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High Usability but Limited Case Capture: Performance of Thailand's Digital Influenza Surveillance System in a Private Hospital Setting

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Abstract

The Digital Disease Surveillance (DDS) system was introduced in 2024 to enhance real-time monitoring of influenza. However, there has been no performance assessment among private hospitals that have adopted this system. This study assessed the performance of the DDS for influenza surveillance at a private hospital in Thailand. We conducted a mixed-methods study from January to December 2024. We analyzed data from the Hospital Information System, DDS and interviewed 23 stakeholders. We assessed system attributes, including sensitivity, positive predictive value (PPV), completeness, accuracy, timeliness, and representativeness. Qualitative findings indicated high system simplicity and usability, with data outputs utilized for hospital-level resource preparation and vaccination campaign planning. Quantitative attributes of 250 reported-cases showed a high PPV (82% for the Division of Epidemiology (DOE) case definition and 100% for physician diagnosis and laboratory-based definitions), 100% data completeness, and 89% timeliness (reporting within 7 days). A critical limitation in system automation was identified, notably incorrect data extraction via an application programming interface (API) necessitated a reliance on manual data entry. This contributed to a low sensitivity (535/5,751: 9%), particularly using the DOE definition, compared to physician diagnosis (622/1,776: 35%) and laboratory-based definitions (723/1,746: 41%). This low sensitivity was attributable to systematic exclusion of outpatients and non-local residents. While the DDS demonstrates high usability and data quality for reported-cases, its reliance on manual workflows due to API failure results in low sensitivity. These gaps limit its effectiveness for comprehensive surveillance. Enhancing API integration, revising case definitions, and standardizing reporting protocols are recommended.

Keywords: influenza, surveillance system, performance, Thailand, private hospital

Introduction

Influenza is an acute respiratory infection caused by influenza viruses.[1] The influenza burden is particularly high in regions with high human mobility.[2] The broader consequences of influenza are cardiovascular events, exacerbations of chronic underlying conditions and economic impact.[3]

Seasonal influenza affects approximately 1 billion people worldwide with 3 to 5 million severe cases and 290,000 to 650,000 deaths reported annually.[1] In 2024, Thailand reported 671,281 influenza cases with an incidence rate of 1,034 per 100,000 population leading to 51 fatalities (case fatality rate 0.008%). Nakhon Pathom Province experienced one of the highest incidence rates in the region at 1,256 per 100,000 population.[4]

Report 506 (R506), the traditional influenza surveillance system in Thailand, has relied on manual case reporting into an electronic surveillance system, which often suffered from delayed data transmission and underreporting. To address these limitations, the Digital Disease Surveillance (DDS) system was introduced in 2023 and fully implemented in 2024 to enhance real-time monitoring and data integration. The system utilizes a real-time application programming interface (API) connection with the hospital information system (HIS), automating case detection and improving reporting accuracy.[5]

In urban areas, private hospitals play a crucial role in influenza surveillance. Understanding the surveillance system's performance in such settings is essential. Hospital X, a private hospital in Nakhon Pathom, adopted the DDS system to replace R506 in 2024. This is the first study that assessed the surveillance system among DDS-adopted private hospitals in Thailand.

This study aims to describe and assess the performance of DDS-based influenza surveillance system at a single private hospital. It is hoped that the findings from this study will enhance the DDS-based influenza surveillance system in Thailand's private hospitals.

Methods

Study Design

A mixed qualitative and quantitative study based on the guidelines for evaluating public health surveillance systems was conducted at a single hospital (Hospital X).[6] The study period was from1 Jan 2024 to 31 Dec 2024. The evaluation included a system description and assessment using qualitative and quantitative attributes.

System Description

We used purposive sampling to enroll participants who were stakeholders and had been involved in influenza surveillance for more than six months. We included 23 participants from national (n=5), regional (n=3), provincial (n=4), and hospital (n=11) levels representing policymakers (n=4), information technology (IT) staff (n=4), data entry operators (n=8), and information users (n=7).

Data were collected through interviews using a semi-structured open-ended questionnaire, document reviews, and direct observation. Findings were presented using flowcharts aiming to describe the public health importance, objectives, usefulness, patients, data flow, and resources, including human resources, budget and equipment related to the DDS system.

Qualitative Assessment

Five key attributes were assessed: 1) simplicity—simpleness of the system structure and the ease of operation, 2) flexibility—ability of the system to adapt to changing information needs, 3) stability—reliability and stability of the system, 4) acceptability—willingness of stakeholders to participate in the surveillance system and 5) automation—application of technology or processes to achieve outcomes with minimal human involvement.

Participants and data collection were the same as the system description. Findings were analyzed using an attribute-based framework (framework analysis).

Quantitative Assessment

A cross-sectional study was conducted to assess sensitivity, positive predictive value (PPV), completeness, accuracy, timeliness, and representativeness.

Influenza cases were identified using three definitions according to the definition of the Division of Epidemiology (DOE), physician diagnosis and laboratory-based.[7] The DDS reporting criteria apply to any patient who meets the DOE definition.

Cases were retrieved from the HIS and classified into two groups based on the International Classification of Diseases 10th revision (ICD-10) codes for influenza (J10–J11) and influenza-like illnesses (J00, J02–J04, J06, J09, J128–J129, J16–J18, J20, J21). There were 10,166 records in total. We extracted data from the HIS and the DDS system using a structured form. Stratified random sampling by ICD-10 code with 10% of the influenza group and 2% of the influenza-like illness group, was applied, with a minimum of 10 records per code.

Information from the pilot study was used for sample size estimation of sensitivity among HIS and PPV among DDS, we got 342 and 250 records respectively.

Sensitivity

Sensitivity was calculated as the percentage of HIS medical records meeting the case definition and were reported in the DDS system. To account for different sampling fractions across ICD-10 codes, weighted sensitivity was calculated.

Positive Predictive Value (PPV)

PPV was defined as the percentage of DDS-reported cases that met the influenza case definition.

Completeness

Completeness was defined as the percentage of complete reported cases out of the total number of observations in the DDS system by variable. We focused on five key variables: age, gender, onset date, patient type (outpatient or inpatient) and current address (subdistrict).

Accuracy

Accuracy was assessed by comparing data from the DDS system to HIS records by variable for the same five variables used in the assessment for completeness. Records were considered accurate if they met the following criteria: age within a one-year window, onset date within a one-day window, and exact matches for gender, patient type, and subdistrict of current address. Records with missing data were excluded from the analysis.

Timeliness

Timeliness was measured by the interval between the diagnosis date and the report date to the Department of Disease Control (DDC). A case was considered timely if it was reported within seven days. Additional time intervals (onset to visit and visit to diagnosis) were calculated. Median and interquartile ranges (IQR) were reported.

Representativeness

Representativeness was evaluated by comparing the characteristics between the HIS medical records meeting the case definition and those DDS reported-cases. The comparison focused on age, gender, week of onset and patient type. Distributions between groups were compared using bar charts and line graphs.

Results

General Information

Hospital X is a 210-bed tertiary hospital located in the urban area of Nakhon Pathom. The hospital adopted the DDS to replace R506 in 2024.

System Description

Public health importance

Influenza remains one of the top three notifiable diseases in Nakhon Pathom. Outbreaks have occurred in high-risk settings such as schools, prisons, and nursing homes, with many deaths. Influenza is preventable with vaccination, which is widely available and effective in reducing mortality.

Objectives and usefulness

The DDS was designed to monitor disease trends and detect outbreaks using automated workflow to improve timeliness and under-reporting. It supported mandatory disease reporting under the Communicable Disease Act B.E. 2558 (2015) and assisted in public health decision-making.[8] For private hospitals, the outputs were useful for situation analyses, vaccination marketing campaigns, and preparing resources such as medications and beds for influenza cases during outbreaks.

Resources

Three main types of resources support DDS operations: (1) personnel including infection control nurses (ICN), informatic staff, epidemiologists, and IT officers; (2) budget amounting to approximately 600,000 U.S. dollar per year for national system maintenance; and (3) equipment encompassing cloud servers, data storage systems, and software supported by both government and private sectors.

Patient and data flows

Influenza cases enter the hospital through the outpatient department (OPD) or emergency room (ER). Influenza diagnoses are based on physician judgement, especially in the OPD of the internal medicine unit, while cases in the ER and pediatric OPD cases are classified upon positive rapid influenza diagnostic test (RIDT) results. For admitted patients, R506 forms are completed in the wards, while non-admitted patients have R506 forms completed by the patients in the OPD or ER (Figure 1).

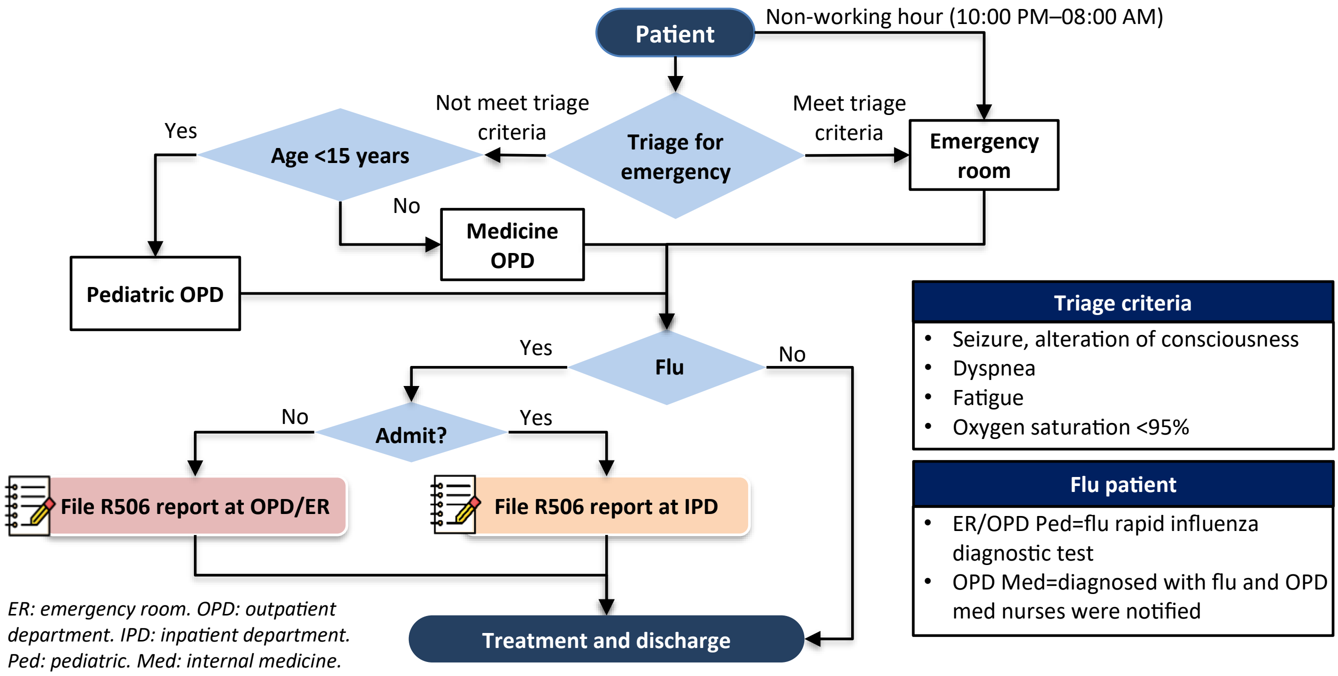


Figure 1. Patient flow in Hospital X in 2024 from entering hospital, capturing to surveillance system and discharge

R506 forms are submitted via the Line application or by clerks to the ICN, who manually enter the data into the DDS web portal for patients residing in Nakhon Pathom only (Figure 2). After validation for completeness and ICD-10 correctness, reports are sent for checking, cleaning and deduplication (if required). Verified data are processed hourly through a secure DDS server and made available for exporting through dashboards, datasets, or APIs (Figure 3).

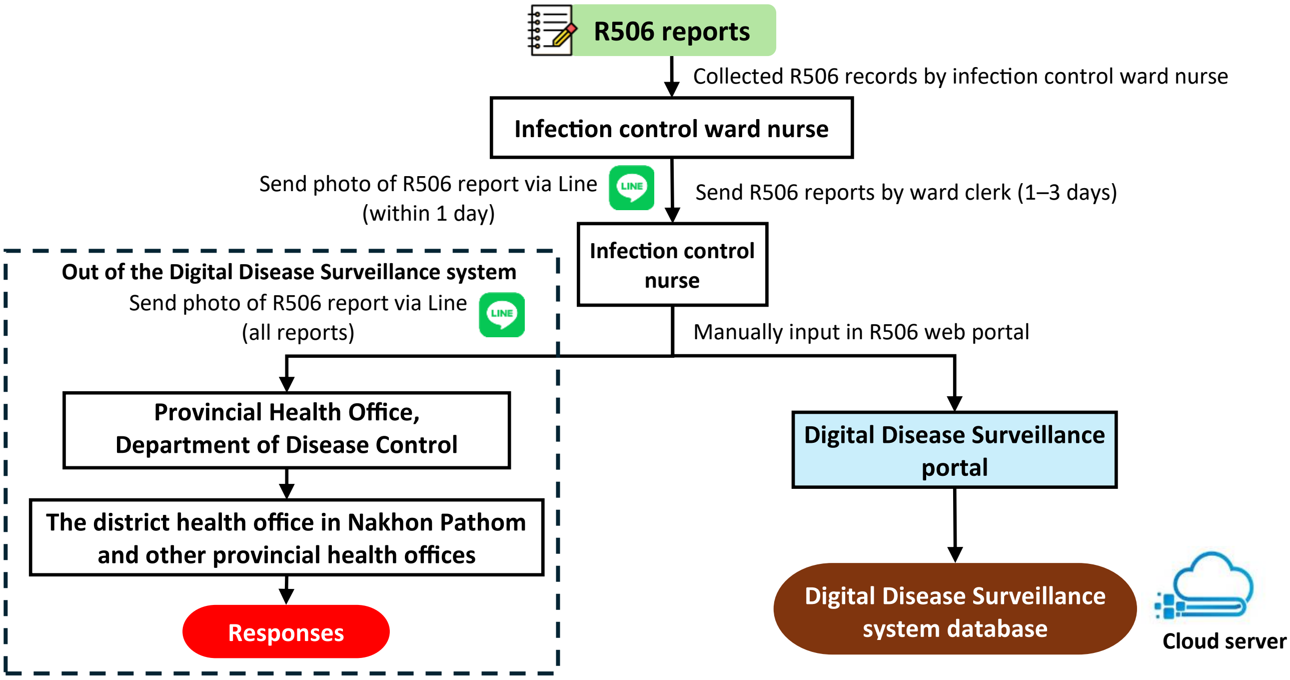
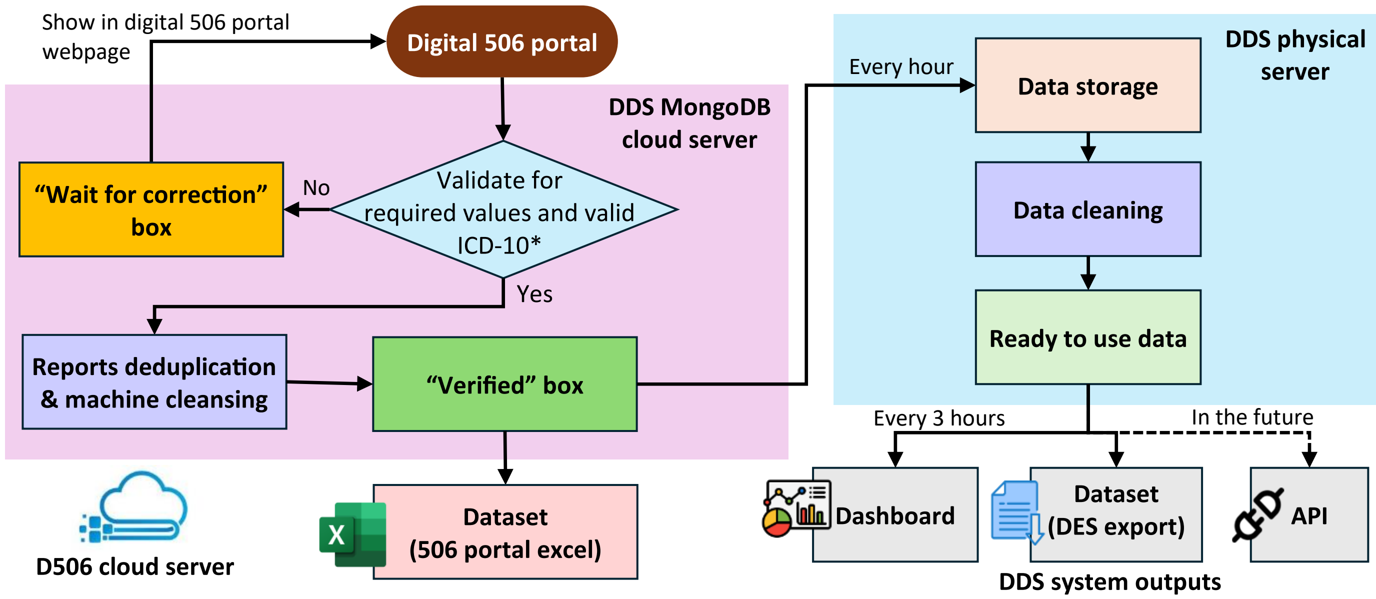


Figure 2. Data flow from Hospital X to the digital disease surveillance system database



**Even some reports met suspected influenza criteria (by symptoms) but had other ICD-10 diagnosis than J10–J11, they will be labeled as invalid ICD-10 and sent "Wait for correction" box. API: application programming interface. D506: digital 506. DDS: digital disease surveillance. DES: data encryption standard. ICD-10: International Classification of Diseases 10th revision.*

Figure 3. Data flow from digital disease surveillance to information users

Qualitative Assessment

Simplicity

The ICN found that the system was user-friendly, especially compared to previous standalone software, stating that "*At the first time I received the web portal link, I could use it instantly without any guidance*." The dashboard was easy to navigate and provided quick summaries. However, some limitations were identified, such as a limited number of data exports and no aggregated data compared to earlier R506 reports.

Flexibility

The DDS could be adapted to align with changing policies such as adding variables or diseases under surveillance, but it required technically skilled personnel, and modifications related to HIS needed approval from the private hospital committee.

Acceptability

Data from the DDS were used by private hospitals for decision-making, as mentioned by the hospital's vice director *"The timeliness and trustworthiness of situation reports help us in preparation of beds, medicine, staff and even the designing of vaccine packages".* However, the ICN expressed: *"I tried using the API system, but the values are often incorrect. Thus, manual input to the online web portal is way faster."* This reaffirmed her concerns about its reliability leading her to prefer the previous R506 report form.

Stability

As the DDS is legally mandated under the Communicable Disease Act B.E. 2558, ongoing support from the public sector is ensured. System downtimes were minimal and usually planned. While data security and power backup were strong, a shortage of trained personnel and a lack of standard operating procedures were noted.

Automation

Despite the auto influenza case detection design by the DDS via the API, the ICN said that the data from this process is usually incomplete and inaccurate. Hence, the R506 form replaced this process to ensure the data quality.

Quantitative Assessment

Based on the DOE case definition, 142 HIS records were identified as influenza cases. The weighted sensitivity values (Table 1) for the DOE, physician diagnosis, and laboratory-based definitions were 9.3% (535/5,751 weighted records), 35.0% (622/1,776 weighted records) and 41.4% (723/1,746 weighted records) respectively. Analysis of 135 unreported DOE definition cases revealed reasons for underreporting, as 100 (74.1%) cases did not receive an influenza diagnosis. Among 35 influenza-diagnosed cases, 27 (77.1%) were outpatient cases or patients residing outside Nakhon Pathom, which led to exclusion for reporting (Figure 4). Among all reviewed records, 19 inpatients cases within the province were missing report due to operational factors: 16 (84%) were admitted outside working hours, 4 (21%) had negative RIDT but had clinical suspicion, and 2 (11%) were admitted during lunch hours.

Table 1. Positive predictive value and weighted sensitivity by case definition

Case definition	PPV (n=250)		Weighted sensitivity	
	n (%)	95% CI	n/total (%)	95% CI
Department of Epidemiology	205 (82.0)	76.7–86.6	535/5,751 (9.3)	8.6–10.1
Physician diagnosis	250 (100.0)	98.5–100.0	622/1,776 (35.0)	32.9–37.3
Laboratory-based	250 (100.0)	98.5–100.0	723/1,746 (41.4)	39.1–43.7

CI: confidence interval. PPV: positive predictive value.

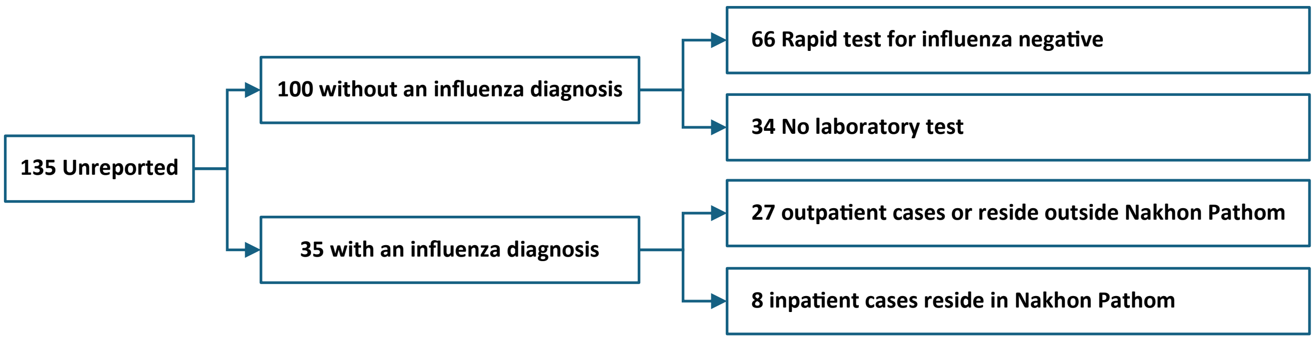


Figure 4. Components of 135 influenza cases based on Department of Epidemiology case definition that were unreported to the Digital Disease Surveillance system in 2024

The PPV (Table 1) of physician diagnosis and laboratory-based definition was 100% (250/250 records). However, the PPV of the DOE definition was slightly lower at 82.0% (205/250 records). Of the 45 reported cases that did not meet the DOE definition, 18 (40%) were for patients aged under 15 years old with no recorded cough, 14 (31%) were aged over 15 years old without cough, and 9 (20%) were aged under 15 years old despite having records on cough. Interviews with pediatricians suggested that children often presented with non-classic influenza symptoms such as fever with vomiting or rhinorrhea, and were not captured by the current DOE definition, which focused on fever and cough.

The completeness of reported influenza cases in the DDS was 100% (250/250) for age, gender, onset date, patient type (outpatient or inpatient) and current address (subdistrict) variables (Table 2).

The accuracy of variables showed more variability. Gender had the highest accuracy at 99.6% (249/250) followed by age and patient type at 98.4% (246/250). However, the accuracy was lower for current addresses at the subdistrict level and onset date (Table 2).

The median time from onset to visit was 1 day (IQR 1–2). The records that had diagnosis times on the same day as the patient visit were 94.8% (237/250). The median duration from diagnosis to report submission was 3 days (IQR 2–6), with 88.8% (222/250) of cases reported within 7 days.

Table 2. Completeness and accuracy of the Digital Disease Surveillance system reported-case in 2024 by variable

Variables	Completeness (n=250)		Accuracy (n=250)	
	n (%)	95% CI	n (%)	95% CI
Gender	250 (100.0)	98.5–100.0	249 (99.6)	97.8–100.0
Age	250 (100.0)	98.5–100.0	246 (98.4)	96.0–100.0
Patient type (OPD/IPD)	250 (100.0)	98.5–100.0	246 (98.4)	96.0–100.0
Address (subdistrict)	250 (100.0)	98.5–100.0	180 (72.0)	66.0–77.5
Onset date	250 (100.0)	98.5–100.0	157 (62.8)	56.5–68.8

OPD: outpatient department. IPD: inpatient department. CI: confidence interval.

For representativeness, the proportion of female cases in the DDS system closely aligned with the DOE, physician, and laboratory-based definitions. In contrast, DDS underrepresented elderly patients (≥60 years), who accounted for only 3% of DDS cases compared to 7% in the DOE definition. Patient type analysis showed a significant gap as DDS included only inpatient cases, whereas HIS indicated a large proportion of outpatient cases (Figure 5). As shown in Figure 6, monthly trends in DDS mirrored those in HIS, particularly during the seasonal peak periods (June to August).

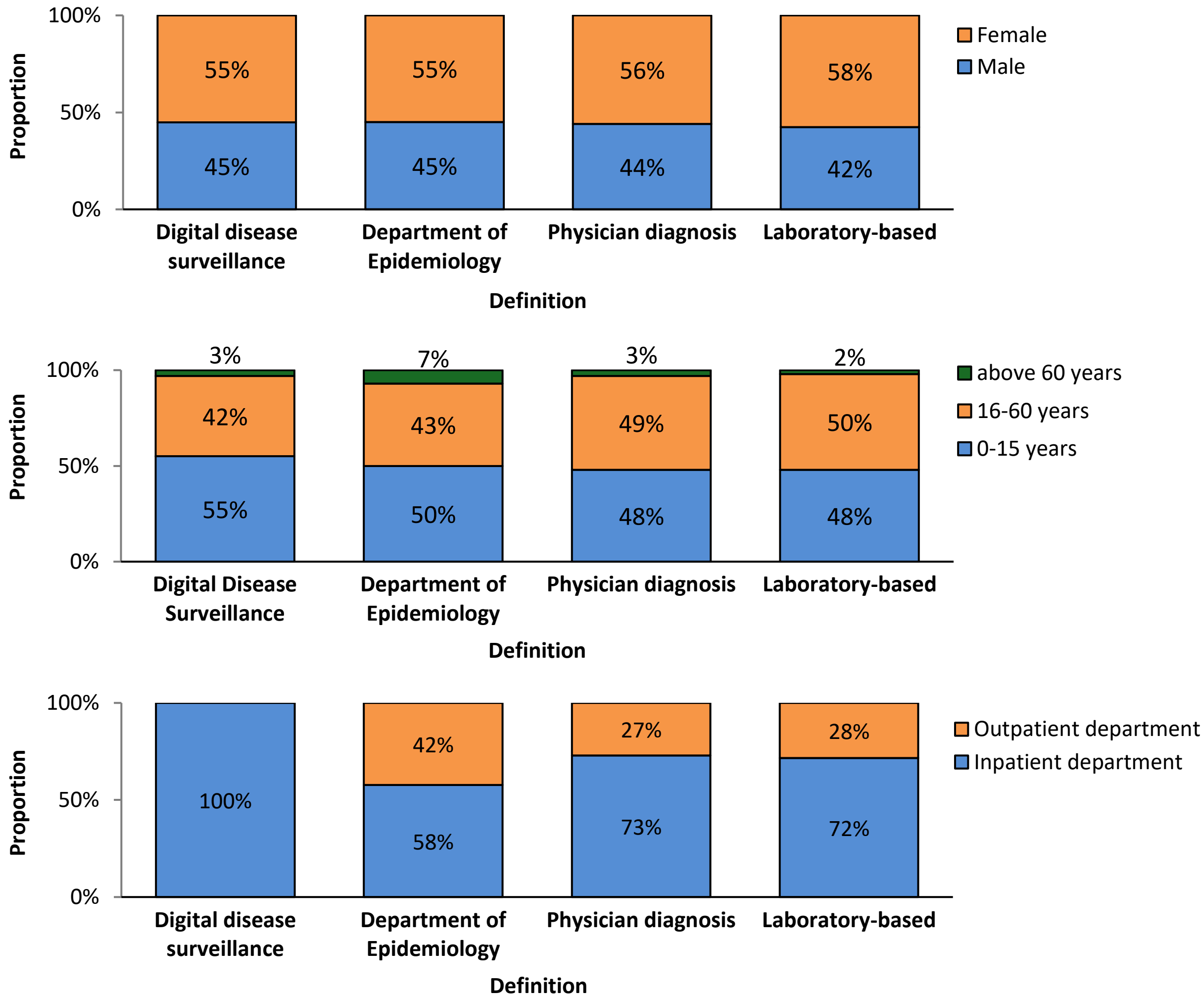


Figure 5. Representativeness of the DDS for gender, age group and patient type by case definition

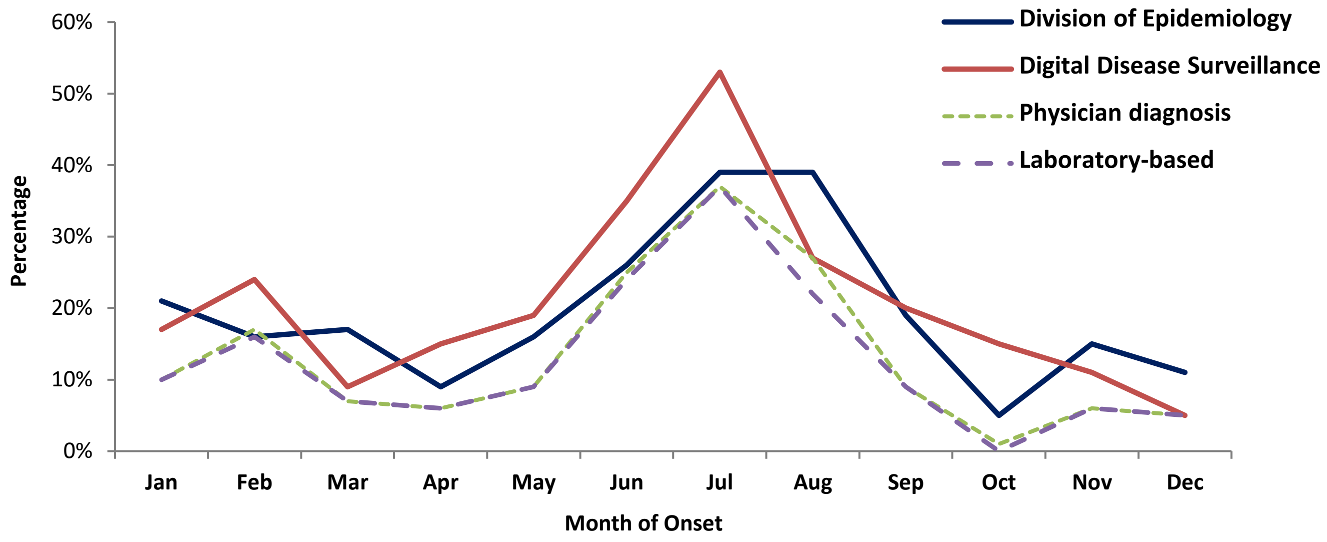


Figure 6. Representativeness of the DDS over month of onset by case definition

Discussion

The DDS system demonstrated significant strengths rooted in its simplicity, modern technology, and stability. It effectively fulfilled its primary objective of providing consistent influenza monitoring from local to national levels, and its applicability in private settings also aided resource management and vaccination campaign planning. This high level of utility and user acceptance was due to its minimal operational burden, facilitated by a technological infrastructure that included APIs, a web portal, and a real-time dashboard. Furthermore, its reliability and continuity were supported by national policies, legal mandates, and secure data management.

Despite its utility, the DDS system faced limitations, notably an unclear capacity for outbreak detection. While generally user-friendly, difficulties with data extraction hinder advanced epidemiological analysis. Furthermore, issues with incorrect data inputs via the API reduced user trust and overall system acceptance.

As shown in patient and data flow, there was no standard procedure for reporting that led to inconsistency across OPDs, the ER, and medicine and pediatric wards, resulting in only inpatient cases being reported to the DDS. These issues affected the accuracy and reliability of the data.

Currently, due to limitations of the API, all reports are manually entered, and this may cause delayed or missed reporting if the case numbers rise. Despite this, the system is deemed to be digitalized but it still necessitates manual operation. Improving the API could correctly automate data transfer, reduce staff workload, and improve the completeness, accuracy, and timeliness of influenza reporting.[9,10]

The sensitivity of the DDS at Hospital X was relatively low when assessed against the DOE definition, with a weighted sensitivity of 9.3%. This low value is likely due to the broad spectrum of clinical presentations that patients who meet the criteria may initially be diagnosed with other respiratory illnesses that mimic influenza such as the common cold, and acute bronchitis or even confirmed with other pathogens.[11] This issue has also been observed in previous evaluations of Thailand's R506 system, which reported sensitivities ranging from 5% to 25% due to similar diagnostic challenges.[12,13] Additional factors contributing to underreporting included the exclusion of outpatient cases and those residing outside Nakhon Pathom. This exclusion does not align with the Communicable Disease Act, which states the hospitals are responsible for reporting any cases of disease under surveillance who visit the hospital.[8] Furthermore, cases presenting outside of regular working hours were often missed either due to consultations with part-time clinicians or delays in influenza diagnosis until the following day after the visit. These findings highlight structural and operational gaps that reduce the reporting of influenza cases into the surveillance system.

The current system only captures about 9% of influenza cases at Hospital X. To improve surveillance accuracy in Thailand, integrating private hospitals into DDS and enhancing sensitivity and performance monitoring are vital.

The PPVs are higher than those from previous evaluations of the R506 system in Thailand, which reported values ranging from 12% to 30%.[12,13] The high value observed in this study may be attributed to validation steps taken before reporting, such as rechecking ICD-10 codes and incorporating RIDT before finalizing diagnoses. These pre-reporting steps help ensure that only clinically appropriate cases are submitted to the DDS system. However, the DOE definition itself may still require revision. For instance, it mandates the presence of a cough, which may not appear in pediatric patients despite other symptoms or positive laboratory results. A prior study revealed that 64% of patients with laboratory-confirmed influenza had fever and cough together.[14] This limitation highlights the need to adapt case definitions to be more inclusive of age-specific presentations, particularly among young children.

The results showed exceptional data quality, with 100% completeness across all key variables. Accuracy was also higher compared to prior evaluations.[11,12] This improvement may be attributed to the relatively smaller volume of cases, which allowed the ICN to review each case thoroughly. However, representativeness remains a challenge. The exclusion of OPD cases and those residing outside Nakhon Pathom from reporting resulted in discrepancies, highlighting the need for more inclusive reporting practices for a comprehensive surveillance picture.

Limitations

This study has three main limitations. First, misclassification bias may have occurred due to human error during medical record reviews. To address this, data extraction followed a standard operating procedure to improve consistency. Second, selection bias may exist, as laboratory-confirmed influenza cases that did not meet selected ICD-10 codes could have been excluded. However, this potential bias was minimized by using a comprehensive and inclusive list of ICD-10 codes to capture as many relevant cases as possible. Third, in the qualitative part, respondent bias may have occurred, as the local staff knew the evaluation was part of the function of the DOE and this might have caused them to express favorable answers.

Recommendations

Hospital X should report the patients from outside Nakhon Pathom and set clear procedures for reporting during weekends and after hours. In the long term, a fully automated API system with correct data extraction should be developed to reduce manual work. The Nakhon Pathom Provincial Public Health Office should provide regular training and communication with healthcare staff. The Division of Epidemiology should revise the influenza case definition to include laboratory-confirmed cases without strict symptom requirements, especially for children. The DDS dashboard and export features should also be improved for easier use.

Conclusion

The DDS-based influenza surveillance system offers clear strengths in simplicity, completeness, timeliness, and PPV, particularly when evaluated against physician diagnosis and laboratory-based definitions. However, sensitivity remains low under the current DOE definition, largely due to the exclusion of pediatric cases or cases with clinical presentations that did not match the DOE definition. The system also showed limited representativeness, especially for outpatients and non-local residents.

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Author Contributions

Thanaphon Yisankhun: Conceptualization, methodology, investigation, writing—original draft, writing—review & editing. **Watcharapol Rongdech:** Conceptualization, methodology, investigation, writing—original draft. **Kogkawee Raruenroeng:** Investigation. **Sethapong Lertsakulbunlue:** Investigation. **Wanchat Saowong:** Investigation. **Thanawadee Chantian:** Supervision, writing—original draft. **Nichakul Pisitpayat:** Supervision, writing—original draft. **Rapeepong Suphanchaimat:** Supervision, writing—original draft.

Ethical Approval

This study only involved interviews with participants who were anonymous, and therefore ethics approval was not required.

Informed Consent

Informed consent was obtained from all participants involved in the study.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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The authors did not receive funding.

Declaration of Generative AI and AI-assisted Technologies in the Writing Process

During the preparation of this work, the authors used ChatGPT to correct grammatical errors. The content produced by this tool was reviewed and edited by the authors, who accept full responsibility for the final text.

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