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MODERN EPIDEMIOLOGICAL FEATURES OF INFLUENZA AND PREVENTION MEASURES

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Abstract: Seasonal influenza remains one of the most important acute respiratory infections worldwide, causing annual epidemics of different intensity and a substantial burden of severe illness and death. This article reviews the modern epidemiological features of influenza, including its global burden, seasonality, high-risk groups and the role of surveillance, and analyses the effectiveness and limitations of preventive measures. Based on global burden estimates, World Health Organization (WHO) documents and recent clinical guidelines, the article shows that annual vaccination is the cornerstone of prevention, that non-pharmaceutical measures complement but do not replace vaccination, and that early antiviral treatment is important for patients with severe illness or at high risk. A practical prevention algorithm is proposed for health-care settings, emphasizing vaccination of priority groups before the season, early recognition and treatment, and the use of surveillance data for planning.
Keywords: influenza, epidemiology, seasonal epidemics, vaccination, surveillance, antiviral therapy, high-risk groups, prevention.

INTRODUCTION

Influenza is an acute viral respiratory infection that spreads easily between people and affects all age groups. Although many patients recover within a week, the infection can cause severe pneumonia, worsen chronic cardiac and pulmonary disease and lead to death, particularly in older adults, young children, pregnant women and people with chronic conditions. Because the virus changes continuously and circulates every year, influenza imposes a recurring burden on health systems, schools and workplaces.

According to the World Health Organization, there are around one billion cases of seasonal influenza annually, including 3–5 million cases of severe illness [1]. A modelling study by Iuliano and colleagues estimated that 291,243 to 645,832 seasonal influenza-associated respiratory deaths occur each year, equal to 4.0–8.8 deaths per 100,000 people, and judged earlier estimates of 250,000–500,000 deaths to be outdated [2]. These figures place influenza among the infections with the largest annual impact on public health, even in years without a pandemic.

The aim of this article is to describe the modern epidemiological features of influenza and to analyse preventive measures that can reduce its burden. The article addresses three questions. First, what do current estimates show about the burden and the groups at greatest risk? Second, how do surveillance and vaccination contribute to control? Third, how should clinical management and non-pharmaceutical measures be combined with vaccination in a practical prevention programme?

LITERATURE REVIEW AND METHODOLOGY

The burden of influenza has been quantified by combining surveillance data with statistical models of excess mortality. Iuliano and colleagues estimated country-specific excess respiratory mortality for 33 countries that together covered 57% of the global population, using time-series regression of vital death records and influenza surveillance data, and extended the estimates to 185 countries. They noted that the contribution of non-respiratory causes of death, such as cardiovascular events triggered by influenza, still needs to be investigated [2]. This limitation means that the published figures should be viewed as a lower bound of the total influenza-related mortality.

The World Health Organization has set the framework for prevention in two key documents. The Global Influenza Strategy 2019–2030 defines four strategic objectives and ten priorities for reducing seasonal, zoonotic and pandemic influenza, and builds on the Global Influenza Surveillance and Response System as the backbone of the global alert system. One of its priorities is to expand seasonal prevention and control policies to protect vulnerable groups [3]. The 2022 position paper on influenza vaccines replaces the 2012 paper and continues to recommend that all countries implement seasonal vaccination programmes, based on disease burden, cost-effectiveness, competing priorities and programme feasibility [4].

Treatment recommendations are summarized in the WHO clinical practice guidelines for influenza. According to the published summary, the guideline panel conditionally recommends oseltamivir for severe influenza, started within 48 hours of symptom onset, and conditionally recommends baloxavir for patients at high risk of progressing from non-severe to severe illness [5]. The summary also lists conditional recommendations against the routine use of corticosteroids, macrolides and several other agents in severe influenza [5].

The present article is a narrative review. Sources were selected from peer-reviewed publications and official WHO documents published in 2016 or later. The analysis proceeded in three steps: first, global burden and epidemiological data were summarized; second, preventive and therapeutic recommendations were compared; third, a prevention algorithm for clinical practice was formulated. The article does not present local surveillance data from Karakalpakstan or Uzbekistan, and the algorithm is therefore intended as a general framework that should be adapted to national and regional data.

VIROLOGICAL AND CLINICAL CHARACTERISTICS

Influenza viruses belong to the family Orthomyxoviridae. Types A and B cause seasonal epidemics in humans, and influenza A viruses are further classified into subtypes according to two surface proteins, haemagglutinin and neuraminidase. The subtypes A(H1N1) and A(H3N2) have been the main seasonal influenza A viruses in recent decades. Influenza A viruses also circulate in birds and other animals, which creates the risk of new subtypes entering the human population and causing a pandemic. This zoonotic dimension is one of the reasons why the Global Influenza Strategy treats seasonal, zoonotic and pandemic influenza together [3].

The virus changes in two ways. Antigenic drift is the gradual accumulation of mutations in the surface proteins, which allows the virus to escape immunity built up from earlier infection or vaccination and explains why the composition of influenza vaccines must be reviewed regularly. Antigenic shift is an abrupt change that produces a virus with new surface proteins to which the population has little immunity, as happens in a pandemic. Drift therefore determines the yearly pattern of epidemics, while shift determines the risk of pandemics.

The infection is transmitted mainly by respiratory droplets and aerosols from coughing, sneezing and talking, and also through contact with contaminated surfaces. The incubation period is short, usually one to four days, and infected people may be contagious shortly before the onset of symptoms. The typical illness begins abruptly with fever, headache, muscle pain, sore throat and dry cough. In uncomplicated cases the symptoms resolve in about a week, but cough and fatigue may persist longer.

Complications include viral and secondary bacterial pneumonia, exacerbation of asthma, chronic obstructive pulmonary disease and heart failure, myocarditis, and encephalopathy. Groups at elevated risk of complications include children aged 6–59 months, older adults, pregnant women, people with chronic medical conditions and health-care workers, who are also at higher risk of exposure. Recognizing these groups is the basis for setting priorities for vaccination and early treatment.

GLOBAL BURDEN AND EPIDEMIOLOGICAL FEATURES

Seasonal influenza follows a recognizable pattern. In temperate regions of the northern and southern hemispheres, epidemics occur mainly during the winter months, while in tropical and subtropical regions influenza may circulate throughout the year or in several peaks. This seasonality has direct implications for planning: vaccination in the northern hemisphere is usually organized in autumn, before the winter peak, which is consistent with the WHO recommendation to vaccinate before the influenza season begins [4].

The burden varies from year to year according to the circulating virus and the level of population immunity. Seasons dominated by A(H3N2) viruses have generally been associated with higher mortality among older adults, while seasons dominated by A(H1N1) or B viruses may affect younger age groups more. The estimate of 291,243–645,832 respiratory deaths per year, with the highest mortality rates in sub-Saharan Africa, south-east Asia and among people aged 75 years and older, shows that the burden is distributed unequally [2]. The wide uncertainty interval reflects the limited availability of surveillance data in many low- and middle-income countries.

An important feature of the modern epidemiology of influenza is its interaction with other respiratory infections. During the COVID-19 pandemic, the strict public health measures introduced in 2020 and 2021 reduced influenza circulation to very low levels in many countries, and the return to normal social life was followed by the reappearance of epidemics. Reduced exposure during the years of low circulation may have lowered population immunity, particularly among young children, and this may influence the size of subsequent seasons. The experience showed both the effectiveness of behavioural measures for limiting respiratory transmission and the risk of resurgence once they are relaxed.

SURVEILLANCE AS A BASIS FOR PREVENTION

Effective prevention depends on reliable information. The Global Influenza Strategy identifies strengthening global surveillance and the use of data as one of its objectives and calls for the integration of virological and disease surveillance [3]. Virological surveillance identifies which viruses are circulating and how they are changing, which allows the vaccine composition to be selected. Epidemiological surveillance, including sentinel monitoring of influenza-like illness and severe acute respiratory infection, shows the timing and intensity of the season and the groups most affected.

For a regional health system, surveillance has three practical uses. First, it indicates when the season starts, so that antiviral treatment and hospital capacity can be prepared. Second, it identifies the age groups and clinical groups with the highest burden, which helps to set vaccination priorities. Third, it provides a measure of the effect of interventions, for example by comparing the numbers of severe cases among vaccinated and unvaccinated patients. Without local data, planning must rely on global estimates, which may not reflect regional conditions.

PREVENTION MEASURES

Annual vaccination is the most effective preventive measure. WHO continues to recommend annual influenza vaccination before the influenza season, and states that countries should implement seasonal programmes based on the burden of influenza and the feasibility of delivery [4]. Children are described as an important target group, which countries may consider as a priority according to national goals, capacity and epidemiology [4]. For settings with limited resources, WHO suggests aiming at maximum population impact, which may be achieved most equitably with traditional, less expensive vaccines that are more widely available [4].

The vaccine needs yearly renewal for two reasons: the viruses change, and protection from vaccination wanes. For this reason a single dose given in a previous year does not protect in the current season. The vaccine composition is reviewed by WHO for each hemisphere, and the programme should therefore be organized as a yearly campaign with early procurement and a clear timetable. The WHO position paper also states that seasonal inactivated influenza vaccines may be co-administered with COVID-19 vaccines, which may increase programme efficiency [4].

Non-pharmaceutical measures complement vaccination. They include hand hygiene, respiratory etiquette (covering the mouth and nose when coughing or sneezing), staying at home when ill, ventilation of indoor spaces, and the use of masks in health-care facilities and during outbreaks. Their value was demonstrated by the very low influenza circulation during the COVID-19 restrictions, but they are difficult to maintain for long periods, so they are best used as a supplement to vaccination and as additional protection during periods of high transmission.

Health-care facilities require specific measures. Vaccination of health-care workers protects both the workers and their patients, since staff can transmit influenza to vulnerable people. Patients with suspected influenza should be separated from others, staff should use appropriate protective equipment, and visiting should be restricted during outbreaks. These measures reduce nosocomial transmission, which is particularly dangerous in departments caring for older, immunocompromised or chronically ill patients.

CLINICAL MANAGEMENT AS PART OF CONTROL

Early recognition and treatment limit complications and reduce transmission within hospitals and families. According to the WHO guideline summary, oseltamivir is conditionally recommended for severe influenza when started within 48 hours of symptom onset, and baloxavir is conditionally recommended for non-severe patients at high risk of progression to severe illness [5]. The same summary advises against the routine use of corticosteroids, macrolides and several other agents in severe influenza [5]. These recommendations mean that treatment decisions should be based on severity and risk, and that unnecessary antibiotic or corticosteroid use should be avoided.

Several practical points follow for clinicians in infectious disease services. Laboratory confirmation should be obtained for severe cases and for patients in hospital, because it guides isolation and treatment and contributes to surveillance. Patients with risk factors should be seen early and not wait for complications. Antipyretics should be selected with care in children, avoiding aspirin because of the risk of Reye syndrome. Secondary bacterial pneumonia should be recognized promptly when fever returns after initial improvement or when respiratory symptoms worsen.

RESULTS AND DISCUSSION

The review leads to four main findings. First, influenza causes a very large annual burden, with around one billion cases and 3–5 million severe cases [1] and an estimated 291,243–645,832 respiratory deaths [2]. Second, the burden falls mostly on identifiable groups, including young children, older adults, pregnant women, people with chronic conditions and health-care workers. Third, prevention depends on a combination of annual vaccination, surveillance and non-pharmaceutical measures [3], [4]. Fourth, early antiviral treatment, selected by severity and risk, reduces the clinical consequences [5].

To illustrate the potential effect of vaccination, consider a constructed example. In a community of 100,000 people, suppose that 10% of unvaccinated people would be infected in a given season. If 50% of the population is vaccinated and the vaccine protects half of those vaccinated against infection, then the vaccinated half would experience an infection rate of 5%. The overall number of cases would fall from 10,000 to 7,500, a reduction of one quarter, without considering any indirect protection of unvaccinated people. The numbers are assumptions chosen for illustration and are not drawn from real surveillance data. They show that even a vaccine of moderate effectiveness produces a large absolute benefit when it is given to many people, and that raising coverage is as important as improving the vaccine.

On this basis, a prevention algorithm for health-care settings is proposed. Step 1: before the season, identify the priority groups in the population served, including children, older adults, pregnant women, patients with chronic disease and health-care workers, and carry out vaccination early. Step 2: during the season, use surveillance data to follow the course of the epidemic and to alert clinics and hospitals. Step 3: at the clinical level, identify patients at high risk, confirm severe cases in the laboratory and start antiviral treatment according to severity and risk. Step 4: apply infection control measures in hospitals

and promote hand hygiene and respiratory etiquette among patients and visitors. Step 5: after the season, review the data and adjust the plan for the next year.

The application of this algorithm in a regional health system faces certain challenges. Vaccine acceptance may be limited by misconceptions, such as the belief that influenza is a minor illness or that the vaccine causes the disease, and this requires active communication by physicians. Surveillance capacity may differ between regions and may need strengthening. Resources for antiviral drugs and laboratory testing should be directed first to severe cases and high-risk patients. Training of primary care and hospital staff in the recognition of influenza and its complications is a further requirement.

The review has limitations. It is a narrative review based on global estimates and guidance documents and it does not include local epidemiological data from Karakalpakstan or Uzbekistan. Burden estimates carry wide uncertainty, particularly in countries with limited surveillance [2]. The clinical guideline is cited through a published summary and not the full text [5]. Future work should combine regional surveillance data with vaccination coverage, hospital data and mortality records to estimate the local burden and the effect of preventive programmes.

CONCLUSION

Seasonal influenza remains a major global health problem, with an annual burden of around one billion cases and hundreds of thousands of deaths, concentrated in high-risk groups. Its epidemiology is shaped by continuous viral change, seasonality and the interaction with other respiratory infections. Prevention rests on annual vaccination before the season, supported by surveillance, non-pharmaceutical measures and infection control, while early antiviral treatment for severe and high-risk patients limits the clinical consequences.

The algorithm proposed in this article links these elements into a single sequence for health-care practice. Its implementation requires reliable surveillance, early procurement and delivery of vaccines, training of health workers and communication with the public. Further studies should apply the algorithm using regional data and evaluate its effect on morbidity and hospital admissions.

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