Development of an Integrated Model for Enhancing Surgical Capacity in Community Hospitals: A Case Study of Laplae Hospital

Jirawit Khaomuangnoi, MD[1], Seubtrakul Tanthalanukul, 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

Abstract

Objective: To pilot-evaluate an integrated model for enhancing surgical capacity at Laplae Hospital (Uttaradit Province) under Thailand's "One Province One Hospital" policy.

Materials and Methods: A mixed-methods pilot study with a predominantly quantitative, one-group pretest-posttest quasi-experimental design was conducted between October 2024 and March 2025. The intervention comprised personnel development, infrastructure and technology enhancement, and surgical service system development. Data comprised satisfaction scores (baseline to six months), SF-36 (baseline and one month), clinical and administrative records, and interviews with 12 stakeholders. Analyses used paired t-tests, repeated measures ANOVA, Fisher's exact test, and content analysis. The 45 patients were the complete census of eligible patients, so findings are preliminary.

Results: Forty-seven procedures were performed in 45 patients. Monthly case volume rose 4.5-fold (2 to 9). One day surgery reached 100% of eligible cases by March 2025. One minor complication occurred (2.1%); there were no major complications, unplanned readmissions, or unplanned referrals. Satisfaction improved from 3.1±0.7 to 4.1±0.5 ($p<0.001$). SF-36 physical domains improved significantly at one month (Bodily pain +21.6, Role limitations-physical +19.4, Physical functioning +16.3, $p<0.001$). Referrals to Uttaradit Hospital fell from 23 to 7, significantly only for hernia (11 to 3, $p=0.011$). Key success factors were leadership, provincial hospital collaboration, and progressive implementation; the main barrier was limited perioperative nursing staff.

Conclusion: The integrated model appears feasible for strengthening surgical capacity in a community hospital. Given the small, single-site, uncontrolled design, findings are hypothesis-generating and require confirmation in adequately powered multi-site studies.

Keywords: Surgical capacity; Community hospital; Health system strengthening; One day surgery; Thailand; Referral system; Pilot study

Received 27 February 2026 | Revised 4 September 2026 | Accepted 8 October 2026

J Med Assoc Thai 2026;109(11):875-88

https://doi.org/10.35755/jmedassocthai.2026.11.04396

The global burden of surgical disease remains a pressing public health concern, with an estimated 5 billion people worldwide lacking access to safe, affordable surgical and anesthesia care when needed. This inequity is particularly pronounced in low- and middle-income countries, as well as in rural regions of middle-income economies, where surgical services are disproportionately concentrated in urban tertiary centers.

Correspondence to:

Tanthalanukul S.

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

Phone: +66-81-4749058

Email: seubtrakul@unc.ac.th

ORCID: 0000-0001-5936-2549

How to cite this article:

Khaomuangnoi J, Tanthalanukul S. Development of an Integrated Model for Enhancing Surgical Capacity in Community Hospitals: A Case Study of Laplae Hospital. J Med Assoc Thai 2026;109:875-88.

In Thailand, despite its well-developed universal health coverage system, surgical care delivery continues to reflect this centralization pattern. A nationwide survey by Tangcharoensathien et al. demonstrated that over 70% of complex surgical procedures are performed in

What is already known about this topic?

Surgical services in Thailand are disproportionately concentrated in urban tertiary hospitals, leaving rural populations with limited access to essential surgical care. Global evidence supports integrated approaches combining workforce development, infrastructure investment, and system strengthening to enhance district-level surgical capacity. Community hospital surgical enhancement has demonstrated potential to reduce referral rates and improve patient outcomes in comparable low- and middle-income country settings.

What does this study add?

This study provides the first prospective, mixed-methods evaluation of an integrated three-pillar model for surgical capacity enhancement in a Thai community hospital under the "One Province One Hospital" policy. The model achieved a 4.5-fold increase in surgical volume, 76.9% referral reduction, and 2.1% complication rate within six months, offering a replicable, evidence-based framework for community-level surgical service development nationwide.

© 2026 Journal of the Medical Association of Thailand

tertiary hospitals located primarily in urban centers, while rural community hospitals manage only 12% of such cases despite serving approximately 40% of the national population[1]. This structural imbalance generates a dual burden: rural populations face prolonged travel times, financial hardship, and delayed care, while regional and provincial hospitals become overcrowded, compromising service quality and patient safety[2]. Recognizing these systemic inequities, the Thai Ministry of Public Health introduced the "One Province One Hospital" policy in 2023, which aims to enhance the capabilities of strategically selected community hospitals to provide more complex medical and surgical services[3]. This policy reflects a broader paradigm shift—from the traditional approach of continually expanding regional referral centers toward building sustainable capacity at lower levels of the health system. Under this framework, Laplae Hospital in Uttaradit Province was designated as a model community hospital for surgical capacity enhancement, with the institutional objective of upgrading from an F1-level facility to an S+ level, thereby enabling the provision of one day surgery (ODS) and minimally invasive surgery (MIS)[4].

Enhancing surgical capacity at the community hospital level is a multidimensional undertaking that extends well beyond the procurement of equipment or the recruitment of surgical personnel. It requires the simultaneous and coordinated development of clinical workforce competencies, physical infrastructure, and integrated care systems—including robust referral pathways and perioperative care protocols[5,6]. International evidence increasingly supports this integrated approach. Studies conducted in sub-Saharan African settings have demonstrated that mentorship-based surgical team development, combined with structured quality improvement systems, can substantially increase surgical volume and reduce complication rates at district hospitals[7,8]. Similarly, research on task-shifting and task-sharing frameworks highlights the feasibility of expanding the surgical workforce through structured training programs in resource-constrained environments[9]. In the context of health systems strengthening, Kamarajah et al. have argued that sustainable improvements in surgical outcomes require alignment across workforce, infrastructure, and governance dimensions—consistent with the principles embedded within National Surgical, Obstetric and Anaesthesia Plans (NSOAPs)[10]. Within the Thai context, prior evidence supports the potential of community-level surgical enhancement. Studies have shown that community hospitals with upgraded surgical services demonstrate complication rates comparable to those of higher-level facilities for selected elective procedures, and that enhanced surgical capability can reduce referral rates for common conditions by 35% or more, substantially alleviating the burden on provincial hospitals[11,12]. The implementation of ODS represents a promising strategy for improving surgical service efficiency and reducing reliance on inpatient hospital care. However, safe and effective implementation requires appropriate patient selection, comprehensive preoperative assessment, adequate anesthetic services, standardized discharge criteria, and structured postoperative care and follow-up systems[13].

Despite this growing body of evidence, few studies have examined the process of developing an integrated surgical capacity model in a Thai community hospital setting using prospective, mixed-methods evaluation. Most existing research has focused either on single-domain interventions—such as training programs or equipment provision—or on retrospective assessments of outcomes without systematic documentation of the implementation process. There remains a critical need for evidence-based, replicable models that address the full complexity of surgical capacity enhancement and can serve as practical roadmaps for policy implementation. The present study addresses this gap by developing and conducting a pilot evaluation of an integrated model for enhancing surgical capacity at Laplae Hospital over a six-month implementation period from October 2024 to March 2025. The model encompasses three interconnected pillars: personnel development, infrastructure and technology enhancement, and surgical service system development. Using a mixed-methods quasi-experimental design, this research documents the process, outcomes, success factors, and barriers encountered during implementation. Given the early-phase nature of the program and the resulting patient volume during the study period, findings are intended to be interpreted as preliminary and hypothesis-generating. The findings are intended to generate actionable evidence that can guide the Ministry of Public Health and community hospital administrators in scaling similar initiatives across Thailand, in alignment with the strategic objectives of the "One Province One Hospital" policy and the broader global agenda for equitable access to essential surgical care[14,15].

Materials and Methods

Study Design

This study employed a mixed-methods research

design with a predominant quantitative component, structured as a quasi-experimental one-group pretest-posttest study. The quantitative component assessed changes in surgical volume, clinical outcomes, patient satisfaction, and referral patterns across five prospectively defined time points: T0 (baseline, prior to surgical capacity enhancement), T1 (one month after implementation), T2 (two months after implementation), T3 (four months after implementation), and T4 (six months after implementation). The qualitative component consisted of in-depth interviews with key stakeholders to explore contextual success factors, implementation barriers, and the impact of the intervention on the provincial referral system. This mixed-methods approach was selected to capture both the measurable outcomes of the intervention and the experiential dimensions of implementation that quantitative data alone cannot adequately represent. Given the early-phase nature of the program and the resultant patient volume accrued during the study period, this study is characterized as a pilot and feasibility evaluation of the integrated model.

Setting

The study was conducted at Laplae Hospital, a community-level (F1) hospital in Laplae District, Uttaradit Province, northern Thailand, and its associated district healthcare network. Laplae Hospital was designated as a model institution under the Thai Ministry of Public Health's "One Province One Hospital" policy[3], with the institutional goal of upgrading to an S+ facility level capable of providing ODS and MIS. The study period spanned six months from October 2024 to March 2025, encompassing both the preparation phase and the active implementation phase of surgical service enhancement. Uttaradit Hospital, a provincial-level referral facility, served as the primary collaborating institution for mentorship, training support, and specialist consultation throughout the study period[4].

Participants

The study involved three distinct participant groups.

Surgical patients: The target sample size for patient-level outcome data were calculated using G*Power 3.1.9.7, with the following parameters: two-tailed significance level α=0.05, statistical power=0.80, and a moderate effect size of 0.3 for the primary outcome of patient satisfaction, consistent with comparable surgical service improvement studies in Thailand[11,12]. The calculated minimum sample was inflated by 15% to account for anticipated data attrition, yielding a target recruitment of 170 patients. Stratified random sampling was applied according to surgical procedure category to ensure proportional representation across procedure types. In practice, the target sample of 170 patients was not achieved during the study period. The 45 patients (47 procedures) enrolled represent the complete census of all eligible patients who received surgical services at Laplae Hospital during the six-month implementation period, as the facility was in an early capacity-building phase with surgical volume expanding incrementally from a near-zero baseline. Consequently, all inferential analyses were conducted with considerably lower statistical power than pre-specified, and findings should be interpreted as preliminary and hypothesis-generating rather than definitive. The authors acknowledge this as a primary limitation of the present study.

Healthcare personnel: All medical and nursing staff directly involved in the delivery of surgical services at Laplae Hospital were included, comprising surgeons, anesthesiologists or anesthetic nurse practitioners, and perioperative nursing staff. This group participated in training evaluations and contributed to clinical outcome documentation throughout the study period.

Key stakeholders: Purposive sampling was used to identify 10-15 key informants for in-depth qualitative interviews, including hospital administrators from Laplae Hospital and Uttaradit Hospital, representatives from the Uttaradit Provincial Health Office, and personnel responsible for patient referral coordination. Recruitment continued until thematic saturation was reached, in accordance with standard qualitative methodology[16].

Intervention

The surgical capacity enhancement intervention was structured around three integrated components, implemented concurrently and progressively over the study period.

Component 1: Personnel development: A structured training program was designed to enhance the surgical competencies of the multidisciplinary team at Laplae Hospital. Training modalities included on-site skills workshops, case-based learning sessions, and observerships at Uttaradit Hospital. Mentorship was provided through regular site visits by specialist surgeons and anesthesiologists from the provincial hospital, alongside teleconsultation support for case planning and perioperative decision-making. This mentorship-based model reflects international evidence

supporting the effectiveness of supervised surgical training in strengthening community-level surgical capacity[8,9].

Component 2: Infrastructure and technology enhancement: Essential surgical equipment was procured and installed, including laparoscopic instrument sets, advanced patient monitoring systems, and electrosurgical units. The existing operating theatre was renovated and reconfigured to meet the technical requirements for MIS and ODS procedures, including upgrades to anesthetic gas delivery systems and sterile processing workflows[17].

Component 3: Surgical service system development: Evidence-based clinical practice guidelines were adapted for the community hospital context and implemented for the targeted surgical procedures. A standardized ODS protocol was developed, encompassing patient eligibility criteria, preoperative assessment pathways, intraoperative care standards, same-day discharge criteria, and postoperative follow-up procedures. A formal referral protocol was established with Uttaradit Hospital for the timely transfer of cases exceeding Laplae Hospital's capacity, ensuring continuity and safety of patient care[5,6].

Data Collection Instruments

Data were collected using four complementary instruments. Patient questionnaires comprised sociodemographic data, service satisfaction assessed using a five-point Likert scale across six domains, and health-related quality of life assessed using the validated Thai-language version of the SF-36 instrument, administered preoperatively and at one-month postoperatively. Clinical data recording forms captured procedure type, operative duration, anesthetic technique, length of hospital stay, postoperative complications, unplanned readmissions within 30 days, and unplanned referrals. Semi-structured interview guides for key stakeholder interviews were developed through systematic literature review and validated by expert consultation. Hospital administrative records were used to extract pre- and post-intervention data on surgical volume, referral rates, and resource utilization.

Instrument Validation and Quality Control

Content validity was assessed by a panel of five experts using the item-objective congruence (IOC) index, with items achieving IOC $\geq$0.67 retained. Reliability was established through pilot testing with 30 patients, with internal consistency evaluated using Cronbach's alpha (minimum acceptable value=0.70). Construct validity of the SF-36 was confirmed through Confirmatory Factor Analysis using accepted fit indices (CFI >0.95, TLI >0.95, RMSEA <0.06, SRMR <0.08). For qualitative data, credibility was enhanced through methodological triangulation and member checking.

Statistical Analysis

Quantitative analysis employed descriptive statistics—including frequencies, percentages, means, and standard deviations—to characterize patient demographics, surgical procedure distribution, and service utilization patterns. Paired t-tests and repeated measures analysis of variance (ANOVA) were applied to compare patient satisfaction scores and SF-36 quality of life data across the five time points. Fisher's exact test was applied to analyze changes in referral patterns and the proportion of cases managed as ODS over time, as expected cell frequencies were less than 5 in multiple cells of the relevant contingency tables, rendering the chi-square test inappropriate. Binary logistic regression to identify factors associated with postoperative complications and unplanned referrals was planned but could not be executed, as only one complication event was recorded across the entire study period, making logistic regression modelling statistically unfeasible. A p-value of less than 0.05 was considered statistically significant for all analyses. All analyses were conducted with the explicit acknowledgement that statistical power was substantially below the pre-specified 80% threshold, and results of inferential testing should be interpreted accordingly.

Qualitative analysis followed a systematic thematic framework approach, with interview transcripts audio-recorded, transcribed verbatim, anonymized, and subjected to open, axial, and selective coding, followed by framework analysis to organize findings by success factors, implementation barriers, and system-level impacts.

Data Management and Ethical Approval

The study protocol received full ethical approval from the Ethics Committee of Uttaradit Provincial Public Health Office (COA No. 081/2567; UPHO REC No. 081/2567). Written informed consent was obtained from all participants prior to enrolment. Participants were informed of their right to withdraw at any time without consequence to their care. All patient data were anonymized and coded to preserve confidentiality. The study was conducted in full accordance with the ethical principles of the Declaration of Helsinki and the ICH Good Clinical Practice guidelines.

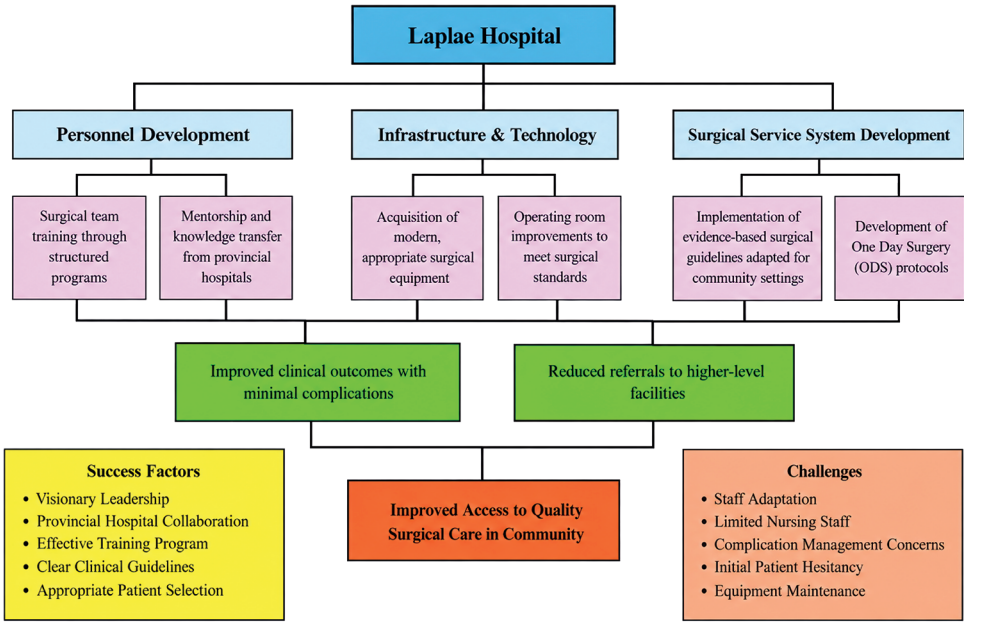


Figure 1. Integrated model for enhancing surgical capacity in community hospitals: Laplae Hospital case study.

RESULTS

Surgical Service Development and Integrated Model

The implementation of the surgical capacity enhancement program at Laplae Hospital was guided by an integrated three-pillar model comprising personnel development, infrastructure and technology enhancement, and surgical service system development. These three components operated synergistically throughout the six-month study period, producing progressive improvements across all measured dimensions of surgical service delivery. The model acknowledged both enabling success factors—including visionary leadership, provincial hospital collaboration, effective training programs, clear clinical guidelines, and appropriate patient selection criteria—and implementation challenges, including staff adaptation to new protocols, limited nursing staff availability, concerns regarding complication management, initial patient hesitancy, and equipment maintenance requirements. The overall framework is illustrated in Figure 1.

Patient Demographics and Surgical Case Volume

During the six-month implementation period from October 2024 to March 2025, Laplae Hospital performed a total of 47 surgical procedures on 45 patients. It is noted that this represents the complete census of all eligible patients treated during the study period, reflecting the early capacity-building phase of the program rather than a fully recruited sample. The demographic characteristics of the surgical patient population are shown in Table 1. The majority of patients were male (71.1%), with a mean age of 56.8±16.2 years (range 14-87). The largest age group was 40-59 years (42.2%), followed by 60-79 years (35.6%). Patients aged 80 years and above accounted for 6.7% of the cohort, reflecting the elderly demographic commonly presenting with hernia and anorectal conditions in rural community settings. The wide age range (14-87 years) and diverse procedural case mix represent sources of heterogeneity that should be considered when interpreting aggregate outcome measures.

Table 1. Demographic characteristics of surgical patients at Laplae Hospital (n=45)

Characteristic	Value
Sex; n (%)	
Male	32 (71.1)
Female	13 (28.9)
Age (years)	
Mean±SD	56.8±16.2
Range	14-87
Age groups; n (%)	
<20 years	1 (2.2)
20-39 years	6 (13.3)
40-59 years	19 (42.2)
60-79 years	16 (35.6)
≥80 years	3 (6.7)

SD=standard deviation

Surgical case volume demonstrated a consistent and progressive increase across the study period. At baseline in October 2024, the hospital performed 2 surgical cases per month. This figure rose incrementally to reach 9 cases per month by March 2025, representing a 4.5-fold increase in monthly surgical throughput over the six-month implementation period. Concurrently, surgical outpatient department (OPD) consultations increased substantially, from 5 patients in October 2024 to 22 patients in December 2024. From January 2025 onward, teleconsultation services were introduced to supplement face-to-face OPD review, further expanding access to preoperative assessment and postoperative follow-up. By March 2025, the surgical OPD was managing approximately 10 patients per clinic day, with an additional 5-7 teleconsultations conducted weekly.

Table 2. Distribution of surgical procedures performed at Laplae Hospital (n=47)

Procedure type	n (%)
Hernioplasty/Herniorrhaphy	18 (38.3)
Excision of benign masses (lipoma, cysts, skin lesions)	15 (31.9)
Hemorrhoidectomy	7 (14.9)
Debridement of infected wounds	5 (10.6)
Other procedures	2 (4.3)

Table 3. Anesthetic techniques used for surgical procedures at Laplae Hospital (n=47)

Anesthetic technique	n (%)
General anesthesia with endotracheal tube (GA+ETT)	20 (42.6)
General anesthesia with laryngeal mask airway (GA+LMA)	9 (19.1)
Spinal anesthesia (SA)	3 (6.4)
Local anesthesia (LA)	15 (31.9)

Types of Surgical Procedures

The distribution of surgical procedures performed at Laplae Hospital during the study period is presented in Table 2. Hernioplasty and herniorrhaphy constituted the most frequently performed procedures, accounting for 38.3% of all cases, followed by excision of benign masses including lipomas, sebaceous cysts, and superficial skin lesions (31.9%), and hemorrhoidectomy (14.9%). Debridement of infected wounds accounted for 10.6% of cases, with the remaining 4.3% comprising miscellaneous minor procedures. Across the study period, a discernible progression was observed from simpler to progressively more complex procedures. Initial cases in October and November 2024 consisted predominantly of minor excisions, with hernioplasties and hemorrhoidectomies increasing in proportion from December 2024 onward as the surgical team's competence and institutional confidence consolidated.

Implementation of One Day Surgery Protocol

The ODS protocol was formally introduced commencing December 2024, following completion of prerequisite infrastructure upgrades and personnel training during the preparatory phase. Prior to December 2024, all surgical procedures were performed under conventional inpatient admission protocols, with an ODS rate of 0%. Following protocol introduction, the proportion of eligible cases managed as ODS increased progressively: 66.7% of eligible cases in December 2024, with continued improvement through subsequent months, reaching 100% of eligible cases by March 2025. By the end of the study period, 13 procedures (27.7% of all procedures performed) had been conducted as ODS, encompassing hernioplasty, hemorrhoidectomy, and excision of benign masses—procedure types identified a priori as appropriate for same-day management based on clinical guideline criteria and patient selection protocols.

Anesthetic Techniques

The anesthetic techniques employed for the 47 surgical procedures are detailed in Table 3. General anesthesia was the most frequently utilized technique, applied in a combined total of 61.7% of procedures, of which 42.6% employed endotracheal intubation and 19.1% utilized a laryngeal mask airway. Local anesthesia was used in 31.9% of cases, principally for minor excision procedures. Spinal anesthesia was employed in 6.4% of cases, primarily for hemorrhoidectomy procedures where regional block was clinically preferred.

Clinical Outcomes

The clinical outcomes of all surgical procedures performed at Laplae Hospital during the study period are summarized in Table 4. The mean length of hospital stay across all procedures was 1.2±0.6 days. Patients managed under the ODS protocol had a mean length of stay of 0.5±0.1 days, compared with 1.5±0.4 days for those managed under conventional inpatient admission.

Regarding surgical safety, only one minor complication was recorded across the entire study period, representing a complication rate of 2.1%. This complication was wound seroma, identified at routine postoperative follow-up and managed successfully with aspiration and wound care without sequelae or prolongation of hospital stay. No major complications

Table 4. Clinical outcomes of surgical procedures at Laplae Hospital

Outcome measure	Value
Length of hospital stay (days); mean±SD	1.2±0.6
For ODS procedures	0.5±0.1
For non-ODS procedures	1.5±0.4
Complication rate; n (%)	
Minor complications	1 (2.1)
Major complications	0 (0.0)
Unplanned hospital readmission within 30 days	0 (0.0)
Unplanned referral to higher-level hospital	0 (0.0)

SD=standard deviation; ODS=one day surgery

were recorded. There were no unplanned hospital readmissions within 30 days of any procedure, and no unplanned referrals to Uttaradit Hospital or any higher-level facility were required during the study period.

Binary logistic regression to identify patient- and procedure-level predictors of postoperative complications and unplanned referrals was planned a priori but could not be executed. With only one complication event recorded across 47 procedures, logistic regression modelling is statistically unfeasible regardless of sample size, as a single outcome event cannot support stable parameter estimation. The near-zero event rate, while representing an excellent clinical safety profile, precluded this planned analysis. This limitation is explicitly acknowledged, and regression-based analysis of complication predictors will be pursued in future studies with larger patient cohorts.

Patient Satisfaction

Patient satisfaction was assessed at each of the five study time points using a validated five-point Likert scale questionnaire covering six service domains. The results are presented in Table 5. Overall satisfaction scores demonstrated a statistically significant improvement from baseline to six months post-implementation, rising from a mean of 3.1±0.7 at T0 to 4.1±0.5 at T4 ($p<0.001$). Significant improvements were recorded across all individual satisfaction domains. Access to surgical services showed the most pronounced absolute improvement, increasing from 2.8±0.8 at baseline to 4.0±0.6 at six months ($p<0.001$), reflecting the fundamental change in service availability for the local population. Preoperative care satisfaction improved from 3.2±0.7 to 4.2±0.5 ($p<0.001$), representing the highest absolute domain score at the study endpoint. Satisfaction with operative care, postoperative care, and information provision also demonstrated statistically significant improvements across the study period (all $p\leq0.003$). All p-values were calculated using repeated measures ANOVA comparing T0 and T4. Given the pilot sample size of 45 patients and the resultant statistical power below the pre-specified 80% threshold, these findings should be interpreted with appropriate caution as preliminary evidence of improvement rather than definitive estimates of effect magnitude.

Health-Related Quality of Life (SF-36)

Health-related quality of life was assessed using the validated Thai-language SF-36 instrument at T0 (preoperative baseline) and T1 (one month postoperatively) in all 45 patients. Complete SF-36 domain scores at both time points, with corresponding inferential statistics, are presented in Table 6.

Statistically significant improvements were observed in three physical health domains: physical functioning (52.4±18.3 to 68.7±16.1, mean change +16.3, 95% CI 10.8 to 21.8, $p<0.001$), role limitations-physical (38.9±24.6 to 58.3±22.4, mean change +19.4, 95% CI 11.6 to 27.2, $p<0.001$), and bodily pain (41.2±19.7 to 62.8±17.5, mean change +21.6, 95% CI 15.4 to 27.8, $p<0.001$). These three domains demonstrated the largest absolute improvements, consistent with the direct resolution of physical

Table 5. Patient satisfaction scores over time

Satisfaction domain	Mean±SD			p-value†
	T0 (Baseline)	T2 (2 months)	T4 (6 months)	
Overall satisfaction	3.1±0.7	3.7±0.6	4.1±0.5	<0.001
Access to surgical services	2.8±0.8	3.6±0.7	4.0±0.6	<0.001
Pre-operative care	3.2±0.7	3.8±0.6	4.2±0.5	<0.001
Operative care	3.3±0.6	3.8±0.5	4.1±0.5	0.003
Post-operative care	3.1±0.7	3.7±0.6	4.0±0.6	<0.001
Information provided	2.9±0.8	3.5±0.7	3.9±0.6	<0.001

SD=standard deviation

† p-values calculated using repeated measures ANOVA (T0 vs. T4). Five-point Likert scale: 1=very dissatisfied, 5=very satisfied.

Table 6. SF-36 health-related quality of life domain scores at preoperative baseline (T0) and one month postoperatively (T1) (n=45)

SF-36 domain	Mean±SD		Mean change (95% CI)	p-value†
	T0 (Preoperative)	T1 (1 month post-op.)		
Physical functioning	52.4±18.3	68.7±16.1	+16.3 (10.8 to 21.8)	<0.001
Role limitations-physical	38.9±24.6	58.3±22.4	+19.4 (11.6 to 27.2)	<0.001
Bodily pain	41.2±19.7	62.8±17.5	+21.6 (15.4 to 27.8)	<0.001
General health	55.6±16.4	61.3±15.8	+5.7 (0.9 to 10.5)	0.021
Vitality	54.3±17.2	59.8±15.6	+5.5 (0.2 to 10.8)	0.043
Social functioning	60.2±20.1	68.4±17.3	+8.2 (1.9 to 14.5)	0.012
Role limitations-emotional	58.7±26.3	63.4±24.1	+4.7 (–2.8 to 12.2)	0.213
Mental health	61.4±15.8	64.2±14.9	+2.8 (–1.6 to 7.2)	0.208

SD=standard deviation; CI=confidence interval

† p-values calculated using paired t-test (T0 vs T1). SF-36 scores range from 0 to 100, higher scores indicate better health status. Given the pilot sample size (n=45), statistical power for individual domain comparisons is limited, all findings should be interpreted as preliminary.

symptoms—including hernia-related discomfort, hemorrhoidal pain, and mass-related functional limitation—that constituted the primary clinical indication for surgery in the majority of cases.

Modest but statistically significant improvements were additionally observed in general health (55.6±16.4 to 61.3±15.8, p=0.021), vitality (54.3±17.2 to 59.8±15.6, p=0.043), and social functioning (60.2±20.1 to 68.4±17.3, p=0.012), reflecting broader improvements in perceived health and daily function at one month postoperatively.

In contrast, role limitations-emotional (58.7±26.3 to 63.4±24.1, mean change +4.7, 95% CI –2.8 to 12.2, p=0.213) and mental health (61.4±15.8 to 64.2±14.9, mean change +2.8, 95% CI –1.6 to 7.2, p=0.208) did not demonstrate statistically significant changes at one month. These findings are consistent with the expected clinical trajectory following elective surgery for predominantly physical conditions, in which psychological health domains typically show less pronounced short-term change. The absence of significant change in these domains may also partly reflect the limited statistical power inherent to the pilot sample size.

Baseline SF-36 scores at T0 were notably lower than population norms in physical health domains—particularly bodily pain, role limitations-physical, and physical functioning—consistent with the functional impairment attributable to the surgical conditions for which patients were enrolled. Mental health domain scores at baseline were closer to population norms, reflecting the absence of significant psychological morbidity in this elective surgical cohort.

All SF-36 findings should be interpreted as preliminary and directional given the pilot sample size (n=45) and the resultant limited statistical power. These data provide hypothesis-generating evidence to inform the design of adequately powered future studies.

Impact on the Provincial Referral System

The impact of surgical capacity enhancement at Laplae Hospital on the provincial referral system is presented in Table 7. Prior to the intervention, Laplae Hospital performed no elective hernia repairs, hemorrhoidectomies, or mass excisions, and virtually all patients with these conditions presenting at the facility were referred to Uttaradit Hospital for surgical management. During the six-month intervention period, 18 hernia cases, 7 hemorrhoid cases, and 15 minor mass excision cases were successfully managed locally at Laplae Hospital.

Referral pattern comparisons were analyzed using Fisher's exact test, as expected cell frequencies were less than 5 in multiple cells of the contingency tables, rendering the chi-square test statistically inappropriate for these sparse data. Hernia referrals to Uttaradit Hospital decreased from 11 to 3 cases (p=0.011), hemorrhoid referrals from 5 to 2 cases (p=0.337), and minor mass excision referrals from 7 to 2 cases (p=0.082). It should be explicitly noted that, owing to the small cell counts inherent to this pilot dataset, only the reduction in hernia referrals reached conventional statistical significance (p<0.05). The observed reductions in hemorrhoid and minor mass excision referrals, while directionally consistent with the intervention effect, did not achieve statistical significance and must therefore be interpreted with considerable caution. These non-significant results likely reflect insufficient statistical power rather than an absence of true effect, and should not be interpreted as evidence that the intervention had no impact on referral patterns for these conditions. Across the three principal

Table 7. Changes in surgical referral patterns before and after intervention

Surgical condition	Pre-intervention (6 months prior)	Post-intervention (6-month study period)	p-value†
Hernia cases			
Treated at Laplae Hospital	0	18	-
Referred to Uttaradit Hospital	11	3	0.011
Hemorrhoid cases			
Treated at Laplae Hospital	0	7	-
Referred to Uttaradit Hospital	5	2	0.337
Minor mass excisions			
Treated at Laplae Hospital	3	15	-
Referred to Uttaradit Hospital	7	2	0.082

† p-values calculated using Fisher's exact test, applied due to expected cell frequencies of less than 5 in multiple cells of the contingency tables. Based on hospital referral administrative records. Only the reduction in hernia referrals reached statistical significance ($p<0.05$), hemorrhoid and minor mass excision referral reductions should be interpreted as directional findings pending confirmation in larger studies.

Table 8. Key success factors and barriers identified through qualitative analysis

Success factors	Barriers
Strong leadership and administrative support	Initial staff adaptation to new surgical protocols
Effective collaboration with Uttaradit Hospital	Limited number of trained perioperative nursing staff
Comprehensive and structured training program	Concerns about intraoperative complication management
Standardized clinical protocols and patient selection criteria	Initial patient hesitancy to undergo surgery locally
Progressive implementation approach (simple to complex)	Equipment maintenance and biomedical support
Regular case conferences and quality improvement meetings	Increased staff workload during transition period
Clear and formalized referral pathway for complex cases	Limited anesthesia provider availability

surgical conditions combined, the overall referral reduction rate was 76.9%, representing a substantial redistribution of common elective surgical workload from the provincial hospital to the community level. This reduction in referrals translated to measurable cost savings in patient transportation and indirect costs, though formal cost-effectiveness analysis was beyond the scope of the present study.

Qualitative Findings: Success Factors and Barriers

In-depth interviews conducted with 12 key stakeholders—comprising hospital administrators, surgeons, anesthetic personnel, perioperative nurses, and provincial health office representatives—identified a set of recurring and mutually reinforcing success factors alongside substantive implementation barriers, as summarized in Table 8.

Among the success factors, strong and visionary leadership at both the hospital director and department head level emerged as the most consistently cited enabling condition, providing the institutional mandate and resource mobilization required to initiate and sustain the intervention. Effective collaboration with Uttaradit Hospital, particularly the structured mentorship program and the availability of on-call specialist consultation, was identified as indispensable to building surgical team confidence during the early implementation phase. The progressive implementation approach—beginning with simpler procedures such as minor excisions before advancing to hernioplasties and hemorrhoidectomies—was recognized as strategically important in allowing the team to develop competence systematically while maintaining patient safety. Standardized clinical protocols, including explicit patient selection criteria for ODS and community-level surgery, were reported to have substantially reduced clinical uncertainty and facilitated consistent decision-making across the surgical team.

The principal barriers encountered related to human resource constraints and organizational adaptation. Limited availability of trained perioperative nursing staff was reported as the most operationally significant constraint, with informants noting that nursing workload during the transition period placed considerable strain on existing staff. Initial hesitancy among community members to undergo surgery at a local hospital was identified as a challenge, particularly during the first two months of implementation, though it was reported to have diminished progressively as positive clinical outcomes became known within the

community. Concerns among clinical staff regarding the management of potential intraoperative or postoperative complications were mitigated by the formalized referral pathway with Uttaradit Hospital. Equipment maintenance and the availability of a qualified biomedical technician were noted as ongoing logistical challenges requiring sustained institutional attention.

Discussion

This pilot study demonstrates that a structured, integrated model for surgical capacity enhancement can be successfully implemented in a Thai community hospital setting within a relatively short timeframe, producing measurable improvements across surgical volume, clinical safety, patient satisfaction, and referral system efficiency. However, given that the final sample of 45 patients represented 26.5% of the pre-specified target of 170 patients, all quantitative findings should be interpreted as preliminary and hypothesis-generating rather than definitive. The study is more accurately characterized as a pilot and feasibility evaluation, and conclusions regarding effect magnitude should be drawn with appropriate caution. The findings from Laplae Hospital nonetheless offer early empirical support for the feasibility of the "One Province One Hospital" policy as a vehicle for achieving more equitable distribution of surgical services at the community level, and contribute practical implementation evidence to an area where rigorous prospective documentation remains limited in the Thai and broader regional literature.

Surgical Volume Growth and Procedural Progression

The progressive increase in monthly surgical case volume—from 2 cases in October 2024 to 9 cases in March 2025—represents a 4.5-fold expansion of surgical throughput within six months and reflects the cumulative effect of the three integrated intervention components operating in concert. While this growth trajectory is directionally encouraging, it should be interpreted in the context of the very low baseline from which expansion occurred; absolute case numbers remained modest throughout the study period, and the sustainability of this growth beyond the pilot phase remains to be established. This trajectory is nonetheless consistent with patterns reported in comparable surgical capacity enhancement programs. Clarke et al. documented that district hospitals implementing structured surgical monitoring and quality control systems demonstrated progressive volume increases during the initial implementation phase, attributable primarily to improved team confidence, standardized protocols, and enhanced case selection systems[7]. Similarly, Broekhuizen et al. reported that mentorship-based surgical team development in Malawi produced significant gains in procedural volume within the first six months of program implementation[8].

The procedural distribution observed—with hernioplasty, benign mass excision, and hemorrhoidectomy collectively accounting for 85.1% of all cases—reflects a deliberately conservative and safety-conscious approach to early implementation. This case mix is well-aligned with international recommendations for community-level surgical service development, which advocate beginning with high-volume, low-complexity elective procedures carrying predictable perioperative risk profiles[10]. The observed progression from simpler to more complex procedures across the study period demonstrates the effectiveness of the incremental implementation strategy in building team competence systematically while maintaining institutional safety standards.

Clinical Outcomes and Safety

The clinical safety profile achieved at Laplae Hospital is noteworthy. A minor complication rate of 2.1%—comprising a single wound seroma managed without sequelae—with zero major complications, zero unplanned readmissions, and zero unplanned referrals compares favourably with benchmarks reported in comparable settings internationally. Biccard et al., in a large cluster-randomized trial examining postoperative outcomes across African hospitals, reported that enhanced perioperative surveillance was associated with substantially reduced postoperative mortality and complication rates at the district hospital level[18]. The low complication rate observed at Laplae Hospital is likely attributable to the combination of rigorous patient selection criteria, comprehensive preoperative assessment protocols, and specialist consultation support from Uttaradit Hospital. However, it must be explicitly acknowledged that the very low event rate—a single complication across 47 procedures—while clinically excellent, precluded the planned binary logistic regression analysis of complication predictors and renders any statistical inference regarding safety outcomes highly limited. The complication rate of 2.1% should be regarded as a preliminary point estimate with wide uncertainty bounds given the small denominator, and should not be over-interpreted as a definitive benchmark for community-level surgical safety.

The absence of unplanned referrals throughout

the study period is significant from both a safety and a systems perspective, reflecting the effectiveness of the patient selection framework and the adequacy of the clinical support infrastructure. This finding is consistent with evidence from Glasbey et al., who emphasized that resilient surgical systems require not only technical competence but also clearly defined escalation pathways and inter-facility communication protocols[19].

One Day Surgery Implementation

The successful implementation of the ODS protocol, achieving 100% uptake among eligible cases by the final month of the study period, represents one of the most operationally significant achievements of this intervention. The mean length of stay of 0.5±0.1 days for ODS procedures—compared with 1.5±0.4 days for conventional admissions—demonstrates efficiency gains achievable through protocol-driven same-day surgery, with direct implications for bed utilization and patient throughput. The progressive adoption of ODS, from 0% in the preparatory phase to full implementation within three months, reflects the effectiveness of the structured training program and the clarity of the clinical eligibility criteria. The utilization of nurse anesthetists and trained perioperative nursing staff within clearly defined scopes of practice was a critical enabler of ODS delivery, aligning with growing international evidence supporting task-shifting as a viable strategy for expanding surgical workforce capacity in settings where specialist provider availability is limited[9]. Wild et al. further demonstrated that structured task-shifting training programs could produce measurable improvements in surgical safety and procedural volume within short timeframes, provided that supervision frameworks and competency assessment systems were rigorously maintained[20].

Impact on the Referral System

The 76.9% reduction in surgical referrals across the three principal condition categories represents the most system-level impactful finding of this study. However, when examined by individual condition using Fisher's exact test—the statistically appropriate method given the small cell counts in this pilot dataset—only the reduction in hernia referrals reached statistical significance (p=0.011). Reductions in hemorrhoid referrals (p=0.337) and minor mass excision referrals (p=0.082) did not achieve statistical significance, and the aggregate 76.9% reduction figure should therefore be interpreted as a descriptive summary of observed trends rather than a statistically confirmed effect. These non-significant results most plausibly reflect insufficient statistical power inherent to the pilot sample size rather than a genuine absence of intervention effect. The capacity of Laplae Hospital to manage these conditions locally nonetheless reduces the direct financial and logistical burden on patients—many of whom face significant travel distances—and releases capacity at Uttaradit Hospital for more complex cases. This finding is directionally consistent with evidence from Mwapasa et al., who demonstrated that a managed surgical consultation network in Malawi produced significant reductions in unnecessary surgical referrals while maintaining clinical safety[11]. The referral reduction also corroborates findings from Ifeanyichi et al., who highlighted the substantial financial burden imposed by surgical referrals in district hospital settings and argued that local capacity enhancement represents the most cost-effective long-term strategy[6].

Patient Satisfaction and Health-Related Quality of Life

The statistically significant improvement in patient satisfaction across all six measured domains—from a mean overall score of 3.1±0.7 at baseline to 4.1±0.5 at six months—reflects the multidimensional benefit of providing accessible, high-quality surgical care within the patient's own community. These findings should nonetheless be interpreted cautiously, as social desirability bias cannot be excluded in a context where patients were receiving newly available local surgical services and may have reported higher satisfaction partly in response to service access rather than objective service quality alone. Additionally, the absence of a control group prevents attribution of satisfaction improvements solely to service quality improvements, as novelty effects and patient gratitude for service access may have contributed to the observed scores.

The SF-36 findings provide additional preliminary evidence supporting the clinical benefit of the intervention. Statistically significant improvements were observed in the three physical health domains most directly linked to the conditions treated—physical functioning, role limitations-physical, and bodily pain—with mean improvements of +16.3, +19.4, and +21.6 points, respectively (all p<0.001). These magnitudes of improvement are clinically meaningful and consistent with the expected trajectory following successful elective surgery for hernia, hemorrhoid, and benign mass excision. Modest but significant

improvements were also observed in general health, vitality, and social functioning (p=0.021, 0.043, and 0.012, respectively), while role limitations-emotional and mental health did not change significantly at one month, consistent with the predominantly physical rather than psychological nature of the conditions treated. Importantly, all SF-36 findings must be interpreted as preliminary given the pilot sample size and limited statistical power; these data are hypothesis-generating and require confirmation in adequately powered prospective studies.

Limitation

Several limitations of this study require explicit acknowledgement. First, and most critically, the final sample of 45 patients was substantially lower than the pre-specified target of 170 patients, representing only 26.5% of the anticipated recruitment. This shortfall was attributable to the early capacity-building phase of the program, in which surgical volume was expanding incrementally from a near-zero baseline. As a consequence, statistical power for all inferential analyses was considerably below the pre-specified 80% threshold; the planned logistic regression analysis could not be executed, and Fisher's exact test rather than chi-square was required for referral pattern analyses due to small cell counts. This study is therefore best characterized as a pilot and feasibility evaluation, and quantitative findings should not be interpreted as definitive estimates of effect. Second, the six-month study period does not permit assessment of long-term sustainability of enhanced surgical capacity. Third, the single-site case study design limits external generalizability. Fourth, the absence of a concurrent control group prevents definitive causal attribution of observed improvements to the intervention alone.

A further limitation concerns the heterogeneity of the enrolled patient population and procedural case mix. Patients ranged in age from 14 to 87 years and underwent five procedural categories with substantially different perioperative complexity profiles. Pooling clinical outcomes across this heterogeneous population may obscure procedure-specific complication rates, recovery trajectories, and satisfaction determinants. Future studies should stratify primary analyses by procedure type and patient risk category. Furthermore, the generalizability of findings is limited by the contextual specificity of Laplae Hospital's designation as a model institution with structured provincial mentorship and exceptional institutional leadership—enabling factors that may not be uniformly present in other community hospitals. Multi-site studies across diverse settings are necessary to evaluate the transferability of the integrated model.

Future Research Directions

The findings of this study identify several priorities for future research. Longitudinal evaluation over a 12-24 months horizon would provide essential evidence regarding sustainability of surgical volume growth and the stability of clinical outcome benchmarks. Formal cost-effectiveness analysis would strengthen the economic case for community-level surgical investment. Adequately powered multi-site studies—designed with the sample size experience of this pilot informing a revised recruitment strategy—are needed to confirm the inferential findings suggested here and to evaluate the generalizability of the integrated model across diverse community hospital contexts. Additionally, research examining patient-reported outcomes beyond satisfaction—including long-term quality of life and return to function—would provide a more complete picture of the social value generated by community-level surgical capacity enhancement.

Conclusion

This pilot mixed-methods evaluation demonstrates the preliminary feasibility of an integrated three-pillar model (personnel development, infrastructure and technology enhancement, and surgical service system development) for enhancing surgical capacity at Laplae Hospital under Thailand's "One Province One Hospital" policy. Within six months, monthly surgical volume increased from two to nine cases, ODS reached full uptake among eligible patients, and safety was maintained, with a single minor complication and no major complications, unplanned readmissions, or unplanned referrals. Patient satisfaction and physical health-related quality of life improved, although satisfaction gains may partly reflect novelty effects and social desirability bias. The observed 76.9% reduction in referrals for common elective conditions suggests meaningful redistribution of surgical workload from the provincial hospital, yet only the reduction in hernia referrals reached statistical significance. Qualitative findings identified strong leadership, structured mentorship from the provincial hospital, standardized protocols, and a progressive simple-to-complex implementation approach as key enablers. Limited perioperative nursing and anesthesia personnel remained the principal constraints. Given the small single-site sample, short follow-up, and absence of a control group, these findings should be regarded as hypothesis-generating. Adequately powered, multi-

site, longitudinal studies incorporating formal cost-effectiveness analysis are needed before the model is scaled across Thai community hospitals.

Acknowledgement

The authors sincerely thank the surgical team and nursing staff of Laplae Hospital for their dedication throughout implementation. Gratitude is extended to Uttaradit Hospital for mentorship and technical support, the Uttaradit Provincial Public Health Office for policy facilitation, and all patients who participated in satisfaction surveys. The Ministry of Public Health is acknowledged for enabling this work through the "One Province One Hospital" policy.

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.

Clinical Trial Registration

Not applicable. This study was a pilot mixed-methods, quasi-experimental service development evaluation conducted at a single community hospital and did not involve a prospective clinical trial requiring registration.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

The datasets generated and analyzed during this study are not publicly available due to patient confidentiality obligations and institutional data governance requirements. De-identified aggregate data supporting the findings are available from the corresponding author upon reasonable request, subject to approval by the Ethics Committee of Uttaradit Provincial Public Health Office.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Uttaradit Provincial Public Health Office (COA No. 081/2567; UPHO REC No. 081/2567). Written informed consent was obtained from all participants before enrolment. Participants were informed of the study purpose, procedures, potential benefits and risks, confidentiality protections, and their right to withdraw at any time without affecting their medical care. All data were anonymized and securely managed in accordance with the Declaration of Helsinki and International Council for Harmonization Good Clinical Practice guidelines.

Funding Disclosure

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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.

References

1. Tangcharoensathien V, Witthayapipopsakul W, Panichkriangkrai W, Patcharanarumol W, Mills A. Health systems development in Thailand: A solid platform for successful implementation of universal health coverage. Lancet 2018;391:1205-23.
2. Sriratanaban J, Ngamkiatpaisarn S, Charoenmukayananta S. Association between hospital accreditation and outcomes: The analysis of inhospital mortality from the national claims data of the universal coverage scheme in Thailand. J Healthc Qual 2020;29:150-7.
3. Ministry of Public Health, Uttaradit Provincial Public Health Office. Strategic plan for public health operations in Uttaradit Province, fiscal year 2025 [Internet]. 2025 [cited 2026 Oct 20]. Available from: https://utoapp3.moph.go.th/app2/plan/views/uploads/674eb84eef131-cf4ef55e0a51357fefbe6f6cb94c6ba1-229.pdf. [in Thai]
4. Uttaradit Provincial Public Health Office. Public health performance report of Uttaradit Province, fiscal year 2024: Development of standardized healthcare services [Internet]. 2024 [cited 2026 Oct 20]. Available from: https://utoapp3.moph.go.th/app2/portfolio/views/uploads/6763d42269d59-3e1299a1223667b32c095b1832704fae-19.pdf. [in Thai]
5. Suriyawongpaisal P, Aekplakorn W, Leerapan B, Lakha F, Srithamrongsawat S, von Bormann S. Assessing system-based trainings for primary care teams and quality-of-life of patients with multimorbidity in Thailand: Patient and provider surveys. BMC Fam Pract

2019;20:85. doi:10.1186/s12875-019-0951-6.
6. Ifeanyichi M, Broekhuizen H, Cheelo M, Juma A, Mwapasa G, Borgstein E, et al. Surgical ambulance referrals in sub-Saharan Africa - financial costs and coping strategies at district hospitals in Tanzania, Malawi and Zambia. BMC Health Serv Res 2021;21:728. doi: 10.1186/s12913-021-06709-5.
7. Clarke M, Pittalis C, Borgstein E, Bijlmakers L, Cheelo M, Ifeanyichi M, et al. Surgical service monitoring and quality control systems at district hospitals in Malawi, Tanzania and Zambia: A mixed-methods study. BMJ Qual Saf 2021;30:950-60.
8. Broekhuizen H, Ifeanyichi M, Mwapasa G, Pittalis C, Noah P, Mkandawire N, et al. Improving access to surgery through surgical team mentoring - policy lessons from group model building with local stakeholders in Malawi. Int J Health Policy Manag 2022;11:1744-55.
9. Ryan I, Shah KV, Barrero CE, Uamunovandu T, Ilbawi A, Swanson J. Task shifting and task sharing to strengthen the surgical workforce in sub-Saharan Africa: A systematic review of the existing literature. World J Surg 2023;47:3070-80.
10. Kamarajah S, Ademuyiwa AO, Atun R, Cieza A, Agyei F, Ghosh D, et al. Health systems strengthening through surgical and perioperative care pathways: A changing paradigm. BMJ Glob Health 2024;9 (Suppl 4):e015058. doi: 10.1136/bmjgh-2024-015058.
11. Mwapasa G, Pittalis C, Clarke M, Bijlmakers L, Le G, Mkandawire N, et al. Evaluation of a managed surgical consultation network in Malawi. World J Surg 2021;45:356-61.
12. Kumluang S, Geue C, Langhorne P, Wu O. Availability of stroke services and hospital facilities at different hospital levels in Thailand: A cross-sectional survey study. BMC Health Serv Res 2022;22:1558. doi: 10.1186/s12913-022-08922-2.
13. Bailey CR, Ahuja M, Bartholomew K, Bew S, Forbes L, Lipp A, et al. Guidelines for day-case surgery 2019: Guidelines from the Association of Anaesthetists and the British Association of Day Surgery. Anaesthesia 2019;74:778-92.
14. Kitreerawutiwong N, Jordan S, Hughes D. Facility type and primary care performance in sub-district health promotion hospitals in Northern Thailand. PLoS One 2017;12:e0174055. doi: 10.1371/journal.pone.0174055.
15. World Health Organization (WHO). Surgical care systems strengthening: Developing national surgical, obstetric and anaesthesia plans [Internet]. Geneva: WHO; 2017 [cited 2025 Aug 30]. Available from: https://apps.who.int/iris/handle/10665/255566.
16. Jaidee PH, Bundittayanurak A, Jindasawat R, Wongdontree S, Sangjun S, Patipat P, et al. Health impact assessment of decentralization of emergency medical services: A case study in Chonburi Province, Thailand. Sci Rep 2025;15:44159. doi: 10.1038/s41598-025-27900-2.
17. Hayirli TC, Meara JG, Barash D, Chirangi B, Hellar A, Kenemo B, et al. Development and content validation of the safe surgery organizational readiness tool: A quality improvement study. Int J Surg 2021;89:105944. doi: 10.1016/j.ijsu.2021.105944.
18. ASOS-2 Investigators. Enhanced postoperative surveillance versus standard of care to reduce mortality among adult surgical patients in Africa (ASOS-2): A cluster-randomised controlled trial. Lancet Glob Health 2021;9:e1391-401.
19. Glasbey JC, Ademuyiwa AO, Chu K, Dare A, Harrison E, Hutchinson P, et al. Building resilient surgical systems that can withstand external shocks. BMJ Glob Health 2024;9 (Suppl 4):e015280. doi: 10.1136/bmjgh-2024-015280.
20. Wild HB, Bednarek OL, van Riswijk H, Poonia K, Simon M, Palet EMM, et al. VitalSurg: Outcomes from a surgical task-shifting training program in a humanitarian context. J Surg Educ 2025;82:103592. doi: 10.1016/j.jsurg.2025.103592.