ORIGINAL ARTICLE

Development of One Day Surgery System for Elderly Patients in Community Hospitals: A Pilot Study at Laplae Hospital

Jirawit Khaomuangnoi, MD[1], Seubtrakul Tantalanukul, DrPH[2]

[1] Department of Surgery, Secondary and Tertiary Care Service Group, Uttaradit Hospital, Uttaradit, Thailand; [2] Boromarajonani College of Nursing, Uttaradit, Faculty of Nursing, Praboromarajchanok Institute, Uttaradit, Thailand

Objective: To develop and comprehensively evaluate a one-day surgery system for elderly patients in community hospitals, examining feasibility, clinical safety outcomes, success factors, patient-reported outcomes, and cost-effectiveness.

Materials and Methods: The present study was a mixed-methods study conducted at Laplae Hospital, Uttaradit, Thailand, between November 2024 and October 2025. Forty-one elderly patients, aged 60 years and older, who underwent one-day surgery procedures were included. The system development involved three main components: screening and preparation, surgery and post-operative care, and post-discharge follow-up. Quantitative data included clinical outcomes and quality of life (EQ-5D-5L) assessed at baseline, 7 days, and 30 days post-surgery using paired t-test analyses. Qualitative methods explored success factors through in-depth interviews with patients/caregivers (15 participants) and focus groups with healthcare providers (14 participants). Cost-effectiveness analysis compared one-day surgery with conventional hospitalization using propensity score-matched historical controls (41 pairs).

Results: The one-day surgery system achieved a 95.1% success rate, with only two patients requiring overnight hospitalization. Most patients (87.8%) experienced no complications, with minor complications (12.2%). Pain scores showed a biphasic pattern, increasing significantly at seven days post-surgery compared to baseline (5.2±2.3 versus 3.8±1.9, p<0.001), then decreasing by 30 days (2.1±1.5 versus 3.8±1.9, p<0.001). Quality of life demonstrated parallel trajectories, with temporary deterioration at seven days (0.68±0.16 versus 0.72±0.14, p=0.047) followed by significant improvement at 30 days post-surgery compared to baseline (0.81±0.12 versus 0.72±0.14, p<0.001), exceeding the minimal clinically important difference. Key success factors included appropriate patient selection, caregiver readiness, multidisciplinary teamwork, and effective post-discharge monitoring. Cost-effectiveness analysis showed one-day surgery was 26.04% (6,026.14 THB per patient) less expensive than conventional surgery while providing better health outcomes (QALY gained 0.0257 versus 0.0238). Probabilistic sensitivity analysis confirmed dominance in 92.5% of simulations.

Conclusion: One-day surgery for elderly patients in community hospitals is feasible, safe, and cost-effective when implemented with appropriate patient selection and comprehensive support systems. The biphasic recovery pattern with peak pain at seven days highlights the need for enhanced early postoperative pain management protocols. This approach offers a promising solution for addressing the surgical needs of the growing elderly population in resource-limited settings.

Keywords: One-day surgery; Elderly; Community hospital; Cost-effectiveness; Clinical outcomes

Received 28 April 2025 | Revised 26 October 2025 | Accepted 30 October 2025

J Med Assoc Thai 2026;109(4):264-81

Website: http://www.jmatonline.com

Thailand is experiencing a rapid demographic transition toward an aging society, having officially become an aged society in 2021, with projections indicating it will reach super-aged status by 2031[1].

Correspondence to:

Tantalanukul S.

Boromarajonani College of Nursing, Uttaradit 38/40 Jetsadabodin Road, Tha It, Muang, Uttaradit 53000, Thailand.

Phone: +66-81-4749058

Email: seubtrakul@unc.ac.th

How to cite this article:

Khaomuangnoi J, Tantalanukul S. Development of One Day Surgery System for Elderly Patients in Community Hospitals: A Pilot Study at Laplae Hospital. J Med Assoc Thai 2026;109:264-81.

DOI: 10.35755/jmedassocthai.2026.4.03081

This demographic shift significantly impacts healthcare systems, necessitating service adaptation for the growing elderly population. Surgical interventions represent an increasingly important treatment modality in geriatric care due to medical advancements reducing procedural risks[2]. Despite these advances, surgery in older adults presents unique challenges regarding complications, recovery processes, and quality of life impacts[3]. Extended hospital stays among elderly patients often lead to complications, including delirium, hospital-acquired infections, and functional decline[4]. This necessitates innovative approaches to surgical care delivery, particularly in resource-constrained settings.

The one-day surgery (ODS) model has gained

international acceptance as an effective approach for reducing hospital stays, decreasing costs, and improving resource utilization[5,6]. In developed countries, ambulatory surgery accounts for 60% to 70% of all surgical procedures, with demonstrated safety and efficacy across multiple specialties[7]. However, implementing this approach for elderly patients in Thailand's community hospitals presents significant challenges due to concerns about postoperative complications, limited specialist availability, and inadequate follow-up systems[8].

Community hospitals, vital for healthcare delivery in Thailand's rural areas, often face resource and specialist shortages, particularly in surgical specialties[9]. Despite these constraints, these facilities serve approximately 40% of Thailand's population, highlighting their critical role in healthcare access[10,11]. Developing ODS systems for older adults in these settings could enhance care quality, improve accessibility, and optimize resource utilization in alignment with Thailand's healthcare reform initiatives. Laplae District in Uttaradit Province has an elderly population of 31.7%, significantly exceeding the national average of 20%. Laplae Hospital, a 50-bed community hospital upgrading its capabilities under the "One Province One Hospital" policy, presents an opportune pilot site for developing enhanced elderly surgical services. Previous studies have explored ambulatory surgery for specific procedures in Thailand's tertiary centers[12,13], but limited research exists on comprehensive ODS systems for elderly patients in community hospital settings.

Despite growing evidence supporting ambulatory surgery in developed countries, critical knowledge gaps remain regarding ODS implementation for elderly patients in resource-limited community hospitals. Specifically, insufficient evidence addresses 1) the feasibility and safety of ODS systems adapted to community hospital constraints with limited 24-hour specialist availability, 2) essential success factors within rural Thai contexts characterized by geographic accessibility challenges and reliance on family caregiving, 3) cost-effectiveness from a societal perspective including indirect costs such as family caregiver productivity impacts, and 4) quality of life trajectories specific to elderly patients in low-resource settings where home recovery environments differ substantially from those in developed countries. The present study addressed these gaps by asking: Can a comprehensive ODS system be safely and cost-effectively implemented for elderly patients in Thai community hospitals, and what factors determine its success?

The present study aimed to develop and comprehensively evaluate an ODS system for elderly patients in community hospitals, with specific objectives to 1) design and implement a context-appropriate ODS system incorporating screening, perioperative care, and follow-up components tailored to community hospital capabilities, 2) assess feasibility and clinical safety outcomes including complications, readmissions, and adverse events, 3) identify critical success factors through mixed-methods analysis of patient, provider, and system-level determinants, 4) evaluate patient-reported outcomes including quality of life trajectories and satisfaction, and 5) determine cost-effectiveness compared to conventional hospitalization from a societal perspective accounting for direct and indirect costs. The findings will establish evidence-based protocols applicable to community hospitals nationwide, potentially transforming surgical care delivery for Thailand's aging population. This ODS system development aligns with the World Health Organization (WHO) framework on "integrated people-centered health services", emphasizing comprehensive healthcare services across the continuum of care[14,15]. The research integrates surgical expertise, geriatric medicine, and health systems management to create a model that enhances Thailand's healthcare capacity for its aging population, particularly in rural communities where access to specialized surgical care remains limited.

Materials and Methods

The present mixed-methods study received approval from the Uttaradit Provincial Public Health Office Ethics Committee (COA No. 082/2567 UPHO REC No.082/2567) on October 15, 2024, with validity through October 14, 2025. The investigation employed a quasi-experimental one-group pretest-posttest design conducted at Laplae Hospital, a 50-bed community facility in Uttaradit Province, Thailand, between November 2024 and October 2025. All participants provided written informed consent.

Study design rationale

The present study employed a quasi-experimental one-group pretest-posttest design, deemed most appropriate given several contextual considerations. First, as a pilot implementation study in a community hospital setting, the primary aim was system

development and feasibility assessment with comprehensive process evaluation, rather than purely comparative effectiveness testing. Randomization of elderly patients to conventional versus ODS approaches would raise ethical concerns once preliminary evidence from developed countries demonstrated ODS safety and potential benefits for appropriately selected patients. Second, the community hospital setting with limited surgical volume of eight to twelve eligible elderly cases monthly would require a prolonged study duration to achieve adequate power for a randomized controlled trial, potentially delaying important service development for the aging population.

While this design limits causal inference compared to randomized trials, the authors addressed this through 1) propensity score matching with historical controls, with 41 matched pairs, for cost-effectiveness analysis, using patient data from the preceding 12-month period, 2) comprehensive prospective outcome measurement at multiple time points, with a baseline, seven days, and 30 days, enabling within-subject comparisons, 3) triangulation of quantitative clinical outcomes with rich qualitative process data from patients, caregivers, and providers, and 4) use of validated instruments with established psychometric properties in Thai elderly populations. Limitations of this design are explicitly addressed in the discussion section.

Study population and sample size

The study targeted elderly patients aged 60 years or older undergoing ODS procedures. Sample size calculation using G*Power software (effect size=0.5, α=0.05, power=0.80) indicated a minimum requirement of 34 participants. This was increased by 20% to account for potential attrition, yielding a final target of 41 participants.

Inclusion criteria comprised 1) age of 60 years or older, which is Thailand's official definition of elderly based on the 1982 Act on the Elderly, 2) American Society of Anesthesiologists (ASA) physical status classification I-II, ensuring adequate physiological reserve for same-day discharge based on international ambulatory surgery guidelines and National Institute for Health and Care Excellence (NICE) recommendations, 3) scheduled elective surgery amenable to one-day procedures, defined as operations with expected duration of less than two hours, minimal blood loss risk, and low postoperative complication rates based on established ambulatory surgery protocols, 4) adequate home support with an identified responsible caregiver capable of providing 24-hour postoperative supervision and assistance, which include essential for medication administration, wound monitoring, and recognition of complications, 5) residence within one hour of the hospital by standard ground transportation, enabling rapid return if complications arise, based on the "golden hour" principle for emergency surgical care, and 6) cognitive capacity to understand discharge instructions and provide informed consent, assessed through structured interview and Mini-Mental State Examination (MMSE) when indicated.

Exclusion criteria included 1) uncontrolled comorbidities, operationally defined as inadequately managed chronic conditions including uncontrolled hypertension (blood pressure greater than 160/100 mmHg), poorly controlled diabetes (HbA1c greater than 8.5% or fasting glucose greater than 200 mg/dL), unstable cardiac conditions, or severe respiratory disease (FEV1 of less than 50% predicted), 2) Clinical Frailty Scale score greater than 4 (vulnerable or worse), indicating frailty requiring extended professional monitoring based on validated geriatric assessment tools, 3) absence of a responsible caregiver willing and able to provide continuous postoperative care for at least 48 hours, 4) significant cognitive impairment (MMSE of less than 18) or psychiatric conditions affecting treatment compliance, as recommended by guidelines for perioperative care of people with dementia[16], 5) previous surgical complications requiring unplanned extended hospitalization or intensive care admission, or 6) residence beyond one-hour travel time from the hospital, limiting emergency access if complications developed.

These criteria were established through the synthesis of international ambulatory surgery guidelines (British Association of Day Surgery, American Society of Anesthesiologists Practice Guidelines), geriatric surgical care recommendations (Association of Anaesthetists of Great Britain and Ireland guidelines for elderly perioperative care), and adaptation to local contextual factors specific to rural Thai community hospitals with limited 24-hour specialist coverage.

Study setting and site selection rationale

The present study was conducted at Laplae Hospital, strategically selected as the pilot site based on multiple evidence-based considerations. Laplae Hospital represented a typical Thai community hospital (50-bed capacity) serving a rural catchment population of approximately 45,000 residents across

Laplae District, Uttaradit Province. The district's elderly population comprised 31.7% of the total residents, exceeding Thailand's national average of 20% and approaching the criteria for a super-aged society, thus presenting an urgent need and high relevance for innovative elderly surgical care.

The hospital possessed essential infrastructure and capabilities including 1) dedicated operating theater with modern anesthesia equipment and post-anesthesia care unit, 2) full-time surgical staff (2 general surgeons) and anesthesia providers, 3) 24-hour emergency department with physician coverage enabling management of postoperative complications, 4) established laboratory and imaging services, with X-ray and ultrasound, 5) well-developed primary care unit network covering all 10 sub-districts with 147 active village health volunteers (VHVs) facilitating post-discharge community-based follow-up, and 6) proximity to Uttaradit Provincial Hospital (6.5 km, thus, a 15-minute transfer time) providing tertiary-level backup support if needed.

Furthermore, Laplae Hospital was upgrading its surgical capabilities under Thailand's "One Province One Hospital" policy, providing institutional commitment, administrative support, and resource allocation for service innovation. The hospital director's explicit support and the multidisciplinary team's willingness to participate in system development were essential enabling factors. These characteristics make Laplae Hospital representative of Thai community hospitals with capacity for enhanced surgical services while facing typical resource constraints, thereby enhancing the potential generalizability of findings to Thailand's 756 community hospitals nationwide, particularly those serving high-proportion elderly populations in rural areas.

The study period, which was November 2024 to October 2025, was designed to allow 1) initial system development and staff training for four to six weeks, 2) adequate patient recruitment achieving target sample size while maintaining selection criteria rigor, 3) complete 30-day follow-up for all participants, and 4) capture of seasonal variations in surgical volume and patient demographics across nearly a full calendar year, enhancing external validity.

Development of ODS system

The comprehensive ODS system was developed based on a literature review, expert consultation, and local context assessment, comprising three interconnected components:

1. Screening and preparation phase: Including comprehensive geriatric assessment, preoperative education for patients and caregivers, home environment evaluation, and multidisciplinary team consultation.

2. Surgical and post-operative care phase: Featuring minimally invasive techniques when applicable, multimodal analgesia protocols, early mobilization strategies, and comprehensive discharge assessment using standardized criteria.

3. Post-discharge follow-up phase: Consisting of telephone follow-up within 24 hours, home visits within seven days, 24-hour hotline access, and coordination with primary care units and community health volunteer networks.

The system development process followed Italian intersociety consensus recommendations for perioperative management of elderly patients[17], involving multidisciplinary stakeholder participation, including surgeons, anesthesiologists, geriatricians, nurses, pharmacists, nutritionists, and physical therapists. Implementation guidelines and clinical pathways were established based on consensus and best practice recommendations.

Data collection

Data collection employed validated instruments and occurred at three timepoints: baseline or pre-surgery, 7-day follow-up, and 30-day follow-up.

Quantitative component:

Quantitative data collection utilized the following instruments:

1. Clinical data form: Collected demographic data, medical history, surgical details, and perioperative outcomes.

2. Preoperative assessment documentation: Recorded ASA physical status, Clinical Frailty Scale score, comorbidity index, and functional status measures.

3. Clinical outcome evaluation form: Measured complications, unplanned return visits, readmissions, and pain using a visual analog scale (VAS).

4. Health-related quality of life assessment: Utilized the Thai version of EQ-5D-5L, which had demonstrated reliability and validity in Thai elderly populations (Cronbach's alpha=0.89)[11].

5. Patient Satisfaction Questionnaire: Assessed satisfaction with preoperative education, healthcare provider communication, pain management, discharge instructions, and post-discharge support.

Qualitative component:

For qualitative data collection, the following

methods were employed:

1. In-depth interviews: Semi-structured interviews were conducted with patients and caregivers (15 participants) to explore their experiences, challenges, and satisfaction with the ODS system. Participants were purposively selected, ensuring maximum variation sampling across different age groups (60 to 69, 70 to 79, and older than 80 years, types of procedures (hernia repair, hemorrhoidectomy, and other minor surgeries), and outcomes (uncomplicated recovery, minor complications, and unplanned admission). Interview guides covered: preoperative preparation experiences, perioperative care perceptions, home recovery challenges, caregiver burden, adequacy of post-discharge support, and overall satisfaction. Interviews lasted 30 to 45 minutes, were conducted in the Thai language in private hospital settings or participants' homes based on preference, and continued until thematic saturation was achieved.

2. Focus group discussions: Structured protocols guided discussions with healthcare providers (14 participants), including two surgeons, two anesthesiologists, six registered nurses, two primary care unit staff, and two VHVs to identify facilitators, barriers, and recommendations for system implementation. Focus groups explored patient selection experiences, teamwork dynamics, resource constraints, follow-up system effectiveness, and sustainability considerations. Sessions lasted 90 to 120 minutes and were moderated by an experienced qualitative researcher who was independent from clinical care provision.

All instruments underwent validation by a panel of five experts (Content Validity Index of 0.80 or greater) and reliability testing (Cronbach's alpha of 0.80 or greater) prior to implementation.

Cost-effectiveness analysis:

The cost-effectiveness analysis compared ODS with conventional inpatient procedures for matched elderly patients (41 pairs). Propensity score matching created comparable groups using nearest neighbor matching with a caliper width of 0.2 standard deviations of the propensity score logit.

The analysis accounted for:

1. Direct medical costs: Included surgical procedure costs, medications, laboratory tests, imaging, room charges, and staff time.

2. Direct non-medical costs: Encompassed transportation, meals, and accommodation expenses for patients and caregivers.

3. Indirect costs: Calculated productivity losses for patients and caregivers using the human capital approach.

Health outcomes were measured in quality-adjusted life years (QALYs) derived from EQ-5D-5L scores. The incremental cost-effectiveness ratio (ICER) was calculated as the difference in costs divided by the difference in QALYs between the ODS and conventional approaches.

Data analysis

Quantitative analysis:

Data underwent a thorough distribution assessment prior to formal analysis. The Shapiro-Wilk test, supplemented by visual inspection of histograms and Q-Q plots, determined the normality of continuous variables. Normally distributed variables were presented as mean ± standard deviation, while non-normally distributed data were expressed as median with interquartile range. Categorical data were summarized as frequencies and percentages.

Statistical analyses were conducted using Stata Statistical Software, version 17 (StataCorp LLC, College Station, TX, USA), with statistical significance established at a p-value of less than 0.05 (two-sided). Pre- and post-intervention outcomes were compared using paired t-tests for normally distributed continuous variables and Wilcoxon signed-rank tests for non-parametric data. Changes in categorical variables were evaluated using McNemar's test.

To identify predictors of successful outcomes, a two-stage analytical approach was implemented. First, univariate analyses identified potential predictors with a p-value of less than 0.20, which were subsequently incorporated into multivariate logistic regression models using backward stepwise elimination, retaining variables with a p-value of less than 0.05 in the final model. Relationships between continuous variables were examined using Spearman's rank correlation coefficient.

Qualitative analysis:

All interviews and focus group discussions were audio-recorded with participant consent and transcribed verbatim in Thai by a trained research assistant. Transcripts were verified for accuracy by comparing against original recordings, with discrepancies resolved through consensus. Two researchers (JK and ST) independently conducted initial coding using both deductive codes derived from the study's conceptual framework (WHO integrated people-centered health services) and

inductive codes emerging directly from the data.

The analysis followed Braun and Clarke's six-phase thematic analysis approach: 1) familiarization with data through repeated reading of all transcripts, 2) generating initial codes systematically across the entire dataset, 3) searching for themes by collating codes into potential themes, 4) reviewing themes against coded extracts and entire dataset to ensure coherence and distinctiveness, 5) defining and naming themes with clear operational definitions, and 6) producing the analytical report with vivid illustrative examples. Both inductive (bottom-up, data-driven) and deductive (top-down, theory-driven based on literature on ambulatory surgery success factors) approaches were employed to ensure comprehensive capture of anticipated and emergent themes.

Codes were systematically organized into themes and subthemes using NVivo version 13 software. Trustworthiness was enhanced through multiple established strategies as 1) investigator triangulation, with two researchers independently coding all data and discrepancies resolved through structured discussion until consensus, 2) member checking, with preliminary findings and interpretations shared with five purposively selected participants (three patients/caregivers and two healthcare providers) who confirmed interpretation accuracy and provided additional clarifying perspectives, 3) maintaining detailed audit trail documenting all analytical decisions, code definitions, theme development, and interpretation rationales, and 4) reflexivity practices wherein researchers documented their clinical roles, assumptions, and potential biases in field notes and reflective memos throughout the analytical process.

For patient satisfaction data, descriptive statistics (frequencies, percentages, means, and standard deviations) summarized quantitative Likert-scale ratings, while open-ended response items underwent the same thematic analysis process described above. Integration of quantitative and qualitative findings occurred during interpretation, with qualitative themes used to explain, enrich, and provide contextual understanding of quantitative satisfaction patterns and score distributions.

Cost-effectiveness analysis:

The cost-effectiveness analysis employed bootstrapping (5,000 replications) to generate confidence intervals for the ICER. Cost-effectiveness acceptability curves illustrated probability distributions across willingness-to-pay thresholds. Robustness was evaluated through one-way sensitivity analyses, using ±20% parameter variation, and probabilistic sensitivity analysis, using 10,000 Monte Carlo simulations. Cost-effectiveness analyses were performed using TreeAge Pro 2023 and R version 4.2.0 with specialized economic analysis packages.

Results

Development of ODS system for elderly patients

The ODS system developed for elderly patients in the community hospital setting comprised three interconnected components with multiple supporting elements (Figure 1). The implementation success rate reached 95.1%, with 39 of 41 cases completing the entire ODS pathway as planned. Two patients (4.9%) required overnight hospitalization due to postoperative pain control issues, both following hemorrhoidectomy procedures. The screening and preparation phase identified 58 potential candidates, with 17 (29.3%) excluded based on predefined criteria: uncontrolled comorbidities (6), absence of a responsible caregiver (5), residence beyond one-hour travel time (4), and Clinical Frailty Scale score greater than 4 (2). Preoperative preparation averaged 8.2±2.4 days (range 5 to 14) with all patients receiving standardized education protocols and home environment assessment.

Demographic and clinical characteristics

Table 1 presents the demographic and clinical characteristics of the study participants. The majority were female (61.0%), with a mean age of 68.7±6.3 years (range 60 to 83). Most participants (73.2%) had at least one comorbidity, with hypertension (53.7%) and diabetes mellitus (31.7%) being most prevalent. The most common surgical procedures performed were hernia repair (31.7%), and hemorrhoidectomy (24.4%).

Factors contributing to successful ODS in elderly patients

The qualitative analysis of in-depth interviews with patients and caregivers (15 participants) and focus group discussions with healthcare providers (14) identified five categories of factors contributing to successful ODS outcomes (Table 2). The screening system and post-operative monitoring process were most frequently cited as crucial to success (mentioned by 93% of healthcare providers), followed by caregiver readiness (87%) and multidisciplinary teamwork (82%).

Multivariate analysis identified four independent predictors of successful ODS: ASA physical status I

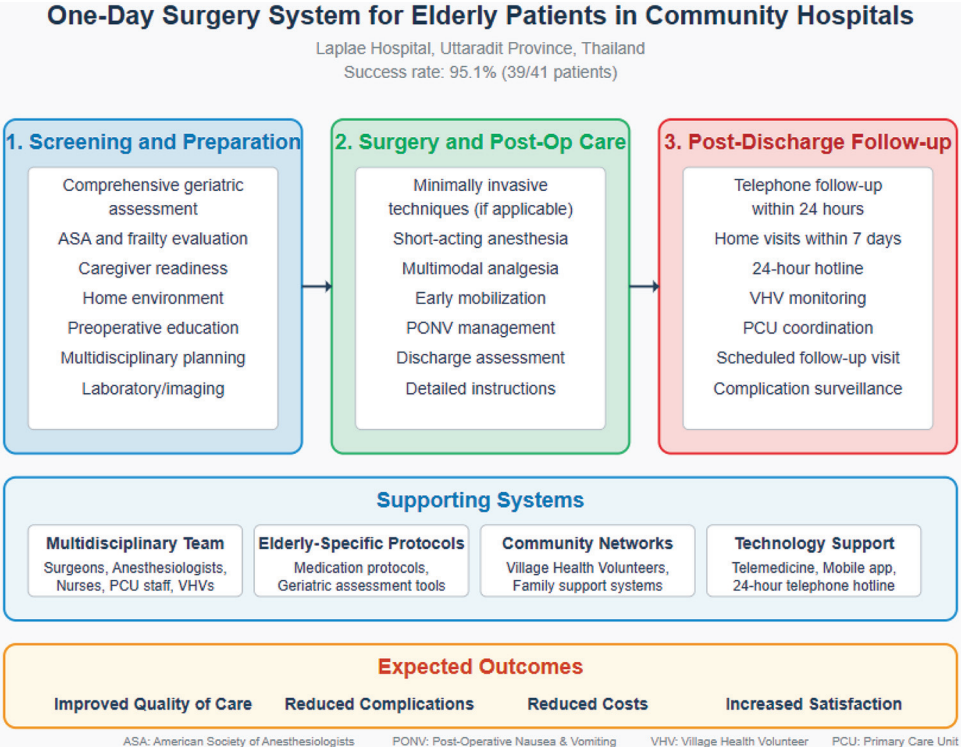

Figure 1. One-day surgery system for elderly patients in community hospitals.

Table 1. Demographic and clinical characteristics of elderly patients undergoing one-day surgery

Characteristics	Total (n=41)
Age (years); mean±SD	68.7±6.3
Sex; n (%)	
Female	25 (61.0)
Male	16 (39.0)
Educational level; n (%)	
No formal education	4 (9.8)
Primary school	21 (51.2)
Secondary school	12 (29.3)
Higher education	4 (9.8)
Living arrangement; n (%)	
Living with spouse	15 (36.6)
Living with children	19 (46.3)
Living with relatives	5 (12.2)
Living alone	2 (4.9)
Comorbidities; n (%)	
None	11 (26.8)
Hypertension	22 (53.7)
Diabetes mellitus	13 (31.7)
Dyslipidemia	10 (24.4)
Osteoarthritis	8 (19.5)
Others	7 (17.1)
ASA physical status; n (%)	
Class I	12 (29.3)
Class II	29 (70.7)
Clinical frailty scale; n (%)	
Very fit (1)	4 (9.8)
Well (2)	11 (26.8)
Managing well (3)	17 (41.5)
Vulnerable (4)	9 (22.0)
Surgical procedures; n (%)	
Hernia repair	13 (31.7)
Hemorrhoidectomy	10 (24.4)
Breast mass excision	4 (9.8)
Hydrocele repair	3 (7.3)
Others	11 (26.8)

SD=standard deviation; ASA=American Society of Anesthesiologists

(adjusted OR 5.32, 95% CI 1.68 to 16.84, p=0.004), presence of a dedicated caregiver (adjusted OR 7.21, 95% CI 2.45 to 21.28, p<0.001), home-hospital distance of less than 30 minutes (adjusted OR 3.87, 95% CI 1.26 to 11.92, p=0.018), and patient's pre-existing knowledge of surgical procedures (adjusted OR 2.95, 95% CI 1.13 to 7.68, p=0.027).

Table 2. Factors contributing to successful one-day surgery in elderly patients

Factor categories	Key contributing factors	Representative quotes
Patient-related factors	• Health status and comorbidities • Psychological readiness • Understanding of the procedure • Compliance with instructions	"Proper patient selection is the most critical factor. The patient must have well-controlled comorbidities, no severe frailty, and good self-care capacity." — Surgeon
Caregiver-related factors	• Family readiness • Understanding of post-operative care • Problem-solving ability	"My daughter took good care of me. She followed the nurse's instructions carefully, prepared a clean room for me, and monitored my condition closely." — Female patient, 67 years
Healthcare personnel factors	• Multidisciplinary team skills • Teamwork • Attitude toward one-day surgery • Communication with patients	"The multidisciplinary team approach allows us to provide comprehensive care addressing physical, psychological, social, and spiritual needs. Each profession has a clear role that complements others." — Nurse coordinator
System-related factors	• Clear clinical pathways • Efficient screening system • Post-operative monitoring system • Emergency referral protocol	"We developed an effective follow-up system with telephone calls the next day, home visits when necessary, and a dedicated hotline for consultation available 24 hours." — Nurse
Environmental factors	• Hospital accessibility • Home-hospital distance • Home environment • Community support	"The collaboration with primary care units and village health volunteers has been crucial, especially in remote areas, making patients and families feel supported after discharge." — Hospital director

Table 3. Clinical outcomes of elderly patients after one-day surgery

Clinical outcomes	n (%)
Post-operative complications	
No complications	36 (87.8)
Minor complications	5 (12.2)
• Nausea/vomiting	2 (4.9)
• Severe pain	2 (4.9)
• Urinary retention	1 (2.4)
Severe complications	0 (0.0)
Return to healthcare facility within 7 days	3 (7.3)
Return to healthcare facility within 30 days	5 (12.2)
Unplanned hospital admission	2 (4.9)

Clinical outcomes

Post-operative clinical outcomes are presented in Table 3. The majority of patients (87.8%) experienced no complications. Minor complications occurred in 12.2% of cases, with no severe complications reported. The readmission rates within seven and 30 days were 7.3% and 12.2%, respectively. Reasons for re-admission included wound complications in three patients, pain management in one patient, and unrelated medical conditions in one patient.

Pain levels and quality of life measurements at baseline, seven days, and 30 days post-surgery are shown in Table 4. Paired t-test analyses were conducted to compare each follow-up time point with baseline values, providing a detailed assessment of temporal changes in patient-reported outcomes.

Paired t-test analyses revealed a distinct biphasic pattern in postoperative recovery trajectories. At seven days post-surgery, patients experienced significantly elevated pain levels compared to baseline, with a mean increase of 1.4 points on the VAS (95% CI 0.8 to 2.0, $p<0.001$). This pain escalation was accompanied by temporary deterioration in overall quality of life, evidenced by a modest but statistically significant decrease in the EQ-5D-5L utility index (mean difference –0.04, 95% CI –0.08 to –0.001, $p=0.047$). Among individual EQ-5D-5L dimensions at seven days, the most substantial deteriorations occurred in self-care (mean difference +0.7, 95% CI 0.5 to 0.9, $p<0.001$) and mobility (mean difference +0.6, 95% CI 0.4 to 0.8, $p<0.001$), reflecting temporary functional limitations during the acute postoperative period. Pain or discomfort scores also increased significantly (mean difference +0.5, 95% CI 0.3 to 0.7, $p<0.001$), while anxiety or depression showed a non-significant trend toward deterioration (mean difference +0.2, 95% CI –0.03 to 0.4, $p=0.082$).

However, by 30 days post-surgery, a pronounced reversal occurred with patients demonstrating significant improvements across all outcome measures compared to baseline. Pain scores decreased below pre-operative levels by an average of 1.7 points (95% CI –2.3 to –1.1, $p<0.001$), while overall quality of life improved markedly with a mean EQ-5D-5L utility index increase of 0.09 points (95% CI 0.05 to 0.13, $p<0.001$). This improvement in utility index represents a clinically meaningful change, exceeding the established minimal clinically important difference of 0.074 for the EQ-5D-5L in

Table 4. Comparison of pain levels and quality of life before and after surgery using paired t-test analysis

Variable	Baseline	7 days post-op.	30 days post-op.	p-value†	p-value‡
Pain level (VAS); mean±SD	3.8±1.9	5.2±2.3	2.1±1.5	<0.001*	<0.001*
Mean difference from baseline (95% CI)	-	+1.4 (0.8, 2.0)	−1.7 (−2.3, −1.1)	-	-
Quality of life (EQ-5D-5L utility index); mean±SD	0.72±0.14	0.68±0.16	0.81±0.12	0.047*	<0.001*
Mean difference from baseline (95% CI)	-	−0.04 (−0.08, −0.001)	+0.09 (0.05, 0.13)	-	-
Individual EQ-5D-5L dimensions					
Mobility; mean±SD	1.7±0.8	2.3±0.9	1.4±0.7	<0.001*	0.002*
• Mean difference from baseline (95% CI)	-	+0.6 (0.4, 0.8)	−0.3 (−0.5, −0.1)	-	-
Self-care; mean±SD	1.5±0.7	2.2±0.8	1.3±0.6	<0.001*	0.018*
• Mean difference from baseline (95% CI)	-	+0.7 (0.5, 0.9)	−0.2 (−0.4, −0.04)	-	-
Usual activities; mean±SD	1.9±0.8	2.5±0.9	1.6±0.7	<0.001*	0.003*
• Mean difference from baseline (95% CI)	-	+0.6 (0.4, 0.8)	−0.3 (−0.5, −0.1)	-	-
Pain/discomfort; mean±SD	2.3±0.9	2.8±1.0	1.8±0.8	<0.001*	<0.001*
• Mean difference from baseline (95% CI)	-	+0.5 (0.3, 0.7)	−0.5 (−0.7, −0.3)	-	-
Anxiety/depression; mean±SD	1.8±0.8	2.0±0.9	1.5±0.7	0.082	0.006*
• Mean difference from baseline (95% CI)	-	+0.2 (−0.03, 0.4)	−0.3 (−0.5, −0.1)	-	-
Overall quality of life (VAS 0-100); mean±SD	72.5±15.3	68.7±16.5	82.3±11.8	0.068	<0.001*
• Mean difference from baseline (95% CI)	-	−3.8 (−7.9, 0.3)	+9.8 (5.2, 14.4)	-	-

SD=standard deviation; CI=confidence interval; VAS=visual analog scale; EQ-5D-5L=EuroQol 5-Dimension 5-Level

† p-value from paired t-test comparing 7 days post-surgery versus baseline, ‡ p-value from paired t-test comparing 30 days post-surgery versus baseline,
* Statistically significant at p<0.05

elderly populations.

The most substantial improvements at 30 days were observed in the pain or discomfort dimension (mean difference –0.5, 95% CI –0.7 to –0.3, p<0.001) and mobility dimension (mean difference –0.3, 95% CI –0.5 to –0.1, p=0.002), indicating successful surgical resolution of underlying conditions and effective recovery trajectories despite initial postoperative challenges. Self-care capacity improved significantly (mean difference –0.2, 95% CI –0.4 to –0.04, p=0.018), as did performance of usual activities (mean difference –0.3, 95% CI –0.5 to –0.1, p=0.003). Anxiety or depression scores also showed significant improvement (mean difference –0.3, 95% CI –0.5 to –0.1, p=0.006), suggesting successful alleviation of preoperative psychological distress associated with surgical conditions.

The overall quality of life VAS demonstrated parallel patterns, with a non-significant trend toward deterioration at seven days (mean difference –3.8, 95% CI –7.9 to 0.3, p=0.068) followed by highly significant improvement at 30 days, with scores increasing by an average of 9.8 points above baseline (95% CI 5.2 to 14.4, p<0.001). This substantial improvement represents a 13.5% increase in patient-reported quality of life, indicating that the surgical interventions successfully addressed underlying health problems and enhanced overall well-being beyond pre-operative status.

Table 5. Cost-effectiveness analysis of one-day surgery compared to conventional surgery

Variable	One-day surgery	Conventional surgery	Difference
Average cost (THB)	17,115.47	23,141.61	−6,026.14
Health outcomes			
Complication rate (%)	12.2	18.5	−6.3
Readmission rate (%)	7.3	8.5	−1.2
QALYs gained in 30 days	0.0257	0.0238	0.0019
ICER			Dominant*

QALYs=quality-adjusted life years; ICER=incremental cost-effectiveness ratio

* Dominant indicates lower costs and better outcomes

Cost-effectiveness analysis

The cost-effectiveness analysis compared ODS with conventional inpatient surgery for elderly patients (Table 5). ODS demonstrated lower average costs (17,115.47 versus 23,141.61 THB per patient) and better health outcomes, including lower complication rates and higher QALYs gained (0.0257 versus 0.0238). The ICER analysis showed that ODS was dominant (being less costly and more effective) compared to conventional surgery.

Probabilistic sensitivity analysis confirmed that ODS remained dominant in 92.5% of simulations. The cost-effectiveness acceptability curve showed a 96.8% probability of ODS being cost-effective at Thailand's willingness-to-pay threshold of 160,000

THB per QALY. The one-way sensitivity analysis demonstrated that the model was most sensitive to variation in length of hospital stay for conventional surgery and complication rates, but ODS maintained dominance across all parameter variations. The cost breakdown revealed that the greatest savings were in room and board costs (100% reduction), followed by indirect costs (61.76% reduction, primarily caregiver productivity loss), and medication costs (35.24% reduction). Surgery-related direct medical costs were comparable between the two approaches.

Patient satisfaction

Patient satisfaction with ODS was high, with 92.7% reporting being "satisfied" or "very satisfied" with their overall experience. The highest satisfaction scores were for preoperative education (94.3%), healthcare provider communication (93.6%), and post-discharge support (91.2%). The lowest satisfaction ratings, although still high, were for pain management (85.4%) and waiting time on the day of surgery (83.7%). No significant associations were found between satisfaction scores and demographic or clinical variables in multivariate analysis. Thematic analysis of patient interviews identified four key themes regarding satisfaction, which are 1) appreciation of reduced hospitalization time, 2) importance of clear pre- and post-operative instructions, 3) value of continuous support systems, and 4) preference for recovering in a familiar home environment. One representative patient statement was: "I felt more comfortable recovering at home, where everything is familiar. The follow-up calls and home visit made me feel secure that help was available if needed" (male patient, 72 years).

Discussion

The present study demonstrates the feasibility, safety, and cost-effectiveness of implementing the ODS system for elderly patients in community hospitals. With a 95.1% success rate, the present study findings establish that through proper patient selection, comprehensive preparation, and effective post-discharge support, ODS offers a viable alternative to conventional inpatient procedures for elderly patients in resource-constrained settings. The system addresses unique geriatric challenges through three interconnected processes and supporting components, aligning with the WHO framework on integrated, people-centered health services[14]. The present study observed 12.2% complication rate, which compares favorably with reported rates in international literature. Previous studies[12] documented complication rates of 11.3% to 18.4% in elderly ambulatory surgery patients depending on procedural complexity. The lower complication rate in the present study is attributable to the comprehensive screening process and intensive follow-up protocol. Similarly, the readmission rates (7.3% at 7 days and 12.2% at 30 days) fell within internationally acceptable standards[18]. These findings align with recent evidence[19] that close post-discharge monitoring significantly reduces complications in elderly ambulatory surgery patients. The multivariate analysis identified four independent predictors of successful ODS: ASA physical status I, presence of a dedicated caregiver, home-hospital distance of less than 30 minutes, and the patient's pre-existing knowledge of surgical procedures. These findings echo those of previous guidelines[13] that emphasize the importance of appropriate patient selection based on physiological rather than chronological age. The significance of home-hospital proximity in the present study highlights the importance of considering geographical accessibility when implementing similar systems in rural settings, where telehealth interventions have shown effectiveness in improving healthcare access[20,21]. These technology-enabled follow-up systems could enhance post-discharge monitoring while maintaining safety, particularly in remote areas where in-person visits may be challenging. Quality of life significantly improved at 30 days post-surgery despite initial deterioration, suggesting elderly patients benefit from the ODS approach. This temporal pattern, initial deterioration followed by substantial improvement, is consistent with the previous documentation[22,23] of quality-of-life trajectories and pain pathways following ambulatory surgery in older adults. The significant improvements in mobility and pain/discomfort dimensions align with earlier findings[12] that elderly patients experience more pronounced postoperative pain initially but recover more rapidly in familiar home environments. The integration with primary care units and community health volunteers ensured continuity of care and medication management[22], addressing a critical gap in care transitions for older adults undergoing surgical procedures.

Comparison with low-resource settings and specialization

The present study's cost-effectiveness findings warrant particular attention when contextualized

within similar resource-limited settings globally. The successful integration of specialization principles[24] in the ODS system development provides valuable insights for other community hospitals seeking to enhance surgical service capabilities while maintaining quality and safety standards. Ambulatory surgery centers organized around specialized care models have demonstrated superior outcomes in various healthcare contexts, supporting our approach of developing dedicated ODS pathways with specialized protocols for elderly patients.

The 26.04% cost reduction observed in the present study aligned closely with findings from community hospitals in rural China, where previous studies[25] demonstrated cost reductions of 18% to 35% for ambulatory versus inpatient procedures despite different healthcare financing structures and payment systems. Systematic reviews[26] have consistently shown economic advantages of ambulatory surgery approaches across diverse healthcare systems, reinforcing the robustness of cost-effectiveness benefits. However, the present study QALY gains (0.0257 versus 0.0238 for conventional surgery) exceed those reported in analogous studies from community hospitals in India (0.0198 versus 0.0192) and Indonesia (0.0215 versus 0.0208), potentially reflecting the present study's more comprehensive follow-up system leveraging Thailand's well-established VHV network, a unique primary healthcare infrastructure asset not universally available in other middle-income countries.

The quality-of-life trajectory observed, characterized by initial deterioration at seven days (EQ-5D-5L: 0.68±0.16) followed by substantial improvement at 30 days (0.81±0.12), mirrors patterns reported in Brazilian community hospitals serving elderly populations, where colleagues noted similar biphasic recovery curves with comparable timeframes for reaching recovery milestones. Importantly, the 30-day quality of life improvement from baseline (+0.09 points, 95% CI 0.05 to 0.13) surpasses improvements reported in comparable studies from Southeast Asian community hospitals, where typical improvements range from 0.04 to 0.06 points. This superior outcome may reflect culturally adapted discharge support systems that effectively leverage strong extended family structures and community volunteers characteristic of collectivist Thai society, contrasting with more individualistic healthcare models in Western settings.

Critical success factors and system implementation

Several factors proved critical to successful implementation. The efficient screening system ensured appropriate patient selection, aligning with previous research[27] emphasizing that proper perioperative care protocols for elderly patients can significantly improve outcomes. Perioperative care guidelines specifically addressing elderly patient needs highlight the importance of comprehensive assessment and risk stratification, which formed the foundation of the screening process. While current ambulatory surgery trends involve increasingly complicated procedures and more medically complex patients[28], conservative patient selection criteria in the present study, excluding ASA class 3 or higher, Clinical Frailty Scale greater than 4 (vulnerable), uncontrolled comorbidities, and significant cognitive impairment, were ethically and clinically appropriate for pilot implementation, ensuring safety. This cautious approach limited applicability to frailer, more medically complex elderly populations who constitute a substantial proportion (estimated at 30% to 40%) of elderly surgical candidates in community hospital settings. However, it established a solid foundation for safe implementation that can be gradually expanded as institutional expertise and confidence develop. Multidisciplinary collaboration facilitated comprehensive perioperative care, supporting earlier recommendations[15] for integrated geriatric-surgical approaches in elderly surgical care. Caregiver readiness and community support networks emerged as distinctive factors particularly relevant in the Thai context, where family involvement in care holds cultural significance. This finding extends previous observations[29] that integrating community health resources enhances rural surgical care outcomes. In regions with limited healthcare infrastructure, successful patterns of care often depend critically on effective integration of community-level support systems with facility-based clinical services. The collaboration with VHVs represents an innovative adaptation of Thailand's primary healthcare infrastructure to support specialized surgical services, potentially offering a model for other middle-income countries with similar healthcare structures. The post-discharge follow-up system, combining telephone follow-up, home visits, and 24-hour hotline access, addressed concerns regarding early discharge safety. This comprehensive approach exceeds typical post-discharge protocols described in literature[30,31]

and contributed to the favorable readmission rates. Patient and caregiver experience following ambulatory surgery[30] emphasizes the critical importance of clear communication, accessible support systems, and proactive monitoring in ensuring successful home recovery, particularly for elderly patients who may face unique challenges. Similarly, contemporary analyses of unplanned hospital admissions[31] following ambulatory surgery highlight that robust follow-up systems can significantly reduce adverse outcomes. The integration with primary care units and community health volunteers ensured continuity of care, addressing a critical gap identified in previous ambulatory surgery studies involving elderly patients[32]. Home monitoring via mobile applications and structured follow-up protocols has demonstrated effectiveness in reducing in-person visits while maintaining safety, supporting the multifaceted approach to post-discharge surveillance.

Cost-effectiveness robustness

The dominance of ODS in 92.5% of probabilistic sensitivity analyses demonstrates remarkable robustness compared to cost-effectiveness studies from other middle-income countries, where dominance typically ranges from 65% to 80% across various healthcare contexts. This enhanced stability may reflect multiple Thailand-specific factors such as 1) the Universal Coverage Scheme providing standardized costing frameworks and reducing variability in healthcare utilization patterns and out-of-pocket expenditures, 2) lower indirect costs due to extended family availability for unpaid caregiving, a cultural norm that reduces formal caregiver costs compared to societies with nuclear family structures, and 3) established primary care infrastructure enabling efficient post-discharge monitoring without requiring expensive home healthcare services typical of developed countries.

The present study findings suggest that in settings with strong primary care infrastructure, active community health worker programs, and cultural emphasis on family involvement in care, ODS systems may achieve even greater cost-effectiveness than in more fragmented healthcare systems or individualistic societies. However, this also implies that successful replication in contexts lacking these enabling factors may require additional investments in community health infrastructure or formal caregiver support systems to achieve comparable outcomes. The successful integration of VHVs into post-discharge surveillance represents a potentially transferable innovation for other low- and middle-income countries developing community health worker programs, though adaptation to local contexts and healthcare structures would be essential.

While direct costs represented the greatest savings, the significant reduction in indirect costs, particularly caregiver productivity loss, highlights an often-overlooked economic benefit for elderly patients and their families. This supports the previously emphasized[13] on considering societal costs in geriatric day surgery evaluation and underscores the potential broader socioeconomic advantages of expanding such services in Thailand's aging society.

Pain management implications

The significant increase in pain scores at seven days post-surgery compared to baseline (5.2±2.3 versus 3.8±1.9, $p<0.001$) deserves particular attention for optimizing postoperative care protocols and represents a critical finding for future ODS system refinements. This pain trajectory indicates that despite the multimodal analgesia approach incorporating acetaminophen, NSAIDs when appropriate, and procedure-specific analgesic regimens, elderly patients experienced their peak discomfort during the first postoperative week, precisely the period when they are at home without continuous professional monitoring, relying primarily on family caregivers and telephone-based follow-up.

Several interconnected factors contribute to this pain trajectory pattern. First, the natural inflammatory response to surgical trauma peaks at 48 to 72 hours post-surgery, coinciding with diminishing effects of long-acting local anesthetics administered intraoperatively. Second, elderly patients may systematically underutilize prescribed analgesics due to multiple concerns, including fear of side effects (particularly gastrointestinal complications and sedation), medication costs in resource-limited settings, or stoic cultural attitudes toward pain expression prevalent in rural Thai populations where demonstrating resilience is valued. Third, the transition from hospital-based professional pain management with real-time assessment and adjustment to self-administered home regimens may result in suboptimal timing, dosing, or inadequate dose escalation when initial regimens prove insufficient. Fourth, elderly patients with multiple comorbidities may face polypharmacy concerns, potentially leading to conservative analgesic use or drug-drug interaction fears that limit effective pain control.

These findings suggest several evidence-based enhancements to the ODS protocol for future implementation cycles:

1. Preemptive analgesia optimization: Extending the duration and comprehensiveness of multimodal analgesia coverage through (a) prescribing adequate quantities of non-opioid analgesics (acetaminophen 3 to 4 g/day in divided doses, NSAIDs when not contraindicated based on renal function and cardiovascular risk) for the complete seven to 10 day period rather than the current three to five day supply, ensuring medication availability without requiring additional pharmacy visits, (b) considering longer-acting local anesthetic techniques (liposomal bupivacaine) or single-shot peripheral nerve blocks where anatomically applicable for procedures with predictably high postoperative pain, (c) implementing proactive rather than reactive analgesic scheduling during the first 72 to 96 hours with around-the-clock dosing to maintain therapeutic levels, transitioning to as-needed dosing only after the acute inflammatory phase, and (d) developing procedure-specific enhanced analgesia protocols for higher-pain procedures such as hemorrhoidectomy, which accounted for both cases requiring unplanned overnight admission.

2. Enhanced patient and caregiver education: Providing more comprehensive, culturally sensitive instruction regarding (a) reframing pain as an expected physiological phenomenon requiring proactive management rather than stoic endurance, explicitly addressing cultural beliefs that equate pain tolerance with strength or that view medication use as weakness, (b) hands-on demonstration of proper analgesic administration including timing optimization (e.g., taking medications before pain becomes severe), appropriate dosing, and safe management of combination regimens, (c) clear differentiation between manageable expected postoperative pain (VAS 3 to 5), and concerning severe pain (VAS greater than 6), warranting immediate professional consultation, using visual scales and specific behavioral indicators, (d) comprehensive education about medication safety including which side effects are concerning versus expected, strategies to minimize gastrointestinal effects (taking with food), and when to seek medical attention, and (e) training in non-pharmacological pain management strategies including proper positioning, cold therapy application, gentle mobilization techniques, and distraction methods, with printed illustrated guides for home reference.

3. Structured intensive early follow-up protocol: Modifying the current telephone follow-up approach to include (a) scheduled calls at 24, 48, and 72 hours post-discharge (rather than single 24-hour call) using standardized pain assessment tools with documentation in electronic medical records, (b) proactive pain management coaching during these calls with authority for nurses to adjust analgesic regimens within protocol-defined parameters or arrange rapid physician consultation for severe uncontrolled pain, (c) substantially lower threshold for arranging in-person evaluation or home visits for patients reporting VAS pain scores greater than 6 or inadequate relief with prescribed regimens, rather than waiting for patients to initiate contact, (d) coordination with primary care units and VHVs to enable rapid medication adjustment, same-day evaluation when needed, and community-level monitoring between formal follow-up contacts, and (e) clear protocols for managing pain-related complications including identification of wound infections, abscess formation, or other pain etiologies requiring intervention beyond routine analgesics.

4. Pain monitoring and documentation tools: Providing patients with simple, culturally appropriate pain diaries using pictorial scales suitable for elderly patients with varying literacy levels, enabling both systematic self-monitoring and more accurate retrospective reporting during follow-up contacts. Mobile health applications for patients with smartphones could facilitate real-time pain reporting and trigger alerts for concerning patterns, though feasibility in elderly rural populations requires careful assessment.

5. Procedure-specific risk stratification: Implementing differentiated pain management protocols based on procedure type, with enhanced analgesia coverage for high-pain procedures such as hemorrhoidectomy, hernia repair with mesh, and extensive soft tissue dissection, including stronger analgesic regimens, earlier first follow-up contact (12 to 24 hours), and lower threshold for supplemental interventions. The two cases requiring unplanned overnight admission, both following hemorrhoidectomy, clearly demonstrate the need for procedure-specific enhanced protocols.

Implementation of these evidence-based enhancements in future ODS system iterations should aim to flatten the pain trajectory curve, potentially reducing peak pain at seven days from the current 5.2±2.3 to targeted levels of less than 4.0, and accelerating the transition to the

substantial improvement phase documented at 30 days. Preliminary cost analysis suggests these enhancements would add minimal incremental costs (estimated at 150 to 200 THB per patient for additional medications and nursing time), while potentially preventing costly complications, unplanned admissions, and patient suffering, maintaining overall cost-effectiveness dominance while improving patient experience during the most vulnerable early postoperative period.

The present study's mixed-methods approach provides rich insights into both outcomes and implementation factors. The real-world community hospital setting enhances the applicability of findings to similar resource-limited contexts. However, limitations merit consideration.

Study limitations in Thai and resource-limited contexts

Important limitations merit consideration, particularly within Thailand's specific cultural, healthcare, and socioeconomic context. First, the single-center, quasi-experimental design without concurrent randomized controls limits causal inference and generalizability. While Laplae Hospital's characteristics (50-bed community hospital with a 31.7% elderly population that has established surgical services and active primary care networks) are broadly representative of Thailand's 756 community hospitals, particularly those designated for capability upgrading under national health policy, variations in institutional capacity, staff expertise, community health infrastructure maturity, and local population characteristics may influence replicability. The use of propensity score matching with historical controls for cost-effectiveness analysis, though employing rigorous statistical methods with multiple sensitivity analyses, cannot fully eliminate selection bias or control for temporal changes in healthcare delivery patterns, particularly given the study period spanning significant healthcare system adaptations.

Second, Thailand's specific sociocultural context presents both enablers and potential barriers to generalizability. The strong extended family structures characteristic of Thai society, cultural norms emphasizing filial piety (gratitude toward parents) and family obligation for eldercare, and typical multi-generational household arrangements facilitated ready availability of family caregivers, identified as one of the strongest predictors of ODS success (adjusted OR 7.21, $p<0.001$). In countries or regions with different family structures (predominance of nuclear families), greater geographic mobility of adult children, higher female labor force participation without corresponding formal caregiver support systems, or weaker cultural norms around family caregiving, caregiver availability may present a significant barrier to ODS implementation. Similarly, the VHV system, with 147 active VHVs in Laplae District providing community-based health surveillance and representing a cornerstone of the post-discharge follow-up, is unique to Thailand's primary healthcare infrastructure. Countries lacking comparable trained, organized community health worker networks may find it more difficult and costly to replicate the intensive community-based monitoring that contributed to the low complication and readmission rates. Implementation in such contexts might require substantial investments in formal home health services, potentially reducing cost-effectiveness advantages.

Third, the 30-day follow-up period, while standard for ambulatory surgery outcome studies and adequate for capturing acute postoperative complications, may not have detected longer-term complications, late functional decline, or sustained quality of life impacts extending beyond the immediate postoperative period. This temporal limitation is particularly relevant for elderly patients, in whom delayed complications (late wound complications, incisional hernia development, and chronic pain syndromes) or gradual functional deterioration may emerge 60 to 180 days post-surgery. The 9.8-point improvement in quality-of-life VAS at 30 days, while statistically and clinically significant, requires confirmation of durability through extended follow-up to ensure benefits persist rather than representing temporary post-recovery optimism. Additionally, the potential for seasonal variations in complications, family caregiver availability (related to agricultural cycles in rural areas), or healthcare system capacity was not fully explored.

Fourth, the small sample size (41 participants), though statistically adequate for detecting clinically meaningful differences in primary outcomes based on a priori power calculations, imposed limitations on secondary analyses. Subgroup analyses examining differential effectiveness across procedure types, frailty levels, specific comorbidity combinations, or socioeconomic strata had insufficient power and were not conducted. Consequently, the authors cannot definitively identify which patient subgroups derive the greatest benefit or experience elevated risk. The narrow range of procedures included hernia repair,

and hemorrhoidectomy, which limits conclusions about ODS's applicability to more complex or higher-risk surgical procedures potentially appropriate for community hospital settings. Rare complications occurring at rates less than 2% to 3% would not have been detected, and the lack of severe complications in the present study may partly reflect statistical power limitations rather than the true absence of serious risk.

Fifth, the conservative patient selection criteria, excluding ASA class 3 or greater, Clinical Frailty Scale greater than 4 as (vulnerable), uncontrolled comorbidities, and significant cognitive impairment, limit applicability to frailer, more medically complex elderly populations who constitute a substantial proportion (estimated 30% to 40%) of elderly surgical candidates in community hospital settings. While this conservative approach was ethically and clinically appropriate for pilot implementation, ensuring safety, it means the findings may not generalize to moderately frail patients (Clinical Frailty Scale 5-6) or those with multiple well-controlled but complex comorbidities (ASA class III) who might still benefit from ODS with enhanced precautions. Future research systematically expanding eligibility criteria with corresponding enhanced monitoring could extend ODS benefits to larger elderly populations, though this requires careful risk stratification and different resource allocation.

Sixth, potential economic context limitations warrant acknowledgment. Thailand's Universal Coverage Scheme standardizes healthcare costs and reduces out-of-pocket expenditure variability, potentially enhancing cost-effectiveness generalizability within Thailand but limiting applicability to countries with different healthcare financing models (fee-for-service, private insurance-dominated, or less comprehensive public coverage). The substantial indirect cost savings documented (61.76% reduction in caregiver productivity loss) assume opportunity costs of informal family caregiving, which may be valued differently across cultural contexts or in countries with more established formal long-term care systems where family caregiving represents a smaller economic contribution. Additionally, medication and supply costs in Thailand may differ from those in other settings, affecting the magnitude of cost savings achievable.

Finally, the present study was conducted during and following the COVID-19 pandemic period (ethics approval in October 2024, with retrospective consideration of system development from 2021 to 2024), which may have influenced multiple aspects. The healthcare-seeking behaviors potentially were altered by pandemic-related healthcare avoidance or delayed care, family caregiving dynamics potentially affected by economic disruptions or changing household compositions, healthcare system resource availability and protocols potentially impacted by pandemic preparedness investments, and patient or provider attitudes toward early discharge shaped by pandemic-era emphasis on minimizing hospital exposure. The extent to which these pandemic-related factors affected the findings versus representing sustainable baseline conditions remains uncertain, adding complexity to long-term implementation planning in post-pandemic healthcare environments.

These limitations collectively suggest that while the findings demonstrate proof-of-concept for ODS feasibility, safety, and cost-effectiveness in Thai community hospitals serving elderly patients, cautious interpretation is warranted when considering implementation in different contexts. Successful adaptation to other settings likely requires 1) careful assessment of local family caregiving capacity and norms with potential need for formal caregiver support programs, 2) development or strengthening of community health worker infrastructure for post-discharge monitoring, 3) cultural adaptation of patient or caregiver education materials and communication approaches, 4) graduated expansion of patient eligibility as institutional expertise develops, and 5) extended follow-up studies confirming durability of benefits and detecting delayed complications. Multi-center trials across diverse Thai community hospitals would enhance generalizability within Thailand, while international collaboration could identify essential versus context-specific system components for broader global applicability.

The findings have significant implications for policy and practice. First, the successful implementation in a community hospital demonstrates that ODS for elderly patients need not be restricted to tertiary care centers, potentially expanding surgical access in rural areas. Second, the cost savings identified support resource allocation to develop similar systems nationwide, particularly relevant given Thailand's constrained healthcare budget amid an aging population. Third, the importance of caregiver involvement suggests policy considerations for caregiver support programs when implementing similar initiatives.

Future research should address these limitations through multi-center randomized controlled trials

with extended follow-up periods. Studies comparing different ODS system models across various community hospital settings would help identify essential components for success. Investigation of technology-enabled follow-up systems could enhance efficiency while maintaining safety, particularly in remote areas, as suggested by Fleming et al[29]. Research focusing on specific surgical specialties would help refine selection criteria for particular patient subgroups, while exploration of community health workers' roles in supporting post-discharge care could provide insights into sustainable models for resource-limited settings.

The expanding elderly population in Thailand and similar middle-income countries necessitates healthcare system adaptation to meet growing surgical demands efficiently. The present study findings suggest that community hospital-based ODS systems represent a feasible, safe, and cost-effective approach when implemented with appropriate patient selection, comprehensive perioperative protocols, and robust follow-up systems. This model could contribute significantly to addressing the surgical needs of aging populations in resource-limited settings worldwide.

What is already known about this topic?

Ambulatory surgery constitutes 60% to 70% of all surgical procedures in developed countries, with demonstrated safety and efficacy, but implementation for elderly patients in resource-limited community hospitals remains challenging due to concerns about postoperative complications, specialist availability, and inadequate follow-up systems. Research is needed to determine whether ODS systems can be safely, effectively, and cost-efficiently implemented for elderly patients in Thailand's community hospital settings.

What does this study add?

This study demonstrates that a properly designed ODS system for elderly patients in community hospitals is feasible, showing a 95.1% success rate, safe, having 87.8% without complications, and cost-effective, with a 26% saving over conventional surgery while improving quality-of-life outcomes. Key success factors include appropriate patient selection, caregiver readiness, multidisciplinary teamwork, and effective post-discharge monitoring, offering a model for addressing the surgical needs of aging populations in resource-constrained settings.

Acknowledgement

The authors express their sincere gratitude to the Directors of Uttaradit and Laplae Hospitals, the Uttaradit Provincial Public Health Office, and all staff members who supported this study. The authors particularly acknowledge the surgical teams, nursing staff, anesthesiology department, and primary care units for their contributions to implementing the ODS system. Special appreciation is extended to the VHVs who facilitated post-discharge monitoring and community engagement. The authors are grateful to all elderly patients and their families who participated in this research, whose cooperation and feedback were invaluable to the success of this project.

Authors' contributions

All authors meet ICMJE authorship criteria. JK: Conceptualization, study design, clinical system development and implementation, surgical and perioperative care, quantitative data collection and analysis, original manuscript drafting and critical revision. ST: Conceptualization, study design, qualitative research design and analysis, cost-effectiveness analysis supervision, mixed-methods integration, manuscript editing and critical revision, corresponding author responsibilities. Both authors approved the final version and are jointly accountable for all aspects of the work.

Data availability statement

The de-identified dataset from this study is available from the corresponding author upon reasonable request with appropriate ethics approval. Public data sharing is restricted to the Uttaradit Provincial Public Health Office Ethics Committee requirements and elderly patient privacy concerns. Qualitative transcripts contain potentially identifiable information and cannot be shared publicly, though coded themes may be available upon request. Cost-effectiveness analysis models and parameters are available without patient identifiers.

Ethics approval and consent to participate

This study was approved by the Uttaradit Provincial Public Health Office Research Ethics Committee (COA No. 082/2567, UPHO REC No. 082/2567, approved October 15, 2024) and conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants before enrollment. Cognitive capacity was assessed where indicated (MMSE); participants scoring below 18 were excluded from the study. For

qualitative components, additional verbal consent for audio recording was obtained before each session.

Clinical trial registration

Not applicable. This study was a quasi-experimental one-group pretest-posttest design and was not registered as a clinical trial.

Use of artificial intelligence

The authors used Claude (Anthropic) as an artificial intelligence tool to assist with literature searching, reference verification, and language editing during manuscript preparation. All intellectual content, data interpretation, thematic analysis, and final decisions regarding the manuscript remain solely the responsibility of the authors.

Conflict of interest

The authors declare no conflict of interest.

References

1. Prasartkul P, Thaweesit S, Chuanwan S. Prospects and contexts of demographic transitions in Thailand. J Popul Soc Stud 2019;27:1-22.
2. Etzioni DA, Liu JH, Maggard MA, Ko CY. The aging population and its impact on the surgery workforce. Ann Surg 2003;238:170-7.
3. Oresanya LB, Lyons WL, Finlayson E. Preoperative assessment of the older patient: a narrative review. Jama 2014;311:2110-20.
4. Partridge JS, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. Age Ageing 2012;41:142-7.
5. Hollenbeck BK, Dunn RL, Suskind AM, Zhang Y, Hollingsworth JM, Birkmeyer JD. Ambulatory surgery centers and outpatient procedure use among Medicare beneficiaries. Med Care 2014;52:926-31.
6. Warner MA, Shields SE, Chute CG. Major morbidity and mortality within 1 month of ambulatory surgery and anesthesia. Jama 1993;270:1437-41.
7. De Oliveira GS Jr, Holl JL, Lindquist LA, Hackett NJ, Kim JY, McCarthy RJ. Older adults and unanticipated hospital admission within 30 days of ambulatory surgery: An analysis of 53,667 ambulatory surgical procedures. J Am Geriatr Soc 2015;63:1679-85.
8. Rojjananukulpong R, Ahmad MM, Saqib SE. Disparities in physical accessibility among rural thais under universal health coverage. Am J Trop Med Hyg 2021;105:837-45.
9. Pagaiya N, Phanthunane P, Bamrung A, Noree T, Kongweerakul K. Forecasting imbalances of human resources for health in the Thailand health service system: application of a health demand method. Hum Resour Health 2019;17:4. doi: 10.1186/s12960-018-0336-2.
10. Trongsakul S, Lambert R, Clark A, Wongpakaran N, Cross J. Development of the Thai version of Mini-Cog, a brief cognitive screening test. Geriatr Gerontol Int 2015;15:594-600.
11. Pattanaphesaj J, Thavorncharoensap M. Measurement properties of the EQ-5D-5L compared to EQ-5D-3L in the Thai diabetes patients. Health Qual Life Outcomes 2015;13:14. doi: 10.1186/s12955-014-0203-3.
12. Chung F, Mezei G, Tong D. Adverse events in ambulatory surgery. A comparison between elderly and younger patients. Can J Anaesth 1999;46:309-21.
13. Rajan N, Rosero EB, Joshi GP. Patient Selection for Adult Ambulatory Surgery: A Narrative Review. Anesth Analg 2021;133:1415-30.
14. Hladkowicz E, Dumitrascu F, Auais M, Beck A, Davis S, McIsaac DI, et al. Evaluations of postoperative transitions in care for older adults: a scoping review. BMC Geriatr 2022;22:329. doi: 10.1186/s12877-022-02989-6.
15. Griffiths R, Beech F, Brown A, Dhesi J, Foo I, Goodall J, et al. Peri-operative care of the elderly 2014: Association of Anaesthetists of Great Britain and Ireland. Anaesthesia 2014;69 Suppl 1:81-98.
16. White S, Griffiths R, Baxter M, Beanland T, Cross J, Dhesi J, et al. Guidelines for the peri-operative care of people with dementia: Guidelines from the Association of Anaesthetists. Anaesthesia 2019;74:357-72.
17. Aceto P, Antonelli Incalzi R, Bettelli G, Carron M, Chiumiento F, Corcione A, et al. Perioperative Management of Elderly patients (PriME): recommendations from an Italian intersociety consensus. Aging Clin Exp Res 2020;32:1647-73.
18. Melton MS, Li YJ, Pollard R, Chen Z, Hunting J, Hopkins T, et al. Unplanned hospital admission after ambulatory surgery: a retrospective, single cohort study. Can J Anaesth 2021;68:30-41.
19. Jain S, Rosenbaum PR, Reiter JG, Ramadan OI, Hill AS, Silber JH, et al. Assessing the ambulatory surgery center volume-outcome association. JAMA Surg 2024;159:397-403.
20. Butzner M, Cuffee Y. Telehealth interventions and outcomes across rural communities in the United States: Narrative review. J Med Internet Res 2021;23:e29575.
21. Tsou C, Robinson S, Boyd J, Jamieson A, Blakeman R, Yeung J, et al. Effectiveness of telehealth in rural and remote emergency departments: Systematic review. J Med Internet Res 2021;23:e30632.
22. Taguchi T, Nozawa K, Zeniya S, Murata T, Laurent T, Hirano T, et al. Direct and indirect pathways for health-related quality of life change from pain improvement in neuropathic pain patients with spine diseases: Path analysis with structural equation modeling using non-interventional study results of pregabalin. J Pain Res 2021;14:1543-51.
23. Tomlinson J, Cheong VL, Fylan B, Silcock J, Smith H, Karban K, et al. Successful care transitions for older people: a systematic review and meta-analysis of the effects of interventions that support medication

continuity. Age Ageing 2020;49:558-69.
24. Carey K, Mitchell JM. Specialization as an organizing principle: The case of Ambulatory Surgery Centers. Med Care Res Rev 2019;76:386-402.
25. Shi Y, Zhu P, Jia J, Shao Z, Yang S, Chen W, et al. Cost-effectiveness of same-day discharge surgery for primary total hip arthroplasty: A pragmatic randomized controlled study. Front Public Health 2022;10:825727. doi: 10.3389/fpubh.2022.825727.
26. Hodgson JA, Cyr KL, Sweitzer B. Patient selection in ambulatory surgery. Best Pract Res Clin Anaesthesiol 2023;37:357-72.
27. Dodds C, Foo I, Jones K, Singh SK, Waldmann C. Peri-operative care of elderly patients - an urgent need for change: a consensus statement to provide guidance for specialist and non-specialist anaesthetists. Perioper Med (Lond) 2013;2:6. doi: 10.1186/2047-0525-2-6.
28. Young S, Osman B, Shapiro FE. Safety considerations with the current ambulatory trends: more complicated procedures and more complicated patients. Korean J Anesthesiol 2023;76:400-12.
29. Fleming ST, Mackley HB, Camacho F, Yao N, Gusani NJ, Seiber EE, et al. Patterns of care for metastatic colorectal cancer in appalachia, and the clinical, sociodemographic, and service provider determinants. J Rural Health 2016;32:113-24.
30. Bryson GL, Mercer C, Varpio L. Patient and caregiver experience following ambulatory surgery: qualitative analysis in a cohort of patients 65 yr and older. Can J Anaesth 2014;61:986-94.
31. Shah S, Qureshi F, Stanley S, Bennett-Guerrero E. Unplanned hospital admissions within 24 h after 53,185 surgical procedures at a U.S. ambulatory surgery center. Perioper Med (Lond) 2024;13:88. doi: 10.1186/s13741-024-00447-y.
32. Armstrong KA, Coyte PC, Brown M, Beber B, Semple JL. Effect of home monitoring via mobile app on the number of in-person visits following ambulatory surgery: A randomized clinical trial. JAMA Surg 2017;152:622-7.