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Nexus of Thai Health Sciences (NTHS) aims to publish academic works and study findings in health sciences integration, with an emphasis on research at the health system and policy level, interprofessional approaches, and the integration of knowledge across disciplines, in order to support the sustainable development and transformation of Thailand's health system and the professional development of Thai public health and medical personnel, at both national and international levels, as well as interested members of the general public.

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Instructions for Authors

Nexus of Thai Health Sciences (NTHS) welcomes articles in the health sciences related to health systems research, health policy analysis, interprofessional practice, digital health, epidemiology, health economics, and related fields, with an emphasis on work that contributes to the development and transformation of Thailand's health system at the system and policy level. Articles must not have been published elsewhere and must not be under consideration by another journal. The guidelines are as follows.

1. Aims and Scope of the Journal

The journal is a forum for researchers, academics, health personnel, and policy makers to exchange knowledge that links multiple professions, from health systems research and policy analysis to digital health and health system innovation. The scope of the journal covers the following areas:

- Health systems research and health policy analysis
- Interprofessional and multidisciplinary practice
- Public health and health promotion
- Digital health and health informatics
- Environmental and occupational health
- Public health education and health workforce development
- Social determinants of health
- Health economics and resource allocation
- Epidemiology and disease surveillance

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Original research articles are reports of the authors' own studies and research, including research and development (R&D), action research, and the development of models or health service systems. They comprise the following sections in order: title; author names and affiliations; abstracts in Thai and English; introduction; research objectives; methods; results; discussion; conclusions; recommendations; acknowledgments (if any); and references.

Academic articles present academic knowledge, concepts, or experience in the health sciences, with analysis, synthesis, and reference to reliable empirical evidence. They comprise an introduction, content, conclusion, and references.

Review articles systematically gather and review knowledge on a topic from domestic and international journals or books. They comprise an introduction, search methods, the content reviewed, critique, conclusion, and references.

Policy analysis articles systematically analyze a health policy or measure using empirical evidence and an appropriate conceptual framework. They comprise an introduction and policy background, analytical framework or methods, analysis results, policy options and recommendations, conclusion, and references.

All article types must not exceed 15 A4 pages, including tables, figures, and references.

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3.1 General Format

- Type in Microsoft Word on single-sided A4 paper and format according to the journal's template
- Use TH Sarabun New font, 16 points, with 2.54 cm margins on all sides
- Maximum length of 15 pages, including tables, figures, and references

3.2 Components of the Article

Title. The title should be short, concise, and informative, consistent with the objectives and content, in both Thai and English, without abbreviations.

Author names. List the names and affiliations of all authors in both Thai and English (no abbreviations), and identify the corresponding author with an e-mail address and a telephone number.

Abstract. Written in both Thai and English, no more than 300 words per abstract, as continuous prose without subdivision into items. It covers the background and objectives, methods, results, and conclusions; includes only key statistics; and contains no citations.

Keywords. In both Thai and English, 3–5 words, placed at the end of the abstract in each language and separated by commas (,).

Introduction. Describes the background and significance of the problem, the situation, related research, the knowledge gap, and the rationale for the study.

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Discussion and conclusions. Discuss the findings in relation to the objectives and hypotheses, explain the reasons for the results, cite relevant theories or studies, state the limitations of the study, and conclude the key findings in line with the objectives.

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Acknowledgments (if any). Identify those who provided assistance, supporters, and sources of research funding.

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The journal uses the Vancouver referencing style. Reference numbers are placed in square brackets [ ] at the end of the statement cited. Use number 1 for the first source cited and continue in order of appearance in the text. If a source is cited again, use the original number. Compile the complete reference list at the end of the article. Authors are responsible for the accuracy of their references. When a source has more than 6 authors, list the first 6 followed by "et al."

4.1 Journal Articles

Author(s). Article title. Journal name. Year of publication; Volume (Issue): First page-last page.

1. Nuannet P, Somboon O. Development of a primary health care system in rural communities. Thai Journal of Public Health. 2023;18(3):112-128.
2. Muangsapaya W, Winichagoon P, Fucharoen S, Pootrakul P, Wasi P. Improved technique for detecting intraerythrocytic inclusion bodies in thalassemic trait. J Med Assoc Thai. 1985;68:43-5.

4.2 Books and Textbooks

Author(s). Book title. Edition. City of publication: Publisher; Year of publication.

1. Ativanichayaphong N. Health policy and the Thai health service system. Bangkok: Thammasat University Press; 2022.

2. Gilstrap LC, Cunningham FG. Operative obstetrics. 2nd ed. New York: McGraw-Hill; 2002.

4.3 Book Chapters

Author(s). Chapter title. In: Editor(s), editor. Book title. City of publication: Publisher; Year of publication. p. First page-last page.

1. Wood WG. Hemoglobin analysis. In: Weatherall DJ, editor. The thalassemias. New York: Churchill Livingstone; 1983. p. 31-53.

4.4 Electronic Media and Articles with a DOI

Author(s). Article title. Journal name [Internet]. Year of publication [cited Year Month Day];Volume(Issue):Pages. Available from: URL

1. Annas GJ. Resurrection of a stem-cell funding barrier--Dickey-Wicker in court. N Engl J Med [Internet]. 2010 [cited 2010 Jun 15];363:1687-9. Available from: http://www.nejm.org/doi/pdf/10.1056/NEJMp1010466

2. Degenhardt L, Bohnert KM, Anthony JC. Assessment of cocaine and other drug dependence in the general population. Drug Alcohol Depend [Internet]. 2008 Mar [cited 2010 Apr 15];93(3):227-32. doi:10.1016/j.drugalcdep.2007.09.024

4.5 Theses and Dissertations

Author(s). Title [Type/degree level]. City of publication: University; Year degree awarded.

1. Srichairattanakool A. Comparison of the quality of life of patients with chronic myeloid leukemia in the chronic and blastic phases [master's thesis]. Bangkok: Chulalongkorn University; 2000.

5. Article Submission

Authors submit articles through the online system on the journal's website, registering as a member before submission and tracking the status of the article online at any time. Research articles involving human participants must state the name of the human research ethics committee and the approval number in the article. For further information, contact E-mail: fetp1yr@gmail.com

6. Review Process

- The editorial board checks that the article is consistent with the journal's aims and scope and with the manuscript preparation format
- Every article is reviewed by at least 3 peer reviewers with no conflict of interest with the authors, using a double-blind peer review process
- The editor decides to accept or reject an article primarily on the basis of academic quality and consistency with the journal's scope

- Authors revise the article according to the suggestions of the reviewers and the editorial board within the specified period and track the review outcome through the online system

7. Publication Fees

The journal charges an article processing charge only after an article has been accepted for publication. The editorial board will notify the payment channels together with the acceptance letter. The rates are as follows:

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THB 4,500	THB 6,500

8. Publication Ethics

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8.2 Reviewers' Ethics

Reviewers must evaluate articles impartially, have expertise in the relevant field, and provide constructive suggestions. They must keep articles confidential, not use information in the articles for personal benefit, inform the editor of any conflict of interest or if an article is found to be significantly similar to other work, and accept the invitation and submit their review within the agreed time.

8.3 Authors' Ethics

Authors must certify that the article is original work that has not been published and is not under consideration by another journal; identify all contributors in accordance with the principles of authorship; report data and findings truthfully, without distorting, fabricating, or omitting significant data; disclose all types of conflicts of interest; and cite sources fully. Duplicate submission and plagiarism constitute serious violations of publication ethics.

8.4 Ethics of Research Involving Humans

Research articles involving humans must be approved by a human research ethics committee, and the approval number and committee name must be stated in the article. Research must be conducted

under the principles of the Declaration of Helsinki, with informed consent from every participant, and with strict protection of personally identifiable information.

Responsibility

Articles and research reports published in Nexus of Thai Health Sciences represent the opinions and research of the authors alone, do not necessarily reflect the views of the editorial team, and are not the responsibility of Key Data Company Limited. All articles have undergone quality review according to research article standards by at least three peer reviewers using a double-blind process.

Nexus of Thai Health Sciences
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Editorial

Nexus of Thai Health Sciences (NTHS), Volume 1 Issue 6 (November – December 2026), presents research from local health service units, reflecting that sustainable health system development begins with solving problems that arise in real frontline practice. All six articles in this issue are original research articles with a shared emphasis: developing models and systems of care that are safe, continuous, and appropriate to the local context, ranging from patients after discharge and patients waiting for services to emergency preparedness and the care of older adults in the community.

The articles in this issue fall into three main themes. The first is continuous and safe care for specific patient groups: the development of a post-discharge care model for patients with substance use disorders after the detoxification phase to prevent relapse, by Phatcharaporn Chanlun (Soiphisai Hospital, Buengkan Province); the development of a screening and nursing care model for patients at risk of clinical deterioration while waiting for examination, by Bunjong Hongthong (Khon Sawan Hospital, Chaiyaphum Province); and the development of a nursing model for mothers with preterm labor, by Siriporn Ruangsaeng (Namon Hospital, Kalasin Province). The second is emergency care systems: the development of a road accident prevention model for emergency ambulances in the Kalasin provincial service network, by Chuthamanee Phalasila; and the development of an emergency patient assessment system for emerging infectious disease response in the Accident, Emergency and Forensic Unit, Namon Hospital, by Jaruwan Pharacharas. The third is community health care: the development of a community participation-based elderly school model in Mu Mon Subdistrict, Somdet District, Kalasin Province, by Naiyana Chamroenchuea.

Taken together, the six articles are consistent with the spirit of the name "Nexus," which reflects the journal's intention to be a point of connection among frontline practitioners, researchers, and policy makers. Each study begins with a problem in the real context of a hospital or community and leads to a model or system that other service units can study and adapt. Every article has been reviewed by at least 3 experts through double-blind peer review, and the journal is published as open access so that readers of all groups can access knowledge free of charge. The editorial board sincerely hopes that readers will build on the ideas and lessons in this issue in service delivery, administration, and health policymaking in concrete ways.

The editorial board thanks all authors who entrusted us with their work, the reviewers who gave their valuable time to review and provide suggestions, the advisors and all editorial board members, and Key Data Company Limited for supporting the production of the journal. The journal welcomes articles from academics and health personnel in all fields and looks forward to suggestions for improving the quality of the journal.

Sergeant Auttawit Noenchard
Executive Editor
Nexus of Thai Health Sciences

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RESEARCH ARTICLE

Development of a Post-Discharge Care Model for Patients with Substance Use Disorders after the Detoxification Phase to Prevent Relapse, Soi Phisai Hospital, Bueng Kan Province

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Abstract

This research and development study aimed to examine the situation and problems, develop a model, and evaluate the outcomes of post-discharge care for patients with substance use disorders after the detoxification phase to prevent relapse at Soi Phisai Hospital, Bueng Kan Province, from January to September 2026. The study had four phases: situation analysis, model development, implementation, and evaluation. Purposively selected participants were 30 discharged patients, 30 family caregivers, and 15 multidisciplinary team and community network members. Instruments were a semi-structured interview guide, a relapse prevention self-efficacy questionnaire, a follow-up record with urine drug test results, and a satisfaction questionnaire. Data were analyzed using descriptive statistics, paired t-test, Fisher's exact test, and content analysis.

Main problems were missed appointments, no hospital-to-community follow-up system, limited family supervision, and return to high-risk environments. The developed "Soi Phisai Seamless Care Model" had five components: individualized discharge planning and relapse risk assessment, family preparation, technology-assisted follow-up, community home visits, and warning-sign management with re-entry into treatment. After implementation, the 3-month relapse rate decreased from 43.33% to 16.67% (p-value = 0.047), and retention increased from 63.33% to 86.67% (p-value = 0.072). Self-efficacy increased significantly (mean±S.D. 2.85±0.52 to 4.12±0.41; p-value <0.001), and satisfaction was at the highest level (4.46±0.48). Seamless hospital-to-community care with family participation and technology-assisted follow-up was associated with reduced relapse. The model should be adopted as standard practice in the drug clinic, and further studies with larger samples and concurrent comparison groups are recommended.

Keywords: Substance use disorders, Detoxification, Relapse prevention, Seamless care

Introduction

Drug problems remain a global challenge with wide-ranging effects on society, the economy, and public health. An estimated 296 million people worldwide, or 5.8% of the population aged 15-64 years, used drugs at least once in 2021, with cannabis the most commonly used substance, followed by opioids and amphetamine-type stimulants.[1] A major concern is relapse after treatment, which occurs in 40-60% of patients within the first year.[2] Factors associated with relapse include personal factors, co-occurring psychiatric disorders, stress, having a social network that uses drugs, and the lack of an effective post-treatment follow-up system.[3]

In Thailand, drug problems continue to spread, particularly in provincial areas.[4] In 2023, 116,850 people received treatment nationwide, an increase of 7.3% over the previous year. Methamphetamine (yaba) was the most commonly used substance (84.6%), and the most affected age group was 20-29 years, which is the working age.[4] The relapse rate among those who completed treatment is 30-40% within 1 year,[5] and the treatment retention rate is 65%, below the 80% target.[6] Factors that cause patients to be lost to follow-up and to relapse include a lack of motivation to stop using drugs, a lack of family support, and living in an environment that facilitates drug use.[6] The Ministry of Public Health therefore established the Service Plan for substance use disorders, 2023-2027, which emphasizes seamless care and increased treatment retention,[7] and which requires integrated cooperation among families, communities, and related agencies.[8]

Bueng Kan is a border province adjacent to the Lao People's Democratic Republic and is therefore at risk of drug smuggling. A total of 1,564 people received treatment, or 326.4 per 100,000 population, higher than the national average, and yaba was the most commonly found substance (92.4%).[9] Soi Phisai District is a transit route connecting to other districts and provinces and is therefore used for transporting and storing drugs. In addition, the growth of rubber-processing factories has drawn in migrant workers. The numbers of patients receiving rehabilitation at Soi Phisai Hospital, under both the voluntary and compulsory treatment systems, in fiscal years 2021-2023 were 438, 155, and 233, respectively; the number in fiscal year 2023 was 50.3% higher than in fiscal year 2022 (Soi Phisai Hospital, 2025). The most common age group was 25-29 years, and the most common occupation was agriculture.

Soi Phisai Hospital currently uses the "Naka Lom Rak Model" for treatment during the detoxification (Detox) phase, which lasts 10-14 days, and plans discharge along three

pathways: 1) referral to intermediate care (Intermediate Care: IMC) at Mini-Thanyarak Seka; 2) referral to long-term care (Long Term Care: LTC) at Thanyarak Udon Thani Hospital or the Khon Di Khuen Sangkhom Camp in Soi Phisai District; and 3) discharge to the community. All groups are scheduled for follow-up at the drug clinic. However, problems remain: patients attend appointments but still test positive for drugs; patients miss treatment or medication appointments and are prosecuted again; the dropout rate has increased; families lack time for supervision; behavioral and psychiatric problems have increased; and treatment facilities remain inadequate. These findings are consistent with a study reporting that missed appointments and the absence of an effective follow-up system are major causes of relapse.[10] Meanwhile, developing a seamless follow-up system, using technology, and involving families and communities can increase treatment retention and reduce relapse.[11-13]

The researcher therefore developed a post-discharge care model for patients with substance use disorders after the detoxification phase to prevent relapse at Soi Phisai Hospital, so that patients receive continuous care from the hospital to the community, relapse rates are reduced, and the quality of life of patients and their families is improved. The results are expected to guide continuous post-discharge care for patients with substance use disorders at the hospital and at service units in nearby areas with similar contexts.

Research Objectives

1. To examine the situation and problems of post-discharge care for patients with substance use disorders after the detoxification phase at Soi Phisai Hospital, Bueng Kan Province
2. To develop a post-discharge care model for patients with substance use disorders after the detoxification phase to prevent relapse
3. To evaluate the outcomes of the developed model, namely the relapse rate, the treatment retention rate, self-efficacy in relapse prevention, and patient satisfaction

Research Methods

This was a research and development study conducted at the drug clinic and inpatient ward of Soi Phisai Hospital, Bueng Kan Province, from January to September 2026, a total of 9 months. The development framework drew on the Department of Medical Services' guideline for treating patients with substance use disorders in the detoxification phase,[1 4] the concept of seamless care,[7] and family and community participation.[11] The work was divided into 4

phases: Phase 1, situation and problem analysis (January-February 2026); Phase 2, model development (March 2026); Phase 3, model implementation (April-August 2026); and Phase 4, evaluation and model refinement (September 2026).

Population

The population comprised patients with substance use disorders who completed detoxification and were discharged from Soi Phisai Hospital, primary family caregivers, and the multidisciplinary team and network partners in Soi Phisai District, totaling 126 people, and 45 network partner personnel.

Sample

The sample was selected by purposive sampling and comprised 3 groups: 1) 30 patients with substance use disorders who completed detoxification and were discharged, with the sample size calculated using G*Power; 2) 30 primary family caregivers; and 3) 15 members of the multidisciplinary team and network partners, namely physicians, professional nurses, psychologists, pharmacists, staff of sub-district health promoting hospitals (SHPHs), village health volunteers (VHVs), and community leaders. Participants were selected according to the inclusion criteria during the study period.

For outcome comparison, retrospective data were drawn from the medical records of 30 similar patients discharged after detoxification in fiscal year 2025, to serve as a pre-development comparison group.

Inclusion Criteria

Aged 18 years or older, diagnosed with a substance use disorder and having completed detoxification as planned, able to communicate in Thai, having a contactable telephone number, residing in Soi Phisai District, and giving consent to participate in the research.

Exclusion Criteria

Severe psychiatric symptoms requiring specialist referral, relocation outside the area, or withdrawal from the research.

Research Instruments

The instruments comprised 1) a general information and treatment record form; 2) a semi-structured interview guide for patients, caregivers, and the multidisciplinary team on the situation, problems, and needs for post-discharge care; 3) a 20-item self-efficacy questionnaire on relapse prevention using a 5-point rating scale; 4) a post-discharge follow-up record covering appointment attendance, urine drug test results, relapse, emergency department visits or readmissions, and return to work or study; and 5) a 10-item patient satisfaction questionnaire on the care model. Mean scores for the assessment and questionnaire were interpreted at 5 levels: 1.00-1.80 lowest, 1.81-2.60 low, 2.61-3.40

moderate, 3.41-4.20 high, and 4.21-5.00 highest, according to Best's criteria.

The instruments were checked for content validity by 3 experts, namely a psychiatrist, a professional nurse specializing in substance use treatment, and a nursing instructor in mental health and psychiatry. The item-level Index of Item-Objective Congruence (IOC) ranged from 0.67 to 1.00, with an overall value of 0.84. The self-efficacy questionnaire and the satisfaction questionnaire were tried out with 10 patients similar to the sample, yielding Cronbach's alpha coefficients of 0.87 and 0.89, respectively.

Data Collection

Phase 1: The researcher reviewed medical records and retrospective treatment statistics, conducted in-depth interviews with patients, caregivers, and the multidisciplinary team (approximately 30-45 minutes each), and held 2 focus groups.

Phase 2: The data obtained were used to draft the model together with the multidisciplinary team and network partners through 2 workshops, and experts reviewed its appropriateness.

Phase 3: Personnel and network partners were trained before the model was implemented with patients discharged after detoxification. Self-efficacy was assessed before discharge, and each patient was followed for 3 months.

Phase 4: Outcomes were evaluated against the indicators, satisfaction was surveyed, and a lessons-learned meeting was held to refine the model.

Data Analysis

General data were analyzed using descriptive statistics, namely frequency, percentage, mean ($\bar{x}$), and standard deviation (S.D.). Mean self-efficacy scores before and after implementation were compared using the paired t-test, with the normality of the score differences checked by the Shapiro-Wilk test, and the mean difference was reported with its 95% confidence interval (CI). Proportions of outcomes between the pre- and post-development groups were compared using Fisher's exact test because some indicators had few events (expected count <5). The level of statistical significance was set at 0.05. Qualitative data were analyzed by content analysis, and trustworthiness was verified by data triangulation.

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Research Ethics

The researcher explained the objectives, procedures, benefits, and possible risks. Participants had the right to refuse or withdraw at any time without any effect on the services they received, and signed an informed consent form before participating. All data were kept confidential, codes were used instead of real names, results were presented in aggregate, and the data will be destroyed within 5 years after the research ends.

Results

1. Situation and problems of post-discharge care for patients with substance use disorders after the detoxification phase

1.1 General characteristics of the patient sample Most of the patient sample were male (86.67%), with a mean age of $\bar{x}$±S.D. 27.17±2.13 years (min = 20, max = 40). Most were aged 25-29 years (36.67%), worked in agriculture (40.00%), used yaba as the main substance (90.00%), entered treatment under the voluntary system (70.00%), and were discharged to the community (60.00%), as shown in Table 1.

Table 1 General characteristics of the patient sample (n = 30)

General characteristics	Number (persons)	Percentage
Sex		
Male	26	86.67
Female	4	13.33
Age (years)		
18-24	8	26.67
25-29	11	36.67
30-39	6	20.00
40 years and over	5	16.67
Occupation		
Agriculture	12	40.00
Hired labor/laborer	9	30.00
Unemployed	6	20.00

General characteristics	Number (persons)	Percentage
Student	3	10.00
Main substance		
Methamphetamine (yaba)	27	90.00
Crystal methamphetamine (ice)	2	6.67
Cannabis	1	3.33
Treatment system		
Voluntary treatment	21	70.00
Compulsory treatment	9	30.00
Discharge pathway		
Discharged to the community	18	60.00
Referred to intermediate-care rehabilitation (IMC)	8	26.67
Referred to long-term rehabilitation (LTC)	4	13.33

1.2 Problems found in post-discharge care A review of retrospective medical records, in-depth interviews, and focus groups identified **4** key problem areas: **1)** Patients: lack of motivation and of skills for managing triggers, with some patients attending appointments but still testing positive for drugs; **2)** Families: most caregivers had to work outside the home, had no time for supervision, and did not recognize the warning signs of relapse; **3)** Service system: follow-up appointments depended mainly on patients coming to the hospital, information was not passed on to sub-district health promoting hospitals and the community, and treatment facilities were inadequate; and **4)** Community: patients returned to their former environment where friends used drugs, and they still faced social stigma from community members.

2. Post-discharge care model for patients with substance use disorders after the detoxification phase to prevent relapse

The problem analysis and the workshops with the multidisciplinary team and network partners yielded the "Soi Phisai Seamless Care Model," which builds on the existing "Naka Lom Rak Model" by connecting care from before discharge through to the community. It has 5 components and was reviewed by 3 experts using an appraisal covering knowledge, skills, and cooperation; its appropriateness was rated at the highest level ($\bar{x}$±S.D. = 4.60±0.42 points).

Table 2 Components and key activities of the post-discharge care model for patients with substance use disorders after the detoxification phase

Component	Key activities	Responsible persons/timing
1. Individualized discharge planning and relapse risk assessment	Assess relapse risk and triggers; provide motivational interviewing; jointly develop an individualized relapse prevention plan	Nurse/psychologist, 3 days before discharge
2. Preparing the family to be the primary caregiver	Educate on addiction as a brain disease, warning signs of relapse, positive communication, and supervising appointment attendance	Nurse/primary caregiver, once before discharge
3. Seamless follow-up through technology	Follow up via LINE Official Account and telephone; assess symptoms and cravings and provide encouragement	Drug clinic nurse, weeks 1, 2, 4, 8, and 12
4. Home visits by community networks	Pass information to SHPHs and VHVs for home visits; coordinate with community leaders to support livelihoods and reduce stigma	SHPHs/VHVs/community leaders, once a month
5. Warning-sign management and re-entry into treatment	When warning signs or a positive urine test are found, reassess and return the patient to treatment without judgment within 72 hours	Multidisciplinary team, throughout the 3 months after discharge

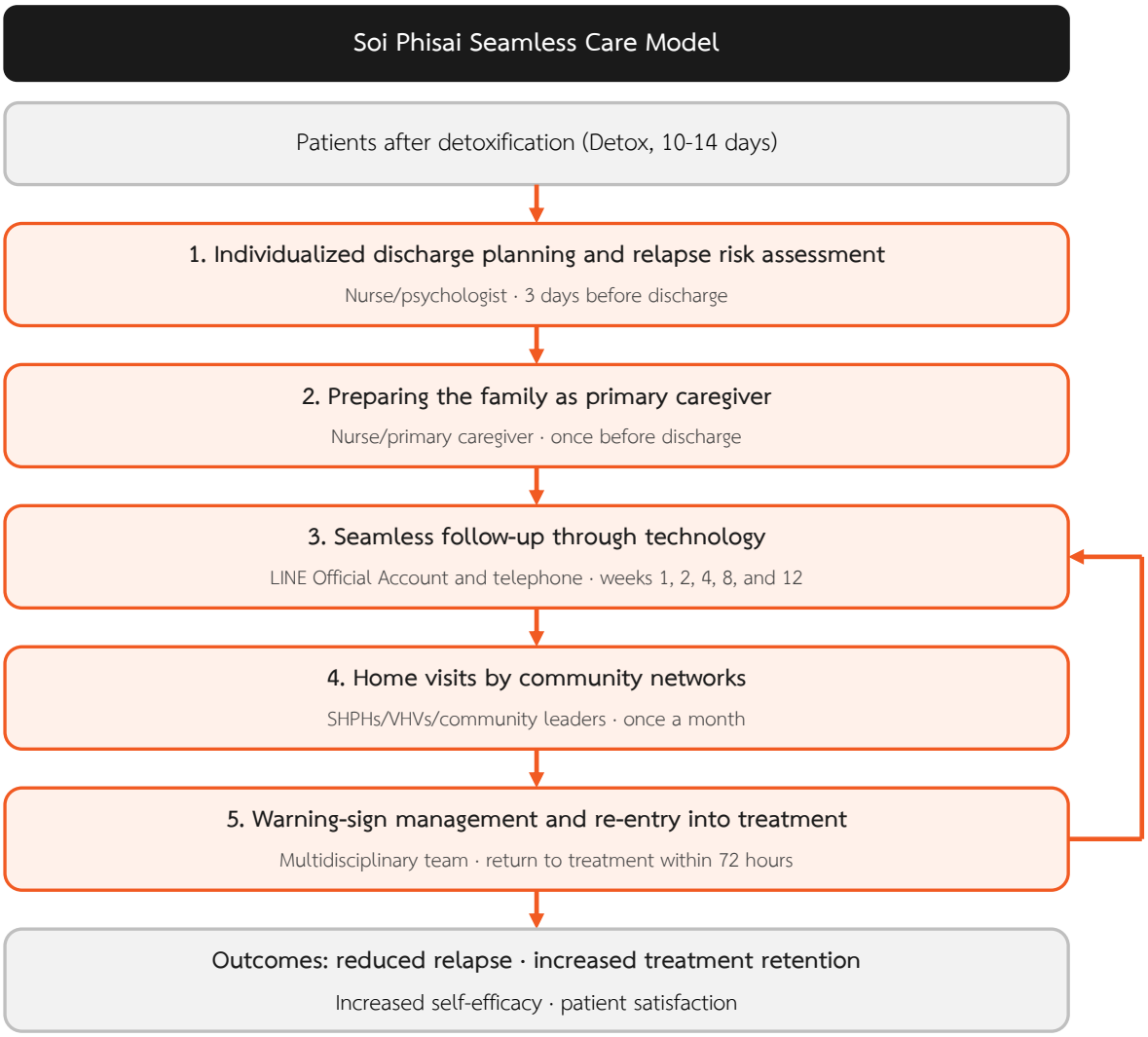

Figure 1 Post-discharge care model for patients with substance use disorders after the detoxification phase to prevent relapse

3. Outcomes of the post-discharge care model for patients with substance use disorders after the detoxification phase

3.1 Relapse rate and other indicators

After implementing the model and following patients for 3 months, the relapse rate decreased from 43.33% to 16.67%, a statistically significant difference (Fisher's exact test, p-value = 0.047). This reduction of 26.67 percentage points exceeded the 15% target. The treatment retention rate increased from 63.33% to 86.67% (p-value = 0.072), consistent with the missed-appointment rate that fell from 36.67% to 13.33%, but the difference was not statistically significant. The proportion of patients returning to work or study increased from 50.00% to 76.67% (p-value = 0.060), which was likewise not statistically significant. Emergency department visits or readmissions for substance withdrawal fell from 13.33% to 3.33%, which met the set

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criterion (not more than 10%); however, the difference was not statistically significant (p-value = 0.353), as shown in Table 3.

Table 3 Comparison of outcomes by indicator before and after implementing the care model

Indicator	Target	Before development (n = 30) Number (%)	After development (n = 30) Number (%)	p-value
Relapse within 3 months	15% reduction	13 (43.33)	5 (16.67)	0.047*
Treatment retention	≥ 80%	19 (63.33)	26 (86.67)	0.072
Emergency department visits or readmissions for substance withdrawal	≤ 10%	4 (13.33)	1 (3.33)	0.353
Return to work or study	≥ 75%	15 (50.00)	23 (76.67)	0.060

*Statistically significant, p-value <.05

3.2 Self-efficacy in relapse prevention The mean self-efficacy score for relapse prevention after implementing the model ($\bar{x}$±S.D. = 4.12±0.41 points) was significantly higher than before (2.85±0.52 points) (mean difference = 1.27, 95% CI = 1.04-1.50, t = 11.24, df = 29, p-value <0.001), as shown in Table 4.

Table 4 Comparison of mean self-efficacy scores for relapse prevention before and after implementing the model (n = 30)

Self-efficacy	Before ($\bar{x}$±S.D.)	After ($\bar{x}$±S.D.)	t	p-value
Managing triggers and cravings	2.71±0.58	4.05±0.47	10.12	<0.001*
Refusing when persuaded	2.78±0.61	4.18±0.45	9.87	<0.001*
Managing emotions and stress	2.92±0.55	4.09±0.44	9.35	<0.001*
Attending appointments and seeking help	2.99±0.57	4.16±0.42	9.02	<0.001*

Self-efficacy	Before ($\bar{x}$±S.D.)	After ($\bar{x}$±S.D.)	t	p-value
Overall	2.85±0.52	4.12±0.41	11.24	<0.001*

*Statistically significant, p-value <.05

3.3 Patient satisfaction with the care model Patients' overall satisfaction with the care model was at the highest level ($\bar{x}$±S.D. = 4.46±0.48 points), with 86.67% reporting high to highest satisfaction, exceeding the 80% target.

Discussion

The situation analysis showed that relapse among patients discharged after detoxification is not caused by patient factors alone but by gaps in the service system, where care is interrupted once patients leave the hospital, by families that are not ready to provide supervision, and by patients returning to their former environment. This is consistent with studies reporting that lack of motivation, lack of family support, and an environment that facilitates drug use are important factors in loss to follow-up and relapse,[6] and with a study in community hospitals in northeastern Thailand reporting that missed appointments and the lack of an effective follow-up system are the main obstacles to post-treatment care.[10] The detoxification phase, which lasts only 10-14 days, should therefore be seen as the beginning of continuing care rather than the end of treatment.[14]

After implementing the model, the relapse rate decreased significantly (p-value = 0.047), and the treatment retention rate tended to increase but not significantly. This may be related to 3 main points. First, discharge planning and an individualized relapse prevention plan before discharge, together with motivational interviewing, helped patients recognize their own triggers and develop coping skills, as reflected in self-efficacy scores that increased in every domain; this is consistent with the holistic approach to substance use care that emphasizes empowering patients to manage themselves.[15] Second, preparing the family to be the primary caregiver and passing information to community networks gave patients a support system around them after returning home. This is consistent with studies reporting that follow-up with family and community participation increases treatment retention and reduces relapse,[11,13] and that integrating multisector cooperation is a key condition for success.[8]

Third, follow-up through LINE Official Account and telephone at set intervals enabled the care team to detect warning signs early and return patients to treatment before

a lapse turned into a return to dependence, which may explain the decrease in missed appointments. This is consistent with studies reporting that follow-up through a mobile application combined with home visits reduces missed appointments and relapse,[12] and that technology increases continuity of care without adding to patients' travel burden.[16,17] In addition, non-judgmental management of warning signs encouraged patients to disclose cravings or episodes of renewed use, so that patients remained in the system even when relapse occurred, which is at the heart of seamless care under the Service Plan for substance use disorders.[7,18]

However, emergency department visits or readmissions decreased but not significantly, possibly because there were few events (5 cases) and the sample was small, giving low statistical power; the same applies to retention in treatment and return to work or study, which increased but not significantly. The increase in return to work or study may reflect the role of community leaders in supporting livelihoods and reducing stigma, which is consistent with the concept of sustainable rehabilitation that requires restoring patients' social roles.[19]

Limitations of the study: 1) the sample was small and purposively selected; 2) the comparison group was retrospective data from medical records, which may differ in context and completeness of recording, there was no randomization, and confounders were not controlled, so causal relationships cannot be concluded; 3) the follow-up period was only 3 months after discharge, so long-term results cannot be concluded; 4) multiple indicators were tested without adjusting the significance level; and 5) the assessment of relapse relied partly on reports from patients and caregivers together with urine tests at appointments, so the relapse rate may be underestimated.

Recommendations

1. Recommendations for applying the results

1.1 The hospital should adopt the post-discharge care model for patients with substance use disorders after the detoxification phase as the standard practice of the drug clinic, starting discharge planning and relapse risk assessment before discharge.

1.2 A system for linking information among the hospital, sub-district health promoting hospitals, and community networks should be developed so that follow-up and return to treatment are seamless.

1.3 The capacity of families, VHVs, and community leaders should be developed to recognize warning signs of relapse, communicate positively, and reduce stigma, together with coordinating livelihood support for patients.

1.4 Suitable venues and treatment rooms for the program should be arranged, and personnel should be assigned to carry out technology-based follow-up continuously.

2. Recommendations for future research

2.1 Future research should study a larger sample, use a concurrent comparison group, and follow up for at least 1 year to confirm the effectiveness of the model.

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RESEARCH ARTICLE

Development of a Screening and Nursing Care Model for Patients at Risk of Clinical Deterioration While Waiting for Examination, Outpatient Nursing Service, Khon Sawan Hospital, Chaiyaphum Province

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Abstract

This research and development (R&D) study aimed to 1) examine the situation of screening patients at risk of clinical deterioration while waiting for examination, 2) develop and implement a screening and nursing care model, and 3) evaluate its outcomes in the Outpatient Nursing Service, Khon Sawan Hospital, Chaiyaphum Province, from January to September 2026 using the R1D1R2D2 process. Participants were 12 registered nurses, 90 consecutively enrolled at-risk patients, and 90 service time records in each period before and after implementation. Instruments included a focus group guide, a warning sign assessment, a nurses' knowledge and skills assessment, a unit-level indicator form, a client satisfaction questionnaire, and a model appropriateness questionnaire. Data were analyzed using descriptive statistics, the Wilcoxon signed-rank test, the Mann-Whitney U test, the chi-square test, and content analysis.

The developed KS-WAIT model comprised four components: Warning sign assessment, Area-specific care, Information handoff, and Training and supervision. After implementation, nurses' knowledge scores increased from 13.83±0.39 to 15.00±0.00 ($Z = -3.28$, p-value = 0.001), whereas skill scores did not differ (p-value = 0.157). Median waiting time for screening decreased from 96.00 to 62.00 minutes ($Z = -8.12$, p-value <0.001), and total service time decreased from 119.00 to 96.00 minutes ($Z = -5.74$, p-value <0.001). The detection rate of at-risk patients increased from 3.64 to 7.91 per 1,000 visits ($\chi^2 = 18.47$, p-value <0.001), and no patient deteriorated while waiting during implementation (one case before). Client satisfaction (4.92±0.28) and model appropriateness (4.62±0.38) were at the

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highest level. The KS-WAIT model enabled systematic screening and monitoring of at-risk outpatients; its scoring tool should be validated and long-term outcomes monitored before wider implementation.

Keywords: Screening, Clinical deterioration, Waiting for examination, Early warning score

Introduction

Overcrowding and prolonged waiting times are major problems for outpatient services worldwide. The World Health Organization reports that more than 10% of patients receiving medical care experience harm from that care, half of which is preventable.[1] Overcrowding adversely affects patients, staff, and the health system as a whole.[2] Physiological changes usually precede clinical deterioration, and areas with low clinical surveillance, such as waiting areas, are high-risk points where deterioration may not be detected in time.[3] The National Early Warning Score (NEWS) and Modified Early Warning Score (MEWS) are therefore used to identify at-risk patients at an early stage.[3] In Thailand, several healthcare facilities have developed guidelines for monitoring deterioration while patients wait for examination, for example in a surgical examination room,[4] among older adults,[5] and in an outpatient building,[6] and the use of a MEWS system enabled nurses to record vital signs completely in 100% of cases.[7]

The Outpatient Nursing Service of Khon Sawan Hospital, Chaiyaphum Province, serves an average of 120–200 patients per day. Patients deteriorated while waiting for examination in 5, 4, 3, and 3 cases in fiscal years (FY) 2022–2025, respectively, mostly older adults with underlying diseases who developed fever or worsening abdominal pain while waiting. The mean screening waiting time increased from 68.30 minutes in FY2024 to 75.90 minutes in FY2025 and 99.70 minutes in FY2026 (first quarter), while the waiting time to see a physician remained relatively stable, indicating that the main bottleneck lay at the screening point. The existing model had limitations: assessment did not systematically cover warning signs of critical conditions, patients were not reassessed while waiting, and coordination between service points was unclear.[6]

This development applied the Early Warning System concept together with the Structure–Process–Outcome framework, which explains that service quality arises from resources and work systems, care practices, and outcomes for patients.[8] However, most previous studies used surveillance approaches specific to a single examination room or to older adults only, and relied on qualitative prioritization.[4-6] No model yet used a quantitative warning score to set reassessment intervals and to escalate care continuously across all service points of a community hospital outpatient department.

The researcher therefore developed a systematic screening and nursing care model for patients at risk of clinical deterioration while waiting for examination, so that nurses can identify risk at an early stage, have clear care guidelines at each service point, and reduce adverse events. The findings will serve as a

standard guideline for the unit and as a prototype for community hospitals in similar contexts.

Research Objectives

1. To examine the situation, problems, barriers, and needs regarding the screening and nursing care of patients at risk of clinical deterioration while waiting for examination, Outpatient Nursing Service, Khon Sawan Hospital, Chaiyaphum Province
2. To develop and implement a screening and nursing care model for patients at risk of clinical deterioration while waiting for examination
3. To evaluate the outcomes of the model, namely the incidence of patients deteriorating while waiting for examination (primary outcome), nurses' knowledge and skills, waiting times, detection of at-risk patients, client satisfaction, and appropriateness of the model

Methods

This research and development (R&D) study followed the R1D1R2D2 process, using the Early Warning System concept together with the Structure–Process–Outcome framework[8] as its framework, and was conducted from January to September 2026. In the R2 phase, evaluation used a one-group pretest-posttest design for nurses and comparison with data from the 3 months before implementation (historical control) for unit-level outcomes. The study comprised four phases, as shown in Figure 1, as follows:

Phase 1: **Research (**R1: **January–February** 2026) examined the situation, problems, barriers, and needs using secondary data from FY2022–2026 and focus group discussions with 12 registered nurses, analyzed by content analysis.

Phase 2: **Development (**D1: **March–April** 2026) drafted the model with the same group of nurses in workshops, had its content validity checked by three experts, and tried out the instruments with a group in a similar context.

Phase 3: **Research (**R2: **May–August** 2026) trained the nurses for one day (6 hours), implemented the model for 3 months (May–July), and collected and analyzed data in August.

Phase 4: **Development (**D2: **September** 2026) analyzed outcomes, held a reflection meeting with nurses and experts, evaluated appropriateness, and finalized the model.

Population

Registered nurses in the Outpatient Nursing Service, Khon Sawan Hospital, and patients attending the outpatient department (an average of 3,850–3,920 visits per month).

Sample

The sample comprised 1) 12 registered nurses working at the screening and examination points, who were all those meeting the criteria (the entire population was studied) and were the same group in both the development and implementation phases; 2) 90 patients screened as at risk during the implementation period, selected by consecutive sampling at 30 patients per month; and 3) service time records from the hospital information system for the 3 months before implementation (February–April) and the

implementation period, 90 records per period, selected by simple random sampling. The sample size was calculated using the formula for comparing the means of two independent groups, $n = 2[(Z\alpha/2+Z\beta)\sigma/d]^2$, with $\alpha = 0.05$, power 0.80, a standard deviation of screening waiting time of 22.00 minutes from the unit's FY2025 data, and a clinically significant difference of 10.00 minutes, giving 76 per group. Allowing 15% for missing data [76/(1–0.15)], the sample was 90 per group.

Inclusion Criteria

Nurses: at least 1 year of experience and willing to participate. Patients: aged 18 years or older, alert, able to communicate in Thai (or with a relative providing information on their behalf), and with a warning score of 2 or higher.

Exclusion Criteria

Unable to provide complete information, or withdrawal from the study. Patients who deteriorated to the point of requiring emergency assistance before completing the satisfaction questionnaire were excluded from the satisfaction analysis but were still counted in every case as incidents in the unit-level indicators.

Operational Definitions

Deterioration while waiting for examination refers to a patient whose vital signs or level of consciousness changed such that the patient had to be transferred to the emergency room, was resuscitated, or had an unplanned hospital admission while waiting for examination. Screening waiting time is counted from card submission to completion of screening; waiting time to see a physician from completion of screening to seeing the physician; and total time from card submission to receiving medication, using times recorded in the hospital information system.

Research Instruments

The instruments comprised 1) experimental instruments, namely the KS-WAIT model, the deterioration warning sign assessment, service-point-specific care plans, and warning cards; and 2) nine data collection instruments: (1)–(4) a demographic form for focus group participants (8 items), a focus group guide (10 topics), a nurse demographic form (7 items), and a patient demographic form (9 items); (5) a nurses' knowledge test of 15 true/false items, with a full score of 15; (6) a nurses' practice skills assessment of 10 items on a 5-point rating scale, rated by the head of the outpatient nursing service from observation of actual practice; (7) a unit-level indicator form of 8 indicators (as shown in Table 2, and completeness of reassessment on schedule); (8) a client satisfaction questionnaire of 8 items; and (9) a model appropriateness questionnaire of 10 items. Items (8) and (9) used 5-point rating scales. Knowledge and skills were interpreted using Bloom's criteria[9] (high knowledge 12–15 points; high skills 3.68–5.00), while satisfaction and appropriateness were interpreted in five levels using Best's criteria[10] (highest 4.51–5.00 to lowest 1.00–1.50).

Quality Assessment of the Instruments

Three experts (emergency nursing, outpatient nursing, and research and development) examined content validity. The

item-level IOC of all instruments ranged from 0.67 to 1.00 (criterion ≥0.50). The instruments were tried out with 15 registered nurses and 30 patients in a neighboring community hospital. The knowledge test had a KR-20 of 0.84, and the skills, satisfaction, and model appropriateness questionnaires had Cronbach's alpha coefficients of 0.90, 0.93, and 0.95, respectively.

Data Collection

Nurses' knowledge and skills were assessed before training and after 3 full months of implementation (late July). Demographic and satisfaction data from patients were collected after they received their medication by research assistants who had not cared for that patient. Unit-level indicator data were extracted from the hospital information system and risk reporting system for both the pre-implementation and implementation periods, and the appropriateness of the model was evaluated at the reflection meeting on September 15, 2026.

Data Analysis

General data were analyzed using frequencies, percentages, means, and standard deviations. The Shapiro-Wilk test showed that knowledge scores, skill scores, and waiting times were not normally distributed (p-value <0.05); therefore, nurses' knowledge and skill scores before and after implementation were compared using the Wilcoxon signed-rank test, and waiting times before and after implementation were compared using the Mann-Whitney U test, reported as medians (interquartile range: IQR) with effect size r = Z/√N. The proportions of at-risk patients per number of service visits were compared using the chi-square test, and incidents and complaints using Fisher's exact test. The level of statistical significance was set at .05. Satisfaction and appropriateness data were analyzed using means and standard deviations, and qualitative data using content analysis.

Research Ethics

This study took human research ethics into account. Before data collection, the participants were informed and signed voluntary consent forms, and could withdraw at any time without any effect on their work or on the services they received. Data were kept confidential, codes were used in place of names, and results were presented in aggregate only. Retrospective data from the information system were anonymized.

Results

1. Situation, problems, barriers, and needs (Phase R1)

1.1 Secondary data The mean screening waiting time increased continuously from 68.30 to 99.70 minutes over FY2024–2026, while the waiting time to see a physician remained relatively stable (36.20, 35.80, and 36.50 minutes, respectively), indicating that the main bottleneck lay at the screening point.

1.2 Focus group results Two focus groups were held (January 15 and 29, 2026). All participants were female, with a mean age of 45.50±10.40 years, and all were professional-level registered nurses with more than 10 years of outpatient experience. Ten (83.33%) rotated across several service points, and 10 (83.33%) had

previously encountered a patient who deteriorated while waiting for examination. Five main themes emerged from 20 coded statements: (1) screening that relied on experience with a single assessment (5 statements); (2) workload and overcrowding at the screening point (4 statements); (3) lack of criteria for reassessment and surveillance while waiting (4 statements); (4) discontinuous information handoff between service points (4 statements); and (5) the need for tools, guidelines, and competency development (3 statements). The nurses wanted a tool that uses vital signs already being measured, with risk-level criteria and reassessment intervals, symbols visible at every service point, and a reporting flowchart.

2. Development and implementation of the model (Phases D1, R2, and D2)

2.1 Model development The researcher used the findings of Phase R1 together with the conceptual framework[8] to draft the model with the nurses in two workshops (March 10 and 24, 2026), resulting in the KS-WAIT model (Khon Sawan – Warning sign assessment, Area-specific care, Information handoff, Training and supervision) with four components. In the first draft, information handoff (I) was a supporting mechanism; it was made a core component in Phase D2 on the experts' recommendation. The warning sign assessment was adapted from the National Early Warning Score 2 (NEWS2)[11] and comprised six physiological parameters (including level of consciousness on the Alert-Voice-Pain-Unresponsive scale: AVPU), with the systolic blood pressure criteria adjusted for hypertensive patients and three added risk factors (age ≥60 years, ≥2 underlying diseases, and pain ≥7). Risk was classified as low (0–1), moderate (2–4), and high (≥5 or a score of 3 on any parameter). This differs from the former model, which measured vital signs once and relied on nurses' judgment. The service-point-specific care plan defined activities at four service points (screening point, waiting area, examination room, and medication pickup point) by risk level.

2.2 Implementation of the model All 12 nurses (100.00%) completed the one-day (6-hour) training and remained until the end of the study. During implementation, 93 patients were screened as at risk, of whom 90 were enrolled (30 per month); 54 (60.00%) were female, the mean age was 61.47±11.06 years, 61 (67.78%) were older adults, and 89 (98.89%) had underlying diseases, with diabetes and hypertension the most common at 70 patients each (77.78%). The most common presenting symptom was fever (33 patients, 36.67%). The mean warning score was 2.46±0.50, and all patients were at moderate risk. Forty-one patients (45.56%) scored 3, and the proportion was higher in months 2 and 3 (30.00%, 50.00%, and 56.67% in months 1, 2, and 3, respectively). Reassessment was recorded completely on schedule in 84 of 90 patients (93.33%).

2.3 Model refinement (Phase D2) At the reflection meeting on September 15, 2026, three problems were identified and the model was refined as follows: (1) between 08:00 and 10:00, reassessment every 30 minutes could not be completed on schedule, so one nurse was assigned to the surveillance zone and patient

assistants repeated vital sign measurements under the nurses' supervision; (2) the colored tags attached to outpatient cards fell off or were swapped, so they were replaced with colored wristbands; and (3) two additional pulse oximeters were allocated. All three refinements began after the implementation period ended. The final KS-WAIT model comprises four components: W, warning sign assessment at the screening point; A, service-point-specific care and a surveillance zone; I, SBAR information handoff together with colored wristbands and warning cards; and T, annual training, weekly supervision, and monthly incident review, under the responsibility of the head of the outpatient nursing service, as shown in Figure 1.

R1 Research Jan–Feb 2026	Secondary data, FY2022–2026 Focus groups with 12 nurses (2 sessions) Content analysis Output: 5 problem themes and nurses' needs
D1 Development Mar–Apr 2026	2 workshops Drafted the model and warning sign assessment 3 experts checked IOC; instruments tried out Output: Draft KS-WAIT model
R2 Research May–Aug 2026	1-day (6-hour) nurse training 3-month implementation with 90 at-risk patients Pre–post measurement and comparison with the 3 months before Output: Nurse, patient, and unit outcomes
D2 Development Sep 2026	Reflection meeting with 15 participants Evaluated appropriateness of the model 3 refinements Output: Final KS-WAIT model (4 components)

Findings from R2 feed back into model refinement in Phase D2. Framework 1: Early Warning System (NEWS2 adapted for outpatients). Framework 2: Structure–Process–Outcome (Donabedian).

Figure 1 Research and development model

3. Outcomes of the model

3.1 Nurses' knowledge and skills Knowledge scores after implementation were significantly higher than before (Z = −3.28, p-value = 0.001, r = 0.67), and all 12 nurses' scores increased. No nurse answered correctly the item on the need to record reassessments before implementation, but all answered it correctly afterward. Practice skills did not differ because 10 of the 12 nurses already had full scores before implementation (ceiling effect) and only 2 nurses' scores changed, so no inferential conclusion could be drawn, as shown in Table 1.

Table 1 Comparison of registered nurses' knowledge and practice skills before and after implementation of the model (Wilcoxon signed-rank test, n = 12)

Variable	Before		After		Level	Z	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.			
Knowledge (full score 15)	13.83	0.39	15.00	0.00	High	−3.28	0.001 *
Practice skills (mean score 1–5)	4.97	0.08	5.00	0.00	High	−1.41	0.157

*Statistically significant, p-value <.05

3.2 Unit-level outcomes Comparing the 3 months before implementation with the 3 months during implementation, the number of service users increased by 1.82%, and the detection rate of at-risk patients increased significantly from 3.64 to 7.91 per 1,000 visits. The mean screening waiting time decreased from 98.40±24.15 to 64.20±18.72 minutes (a 34.76% reduction), and the mean total time decreased from 121.60±28.30 to 98.30±22.65 minutes (a 19.16% reduction), both statistically significant (r = 0.61 and 0.43, respectively). The waiting time to see a physician did not differ. The incidence of patients deteriorating decreased from 1 case to 0, and complaints decreased from 4 to 1, neither of which was statistically significant, as shown in Table 2.

Table 2 Comparison of unit-level outcomes 3 months before and during implementation of the KS-WAIT model

Indicator	Before implementation	During implementation	Test statistic	p-value
Number of service visits	11,550	11,760	–	–
Patients screened as at risk, n (per 1,000 visits)	42 (3.64)	93 (7.91)	χ^2 = 18.47	<0.001*
Screening wait (min), Median (IQR)[a]	96.00 (81.00-114.00)	62.00 (51.00-75.00)	Z = −8.12	<0.001*
Wait to see physician (min), Median (IQR)[a]	35.00 (28.00-44.00)	33.00 (26.00-42.00)	Z = −1.36	0.174
Total time (min), Median (IQR)[a]	119.00 (101.00-139.00)	96.00 (83.00-112.00)	Z = −5.74	<0.001*
Deterioration while waiting, n (per 1,000 visits)	1 (0.09)	0 (0.00)	Fisher's exact	0.495
Complaints about waiting, n (per 1,000 visits)	4 (0.35)	1 (0.09)	Fisher's exact	0.215

[a]Randomly selected from time records in the information system, 90 records per period (Mann-Whitney U test). *Statistically significant, p-value <.05

3.3 Satisfaction and appropriateness of the model The 90 service users reported the highest level of overall satisfaction (4.92±0.28). The highest-rated item was feeling safe while waiting for examination (4.97±0.18), followed by clarity of advice on symptoms to report to a nurse immediately (4.94±0.23), and the lowest was overall waiting time (4.87±0.43). The appropriateness of the model, rated by 15 evaluators, was at the highest level (4.62±0.38). The highest-rated item was benefit to patient safety (4.87±0.35) and the lowest was appropriateness of the reassessment interval (4.27±0.59), which was at the high level.

Discussion

Findings for Objective 1: The screening waiting time rose continuously while the waiting time to see a physician remained constant, reflecting that the bottleneck lay at the screening point. This is consistent with studies finding that emergency department crowding is associated with higher mortality[12] and 7-day mortality.[13] Moreover, screening based on a single assessment misses abnormal signs that often precede critical conditions.[3] Analyzing the problem together with practitioners from the outset therefore helped to identify risk factors clearly.[6]

Findings for Objective 2: All four components of KS-WAIT directly addressed the five issues identified in Phase R1. The adaptation of NEWS2 is consistent with a systematic review finding that NEWS2 is the most suitable tool for screening emergency patients likely to deteriorate,[14] and higher NEWS scores are associated with intensive care admission and resuscitation.[15] Adding scores for age and underlying diseases makes the tool suitable for older outpatients with chronic diseases.[5] The model is similar to the emergency surveillance model for patients waiting for examination at Phayakkhaphum Phisai Hospital,[16] but KS-WAIT uses a quantitative score to set reassessment intervals and escalation, defines activities at all four service points, and can be used together with the existing urgency triage system.[17] The highest-level appropriateness rating was probably due to

the participation of the nurse users in the design from the outset; however, most evaluators were co-developers, so the ratings may be higher than the true level.

Findings for Objective 3: Nurses' knowledge increased, particularly on recording reassessments, reflecting that training and supervision helped change prior beliefs.[5] The more than twofold increase in the detection rate of at-risk patients may result both from the assessment tool helping to find patients who were previously overlooked and from the new criteria, which add scores for age and underlying diseases and thus define the at-risk group differently from before. The absence of deteriorating patients is consistent with a study that found no deaths while waiting for examination after developing a model,[16] but incidence was already trending downward and events were rare, so causality cannot yet be concluded. The reductions in screening and total times may be explained by the short assessment that uses vital signs already measured, together with moving at-risk patients to the surveillance zone, which reduced crowding at the screening point. The waiting time to see a physician lies outside the scope of a nursing model.[2] Service users were satisfied at the highest level, especially regarding feeling safe, consistent with previous studies.[16,17]

Limitations of the study This study had no concurrent control group; the incidence was a rare event; the sample came from a single hospital; all patients were at moderate risk, so the care plan for high-risk patients could not be evaluated; the inclusion criterion of being alert meant abnormal AVPU parameters were not assessed; the implementation period was only 3 months; the pre-implementation data overlapped with Phase D1, when nurses had already begun to learn the model's concept; and the sensitivity and specificity of the warning sign assessment have not been tested.

Conclusion

This research and development produced the KS-WAIT model, which comprises warning sign assessment, service-point-specific care by risk level, information handoff between service points, and training with supervision and follow-up. After implementation, nurses' knowledge increased, more at-risk patients were detected, and screening waiting time and total time decreased significantly. No patient deteriorated while waiting during the implementation period, and service users were satisfied at the highest level.

Recommendations

1. Recommendations for application. The KS-WAIT model should be continued together with monitoring of indicators; a nurse should be assigned to the surveillance zone from 08:00 to 10:00; sufficient pulse oximeters, colored wristbands, and warning cards should be provided; workshops should be held at least once a year, with orientation for new nurses before they work at the screening point; and the model should be extended to community hospitals in similar contexts.

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2. Recommendations for future research. Quasi-experimental studies with a comparison group or multiple hospitals should be conducted, with follow-up of at least 6–12 months; the sensitivity, specificity, and cut-off scores of the warning sign assessment should be studied, including high-risk patients; and a more demanding skills assessment tool using independent assessors should be developed to reduce the ceiling effect.

Acknowledgments

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RESEARCH ARTICLE

Development of a Nursing Model for Mothers with Preterm Labor, Namon Hospital, Namon District, Kalasin Province

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Abstract

This research and development study aimed to analyze the situation, develop a nursing model for mothers with preterm labor and to evaluate its outcomes. It was conducted in the labor room of Namon Hospital, Namon District, Kalasin Province, from January 2025 to October 2026, using Donabedian's structure–process–outcome framework, in four research and development phases: situational analysis, model development, implementation, and evaluation. Participants were 12 labor room nurses and 20 women with preterm labor (10 before implementation from retrospective records and 10 after implementation), selected by purposive sampling. Instruments were the nursing model and clinical practice guideline, competency and satisfaction questionnaires, and a clinical outcome record form. Data were analyzed using descriptive statistics, paired t-test, independent t-test, and Fisher's exact test.

The model comprised structure, process, and outcome components. After implementation, nurse competency increased from 3.15±0.42 to 4.72±0.31 ($t = 14.31$, p-value <0.001) and satisfaction from 3.24±0.45 to 4.38±0.36 ($t = 9.63$, p-value <0.001). Decision-to-referral time decreased from 52.50±9.80 to 35.30±8.40 minutes ($t = -4.21$, p-value <0.001), and maternal satisfaction was high (4.45±0.38). Appropriate and timely referral (90.00% vs. 60.00%; p-value = 0.303) and complications (40.00% vs. 50.00%; p-value = 1.000) did not differ. The model appears feasible for community hospitals; however, the maternal sample was small, and larger studies with long-term follow-up are needed.

Keywords: Nursing model, Preterm labor, Referral system, Community hospital

Introduction

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Preterm birth refers to delivery before 37 completed weeks of gestation and is a major global public health problem. The World Health Organization reported that in 2020 approximately 13.40 million babies were born preterm, or 1 in 10 live births worldwide.[1] Complications of preterm birth are the leading cause of death among children under 5 years of age, accounting for 18.00% of all deaths in this age group and 35.00% of neonatal deaths. South Asia and sub-Saharan Africa account for 65.00% of preterm births worldwide, and infants born before 28 weeks of gestation in low-income countries have a survival rate of only 10.00%, compared with more than 90.00% in high-income countries.[2] In Thailand, the preterm birth rate (24 weeks to 36 weeks 6 days of gestation) was 12.50% in fiscal year 2021 and 11.60% in fiscal year 2022, higher than the global average (9.90%),[2,15,17] while the number of births has fallen to only 485,085 in 2021,[3] making it all the more important that every infant survives with a good quality of life. Important risk factors include multiple pregnancy (OR 9.47, 95%CI 1.20-74.86), insulin-treated gestational diabetes (OR 49.09, 95%CI 3.76-640.13), and a history of preterm birth (OR 8.46, 95%CI 1.03-69.75),[4] as well as short cervix, anemia, and a first antenatal visit after 12 weeks of gestation, which together predicted 29.20% of preterm births.[5]

In Kalasin Province, a study of factors affecting preterm birth found that the main risk factors were incomplete antenatal care according to the criteria, maternal complications, and lack of knowledge about warning signs.[6] This is consistent with Bueng Kan Hospital, which found a preterm birth rate of 9.29%, with preterm premature rupture of membranes, incomplete antenatal care, and hypertension during pregnancy as important factors.[7] Namon Hospital, Namon District, is a 30-bed community hospital serving people in a remote area, including general patients, emergency patients, and women in labor.[8] Labor room data showed preterm births among 7.59% of mothers in 2022 and 9.39% in 2023, a rising trend; about 8.00-10.00% of all women giving birth (approximately 25-31 cases per year out of approximately 330 births per year) had to be referred to higher-capacity hospitals, namely Kalasin Hospital, Khon Kaen Hospital, and Srinagarind Hospital. The main problems were inaccurate risk assessment and delayed referral decisions, taking approximately 45-60 minutes, resulting in 6.00-8.00% of mothers giving birth during referral.

Donabedian's framework evaluates the quality of health services through structure, process, and outcomes[9] and has been used to develop nursing practice guidelines for pregnant women with preterm labor.[10] Previous studies developed nursing models based on the quality dimensions framework for labor services,[11] a nursing model for pregnant women with preterm labor,[12] a discharge planning program,[13] and continuity of care from hospital to home,[14] all of which yielded better outcomes. However, these studies focused on only some dimensions of care, and there is still no model that

integrates nurse competency, clinical practice guidelines, and the referral system in community hospitals with limited resources.

Namon Hospital therefore needs to develop a context-appropriate nursing model for mothers with preterm labor, covering risk assessment, inpatient care, referral, and follow-up, together with developing the competency of labor room nurses. This study is expected to yield a model that helps reduce complications, reduce referral delays, increase the safety of mothers and infants, and serve as a prototype for other community hospitals in similar contexts.

Research Objectives

1. To study the situation and problems of caring for mothers with preterm labor at Namon Hospital
2. To develop a nursing model for mothers with preterm labor at Namon Hospital based on Donabedian's framework
3. To evaluate the outcomes of using the model, namely the competency and satisfaction of labor room nurses, clinical outcomes, referral, and maternal satisfaction

Methods

This research and development (R&D) study was conducted in the labor room of Namon Hospital, Namon District, Kalasin Province, from January 2025 to October 2026 (22 months), using Donabedian's structure–process–outcome framework[9] to define the components and indicators of the model. The work was divided into four phases according to the research and development process: Phase 1, situational study and problem analysis (January–February 2025); Phase 2, model design and development (March–May 2025); Phase 3, model implementation (June 2025–March 2026); and Phase 4, evaluation and refinement (April–October 2026). Nurse outcomes were evaluated using a one-group pretest-posttest design, while maternal outcomes were compared between the post-implementation group and the pre-implementation group using retrospective data (historical control), as detailed below.

Population

The population comprised 1) 12 registered nurses working in the labor room of Namon Hospital; 2) mothers with preterm labor receiving services at Namon Hospital; and 3) stakeholders in developing the model, namely physicians, administrators, and the multidisciplinary team.

Sample

The sample comprised 1) 12 labor room nurses, with all eligible nurses studied; 2) two groups of mothers with preterm labor, namely the pre-implementation group (retrospective data, January 2023–December 2024) and the post-implementation group (June 2025–

October 2026), 10 in each group, selected by purposive sampling according to the specified criteria. The sample size was calculated with G*Power for a two-tailed independent t-test, with an effect size of 0.50 (a medium effect size according to Cohen's criteria), power of 0.80, and a significance level of .05, giving 64 per group. However, this study collected data from only 10 per group, fewer than the calculated sample size, so statistical power is limited (power for an effect size of 0.50 was 0.19). (The researcher gathered every eligible mother consecutively in chronological order. In the pre-implementation period, 18 mothers met the inclusion criteria and 8 were excluded under the exclusion criteria (5 with incomplete medical records, 2 who gave birth before being assessed in the labor room, and 1 with intrauterine fetal death), leaving 10. In the post-implementation period, 13 mothers met the inclusion criteria and 3 were excluded (1 who gave birth before being assessed in the labor room, 1 with intrauterine fetal death, and 1 who withdrew), leaving 10. The sample size therefore depended on the number of eligible mothers in a small community hospital.) and 3) 10 stakeholders (2 physicians, 2 hospital administrators and nursing department heads, 1 pharmacist, 2 antenatal clinic nurses, 2 accident and emergency and referral nurses, and 1 medical records officer) who took part in brainstorming and lesson-learned meetings.

Inclusion Criteria

1) Nurses: registered nurses who had worked in the labor room for at least 6 months and were willing to participate. 2) Mothers: pregnant women at 28 weeks to less than 37 weeks of gestation, diagnosed with preterm labor and admitted to the labor room of Namon Hospital, diagnosed according to the clinical practice guideline of the Royal Thai College of Obstetricians and Gynaecologists[17] as regular uterine contractions with cervical change (thinning and/or increased dilatation) or cervical dilatation of at least 2 centimeters. Gestations of less than 28 weeks were excluded because community hospitals have no neonatal intensive care unit and must refer immediately, with care guidelines that differ from those for gestations of 28 weeks or more.

Exclusion Criteria

1) Nurses who took study leave, long-term leave, or transferred to another unit during the study. 2) Mothers who gave birth before being assessed in the labor room, had intrauterine fetal death, or had incomplete medical records; post-implementation mothers who withdrew from the study were considered to have discontinued participation.

Research Instruments

The instruments comprised 1) instruments for development and implementation, namely the nursing model for mothers with preterm labor, the nursing clinical practice guideline (CPG), the operations manual for labor room nurses, and the competency development program for labor room nurses; and 2) data collection instruments, namely a 30-item competency assessment for caring for

mothers with preterm labor (nurse self-assessment), a 15-item nurse satisfaction questionnaire on the model, a 12-item satisfaction questionnaire for mothers and families (5-point rating scale), and a clinical outcome and referral record form. Content validity was checked by three experts, giving an IOC of 0.67-1.00. The competency assessment and nurse satisfaction questionnaire were tried out with 10 labor room nurses in a neighboring community hospital, and the maternal satisfaction questionnaire with 10 mothers with preterm labor with characteristics similar to the sample. The Cronbach's alpha coefficients of the competency assessment, nurse satisfaction questionnaire, and maternal satisfaction questionnaire were 0.89, 0.91, and 0.93, respectively. Mean scores were interpreted in 3 equal-width levels: low (1.00-2.33), moderate (2.34-3.67), and high (3.68-5.00). The model used a preterm birth risk assessment form developed by the researcher from the risk factors in the references[4,5,17]: history of preterm birth, multiple pregnancy, short cervix, anemia, hypertension, diabetes, first antenatal visit after 12 weeks of gestation, and premature rupture of membranes. Decision-to-referral time was counted from the time of admission and documentation of the preterm labor diagnosis in the labor room until the time the physician ordered referral on the referral form. Time to corticosteroid initiation was counted from admission until the first dose was given. Maternal and neonatal complications were defined as the occurrence of at least one of the following from admission until discharge or referral: delivery during referral, postpartum hemorrhage, infection, or severe hypertension in the mother, and an Apgar score at 5 minutes below 7, need for ventilation, or death in the neonate. Appropriate and timely referral was defined as a referral in which risk was assessed with the assessment form, the receiving hospital was contacted before transfer, corticosteroid was given before transfer when indicated, a registered nurse accompanied the transfer, and the mother arrived at the receiving hospital before delivery.

Data Collection

Phase 1: Retrospective statistics on preterm birth, complications, referral time, and clinical outcomes were collected from medical records, nurses' competency and needs were assessed, and a stakeholder brainstorming meeting was held. Phase 2: The model was developed and its quality checked by experts. Phase 3: Nurses were trained according to the program, the model was applied to the post-implementation mothers, and the first lesson-learned session was held in month 8 (August 2025). Phase 4: Nurses' competency and satisfaction after implementation were assessed, clinical outcomes and maternal satisfaction data were collected, the second lesson-learned session was held (July 2026), and results were summarized. The researcher collected all data personally. Nurses' competency and satisfaction were measured before implementation in February 2025 (end of Phase 1) and after implementation in April 2026

(after 10 full months of implementation). For maternal satisfaction in the pre-implementation group, for whom there were no data in the retrospective medical records, the researcher conducted telephone interviews using the same questionnaire after obtaining consent. Qualitative data were collected from stakeholder group meetings using a set of guiding questions, audio-recorded with permission, and transcribed verbatim.

Data Analysis

General data were analyzed using descriptive statistics, namely frequency, percentage, mean, and standard deviation. The Shapiro-Wilk test showed that the data were normally distributed (p-value >.05), so parametric statistics were used. The general characteristics of the two maternal groups (age and gestational age at admission) were compared with the independent t-test. Nurses' competency and satisfaction before and after implementation were compared with the paired t-test. Continuous maternal outcomes between the pre- and post-implementation groups were compared with the independent t-test, and categorical variables with Fisher's exact test because expected cell counts were less than 5. Mean differences were reported with 95% confidence intervals, and the level of statistical significance was set at .05. Qualitative data were analyzed by content analysis.

Research Ethics

This study observed the principles of research involving human participants. The researcher protected participants' rights by explaining the objectives and procedures, obtaining written informed consent, keeping data confidential, using codes instead of names in the retrospective data and presenting results in aggregate, and allowing withdrawal at any time without any effect on treatment or work. Retrospective medical record data of mothers in the pre-implementation group were anonymous, and the ethics committee waived the requirement for consent for these data. The satisfaction data collected from this group by telephone were obtained with the mothers' consent before data collection.

Results

1. Situation and problems of caring for mothers with preterm labor at Namon Hospital

1.1 General characteristics of the sample All 12 labor room nurses were female (100.00%), with a mean age of 38.42±7.15 years and mean labor room experience of 9.58±6.21 years. Mothers with preterm labor in the pre- and post-implementation groups had mean ages of 27.90±6.18 and 28.40±6.52 years and mean gestational ages at admission of 33.12±2.36 and 33.45±2.28 weeks, respectively, with no statistically significant differences (independent t-test; age t = −0.18, p-value =

0.862; gestational age t = −0.32, p-value = 0.754).

1.2 Situation and problems The situational analysis in Phase 1 found preterm birth in 7.59% of mothers in 2022 and 9.39% in 2023. The main problems were 1) risk assessment relied on clinical judgment, which was inaccurate in 2-3 of 10 cases (20.00-30.00%) in the review of medical records of the pre-implementation group; 2) delayed referral decisions, taking a mean of 52.50±9.80 minutes (range 40-69 minutes), with 6.00-8.00% of mothers giving birth during referral (labor room statistics, 2022-2023); 3) ineffective communication within the team; 4) lack of a standardized practice guideline; and 5) nurses' competency in caring for mothers with preterm labor was at the moderate level (3.15±0.42) and satisfaction with the existing system was moderate (3.24±0.45). In the brainstorming meeting with 10 stakeholders, participants proposed a standard risk screening tool, clear decision criteria and referral steps, a direct communication channel with the referral hospital, corticosteroid administration before referral, and nurse training using simulated scenarios.

2. Development of a nursing model for mothers with preterm labor

2.1 Model development process Development proceeded in four phases according to the research and development process, using Donabedian's framework, as shown in Table 1

Table 1 Steps in developing the nursing model for mothers with preterm labor, Namon Hospital

Phase	Activities/content	Instruments	Duration	Academic rationale
1	Studied the situation and analyzed problems; collected statistics on preterm birth, complications, and clinical outcomes; analyzed nurses' competency and needs; reviewed the literature; held a stakeholder brainstorming meeting	Medical record data form, nurse competency assessment, group meeting guide	Jan–Feb 2025 (2 months)	Assessed the existing structure, process, and outcomes before designing the model based on Donabedian's framework[9]
2	Designed and developed the model; prepared the CPG; developed the competency development program; defined nurses' roles in each phase of care; established a referral system with the referral hospital; prepared the manual and quality assessment tools	CPG, operations manual, competency development program, expert appropriateness assessment form	Mar–May 2025 (3 months)	Using empirical evidence and labor service quality dimensions improves the quality of care[11,12]

Phase	Activities/content	Instruments	Duration	Academic rationale
3	Implemented the model; trained nurses according to the program; followed the CPG; coordinated referrals through the system; monitored practice; held the first lesson-learned session in month 8 (August 2025); and refined the model	Training plan, simulated scenarios, CPG compliance monitoring form, outcome record form	Jun 2025–Mar 2026 (10 months)	Practice, simulation, and continuous mentoring support competency development
4	Evaluated and refined; assessed competency, satisfaction, clinical outcomes, and referral; held the second lesson-learned session (July 2026); summarized the report and disseminated the model	Competency assessment, satisfaction questionnaire, outcome record form	Apr–Oct 2026 (7 months)	Evaluated outcomes and refined continuously according to the quality cycle so that the model suits the community hospital context

2.2 The developed model The nursing model for mothers with preterm labor at Namon Hospital comprises three components, as shown in Figure 1: 1) Structure: one clinical practice guideline (CPG), labor room nurses who have undergone competency development, an operations manual, necessary drugs and equipment, an information system, and a multidisciplinary team; 2) Process: screening and risk assessment with a standard tool, inpatient care (monitoring uterine contractions and cervical change, administering drugs according to the treatment plan, and psychological support), referral decision-making and coordination with the referral hospital, and continuing follow-up; and 3) Outcomes: nurses' competency and satisfaction, maternal and neonatal complications, appropriate and timely referral, and maternal satisfaction. Data from the two lesson-learned sessions were used to refine the model continuously. The reusable essentials of the model are: 1) risk screening criteria, using the risk assessment form immediately upon admission and reassessing when symptoms change; 2) referral criteria and steps, namely referring when gestational age is less than 34 weeks or when delivery within 7 days is highly likely, for example cervical dilatation of 3 centimeters or more or effacement of 75% or more, which is the group with an indication for corticosteroids according to the clinical practice guideline,[17] deciding and coordinating with the referral hospital within 45 minutes of admission, communicating using the SBAR format, giving corticosteroid before referral when indicated, and having a registered nurse accompany the transfer; and 3) a nurse competency development program lasting 2 days (12 hours), comprising risk assessment, inpatient care and medication, emergency delivery and neonatal resuscitation, SBAR communication, and two simulated scenarios,

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followed by monthly mentoring. Three experts rated the appropriateness of the model at the high level (mean 4.52). After the first lesson-learned session, the risk assessment form was changed to a one-page checklist and a hotline and coordinator at the referral hospital were designated; after the second, the referral criteria were made clearer, monthly case reviews were added, and corticosteroid initiation before referral was required for every mother with an indication.

3. Outcomes of using the nursing model for mothers with preterm labor

3.1 Competency and satisfaction of labor room nurses After implementation, labor room nurses' competency scores in caring for mothers with preterm labor increased from the moderate level (3.15±0.42) to the high level (4.72±0.31), and satisfaction increased from the moderate level (3.24±0.45) to the high level (4.38±0.36), both statistically significant (t = 14.31 and 9.63, respectively, df = 11, p-value <0.001), as shown in Table 2

Table 2 Comparison of mean competency and satisfaction scores of labor room nurses before and after implementation of the model (Paired t-test, n=12)

Variable	Group	Before		After		Level	$\bar{d}$	95%CI	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Competency in caring for mothers with preterm labor (full score 5)	Labor room nurses	3.15	0.42	4.72	0.31	Mod. → High	1.57	1.33 to 1.81	14.31	<0.001*
Satisfaction with the model (full score 5)	Labor room nurses	3.24	0.45	4.38	0.36	Mod. → High	1.14	0.88 to 1.40	9.63	<0.001*

*Statistically significant, p-value <.05; Mod. = Moderate

3.2 Referral outcomes and maternal satisfaction Comparing the post-implementation group with the pre-implementation group, decision-to-referral time decreased from 52.50±9.80 to 35.30±8.40 minutes (a 32.76% reduction; t = −4.21, p-value <0.001), time to corticosteroid initiation after admission decreased from 68.40±18.60 to 41.20±12.30 minutes (t = −3.86, p-value = 0.001), and maternal and family satisfaction was at the high level (mean 4.45±0.38, or 89.00%), significantly higher than in the pre-implementation group (3.58±0.52) (t = 4.27, p-value <0.001), as shown in Table 3 (all mothers in both groups were referred and had an indication for corticosteroids, so complete data were used for 10 per group, df = 18; satisfaction scores for the pre-implementation mothers were obtained by telephone interview).

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Table 3 Comparison of outcomes of mothers with preterm labor between the post- and pre-implementation groups (n=10 per group)

Variable	Post-implementation		Pre-implementation		df	$\bar{d}$	95%CI	t	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Decision-to-referral time (min)	35.30	8.40	52.50	9.80	18	-17.20	−25.78 to −8.62	-4.21	<0.001*
Maternal and family satisfaction (full score 5)	4.45	0.38	3.58	0.52	18	0.87	0.44 to 1.30	4.27	<0.001*
Time to corticosteroid initiation after admission (min)	41.20	12.30	68.40	18.60	18	-27.20	−42.01 to −12.39	-3.86	0.001*

*Statistically significant, p-value <.05

3.3 Complications and appropriateness of referral The post-implementation group had maternal and neonatal complications in 4 cases (40.00%) and the pre-implementation group in 5 cases (50.00%), with no statistically significant difference (Fisher's exact test, p-value = 1.000). Appropriate and timely referral occurred in 9 cases (90.00%) and 6 cases (60.00%), respectively, with no statistically significant difference (Fisher's exact test, p-value = 0.303). Delivery during referral occurred in 0 cases (0.00%) in the post-implementation group and 1 case (10.00%) in the pre-implementation group, with no statistically significant difference (Fisher's exact test, p-value = 1.000), as shown in Table 4

Table 4 Comparison of complications and appropriateness of referral between the post- and pre-implementation groups

Variable	Post-implementation (n=10), number (%)	Pre-implementation (n=10), number (%)	Statistic	p-value
Maternal and neonatal complications	4 (40.00)	5 (50.00)	Fisher's exact test	1.000
Appropriate and timely referral	9 (90.00)	6 (60.00)	Fisher's exact test	0.303
Delivery during referral	0 (0.00)	1 (10.00)	Fisher's exact test	1.000

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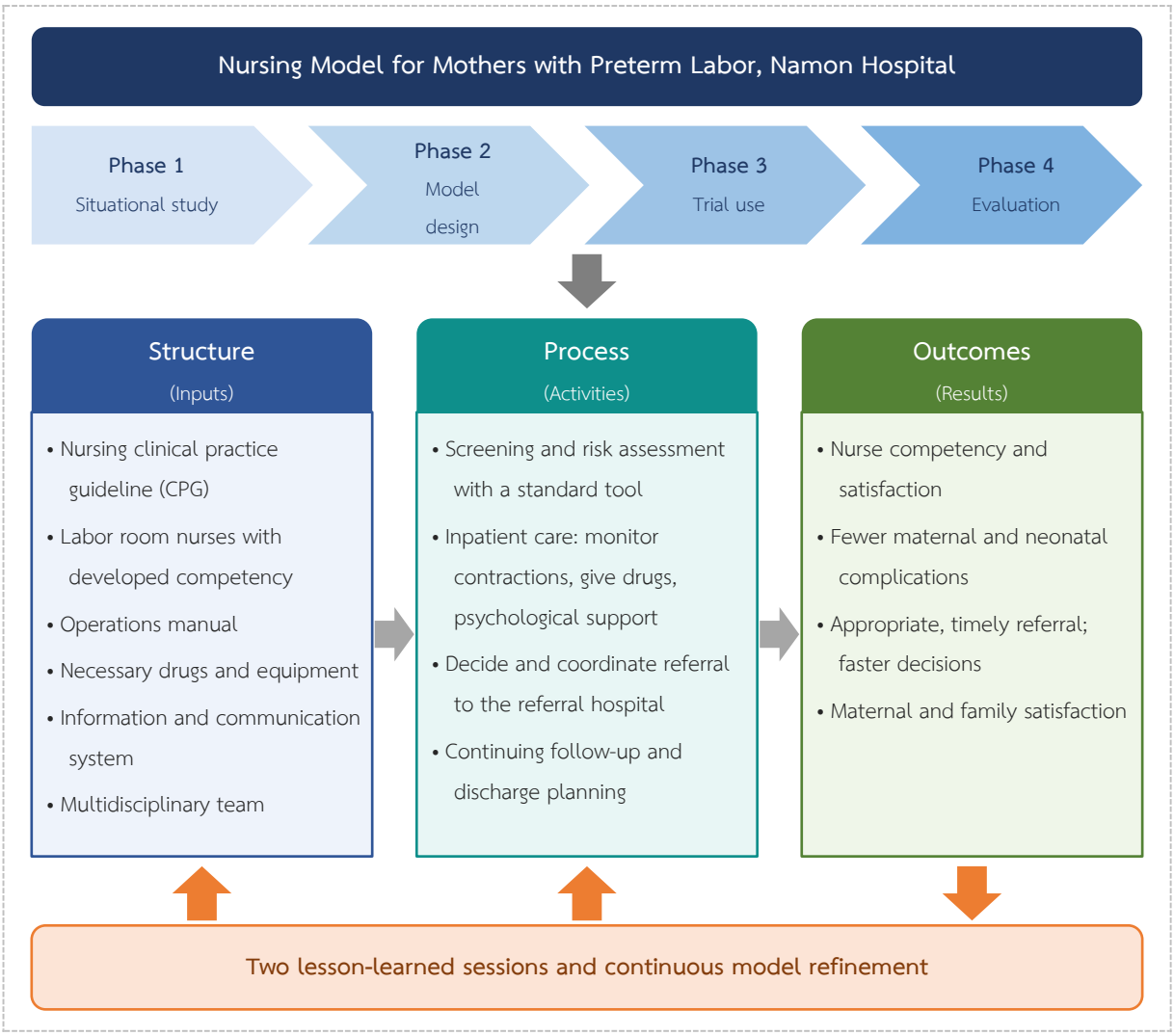

Figure 1 Nursing model for mothers with preterm labor, Namon Hospital

Discussion

The situation at Namon Hospital, where preterm birth occurred in 7.59-9.39% of mothers with an increasing trend, is close to the rate at Bueng Kan Hospital (9.29%)[7] and to global statistics.[1] The problems of inaccurate risk assessment and delayed referral decisions are related to risk factors detectable from antenatal care, such as incomplete antenatal care, maternal complications, and lack of knowledge about warning signs,[6,7] as well as short cervix and anemia.[5] The role of labor room nurses in assessing and providing timely assistance[15] therefore requires a standard assessment tool in place of individual judgment, as well as nurse competency development, which is consistent with the finding that existing competency was at the moderate level.

The model developed on Donabedian's framework covers structure, process, and outcomes, enabling the quality of care to be evaluated and improved systematically,[9] consistent with the development of nursing practice guidelines for pregnant women with

preterm labor[10] and nursing models based on the quality dimensions framework for labor services.[11,12] Having stakeholders jointly analyze problems and take part in two lesson-learned sessions helped make the model suit a community hospital with limited resources and fostered staff acceptance. Linking care from admission through inpatient care, referral, and follow-up is consistent with the concept of continuity of care.[13,14]

After implementation, nurses' competency and satisfaction increased significantly, which may result from continuous competency development through workshops and follow-up and from having a CPG as a common guideline for the whole unit. The 32.76% shorter decision-to-referral time is important because prolonging labor for at least 48 hours so that the infant can receive corticosteroids, and referring to facilities ready to care for low-birth-weight infants, improve maternal and neonatal outcomes.[16] Complications (40.00% and 50.00%) and appropriate and timely referral (90.00% and 60.00%) did not differ statistically, possibly because of the small sample and differing severity of risk. The limitations of this study were as follows: it was conducted in a single community hospital; the maternal sample was small (10 per group), limiting statistical power; the comparison was with a pre-implementation group from retrospective data, which may be confounded by time period; purposive sampling may have introduced selection bias; the researcher collected the data personally, which may have introduced measurement bias; nurses assessed their own competency and pre-implementation mothers completed the questionnaire retrospectively by telephone, which may have introduced recall bias and social desirability bias; the model was refined during implementation; there was no comparison group for the nurse evaluation; and outcomes were followed only in the short term. It therefore cannot be concluded that the improved outcomes were a direct result of the model.

Conclusion

The nursing model for mothers with preterm labor at Namon Hospital, developed on Donabedian's framework, comprises structure, process, and outcomes, with the CPG, nurse competency development, and the referral system as key components. After implementation, nurses' competency and satisfaction increased (from 3.15 to 4.72 and from 3.24 to 4.38), and decision-to-referral time shortened by 32.76%, while appropriate and timely referral (90.00%) and complications (40.00%) did not differ from the pre-implementation group, and mothers' satisfaction was high (4.45, or 89.00%).

Recommendations

1. Recommendations for application. Administrators should continuously support the use of the model and CPG in the labor room together with indicator monitoring, support continuous nurse competency development,

develop coordination systems and referral networks with the referral hospital, develop an information system to record and monitor data, and consider extending the model to community hospitals in similar contexts once evaluation results from larger samples are available.

2. Recommendations for future research. Multicenter studies should be conducted in several community hospitals, enrolling all patients consecutively and including a comparison group; the long-term effectiveness of the model compared with the former approach should be studied to assess sustainability; factors affecting clinical outcomes of mothers and infants with preterm labor should be studied; and studies should be conducted in larger hospitals to understand problems in more complex contexts.

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RESEARCH ARTICLE

Development of a Road Accident Prevention Model for Emergency Ambulances in the Kalasin Provincial Service Network

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Abstract

This research and development study, guided by the ADDIE model with a one-group pretest-posttest evaluation, aimed to examine the situation, develop a road accident prevention model for emergency ambulances, and evaluate its effectiveness in the Kalasin Provincial Service Network between January 2022 and October 2026. Participants were 42 members of the emergency medical services committee (purposive sampling) and 77 emergency medical service coordinators and ambulance drivers (simple random sampling). Instruments were a focus group guide and assessments of health literacy, safe driving behavior, and satisfaction. Data were analyzed using descriptive statistics, a paired t-test, and incidence rate ratios.

The resulting GPS-Safety Model comprised seven core processes. After 10 months of implementation, health literacy increased from 17.12±3.86 to 23.41±1.52 points ($t = 15.84$, p-value <0.001) and safe driving behavior from 82.56±15.42 to 112.47±8.93 points ($t = 18.73$, p-value <0.001). Satisfaction was high (4.39±0.64). Comparing the 8 months before with the 10 months after implementation, accident incidence fell from 1.13 to 0.20 events per month (IRR 0.18, 95%CI 0.02-0.86) and injuries from 2.75 to 0.50 persons per month, with no fatalities after implementation. During the 37-month follow-up, accidents averaged 0.16 per month with no fatalities. The model improved staff health literacy and safe driving behavior; its effect on accident incidence is descriptive, based on few events, and should be confirmed with continued monitoring and a comparison area before expansion.

Keywords: Emergency ambulance, Accident prevention, Global Positioning System (GPS), Haddon Matrix

Introduction

Road traffic accidents are a major global public health problem. The World Health Organization reports approximately 1.19 million road traffic deaths per year, equivalent to 15.00 per 100,000 population, with 92.00% of deaths occurring in low- and middle-income countries. Thailand has approximately 18,218 deaths per year, or 25.40 per 100,000 population, which is 1.69 times the global average.[1] In 2023, 17,498 people died in road traffic accidents in Thailand, of whom 14,432 (82.50% of all deaths) were motorcyclists, mainly due to risky behaviors such as drunk driving, speeding, and not wearing helmets.[2] Emergency ambulances, which are key operational units of the emergency medical service system, also continue to be involved in accidents: in 2014 there were 61 ambulance accidents with 130 injuries and 19 deaths, and in the first half of 2015 there were 28 accidents with 54 injuries and 5 deaths, caused by drivers (speeding, fatigue, unfamiliarity with the route), vehicles (non-standard vehicles and equipment, no GPS installed), and the environment (curves, dual-lane roads, crowded areas).[3] The latest Ministry of Public Health data for FY2024–2026 (as of May 2026) show 186 ambulance accidents (plus 11 involving other government vehicles), with 32 deaths and 319 injuries in total.[4]

In Kalasin Province in 2020–2022, road traffic accidents caused 5,560 injuries and 900 deaths, occurring most often in January between 17:01 and 22:00, with 181 black spots (these are black spots on all types of roads in the province from general accident data, whereas the 23 black spots in Results 1.3 are black spots on routes used by the network's ambulances, which the researcher additionally surveyed).[5] Regarding ambulances, an ambulance collided with a sedan on March 7, 2014, killing 1 person and injuring 9, and another collided with a motorcycle on September 22, 2022, killing 1 person (this event occurred before full implementation of the model began on October 1, 2022, while the network was still in the preparation phase). Data from three databases (the Ministry of Public Health, the police, and the Road Accident Victims Protection Company) for 2018–2022 show 11 emergency ambulance accidents in the province, with 27 injuries and 1 death; 2022 was the most severe year, with the first death in 5 years.

The Haddon Matrix framework is used to analyze the causes and risk factors of accidents across three time periods (pre-event, event, and post-event) together with four factors (human, vehicle and equipment, physical environment, and social and economic environment).[6] Using GPS technology to control and track ambulance speed is an effective measure for reducing accidents.[7,8] However, previous studies have tended to focus on single measures, and there is still no model that integrates multiple databases, ambulance safety standards, GPS technology, development of personnel health literacy, and lessons learned at the level of a provincial service network.

This study therefore developed a road accident prevention model for emergency ambulances in the Kalasin Provincial Service Network by integrating three databases (the Ministry of Public Health, the police, and the Road Accident Victims Protection Company),

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Ambulance Safety standards, enforcement of the GPS Model, a reporting and monitoring system, and lessons learned, in order to reduce accident incidence, injuries, and deaths and to provide a guideline for scaling up to other provinces with similar contexts.

Research Objectives

1. To examine the situation of road accidents in emergency ambulances, including risk factors, causes, and black spots, in the Kalasin Provincial Service Network
2. To develop a road accident prevention model for emergency ambulances appropriate to the context of the Kalasin Provincial Service Network
3. To evaluate the effectiveness of the model on health literacy, safe driving behavior, satisfaction, accident incidence, injury rate, and death rate

Methods

This research and development (R&D) study followed the ADDIE Model process. Health literacy and behavior were evaluated using a one-group pretest-posttest design, and accident data before and after implementation were compared. The study was conducted in the Kalasin Provincial Service Network, covering 18 hospitals in total (Kalasin Hospital and the community hospitals), from January 2022 to October 2026 (58 months). It was divided into five ADDIE phases plus a follow-up phase, six phases in total: Phase 1, Analysis (January–March 2022); Phase 2, Design (April–June 2022); Phase 3, Development (July–September 2022); Phase 4, Implementation (October 2022–July 2023, 10 months in total, with full implementation starting on October 1, 2022, after briefing, training, and installation of GPS in all 77 vehicles in September 2022); Phase 5, Evaluation (August–September 2023); and Phase 6, Continuous follow-up and scale-up (October 2023–October 2026), as detailed below.

Population

1) Model development stage: the Kalasin emergency medical system operating committee, comprising provincial executives, hospital directors, physicians, registered nurses, ambulance drivers, and emergency medical system staff in 18 hospitals. 2) Evaluation stage: emergency medical service coordinators and ambulance drivers in actual service, 154 in total (18 emergency medical service coordinators and 136 ambulance drivers).

Sample

1) Model development stage: 42 participants selected by purposive sampling, comprising 3 provincial executives, 18 hospital directors, 5 physicians, 8 registered nurses, 5 ambulance drivers, and 3 staff (the 37 informants in the analysis phase, namely 10 in-depth interviewees and 27 focus group participants, together with 5 experts who joined the meetings in the design phase, made 42). 2) Evaluation stage: 77 participants, calculated using the formula for estimating a proportion with a known population (N = 154, Z = 1.96, p = 0.50, e = 0.08), giving 76.25 (an acceptable error of 8% was set because the population was limited; and for a paired t-test with an effect size of 0.50, significance level .05, and power 0.80, at least 34 pairs are needed, so a sample of 77 is sufficient). This was rounded to 77 to match the 77 ambulances, comprising 18 coordinators and 59 drivers, selected by simple random sampling from the registry (all 18 coordinators, one per hospital, were included, and simple random sampling was applied only to 59 of the 136 drivers).

Inclusion Criteria

1) Evaluation group: emergency medical service coordinators or ambulance drivers in network hospitals with at least 6 months of experience, a valid class 2 driving license (drivers), completed emergency responder training, able to use a smartphone and the GPS system, and willing to participate. 2) Model development group: at least 3 years of experience in emergency medical services or system management, involvement in system oversight, and willingness to be interviewed or take part in focus groups.

Exclusion Criteria

Unable to provide complete information, withdrawal, transfer out of the network, resignation or retirement during the project, health problems preventing continued work, or missing activities or questionnaires more than twice consecutively without reasonable cause (no participant dropped out during the 10-month implementation phase; all 77 participants remained).

Research Instruments

The instruments comprised 1) instruments for development and activities: the focus group guide, the accident prevention model of seven processes, and learning media (demonstration video, brochure, manual); and 2) four quantitative data collection instruments: a general information questionnaire (8 items), a health literacy assessment (25 true/false items), a safe driving behavior assessment (25 items), and a satisfaction assessment (25 items, 5-point scale). Results were interpreted using Bloom's criteria:[9] 80.00% or above was high (literacy) or good (behavior), 60.00–79.99% was moderate, and below 60.00% was low or

needing improvement. Accident record forms and data from the GPS Dashboard were also used. Content validity was examined by five experts, with IOC of 0.60–1.00. The instruments were tried out with 30 similar participants in Maha Sarakham Province, giving a KR-20 of 0.82 for the health literacy assessment and Cronbach's alpha coefficients of 0.89 and 0.91 for the behavior and satisfaction assessments, respectively. Mean satisfaction was interpreted using Best's criteria:[10] 4.51–5.00 highest, 3.51–4.50 high, 2.51–3.50 moderate, 1.51–2.50 low, and 1.00–1.50 lowest. The health literacy assessment consisted of knowledge and comprehension questions on accident prevention (basic-level health literacy); coordinators who did not drive answered the behavior assessment according to their actual roles on the ambulance; and the overall IOC across the instruments was 0.65.

Data Collection

Phase 1 comprised in-depth interviews with 10 executives and coordinators, three focus groups (27 participants), and analysis of secondary data from the three databases over the previous 5 years (2018–2022). Pre-implementation quantitative data were collected from the 77 participants in August 2022. Monthly data were tracked from the GPS Dashboard and the three databases throughout the 10 months of implementation. Post-implementation data were collected using the same questionnaires and the satisfaction assessment in July 2023, with four focus groups and 10 in-depth interviews in August–September 2023, by the researcher and trained research assistants. Incidence and safety indicators were then monitored monthly until October 2026 (an ambulance accident means an event in which an ambulance of a network service unit collided, overturned, or ran off the road while on duty; duplicate records across the three databases were removed by matching date, time, location, and vehicle registration number; the 8 pre-implementation months were February–September 2022; and pre-implementation speeding data were obtained from the installed GPS devices, which recorded baseline data before the alert system was activated in August–September 2022).

Data Analysis

General data, health literacy, behavior, and satisfaction were analyzed using descriptive statistics: frequency, percentage, mean, and standard deviation. Health literacy and driving behavior scores before and after implementation were compared using a paired t-test, with the level of statistical significance set at .05. Incidence, injury rate, and death rate before and after implementation were compared using counts, monthly means, and percentage change. In addition, accident incidence and injury rates were compared using the incidence rate ratio (IRR) with an exact Poisson 95% CI, and the proportion of ambulances involved in

accidents was compared using Fisher's exact test. The number of deaths was not tested for statistical significance because there was only one event, and rates per number of operational trips were not calculated because trip counts were not available for the pre-implementation period. Qualitative data were analyzed by content analysis, and credibility was checked by triangulation.

Research Ethics

This study took human research ethics into account. The researcher protected participants' rights by explaining the objectives, procedures, and benefits of the research, obtaining signed consent, keeping data confidential, presenting results in aggregate, and allowing participants to decline or withdraw without any effect on their work or on any performance evaluation.

Results

1. Situation of road accidents in emergency ambulances, risk factors, causes, and black spots

1.1 General information of the sample The 42 participants in the model development stage were 66.67% male, with a mean age of 44.26±9.15 years; the most common age group was 45–54 years (42.86%), 54.76% held a bachelor's degree, 18 were hospital directors (42.86%) and 8 were registered nurses (19.05%), and the mean experience in emergency medical services was 11.24±5.38 years. The 77 participants in the evaluation group were 84.42% male, with a mean age of 41.85±10.24 years; 59 were ambulance drivers (76.62%), the mean experience in emergency medical services was 10.38±6.12 years, and 63.64% had never received training in road accident prevention.

1.2 Emergency ambulance accident statistics, 2018–2022 The three databases showed a total of 11 accidents, 27 injuries, and 1 death, with a mean of 2.45 injuries per accident and a mean incidence of 0.18 accidents per month. In 2022 there was 1 accident, but it was the most severe, with 3.00 injuries per accident and the first death in 5 years, as shown in Table 1.

Table 1 Statistics of emergency ambulance accidents in Kalasin Province, 2018–2022

Year	Accidents (n)	Injuries (persons)	Deaths (persons)	Injuries per accident
2018	2	4	0	2.00
2019	2	5	0	2.50
2020	3	8	0	2.67

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Year	Accidents (n)	Injuries (persons)	Deaths (persons)	Injuries per accident
2021	3	7	0	2.33
2022	1	3	1	3.00
Total	11	27	1	2.45

1.3 Risk factors, causes, and black spots Analysis using the Haddon Matrix showed that, for the human factor: speeding in order to deliver patients quickly, fatigue, stress, and unfamiliarity with the route; for vehicles and equipment: most vehicles were older than 10 years, had no GPS, had insufficient safety equipment, and lacked preventive maintenance; for the environment: 23 black spots were found in 6 districts on Highways 12, 213, 214, and 227 and local highways, including dangerous curves, intersections, damaged roads, narrow roads, and steep downhill slopes, with Huai Mek District having the most black spots (6 spots), and most accidents occurring between 17:01 and 22:00; for social and system factors: although there was a policy limiting speed to no more than 80 kilometers per hour, enforcement was not strict, there was no real-time tracking system, reporting and lessons learned were not systematic, and data were not integrated across agencies.

2. Development of a road accident prevention model for emergency ambulances

2.1 Model development process The process was carried out in five phases following the ADDIE Model, namely analysis, design, development, implementation, and evaluation, with a sixth phase added, continuous follow-up and scale-up, as shown in Table 2 (five experts assessed the appropriateness of the model, and testing in two pilot hospitals led to improvements of the manual and the Dashboard before actual use).

Table 2 Steps in developing the road accident prevention model for emergency ambulances

Phase	Activities/content	Instruments	Duration	Academic rationale
1	Analysis: analyzed secondary data from 3 databases over the previous 5 years, surveyed black spots, 10 in-depth interviews, and 3 focus groups (27 participants), analyzed with the Haddon Matrix	Accident record form; interview and focus group guides	Jan–Mar 2022 (3 months)	Analysis of risk factors across 3 time periods × 4 factors[6]
2	Design: designed the 7-process model, the GPS Model system, Ambulance Safety standards, and the Dashboard; meeting of 5 experts	Draft model; appropriateness assessment	Apr–Jun 2022 (3 months)	Integration of the Haddon Matrix with the Theory of Change and health system development
3	Development: developed the GPS Model system and Dashboard, assessments, 2 manuals, and learning media; tested in 2 pilot hospitals	GPS Dashboard system; manuals; learning media	Jul–Sep 2022 (3 months)	Pre-implementation testing to reduce system defects
4	Implementation: briefing for 150 participants, 2-day workshop for 77 participants, installation of GPS in 77 vehicles (carried out in September 2022, before full implementation began on October 1, 2022), and operation of the 7 processes	GPS Dashboard system; manuals; assessments	Oct 2022–Jul 2023 (10 months)	Developing personnel knowledge and skills alongside technology[13]

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Phase	Activities/content	Instruments	Duration	Academic rationale
5	Evaluation: post-implementation data collection; assessment of health literacy, behavior, and satisfaction; 4 focus groups and 10 interviews	Three assessments; accident record form	Aug–Sep 2023 (2 months)	Pre–post comparison using a paired t-test
6	Follow-up and scale-up: monthly monitoring of indicators through the Dashboard, model review, annual lessons learned, scale-up and dissemination	GPS Dashboard system; accident record form	Oct 2023–Oct 2026 (37 months)	Assessment of the sustainability of the model

2.2 The developed model The GPS-Safety Model was developed, integrating the Haddon Matrix with the Theory of Change and the concept of health system development. It comprises seven core processes, as shown in Figure 1: 1) situation analysis integrating the three databases; 2) development of emergency medical services to meet the five-domain Ambulance Safety standard (vehicles, safety equipment, medical equipment, personnel, and processes); 3) enforcement of the GPS Model - Road Traffic Injury in 77 ambulances, with real-time tracking of location and speed and an alert when speed exceeds 80 kilometers per hour; 4) evaluation and compilation of digital GPS Ambulance system data through the Dashboard; 5) monthly reporting to executives; 6) follow-up at meetings of the emergency medical service system management committee; and 7) summary and lessons learned from accident cases. Supporting mechanisms were the development of health literacy, safe driving skills, a safety culture, and psychological support for personnel (the Theory of Change was used to define the pathway from activities to outcomes following Weiss's concept,[11] and the health system development concept refers to the World Health Organization's framework of health system building blocks.[12] The links to the Haddon Matrix are as follows: Process 1 (database integration and black spot identification) addresses environmental factors before the event; Process 2 (Ambulance Safety standards) addresses vehicle and equipment factors before and during the event; Process 3 (GPS Model) addresses human factors (speeding) before the event; Processes 4–6 (Dashboard, reporting, and follow-up) address social and economic factors before the event; and

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Process 7 (lessons learned) addresses all factors in the post-event period).

3. Effectiveness of the road accident prevention model for emergency ambulances

3.1 Health literacy and safe driving behavior After 10 months of implementation, the 77 participants' health literacy scores increased from 17.12±3.86 (68.48%, moderate) to 23.41±1.52 (93.64%, high), and safe driving behavior scores increased from 82.56±15.42 (66.05%, moderate) to 112.47±8.93 (89.98%, good), significant differences (t = 15.84 and 18.73, respectively, df = 76, p-value <0.001), as shown in Table 3.

Table 3 Comparison of health literacy and safe driving behavior scores before and after implementation (paired t-test, n = 77)

Variable	Full score	Before		After		Level	$\bar{d}$	95%CI	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Health literacy	25	17.12	3.86	23.41	1.52	Moderate / High	6.29	5.50 to 7.08	15.84	<0.001*
Safe driving behavior	125	82.56	15.42	112.47	8.93	Moderate / Good	29.91	26.74 to 33.08	18.73	<0.001*

*Statistically significant, p-value <.05, $\bar{d}$ = mean difference (after – before), df = 76

3.2 **Satisfaction with the model** Overall satisfaction was at the high level (4.39±0.64, or 87.80%) (interpreted using Best's criteria[10]). The three highest-rated items were that the model helped reduce accident incidence (4.61±0.52), that the model helped increase accident prevention literacy (4.58±0.54), and overall satisfaction with the model (4.56±0.55). The lowest-rated item was that the reporting system was not complicated and not overly burdensome (4.18±0.76).

3.3 **Incidence, injury rate, and death rate** Comparing retrospective data for the 8 months before implementation (February–September 2022) with the 10 months after implementation (October 2022–July 2023), accident incidence decreased from 1.13 to 0.20 per month (an 82.30% reduction), the injury rate decreased from 2.75 to 0.50 persons per month (an 81.82% reduction), and there were no deaths, compared with 0.13 deaths per month before (a 100.00% reduction). The proportion of ambulances involved in accidents decreased from 11.69% to 2.60%, accident costs decreased from 267,563 to 29,200 baht per month (89.09%), speeding beyond the limit recorded by the GPS system decreased from 35.20% to 8.40%, and the proportion of ambulances meeting the Ambulance Safety standard increased from 62.34% to 94.81%, as shown in Table 4

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(before implementation there were 9 accidents, 22 injuries, and 1 death (the event of September 22, 2022) in 8 months, and after implementation there were 2 accidents, 5 injuries, and no deaths in 10 months, giving an IRR of 0.18 for incidence (95%CI 0.02-0.86) and 0.18 for the number of injuries (95%CI 0.05-0.49). The proportion of ambulances involved in accidents, 9/77 vehicles compared with 2/77 vehicles, did not differ significantly (Fisher's exact test, p-value = 0.056). The pre-implementation data were collected from the accident records of network hospitals, which cover more events than the three databases in Table 1, so they should not be compared directly with Table 1, and the pre-implementation speeding data were obtained from GPS devices installed to record baseline data before the alert system was activated).

Table 4 Comparison of safety outcomes before and after implementation (8 months before and 10 months after implementation)

Indicator	Before implementation	After implementation	Percentage change
Accident incidence (events/month)	1.13	0.20	Decreased 82.30
Injury rate (persons/month)	2.75	0.50	Decreased 81.82
Death rate (persons/month)	0.13	0.00	Not calculated (1 event)
Ambulances involved in accidents (%)	11.69	2.60	Decreased 77.78
Accident costs (baht/month)	267,563	29,200	Decreased 89.09
Speeding beyond the limit (%)	35.20	8.40	Decreased 76.14
Ambulances meeting the Ambulance Safety standard (%)	62.34	94.81	Increased 52.08

3.4 Continuous follow-up results Over the 37 months (October 2023–October 2026), there were 6 emergency ambulance accidents (a mean of 0.16 per month), 12 injuries (a mean of 0.32 persons per month, or 2.00 persons per accident), and no deaths. The incidence during follow-up was close to the 2018–2022 mean (0.18 accidents per month).

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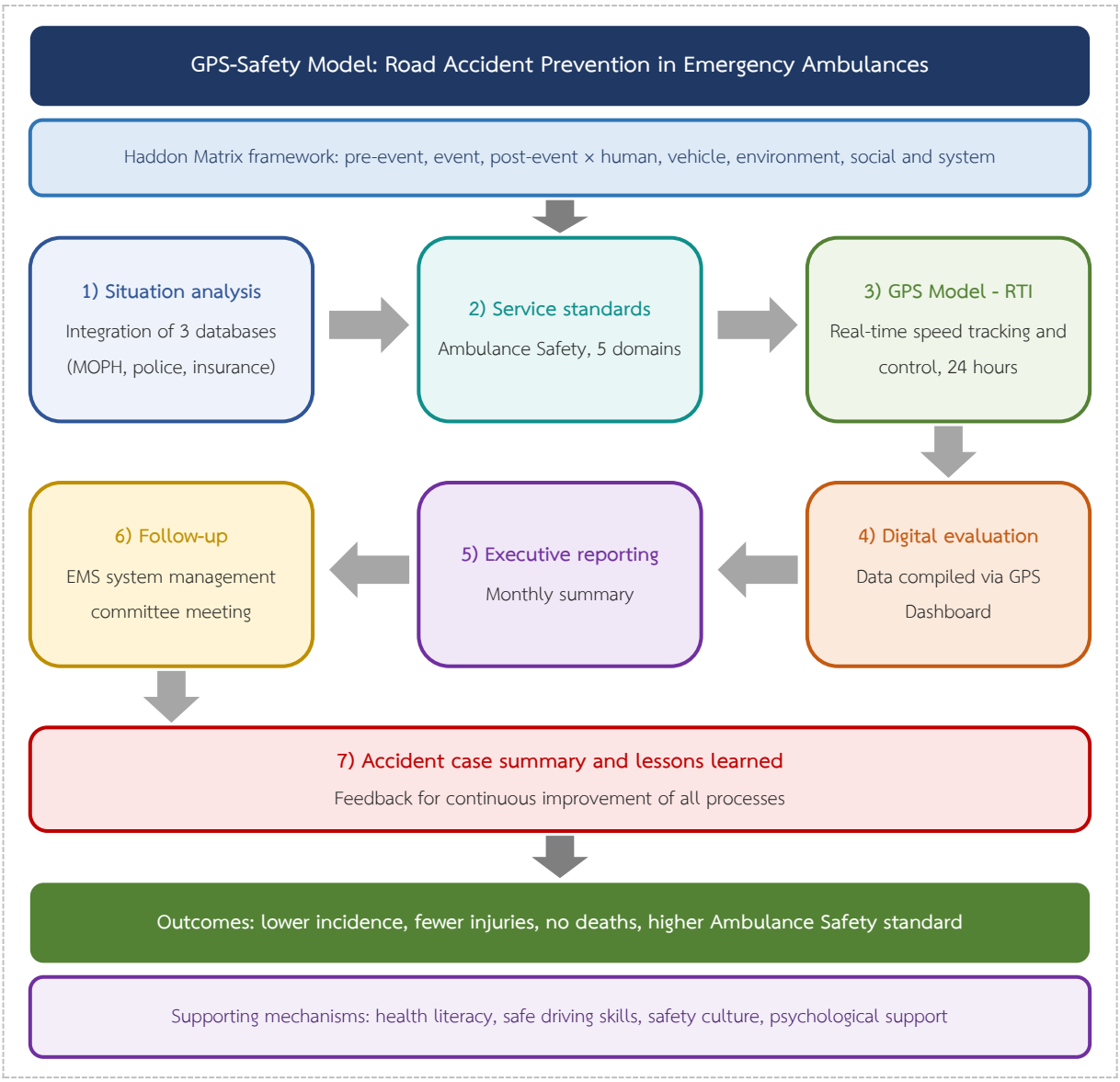

Figure 1 Road accident prevention model for emergency ambulances (GPS-Safety Model)

Discussion

The accident statistics for ambulances in Kalasin Province in 2018–2022 (11 accidents, 27 injuries, 1 death), with 2022 the most severe year, are consistent with the national report that ambulance accidents occur continuously and cause deaths.[3] Human factors, namely speeding, fatigue, stress, and unfamiliarity with the route, are consistent with Zhang et al., who analyzed 1,856 ambulance accidents in China and found fatigue (52.30%), speeding (48.70%), and stress (35.20%) to be the main factors,[14] and with Patterson et al., who found that working more than 12 consecutive hours increased risk 5.20-fold.[15] Regarding vehicles, old ambulances without GPS and lacking maintenance are consistent with worn tires (31.40%) and ineffective brakes (28.60%) as contributing factors,[14] and the systematic

development of ambulance safety standards reduced accidents by 78.60%.[16] The 23 black spots and the 17:01–22:00 period with inadequate lighting are consistent with the finding that integrating databases identified black spots 87.50% more accurately.[17]

The GPS-Safety Model integrates the Haddon Matrix, covering all 3 time periods and 4 factors,[6] consistent with Zhang et al., who used the Haddon Matrix in 6 provinces for 24 months and reduced ambulance accidents by 63.00%.[14] The GPS component is consistent with the installation of GPS systems in Ubon Ratchathani Province, which reduced speeding from 45.80% to 12.30% and accidents from 8.50% to 2.10%,[7] and with the use of GPS together with telematics in Spain, which reduced dangerous driving behavior by 61.00%.[18] Integrating the three databases improved data completeness to 96.80% and reduced road accidents by 23.40% in 2 years.[17] The Ambulance Safety standard is consistent with ambulance safety standards in 24 community hospitals, which raised safety scores from 62.40% to 91.70%.[16]

After 10 months of implementation, incidence decreased by 82.30% and the injury rate by 81.82%, higher than ambulance speed control, which reduced accidents by 72.40% and injuries by 68.90%,[8] use of the Haddon Matrix (63.00%),[14] and use of GPS with telematics (55.00%).[18] However, these studies differ in context, denominators, and measurement methods, so the sizes of effect cannot be compared directly. The findings may be related to this model's integration of technology, standards, data, personnel development, and monitoring. The reduction in speeding from 35.20% to 8.40% is consistent with automatic speed warning systems that reduced speeding by 68.00%.[19] The improvements in health literacy and driving behavior are consistent with the positive relationship between literacy and accident prevention behavior[20] and with training that increased knowledge and reduced accidents by 58.00%.[13] No deaths occurred during the 10 months or the 37-month follow-up, but the number of events was too small to draw conclusions about accident severity. The limitations of this study were as follows: the evaluation was made 10 months after implementation; it was a before–after comparison without a control group; it was conducted in a single province; the researcher implemented and evaluated the project; the small number of accidents led to wide confidence intervals for the IRR; there were no data on the number of operational trips with which to calculate workload-adjusted rates; the pre-implementation data were collected from sources different from Table 1; the model was introduced after the most severe event (September 22, 2022), so regression to the mean is possible; health literacy and behavior were measured by self-report, with the literacy assessment mainly measuring basic knowledge and

comprehension; and internet connectivity in some remote areas was unstable.

Conclusion

The GPS-Safety Model comprises seven core processes. After 10 months of implementation, health literacy increased from 17.12 to 23.41 points and safe driving behavior from 82.56 to 112.47 points (p-value <0.001); accident incidence decreased by 82.30% (comparing the 8 months before with the 10 months after implementation); the injury rate decreased by 81.82%; there were no deaths; speeding beyond the limit decreased from 35.20% to 8.40%; ambulances meeting the Ambulance Safety standard increased from 62.34% to 94.81%; and satisfaction was high (4.39). Continuous follow-up through October 2026 found a mean of 0.16 accidents per month and no deaths.

Recommendations

1. Recommendations for application. The Ministry of Public Health and the National Institute for Emergency Medicine should consider supporting trials of the model in other provinces with evaluation, before incorporating it into emergency medical service standards and supporting the GPS system budget. Provincial public health offices should provide continuous oversight and monitoring; hospitals should set it as a policy with indicators and support vehicle maintenance and personnel development; and local administrative organizations should improve black spots (warning signs, lighting, road repair). Scale-up should begin with 2–3 pilot hospitals, and it should be communicated that GPS is intended for safety, not punishment.

2. Recommendations for future research. Long-term follow-up of 2–3 years, interrupted time series studies or studies with comparison provinces in multiple areas, cost–benefit analysis, application of artificial intelligence and applications for drivers, and studies of success factors in leadership and organizational culture should be undertaken.

Acknowledgments

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RESEARCH ARTICLE

Development of an Emergency Patient Assessment System for Emerging Infectious Disease Response in the Accident, Emergency and Forensic Unit, Namon Hospital, Namon District, Kalasin Province

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Abstract

This research and development study aimed to examine the situation, develop, and evaluate an emergency patient assessment system for emerging infectious disease response, using coronavirus disease 2019 (COVID-19) as a case study, in the Accident, Emergency and Forensic Unit, Namon Hospital, Namon District, Kalasin Province. It was conducted from October 2024 to September 2026. Participants were all 38 emergency department staff, 90 patients selected by simple random sampling in each of the pre- and post-development periods, and 1,381 medical records per period. Instruments were a health literacy questionnaire, a triage knowledge and skill test, a triage quality audit form, an incident record form, and a satisfaction questionnaire. Data were analyzed using descriptive statistics, a paired t-test, an independent t-test, and a chi-square test; risk incidents were compared descriptively.

The system comprised four measures: joint guidelines with related teams, five-level Emergency Severity Index (ESI) triage, antigen test kit (ATK) or RT-PCR testing and personal protective equipment (PPE) use before aerosol-generating procedures, and monthly lessons-learned review. After implementation, total health literacy increased from 131.65±8.54 to 154.87±7.48 points ($t = 19.40$, p-value <0.001), and nurses' triage knowledge and skill from 6.65±1.08 to 7.60±1.27 points ($t = 5.10$, p-value <0.001). Triage accuracy rose from 81.10% to 87.40% ($\chi^2 = 20.65$, p-value <0.001), risk incidents fell from 50 to 16 (9.48 to 2.18 per 1,000 visits), and satisfaction increased from 3.42±0.65 to 4.11±0.82 points ($t = 6.26$, p-value <0.001). The system is feasible for community hospital emergency departments and may be adapted to other emerging diseases, subject to further evaluation.

Keywords: Emergency patient assessment system, Emerging infectious disease, Triage, Coronavirus disease 2019, Emergency department

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Introduction

Coronavirus disease 2019 (COVID-19), an emerging infectious disease, has spread worldwide. By early June 2022, there were more than 529 million confirmed cumulative cases and more than 6 million deaths. Thailand recorded 4,463,557 cumulative cases and 30,143 deaths,[1,2] Kalasin Province recorded 23,352 cases and 147 deaths,[3] and Namon District recorded 310 cases and 4 deaths[4] (national cumulative data as of 4 June 2022; provincial and district data as of 28 June 2022). Large numbers of patients sought care at emergency departments, which pushed workloads beyond normal levels and exposed staff to the risk of infection. Meanwhile, the numbers of patients picked up at the scene by the emergency medical system in 2018–2020 were 1,587,173, 1,678,805, and 1,673,237, respectively.[5] After the pandemic, COVID-19 was reclassified as a communicable disease under surveillance from October 2022 but continued to resurge in waves; in 2025, Thailand experienced a new wave between May and June, with 555,393 cumulative cases since the beginning of the year as of 28 June 2025.[6]

Namon Hospital is a 30-bed community hospital providing 24-hour services. In 2019–2022, the Accident, Emergency and Forensic Unit (hereafter, the emergency department) served 28,665, 27,602, 27,973, and 26,029 patients per year, respectively, and 26,097 patients in fiscal year 2023 (an average of 2,175 per month), comprising 120 red, 231 pink, 4,863 yellow, 9,323 green, and 11,560 white patients. The emergency department has one general practitioner per shift, and nurses at the triage point work on rotation with no single triage standard, which led to triage errors and delayed treatment. During the outbreak, 5 staff members (13.16% of 38 staff) became infected, causing staff shortages, and before development, triage errors were found in 18.90% of audited records (261 of 1,381).

Triage is the heart of the emergency department, used to identify patients who cannot wait for examination and to use limited resources appropriately. Thailand has developed its triage system from three levels to five levels following the Emergency Severity Index (ESI) version 4,[7] and the National Institute for Emergency Medicine has set five-level criteria for triaging emergency patients,[8] while the Department of Medical Services has produced the MOPH ED Triage manual.[9] Accurate triage reduces delays and avoidable mortality,[10] whereas under-triage causes patients to receive delayed care.[11]

Emergency department guidelines and COVID-19 response systems have previously been developed in several large hospitals,[12-14] along with an ESI-based triage model in Kalasin Province.[15] However, these works focused on only one aspect—the treatment system, nursing practice guidelines, or triage—and few have integrated triage, infection prevention, and lessons-learned review in the emergency department of a small community hospital. This study used the concepts of structure, process, and outcome as the framework for system development, following Donabedian's framework:[16] structure refers to guidelines and team roles, process refers to triage, infection prevention, and lessons-learned review, and outcome refers to triage accuracy, risk

incidents, staff knowledge, health literacy, and satisfaction. The researcher therefore developed an emergency patient assessment system for emerging infectious disease response, using COVID-19 as a case study, to reduce triage errors and risks to patients and staff and to provide a model for other community hospitals.

Research Objectives

1. To examine the situation, problems, and previous system of emergency patient assessment during an emerging infectious disease outbreak in the Accident, Emergency and Forensic Unit, Namon Hospital
2. To develop an emergency patient assessment system for emerging infectious disease response
3. To examine the effects of using the emergency patient assessment system on triage accuracy (the primary outcome), registered nurses' triage knowledge and skills, health literacy, risk incidents, and satisfaction

Methods

This study was a research and development (R&D) study conducted in the Accident, Emergency and Forensic Unit, Namon Hospital, Namon District, Kalasin Province, from October 2024 to September 2026 (24 months). The evaluation used a pre- and post-development comparison design without a comparison group: registered nurses formed a single group measured before and after (one-group pretest-posttest design), patients formed two independent groups before and after development, and medical records and risk incidents were compared between two time periods. The study was divided into five phases. Phase 1 (months 1–3) examined the context and problems. In Phase 2 (month 4), the system was designed and the draft was reviewed for appropriateness by three experts, who rated it as most appropriate (mean 4.67 out of 5); it was revised according to their recommendations before implementation. Phase 3 (months 5–7) implemented the system. Phase 4 (months 8–18) monitored and evaluated outcomes, held lessons-learned meetings once a month, and reviewed and improved the measures every 3 months, together with summarizing and disseminating the system (month 18). Phase 5 (months 19–24) involved continued monitoring and preparation for responding to other emerging infectious diseases. The details are as follows.

Population

There were three groups: 1) the 38 emergency department staff of Namon Hospital; 2) people who used the Namon Hospital emergency department during the study period—5,275 before development and 7,347 after development; and 3) the medical records of patients in the same periods.

Sample

There were three groups: 1) all 38 emergency department staff, of whom 20 were registered nurses who were assessed for triage knowledge and skills; 2) patients, 90 before development and 90 after development, who were different individuals. The sample size for

comparing the means of two independent groups was calculated using G*Power with an effect size of 0.50, a significance level of .05, and a power of 0.80, giving 64 per group, which was increased to 90 per group (about 40% more) to allow for incomplete data. Patients were selected by simple random sampling, drawing lots from the daily patient register until the required number was reached. If a randomly selected patient did not consent, the next randomly selected patient was used instead. One patient was sampled per day until 90 were obtained, rotating to cover all 3 shifts (morning, afternoon, and night). Respondents were the patients themselves; if a patient could not respond, an accompanying relative responded on the patient's behalf; and 3) 1,381 medical records per period, selected by stratified random sampling across the five urgency levels, with equal numbers in the two periods. The sample size was calculated using the formula for comparing two independent proportions, with an accuracy proportion of 81% before development and an expected 85% after development, a significance level of .05, and a power of 0.80, giving 1,381 records per period, which were then selected by simple random sampling within each level using a random number program.

Inclusion Criteria

Staff: 1) worked in the Namon Hospital emergency department during the study period, and 2) consented to participate in the study. Patients: 1) visited the Namon Hospital emergency department and were aged 18 years or older, 2) resided in Namon District, 3) could read, listen, and write in Thai, and 4) consented to participate in the study. Medical records: records of patients who visited the emergency department during the study period with complete triage documentation.

Exclusion Criteria

1) Patients who were critically ill or confused to the point that they could not provide information and had no relative to provide it on their behalf, and 2) staff who took leave or transferred during the study. Withdrawal criteria were 1) requesting to withdraw or being unwilling to continue providing information, and 2) incomplete questionnaire responses.

Research Instruments

The instruments consisted of 1) tools for conducting activities, namely interview guides and group processes used to analyze problems, define measures, assign roles, and review lessons learned. Twelve key informants were interviewed once each: 2 physicians, 6 registered nurses, and 1 representative each from the infection prevention and control (IC) unit, the Surveillance and Rapid Response Team (SRRT), the laboratory, and the administration. Three stakeholder group meetings were held (2 in Phase 1 and 1 in Phase 2), and lessons-learned meetings were held once a month, for a total of 11 meetings (months 8–18); and 2) five data collection instruments. Set 1 was a 45-item COVID-19 health literacy questionnaire with 7 domains, used to collect data from patients and adapted from the health literacy questionnaire of the Division of Health Education, Ministry of Public Health: knowledge and understanding, 10 items (1 point for a correct answer and 0 for an incorrect answer; maximum 10 points); access to information and services, 5 items (maximum 25 points); communication for skill enhancement, 6 items

(maximum 30 points); self-management of health conditions, 5 items (maximum 25 points); media literacy, 5 items (maximum 25 points); decision making, 4 items (maximum 20 points); and self-care behaviors, 10 items (maximum 50 points). Domains 2–7 used a 5-point rating scale (1–5 points), for a total maximum score of 185 points. Set 2 was a 10-item triage knowledge and skill test (maximum 10 points) using simulated patient scenarios in which respondents determined the triage level, based on the emergency illness triage card of the National Institute for Emergency Medicine (NIEM). Set 3 was a triage quality audit form for medical records according to the five severity levels. Set 4 was an 8-item triage and risk incident record form, and Set 5 was a 13-item satisfaction questionnaire using a 5-point rating scale, with mean scores of 3.41–4.20 interpreted as high and 4.21–5.00 as highest. Content validity was examined using the Index of Item-Objective Congruence (IOC) by three experts who were lecturers at the Faculty of Health Science, Kalasin University (Set 4 was reviewed by three experts, with agreement defined as 2 of 3), yielding IOC values of 0.67–1.00. Reliability was tested with 30 respondents from a similar group in a neighboring district, giving Cronbach's alpha of 0.87 for the health literacy questionnaire and 0.92 for the satisfaction questionnaire, while the KR-20 for the triage knowledge and skill test was 0.81.

Data Collection

Pre-development data were collected in Phase 1 and post-development data in Phase 4 (pre-development: October 2024 to January 2025; post-development: September to December 2025) from the 38 staff and from 90 patients per period. The triage knowledge and skills of the 20 registered nurses were assessed before and after training, which was held once a month for 2 hours per session, covering triage according to ESI and NIEM criteria using simulated scenarios, infection prevention, donning and doffing of PPE, and ATK testing. The pre-training measurement was taken before the first session in January 2025 and the post-training measurement in September 2025, approximately 8 months apart. Triage quality was audited from 1,381 medical records per period by three experts, using the criterion of correct by 2 of 3 experts. The experts were registered nurses with at least 5 years of triage experience in an emergency department who had been trained in triage according to ESI or NIEM criteria. They were blinded to the period of each record (before or after development) by removing the dates and shuffling the order of the files. Risk incident data were collected from the hospital's risk reporting system for the same periods as the medical record audit, and lessons-learned reviews were held once a month. The researcher collected all data personally.

Data Analysis

Data were processed using R version 4.5.1. General data were analyzed using frequencies, percentages, means, and standard deviations. Registered nurses' triage knowledge and skills before and after training were compared using a paired t-test. Health literacy and satisfaction of patients, who formed two independent groups before and after development, were compared using an independent t-test. Overall triage accuracy and accuracy by urgency level were compared

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using the chi-square test, together with the difference in proportions and 95% confidence intervals (95%CI). Risk incidents were presented as numbers and as rates per 1,000 visits. Qualitative data were analyzed using content analysis. The level of statistical significance was set at .05.

Research Ethics

This study took into account the ethical principles of research involving human participants. The researcher protected participants' privacy, confidentiality, and right to give consent by explaining the objectives and the right to refuse or withdraw without any effect on patients' care or on staff members' work or performance evaluation. Patients were asked for consent after they had been treated and were out of the urgent phase, and data from medical records were recorded using codes in place of names and patient identification numbers.

Results

1. Situation, problems, and previous model of emergency patient assessment

1.1 General information Of the 38 emergency department staff, 81.58% were female, with a mean age of 37.36±7.12 years; 20 (52.63%) were registered nurses and 5 (13.16%) were physicians. Registered nurses had a mean triage experience of 8.33±3.21 years, and 14 (70.00% of the 20 registered nurses) had previously been trained in triage. Of the 90 patients before development, 47 (52.22%) were female, 23 (25.56%) were aged 60 years or older, 53 (58.89%) used the Universal Health Coverage scheme, and 50 (55.56%) were at the Non-Urgent level. Of the 90 patients after development, 49 (54.44%) were female, 26 (28.89%) were aged 60 years or older, 55 (61.11%) used the Universal Health Coverage scheme, and 52 (57.78%) were at the Non-Urgent level.

1.2 Previous model and problems Before development, 1) there was no joint planning or guideline among the various units; each person acted according to what they had learned, and staff were fearful and anxious at work; 2) triage was performed, but the guideline was not clearly understood or followed, and workloads increased during the outbreak; 3) no ATK test was performed before aerosol-generating procedures, which put staff at risk of infection; and 4) lessons were reviewed in only some cases. There were 50 risk incidents arising from patient assessment: delayed triage of emergency patients (Emergent and Urgent) waiting for examination, 34 incidents (68.00%); delayed triage of critically ill patients, 9 incidents (18.00%); deterioration of emergency patients while waiting for examination, 3 incidents (6.00%); and other incidents, 4 (8.00%), namely prolonged waiting of 2 patients with myocardial infarction (MI) and 2 patients with acute stroke on the stroke fast track. The number of emergency department patients rose from 5,275 in the 4 months before the outbreak (October 2024 to January 2025) to 8,524 (an increase of 61.59%) in the first outbreak period (May to August 2025), 7,347 (an increase of 39.28%) in the second period (September to December 2025), and 7,909 (an increase of 49.93%) in the third period (January to April 2026). However, the

baseline of 5,275 (an average of 1,319 per month) was lower than the average for fiscal year 2023 (2,175 per month); the percentage increases may therefore be overestimated and should be interpreted with caution.

2. Development of an emergency patient assessment system for emerging infectious disease response

2.1 Development process The process was carried out in five phases, as shown in Table 1. In Phase 1, 12 people participated in the design, which identified the 4 problems described in section 1.2 and defined 4 measures. In Phase 2, three experts rated the draft system as most appropriate (mean 4.67 out of 5), and the wording of the guidelines was revised. In Phase 3, the system was implemented on all shifts. In Phase 4, the measures were improved 3 times on the basis of lessons learned: adding a review of triage cards with the physician on duty, adjusting the ATK testing procedure for critically ill patients, and adding PPE donning and doffing drills.

Table 1 Development process of the emergency patient assessment system for emerging infectious disease response

Phase	Activities/Content	Instruments Used	Duration	Academic Rationale
1	Studied the context and problems; analyzed the situation; collected patient and incident data; held group meetings to analyze problems and define measures	Data collection forms, interview guides, group meetings	Months 1–3 (Oct–Dec 2024)	To understand the situation and previous problems before designing the system
2	Designed the system; defined 4 measures and the roles of the multidisciplinary team; expert review of appropriateness	Draft system, NIEM ESI criteria, Department of Medical Services manual	Month 4 (Jan 2025)	Applied the ESI criteria and the MOPH ED Triage manual to the community hospital context[7,9]
3	Implemented the system; carried out the measures, activities, and roles as defined	Guidelines, triage cards, PPE sets, ATK test kits	Months 5–7 (Feb–Apr 2025)	To prevent infection in aerosol-generating procedures and to coordinate the team

Phase	Activities/Content	Instruments Used	Duration	Academic Rationale
4	Monitored and evaluated outcomes; held lessons-learned meetings once a month; reviewed and improved the measures every 3 months; held training once a month; summarized and disseminated the system (month 18)	5 assessment instruments, medical records, lessons-learned meetings	Months 8–18 (May 2025–Mar 2026)	Continuous improvement based on feedback
5	Continued monitoring and preparedness; reviewed the measures and rehearsed plans for responding to other emerging infectious diseases	Assessment forms, monthly reports	Months 19–24 (Apr–Sep 2026)	Evaluated sustainability and readiness to respond to emerging infectious diseases

2.2 The developed system The system consisted of 4 measures, as shown in Figure 1: 1) establishing guidelines and measures jointly with the related units, namely the infection prevention and control (IC) unit, the Surveillance and Rapid Response Team (SRRT), the laboratory, the inpatient department, and the outpatient department, together with jointly defining roles; 2) triaging patients into 5 levels (white, green, yellow, pink, and red) according to the ESI criteria of the National Institute for Emergency Medicine together with the Department of Medical Services' COVID-19 response manual, and training and testing staff once a month; 3) infection prevention, by testing patients with ATK or RT-PCR before every aerosol-generating procedure (only patients who required such procedures were tested, not every patient; critically ill patients who could not wait for test results were treated as possible infected cases, with the highest level of PPE worn immediately, and were then tested for confirmation) and wearing PPE during aerosol-generating procedures such as nebulization, suctioning, and gastric lavage tube insertion; and 4) reporting and reviewing lessons learned once a month to administrators and related units, and reviewing and improving the measures every 3 months.

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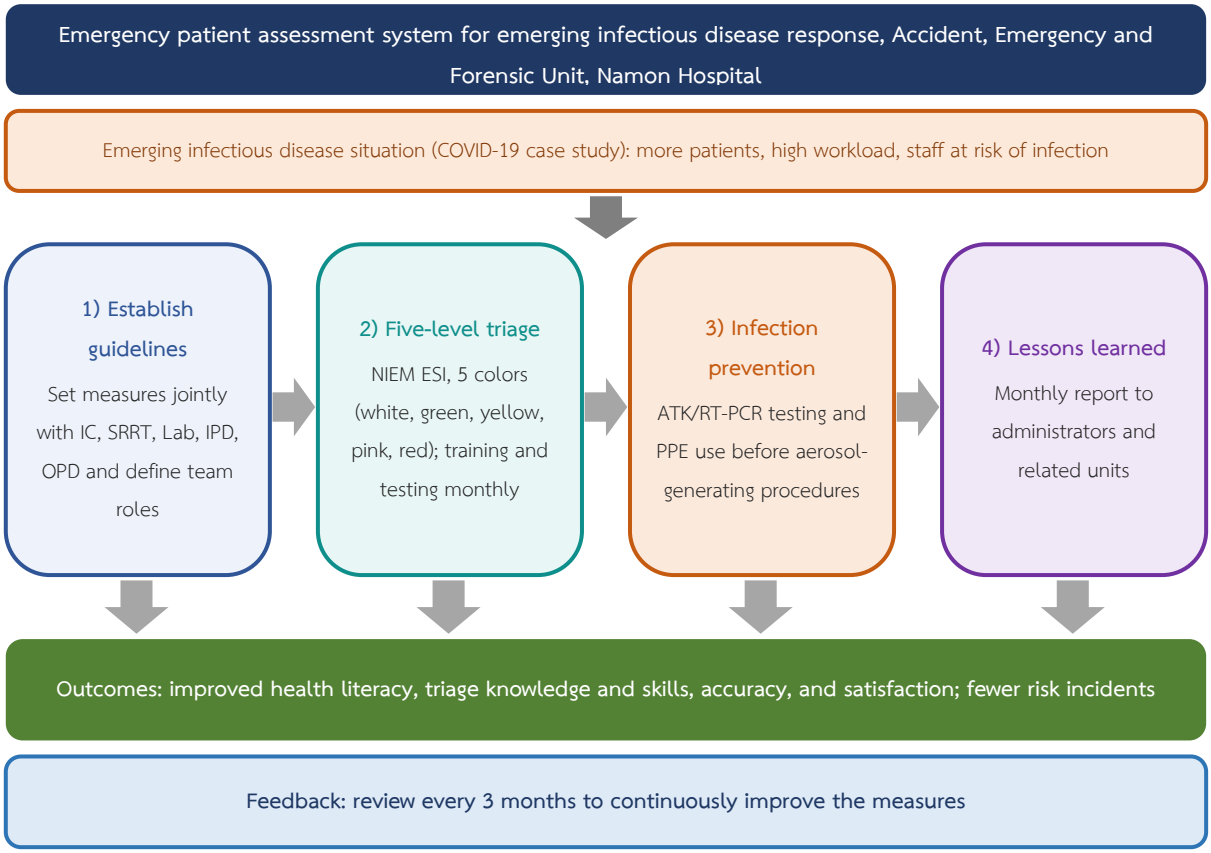

Figure 1 Emergency patient assessment system for emerging infectious disease response, Accident, Emergency and Forensic Unit, Namon Hospital

3. Effects of using the emergency patient assessment system

3.1 Triage knowledge and skills After training, the 20 registered nurses' triage knowledge and skill scores increased from 6.65±1.08 to 7.60±1.27 points (out of 10), a statistically significant increase (t = 5.10, df = 19, p-value <0.001), as shown in Table 2.

Table 2 Comparison of registered nurses' triage knowledge and skill scores before and after training (paired t-test)

Variable	Group	Before		After		df	$\bar{d}$	95%CI	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Triage knowledge and skills (maximum score 10)	Nurses (n=20)	6.65	1.08	7.60	1.27	19	0.95	0.56 to 1.34	5.10	<0.001*

*Statistically significant, p-value <.05

3.2 Health literacy and satisfaction Among the 90 patients per group, the total health literacy score across the 7 domains increased from 131.65±8.54 to 154.87±7.48 points (t = 19.40, df = 178, p-value <0.001), with significant increases in 5 domains: knowledge and understanding, communication for skill enhancement, self-management of health conditions, decision making, and self-care behaviors. Access to information and

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services (p-value = 0.180) and media literacy (p-value = 0.949) did not differ significantly. Mean satisfaction increased from 3.42±0.65 to 4.11±0.82 points (t = 6.26, df = 178, p-value <0.001), as shown in Table 3. After development, the three domains with the highest numbers of patients reporting a high level of satisfaction were attentive care and treatment, 58 patients (64.44%); staff knowledge and competence, 57 patients (63.33%); and service according to severity, 56 patients (62.22%).

Table 3 Comparison of health literacy and satisfaction scores before and after development (independent t-test, 90 patients per group)

Variable	Before development		After development		df	Mean diff.	95%CI	t	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.					
1. Knowledge and understanding (maximum 10)	5.73	1.58	7.71	1.06	178	1.98	1.58 to 2.38	9.87	<0.001*
2. Access to information and services (maximum 25)	19.59	2.68	20.10	2.39	178	0.51	-0.24 to 1.26	1.35	0.180
3. Communication for skill enhancement (maximum 30)	22.27	3.97	24.86	3.46	178	2.59	1.49 to 3.69	4.67	<0.001*
4. Self-management of health conditions (maximum 25)	19.80	4.26	21.97	1.98	178	2.17	1.19 to 3.15	4.38	<0.001*
5. Media literacy (maximum 25)	21.91	2.03	21.93	2.18	178	0.02	-0.60 to 0.64	0.06	0.949
6. Decision making (maximum 20)	13.26	2.12	15.97	2.12	178	2.71	2.09 to 3.33	8.58	<0.001*
7. Self-care behaviors (maximum 50)	29.09	5.16	42.33	5.14	178	13.24	11.72 to 14.76	17.25	<0.001*
Total health literacy, 7 domains (maximum 185)	131.65	8.54	154.87	7.48	178	23.22	20.86 to 25.58	19.40	<0.001*
Satisfaction (maximum score 5)	3.42	0.65	4.11	0.82	178	0.69	0.47 to 0.91	6.26	<0.001*

*Statistically significant, p-value <.05

3.3 Triage accuracy From 1,381 medical records per period, correct triage increased from 1,120 records (81.10%) to 1,207 records (87.40%) (χ^2 = 20.65, df = 1, p-value <0.001), a difference of 6.30% (95%CI 3.59 to 9.01). The largest increase was at the Emergent level (9.68%), followed by Resuscitation (9.09%) and Non-Urgent (6.67%). When tested by level, statistically significant increases were found at the Urgent level (χ^2 = 5.46, p-value = 0.019) and the Non-Urgent level (χ^2 = 9.41, p-value = 0.002), whereas the Resuscitation, Emergent, and Less-Urgent levels did not differ significantly, as shown in Table 4.

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Table 4 Comparison of triage accuracy by urgency level before and after development (chi-square test)

Urgency level	Before development	After development	Difference (%)	χ^2	p-value
Resuscitation	25/33 (75.76)	28/33 (84.85)	9.09	0.86	0.353
Emergent	89/124 (71.77)	101/124 (81.45)	9.68	3.24	0.072
Urgent	289/352 (82.10)	311/352 (88.35)	6.25	5.46	0.019*
Less-Urgent	276/332 (83.13)	290/332 (87.35)	4.22	2.35	0.126
Non-Urgent	441/540 (81.67)	477/540 (88.33)	6.67	9.41	0.002*
Total	1,120/1,381 (81.10)	1,207/1,381 (87.40)	6.30	20.65	<0.001*

*Statistically significant, p-value <.05

Data are presented as the number of correctly triaged records/total number of records (%). Before development: October 2024 to January 2025. After development: September to December 2025.

3.4 Risk incidents Risk incidents decreased from 50 to 16, equivalent to 9.48 and 2.18 per 1,000 visits (counted in the pre-development period, October 2024 to January 2025, and the post-development period, September to December 2025, with the denominators being the numbers of patients in the same periods, 5,275 and 7,347, respectively). The 16 incidents comprised delayed triage of emergency patients waiting for examination, 11 incidents; delayed triage of critically ill patients, 4 incidents; and deterioration of a patient while waiting for examination, 1 incident. No patients with myocardial infarction (MI) or acute stroke on the stroke fast track experienced prolonged waiting. This result is a descriptive comparison.

3.5 Follow-up results In Phase 5 (April to September 2026, a total of 6 months), triage accuracy from medical records randomly sampled at 100 per month (600 in total) was 531 records (88.50%); there were 12 risk incidents among 9,150 patients (1.31 per 1,000 visits); and adherence to the measure of ATK or RT-PCR testing together with PPE use before aerosol-generating procedures was 48 of 50 occasions (96.00%). These results are a descriptive comparison and were not statistically tested.

Discussion

Before development, the Namon Hospital emergency department had no joint guidelines, triage was inaccurate, no ATK test was performed before aerosol-generating procedures, and lessons were reviewed in only some cases, while patient numbers rose by 39.28–61.59% during the outbreak. Namon Hospital is a small hospital with limited personnel; it was therefore necessary to develop staff knowledge, establish clear guidelines, set up safety systems, and review lessons from errors in order to cope with the outbreak, which is consistent with the development of a care system for patients with respiratory infections in the emergency department.[17] Inaccurate triage causes

patients to receive delayed care,[11] which was seen in the 50 risk incidents before development.

The developed system had 4 measures: establishing guidelines jointly with the related teams, five-level triage, infection prevention in aerosol-generating procedures, and monthly lessons-learned review. It drew on NIEM triage criteria and the Department of Medical Services manual and emphasized coordination with internal and external units, creating safety and confidence in working in situations with a risk of infection. This is consistent with the new normal emergency care system during COVID-19[12] and the nursing practice guidelines for COVID-19 patients in the accident and emergency department.[13] The structure of the system could feasibly be adapted to other emerging infectious diseases, which requires further evaluation, because it establishes joint guidelines, triage, infection prevention, and repeated learning in a cyclical manner.

After development, total health literacy increased significantly (from 131.65 to 154.87 points), which may result from providing information to patients according to the system's guidelines together with COVID-19 information received from other sources during the outbreak; it therefore cannot be concluded that the increase resulted from the developed system alone. This is in the same direction as a study of health literacy on emergency illness among service users.[18] Access to information and services and media literacy did not change, possibly because the measures did not directly aim to develop these skills. The increase in triage accuracy from 81.10% to 87.40% is in the same direction as the development of an ESI-based triage model in Kalasin Province,[15] which was an action research study of 9 personnel and is therefore of limited comparability. However, the increases at the Resuscitation and Emergent levels were not statistically significant, possibly because the number of medical records at these two levels was small, while the outbreak affected the triage of level 1 patients in the emergency department.[19] The increase in nurses' knowledge and skill scores after training is consistent with the development of nursing practice guidelines for critically ill emergency patients during COVID-19,[14] and the increase in satisfaction is consistent with the use of nursing practice guidelines for COVID-19 patients.[13] Follow-up through September 2026 found that triage accuracy and risk incidents remained at levels similar to the post-development period, as shown in section 3.5.

The limitations of this study were that it was conducted in a single community hospital; it compared before and after without a control group; the patient samples before and after development were different groups; COVID-19 was used as the case study of an emerging infectious disease; the pre-development period was before the outbreak whereas the post-development period fell during the outbreak; the researcher collected the data personally; risk incidents were not statistically tested; staff infections and waiting times were not measured; and the 4 measures were implemented simultaneously, so the effect of each measure could not be separated.

Conclusion

Before development, the Namon Hospital emergency department had no joint guidelines and no single triage standard. The developed emergency patient assessment system for emerging infectious disease response comprised 4 measures: establishing guidelines jointly with the related teams, five-level triage according to ESI, ATK/RT-

PCR testing and PPE use before aerosol-generating procedures, and monthly lessons-learned review. After development, total health literacy increased from 131.65 to 154.87 points, triage knowledge and skills increased from 6.65 to 7.60 points, triage accuracy increased from 81.10% to 87.40%, risk incidents fell from 50 to 16 (descriptive comparison), and satisfaction increased from 3.42 to 4.11 points.

Recommendations

1. Recommendations for applying the findings. Community hospitals with a similar context can adapt all 4 measures by holding regular monthly training and triage testing and reviewing lessons learned together with the related teams. At the provincial level, the development of knowledge on emergency patient assessment in the emergency department during emerging infectious disease situations should be supported, and a system for area-based monitoring and lessons-learned review should be established. Implementation should begin by analyzing the situation with the multidisciplinary team when an emerging infectious disease occurs and by training personnel according to the current guidelines.

2. Recommendations for future research. Comparative studies should be conducted in neighboring districts or other hospitals to identify differences and shortcomings for further development, using a design with a comparison hospital or an interrupted time series study based on monthly data, measuring staff infections and waiting times as outcomes, and testing the system with other emerging infectious diseases or through drills.

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RESEARCH ARTICLE

Development of a Community Participation-Based Elderly School Model Mu Mon Subdistrict, Somdet District, Kalasin Province

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Abstract

This one-cycle action research study aimed to examine the context, operations, and needs, develop, and evaluate a community participation-based elderly school model in Mu Mon Subdistrict, Somdet District, Kalasin Province, using the Plan-Do-Check-Act (PDCA) quality cycle and the Context-Input-Process-Product (CIPP) evaluation framework. It was conducted from October 2025 to September 2026. Participants were 30 stakeholders (purposive sampling) and 60 older adults attending the school, recruited from 73 target older adults. Instruments were a focus group guide, assessments of knowledge, health behavior, and social participation, and a CIPP evaluation form. Data were analyzed using descriptive statistics, a paired t-test and an independent t-test.

The resulting model engaged older adults and network partners in every step of the PDCA cycle. After implementation, older adults' self-care knowledge increased from 11.85±2.76 to 16.42±2.11 points (t = 12.00, p-value <0.001), health behavior from 3.21±0.52 to 4.18±0.41 points (t = 13.66, p-value <0.001), and social participation from 3.05±0.61 to 3.96±0.49 points (t = 11.37, p-value <0.001). Of 73 target older adults, 60 enrolled (82.19%), and 13 of 15 partner organizations participated (86.67%). Mean CIPP ratings ranged from 4.12 to 4.51 (high to highest). The model suits the local context and may serve as a guide for areas with a similar context.

Keywords: Elderly school, Community participation, Active ageing, Action research

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Introduction

Thailand has become a complete aged society. In 2025, there were 14,286,095 people aged 60 years and over, accounting for 21.70% of the total population[1]. Promoting the health and quality of life of older adults is therefore an important issue requiring systematic and continuous action. Promoting lifelong learning is a key approach to developing the potential of older adults, including knowledge and life skills, physical and mental health care, social relationships, and the use of experience and wisdom for community development. The elderly school is one mechanism that facilitates learning and the exchange of experiences between older adults and community members[2], consistent with the World Health Organization's active ageing concept, which emphasizes health, participation, and security[3].

In 2025, Kalasin Province had a population of 952,823, of whom 191,274 (20.07%) were aged 60 years and over[4]. In Somdet District, in fiscal year 2025, 9,565 of 9,596 target older adults (99.68%) were screened for Activities of Daily Living (ADL)[5]. However, comprehensive screening data alone are insufficient for developing older adults' potential without a process that uses the data to design learning activities and monitor outcomes continuously. Mu Mon Subdistrict therefore needed an elderly school model linking health data with activities that promote knowledge of self-care, disease prevention, mental health care, fall prevention, and social participation.

The development of the elderly school drew on the elderly school concept[2], active ageing[3], adult learning theory[6], and the concept of community participation[7], driven by the PDCA quality cycle[8] and evaluated using the CIPP Model[9]. Previous studies have emphasized the use of local wisdom and community resources for participatory elderly care in Namon District[10]; participation from problem identification, planning, and teaching through to evaluation in elderly school management[11]; and network building, course development, and monitoring and evaluation[12]. However, approaches from other areas must be adapted to the local context and readiness, and Mu Mon Subdistrict still lacked a model that systematically links community participation with a development and evaluation cycle. This study used the PDCA cycle as the model development process and the CIPP framework to evaluate the model at the end of the cycle.

This study therefore developed a community participation-based elderly school model in Mu Mon Subdistrict, Somdet District, Kalasin Province, encouraging older adults and network partners to participate in every step and using PDCA as the framework for operation and continuous improvement. The results are expected to provide guidance for elderly schools to establish a clear management system that meets the needs of older adults and the community and promotes older adults' quality of life and their role in sustainable community development.

Research Objectives

1. To examine the context, operations, and needs for developing a community participation-based elderly school
2. To develop a community participation-based elderly school model consistent with the context and needs of older adults and network partners
3. To evaluate the use of the model in terms of operational processes, network partner participation, and outcomes among older adults, with the self-care knowledge score as the primary outcome

Methods

This study was action research conducted in Mu Mon Subdistrict, Somdet District, Kalasin Province, from October 2025 to September 2026 (12 months), for one cycle. Outcomes among older adults were evaluated using a one-group pretest-posttest design. The four-step PDCA quality cycle was applied: Plan, Do, Check, and Act. The model was evaluated using the four dimensions of the CIPP Model: Context, Input, Process, and Product[9], with all four dimensions assessed at the end of the cycle. The Plan step took 3 months, Do 6 months, Check 2 months, and Act 1 month, as detailed below.

Population

1) Stakeholders in the development of the elderly school, including older adults, families and caregivers, community leaders, the Subdistrict Administrative Organization, public health officers, village health volunteers (VHVs), and the elderly club of Mu Mon Subdistrict; and 2) the 73 target older adults of the Mu Mon Subdistrict elderly school.

Sample

1) Thirty stakeholders selected by purposive sampling: 6 older adult representatives, 4 family members or caregivers, 4 community leaders, 3 Subdistrict Administrative Organization staff, 4 public health officers, 6 VHVs, and 3 elderly club members; and 2) 60 older adults attending the elderly school. The sample size was calculated using G*Power for a two-tailed paired t-test with an effect size of 0.50, power of 0.80, and significance level of .05, yielding 34 participants; adding 20% to compensate for attrition gave 41. All eligible applicants were accepted, totaling 60, making this a volunteer sample.

Inclusion criteria

1) Older adults: aged 60 years or over, residing in Mu Mon Subdistrict for at least 1 year, independent in daily living (ADL score of 12 or higher), able to communicate in Thai, and consenting to participate; 2) Stakeholders: involved in caring for or supporting older adults in the subdistrict and consenting to participate.

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Exclusion criteria

Severe illness preventing participation in activities. Discontinuation criteria were moving out of the area, missing more than 25.00% of activities, or requesting withdrawal.

Research instruments

These comprised 1) instruments for developing and conducting activities: a focus group guide and the elderly school curriculum and activity plan; and 2) data collection instruments: a general information questionnaire; a 20-item self-care knowledge assessment (total score 20), classified as good (80.00% or above), moderate (60.00-79.99%), and needs improvement (below 60.00%); a 15-item health behavior and social participation assessment (5-point rating scale), with mean scores of 3.41-4.20 interpreted as high and 4.21-5.00 as highest; a four-dimension CIPP evaluation form; and an activity attendance record. Content validity was verified by 3 experts, yielding an Index of Item-Objective Congruence (IOC) of 0.67-1.00. The instruments were tried out with 30 older adults in a neighboring subdistrict, yielding a KR-20 of 0.81 for the knowledge assessment and Cronbach's alpha of 0.84-0.92 for the other assessments.

Data collection

In the Plan step, the context, situation, problems, and needs were examined using existing health data and focus group discussions (1 group of 15 participants, 3 sessions). In the Do step, the model was implemented. In the Check step, the participation process, problems, obstacles, and outcomes were monitored. In the Act step, recommendations were used to improve the model before the next cycle. Older adults' knowledge, health behavior, and social participation were measured before and after the activities (months 4 and 9), and the CIPP evaluation was completed by older adults and network partners at the end of the study. Data were collected by the researcher and trained VHVs.

Data analysis

General data were analyzed using frequency, percentage, mean, and standard deviation. Scores before and after attending the elderly school were compared using a paired t-test. CIPP ratings of older adults and network partners were compared using an independent t-test. Knowledge levels before and after, as paired data from the same group, were compared using the McNemar-Bowker test. The significance level was set at .05. Analyses were performed using R version 4.5.2. Qualitative data were analyzed using content analysis.

Research ethics

This study adhered to the ethical principles of human research. The researcher protected participants' rights by explaining the study objectives and procedures, obtaining signed informed consent, keeping data confidential and presenting results only in aggregate, and granting the right to refuse or

withdraw at any time without affecting older adults' access to services or having any impact on network partners.

Results

1. Context, operations, and needs

1.1 General information The 60 participating older adults were 68.33% female, with a mean age of 67.85±5.42 years; 70.00% had completed primary education, 61.67% had chronic diseases, and all were independent in self-care. Of the 30 stakeholders, 6 were VHVs (20.00%), 6 were older adult representatives (20.00%), and 4 were public health officers (13.33%).

1.2 Previous operations and needs Baseline data showed that 20.07% of the population of Kalasin Province were older adults and that Somdet District achieved 99.68% ADL screening coverage, an important database for designing activities. Focus group discussions revealed that the existing elderly school held activities only occasionally, older adults had not participated in setting the curriculum, network partners lacked clear roles, and there was no continuous follow-up. Older adults wanted to learn about health care, prevention of chronic diseases and falls, mental health, and the exchange of local wisdom, with classes held near home and VHVs helping with transportation.

2. Community participation-based elderly school model

2.1 Development process The model was developed following the four steps of the PDCA cycle, as shown in Table 1.

Table 1 Steps in developing the community participation-based elderly school model according to the PDCA cycle

Step	Activities/Content	Instruments	Duration	Academic rationale
1	Plan: Examine the context, situation, problems, needs, and potential of the community; jointly define the components, curriculum, activities, network partner roles, and supporting resources	Health data (ADL), focus group guide	Months 1-3 (Oct-Dec 2025)	Use contextual and needs data as the foundation and involve older adults in setting the direction[7]

Step	Activities/Content	Instruments	Duration	Academic rationale
2	Do: Implement the model as planned, coordinate with network partners, and encourage older adults to participate appropriately in activities	Elderly school curriculum, local speakers	Months 4-9 (Jan-Jun 2026)	Provide experiential and practice-based learning based on adult learning principles[6]
3	Check: Monitor the participation process, problems, obstacles, and outcomes; evaluate using the CIPP framework	CIPP evaluation form, activity attendance record	Months 10-11 (Jul-Aug 2026)	Evaluate context, input, process, and product[9]
4	Act: Use evaluation results and recommendations to improve components and operational guidelines before the next cycle	Lessons-learned meeting	Month 12 (Sep 2026)	Use feedback for continuous improvement[8]

2.2 The developed model The model consists of four PDCA steps, as shown in Figure 1, with community participation as the key mechanism. Older adults, families, community leaders, the Subdistrict Administrative Organization, public health agencies, VHVs, and the elderly club jointly defined the curriculum and activities, provided resources, assigned roles, and participated in monitoring and evaluation. The curriculum comprised 8 topics: health care and chronic disease prevention, fall prevention, appropriate exercise, nutrition, mental health and stress management, information literacy, local wisdom and occupations, and participation in community activities. Sessions were held once a week for 3 hours over 6 months, with 3 one-hour sessions per topic.

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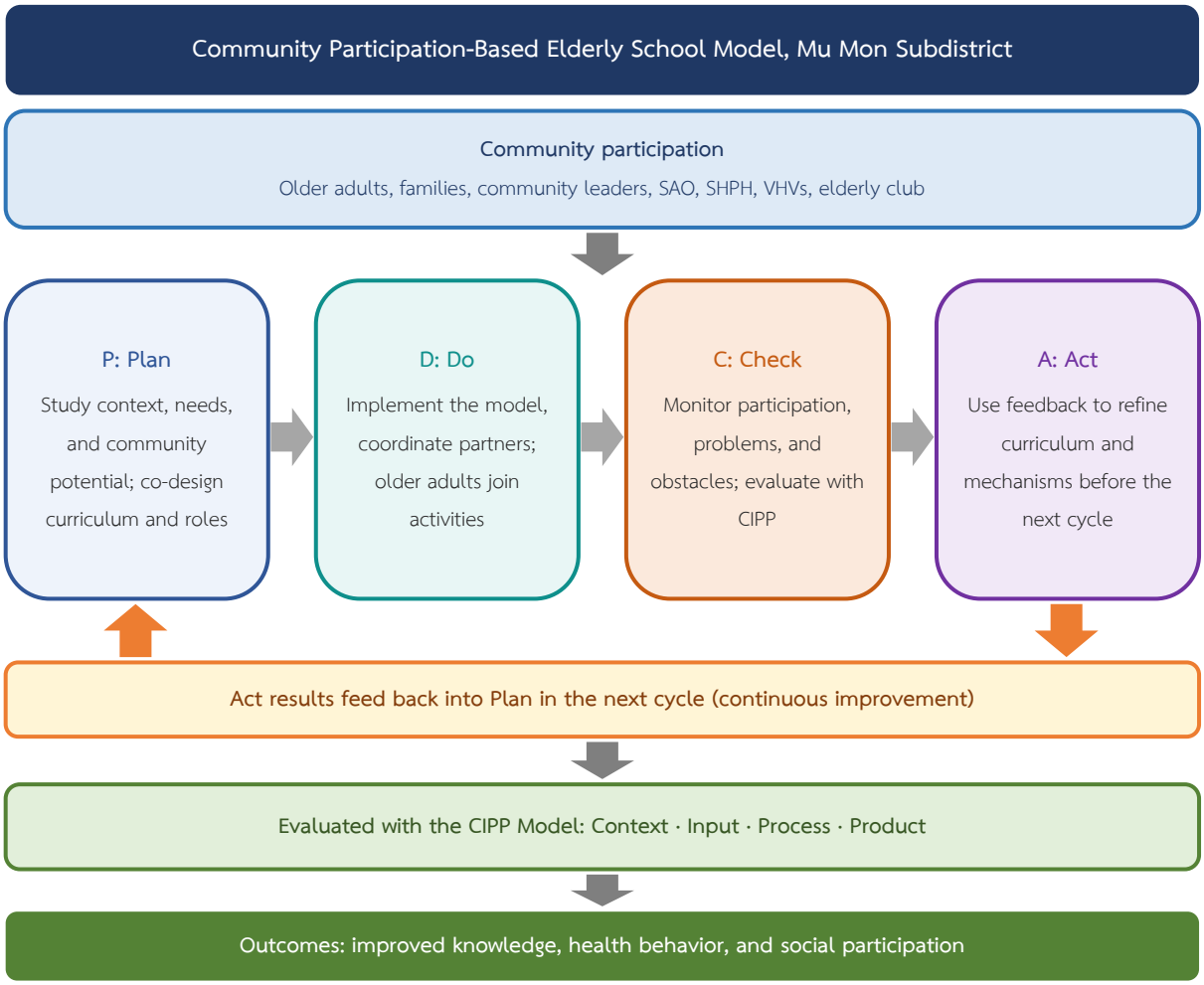

Figure 1 Community participation-based elderly school model, Mu Mon Subdistrict, Somdet District, Kalasin Province

3. Evaluation of model implementation

3.1 Older adults' knowledge, health behavior, and social participation After attending the elderly school, the 60 older adults' self-care knowledge scores increased from 11.85±2.76 to 16.42±2.11 points, health behavior from 3.21±0.52 to 4.18±0.41 points, and social participation from 3.05±0.61 to 3.96±0.49 points, all statistically significant (t = 12.00, 13.66, and 11.37, respectively; df = 59; p-value <0.001), as shown in Table 2.

Table 2 Comparison of older adults' knowledge, health behavior, and social participation scores before and after attending the elderly school (n=60)

Variable	Group	Before		After		df	$\bar{d}$	95%CI	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Self-care knowledge (total 20)	Older adults (n=60)	11.85	2.76	16.42	2.11	59	4.57	3.81, 5.33	12.00	<0.001*

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Variable	Group	Before		After		df	$\bar{d}$	95%CI	t	p-value
		$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Health behavior (total 5)	Older adults (n=60)	3.21	0.52	4.18	0.41	59	0.97	0.83, 1.11	13.66	<0.001*
Social participation (total 5)	Older adults (n=60)	3.05	0.61	3.96	0.49	59	0.91	0.75, 1.07	11.37	<0.001*

*Statistically significant at p-value <.05

3.2 CIPP evaluation Older adults (n=60) and network partners (n=30) rated the model at high to highest levels (mean 4.12-4.51). Older adults rated process (4.42±0.46) and product (4.51±0.44) significantly higher than network partners did (4.12±0.58 and 4.20±0.53) (t = 2.67, p-value = 0.009 and t = 2.94, p-value = 0.004, respectively), whereas differences in context and input were not statistically significant, as shown in Table 3.

Table 3 Comparison of CIPP evaluation results between older adults (n=60) and network partners (n=30)

Variable	Older adults (n=60)		Network partners (n=30)		df	Mean diff.	95%CI	t	p-value
	$\bar{x}$	S.D.	$\bar{x}$	S.D.					
Context (total 5)	4.35	0.48	4.22	0.55	88	0.13	-0.09, 0.35	1.15	0.252
Input (total 5)	4.18	0.52	4.31	0.49	88	-0.13	-0.36, 0.10	-1.14	0.258
Process (total 5)	4.42	0.46	4.12	0.58	88	0.30	0.08, 0.52	2.67	0.009*
Product (total 5)	4.51	0.44	4.20	0.53	88	0.31	0.10, 0.52	2.94	0.004*

*Statistically significant at p-value <.05

3.3 Knowledge levels and success indicators The proportion of older adults with good knowledge increased from 25.00% to 70.00% (χ^2 = 25.79, df = 2, p-value <0.001), as shown in Table 4. Regarding the indicators, 60 of 73 target older adults enrolled (82.19%; criterion ≥75.00%), 53 older adults showed improved knowledge or behavior (88.33%; criterion ≥80.00%), 13 of 15 partner organizations participated (86.67%; criterion ≥80.00%), and one model was implemented and evaluated.

Table 4 Comparison of older adults' self-care knowledge levels before and after attending the elderly school (n=60)

Knowledge level	Before n (%)	After n (%)	χ^2	p-value
Good	15 (25.00)	42 (70.00)		
Moderate	30 (50.00)	15 (25.00)		

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Knowledge level	Before n (%)	After n (%)	χ^2	p-value
Needs improvement	15 (25.00)	3 (5.00)		
Total	60 (100.00)	60 (100.00)	**25.79**	**<0.001***

*Statistically significant at p-value <.05

Discussion

Existing health data, such as Somdet District's ADL screening with 99.68% coverage[5], provided an important basis for designing activities, but screening data alone are insufficient unless they are used to plan learning activities and monitor outcomes continuously. The focus group finding that the existing elderly school held activities only occasionally and that older adults had not participated in setting the curriculum is consistent with the view that establishing an elderly school alone is not enough and that clear management, support, and monitoring are needed[12], as well as with the use of local wisdom and community resources to promote older adults' health[10].

The developed model used PDCA as the driving mechanism and engaged older adults and network partners in every step, from problem identification, planning, and teaching to evaluation, consistent with a study of participatory processes in elderly school management[11] and the concept of participation in decision-making, implementation, benefits, and evaluation[7]. Designing activities around learners' experiences and interests is consistent with adult learning theory[6], and covering health, participation, and security is consistent with the active ageing concept[3].

After implementation, older adults' knowledge, health behavior, and social participation increased significantly, and all success indicators met their criteria. This may be related to involving older adults in defining content and activities, using local wisdom and community resources, and monitoring and improving the model through the PDCA cycle[8]. The CIPP evaluation revealed the quality of the model in terms of context, input, process, and product[9]. Older adults rated process and product higher than network partners did, possibly because older adults benefited directly, whereas network partners were more aware of limitations in resources and coordination.

Limitations of this study include implementation of only one PDCA cycle in a single subdistrict; a one-group pretest-posttest design without a comparison group; a volunteer sample; self-reported health behavior and social participation, with data collected by the activity organizers; a single CIPP evaluation at the end of the study by people involved with the model; and no follow-up on the persistence of effects. In addition, participation of older adults and network partners varied according to their health and workload, and the continuity of operations may depend on key individuals.

Conclusion

The existing elderly school held activities only occasionally, and older adults had not participated in setting the curriculum. The community participation-based elderly school model developed for Mu Mon Subdistrict used the four-step PDCA cycle and engaged older adults and network partners in every step. After implementation, older adults' knowledge scores increased from 11.85 to 16.42, health behavior from 3.21 to 4.18, and social participation from 3.05 to 3.96 (p-value <0.001). All indicators met their criteria, and CIPP ratings were at high to highest levels.

Recommendations

1. Recommendations for applying the findings: The roles and responsibilities of older adults, families, the community, local government organizations, public health agencies, and network partners should be clearly defined; planning and monitoring meetings should be held regularly; community resources and local wisdom should be surveyed and used; activities should be integrated with existing plans; knowledge should be transferred to community leaders to foster community ownership; and indicators and data collection tools suitable for older adults should be defined from the planning stage.

2. Recommendations for future research: Long-term follow-up studies should be conducted to assess sustainability; quasi-experimental studies should use neighboring subdistricts as comparison groups; action research should be conducted for at least two cycles; and approaches to support dependent older adults or those with limited ability to participate in activities should be studied.

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