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Authors: Marcin Wełnicki, Karol Kamiński, Agnieszka Mastalerz-Migas, Ernest Kuchar, Piotr Jankowski, Robert Gil, Przemysław Mitkowski, Artur Mamcarz, Jacek Wysocki

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Marcin Wełnicki[1], Karol Kamiński[2], Agnieszka Mastalerz-Migas[3], Ernest Kuchar[4], Piotr Jankowski[5], Robert Gil[6], Przemysław Mitkowski[7], Artur Mamcarz[1], Jacek Wysocki[8]

Reviewers: Agata Bielecka-Dąbrowa[9], Adam Antczak[10]

[1]3rd Department of Internal Medicine and Cardiology, Medical University of Warsaw, Warszawa, Poland
[2]Department of Population Medicine and Prevention of Civilization Diseases, Medical University of Bialystok, Białystok, Poland
[3]Chair and Department of Family Medicine, Medical University of Wroclaw, Wrocław, Poland
[4]Department of Pediatrics with Clinical Assessment Unit, Medical University of Warsaw, Warszawa, Poland
[5]Department of Internal Medicine and Gerontology, Medical Center for Postgraduate Education, Warszawa, Poland
[6]Department of Invasive Cardiology, Medical Center for Postgraduate Education at the Central Clinical Hospital of the Ministry of Interior and Administration, Warszawa, Poland
[7]1st Department of Cardiology, Poznan University of Medical Sciences, Poznań, Poland
[8]Chair and Department of Health Prophylaxis, Medical University of Poznan, Poznań, Poland
[9]Department of Preventive Cardiology and Lipidology, Medical University of Lodz, Łódź, Poland
[10]Department of General and Oncological Pulmonology, Medical University of Lodz, Łódź, Poland

Correspondence to:
Prof. Karol Kamiński, MD, PhD,
Department of Population Medicine
and Prevention of Civilization Diseases,
Medical University of Bialystok,
Waszyngtona 15B, 15–269 Białystok, Poland,
phone: +48 85 686 53 65,

e-mail: karol.kaminski@umb.edu.pl

ABSTRACT

Influenza increases the risk of cardiovascular incidents, hospitalization for heart failure, heart attack, stroke and cardiovascular death. Annual influenza vaccination is a well-known, safe and effective method of reducing the risk of infection in general and, above all, reducing the risk of severe disease. The preventive effect of annual vaccination is particularly important in groups at risk of a severe course of infection and the development of complications — these include cardiac patients. In this group, the additional benefits of vaccination are also particularly important — reducing the risk of cardiovascular incidents and death. However, vaccination coverage in Poland is still at a staggeringly low level. This document aims to popularise influenza vaccination as one of the key elements of general health and cardiovascular prevention.

Key words: cardiovascular mortality, elderly patient, heart failure hospitalization, pneumonia

INTRODUCTION

Influenza, despite the widespread availability of vaccination, remains a major health problem. The number of confirmed cases remains at several million per year, the number of hospitalizations in the post-pandemic COVID-19 period has increased many times over. This is probably partly due to the increasing prevalence of tests to identify respiratory viruses. The problem of the severe course of the disease mainly concerns extreme age groups, in the context of cardiovascular disease — primarily patients over 65 years of age. The risk of death is also highest in this group, and analysing aggregate epidemiological data, it is difficult not to conclude that the number of influenza-related deaths is underestimated. Influenza virus infection is particularly dangerous for chronically ill patients, including those with cardiovascular disease. Studies in recent years also clearly show that seasonal influenza vaccination not only reduces the risk of illness and severity of infection, but also reduces the risk of cardiovascular incidents and death. The aim of this expert position statement is to draw the attention of the cardiology community to the fact that influenza vaccination should be a routine preventive element in the cardiovascular patient population.

EPIDEMIOLOGY — NOT FULLY CONSISTENT DATA

Influenza remains a real and recurrent health problem. Polish epidemiological data on the number of cases and their course are unfortunately fragmentary. Approximately 3–5 million cases or suspected cases of influenza were reported annually, but in recent years the strategy for monitoring influenza virus infections has changed and only confirmed cases are reported [1]. In 2022/2023, the SENTINEL project registered 3217 influenza tests, of which 1262 (39.2%) were positive [2]. The majority of tests (more than 2000) were performed in the age group 15–65 years [2]. However, in 2023, the provisions of the law governing the Public Statistics Research Programme were amended, and as a result of the changes, the Department of Epidemiology of Infectious Diseases and Surveillance of the National Institute of Public Health ceased to publish weekly reports. Meanwhile, the number of hospitalizations related to influenza infection appears to be increasing rapidly. Between 2015 and 2022, the number remained at several thousand per year, reaching 35 000 in 2023 [2]. Perhaps this is a consequence of the markedly increased availability of antigen and genetic testing, since the COVID-19 pandemic performed essentially routinely in patients with symptoms of respiratory tract infection in primary care clinics, emergency departments and hospital wards. Data for 2024 and 2024/2025 are discrepant. The latest available data from Poland compares 2024 and 2025 and comes from a report on infectious diseases, which was prepared in cooperation between the e-Health Centre, the Chief Sanitary Inspectorate and the Ministry of Health [3]. The report shows that at the peak of the flu season in 2024, the incidence rate was 142/100 000 people, while in January 2025 it was as high as 363/100 000 people. The period of increased incidence was also longer than in the previous year, lasting from November 2024 to early April 2025, whereas in the previous year it began in January and ended in March 2024 [3]. It should be noted that the highest number of COVID-19 cases was recently recorded in October 2024, amounting to approximately 140 cases per 100 000 people [3]. In turn, a document from the Department of Infectious Disease Epidemiology and Surveillance of the National Institute of Public Health — National Institute of Hygiene shows that between January 1 and March 31, 2025, there were 2000 more confirmed cases of influenza than in the same period in 2024 (for comparison, the number of confirmed cases of COVID-19 decreased from nearly 48 000 to less than 18 000, while the number of confirmed cases of respiratory syncytial virus more than doubled to 81 000) [4].

However, it is worth noting the problem of reports on the number of deaths related to influenza that are inadequate to reality. In the 2022/2023 season, 122 influenza-related deaths were recorded, but according to the National Institute of Hygiene (PZH) report, influenza and pneumonia account for 4% of deaths, or approximately 18 000 deaths per year [2]. On the other

hand [4], according to estimates by the Global Pandemic Mortality Project II, influenza-related mortality in people aged ≥65 years is estimated at 10/100 000 [5]. Given the year-on-year increase in the number of deaths during typical seasonal influenza epidemics, it is difficult not to combine the facts and assume that the official epidemiological data are underestimated (Figure 1).

According to data collected in the United States, despite a marked increase in the population and in the proportion of people over 65 years of age, the number of deaths due to influenza appears to have remained constant. This fact is explained by the high vaccination rate. According to World Health Organization recommendations, this percentage in the population over 65 years of age should exceed 75%, while in Poland approximately 20% of people in this age group are vaccinated [6–8]. According to the report cited above, a total of approximately 1.8 million people were vaccinated in Poland during the 2024/2025 season, which represents about 5% of the country's population [3]. These figures indicate a lack of awareness of the importance of influenza vaccination in our society.

Despite national and international recommendations, influenza is, wrongly, perceived as a benign and harmless disease and the validity of vaccination is not sufficiently argued.

ASSOCIATION BETWEEN INFLUENZA AND CARDIOVASCULAR INCIDENTS

The season of increased influenza cases is associated with an increased number of cardiovascular incidents and cardiovascular deaths. These are not new findings.

Initially these observations were empirical, but over time they have been confirmed in observational, cohort and finally prospective studies. Data confirming this correlation are available for every continent and country. During seasonal influenza epidemic periods, the number of cardiovascular deaths increases from 3.4% to 5.6% [11–15]. Seasonal epidemic periods also overlap with an increased risk of hospitalization for heart failure exacerbations [16]. A 5% monthly increase in flu-like illness activity translates into a 24% increase in hospitalizations for heart failure during the same month [17]. The risk of a cardiovascular incident is highest in the first few days after the onset of infection. One study found that the onset of respiratory infection symptoms was associated with a 17-fold increase in myocardial infarction (MI) within the first seven days. However, the relative risk, while gradually decreasing, remained elevated for 1 month after respiratory infection [18]. Another study found that the risk of hospital admission for acute MI increases 6-fold within 7 days of influenza virus infection [19]. A Scottish study shows that influenza virus infection increases the risk of a first MI tenfold and the risk of stroke eightfold [20]. In contrast, a Danish study suggests that within

three days of influenza virus infection, the risk of a first MI increases 17-fold and the risk of a first stroke increases 10-fold [21]. Analysis of data from more than 86 000 patients in the United States showed that the onset of influenza-like illness was associated with a 39% increased risk of ischemic stroke and 24% increased risk of MI. The risk of stroke was increased even one year after the onset of infection, with 6% of ischemic strokes and 7% of MIs having had at least one episode of influenza-like illness in the previous 365 days [21].

Epidemiological data on myocarditis associated with influenza virus infection are difficult to estimate. The latest European Society of Cardiology (ESC) guidelines on myocarditis and pericarditis emphasise that viral infections are one of the most common etiologies of myocarditis [22]. In a meta-analysis conducted by Ouranos et al. [23], the cumulative incidence of myocarditis was 2.56% (95% confidence interval, 0.66%–5.38%). It is worth noting that the H1N1 strain was identified in almost half of the confirmed cases [23]. Current guidelines recommend that myocarditis be included in the differential diagnosis of any person who, within 2–4 weeks after the onset of the first symptoms of viral infection, experiences chest pain, tachycardia and/or hemodynamic instability [22]. Of course, the selected studies cited above are not free of methodological errors, and they refer to different epidemic periods, different populations. Moreover, the standards of treatment for cardiovascular conditions have undergone many changes over the past decades. However, the pathophysiology of cardiovascular complications in influenza has not changed — three main mechanisms are responsible:

1) Destabilisation of the atherosclerotic plaque caused by the inflammatory process and symptomatic treatment, which may contribute to an increase in arterial pressure;
2) An increase in the metabolic demand of myocardial cells and peripheral tissues and organs, leading to myocardial hypoxia and ischemia; and
3) Direct damage to the myocardium or arteries causing myocarditis.

Thus, it remains valid that many patients hospitalized for MI or stroke may have had a severe influenza infection several months earlier. Despite the lack of complete epidemiological data, it is difficult not to observe such a correlation, but in practice we rarely see a cause-and-effect relationship (Figure 1).

FLU VACCINATION AND CARDIOVASCULAR RISK

The influenza vaccines used today show varying degrees of effectiveness in terms of reducing the risk of contracting the disease, but definitely reduce the risk of severe infection. At the same time, there is increasing evidence that, in addition to reducing the risk of illness and its severity,

being vaccinated against influenza reduces cardiovascular risk. One study showed that vaccination reduced the risk of stroke by 55% and that the preventive effect persisted for 5 years after vaccination [24]. In contrast, other analyses show that influenza vaccination achieves a 36% reduction in the risk of major cardiovascular incidents [25]. The number needed to treat for this effect is 58 in the general population and only 8 in patients with a recent acute coronary syndrome [25]. According to data from a Danish registry involving 130 000 patients, annual influenza vaccination in a population with known heart failure reduces the risk of death from any cause and cardiovascular death by 19% [26]. In another study of 34 000 patients aged ≥65 years hospitalized in intensive care units, influenza vaccination was shown to be associated with a 16% reduction in the risk of hospitalization for stroke within 1 year and an 8% reduction in the risk of death [27]. In 2021, the results of the first randomised trial evaluating the impact of influenza vaccination on the prognosis of patients with heart failure were published. It showed that vaccination of the study patient population during a period of increased influenza incidence translated into:

- 21% relative reduction in the risk of death;
- 23% relative reduction in the risk of cardiovascular death;
- 16% reduction in the risk of hospitalization for any cause; and
- 42% relative reduction in the risk of pneumonia [28].

The result of this study has been shown in Table 1. It is also worth noting the results of a meta-analysis of observational and randomised trials on the effects of vaccination by Yedlapati et al. [29], which showed an effect of influenza vaccination in reducing overall mortality, cardiovascular mortality and reducing the risk of a cardiovascular incident. All those effects were statistically significant — see Table 2 [29].

INFLUENZA VACCINATION AND CARDIOLOGY GUIDELINES

Influenza vaccination is recommended for patients with cardiovascular disease by health authorities, advisory bodies and medical societies, e.g. World Health Organization, ESC, American College of Cardiologists, American Heart Association, Heart Failure Society of America or Centers for Disease Control [30, 31]. Unfortunately, the new ESC guidelines for atrial fibrillation, hypertension or peripheral artery and aortic disease do not mention influenza vaccination et all [32–34]. Representatives of the cardiology community, commenting on the lack of explicit vaccination provisions in cardiology guidelines, highlight formality issues and the lack of prospective, randomized trials proving the effects of vaccination on the hard

endpoints typical of cardiovascular disease trials. However, it would be unethical to randomly and deliberately expose patients belonging by definition to high risk groups for severe disease by deliberately failing to administer an effective vaccination. However, the authors of this document are of the opinion that these documents concern groups of patients at increased risk of complicated influenza — vaccinations should therefore be recommended for them. Meanwhile, only in the guideline on chronic coronary syndromes is the vaccination against influenza, next to vaccination against pneumococcal and other conditions (including COVID-19), recommended and only in the context of a general health approach to life [35]. Perhaps, indeed, vaccination should be treated in the same way as weight control, physical activity or a healthy diet, i.e., an obvious part of a healthy lifestyle, a pillar of preventive action that needs no specific recommendation. However, the low vaccination rate in the Polish population clearly shows that we do not perceive vaccination in these terms.

While this document was being developed, ESC experts published a special article on vaccination as a new form of prevention in cardiology [36]. This document is an expert opinion, so the statements it contains are not recommendations of a specific class or strength. However, the tone of this document is consistent with the opinions of Polish experts on the importance of vaccination against COVID-19 and pneumococci in cardiology [37, 38]. It also fully coincides with the message of this position on the validity of influenza vaccination. We are still faced with the lack of elementary knowledge of the design and type of vaccines, the proper interpretation of the organism's response to vaccine administration, and the frustration associated with their lack of 100% effectiveness in the context of infection prevention. This is certainly at least partly a consequence of communication failures between the medical community and patients. The low vaccination rate is also influenced by the issue of the organisation of the health care system.

VACCINATION OF OLDER PEOPLE — CURRENT OPTIONS

There are several types of influenza vaccines. Inactivated, subunit vaccines contain only surface proteins: hemagglutinin and neuraminidase [39]. Another type is split-virion vaccines, where, in addition to the surface proteins, the entire split virus is included in the vaccine, so there is more antigenic material [40]. Due to the lower efficacy of standard vaccines in the elderly, a high-dose antigenic vaccine has been developed. The high-dose vaccine is an inactivated vaccine with a cleaved virus and four times the amount of hemagglutinin compared to standard-dose vaccines [41]. Its efficacy was evaluated in a randomised controlled trial in over 32 000 elderly (65+) during two flu seasons. The primary endpoint was laboratory-confirmed influenza

symptoms. The high-dose vaccine was compared with the standard vaccine. The high-dose vaccine showed a 24.2% advantage in terms of preventing symptomatic serologically confirmed influenza infection. Importantly, those aged ≥75 years responded slightly better to vaccination than those aged 65–74 years. Similarly, co-morbidities did not interfere with vaccine efficacy [42, 43]. Another study, involving residents of more than 800 nursing homes (more than 53 000 patients in total), showed superior efficacy of the high-dose vaccine compared to the standard vaccine in terms of its effect on reducing the risk of hospitalization for respiratory diseases (12.7% reduction) and the number of hospitalizations for pneumonia (20.9% reduction) and the number of hospitalizations for any cause (8% reduction) [44]. The Danish DANFLU-1 study also showed superior efficacy of the high-dose vaccine compared to the standard vaccine — expressed as a 64% lower risk of hospitalization for influenza and pneumonia and a 49% lower risk of death [45]. The most recent meta-analysis by Skaarup et al. [46], published in May 2024, including five papers and a total of more than 105 000 patients, confirmed the superiority of the high-dose vaccine over the standard vaccine. Using the new vaccine, there was a 23.5% reduction in the risk of hospitalization for influenza and pneumonia and a 7% reduction in the risk of hospitalization for any cause. No significant differences were observed for death from any cause [46]. It should also be noted that the safety profile of the high-dose vaccine has been confirmed [47-49], and that it is currently recommended for patients over 60 years of age in many European countries, including Poland [50].

SUMMARY

The authors of this position paper are convinced that the arguments in favour of annual influenza vaccination and vaccination recommended as part of the vaccination calendar for adults are clear. However, the issue of the safety and efficacy of vaccination in general and against influenza in particular, in terms of reducing the risk of disease and severity of infection, are not the focus of this paper. Vaccination should not be seen as a sophisticated, dangerous procedure available to the few, but as a pillar of action to prolong life and improve its quality, just like not smoking, exercise or a healthy diet. The patient should receive a clear message about the rationale for vaccination according to the current schedule (Graphical abstract). A verbal message and a record in the documentation in the form of a recommendation completes the issuing of a prescription for the appropriate vaccine. This is the target model of action — especially in special populations, which include patients with cardiovascular disease. We have sufficient evidence from various studies and meta-analyses to consider the “additional cardiovascular benefit” of influenza vaccination as proven. For the time being, therefore, it

seems crucial to find the right communication tools, an agreement on many levels. In the medical community, it is necessary to raise awareness that reliable information on recommended prophylactic vaccination is our common duty, independent of the speciality represented. The message confirming the appropriateness of vaccination, especially in populations of patients with chronic diseases, reinforced by successive specialists taking care of the patient, emphasized by an oral message, an entry in the documentation or finally by issuing a prescription, has a real chance of changing the epidemiological situation in our country. The addressee of this message is the patient. However, reliable communication is also necessary within the medical community itself — doctors of various specialisations, but also representatives of other medical professions — nurses, physiotherapists, paramedics, pharmacists (Graphical abstract). New regulations allowing pharmacies to vaccinate may prove to be a breakthrough for effectively increasing vaccination rates. Finally, communication between the medical profession and the decision-makers and institutions responsible for shaping the health care system in our country is crucial.

What needs to be constantly emphasised is the obvious and confirmed truth that the possibility of preventing infections is the quintessence of prevention, an intervention aimed at healthy people, an investment whose health, financial and social effects should be assessed in the perspective of years, not single terms. Influenza vaccination appears to be the best researched intervention in recent decades. An intervention that is safe, effective, widely available and provides benefits that outweigh any reduction in the risk of influenza.

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REFERENCES

1. National Institute of Public Health, National Research Institute, Department of Infectious Disease Epidemiology and Surveillance, Laboratory for Monitoring and

Analysis of the Epidemiological Situation. Information on infectious diseases and poisoning in Poland in 2021 [in Polish]. http://wwwold.pzh.gov.pl/oldpage/epimeld/2021/index_mp.html (accessed: November 12, 2025).

2. National Institute of Public Health, National Research Institute. Epidemiological reports [in Polish]. https://www.pzh.gov.pl/epidelm (accessed: November 12, 2025).
3. Report on infectious diseases [in Polish]. https://ezdrowie.gov.pl/portal/home/badania-i-dane/raport-o-chorobach-zakaznych (accessed: September 8, 2025).
4. Cases of selected infectious diseases in Poland from January 1 to March 31, 2025, and in the comparable period of 2024. Department of Epidemiology of Infectious Diseases and Surveillance, National Institute of Public Health – National Research Institute. Department of Prevention and Control of Infectious Diseases, Chief Sanitary Inspectorate [in Polish]. https://wwwold.pzh.gov.pl/oldpage/epimeld/2025/INF_25_03B.pdf (accessed: September 8, 2025).
5. Książkowski M, What are Poles dying from – the latest data from NIZP-PZH [in Polish]. Puls Medycyny, January 13, 2023. https://pulsmedycyny.pl/na-co-umieraja-polacy-najnowsze-dane-nizp-pzh-1174706 (accessed: November 12, 2025).
6. Our World in Data. Respiratory death rate from seasonal influenza, age 65+, 2011. https://ourworldindata.org/grapher/annual-mortality-rate-from-seasonal-influenza-ages-65 (accessed: November 12, 2025).
7. Dattani S, Spooner F. How many people die from the flu? 2022. https://ourworldindata.org/influenza-deaths (accessed: November 12, 2025).
8. Market estimates based on data from distributors and available at www.pzh.gov.pl.
9. Our World in Data. Flu vaccination coverage in the over-65's, 2021. https://ourworldindata.org/grapher/influenza-vaccination-rate-elderly-oecd (accessed: November 12, 2025).
10. European Centre for Disease Prevention and Control. Seasonal influenza vaccination and antiviral use in EU/EEA Member States. Overview of vaccine recommendations for 2017–2018 and vaccination coverage rates for 2015–2016 and 2016–2017 influenza seasons. Technical report. 2018. https://www.ecdc.europa.eu/sites/default/files/documents/seasonal-influenza-antiviral-use-2018.pdf (accessed: November 12, 2025).

11. Warren-Gash C, Hayward AC, Hemingway H, et al. Influenza as a trigger for acute myocardial infarction or death from cardiovascular disease: A systematic review. Lancet Infect Dis. 2009; 9(10): 601–610, doi: 10.1016/S1473-3099(09)70233-6, indexed in Pubmed: 19778762.
12. Warren-Gash C, Bhaskaran K, Hayward A, et al. Circulating influenza virus, climatic factors, and acute myocardial infarction: A time series study in England and Wales and Hong Kong. J Infect Dis. 2011; 203(12): 1710–1718, doi: 10.1093/infdis/jir171, indexed in Pubmed: 21606529.
13. Kwok CS, Aslam S, Kontopantelis E, et al. Influenza, influenza-like symptoms and their association with cardiovascular risks: A systematic review and meta-analysis of observational studies. Int J Clin Pract. 2015; 69(9): 928–937, doi: 10.1111/ijcp.12646, indexed in Pubmed: 25940136.
14. Barnes M, Heywood AE, Mahimbo A, et al. Acute myocardial infarction and influenza: A meta-analysis of case-control studies. Heart. 2015; 101(21): 1738–1747, doi: 10.1136/heartjnl-2015-307691, indexed in Pubmed: 26310262.
15. Finelli L, Chaves SS. Influenza and acute myocardial infarction. J Infect Dis. 2011; 203(12): 1701–1704, doi: 10.1093/infdis/jir175, indexed in Pubmed: 21606526.
16. Kytömaa S, Hegde S, Claggett B, et al. Association of influenza-like illness activity with hospitalizations for heart failure: The atherosclerosis risk in communities study. JAMA Cardiol. 2019; 4(4): 363–369, doi: 10.1001/jamacardio.2019.0549, indexed in Pubmed: 30916717.
17. Ruane L, Buckley T, Hoo SYS, et al. Triggering of acute myocardial infarction by respiratory infection. Intern Med J. 2017; 47(5): 522–529, doi: 10.1111/imj.13377, indexed in Pubmed: 28105763.
18. Kwong JC, Schwartz KL, Campitelli MA, et al. Acute myocardial infarction after laboratory-confirmed influenza infection. N Engl J Med. 2018; 378(4): 345–353, doi: 10.1056/NEJMoa1702090, indexed in Pubmed: 29365305.
19. Warren-Gash C, Blackburn R, Whitaker H, et al. Laboratory-confirmed respiratory infections as triggers for acute myocardial infarction and stroke: A self-controlled case series analysis of national linked datasets from Scotland. Eur Respir J. 2018; 51(3): 1701794, doi: 10.1183/13993003.01794-2017, indexed in Pubmed: 29563170.
20. Ohland J, Warren-Gash C, Blackburn R, et al. Acute myocardial infarctions and stroke triggered by laboratory-confirmed respiratory infections in Denmark, 2010 to 2016.

Euro Surveill. 2020; 25(17): 1900199, doi: 10.2807/1560-7917.ES.2020.25.17.1900199, indexed in Pubmed: 32372757.

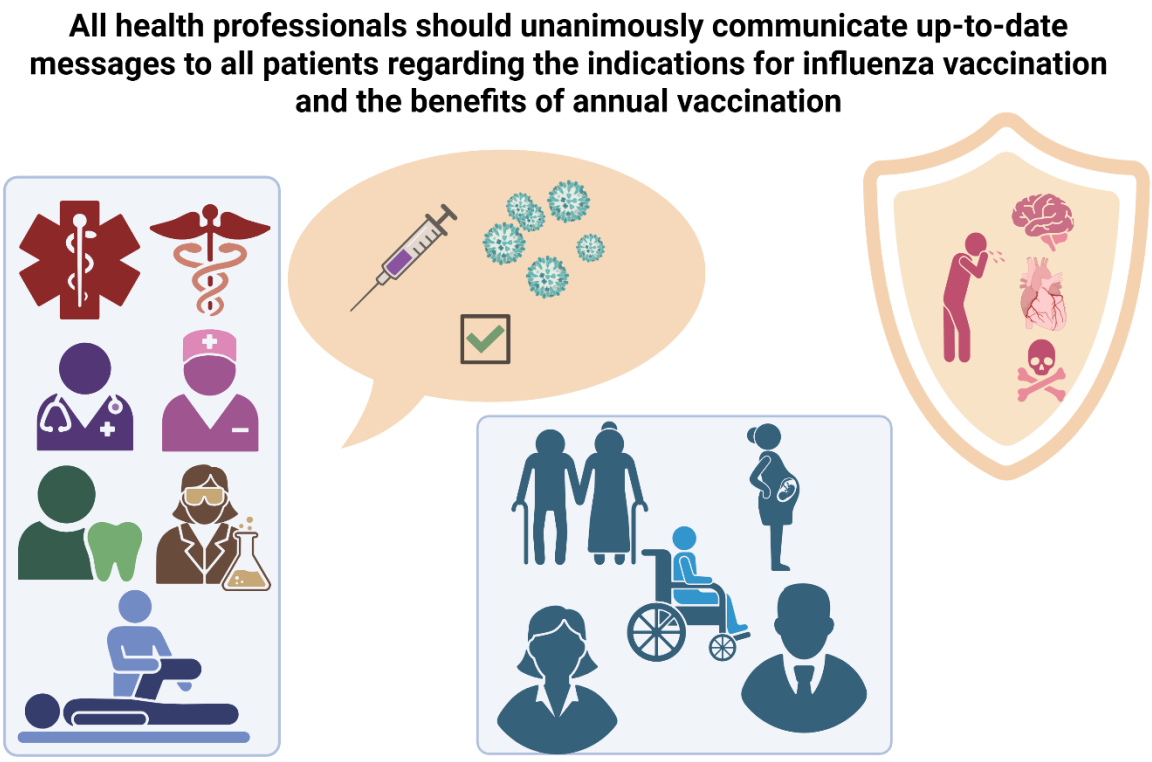
21. Kulick ER, Alvord T, Canning M, et al. Risk of stroke and myocardial infarction after influenza-like illness in New York State. BMC Public Health. 2021; 21(1): 864, doi: 10.1186/s12889-021-10916-4, indexed in Pubmed: 33952233.
22. Schulz-Menger J, Collini V, Gröschel J, et al. 2025 ESC Guidelines for the management of myocarditis and pericarditis. Eur Heart J. 2025; 46(40): 3952–4041, doi: 10.1093/eurheartj/ehaf192, indexed in Pubmed: 40878297.
23. Ouranos K, Vassilopoulos S, Vassilopoulos A, et al. Cumulative incidence and mortality rate of cardiovascular complications due to laboratory-confirmed influenza virus infection: A systematic review and meta-analysis. Rev Med Virol. 2024; 34(1): e2497, doi: 10.1002/rmv.2497, indexed in Pubmed: 38126946.
24. Lavallée P, Perchaud V, Gautier-Bertrand M, et al. Association between influenza vaccination and reduced risk of brain infarction. Stroke. 2002; 33(2): 513–518, doi: 10.1161/hs0202.102328, indexed in Pubmed: 11823662.
25. Udell JA, Zawi R, Bhatt DL, et al. Association between influenza vaccination and cardiovascular outcomes in high-risk patients: A meta-analysis. JAMA. 2013; 310(16): 1711–1720, doi: 10.1001/jama.2013.279206, indexed in Pubmed: 24150467.
26. Modin D, Jørgensen ME, Gislason G, et al. Influenza vaccine in heart failure. Circulation. 2019; 139(5): 575–586, doi: 10.1161/CIRCULATIONAHA.118.036788, indexed in Pubmed: 30586760.
27. Christiansen CF, Thomsen RW, Schmidt M, et al. Influenza vaccination and 1-year risk of myocardial infarction, stroke, heart failure, pneumonia, and mortality among intensive care unit survivors aged 65 years or older: A nationwide population-based cohort study. Intensive Care Med. 2019; 45(7): 957–967, doi: 10.1007/s00134-019-05648-4, indexed in Pubmed: 31187170.
28. Loeb M, Dokainish H, Dans A, et al. IVVE investigators. Randomized controlled trial of influenza vaccine in patients with heart failure to reduce adverse vascular events (IVVE): Rationale and design. Am Heart J. 2019; 212: 36–44, doi: 10.1016/j.ahj.2019.02.009, indexed in Pubmed: 30933856.
29. Yedlapati SH, Khan SU, Talluri S, et al. Effects of influenza vaccine on mortality and cardiovascular outcomes in patients with cardiovascular disease: A systematic review and meta-analysis. J Am Heart Assoc. 2021; 10(6): e019636, doi: 10.1161/JAHA.120.019636, indexed in Pubmed: 33719496.

30. WHO. Influenza (Seasonal) – Factsheet. 2023. https://www.who.int/news-room/factsheets/detail/influenza-(seasonal) (accessed: September 8, 2025).
31. European Centre for Disease Prevention and Control. Seasonal influenza vaccination and antiviral use in EU/EEA Member States. An overview of vaccine recommendations for 2017–2018 and vaccination coverage rates for 2015–2016 and 2016–2017 influenza seasons. Technical report. 2018. https://ecdc.europa.eu/sites/portal/files/documents/Seasonal-influenza-antiviral-use-EU-EEAMember-States-December-2018_0.pdf (accessed: September 8, 2025).
32. Van Gelder IC, Rienstra M, Bunting KV, et al. 2024 ESC Guidelines for the management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS). Eur Heart J. 2024; 45(36): 3314–3414, doi: 10.1093/eurheartj/ehae176, indexed in Pubmed: 39210723.
33. McEvoy JW, McCarthy CP, Bruno RM, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension. Eur Heart J. 2024; 45(38): 3912–4018, doi: 10.1093/eurheartj/ehae178, indexed in Pubmed: 39210715.
34. Mazzolai L, Teixido-Tura G, Lanzi S, et al. 2024 ESC Guidelines for the management of peripheral arterial and aortic diseases. Eur Heart J. 2024; 45(36): 3538–3700, doi: 10.1093/eurheartj/ehae179, indexed in Pubmed: 39210722.
35. Vrints C, Andreotti F, Koskinas K, et al. 2024 ESC Guidelines for the management of chronic coronary syndromes. Eur Heart J. 2024; 45(36): 3415–3537, doi: 10.1093/eurheartj/ehae177, indexed in Pubmed: 39210710.
36. Heidecker B, Libby P, Vassiliou VS, et al. Vaccination as a new form of cardiovascular prevention: A European Society of Cardiology clinical consensus statement. Eur Heart J. 2025; 46(36): 3518–3531, doi: 10.1093/eurheartj/ehaf384, indexed in Pubmed: 40582710.
37. Wełnicki M, Mamcarz A, Kuchar E, et al. The Impact of COVID-19 and the Practical Importance of Vaccinations and Nirmatrelvir/Ritonavir for Patients with Cardiovascular Disease. Vaccines (Basel). 2025; 13(6): 554, doi: 10.3390/vaccines13060554, indexed in Pubmed: 40573885.
38. Mamcarz A, Wełnicki M, Drożdż J, et al. The role of pneumococcal vaccination in reducing cardiovascular risk in cardiac patients: Expert opinion of the Prevention Committee of the Polish Cardiac Society supported by the Polish Vaccinology Society. Kardiol Pol. 2023; 81(10): 1038–1046, doi: 10.33963/v.kp.96718, indexed in Pubmed: 37660388.

39. Summary of product characteristics: InfluvacTetra.
40. Summary of product characteristics: VaxigripTetra.
41. Goodwin K, Viboud C, Simonsen L. Antibody response to influenza vaccination in the elderly: A quantitative review. Vaccine. 2006; 24(8): 1159–1169, doi: 10.1016/j.vaccine.2005.08.105, indexed in Pubmed: 16213065.
42. DiazGranados CA, Dunning AJ, Kimmel M, et al. Efficacy of high-dose versus standard-dose influenza vaccine in older adults. N Engl J Med. 2014; 371(7): 635–645, doi: 10.1056/NEJMoa1315727, indexed in Pubmed: 25119609.
43. DiazGranados CA, Dunning AJ, Robertson CA, et al. Efficacy and immunogenicity of high-dose influenza vaccine in older adults by age, comorbidities, and frailty. Vaccine. 2015; 33(36): 4565–4571, doi: 10.1016/j.vaccine.2015.07.003, indexed in Pubmed: 26187260.
44. Gravenstein S, Davidson HE, Taljaard M, et al. Comparative effectiveness of high-dose versus standard-dose influenza vaccination on numbers of US nursing home residents admitted to hospital: A cluster-randomised trial. Lancet Respir Med. 2017; 5(9): 738–746, doi: 10.1016/S2213-2600(17)30235-7, indexed in Pubmed: 28736045.
45. Johansen ND, Modin D, Nealon J, et al. A pragmatic randomized feasibility trial of influenza vaccines. NEJM Evid. 2023; 2(2): EVIDoa2200206, doi: 10.1056/EVIDoa2200206, indexed in Pubmed: 38320035.
46. Skaarup KG, Lassen MC, Modin D, et al. The relative vaccine effectiveness of high-dose vs standard-dose influenza vaccines in preventing hospitalization and mortality: A meta-analysis of evidence from randomized trials. J Infect. 2024; 89(1): 106187, doi: 10.1016/j.jinf.2024.106187, indexed in Pubmed: 38795774.
47. Moro PL, Arana J, Cano M, et al. Postlicensure safety surveillance for high-dose trivalent inactivated influenza vaccine in the Vaccine Adverse Event Reporting System, 1 July 2010-31 December 2010. Clin Infect Dis. 2012; 54(11): 1608–1614, doi: 10.1093/cid/cis256, indexed in Pubmed: 22441652.
48. Moro PL, Woo EJ, Marquez P, et al. Monitoring the safety of high-dose, trivalent inactivated influenza vaccine in the vaccine adverse event reporting system (VAERS), 2011-2019. Vaccine. 2020; 38(37): 5923–5926, doi: 10.1016/j.vaccine.2020.07.007, indexed in Pubmed: 32709434.
49. European Centre for Disease Prevention and Control. Systematic review of the efficacy, effectiveness and safety of newer and enhanced seasonal influenza vaccines for the prevention of laboratory confirmed influenza in individuals aged 18 years and over.

Technical report. 2020. https://www.ecdc.europa.eu/sites/default/files/documents/seasonal-influenza-vaccines-systematicreview-efficacy.pdf (accessed: September 8, 2025).

50. https://szczepienia.pzh.gov.pl/ (accessed: November 12, 2025).



Graphical abstract. The need for unanimous message on the safety, validity and effects of influenza vaccination

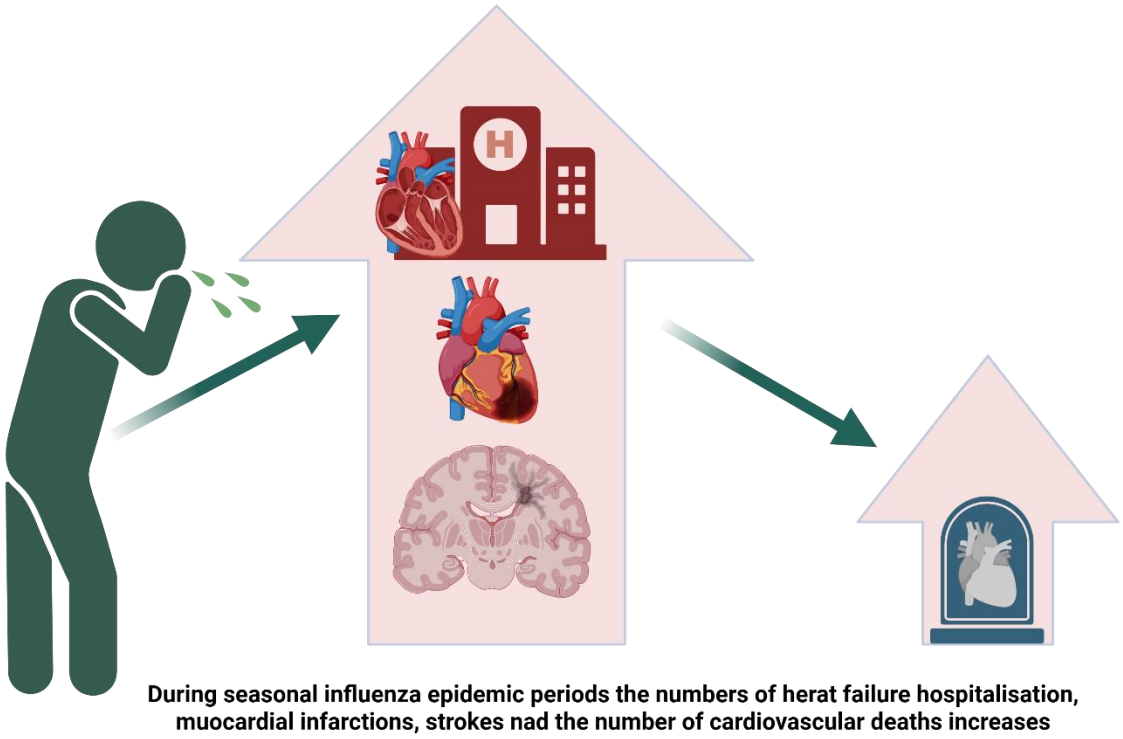


Figure 1. Possible cardiovascular consequences of influenza infection

Table 1. Events by treatment group during of peak influenza period according to Loeb et al. [28]

	Infuenza vaccine (n = 2560)	Placebo (n = 2569)	HR (95% CI)	*P*-value
Primary outcome[a]	193 (7.5%)	237 (9.3%)	0.82 (0.68–0.99)	**0.038**
First co-primary outcome[b]	270 (10.5%)	308 (12.0%)	0.88 (0.74–1.03)	0.11
Death all causes pneumonia	212 (8.3%)	269 (10.5%)	0.79 (0.66–0.95)	**0.0099**
Death cardiovascular	170 (6.6%)	221 (8.6%)	0.77 (0.63–0.94)	**0.0099**

Non-fatal myocardial infarction	9 (0.4%)	13 (0.5%)	0.69 (0.29–1.61)	0.39
Non-fatal stroke	23 (0.9%)	24 (0.9%)	0.98 (0.55–1.74)	0.95
Hospitalization all causes	195 (7.6%)	230 (9.0%)	0.84 (0.69–1.01)	**0.067**
Hospitalization for heart failure	128 (5.0%)	124 (4.8%)	1.03 (0.8–1.31)	0.84
Pneumonia	28 (1.1%)	54 (2.1%)	0.51 (0.32–0.81)	**0.0034**

[a]Primary outcome: cardiovascular death, non-fatal myocardial infarction, or non-fatal stroke. [b]First co-primary outcome: cardiovascular death, non-fatal myocardial infarction, non-fatal stroke or hospitalization for heart failure

Abbreviations: CI, confidence interval; HR, hazard ratio

Table 2. Effects of influenza vaccination — meta-analysis of both — randomized and observational studies. According to Yedlapati et al. [29]

Effect of influenza vaccination	**Randomized control trials**		**Observational studies**	
	RR	**95% CI; (*P*-value)**	**RR**	**95% CI; (*P*-value)**
All-cause mortality	0.53	0,28-0,99; (p=0,05)	0.79	0,62-,099; (p=0,04)
Cardiovascular mortality	0.44	0,26-0,76; (p<0,001)	0.82	0,80-0,84; (p<0,01)
MACE	0.57	0,43-0,74; (p<0,01)	0.90	0,83-0,98; (p=0,02)

Abbreviations: MACE, major adverse cardiovascular events; RR, risk ratio; other — see Table 1