ASSESSMENT OF THE STRENGTHS AND WEAKNESSES OF AN ACTIVE POPULATION-BASED PNEUMONIA SURVEILLANCE SYSTEM IN NAKHON PHANOM PROVINCE, THAILAND

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Abstract. Pneumonia is a major cause of morbidity and mortality in Thailand. In this study, we aimed to assess the strengths and weaknesses of an active population-based pneumonia surveillance system implemented in Nakhon Phanom Province, Thailand, in order to inform public health resource allocation in that province. The surveillance system recorded the incidence and causative organisms of pneumonia in the study province. In order to assess this surveillance system, we purposely recruited 15 key local, national, and international subjects with the experience to accurately conduct this assessment: policymakers (n = 6), epidemiologists (n = 5), laboratory technicians (n = 3) and a physician (n = 1). Each subject was interviewed using standardized questions and the answers were recorded. Interview transcripts were analyzed using conventional content analysis. The 15 subjects, consisted of 11 (73.3%) males and 4 (26.7%) females. The mean age of subjects was 51 (range: 39-61) years. The study subjects stated the surveillance system should have 5 main objectives: 1) identify the pneumonia etiological organisms, 2) detect and report pneumonia cases in a timely manner, 3) support public health policy decisions, including resource allocation and targeted prevention, such as vaccination of high-risk groups, 4) monitor changes in respiratory pathogens over time, and 5) estimate the incidence of pneumonia and associated mortality. Subjects stated the strengths of the surveillance system were 1) its strong inter-agency collaboration, 2) the surveillance system support by hospital administrators and 3) the good cooperation among physicians,

nurses and surveillance officers. The subjects stated the weaknesses of the surveillance system were lack of limited sharing of the surveillance findings with the medical providers and inadequate integration between pneumonia-specific and routine hospital laboratory systems. More specifically, medical providers and routine hospital laboratories in the study area could not access the summarized laboratory results produced by the surveillance system. The subjects suggested the following improvements be made to the surveillance system: 1) improve data-sharing mechanisms among all those involved in the system, including the medical providers, 2) improve integration between the pneumonia-specific laboratory activities and routine hospital laboratory systems and 3) improve communication across local, national and international levels. In summary, the aims of the surveillance system should be to identify the causes of pneumonia, their change over time and the incidence of pneumonia in a timely manner following national public health policies. Strengths of the system were the support the system had at multiple levels but weaknesses were inadequate communication of data and lack of systems to easily share this data. We conclude more effort should be put into the system at all levels to allow adequate communication and sharing of system data. Further studies are needed to determine what reasonable technologies are needed to allow good communication and data sharing in the system at all levels and how best to integrate this into other active surveillance systems nationally.

Keywords: pneumonia surveillance; active surveillance; population-based surveillance; qualitative study; Thailand

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INTRODUCTION

Pneumonia is an important cause of morbidity and mortality worldwide, including in Thailand (Rudan *et al*, 2008; Oliveira E Silva *et al*, 2023). The 2023 Annual Epidemiological Surveillance Report for Thailand reported the incidence of pneumonia in Thailand

that year was 452 cases per 100,000 population (Tirakotai, 2023).

Public health surveillance is important to detect the incidence of and changes in disease incidence and identify the factors associated with these changes.

Active surveillance provides up to date data regarding the disease surveilled in order to inform timely decision making to control the surveilled disease (Breiman *et al*, 2013; Van Beneden *et al*, 2013).

In 2003, the Thailand Ministry of Public Health and the US Centers for Disease Control and Prevention (US CDC) through the International Emerging Infections Program implemented an active population-based pneumonia surveillance system. The surveillance system was designed to identify pneumonia cases, estimate the incidence of pneumonia and associated mortality, and generate epidemiological, clinical, radiographic, and laboratory information relevant to disease prevention and control. Previous studies of this surveillance system reported estimating the incidence of pneumonia and identifying important respiratory pathogens in Nakhon Phanom Province (Prapasiri *et al*, 2008; Baggett *et al*, 2009; Olsen *et al*, 2010). Surveillance findings from this platform have also contributed to broader understanding of influenza and respiratory disease epidemiology in Thailand and have informed vaccine-related public health discussions (Montgomery *et al*, 2025).

The benefits of this surveillance system depend not only on the recorded data but how that data is shared and to whom it is shared. This makes it important to know what the opinions of the beneficiaries of the program are regarding the surveillance system. This also depends on the purpose of the surveillance system, which needs to be clarified. The need for this type of information is has been well studied (O'Brien *et al*, 2009; Feikin *et al*, 2014; Jain *et al*, 2015).

In this study, we aimed to assess

the strengths and weaknesses of an active population-based pneumonia surveillance system implemented in Nakhon Phanom Province, Thailand, in order to inform public health resource allocation in that province.

MATERIALS AND METHODS

Study subjects and sampling

This active population-based surveillance system has been described previously (Prapasiri *et al*, 2008; Olsen *et al*, 2010). Briefly, it conducts hospital-based active case finding for community-acquired pneumonia among residents of Nakhon Phanom Province. Surveillance officers screen all hospital admissions; residents of Nakhon Phanom Province for at least six months who were admitted with one of 59 predefined ICD-10 admission diagnoses were eligible for screening. A clinical pneumonia case required at least one respiratory sign or symptom and at least one sign of infection, and was classified as radiographically-confirmed when a chest radiograph taken within 48 hours of admission was confirmed by at least two of three radiologists. Although the system targets community-acquired pneumonia, comprehensive laboratory testing of blood, urine and nasopharyngeal specimens was used to identify causative respiratory pathogens, which is why it has also generated data on other respiratory diseases such as influenza. Diseases occurring outside the surveillance hospitals were not captured by the system.

We selectively recruited study subjects, following the method described previously (Patton, 2002), who were directly involved in or knowledgeable about the surveillance system. Subjects were selected to represent the various aspects of or administrative roles involved in the surveillance system. Inclusion criteria for study subjects were having at least five years' experience in disease surveillance and having worked with, used or managed the pneumonia surveillance system

evaluated here. Exclusion criteria for study subjects were not meeting inclusion criteria or declining participation in the study.

A total of 15 subjects were included in the study, consisting of policymakers (n = 6), epidemiologists (n = 5), a physician (n = 1) and laboratory technicians (n = 3). These subjects represented local (n = 7), national (n = 5) and international (n = 3) levels of involvement. Local level subjects were based in Nakhon Phanom Province, Thailand. National level subjects worked in Thai agencies involved in surveillance, laboratory support or public health decision-making. International-level subjects worked with the international collaboration component of the surveillance system (Tables 1 and 2).

Subject interviews

Each subject was interviewed using a semi-structured questionnaire assessing the objectives and structure of the surveillance system, its usefulness, simplicity, flexibility, acceptability, participation, information use and recommendations for improvement. Subject interviews were conducted in December 2014. All interviews were audio-recorded with subject permission to ensure accuracy.

Interview analysis

The interviews were analyzed using conventional content analysis (Hsieh and Shannon, 2005). Interview transcripts were reviewed to identify key words, meaningful phrases and recurring ideas. These were grouped into thematic categories and then synthesized into broader themes related to the objectives of the surveillance system, its perceived strengths, its perceived weaknesses and needed improvement. Several measures were used to improve the trustworthiness of the analysis following established qualitative research criteria (Lincoln and Guba, 1985). Credibility was strengthened through triangulation and member checking, with the transcripts discussed by the research team to confirm consistent themes.

Dependability was supported by applying the same analytical process to all transcripts and maintaining an audit trail of the research process. Confirmability was reinforced by grounding interpretations in verbatim excerpts and through reflexive journaling and peer debriefing to minimize researcher bias and misinterpretation. The context of the surveillance system, the familiarity of subjects with the system and the study setting were used to maximize the transferability of these study results to the entire surveillance system.

Ethical considerations

This study was reviewed and approved by the Ethics Committee of the Faculty of Public Health, Mahidol University, Thailand (Ref. No. MUPH2014-169). All subjects gave informed consent prior to participation.

RESULTS

Characteristics of study subjects

Of the 15 interviewed subjects, 11 (73.3%) were male. The mean age of subjects was 51 (range: 39-61) years. The average length of time the subjects worked in disease surveillance was 16 (range: 5-33) years and the average length of time the subjects worked in pneumonia surveillance was 8 (range: 5-10) years (Tables 1 and 2).

Objectives of the surveillance system

The interviewed subjects stated the pneumonia surveillance system should have 5 objectives.

The first objective was to identify etiologic organisms for the pneumonia cases in order to inform disease treatment, control and prevention efforts. Several subjects identified this as the most important objective of the system.

The second objective was to detect and report pneumonia cases in a timely manner, particularly to support early detection of outbreaks and emerging respiratory pathogens.

The third objective was to provide information for public health policy and response

Table 1

Occupations and levels of interviewed subjects (*N*=15)

Category	Local level	National level	International level
Policymaker	Nakhon Phanom Provincial Chief of Medical Office (*n*=1) Hospital Director in Nakhon Phanom (*n*=2)	Director General (*n*=1) Senior advisor in preventive medicine (*n*=1)	Director of IEIP Thailand (*n*=1)
Epidemiologist	Provincial Public Health Office (epidemiologist or disease control officer) (*n*=2)	Epidemiologist in the central bureau (*n*=2)	Epidemiologist in the pneumonia program (*n*=1)
Physician	Infectious disease doctor at Nakhon Phanom Hospital (*n*=1)		
Laboratory technician	Laboratory technician at Nakhon Phanom Hospital (*n*=1)	Laboratory technician at the National Institute of Health (*n*=1)	IEIP laboratory technician (*n*=1)

IEIP: International Emerging Infections Program

Table 2

Selected characteristics of interviewed subjects (N=15)

No.	Occupation	Level	Age in years	Education level	Length of work in disease surveillance in years	Length of work in pneumonia surveillance in years
1	Policymaker	National	61	Masters	33	7
2	Policymaker	International	60	Masters	30	5
3	Policymaker	National	61	Masters	32	6
4	Policymaker	Local	54	Bachelors	15	10
5	Policymaker	Local	57	Bachelors	17	10
6	Physician	Local	57	Bachelors	5	10
7	Policymaker	Local	39	Bachelors	5	5
8	Laboratory technician	Local	48	Bachelors	9	7
9	Epidemiologist	Local	54	Bachelors	10	9
10	Epidemiologist	Local	49	Doctorate	13	9
11	Laboratory technician	National	53	Doctorate	12	10
12	Laboratory technician	International	41	Masters	9	7
13	Epidemiologist	National	41	Doctorate	15	6
14	Epidemiologist	National	40	Doctorate	13	5
15	Epidemiologist	International	57	Masters	28	10

Note: Subjects comprised 11 males (73.3%) and 4 females (26.7%). Mean age was 51 years (range 39-61); mean experience was 16 years (range 5-33) in disease surveillance and 8 years (range 5-10) in pneumonia surveillance.

decisions. Subjects described these data as enabling policymakers to allocate resources and target prevention, such as vaccination of high-risk groups.

The fourth objective was to monitor respiratory pathogen trends, especially those with contagious potential.

The fifth objective was to estimate the incidence of pneumonia and associated mortality and identify at risk populations.

Strengths of the surveillance system

Interviewed subjects identified several strengths of the pneumonia surveillance system.

The first strength was that the system involved strong collaboration among agencies involved, including public health offices, hospitals, surveillance personnel, clinicians and laboratory partners. The collaboration facilitated communication within the system.

A second strength of the system was that it had the support of hospital administrators allowing surveillance activities to proceed smoothly and resulted in staff cooperation with the system.

A third strength of the system was that it allowed coordination among physicians, nurses and surveillance officers. One interviewed subject (Subject 10) described this coordination, *"The surveillance officer worked closely with the ward nurses to screen patients every day. When a patient met the surveillance criteria, the physician was notified immediately."*.

A fourth strength of the system was that it integrated epidemiological, clinical, radiographic and laboratory information allowing a better understanding of pneumonia etiologies and disease patterns in order to support prevention and control activities.

A fifth strength of the system was the surveillance platform resulted in standardization of pneumonia diagnosis and strengthened the capacity of the institution to provide better epidemiological data,

clinical care and more standardized laboratory investigations.

Weaknesses of the surveillance system

The interviewed subjects also identified several weaknesses of the surveillance system.

The first weakness was limited sharing of surveillance findings with intended users, particularly epidemiologists and health personnel outside the immediate surveillance system, reducing the usefulness of the surveillance system. One interviewed subject (Subject 1) described this problem as follows, *"Access to the surveillance data was limited, which made it difficult for epidemiologists to use the information for timely disease control."*.

The second weakness was inadequate integration between pneumonia-specific laboratory results and routine hospital laboratory systems. The subjects stated this inadequate integration limited information flow and reduced coordination between the surveillance system and routine patient care systems.

A third weakness was the surveillance system benefits were not equally distributed among all the stakeholders. There was limited access to surveillance information by external stakeholders, meaning the only people who benefited by the system were those who worked at the hospitals where the system was being used but the rest of the institutions had little or no access to this useful information or were not even aware that the information was being collected and available.

Suggestions for improvement

The interviewed subjects made several suggestions to improve the surveillance system.

The first suggestion was to improve data-sharing mechanisms to allow surveillance data to be accessed by all relevant stakeholders at local, provincial and national levels.

The second suggestion was to improve integration between pneumonia-specific laboratory results and routine hospital laboratory systems, in order

improve efficiency, communication and practical use of laboratory results.

The third suggestion was to improve communication across all levels of the health system in order improve coordination and sustainability of the surveillance system.

The fourth suggestion was to adapt the surveillance system to the context of the specific institutions to improve routine surveillance based on clear policies and to improve operational planning.

DISCUSSION

In this study we evaluated selected subject opinions regarding the pneumonia surveillance system in Nakhon Phanom Province, Thailand.

In our study, the subjects stated a major strength of the surveillance system was the collaboration among agencies and professional groups. The surveillance system to be effective must have coordination. This finding is consistent with an enhanced surveillance system for severe pneumonia in Thailand, in which interlinked clinical, laboratory, pathological and epidemiological components along with close coordination across hospitals in several provinces were central to case detection and notification (Bunthi *et al*, 2019).

In our study, another strength was the support of hospital administrators which allowed coordination to improve workflow. This suggests the system benefited from established working relationships at the institutions where the surveillance system was present. A similar pattern was reported in a multihospital quality-improvement collaborative for pediatric community-acquired pneumonia, in which hospital leadership and administrative support were identified as a primary facilitator of implementation across clinical departments (Leyenaar *et al*, 2019).

In our study, subjects stated another strength of the surveillance system was that it generated

integrated clinical, epidemiological, radiographic and laboratory information. Previous studies from this surveillance platform have shown its value in estimating the incidence of pneumonia and identifying important respiratory pathogens in Nakhon Phanom Province (Prapasiri *et al*, 2008; Baggett *et al*, 2009; Olsen *et al*, 2010). In this context, the present findings suggest that key informants regarded these outputs not only as surveillance products, but also as evidence of the practical utility of the system.

A further strength of the surveillance system noted by subjects was that it could influence public health priorities. This interpretation is consistent with prior publications from the surveillance platform and with broader surveillance and policy discussions in Thailand (Prapasiri *et al*, 2008; Baggett *et al*, 2009; Olsen *et al*, 2010; Montgomery *et al*, 2025). However, the present study was qualitative and addressed perceived utility rather than direct measurement of policy impact.

In our study, subjects stated a weakness of the surveillance system was that it had limited dissemination of surveillance data to some of the intended users. This communication problem needs to be distinguished from internal operational coordination, which was viewed as a strength of the system by subjects. A similar problem was seen between internal communication and external communication in another study from Thailand regarding influenza surveillance (Watcharaporn *et al*, 2017). These findings suggest there is a continuing problem with dissemination of information outside the surveillance systems in Thailand and needs to be addressed to better use the data collected.

Another weakness of the surveillance system pointed out by subjects was inadequate integration between pneumonia-specific laboratory activities and routine hospital laboratory systems. This shows a technological problem with communication between

different computerized systems. This communication must occur for surveillance systems to operate efficiently (Neves *et al*, 2023). This may be related to the previously mentioned problem of dissemination of system information outside the system and suggests there is a need for a technological solution for this problem where software do not communicate with each other.

Our subjects made suggestions for improvement, including stronger data sharing, better integration between pneumonia-specific and routine laboratory activities, and improved communication across levels of the health system. These suggestions show where changes need to be made to improve the weaknesses of the system in order to improve its efficacy. These suggestions all point to a technological issue of communication among multiple systems at multiple levels, which is necessary to improve the efficacy of the system (Wongsanuphat *et al*, 2025). Active population-based surveillance platforms use different software and have different goals than software used within institutions for patient care. These software systems work well within the same system but have not been designed to communicate with other systems. This makes collection of surveillance data useful for record keeping but not useful in the real world where patients are being seen. This suggests there is a need to redesign surveillance systems to allow the data to be easily communicated among various systems and not just to record the data. This also suggests a need to develop a way to coordinate the various systems at the public health level in order to improve the usefulness of the pneumonia surveillance system evaluated in this study.

Our study had several limitations. First, it was a qualitative key informant study based on a small number of purposely selected subjects having experience with the surveillance system. There may have been subject selection bias that affected the results and the small

number of subjects may provide a skewed representation of opinions. Second, the study was conducted in 2014 and may not reflect the current opinion of these subjects. Third, the study reflects only the perceptions of the subjects, which may not reflect the actual situation with the surveillance system. Fourth, the study reflects individual opinions and not consensus opinions for the group.

In spite of the above limitations, the study reflects an underlying communication problem from those within the system to those outside the system. This is useful for informing efforts to improve this problem. It also reflects opinions from a variety of subjects with experience with different parts of the surveillance system, reflecting the overall situation perceived by the study subjects.

In summary, the aims of the surveillance system should be to identify the causes of pneumonia, their change over time and the incidence of pneumonia and do this in a timely manner following national public health policies. Strengths of the system were the support the system had at multiple levels but weaknesses were inadequate communication of data and lack of systems to easily share this data. We conclude more effort should be put into the system at all levels to allow adequate communication and sharing of system data.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflicts of interest.

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