hunger and satiety.	22 (22.92%)
Impaired food recognition	Difficulty identifying food, distinguishing edible from non-edible items, or understanding how to eat properly because of cognitive decline, impaired judgment, or reduced attention.	26 (27.08%)
Communication-related feeding difficulty	Difficulty expressing hunger, thirst, food preferences, discomfort, or refusal to eat because of aphasia, memory decline, or impaired language and communication ability.	20 (20.83%)
Loss of self-feeding ability	Reduced or absent ability to use utensils or feed independently, possibly related to apraxia, sensory decline, impaired coordination, or motor dysfunction.	16 (16.67%)

than in the conventional care group ($p < 0.05$, Table 3).

Comparison of Immune Function

After the 10-week observation period, IgG, IgM, IgA, and CD4/CD8 levels increased in both groups, and higher levels were observed in the NDB theory-guided stepwise feeding group than in the conventional care group ($p < 0.05$, Table 4).

Comparison of Feeding Difficulties

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Table 3. Comparison of nutritional status between the two groups ($\bar{x} \pm s$).

Items	Timing of intervention	Conventional care group (n = 58)	NDB theory-guided stepwise feeding group (n = 38)	*t*	*p*
BMI (kg/m^2)	Before	18.71 ± 2.08	18.35 ± 2.53	0.770	0.443
	After	20.98 ± 2.38*	22.88 ± 2.25*	3.897	< 0.001
Hb (g/L)	Before	98.15 ± 9.11	98.16 ± 10.13	0.002	0.998
	After	106.40 ± 7.98*	112.92 ± 8.17*	3.878	< 0.001
ALB (g/L)	Before	34.36 ± 3.45	34.59 ± 3.39	0.316	0.753
	After	37.09 ± 3.16*	39.25 ± 2.97*	3.348	0.001

BMI, body mass index; Hb, hemoglobin; ALB, albumin; NDB, Need-Driven Dementia-Compromised Behavior. *$p < 0.05$ for within-group comparison before vs. after 10-week observation period.

Table 4. Comparison of immune indicators between the two groups ($\bar{x} \pm s$).

Items	Timing of intervention	Conventional care group (n = 58)	NDB theory-guided stepwise feeding group (n = 38)	*t*	*p*
IgG (g/L)	Before	9.20 ± 1.17	9.24 ± 1.28	0.172	0.864
	After	12.20 ± 2.09*	13.61 ± 2.31*	3.100	0.003
IgM (g/L)	Before	1.03 ± 0.13	1.05 ± 0.13	0.786	0.434
	After	1.52 ± 0.15*	1.72 ± 0.15*	6.099	< 0.001
IgA (g/L)	Before	2.15 ± 0.22	2.10 ± 0.24	1.171	0.244
	After	2.89 ± 0.84*	3.37 ± 0.78*	2.866	0.005
CD4/CD8	Before	1.01 ± 0.08	1.04 ± 0.07	1.747	0.084
	After	1.61 ± 0.09*	1.89 ± 0.06*	17.288	< 0.001

IgG, immunoglobulin G; IgM, immunoglobulin M; IgA, immunoglobulin A; CD4/CD8, cluster of differentiation 4/cluster of differentiation 8 ratio; NDB, Need-Driven Dementia-Compromised Behavior. *$p < 0.05$ for within-group comparison before vs. after the 10-week observation period.

After the 10-week observation period, the indicators of feeding difficulties in the conventional care group decreased compared to before care. The total EdFED score, defined as the primary outcome, was lower after the 10-week observation period in the NDB theory-guided stepwise feeding group than in the conventional care group ($p < 0.05$, Table 5).

Comparison of the Incidence of Adverse Events

During the 10-week observation period, documented adverse events occurred in 5 patients (13.16%) in the NDB theory-guided stepwise feeding group and 18 patients (31.03%) in the conventional care group. The overall documented incidence was lower in the NDB theory-guided stepwise feeding group than in the conventional care group ($\chi^2 = 4.027$, $p < 0.05$, Table 6).

Discussion

In this retrospective observational study, patients who received the NDB theory-guided stepwise feeding strategy showed more favorable post-treatment nutritional indicators and lower EdFED scores than those who received conventional feeding care. A lower documented incidence of feeding-related adverse events was also observed in the NDB theory-guided stepwise feeding group. However, because group allocation was not randomized and baseline-adjusted analyses were not performed, these findings should be interpreted as associations rather than evidence of comparative efficacy.

Previous studies have explored various dietary patterns in relation to cognitive health in older adults [16–19]. These studies mainly focused on nutritional composition, whereas the present study focused on the feeding process and mealtime support. This distinction is clinically relevant because patients with dementia-related feeding difficulties often require not only appropriate nutrition, but also individualized assistance, environmental support, and caregiver guidance during meals.

The clinical value of the NDB theory-guided stepwise feeding strategy may lie in its individualized and structured approach to mealtime support. Feeding difficulties in patients with dementia may result from impaired food recognition, reduced attention, communication difficulties, chewing or swallowing problems, and loss of self-feeding ability [20,21]. From the perspective of the NDB model, feeding-related behaviors may reflect unmet needs rather than isolated behavioral problems. Therefore, assessing the

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Table 5. Comparison of feeding difficulties between the two groups [$\bar{x} \pm s$, median (minimum, maximum)].

Items	Timing of intervention	Conventional care group (n = 58)	NDB theory-guided stepwise feeding group (n = 38)	Z	p
Nursing interventions	Before	3 (0, 4)	3 (2, 4)	0.416	0.678
	After	2 (1, 4)	2 (0, 4)*	2.103	0.035
Patient behavior	Before	6 (1, 9)	6 (2, 9)	0.455	0.649
	After	6 (2, 9)	3 (0, 9)*	4.569	< 0.001
An indicator of feeding difficulty	Before	2 (2, 2)	2 (2, 2)	0.162	0.871
	After	1 (1, 1)*	1 (0, 1)*	2.019	0.043
Total EdFED score	Before	10 (9, 12)	10 (9, 12)	0.431	0.666
	After	9 (7, 11)*	6 (4, 7)*	4.949	< 0.001

EdFED, Edinburgh Feeding Evaluation in Dementia; NDB, Need-Driven Dementia-Compromised Behavior. *$p < 0.05$ for within-group comparison before vs. after the 10-week observation period. Data are expressed as median (minimum, maximum) for non-normally distributed variables, and nonparametric tests were applied accordingly.

Table 6. Comparison of the incidence of adverse events between the two groups [n (%)].

Group	Coughing	Aspiration	Aspiration pneumonia	Total
Conventional care group (n = 58)	13 (22.41%)	4 (6.90%)	1 (1.72%)	18 (31.03%)
NDB theory-guided stepwise feeding group (n = 38)	4 (10.53%)	1 (2.63%)	0 (0.00%)	5 (13.16%)
χ^2				4.027
p				0.045

NDB, Need-Driven Dementia-Compromised Behavior.

possible causes of feeding difficulties and providing graded support may help caregivers respond more appropriately during meals. In practice, this strategy may include verbal prompting, demonstration, hand-over-hand guidance, environmental cueing, food texture modification, appropriate positioning, and adjustment of feeding assistance according to patient tolerance. These components may be particularly useful in routine nursing settings where feeding support is provided by nurses and family caregivers.

In addition to feeding difficulties and nutritional indicators, immune-related laboratory indicators, including IgG, IgM, IgA, and the CD4/CD8 ratio, were analyzed as exploratory outcomes. These indicators were selected because they were available from routine clinical records and may provide indirect information on the general health status of older patients with dementia. However, they are less clinically direct than feeding-related outcomes, nutritional status, functional status, or quality-of-life measures. Therefore, the EdFED score and nutritional indicators should be regarded as the main clinically meaningful outcomes of this study, whereas immune-related indicators should be interpreted as exploratory laboratory outcomes only.

The interpretation of immune-related indicators is limited by the retrospective design. Although patients with acute infections or serious acute physical illnesses were not included in the final analysis, infection status during follow-up was not prospectively or uniformly assessed. Other factors, including medication use, chronic inflammation, comorbidities, and laboratory variability, may also have influenced these markers. Accordingly, the observed differences in immune-related indicators should be considered hypothesis-generating only and should not be interpreted as evidence that the feeding strategy directly improved immune function.

The EdFED scale is the main method for standardizing the measurement of feeding difficulties in patients with dementia. During the course of the disease, patients with dementia often exhibit feeding difficulties, which are caused by physical and cognitive decline, psychological state, and insufficient interaction with caregivers and environmental support [22]. The findings of this study may suggest an association between structured, individualized mealtime support and less severe feeding difficulties; however, these findings should not be interpreted as definitive evidence of treatment efficacy because of the observational design and lack of baseline-adjusted analyses. One possible explanation is that NDB-guided assessment encourages caregivers to identify the potential needs underlying feeding-related behaviors, such as discomfort, reduced attention, impaired recognition, or difficulty expressing preferences, and to adjust feeding support accordingly.

In addition, the lower post-treatment EdFED scores

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observed in the NDB theory-guided stepwise feeding group may be explained by that the strategy emphasized individualized assessment and graded mealtime support. Feeding difficulties in patients with dementia may arise from impaired food recognition, reduced attention, communication difficulty, swallowing-related symptoms, or loss of self-feeding ability. By identifying these problems and adjusting the level of assistance accordingly, caregivers may be able to reduce mealtime confusion, improve patient participation, and respond more appropriately to feeding-related behaviors. Improved meal completion, better matching of food texture to chewing and swallowing ability, and closer monitoring of intake during routine care may also partly explain the more favorable post-treatment nutritional indicators. Environmental modification, such as reducing noise, improving lighting, and using visual cues, may help patients maintain attention and recognize food more easily. In addition, caregiver guidance may improve the quality of mealtime interaction and encourage safer, more consistent food intake. The lower documented incidence of feeding-related adverse events may be related to earlier recognition of coughing, choking, fatigue, refusal to eat, or poor tolerance during meals, allowing caregivers to adjust feeding pace, posture, food texture, and assistance level according to patient tolerance. However, this interpretation should remain cautious because adverse events were identified retrospectively from medical records and the number of events was small.

The NDB theory-guided stepwise feeding strategy aims to gradually adjust patients' feeding methods, environments, and types of food to ensure safe and effective feeding. It typically includes personalized assessment and planning (e.g., individualized meal timing [23,24]), gradual food adjustments (altering the characteristics of food intake [25]), environmental optimization (such as improving the dining environment [26] and enhancing the human environment [27]), caregiver guidance and support (using brief statements and a positive attitude to engage patient interaction [28–30]), and multidisciplinary team collaboration [31–33]. These measures are intended to address the physiological, psychological, and social needs of patients, and may contribute to the safety and effectiveness of feeding and to overall behavioral outcomes. Swallowing difficulties are a common mortality risk factor in dementia patients, potentially leading to severe complications such as dehydration, malnutrition, and respiratory infections like aspiration pneumonia. Data indicate that the prevalence of swallowing difficulties in elderly dementia patients is rising [34,35]. Stepwise swallowing training has been reported as a safe and potentially effective approach for managing swallowing difficulties in elderly dementia patients [36], which is consistent with the observational findings of this study.

This study has several limitations. First, it was a retrospective, single-center study with a relatively small sample size, which may limit the generalizability of the findings. Group allocation was based on routine nursing care rather than randomization, and no baseline-adjusted analyses, multivariable regression models, mixed models, or propensity score methods were performed. Therefore, residual confounding, baseline imbalance, and regression to the mean cannot be excluded, and the observed between-group differences should be interpreted as associations rather than causal effects. Second, the study may have been underpowered for several secondary outcomes, particularly adverse events and immune-related indicators. Third, although an operational summary of the NDB theory-guided stepwise feeding strategy was added to improve transparency, the treatment was implemented as part of routine clinical care rather than according to a prospective standardized protocol. Therefore, the intensity and frequency of some components may have varied among patients, and adherence to each component could not be quantified using a standardized checklist. Finally, immune-related indicators were exploratory laboratory outcomes, and their clinical relevance remains limited because they may be influenced by infection status, medication use, chronic inflammatory conditions, comorbidities, and laboratory variability. Future multicenter prospective studies with larger samples, standardized treatment manuals, predefined feeding-stage progression criteria, structured caregiver training, prospective adherence assessment, and adjusted analyses are needed to confirm these observations.

Conclusions

In summary, the NDB theory-guided stepwise feeding strategy was associated with more favorable post-treatment nutritional indicators, lower EdFED scores, and a lower documented incidence of feeding-related adverse events in patients with dementia-related feeding difficulties. Exploratory immune-related laboratory findings should be interpreted cautiously and considered hypothesis-generating only. Further prospective studies with larger samples, standardized protocols, and adjusted analyses are needed to confirm these observations.

Availability of Data and Materials

The data used to support the findings of this study are included within the article, and during the present study are

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available from the corresponding author on reasonable request.

Author Contributions

HL and QQL designed the research; HL collected and analyzed the data; QQL interpreted the results and drafted the manuscript; ZXS and DPH analyzed and interpreted the data and contributed to writing and revising the manuscript; WDC and SL were responsible for project administration and contributed to the design and implementation of the study, as well as manuscript revision. All authors contributed to editorial changes in the manuscript. All authors took public responsibility for their contributions, approved the final manuscript for publication, agreed to be accountable for all aspects of the work, and ensured that any questions related to the accuracy or integrity of the study were appropriately investigated and resolved.

Ethics Approval and Consent to Participate

This study was approved by the Human Ethics Committee of The General Hospital of the Southern Theater Command of the People's Liberation Army of China (Approval No. 2022-022) and conducted in accordance with the Declaration of Helsinki. Due to the retrospective nature of the study, the requirement for written informed consent was waived by the ethics committee.

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Conflict of Interest

The authors declare no conflict of interest.

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