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Research article

Epidemic Signals of Mycoplasma Pneumonia outbreaks in 2023 and early 2024 using Artificial Intelligence System (EPIWATCH®)

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Abstract

Background: Mycoplasma pneumonia is a significant respiratory infection that primarily affects children and young adults and is responsible for 10 to 40% of community-acquired pneumonia cases. Transmission occurs through close contact, complicating infection control in schools, families, and institute settings. The incidence rate of Mycoplasma pneumonia dropped during COVID-19; however, concerning trends emerged in mid-October 2023. This study aims to identify and summarise the timelines of AI intelligence-EPIWATCH signals for enhanced surveillance of Mycoplasma pneumonia in 2023 and early 2024.
Methods: EPIWATCH® database was utilized to retrieve syndromic surveillance reports between January 1, 2023, and February 13, 2024, using syndromic keywords such as influenza-like illness, febrile syndromes, pneumonia of unknown origin, and the disease keyword Mycoplasma pneumonia. Study findings were grouped according to geographical locations, and a descriptive epidemiologic analysis of the outbreak was conducted. The top 5 countries were selected for further analysis to show the trends and patterns over the study period.
Results: The syndromic surveillance included a total of 1943 reports, including 26 reports of confirmed Mycoplasma pneumonia outbreaks. China, India, Russia, the USA, and Pakistan were included in the descriptive analysis. The trend in the EPIWATCH® syndromic surveillance data between January 1, 2023, and February 11, 2024, across these 5 countries revealed increases in reporting of influenza-like illness and pneumonia of unknown origin starting around August or September 2023, with notable spikes occurring in November or December 2023.
Conclusion: This study demonstrates the effectiveness of using EPIWATCH® as a syndromic surveillance tool in providing timely early signals of outbreaks compared to traditional surveillance methods. This proactive approach helps in understanding and managing emerging infectious diseases, facilitating effective control measures to mitigate the impact of future Mycoplasma pneumonia outbreaks.

Keywords: EPIWATCH®, Syndromic Surveillance, Mycoplasma pneumonia

Introduction

Mycoplasma pneumonia, a bacterial respiratory infection, is a significant health concern, particularly among children and young adults [1, 2]. Accounting for 10 to 40% of all community-acquired pneumonia (CAP) cases [1, 3, 4], Mycoplasma pneumonia's prevalence underscores its role as a major infectious agent. Notably, children exhibit a higher susceptibility to Mycoplasma pneumonia infection [2, 4], a pattern that presents unique challenges for public health measures in communal settings such as families, schools, and institutions [2]. The transmission of Mycoplasma pneumonia, primarily through close contact via aerosolized particles and respiratory droplets [5, 6], complicates the implementation of effective infection control strategies, highlighting the need for heightened vigilance in these environments.

The clinical manifestations of Mycoplasma pneumonia infections range from mild symptoms, including cough, fever, sore throat, and malaise, to more severe conditions like tracheobronchitis and pneumonia [5]. While the majority of cases are not severe, necessitating minimal clinical intervention, a subset of patients may require hospitalization due to the severity of their infections [4]. In these severe instances, there is a potential for multiple organ system involvement, a complication observed in both adults and children [4]. The presentation of pneumonia caused by Mycoplasma pneumonia is often deceptive, with patients appearing relatively healthy despite their illness—earning it the moniker "walking pneumonia. [5]" In children under five years of age, the infection may present with flu-like symptoms, vomiting, and diarrhea, indicating a diverse clinical spectrum [5].

Treatment protocols for Mycoplasma pneumonia typically involve antibiotics, with macrolides, tetracyclines, and quinolones being the drugs of choice for adults [7]. However, due to concerns over potential adverse effects, macrolides remain the preferred treatment for paediatric patients [7]. This therapeutic approach highlights the importance of selecting

appropriate antibiotics to manage the disease effectively while minimizing the risk of side effects. The overall mortality rate of Mycoplasma pneumonia infection is relatively low post-treatment with antibiotics, respiratory support, and extracorporeal life support [1, 8]. Studies indicate that the case fatality rate (CFR) in children can range from 0.1 to 4% [8]. Furthermore, children with severe Mycoplasma pneumonia exhibit a high prevalence of macrolide resistance concurrent with extrapulmonary organ dysfunction, which correlates with poorer outcomes [4, 8].

The incidence of Mycoplasma pneumonia varies significantly across both geographical regions and seasons. Studies indicate patterns of endemic disease transmission punctuated by cyclic epidemics every 3 to 7 years [1, 3]. These epidemics, which tend to peak during the autumn and winter months before subsiding in the summer, typically span 12 to 18 months, with varying subtypes of Mycoplasma pneumonia implicated in each outbreak [1, 7]. Notably, the prevalence of Mycoplasma pneumonia from 1 April 2022 to 31 March 2023, as determined by polymerase chain reaction (PCR) testing, has been significantly higher in European and Asian populations than in America and Oceania [9, 10]. This discrepancy emphasises the influence of regional and seasonal factors on the transmission dynamics of Mycoplasma pneumonia, suggesting a need for tailored public health strategies to address these variations effectively. Diagnosis of Mycoplasma pneumonia infections typically involves culture, serology, or nucleic acid amplification methods and a chest X-ray [11], which can be time-consuming and require significant manpower. Therefore, syndromic surveillance offers a more efficient method for detecting early signals and responding to diseases of public health importance [12].

In early 2021, a comprehensive study shed light on the impact of COVID-19 non-pharmaceutical interventions on Mycoplasma pneumonia incidence, revealing a substantial decline from 8.6% (2017-2020) to approximately 1.7% (April 1, 2020, to March 31, 2021) globally [6, 9]. Despite the subsequent easing or discontinuation of these measures in the following year, the incidence remained persistently low at 0.7% [6]. However, concerning trends emerged in mid-October 2023, as reported by the World Health Organization (WHO), indicating a surge in influenza-like illness among children in northern China [13]. Chinese health authorities corroborated this, citing an uptick in outpatient consultations and hospital admissions for Mycoplasma pneumonia since May 2023 [13]. Similarly, Denmark also experienced a surge in respiratory illnesses among children and adolescents attributed to Mycoplasma pneumonia since October 2023 [14]. These recent developments highlight the need for ongoing vigilance and responsive public health measures to address emerging respiratory pathogens like Mycoplasma pneumonia.

Traditional disease surveillance relies on established systems, such as healthcare facilities, laboratories, and public health agencies, for data collection, analysis, and reporting. Furthermore, this approach has limitations, such as reporting delays, underreporting, and geographic disparities in surveillance capacity, which are often expensive and complex. Open-source intelligence (OSINT) is a concept of searching, collecting, analysing, and using information from open sources, such as news reports, government websites, and online forums [15]. In recent years, numerous OSINT digital surveillance, such as Google Flu Trends, the Global Public Health Intelligence Network (GPHIN), and ProMED, have been introduced into the health surveillance system [16]. The deployment of OSINT highlights its effectiveness in enhancing global health surveillance efforts.

EPIWATCH® is an advanced epidemic surveillance system that has been in operation since 2016. Its main objective is collecting, processing, and analysing outbreak data from various online sources, including news outlets and social media platforms [17, 18]. EPIWATCH® has been used to detect the early signals of COVID-19 in Indonesia, global outbreaks of Zika infection, and Hepatitis A outbreaks [17-20]. Its capabilities extend to the early detection of outbreaks and diseases, enabling the generation of timely and effective public health interventions to address emerging health threats. This study aims to identify and summarize the timelines of AI intelligence-EPIWATCH signals for enhanced surveillance of Mycoplasma pneumonia in 2023.

Methods

EPIWATCH® is a semi-automated open-source epidemic surveillance platform powered by artificial intelligence that collects and analyses outbreak data from various open-source channels, such as Google news alerts, social media, and news releases from public health agencies [17-21]. This platform was created to detect early signals of disease outbreaks or epidemics of emerging and re-emerging infections globally. EPIWATCH® demonstrates efficiency in conducting disease and syndromic surveillance using multiple languages across the platform.

To investigate the early signals of the Mycoplasma pneumonia outbreak from 2023 to 2024, data was extracted from EPIWATCH® for the period of January 1, 2023, to February 11, 2024. This dataset was filtered for syndromic keywords associated with the primary syndrome of Mycoplasma pneumonia, including "influenza-like illness," "febrile syndromes," and "pneumonia of unknown origin" for subsequent analysis. Furthermore, reports containing confirmed cases of Mycoplasma pneumonia were specifically highlighted within the dataset. Exclusions were applied for reports detailing specific diseases such as

COVID-19, influenza, Legionnaires, pertussis, pneumococcal and streptococcal pneumonia, and animal cases. Subsequently, the data was organized into outbreak clusters and categorized according to geographical location and time.

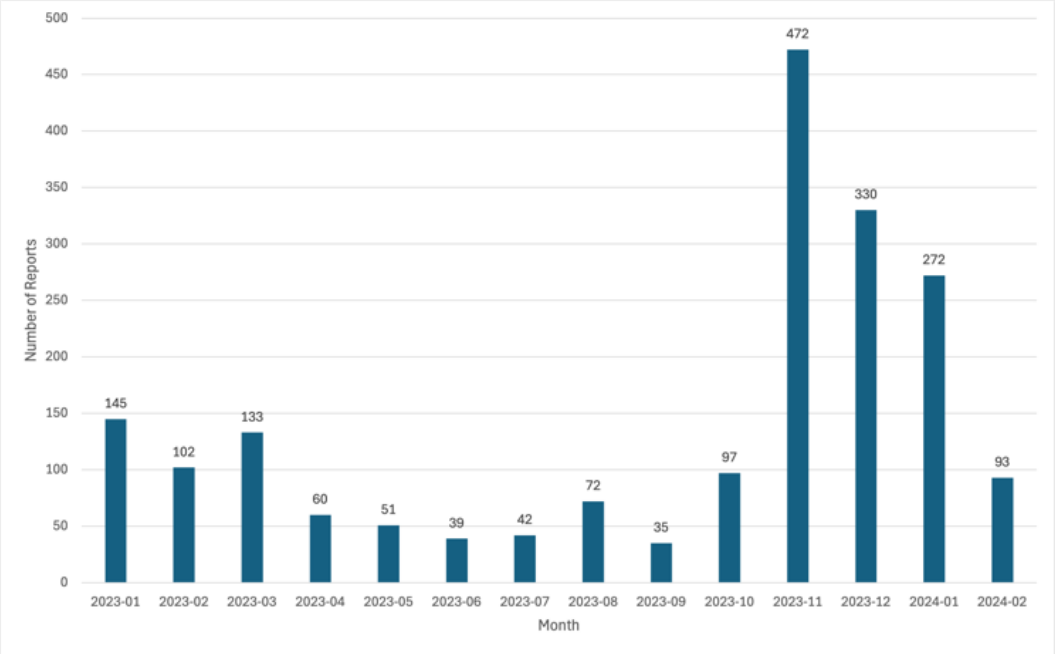
Microsoft Excel 2024 was utilized to perform a descriptive analysis. Data were systematically examined and summarized across various geographical locations. Graphical representations of the top 5 reporting countries were generated to illustrate trends and patterns in these countries over the study period.

Results

Between January 1, 2023, and February 13, 2024, 80790 reports were in EPIWATCH®. Based on syndromic keyword searches, a subset of 1,943 reports (2.41%) was selected for further analysis. These reports represent data gathered from 32 countries and regions spanning Asia, Europe, the Middle East, America, and Australia.

Figure 1 illustrates the trend of monthly EW reports, indicating a signal encompassed in syndromic surveillance in the dataset from January 1, 2023, to February 13, 2024. The peak in reporting activity occurred in November 2023, with 472 reports concerning “influenza-like illness," "febrile syndromes," and "pneumonia of unknown origin." For confirmed Mycoplasma pneumonia infections, the number of reports of Mycoplasma pneumonia was 26 in total.

Figure 1. Number of Global Syndromic Surveillance Reports by Month and Year between 1 January 2023 and 11 February 2024.



China emerged as the majority of the reports (23.1%, N=450/1946), followed by India (13.2%, N=257/1946), Russia (8.5%, N=166/1946), Pakistan (7.7%, N=149/1946), and the USA (6.9%, N=134/1946). These regional data are depicted in Appendix 1. Significant spikes occurred across Asian, European, and American regions in December 2023. Detailed analysis was centred on the top 5 countries.

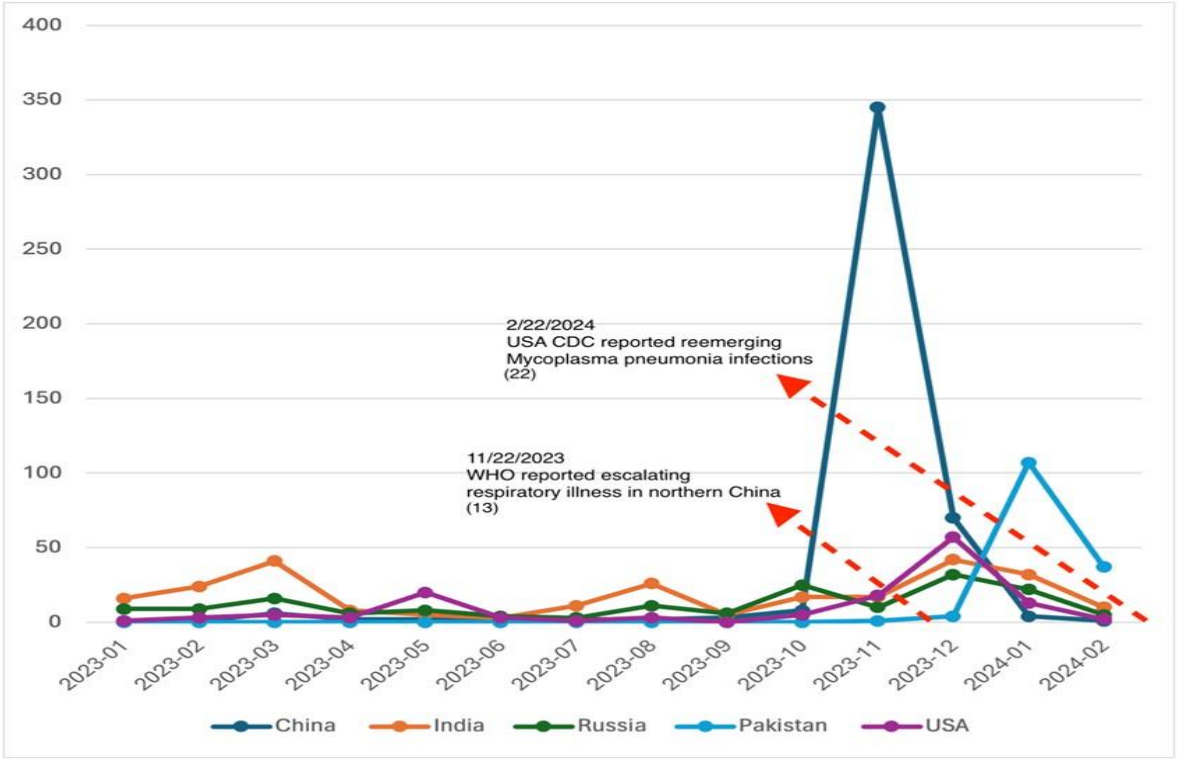
Between January 1, 2023, and February 11, 2024, varied trends in syndromic reporting were observed across the top 5 selected countries. China had scattered occurrences of influenza-like illness and pneumonia, with a significant spike in November 2023; moreover, confirmed Mycoplasma pneumonia reports had been identified since mid-August 2023. India experienced a consistent number of reports of both influenza-like illness and pneumonia of unknown origin throughout the year, with a prominent peak in December 2023. Russia had two reports of confirmed Mycoplasma pneumonia in August 2023 and showed sporadic reporting with a notable peak of pneumonia of unknown origin in December 2023. In January 2024, there was a significant increase in the reporting of pneumonia cases with an unknown cause in Pakistan. In the USA, intermittent reporting was evident, with notable spikes of influenza-like illness in November 2023 and a peak of pneumonia of unknown origin in December 2023, along with one confirmed report of Mycoplasma pneumonia in December 2023 (Table 1.)

Table 1. Number of reports of Syndromic keywords and confirmed Mycoplasma pneumonia based on news reports in China, India, Russia, Pakistan, and the USA from January 1, 2023, to February 13, 2024.

		2023												2024	
Syndromic keywords	**Countries**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Influenza Like illness	**China**	1	1	5	2	1	-	-	-	2	2	33	8	-	1
	India	6	18	32	6	4	1	6	11	1	9	8	15	10	3
	Russia	7	7	11	4	2	2	-	-	-	4	5	9	10	5
	Pakistan	-	-	-	-	-	-	-	-	-	-	1	-	1	-
	USA	1	3	1	1	18	-	-	1	-	-	15	24	13	1
Febrile Syndromes	**China**	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	India	-	1	-	-	-	-	1	-	-	-	-	-	-	-
	Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Pakistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	USA	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pneumonia of unknown origin	**China**	-	-	1	-	1	3	2	-	1	4	310	60	4	-
	India	10	6	9	2	2	2	5	15	4	8	9	27	22	7
	Russia	2	3	5	2	6	2	3	9	6	21	4	23	11	-
	Pakistan	-	-	-	-	-	-	-	-	-	-	-	4	106	37
	USA	-	-	4	2	2	3	1	2	-	5	3	33	-	1
Disease Keywords	**Countries**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**
Mycoplasma Pneumonia	**China**	-	-	-	-	-	-	-	2	1	2	2	2	-	-
	India	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Russia	-	-	-	-	-	-	-	2	-	-	-	-	-	-
	Pakistan	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	USA	-	-	-	-	-	-	-	-	-	-	-	1	-	-

*Source: EPIWATCH®

Figure 2. The trend of syndromic surveillance of China, India, Russia, Pakistan, and the USA from January 1, 2023, to February 13, 2024, from EPIWATCH®



The trend in the EPIWATCH® syndromic surveillance data between January 1, 2023, and February 11, 2024, across China, India, Russia, and Pakistan revealed increases in reporting of influenza-like illness and pneumonia of unknown origin starting around August or September 2023, with notable spikes occurring in November or December 2023.

Furthermore, confirmed reports of Mycoplasma pneumonia were identified from the EPIWATCH® as early as mid-August. The WHO reported escalating respiratory illness in northern China on November 22, 2023 [13], and the USA CDC Weekly report flagged the re-emergence of Mycoplasma pneumonia infections among children and adolescents on February 22, 2024 [22] (Figure 2).

Discussion

This research aims to highlight the use of syndromic surveillance and artificial intelligence as a method to detect early signals of Mycoplasma pneumonia outbreaks. In this study, we analysed outbreaks of Mycoplasma pneumonia across the globe, using syndromic data from EPIWATCH®. The study included a total of 1943 reports of "influenza-like illness", "febrile syndromes", and "pneumonia of unknown origin" from January 1, 2023, to February 13, 2024, indicating a strong signal for Mycoplasma pneumonia at the time. Our findings from EPIWATCH® showed the number of global reports using syndromic surveillance peaked in November 2023 and declined substantially from December 2024 to February 2024, with 21 countries having similar trends. Most of the reports in EPIWATCH® were from China, with 450 in total.

EPIWATCH® identified an increasing trend in syndromic keywords associated with pneumonia from October 2023 in, including China, the USA, France, and the Netherlands. The WHO reported an increase in respiratory illnesses among children in Northern China since mid-October 2023, later confirmed as a Mycoplasma pneumonia outbreak by the Chinese government. Additionally, the WHO reported a rise in respiratory infectious diseases across the European Region in December 2023, with several countries reporting increasing Mycoplasma pneumonia infections and related hospitalizations [23, 24]. The utilisation of syndromic surveillance with EPIWATCH® demonstrated its effectiveness in identifying emerging Mycoplasma pneumonia cases before they are officially reported by health authorities such as the WHO.

The European Center for Disease Prevention and Control (ECDC) reported an increase in Mycoplasma pneumonia detections by compiling laboratory-confirmed reports from national authorities in Denmark, France, Ireland, the Netherlands, Norway, and Sweden [25]. This rise has been observed across all age groups but was more prevalent among children and adolescents [25]. Furthermore, a global prospective surveillance study was conducted by the international collaborative network established by the Mycoplasma and Chlamydia Infectious Study Group (ESGMAC) [26], indicating a rebound of Mycoplasma pneumonia cases during the autumn of 2023 using PCR and/or serology testing [27].

Research conducted in Europe and the USA has highlighted a notable Mycoplasma pneumonia epidemic from late 2019 to early 2020, before the onset of the COVID-19 pandemic [22, 28, 29]. However, with the implementation of non-pharmaceutical interventions aimed at mitigating COVID-19 transmission, there was a substantial decrease in Mycoplasma pneumonia prevalence on a global scale [22, 28, 29]. As a consequence of the diminished occurrence of Mycoplasma pneumonia throughout the 3.5-year duration of the COVID-19 pandemic, herd immunity against this pathogen may have waned [22, 28, 29]. Therefore, the resurgence of Mycoplasma pneumonia and its current epidemic manifestation is not unexpected. This emphasizes the indispensable role of global prospective surveillance systems in monitoring and addressing emerging infectious diseases like the Mycoplasma pneumonia outbreaks worldwide. The EPIWATCH® system provides a comprehensive and timely approach to global data collection and analysis [19]. This system is designed to facilitate the early detection and tracking of disease patterns, empowering public health authorities with the capabilities for prompt intervention and response strategies.

In January 2024, there was a sudden increase in cases of paediatric pneumonia in Pakistan [30, 31]. Many news reports covered this outbreak but did not specifically mention the confirmed pathogen responsible for it. Despite several reports, no official documentation or published articles are available to confirm the underlying cause. However, given that the affected population is mostly children, it is likely that Mycoplasma pneumonia could be one of the pathogens which is responsible for this outbreak.

Mycoplasma pneumonia is not a notifiable infectious disease in many countries [25, 32]. As a result, acquiring official data or case counts from public health authorities has proven to be difficult. The resurgence of Mycoplasma pneumonia is a matter of significant concern, and studies believe that the presence of macrolide-resistant Mycoplasma pneumonia (MRMP) certainly represents a significant factor in this matter [27, 33]. Recent observations have raised concerns over the emergence of MRMP strains, particularly in Far East Asian countries such as China, Japan, Korea, and Taiwan [7, 34]. This development highlights the need for ongoing and enhanced surveillance and research to understand the resistance mechanisms and develop strategies to overcome this challenge, ensuring the effective management of Mycoplasma pneumonia infections in the face of evolving drug resistance.

By leveraging EPIWATCH®, public health officials can quickly identify and analyse global patterns of disease, enabling them to take necessary actions, such as early intervention and response strategies. This is critical in the fight against disease, and its widespread adoption can help combat the spread of disease globally.

Limitations

This study has several limitations. First, due to the nature of Mycoplasma pneumonia, it is plausible that the concurrent emergence of other viral infections presenting similar syndromes, such as influenza, adenovirus, and respiratory syncytial virus, may occur. Consequently, these diseases could contribute to fluctuations in trends, potentially obscuring clear results in syndromic surveillance efforts. To minimize misclassification bias, we used accurate case definitions and narrowed down the syndromic keywords of Mycoplasma pneumonia, then double-checked our data sets with and without the adjusted keywords to minimize the risk. Moreover, internet-based surveillance systems are significantly impacted by the socioeconomic status of countries, as well as their levels of media and internet penetration [19]. In nations like Pakistan, North Korea, Russia, and many in the Middle East, reporting systems are often opaque and ambiguous. This ambiguity makes it notably more challenging to identify signals and trends of outbreaks within these regions.

Finally, it's worth noting that EPIWATCH® only included Mycoplasma pneumonia in its disease list in late 2023, and the limited languages used in the system may cause barriers in capturing reports from certain language-speaking countries. Therefore, further research is imperative to gain a more comprehensive understanding of this disease.

Conclusion

After COVID-19, Mycoplasma pneumonia has re-emerged as a significant public health concern in numerous countries. This resurgence is compounded by the escalating prevalence of macrolide-resistant strains of Mycoplasma pneumonia, further complicating treatment options and highlighting the urgent need for comprehensive surveillance and intervention strategies. By utilizing EPIWATCH®, this study observed the dynamic nature of Mycoplasma pneumonia outbreaks. It highlighted the significance of timely surveillance it offers beyond the traditional approaches of surveillance systems, particularly using syndromic surveillance. This proactive signal-based approach to intervention serves as a valuable strategy for enhancing our understanding of public health threats and emerging infectious diseases. Moreover, EPIWATCH® facilitates the implementation of effective management and control measures to mitigate the impact of Mycoplasma pneumonia infections on public health.

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Ethics:

Ethics approval was not required for this study.

Data and Data Sharing

The authors had full access to all of the data (including statistical reports and tables) in this study.

The study data can be accessed by contacting the corresponding author.

Competing interests

No relevant disclosures to declare by the authors.

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