ORIGINAL ARTICLE

Factors related to adverse events in referring patients from Khon Kaen Hospital, Khon Kaen Province, for continuing treatment near their homes: a retrospective cohort study

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Received: 6 August 2024 **Revised:** 8 November 2024 **Accepted:** 9 November 2024 **Available online:** May 2025
DOI: 10.55131/jphd/2025/230211

ABSTRACT

Comprehending the factors linked to adverse events during patient referrals is essential for developing standardized safety protocols. These findings will enhance referral practices and mitigate complications in high-volume referral hospitals. The purpose of this study was to examine the factors associated with adverse events during referrals for continued treatment at community hospitals near patient homes. This retrospective cohort study collected data from a patient medical record database at Khon Kaen Hospital during 2019-2021. The study population consisted of 441 patients evaluated by an attending physician for referral to ongoing treatment at a nearby hospital. The data were analyzed using the generalized linear model to assess the adjusted relative risk (RR) with a 95% confidence interval. After adjusting the variables in the final model, the study showed statistical significance for certain factors relating to the adverse events in referring patients to continuing treatment near home ($p<0.05$). These factors included intubated patients (adjusted RR: 2.07; 95% CI: 1.33-2.86), patients with a principal diagnosis of infection (adjusted RR: 1.83; 95% CI: 1.16-2.89), patients with a principal diagnosis of respiratory problems (adjusted RR: 1.57; 95% CI: 1.01-2.44) and patients with a principal diagnosis of cardiovascular disease (adjusted RR: 1.84; 95% CI: 1.22-2.78). Therefore, there should be patient referral procedures that are tailored for patients with each group of diseases, especially in intubated patients with infection, respiratory, or cardiovascular diseases, as they are more likely to experience adverse events during patient referral. These tailored procedures should cover the assessment of patients by a medical specialist in that disease group and clear communication of the patient's information on treatment and symptoms before starting the patient referral process.

Keywords:
adverse events; referring patients to continuing treatment near home; inter-hospital transfer; patient transfer; referral safety; risk factors

Citation:
Chananya Jirapornkul, Onanong Sapphasombat, Naowarat Maneenin, Supot Kamsa-ard, Seathapong Thanoorat, Nathakon Nilnate. Factors related to adverse events in referring patients from Khon Kaen Hospital, Khon Kaen Province, for continuing treatment near their homes: a retrospective cohort study. J Public Hlth Dev. 2025;23(2):152-164 (https://doi.org/10.55131/jphd/2025/230211)

INTRODUCTION

Currently, overcrowding in large hospitals is increasing due to ever greater demand for medical services.[1] The occupancy rate for beds in large hospitals is rising every year.[2] Recent systematic reviews have shown that hospital overcrowding leads to increased mortality rates, delayed treatments, and reduced quality of care, with average emergency department waiting times increasing by 43% in overcrowded conditions[3] In practice, patients can be referred to community hospitals nearer to their homes or to hospitals that are assigned to them by their government healthcare plans.[4] This process is done when patients have passed a critical stage or when their sickness can be treated at a community hospital. In the remainder of the paper, this process will be called patient referral (PR) and it refers to operations by Khon Kaen Hospital. PR is an essential process in the health care system. It reduces overcrowding in large hospitals.[1] However, there are no clear standard practices for assessing the readiness of patients to be transferred during the PR process or for continuous treatment and care.[1]

In the 7th Health Service Region of Thailand, which covers Kalasin, Khon Kaen, Mahasarakham and Roi Et provinces, the number of inter-hospital referrals is among the highest in the country.[5] Khon Kaen Hospital is a Level A hospital with 1,000 beds. It has the capacity to accommodate patients who require complex treatments using its expertise and advanced medical technology[6], which has led it to have the highest number of referrals in the 7th Health Service Region.[5] Due to numerous factors, there is a risk of adverse events (AEs) during PR.[7,8] When categorizing the incidence of clinical risk associated with the referral system at Khon Kaen Hospital, it was found that in 2020 and 2021, 59 and 64 patients who respectively needed PRs did not receive proper referrals. Complications or AEs that occurred accordingly could have been prevented, 17 and 9 times, respectively.[9] In the 2018–2020 fiscal years, Khon Kaen Hospital had a respective total of 7121, 6211 and 5414 patients. It was found that there were 23, 21 and 30 AEs among patients receiving referrals during those respective years. The AEs were classified as follows: 1) Incidence of AEs due to respiratory system complications was 18, 17 and 24 cases per year, respectively, and the patients were sent back to Khon Kaen hospital within 48 hours, 2) Incidence of AEs due to miscommunication and failure to provide critical treatment information to the receiving hospitals, was reported 3, 3, and 4 times, respectively, and 3) AEs due to lack of necessary medical equipment was noted in 2, 1, and 2 cases, respectively.[10]

Previous studies that looked at factors related to adverse events in referring patients found that the marital status of African American patients (p-value=0.380) and Caucasian patients (p-value=0.900) was not statistically significantly linked to the occurrence of adverse events. [11] The study observed a higher incidence of AEs with patients that had their first follow-up visit within 7 days after hospital discharge (33.5% vs. 23.0%, p = 0.007). This effect was attenuated somewhat but remained significant when adjusted for several patient factors (adjusted OR 1.33, 95% confidence interval 1.16-2.71).[12] A study on adverse events during hospital transfers from the emergency department revealed a significant correlation between transfer timing and the occurrence of adverse events (p-value = 0.012). After accounting for the variables in the final equation, we found that transferring patients during the morning and afternoon shifts increased the risk of adverse events by 0.21 times (adjusted OR: 0.21; 95% CI: 0.06-0.69) and

0.24 times (adjusted OR: 0.24; 95% CI: 0.08-0.73), respectively, compared to transferring patients during the night shift.[13] Additionally, after discharge, patients living in urban areas were found to be 1.04 times more likely to experience an adverse event than patients living outside the city (adjusted RR: 1.04, 95% CI: 0.82-1.32).[14] Previous studies identified several factors linked to adverse events; however, most relied on data from a single service provider, excluding information from the nearby hospital that delivered ongoing treatment, resulting in undetermined identification of adverse events. AEs that occur during PRs are important information that reflects the quality of care provided by the original hospital, care during the transport process, and care provided by the receiving hospital near the patient's home. There was a collection of AE incidents during PRs, which illustrated that these events caused complications during PR and significantly impacted patient safety.[15] In Thailand, there are few studies on AEs related to PR. In addition, it also lacks studies on the magnitude of problems associated with PR. Therefore, this study was conducted to determine factors that were related to AEs during the PR process.

METHODOLOGY

An analytical examination was done as a cohort study using retrospective secondary data collected from medical records and referral assessment forms of Khon Kaen Hospital. The study population consisted of in-patients admitted during the years of 2019-2021. Attending physicians assessed the readiness of individual patients to be referred for continuing treatment at a community hospital near their home. When the patient was ready, the PR process began with the following steps: 1) coordinating and sending patient information to the receiving hospital, 2) preparing the patient for transport by assessing symptoms, developing treatment plans for the patient, notifying relatives and preparing equipment for continuing care, 3) care during transport that involved monitoring patient conditions and reporting any changes, and 4) monitoring the patient for 48 hours after arrival at the receiving hospital.

Sample size was determined for the research design and statistical methods used in the study. The generalized linear model (GLM) was used in the study analysis. The sample size was determined as described by Hsieh, Bloch & Larsen, 1989[16]. The details of the sample size calculation are provided below.

$$n= \frac{\{Z_{1-\alpha/2}[P(1-P)/B]^{1/2} + z_{1-\beta}[P_1(1-P_1) + P_2(1-P_2)(1-B)/B]^{1/2}\}^2}{[(P_1 - P_2)^2 (1-B)]}$$

P_1 = The proportion of adverse events in male patients referred for further treatment was 0.156.

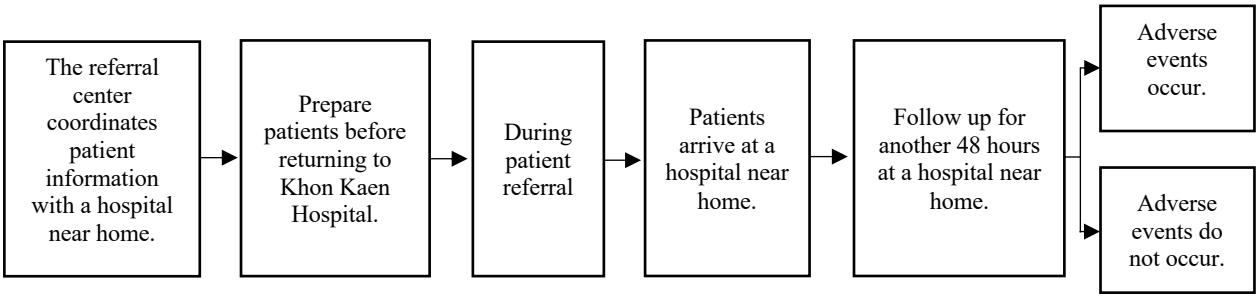
P_2 = The proportion of adverse events in female patients referred for further treatment was 0.293.

B = The proportion of female patients who were referred for further treatment was 0.551.

The researchers used the values of P_1, P_2, and B based upon a study examining AEs of patients upon hospital discharge.[17]

The required sample size was obtained from a sample size calculation. A study group of 298 people was obtained. Through statistical analysis and considering that the multiple correlation coefficient was 0.5, it was found that a sample of 441 people was needed.

The study's sample group included patients admitted to the inpatient department at Khon Kaen Hospital until they received care and were diagnosed by the doctor who treated them, who assessed their suitability for referring to a nearby hospital for continued treatment, which included the following follow-up procedures:



***Inclusion criteria*:** patients being treated at Khon Kaen Hospital during the 2019-2021 period were assessed by an attending physician for referral to a hospital near their home for continuing treatment.

***Exclusion criteria*:** patients were excluded from the current study if they were terminally ill, were being sent for further treatment at a hospital near their home and had signed a clear palliative treatment consent form at Khon Kaen Hospital.

The data in the current study were derived from patient information and medical records. A standardized data extraction form was developed based on a literature review and validated by three experts in emergency medical services. The form demonstrated a content validity index of more than 0.6 for all questions. Patient records were examined by a physician and two registered nurses who had at least five years of experience in emergency care. Part 1 of these forms consisted of patient demographic data, including gender, age and marital status. Part 2 described their underlying diseases, intubation, and respiration data during transport, as well as diseases for which they were being treated. Part 3 indicated the time the patient was discharged from the hospital the and transport distance. In Part 4, the dependent variable was the AEs observed in the patients. The AEs included 1) complications during transport, *e.g.*, the patients developed respiratory problems or abnormal blood pressure, among others, 2) miscommunication of patient information, *e. g.* , incomplete or incorrect treatment information, and 3) improper PRs that involved incorrect arrangement of personnel, vehicles and medical equipment, or transport was delayed, among other problems.

The extraction form consisted of four parts. Part 1 collected patient demographic data, including gender, age and marital status. Part 2 documented their underlying diseases, intubation, and respiration data during transport, as well as diseases for which they were being treated. Part 3 recorded the time the patient was discharged from the hospital and the transport distance. In Part 4, the dependent variable was the AEs observed in the patients. The AEs included 1) complications during transport, *e.g.*, the patients developed respiratory problems or abnormal blood pressure, among others, 2) miscommunication of patient information, *e.g.*, incomplete or incorrect treatment information, and 3) improper PRs that involved incorrect arrangement of personnel, vehicles and medical equipment, or transport was delayed, among other problems.

Statistical methods

Descriptive statistics

Patient characteristics, referral information including the period when the patient was discharged from the hospital, transport distance, characteristics of illness, and characteristics of the PR process were summarised using descriptive statistics for continuous variables, means (standard deviations, SDs), medians (minimum and maximum), and frequency counts and percentages for categorical variables.

Inferential statistics

Crude analysis:

A crude analysis determines the relationship between various factors and AEs during PR without controlling for confounding variables. The crude relative risk (crude RR) and its 95% confidence intervals (95 % CI) were calculated by bivariate analysis. Generalised linear models (GLM) were selected as the primary analytical method due to their ability to handle binary outcome variables (presence/absence of AEs) while allowing for non-normal distribution of data. Additionally, GLM provides more reliable estimates of relative risks compared to logistic regression when the outcome is not rare, making it particularly suitable for our study objectives focusing on risk assessment during PR. GLM, binomial family distribution, linking functions, and linear models (log) were used for the analyses.[18]

Multivariable analysis:

Multivariable analysis was used to compute the adjusted relative risk (adjusted RR) and their 95% confidence intervals (95 % CI) to investigate the various factors and AEs during PR while controlling for the effects of confounding variables such as demographic variables.[19]

Model fitting:

Candidate variables for the multivariable analysis were selected according to two criteria: first, variables in the crude analysis with p-values < 0.25, and second, variables from a literature review associated with AEs during PR. Backward stepwise elimination was used for the model-fitting strategy. Finally, Akaike's Information Criterion (AIC) was applied to assess the best model.[20]

All test statistics were two-sided; p-values< 0.05 were considered significant. All analyses used Stata version 10.0.[21]

Prevention and reduction of bias.

The researchers designed this study to reduce bias in the following ways:

Selection bias: the occurrence of adverse events by physicians and nurses who assess patients when an adverse event occurs, which can indicate the occurrence of adverse events in referring patients to continuing treatment at hospitals near their homes.

Information bias: when hospitals near the patients' homes referred them for further treatment, researchers followed up with patients who had incomplete data through information requests and telephone calls.

Confounding bias: The study of the relationship between variables and adverse events is conducted, which may suggest an incidence of adverse events in patients referred for continued treatment at Khon Kaen Hospital, utilizing a Generalized Linear Model (GLM).

Ethical considerations

The Human Research and Ethics Committee of Khon Kaen University (HE652061) and Khon Kaen Center Hospital (KEMOU65019) reviewed and approved this project.

RESULTS

Demographic characteristics

The majority of the subjects undergoing PR were males (256, 58.0%). The 70–79-year-olds comprised 108 people (24.5%). Their median age was 61.49 years with a range of 3-92 years. Most patients were married (303 people, 68.7%).

Characteristics of illnesses

Of those undergoing PR, 334 people had underlying diseases (comorbidities) (75.7%), and 221 patients (50.1%) were not intubated during treatment. The largest group of patients had cardiovascular diseases, totaling 99 people (22.4%). Respirators were not often used during transport. The majority of patients, 304 people (68.9%), were able to breathe on their own.

Table 1. Patient demographic data (n=441)

Variables	n	%
Demographic data		
Gender		
Male	256	58.0
Female	185	42.0
Age		
<20 years	11	2.5
20–29 years	19	4.3
30–39 years	24	5.4
40–49 years	40	9.1
50–59 years	77	17.5
60–69 years	104	23.6
70–79 years	108	24.5
≥ 80 years	58	13.1
Average age (standard deviation)	61.49 (17.34)	
Median age (minimum: maximum)	65 (3: 92)	
Marital status		
Single	84	19.1
Married	303	68.7
Divorced/widowed	54	24.2
Characteristics of illness		
Underlying disease		
No	107	24.3
Yes	334	75.7
Intubation during treatment		
No endotracheal intubation	221	50.1
Intubation during treatment	220	49.9
Endocrinal system		
No disease	432	98.0
Disease present	9	2.0
Tumors or cancer		
No disease	430	97.5
Disease present	11	2.5
Musculoskeletal disease		
No disease	429	97.3
Disease present	12	2.7
Digestive system		
No disease	411	93.2
Disease present	30	6.8

Variables	n	%
Urinary tract system		
No disease	400	90.7
Disease present	41	9.3
Injury or accident		
No disease	394	89.3
Disease present	47	10.7
Infectious disease		
No disease	380	86.2
Disease present	61	13.8
Respiratory system		
No disease	354	80.3
Disease present	87	19.7
Cardiovascular system		
No disease	342	77.6
Disease present	99	22.4
Respiration during transport		
Able to breath on their own	304	68.9
Oxygen given (nasal cannula, mask with bag	125	28.3
Oxygen collar mask	9	2.0
Use a breathing apparatus	3	0.7
Patient referral (PR) characteristics		
Patient discharge time		
Morning shift	410	93.0
Afternoon shift	30	6.8
Late night shift	1	0.2
Transport Distance		
Less than 30 kilometers	90	21.4
30 - 49 kilometers	110	24.9
50 - 99 kilometers	202	45.8
100 kilometers or more	39	8.4
Average	57.03 (33.63)	
Median (minimum: maximum)	52.4 (0 : 311)	

Table 2. Factors related to adverse events associated with PRs to continuing care near home from Khon Kaen Hospital (n=115)

Factors	n	n (%)	RR (95%CI)		p-value
		Unexpected Incident	Crude	Adjusted	
Gender					0.409
Male	265	63 (24.6)	1		
Female	185	52 (28.1)	1.14 (0.83-1.56)		
Age					0.973
<60 years	171	40 (23.4)	1		
≥60 years	270	75 (27.8)	1.19 (0.85-1.46)		
Marital status					0.809
Single	84	22 (26.2)	1		

Factors	n	n (%)	RR (95%CI)		p-value
		Unexpected Incident	Crude	Adjusted	
Married	303	77 (25.4)	0.97 (0.64-1.46)		
Divorced/ Widowed	54	16 (26.6)	1.13 (0.66-1.95)		
Underlying disease					0.012
Do not have	107	18 (16.8)	1		
Have	334	97 (29.0)	1.72 (1.10-2.72)		
Intubation during treatment					<0.001
No endotracheal intubation	221	35 (15.8)	1	1	
Intubation during treatment	220	80 (36.4)	2.30 (1.61-3.26)	2.07 (1.45-2.95)	
Main disease groups treated					
Endocrinal system					0.616
No disease	432	112 (25.9)	1		
Has disease	9	3 (33.3)	1.13 (0.50-3.28)		
Tumor and cancer					0.546
No disease	430	113 (26.3)	1		
Has disease	11	2 (18.2)	0.83 (0.44-1.56)		
Musculoskeletal system					0.723
No disease	429	114 (26.6)	1		
Has disease	12	1 (8.3)	0.89 (0.46-1.73)		
Digestive system					0.009
No disease	405	112 (27.7)	1		
Has disease	36	3 (8.3)	0.30 (0.10-0.90)		
Urinary tract system					0.168
No disease	400	108 (27.0)	1		
Has disease	41	7 (17.1)	0.63 (0.32-1.27)		
Injuries and accidents					0.135
No disease	394	107 (27.2)	1		
Has disease	47	8 (17.0)	0.63 (0.33-1.20)		
Infectious diseases					0.016
No disease	380	93 (24.5)	1	1	
Has disease	61	22 (36.1)	1.47 (1.01-2.15)	1.83 (1.16-2.89)	
Respiratory system					0.048
No disease	354	87 (24.6)	1	1	
Has disease	87	28 (32.2)	1.30 (0.92-1.86)	1.57 (1.01-2.44)	
Cardiovascular system					0.004

Factors	n	n (%)	RR (95%CI)		p-value
		Unexpected Incident	Crude	Adjusted	
No disease	342	82 (24.0)	1	1	
Has disease	99	33 (33.3)	1.39 (0.99-1.95)	1.84 (1.22-2.78)	
Respiration during transport					0.016
Able to breathe on their own	304	69 (22.7)	1	1	
Use oxygen	137	46 (33.6)	1.48 (1.08-2.02)	1.84 (1.22-2.78)	
Time of patient discharge					0.221
Morning shift	410	110 (26.8)	1		
Afternoon shift	31	5 (16.1)	0.62 (0.27-1.40)		
Transport distance					0.057
Outside of Khon Kaen Province	43	6 (13.9)	1		
Within Khon Kaen Province	398	109 (27.4)	1.96 (0.92-4.19)		

Patient referral (PR) characteristics

Of those undergoing PR, most (410, 93%) were transported during the morning shift (8:00 a.m. - 4:00 p.m.). The largest number of the patients (202, 45.8%) were transported a distance of 50–99 km to hospitals near their homes (Table 1).

Factors related to the occurrence of AEs during PR using univariate analysis.

It was found that underlying diseases, intubation during treatment, the type of disease treated, infectious diseases and breathing problems were associated with AEs during PRs at a statistically significant level (p-value < 0.05). Gender, age, marital status, patient discharge time from the hospital and transport distance were not significantly correlated with AEs during PRs (Table 2).

Factors related to the occurrence of AEs during patient referral (PR) using multivariate analysis.

To analyze the relationship between demographic factors, illness characteristics, and referral characteristics, a Generalized Linear Model (GLM) was applied, with control for confounding factors using the backward elimination technique. This analysis considered relevant knowledge and theories concerning adverse events during patient transfers for continued treatment near their home. The model included variables identified in the univariate analysis with a p-value of less than 0.25. Seven variables met the inclusion criteria: underlying diseases, intubation during treatment, digestive system conditions, infectious diseases, respiratory system conditions, cardiovascular system conditions, and respiration status during transport. When the final equation's other variables were taken into account, the final generalized linear model analysis showed that there were statistically significant factors related to adverse events in referring patients for continuing treatment near their homes (p-value<0.05):

It was found that among patients intubated for respiratory diseases, those with infectious diseases, respiratory problems or cardiovascular diseases were associated with AEs during PR at a statistically significant level. Among intubated patients, there is a 2.07 times

higher risk of AEs than those who were not intubated (adjusted RR: 2.07; 95% CI: 1.45-2.95; p-value < 0.001).

Patients with infectious diseases undergoing PR were 1.83 times more likely to experience AEs than those with no infectious diseases (adjusted RR: 1.83; 95% CI: 1.16-2.89; p-value=0.016).

Those patients with respiratory diseases had a 1.57 times greater risk of AEs than those who did not have a respiratory disease during PR (adjusted RR: 1.57; 95% CI: 1.01-2.44; p-value=0.048). Finally, those patients with cardiovascular diseases had a 1.84 times higher chance of AEs during PR than those without cardiovascular disease (adjusted RR: 1.84; 95% CI: 1.22-2.78; p-value=0.004) (Table 2).

DISCUSSION

From the current study, it was found that patients who were intubated during treatment showed a statistically significant correlation with AEs during patient referral (adjusted RR: 2.07; 95% CI: 1.45-2.95; p-value<0.001). This finding matches with a study conducted in an emergency department in Denmark, which revealed that over 50% of critically ill non-trauma patients experienced respiratory and circulatory issues.[22] This agrees with a study in which intubated patients were 1.69 times more likely to experience AEs than those who were not intubated (crude OR: 1.69; 95% CI: 0.67-4.22).[23] This might have occurred since these patients have a risk of experiencing AEs due to the nature of their illnesses, especially those who receive intubation.[24] Therefore, staff must exercise increased vigilance when accompanying these patient groups for referral to continuing treatment near their homes.

Patients with infectious diseases showed a statistically significant correlation with AEs during PR, (adjusted RR: 1.83; 95% CI: 1.16-2.89; p-value=0.016). This finding agrees with a study in which patients transferred from hospitals in urban areas to hospitals in a city showed a statistically significant correlation with AEs (p-value=0.040). When other factors in the final equation were controlled, patients with infectious diseases, among other diseases studied, discharged from urban hospitals were more likely to experience AEs (adjusted RR: 1.68; 95% CI: 1.12-2.52)[14] Patients with infectious diseases are often at greater risk for complications during patient transfers due to the nature of their illnesses, which may require specialized and continuous care, making them more susceptible to AEs.

Respiratory patients showed a correlation with AEs during PR (adjusted RR: 1.57; 95% CI: 1.01-2.44; p-value=0.048). This finding agrees with a study on the incidence of adverse events following hospital discharge, where respiratory patients with pneumonia showed a significant association with adverse events (p-value<0.05). When other factors were controlled in the final equation, they had a 1.9 times higher chance of experiencing AEs than those without pneumonia (adjusted OR: 1.9; 95% CI: 1.0-3.6).[17] This result is not consistent with an earlier study examining AEs associated with respiratory patients during transport.[25] Underlying respiratory impairments and the complexities of managing these patients may exacerbate existing health issues, thereby increasing susceptibility to adverse events. Therefore, there is a need for specialized interventions to address the unique challenges faced by respiratory patients during the referral process.

Patients with cardiovascular diseases also had a significant correlation with AEs during PR (adjusted RR: 1.84; 95% CI: 1.22-2.78; p-value=0.004). This is

inconsistent with AE studies in hospitals referring patients from emergency departments. Among the patients with cardiovascular, respiratory, digestive, endocrinal, and neurological diseases, as well as those suffering from accidents and other injuries, there were no significant correlations with AEs (p-value > 0.05)[23] This is inconsistent with previous research examining AEs associated with transport of cardiovascular patients.[25] The data from the current study is also inconsistent with the incidence of AEs after hospital discharge among African American and Caucasian patients (p-value > 0.05).[11] Infectious respiratory and cardiovascular diseases are quite severe. Symptoms can change while transporting these patients, such as when moving a patient from a ward to an ambulance. From the data, during PR, patients with infectious, respiratory or cardiovascular diseases who were older than 60 years with underlying diseases are at risk of complications.

RESEARCH LIMITATIONS

The current study involves retrospective data collection from patient medical records and the records of patient assessment from a hospital database. It is expected that other factors may impact AEs during PR. These factors could be the nature and severity of the illness, environmental factors, patient care during preparation for transport and the expertise of the medical staff transporting the patient, among others.

RECOMMENDATIONS FOR FURTHER RESEARCH

Intubated patients with infectious, respiratory or cardiovascular diseases are more likely to experience AEs during PR. Therefore, there should be PR procedures that are tailored for patients in each group of diseases. These tailored procedures should cover the assessment of patients by a medical specialist in that disease group and clear communication of the patient's information on treatment and symptoms before starting the PR process. Each step should be double checked. Personnel involved in the transport process should be specialized in transporting patients in that particular disease group. The transport vehicle and medical equipment should be suitable for use to transport patients with that specific disease. Patients should be monitored during transport according to guidelines for their specific ailments. In the next research study, a prospective study should collect additional data on pertinent aspects, such as environmental factors, patient care during transfer, pre-transfer preparation, and the medical team's expertise.

ACKNOWLEDGMENT

The authors express their deep appreciation to the staff of the Patient Referral Center at Khon Kaen Hospital, who courteously supplied all of the information used in the study.

REFERENCES

1. Thangkratok P. Patient Referral Systems: key processes of health services management. J Med Health Sci. 2018;25(3):369–373.
2. Ministry of Public Health Thailand. Bed Occupancy of Hospital in Government. Hdcservice. 2021 [Cited 2023 September 10]. Available from: https://hdcservice.moph.go.th/hdc/reports/report.php?source=pformated/format1.php&catid=9d8c311d6336373d40437c4423508cad&id=39afb27f0e1256396e6a972716d20e2e.
3. Morley C, Unwin M, Peterson GM, Stankovich J, Kinsman L. Emergency department crowding: A systematic review of causes, consequences and

solutions. PLoS One. 2018;13(8): e0203316.
4. Sub-Committee on Development and Referral System Guidelines. Development and Referral System Guidelines. Nonthaburi: Office of the Permanent Secretary Ministry of Public Health Thailand. 2020.
5. National Refer (nRefer) Ministry of Public Health Thailand. Number of Referral Patients in Ministry of Public Health. nRefer. 2021 [Cited 2023 September 10]. Available from: http://refer.moph.go.th/#/main/reports/dashboard.
6. Thanoorat S, Tantibundit P. Characteristic of the Death at First 24 Hours in Referral Patients from Rural Hospital: A Study of Provincial Data Analysis. J DMS. 2021;46(3):89-95.
7. Risk Management Board Khon Kaen Hospital. Adverse Event Management Procedures and Sentinel Event Khon Kaen Hospital. Intranet Khon Kaen Hospital. 2021 [Cited 2023 September 10]. Available from: http://in.kkh.go.th.
8. Healthcare Accreditation Institute. Template & Definition Risk Incident National Reporting and Learning System (Thailand) & Healthcare Risk Management System on Cloud. thai-nrls. 2021. [Cited 2023 September 2]. Available from: https://www.thainrls.org/KMS/ContentDetail/515.
9. Healthcare Accreditation Institute. National Reporting and Learning System (Thailand). Thai-NRIL. 2021. [Cited 2023 September 18]. Available from: https://www.thai-nrls.org.
10. Referral Center Khon Kaen Hospital. Operation Report on July 2021. Department of Nursing Khon Kean Hospital. Khon Kean Hospital. 2021.
11. Costello WG, Zhang L, Schnipper J, Tsilimingras D. Post-discharge adverse events among African American and Caucasian patients of an urban community hospital. J Racial Ethn Health Disparities. 2021;8(2):439-447. doi: 10.1007/s40615-020-00800-z
12. Tsilimingras D, Ghosh S, Duke A, Zhang L, Carretta H, Schnipper J. The association of post-discharge adverse events with timely follow-up visits after hospital discharge. PLoS One. 2017 Aug 10;12(8):e0182669. doi: 10.1371/journal.pone.0182669. PMID: 28796810; PMCID: PMC5552135.
13. Ismail MRM, Baharuddin KA, Abidin ZEZ, Bakar MAA, Sjahid AS. Study on the incidence of adverse events during intra-hospital transfer of critical care patients from emergency department. Med J Malaysia 2020;75(4): 325-330.
14. Tsilimingras D, Schnipper J, Duke A, Agens J, Quintero S, Bellamy G, et al. Post-Discharge Adverse Events Among Urban and Rural Patients of an Urban Community Hospital: A Prospective Cohort Study. J Gen Intern Med. 2015;30(8):1164-1171. doi: 10.1007/s11606-015-3260-3
15. Talsab W, Sriharat W. Evaluation of referral centers in Khon Kaen Province. Academic Journal of Mahasarakham Provincial Public Health Office. 2018;(4):37-49.
16. Hsieh FY, Bloch DA, Larsen MD. A simple method of sample size calculation for linear and logistic regression. Stat Med. 1998;17(14): 1623-34. doi: 10.1002/(sici)1097-0258(19980730)17:14<1623::aid-sim871>3.0.co;2-s
17. Forster AJ, Clark HD, Menard A, Dupuis N, Chernish R, Chandok N, et al. Adverse events among medical patients after discharge from hospital. CMAJ. 2004;170(3):345-349.
18. Hardin JW, Hilbe J. Generalized Linear Models and Extensions, 3rd Edition, Stata Press books. StataCorp LP. 2012.
19. Kleinbaum DG, Klein M Survival Analysis: A Self-Learning Text. 3rd Ed.

New York, NY: Springer New York (Statistics for Biology and Health). 2005 [Cited 2023 January 12]. Available from: 10.1007/0-387-29150-4.
20. Akaike H. Information Theory and an Extension of the Maximum Likelihood Principle. In: Parzen, E., Tanabe, K., Kitagawa, G. (eds) Selected Papers of Hirotugu Akaike. Springer Series in Statistics. Springer, New York, NY. 1998. doi: 10.1007/978-1-4612-1694-0_15
21. StataCorp. Stata Statistical Software: Release 10. Texas,USA: StataCorp LP. 2007 [Cited 2023 January 12]. Available from: http://www.stata.com
22. Jensen SM, Do HQ, Rasmussen SW, Rasmussen LS, Schmidt TA. Emergency team calls for critically ill non-trauma patients in the emergency department: an observational study. Scand J Trauma Resusc Emerg Med 2015;23:76. doi: 10.1186/s13049-015-0159-2
23. Mohd Ismail MR, Baharuddin KA, Zainal Abidin ZE, Abu Bakar MA, Sjahid AS. Study on the incidence of adverse events during intra-hospital transfer of critical care patients from emergency department. Med J Malaysia. 2020;75(4):325-330
24. Thanoorat S, Piyawatchwela T. Real Time Tele-Monitoring and On-Line Medical Direction for Inter-Facility Transfer in The Critically Ill Patients. SRIMEDJ. 2021;36(3):358-365.
25. Singh JM, MacDonald RD, Ahghari M. Critical events during land-based interfacility transport. Ann Emerg Med. 2014;64(1):9-15.e2. doi: 10.1016/ j.annemergmed.2013.12.009