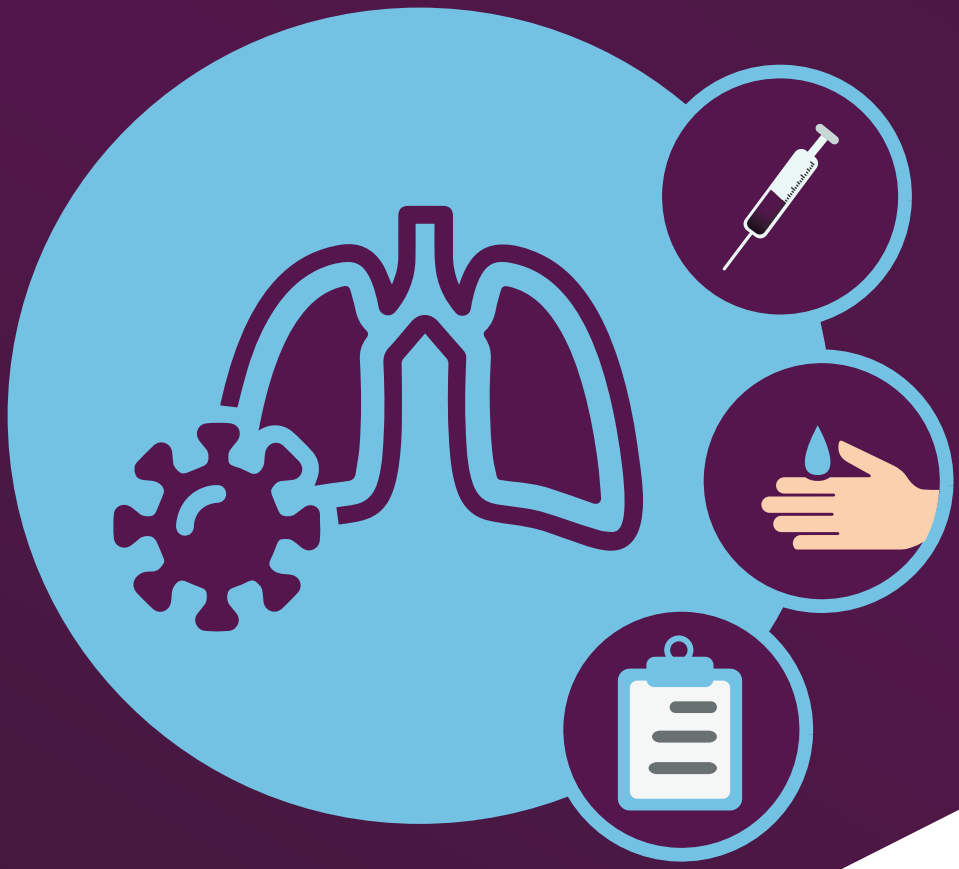
Addressing the Significant Impact of RSV Infections among Older Canadians. It's Time for Action.



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About the National Institute on Ageing

The National Institute on Ageing (NIA) is a public policy and research centre based at Toronto Metropolitan University (formerly Ryerson University). The NIA is dedicated to enhancing successful ageing across the life course. It is unique in its mandate to consider ageing issues from a broad range of perspectives, including those of financial, psychological, and social well-being.

The NIA is focused on leading cross-disciplinary, evidence-based, and actionable research to provide a blueprint for better public policy and practices needed to address the multiple challenges and opportunities presented by Canada's ageing population.

The NIA is committed to providing national leadership and public education to productively and collaboratively work with all levels of government, private and public sector partners, academic institutions, ageing related organizations, and Canadians.

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Acronyms

ACIP	Advisory Committee on Immunization Practices
AE	Acute Exacerbations
ARI	Acute Respiratory Infections
Ro	Basic Reproductive Number
CHSS	Canadian Health Survey on Seniors
CIHI	Canadian Institute for Health Information
CCI	Charlson Comorbidity Index
COPD	Chronic Obstructive Pulmonary Disease
CHF	Congestive Heart Failure
ED	Emergency Department
FDA	Food and Drug Administration
HSCT	Hematopoietic Stem Cell Transplant
HMDB	Hospital Morbidity Database
hMPV	Human Metapneumovirus
hRV	Human Rhinovirus
ICU	Intensive Care Unit
IMPACT	Immunization Monitoring Program ACTive
IRFS	Immunization Registry Functional Standards
IFAs	Immunofluorescence Assays
LNPs	Lipid Nanoparticles
LRTD	Lower Respiratory Tract Disease
NACI	National Advisory Committee on Immunization
PCV13	Prevnar®13
PHAC	Public Health Agency of Canada
QALYs	Quality-Adjusted Life Years
RADTs	Rapid Antigen Detection Tests
RSV	Respiratory Syncytial Virus
RVDSS	Respiratory Virus Detection Surveillance System
RT-PCR	Reverse Transcription-Polymerase Chain Reaction
SARI	Severe Acute Respiratory Infection
US	United States
URTD	Upper Respiratory Tract Disease
WHO	World Health Organization

Executive Summary

Respiratory syncytial virus (RSV) is one of the main respiratory viruses that impacts the health and well-being of Canadians.

RSV is a virus that infects people's airways and lungs,[1] causing infection in the upper and lower parts of their respiratory systems.[2] RSV infections generally cause mild illness with cold-like symptoms (e.g., runny nose, coughing),[3] with infected individuals generally recovering from them in one to two weeks.[4] However, those who are the most vulnerable to experience significant complications as a result of RSV infections, include children younger than two years of age, older adults, individuals with certain high-risk conditions such as cardiac and respiratory disease, and immunocompromised individuals.[5,6]

Almost all children will have experienced their first RSV infection by the age of two.[7] Furthermore, as individuals who are infected with RSV only develop temporary immunity, one may experience repeat infections at any age.[8]

Adults 65 years and older experience more complications from RSV infections, with a sizeable proportion of older adults hospitalized also requiring mechanical ventilation and admission to an intensive care unit.[9]

In fact, this older age group also has the highest mortality rate attributable to RSV infections, more than six times larger than the mortality rate among children younger than one year of age who also experience high rates of hospitalization.[10]

Additionally, there are no specific treatments for RSV infections with the main focus being supportive care.[11,12]

RSV is particularly problematic because it is more contagious than seasonal influenza.[13] Even though hospitalizations attributed to influenza are higher than RSV among older adults,[14] it was found that for adults 60 years and older, there is a similar risk of mortality compared to those infected with influenza.[15]

The reported incidence of hospitalizations attributed to RSV infections among adults has been found to be under-represented, especially among older adults,[16] which is due to limited standard-of-care testing evident in retrospective studies,[17,18] and the lack of sensitivity for detecting RSV among common testing methods.[19,20] This is further compounded by the lack of robust surveillance systems for RSV infections across Canada.[21]

In terms of preventing RSV infections and their complications, there are currently monoclonal antibodies available in Canada for use among certain groups of

infants and children to prevent serious RSV disease.[22] The high cost and health care utilization to administer monoclonal antibodies, specifically palivizumab, has limited its use in older age groups.[23,24,25]

There are numerous types of vaccines now being developed for pediatric, maternal and older adult populations.[26] Currently, there are three vaccines for older adults that either have or are currently seeking market approval for use in various countries: GSK's Arexvy, Pfizer's Abrysvo™ and Moderna's mRNA-1345.[27,28,29] All three vaccines have shown significant vaccine efficacy against RSV lower respiratory tract disease (RSV-LRTD) and severe RSV-LRTD in the first RSV season or year of vaccination.[30,31,32]

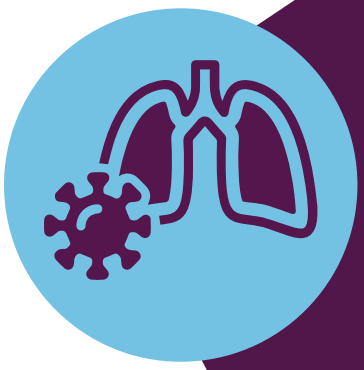
For Canada, Arexvy recently received approval from Health Canada in August 2023,[33] with the application for Abrysvo™,[34] expected to be approved for use in Canada as early as this fall.

With regard to other countries, Arexvy has received approval in the United States (May 2023)[35] and the European Union (June 2023) for use among the older populations.[36] Abrysvo™ has also received approval in the United States (May 2023),[37] the United Kingdom (July 2023) and the European Union (August 2023)[38] for use among older adults.[39] In terms of other populations, Abrysvo™ has received approval in the United States and the European Union in August 2023 for use as a maternal vaccine to protect infants up to six months of age.[40]

Despite the recent advancements in the development of effective RSV vaccines, a lot more work needs to be done in Canada to promote and support improved access to these and other vaccines among older Canadians, which is evident by their continued underwhelming rates of vaccination against several vaccine-preventable diseases.[41] Health care providers will especially need to continue to play an important role to improve the overall understanding and access older Canadians have around their recommended vaccines,[42,43] to overcome the low perceived risks of vaccine-preventable diseases[44] and the still not uncommon belief that certain vaccinations for older adults are not necessary.[45] Health authorities and government bodies will also need to move to harmonize messaging and availability of vaccinations,[46] as well as improve national surveillance and reporting systems.[47,48] Additionally, a lack of awareness of RSV disease by the public and health care providers needs to be addressed with ongoing education and engagement.[49,50]

The NIA has developed nine evidence-informed policy recommendations and practice approaches that can be used by governments, health authorities, health care organizations and their providers to better support RSV vaccination efforts and reduce the overall impact of RSV infections across Canada.

1. Promote General Preventive Practices
2. Improve the Surveillance of RSV Infections and Mortality Across Canada and Understanding of its Impact on Canadian Health care Systems
3. Continue to Work on the Development of RSV Vaccines
4. Promote a Life-Course Vaccination Schedule that Includes Older Adults
5. Provide RSV Vaccinations Free of Cost to Populations for which RSV Vaccination is Cost-Effective
6. Promote Following National Advisory Committee on Immunization (NACI) Statements for RSV Vaccination
7. Provide Clinician Education and Support for Pharmacists, Primary Care and Other Health Care Providers to Deliver RSV Vaccinations
8. Harmonize Vaccination Administration Across and Within Canada's Provinces/ Territories
9. Establish Accurate Reporting and Monitoring of RSV Vaccination Rates



Background and Context

What is RSV?

Respiratory syncytial virus (RSV) is an RNA virus that infects the airways and lungs of humans.[51,52] The virus causes infection in both the upper and lower parts of the respiratory system.[53] RSV only affects humans, who may become infected multiple times throughout their lives. Almost all children will have experienced their first RSV infection by the age of two.[54]

The two main subtypes of RSV are RSV/**A** and RSV/**B**, which are based on the differences in the G surface protein of the virus. There are various genotypes within these two subtypes.[55] These strains of RSV can circulate at the same time, with their proportions varying year to year.[56]

How Does a Person Become Infected with RSV?

The RSV virus has similar paths of transmission as other common respiratory viruses (e.g., seasonal influenza and rhinovirus— the virus that causes the common cold).[57] It is passed along between persons by direct and indirect contact with respiratory secretions. Direct transmission occurs when an infected individual coughs or sneezes and the droplets come into contact with another person, specifically their nose, mouth and eyes (or their hands, with which they then touch their nose, mouth or eyes). Indirect transmission can also occur when an individual comes in contact with surfaces and objects contaminated by an infected individual, who then touches their nose, mouth or eyes.[58]

When comparing the time period to symptom onset (incubation period), RSV symptoms take longer to appear on average (4.4 days), compared to influenza A (1.4 days), influenza B (0.6 days) and the Omicron variant of SARS-CoV-2 (3.42 days).[59,60]

RSV infected individuals may be contagious for three to eight days, with this period potentially beginning even before symptoms appear.[61] It is important to note that immunocompromised individuals and some infants can be contagious for up to four weeks,[62] with RSV being an important cause of health care associated respiratory infections among these groups, including older adults.[63] In terms of the basic reproductive number (Ro) associated with infections, which looks at the number of individuals subsequently infected by a single infected individual on average, it was found that the Ro associated with influenza A is only 0.9-2.1, whereas RSV is 3.0, with SARS-CoV-2 (Omicron variant) that causes COVID-19 being 9.5.[64,65,66]

Individuals may experience repeat infections at any age; however, subsequent infections are usually milder than the initial infection. The reason this occurs is due to RSV infections generally producing temporary immunity.[67] Specifically in older children and younger adults without comorbidities, reinfections are common and can vary from experiencing no symptoms to upper respiratory tract disease (URTD).[68]

What Are the Symptoms of RSV?

RSV infections generally cause a mild illness with cold-like symptoms, which begin two to eight days after being exposed to the virus.[69]

RSV infection symptoms may include:[70]

- Runny nose (rhinorrhea)
- Coughing
- Sneezing
- Wheezing
- Fever
- Decrease in appetite and energy

The symptoms of RSV infections are similar to the symptoms experienced from other respiratory illnesses. Even though nasal congestion, wheezing and fever were all found to be statistically more frequent among older adults infected by RSV compared to non-RSV illnesses, none of these individual symptoms on their own or combined were able to accurately differentiate those who are specifically infected by RSV.[71] Several studies have noted that there is also considerable overlap specifically between RSV and influenza symptoms among older adults, but one distinguishing characteristics of RSV is the reduced prevalence of fever.[72,73]

It is important to note that RSV symptoms tend to occur in stages.[74] Infections generally begin with rhinorrhea and congestion (URTD symptoms) over a few days before progressing to cough, sputum production and wheezing (lower respiratory tract disease [LRTD] symptoms).[75,76] As mentioned earlier, possibly due to the slower onset of symptoms and reduced prevalence of fever compared to those infected with influenza, individuals with RSV infections usually take longer to seek medical attention and become hospitalized.[77]

What Are the Complications of RSV Infections?

RSV infections can cause various complications, depending on the age of those being infected.[78] For children younger than one year of age, RSV infection is the most common cause of pneumonia and bronchiolitis,[79] with 20–30% of RSV-infected infants developing these conditions.[80]

Age is an important factor of hospitalization risk. Hospitalization rates are highest among young children, with rates being particularly high among premature children younger than one year of age.[81] Among adults, hospitalization rates increase with age, especially among individuals 65 years and older.[82] For older adults, a sizeable percentage of hospitalized patients require mechanical ventilation and admission to intensive care unit (ICU).[83]

While mortality from RSV infections is rare among children, it occurs more commonly among older adults hospitalized for an RSV infection.[84] This was especially seen though a recent study on RSV-associated underlying respiratory mortality rates in the United States, where not only was the highest mortality rate observed among adults 65 years and older (14.7 per 100,000), but it was also observed to be more than six times higher than the mortality rate among children younger than one year (2.4 per 100,000).[85] A recent systematic review found the case fatality rate among older adults hospitalized with RSV infections in the United States (US) to be 6–8%.[86]

To provide further context on the impact of RSV complications among older adults, it was estimated that there were approximately 1.5 million cases of RSV acute respiratory infections (RSV-ARI) among older adults across industrialized countries in 2015.[87] Globally, it was estimated that were 336,000 hospitalizations for RSV-ARI and 14,000 in-hospital deaths related to RSV-ARI among older adults in 2015.[88] These numbers may under-represent the actual burden of RSV infections, with the National Institute of Allergy and Infectious Diseases in 2022, estimating that RSV affects approximately 64 million people of all ages and leads to 160,000 deaths annually. However, it is unclear exactly how these values were estimated.[89]

With regard to other infections, a recent systematic review found that among adults 60 years and older, those with RSV infections had a similar risk of hospitalization and mortality compared to those with influenza.[90] Generally, most studies note RSV, human metapneumovirus (hMPV) and influenza-related hospitalizations among adults are similar in their severity (e.g., hospital duration, ICU admission and duration).[91,92,93] However, a US study found geographical variation among mortality rates among adults 65 years and older with RSV infections, which was not observed among individuals infected with influenza.[94] The most evident differentiation between respiratory virus outcomes, was among those younger than one year of age, where the observed mortality rate for RSV infections was five times higher than for influenza.[95]

Another common complication experienced in association with RSV infections is the worsening of pre-existing health conditions. These include asthma, chronic obstructive pulmonary disease (COPD) and congestive heart failure (CHF).[96] Across age groups, both in infants and older adults, RSV infections can also cause pneumonia.[97]

Studies have noted that RSV infections were associated with the hospital admissions for acute myocardial infarction,[98] especially among adults 65 years and older.[99] RSV infections were also significantly associated with hospital admissions for ischemic stroke among adults 75 years and older.[100] In terms of cardiovascular complications in general, a similar percentage of adults with RSV infections experienced cardiovascular complications compared to adults with influenza infections.[101]

Individuals with RSV may also experience viral or bacterial co-infections. Among immunocompromised RSV-positive patients, It has been found that bacterial co-infection significantly increased the chances of presenting with LRTD and pneumonia. Specifically, among adults, bacterial co-infection was found to be an independent predictor of LRTD.[102] The impact of bacterial co-infections is likely due to the damage RSV infections cause on the airway epithelium, or lining, which increases bacterial adherence.[103] Another study also found bacterial co-infections among RSV-positive hospitalized adults significantly influences mortality rates.[104] In regards to viral co-infections it has been noted across a few studies that it generally did not create a difference in clinical severity outcomes among RSV-positive patients.[105,106]

How Does One Test for an RSV Infection?

Table 1: Types of Testing Used in Clinical Settings for RSV Infections

	Viral Culture	Reverse Transcription-Polymerase Chain Reaction (RT-PCR)	Antigen Detection	
			Immunofluorescence Assays	Rapid Antigen Detection Tests
Length of Time	3-5 days[107]	2-24 hours[108]	1-2 hours[109]	Within 30 minutes[110]
Test Sensitivity in Older Adults	Less sensitive[111]	More sensitive[112]	Less sensitive[113]	Less sensitive[114]
Trained Personnel and Equipment Required	Yes[115]	Yes[116]	Yes[117]	No[118]

Testing for RSV infections is important, especially as these infections cannot be readily differentiated from other respiratory illnesses.[119] In outpatient settings, however, RSV testing is not regularly performed due to test availability, cost and no clinical application of findings from the lack of treatment options.[120]

There are various types of testing available to detect RSV infections including: antigen detection tests, RT-PCR and viral culture. The most commonly used RSV tests are real-time RT-PCR and antigen testing, whereas viral culture is less used.[121] Please note, serology is another form of testing; however, as it is currently only used for surveillance and research, it will not be discussed in this section.[122]

In addition to tests, there are also different types of test samples collected, from the upper or lower airway. Nasal wash samples are used generally for young children, whereas nasopharyngeal swab samples are used for adults.[123]

Antigen Detection Tests

With regard to antigen detection tests, these are highly sensitive for children, but not as sensitive for adults,[124] especially older adults.[125] This is due to adults typically shedding a lower amount of virus over a shorter period of time compared to children.[126] There are also various types of antigen detection assays, including immunofluorescence assays (IFAs) and rapid antigen detection tests (RADTs).[127] The IFAs look for viral proteins on antibodies. This type of testing is labour intensive, allows assessment of

sample quality and takes two to four hours for results.[128] It is rarely performed as it is not more sensitive that PCR, and is expensive and requires considerable technical expertise. The RADTs look for signal-labelled antibodies that are attached to target proteins. Unlike IFA, this form of testing does not require trained personnel, is easy to use and provides point-of-care results within approximately 30 minutes. However, a systematic review of RADTs shows the drastic variation in sensitivity across population groups. Despite RADTs having an overall sensitivity of 80%, they perform significantly better in children (81%) compared to adults (29%).[129]

RT-PCR Tests

RT-PCR is currently the most preferred form of testing for diagnosing RSV infection.[130] This is due to this test's ability to detect low viral loads, resulting in a higher sensitivity than the previously mentioned types of testing, especially when focused only on adults.[131,132] Also, results are able to be obtained within a day,[133] and RT-PCR tests may distinguish RSV serotypes, detect other respiratory viruses and pathogens using multi-channel assays.[134]

Viral Culture Tests

Viral culture was once a highly regarded form of testing for RSV infection diagnosis.[135] However viral cultures require trained staff, careful transportation and multiple days for results to be generated.[136] Also, the sensitivity of this method is low (17–39%) compared to RT-PCR or serology, possibly due to the thermolability of the virus.[137]

Specimen Collection Methods

It is important to point out that the specimens used for testing can impact sensitivity as well.[138] The most commonly used specimen collection methods are nasopharyngeal swabs, which collects specimen from the upper part of the throat. These are more sensitive than oropharyngeal swab specimens, which collects specimen from the middle part of the throat.[139] Nasopharyngeal swabs are also better tolerated for adults than nasal aspirations or washes, where specimen is collected through the nasal cavity.[140] However, nasopharyngeal swabs have still been found to underestimate RSV infection as research has shown that lower respiratory tract sputum samples may provide a better collection of viral load compared to nasopharyngeal samples among adults.[141,142]

What Are the Treatments Available for RSV Infections?

There are no specific treatments for RSV infection.[143] Currently, providing supportive care remains the main focus of treating people experiencing RSV infections.[144,145] People are encouraged to drink fluids, get rest and use over-the-counter medications to manage pain, fever and other symptoms.[146]

Individuals experiencing severe cases of RSV infection usually have to be admitted to the hospital to receive additional oxygen, IV fluids or intubation with mechanical ventilation depending on their situation.[147] For older adults or those with respiratory-related comorbidities who have acute wheezing, they may be given inhaled or systemic corticosteroids

and bronchodilators.[148] Most individuals are discharged from the hospital in a few days.[149]

For severe RSV-LRTD symptoms, VIRAZOLE® (ribavirin) aerosol is a treatment available for hospitalized infants and children.[150] There has been limited research showing VIRAZOLE®, administered as an aerosol, may be beneficial for severe RSV-LRTD for newborns and infants who are immunocompromised or have cardiovascular, pulmonary issues.[151] Even though VIRAZOLE® is not for adults,[152] the product (as an aerosol or through an oral off-label version) has been used for adult haematopoietic stem cell transplant and lung transplant patients, despite there being limited data to support this.[153,154] Also, VIRAZOLE® has warnings and precautions (e.g., bronchospasm, teratogenic effects), for patients and health care providers based on human and animal studies.[155] Use of aerosolized ribavirin is further limited due to costs and inconvenience of administering the treatment.[156,157]

A systematic review evaluating the impact of ribavirin treatments found no differences in mortality among patients who were given either oral/aerosol ribavirin compared to supportive care.[158] However, when looking at specific patient groups, mortality was significantly lower in haematological malignancy/stem cell transplant patients in comparison to receiving supportive care. Mortality was not significantly lower in lung transplant patients in comparison to supportive care. For this reason, it was indicated that ribavirin should be considered for RSV-LRTD treatment specifically for haematological malignancy/stem cell transplant patients.[159]

Ribavirin treatments may also be combined with the monoclonal antibody treatment, palivizumab, for RSV disease.[160] Monoclonal antibodies are laboratory-made proteins that are delivered to fight off pathogens.[161] Limited data of early use of intravenous palivizumab and ribavirin in high-risk adults (e.g., heart-lung transplant recipients) indicates potential to reduce progression of the infection to LRTD. However, as the cost of palivizumab is based on weight, it is highly expensive for use in adults compared to children.[162]

There are numerous emerging drug treatments for RSV infections in various stages of clinical development.[163] However, there are particular challenges faced with such developments for the adult population, including an under-appreciation of the impact of RSV infection in the overall adult population that impacts the understanding of potential market size by drug manufacturers. Recruitment for these studies is also highly influenced by the lack of routine availability of point-of-care testing and the many different viruses that cause respiratory infections among adults.[164] RSV may go through changes and mutations that make it resistant to existing drug therapies and vaccines over time. Not only have study findings been disappointing, the treatment of viral infections is usually most successful early in the course of illness; since most persons infected with RSV present for medical care several days into their illness, this can impact the overall treatment efficacy,[165] as has been seen with other antiviral treatments.[166]

Vulnerable Populations in Regards to RSV Infections

As noted earlier, individuals generally recover from RSV infections in one to two weeks, but the risk of severe outcomes from RSV infection are increased among certain groups including: children younger than two years of age; children with neuromuscular disorders; individuals with chronic lung disease, heart disease and compromised immune systems; and adults 65 years and older.[167]

Older Adults

Older adults are a high-risk group for severe RSV complications for various reasons. One includes the natural waning of immune systems that occurs due to ageing, known as immunosenescence. This results in older adults having decreased B-cell responses to new pathogens and decreased cytotoxic T-cell activity, leading to older adults having less effective natural killer cells as they age.[168] This process also results in older adults having decreased responses to vaccination as they age.[169] Another factor includes reduced strength of the respiratory muscles and diaphragm among older adults, which influences lung expansion and a person's ability to fight infections.[170]

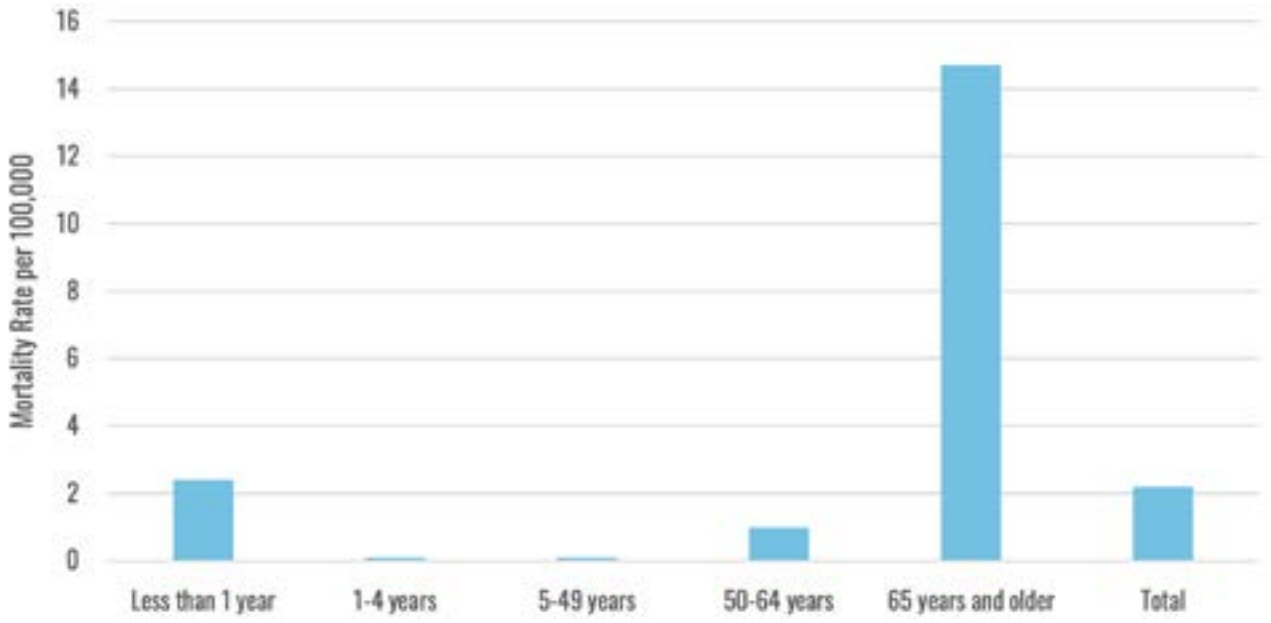
Reviews have shown medically-attended RSV and hospitalized RSV-related acute respiratory illness (ARI) rates increase with age among adults.[171,172]

A recent study in Ontario, Canada, found annual rates of RSV-hospitalizations to be double among individual 70 to 79 years (37 per 100,000 people) and eight times higher among individuals 80 years and older (123 per 100,000 people), when compared to the overall rates of RSV-hospitalizations among adults (15 per 100,000 people).[173] It was found that RSV may be the causative agent in up to 12% of cases for medically-attended ARI among older adults in the United States. The same review also noted that 10–31% of hospitalized older adults with RSV were admitted to an intensive care unit.[174] In terms of inpatient costs and LOS, it was found that among long-term care home residents the rates of cardiorespiratory hospitalizations attributed to RSV was similar to influenza.[175]

Additionally, the incidence of hospitalization attributed to RSV among adults has been found to be significantly under-represented, especially among older adults,[176] due to limited standard-of-care testing evident in retrospective studies.[177,178] This may be due to the minimal impact testing will have on treatment for those with LRTI. Furthermore, the underestimation of hospitalization rates has likely been influenced by the suboptimal sensitivity from RT-PCR testing with nasal or nasopharyngeal swabs, a common testing method across studies.[179] This has especially been demonstrated in comparison studies that have paired this testing with additional specimen types and testing methods.[180,181]

Studies have found that the burden of disease faced by RSV infections is similar to the burden of seasonal influenza. This has especially been seen from a recent study that looked at the excess mortality associated with RSV and influenza in the US over a 20-year period.[182] Excess mortality is the estimated difference between observed and expected underlying respiratory mortality across each respiratory season. It was indicated that the highest mean mortality rate for both viruses were among older adults. The impact of RSV-associated mortality can be seen in Figure 1 below, where the rate among adults 65 years and older was 14.7 per 100,000 people, whereas the next age group with the highest rate was children younger than one year at 2.4 per 100,000 people.[183] Amongst older adults, a study found the mortality rates among RSV-hospitalizations within 30 days of hospitalizations significantly increased with age, with the rate being almost double for individuals 80 years and older (14%), compared to individuals 60 to 69 years (7.6%).[184]

Figure 1: Estimated Annual RSV-Associated Underlying Respiratory Mortality Rates per 100,000 Population in the United States, 1999-2000 to 2017-18[185]



Immunocompromised Individuals

Similar to other respiratory illnesses, immunocompromised individuals are a vulnerable group with respect to RSV infections. Specifically, those who are stem cell transplant and lung transplant recipients were found to experience significant burden due to RSV (e.g., severe disease and mortality).[186] Among hematopoietic stem cell transplant (HSCT) recipients infected with RSV, mortality rates associated with LRTD was found to be up to 80%.[187]

A 10-year retrospective study found that among immunocompromised populations, adults requiring chronic immunosuppressive treatments for rheumatological conditions and those with solid tumors were significantly more likely to be admitted to hospital for an RSV infection compared to HSCT recipients. This study also compared children and adults within this population group, discovering that despite children having significantly more ARI-attributable hospital admissions, adults experienced significantly higher lengths of hospital stay, ICU admissions, mechanical ventilation and mortality (Table 2). Also, immunocompromised adults had significantly higher cases of LRTDs and RSV-attributable pneumonia.[188]

Table 2: Clinical Outcomes of Hospitalized Immunocompromised Children and Adults with RSV Infections from a 10-Year Study in Switzerland[189]

Outcome	Children	Adults
All-Cause Admission to Hospital*	48	107
ARI-Attributable Hospital Admission*	31 (48.4%)	58 (34.1%)
- Mean Length of Hospital Stay*	5	9
- ICU Admission*	2 (6.5%)	17 (29.3%)
- Mechanical Ventilation Use*	1 (3.2%)	13 (22.4%)
- Mortality within 30 days of Admission*	0 (0%)	11 (19.0%)

** The difference between children and adults was found to be significant.*

Individuals Living with Chronic Conditions

Studies have also noted the prevalence of chronic conditions among RSV-infected adults admitted to hospitals,[190,191] with some studies noting 97–98% of these patients having one or more underlying chronic conditions.[192,193] This has also been the case with respect to studies of mortality rates among RSV-positive patients.[194]

A specific focus of research has been on the association between cardiopulmonary disease (e.g., COPD and CHF) and RSV infections. A 12-year study of adults 60 years and older seeking outpatient care for ARI, found that seasonal RSV incidence was significantly higher among those living with cardiopulmonary disease conditions. The seasonal RSV incidence among individuals with chronic cardiopulmonary disease was 196 cases per 10,000 individuals, whereas those without chronic cardiopulmonary disease had a rate of 103 cases per 10,000 individuals. This finding was further reiterated by how COPD and CHF have been found to have the highest relative risk for serious outcomes among RSV-positive patients compared to other high-risk comorbid conditions (Table 3).[195]

Table 3: Relative Risk of Serious Versus Non-Serious Outcomes of RSV-Positive Patients across High-Risk Comorbid Conditions[196]

High-Risk Comorbid Conditions	Relative Risk of Serious* vs. Non-Serious Outcomes
CHF	2.38
COPD	2.18
Immune-Compromised	1.81
Diabetes	1.44
Asthma	1.39

** Serious outcomes included acute care hospital admission, emergency department (ED) visit for acute illness, or pneumonia taking place within 28 days.*

It is important to also highlight that RSV infections can lead to the worsening of asthma, COPD and CHF. A systematic review found that in patients with COPD or asthma, RSV infections caused between 0.6–8% of acute exacerbations of COPD (AE-COPD).[197] Another systematic review found that RSV was one of the most prevalent viruses found in samples of patients with AE-COPD.[198] In the analysis of various viruses during asthma exacerbations, in addition to RSV having one of the higher mean prevalence, when stratified by age, RSV was one of the more prevalent viruses in children.[199] A retrospective cohort study found that more than one in four RSV-positive patients admitted to hospital were also diagnosed with an exacerbation of a lung or cardiac disease.[200]

High-Risk Conditions

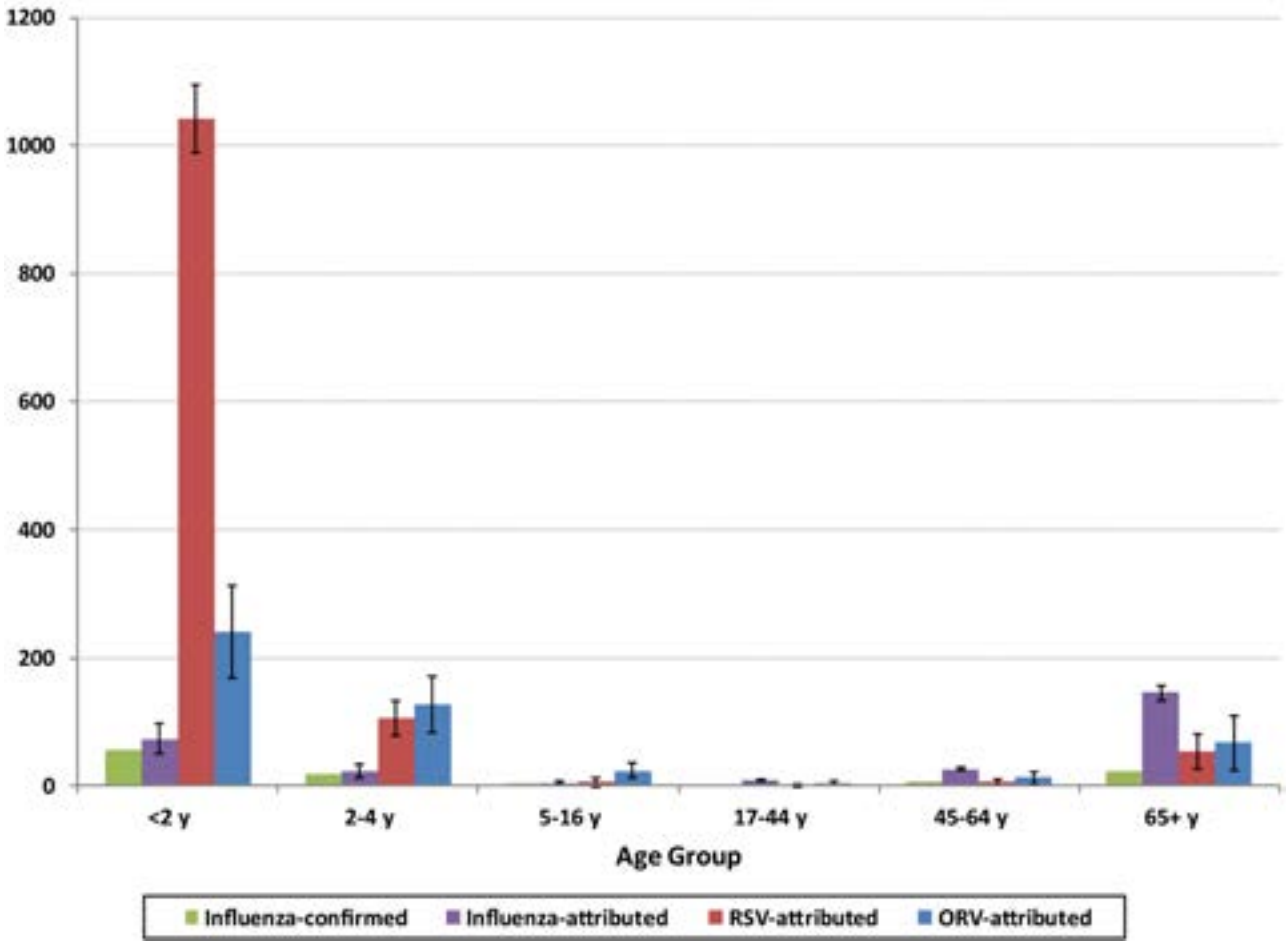
Three other groups of adults that are at high-risk include those who experience homelessness, have a history of smoking, and reside in long-term care homes and other congregate care settings. It has been found that in comparison to influenza-associated hospitalizations, homelessness was associated with an increased odds ratio for RSV-associated hospitalizations.[201] A study based in Ontario, Canada noted residence in a long-term care home was one of the predictors of mortality (within 30 days) following RSV-associated hospitalizations.[202] Lastly, the prevalence of RSV-associated hospitalizations having a history of smoking was evident across studies.[203,204]

Infants and Young Children

As noted earlier, most children will have experienced an RSV infection by two years of age.[205] This can be seen in the annual incidence rate of medically-attended RSV in Alberta from 2010 to 2019, which was reported to be 1,743 cases per 100,000 people, with the highest annual incidence rate found to be among children aged six months to less than one year of age with 6,461 cases per 100,000 people.[206] RSV infections are also the main cause of pneumonia and bronchiolitis among young children and infants,[207] with around 20–30% of RSV-infected infants developing these conditions.[208]

The prevalence of RSV infections in young children is also seen with their corresponding levels of excess respiratory hospitalizations in Canada across multiple years, when compared to other respiratory illnesses. Despite average annual rates of excess respiratory hospitalizations associated with RSV, influenza and other respiratory viruses ranging from 27–33.1 cases per 100,000 people, it was found to be the highest for RSV-attributed hospitalizations among children under two years of age, with 1,042 cases per 100,000 people (Figure 2).[209] However, it is important to keep in mind that these values are based on testing results, which has a significantly higher viral identification for the pediatric population in comparison to the adult population across all virus types,[210] indicating a biased overview of hospitalization rates.

Figure 2: Respiratory Hospitalization Rates/100,000 Population, by Age Group and Viral Attribution[211]



From "Burden of Influenza, Respiratory Syncytial Virus, and Other Respiratory Viruses and the Completeness of Respiratory Viral Identification Among Respiratory Inpatients, Canada, 2003-2014," by D. L. Schanzer, M. Saboui, L. Lee, A. Nwosu, and C. Bancej, 2017, Influenza and Other Respiratory Viruses, 12(1), p. 116 (https://doi.org/10.1111/irv.12497). Copyright 2017 by D. L. Schanzer, M. Saboui, L. Lee, A. Nwosu, and C. Bancej.

Beyond the conditions noted above, young children at highest risk of RSV disease and its burden (e.g., hospitalization) include those born prematurely, living with Down's Syndrome and neuromuscular disorders.[212]

As noted earlier in Figure 1, while the incidence of RSV infections tends to be very high for infants and young children, the RSV-associated underlying respiratory mortality rate remains far less among children younger than one year of age (2.4 per 100,000) compared to adults 65 years and older (14.7 per 100,000). Nevertheless, the RSV-associated underlying respiratory mortality rate was still found to be five times higher than the influenza-associated underlying respiratory mortality rate among children younger than one year of age.[213]

RSV Infections in the Canadian Context

The Prevalence of RSV Infections in Canada and the Impact of COVID-19

The transmission of RSV infections in Canada generally follows a seasonal winter pattern similar to other temperate areas,[214] beginning in October/November and ending in April/May with the majority of cases occurring from December to March.[215] In tropical areas, the RSV season may take place during rainy seasons or throughout the year.[216] The length of annual RSV seasons varies based on location and year. For example, certain locations in the US have RSV seasons that range from 13 to 23 weeks.[217]

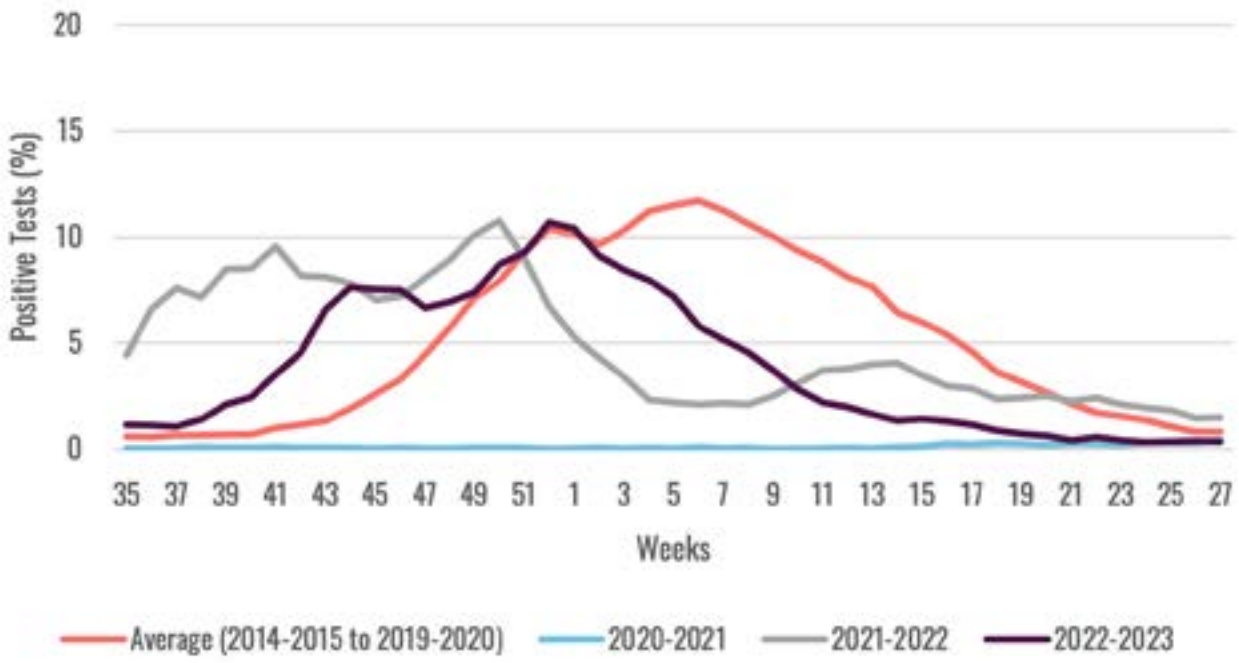
With regard to the two RSV subtypes (RSV/**A** and RSV/**B**), one can be more prevalent or both can circulate during an RSV season.[218] In Canada, both RSV subtypes have been found to co-circulate;[219] however, no consistent trend has been found between these subtypes (and their various genotypes) and RSV disease severity.[220]

Compared to influenza and other respiratory viruses in Canada, despite respiratory hospitalizations attributed to RSV infections being similar in overall incidence, ranging between 27.0 to 33.1 cases per 100,000 people, this is not the case for specific age groups. It was found that not only was the highest rate among RSV-attributed hospitalizations in infants younger than two years (1,042 cases per 100,000 people), but it was also 14 times higher than the rate of influenza for this same age group (72.5 cases per 100,000 people) (Figure 2).[221] Among adults 65 years and older, however, the highest rate was among influenza-attributed hospitalizations (144.9 cases per 100,000 people), with RSV (52.7 cases per 100,000 people) and other respiratory illnesses (67.2. cases per 100,000 people) having significantly smaller rates.[222]

In terms of mortality, Figure 1 based on US data, demonstrates how the RSV-associated underlying respiratory mortality rate remains considerably higher among persons 65 years of age and older (14.7 deaths per 100,000 people) compared to that of children younger than one year of age (2.9 deaths per 100,000 people).[223] This was reiterated by a recent study based in Ontario, Canada, that found similar to influenza or SARS-CoV-2, 85% of deaths among hospitalized patients with RSV were among adults 65 years and older.[224]

During the COVID-19 pandemic, the transmission of RSV along with other respiratory viruses was found to have been drastically reduced in Canada from the implementation of various public health measures (e.g., physical distancing, quarantine measures) especially during 2020 and 2021 (Figure 3).[225,226] This was evident from how prior to these public health measures, there were no significant changes across various respiratory viruses trends, but after the implementation of these measures, test positivity rates of RSV, parainfluenza virus, hMPV, seasonal human coronavirus and influenza A/B all decreased significantly across Canada.[227] This trend was also experienced in many other countries such as the United States, South Korea, Australia and Japan.[228,229]

Figure 3: Positive RSV Tests (%) Reported by Participating Laboratories in Canada by Surveillance Week Compared to Average across the 2014-15 to 2019-20 Seasons[230]



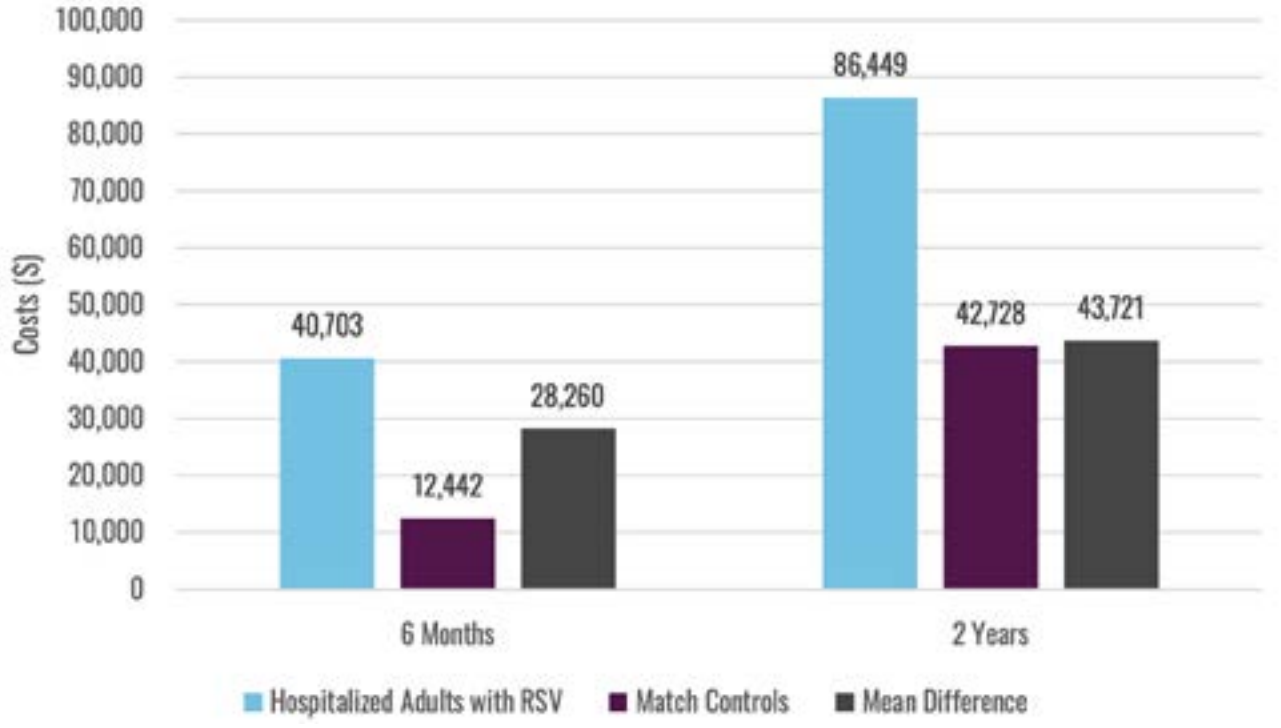
As public health measures were gradually lifted, delayed RSV outbreaks have been noticed across various countries starting from the spring of 2021 onward.[231] Also, there has been an increase in the number of cases during these outbreaks, potentially due to reduced immunity in the community from the lack of exposure to prior RSV infections. However, this was not the case in some countries where a lower number of cases than average was seen during their delayed outbreaks, emphasizing the complex nature of RSV transmission.[232]

In fall 2022, as COVID-19 public health measures were mostly removed,[233] not only did RSV outbreaks occur earlier than usual in Canada (Figure 3),[234] but this was coupled with increases in SARS-CoV-2 and influenza cases, causing a "tripledemic" of respiratory infections.[235,236] It was noted that this may have been due to the public health measures that kept children and pregnant women from being infected with viruses for two years. This caused infants and children from not having had earlier opportunities to develop some level of immunity against these infections.[237] However, it was stated that despite the higher cases, it was not apparent that children were facing greater rates of serious complications from RSV.[238] Overall, this large burden of disease caused numerous impacts, including pediatric hospitals being overcapacity, long emergency room wait times (up to 24 hours), non-emergency surgeries being postponed and transfers of older children to adult hospitals for care.[239]

The Associated Costs of RSV Infections

Various studies have analyzed the costs associated with RSV infections among Canadian adults. An Ontario-based study noted the total costs of adults (18 years and older) hospitalized with RSV infections was $40,703 six months after hospitalization and $86,449 two years after hospitalization. In comparison to the control group, which consisted of adults with non-RSV illnesses matched based on various variables, the mean difference was $28,260 six months after hospitalization and $43,721 two years after hospitalization (Figure 4). At both time points, despite various cost categories contributing to the overall mean difference, it was hospitalization and total physician services that accounted for 70–80% of the overall costs.[240]

Figure 4: Mean Total Costs of Adults Hospitalized with RSV, Match Controls, and their Mean Difference within Six Months and Two Years After Hospitalization[241]

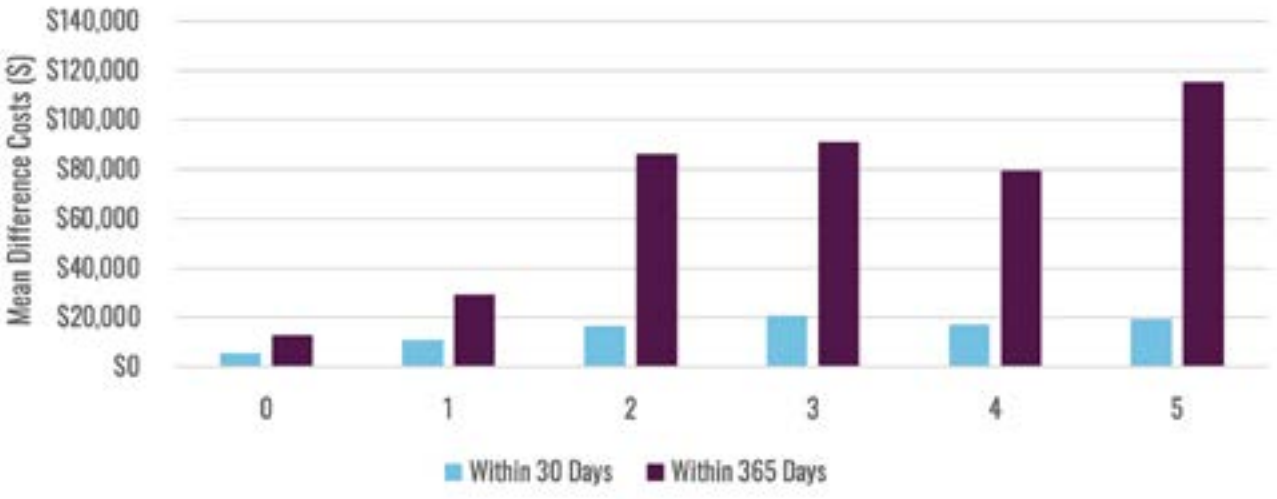


A recent study from Alberta also evaluated the individual health care costs of medically attended RSV cases across two case definitions.

Similar to the previous study, it was found that RSV cases on average had higher costs than their matched controls, with the mean difference increasing over time.[242,243]

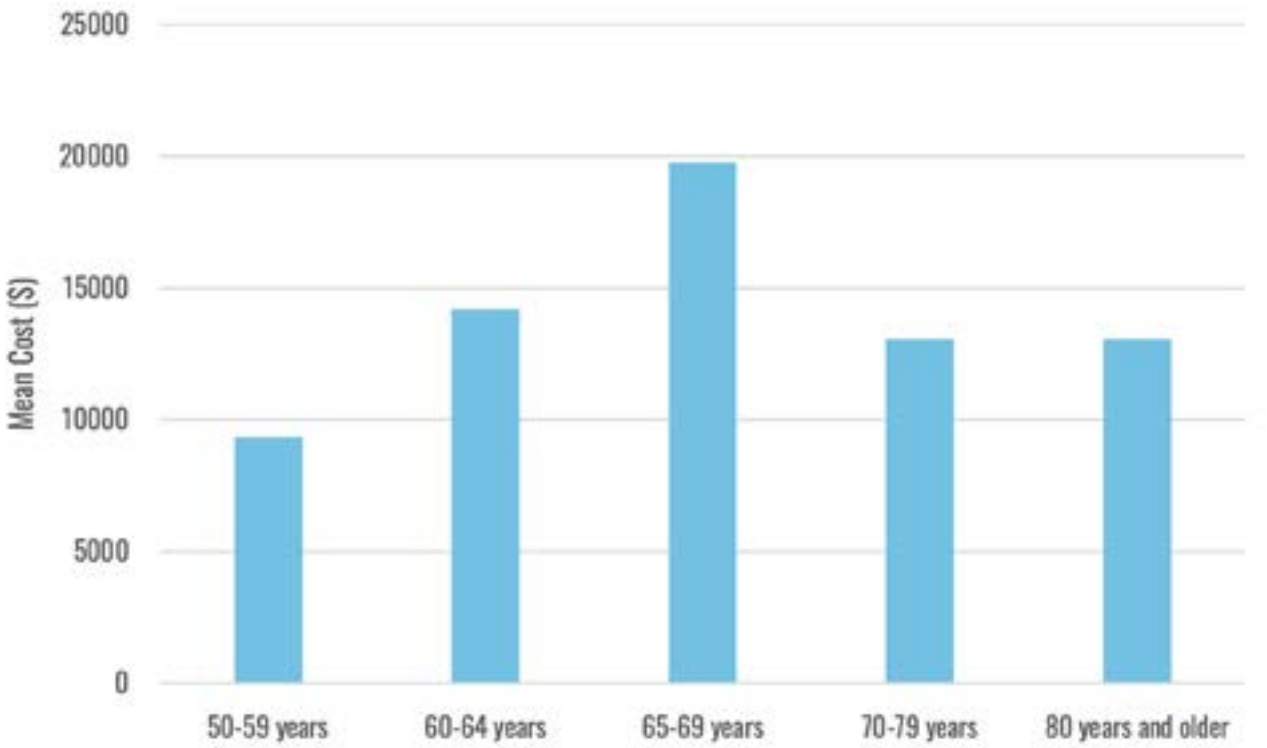
Also, in-patient costs made up the largest category associated with these costs. The mean difference varied based on sex, comorbidities, location (urban/rural) and age (highest among adults 65 years and older, and infants younger than 90 days). One of the variables that showed a big range in mean difference was the severity of a patient's comorbidities. Using the Charlson Comorbidity Index (CCI) score (0 – lowest, 5 – highest), Figure 5 shows the increase in mean difference among laboratory-confirmed RSV cases based on the severity of patient's comorbidities.[244]

Figure 5: Mean Difference Costs among Laboratory-Confirmed Cases across Patient CCI Scores at 30 and 365 Days Following Diagnosis[245]



Another study looked at national data surrounding RSV cases among hospital patients 50 years and older with ARI during influenza seasons. It was found that the mean cost per hospitalized RSV case 30 days after discharge was $13,602, with adults 50 to 59 years having the lowest cost ($9,340) and adults 65 to 69 years having the highest cost ($19,786) (Figure 6).[246] This is in line with findings from the previous study that also found a similar trend for costs 30 days post-diagnosis for laboratory-confirmed RSV cases increasing up to the 50 to 64 years age group and decreasing slightly afterwards.[247] Across the provinces analyzed, mean costs per hospitalized RSV case were found to vary greatly from $7,862 in New Brunswick to $20,291 in Québec. It was predicted that these costs during influenza seasons alone would add up to more than $71 million annually for Canadians 50 years and older and $65 million annually for Canadians 60 years and older.[248]

Figure 6: Estimated Mean Costs for Hospitalized RSV Patients with ARI across Age Groups[249]



RSV Infection Surveillance

Canada's National Surveillance Systems

RSV is currently not a reportable disease in Canada.[250] However, the current spread of RSV is being evaluated through various surveillance systems, including: Respiratory Virus Detection Surveillance System (RVDSS); Immunization Monitoring Program ACTive (IMPACT); and the Canadian Institute for Health Information (CIHI) Hospital Morbidity Database (HMDB). All three of these surveillance systems are focused on passive surveillance, which is where reports are provided from different sources around patients seeking medical attention who are tested to identify RSV infections.[251]

Respiratory Virus Detection Surveillance System

The RVDSS is a national surveillance system coordinated by the Public Health Agency of Canada (PHAC) since 2003.[252,253] This system tracks the circulation of various respiratory viruses including: influenza A and B; RSV; parainfluenza; adenovirus; hMPV; human rhinovirus (hRV); and coronavirus.[254] These viruses are monitored throughout the year with information on test volumes and results collected from certain public health and hospital laboratories across all provinces and territories.[255,256] The tests conducted within these laboratories are generally multiplex PCR tests that are designed to detect RSV among other viruses.[257]

Certain challenges with the RVDSS exist, including not stratifying test volumes and results by other indicators that are important to consider for respiratory infections (e.g., age, sex).[258,259] Also, the RVDSS is not linked with other databases that look into outcomes such as ED visits and hospitalizations, which may assist in the analysis of the burden of RSV infections in Canada.[260,261] Even though each laboratory in this system goes through audits for quality assurance, they decide on their own multiplex PCR assays for virus testing, which may ultimately impact surveillance results.[262,263]

Immunization Monitoring Program ACTive

The IMPACT system is a national hospital-based surveillance network that was established in 1991 to monitor various infectious diseases, along with immunization-related adverse events and vaccine failures among children.[264] It is coordinated by the Canadian Paediatric Society across 12 Canadian centres.[265] The IMPACT system covers not only 50% of the Canadian paediatric population, but also 90% of all tertiary care pediatric beds in the country.[266] The information captured among patients include date of disease onset, sex, age, co-morbid conditions, infections, vaccine history, intensive care need and discharge outcome.[267]

Experts have noted that this system provides adequate data on RSV strain characteristics and specifically with high-

risk pediatric populations, information on RSV-associated hospitalizations and deaths. However, it was also noted that the system gives limited data on the infection and incidence of RSV in rural and remote communities, especially as there are no surveillance centres in Canada's territories or northern provincial areas.[268]

CIHI Hospital Morbidity Database

The HMDB system has been coordinated by CIHI since 1994.[269] This national system focuses on hospital inpatient discharges, specifically administrative data (e.g., admission/discharge dates), clinical data (e.g., diagnosis) and demographic data (e.g., sex). This data is obtained through Canadian acute care centres and day care centres in Quebec.[270] Unlike the IMPACT system, HMDB provides hospitalization data across all ages and populations (e.g., infants, children and older adults).[271]

Despite information being provided for various population groups and measures of RSV burden, experts have noted that no information surrounding RSV virus strains is collected. Also, the HMDB's data in general has been found to be limited as testing is not always done at hospitals and modelling is needed to estimate hospitalizations. In addition, the data on high-risk populations is limited from the way chronic conditions are captured in the HMDB's administrative databases.[272]

A Comparison to Other National Surveillance Systems

United States

The US has various systems to support RSV infection surveillance. One example is the National Respiratory and Enteric Virus Surveillance System (NREVSS), where participating laboratories voluntarily report their test volumes and results on a weekly basis.[273] This is similar to Canada's RVDSS. However, where the NREVSS differentiates itself from the RVDSS is how that system also collects the information regarding testing method (e.g., PCR, antigen detections) and location of testing (e.g., census regions, state level) to provide various trend data.[274]

Another US surveillance system, the Respiratory Syncytial Virus Hospitalization Surveillance Network (RSV-NET) was developed to conduct population-based surveillance for laboratory-confirmed RSV-associated hospitalizations. The system collects various types of demographic (e.g., age, sex, race) and clinical information (e.g., health conditions, outcomes) among children and adult populations.[275]

Other US-based RSV infection surveillance systems include the New Vaccine Surveillance Network, which is a similar surveillance network to the RSV-NET, but focuses on both hospitalization and outpatient visits among children that have RSV infections or other ARIs. The RSV Surveillance in Native American Persons system also focuses on RSV-associated hospitalization and outpatient visits

but specifically amongst the Indigenous populations within specific areas of the US. Lastly, Investigating Respiratory Viruses in the Acutely Ill Network focuses on evaluating the impact of vaccines in preventing hospitalizations among adults. RSV was added to this system in 2022, in anticipation of the availability of RSV vaccines across the US starting in 2023.[276]

European Countries

An evaluation of all European and European Economic Area countries, apart from Liechtenstein, found that a large majority (27/30) of them have an RSV infection surveillance system in place.[277] Within this group, half had a sentinel surveillance system (similar to Canada's IMPACT system) and 26 nations had a non-sentinel surveillance system (similar to Canada's HMDB system). There was a large range in the data being provided to these systems from very broad (e.g., aggregated data) to more advanced (e.g., case based). Similar to the Canadian surveillance systems, the RSV surveillance systems of many European counties is part of their influenza surveillance systems and conduct passive surveillance. Of all the European countries that provide testing information, apart from one country, all had capacity for PCR testing as well.[278]

The Issue of There Being No Standard Syndromic Case Definition for RSV Infections

A prevalent issue across most countries is that there is no standard syndromic case definition to accurately monitor RSV infections.[279,280,281] This further affects the interpretation of RSV surveillance data being collected. This is evident by how RSV surveillance systems use the monitoring of either influenza-like illness or severe acute respiratory infection (SARI) case definitions.[282] The issue with both of these case definitions is that one of their requirements is related to the presence of a "fever," which would not include a significant portion of RSV infection cases among both young children and older adults.[283,284]

To standardize RSV infection surveillance efforts, the World Health Organization (WHO) piloted a RSV infection surveillance strategy based on the Global Influenza Surveillance and Response System, but using a wider case definition.[285,286] This was done across 14 countries where case-based clinical, epidemiological and laboratory data was collected weekly.[287,288]

Two types of surveillance were conducted in this pilot, hospital-based and community-based surveillance. For the former, patients of all ages with extended SARI case definitions were included if they had a cough or shortness of breath that began in the last 10 days requiring hospitalization. Also, all infants (less than six months) with apnea or sepsis were included, as these are common conditions for those infected with RSV in

this population. For community- based surveillance, individuals who met the WHO ARI case definition were included. ARI are clinic patients who have a sudden onset of either shortness of breath, cough, sore throat or coryza. All laboratories used real-time reverse transcription PCR testing to confirm RSV infections.[289]

The use of these definitions was found to substantially increase the number of RSV infections detected. For example, within this pilot, among hospitalized infants (less than six years of age), it was found that 29% of the cases using extended SARI case definitions were missed when fever was one of the inclusion factors (the original SARI case definition).[290] Also, when these definitions were evaluated using surveillance data across New Zealand hospitals, it was found that sensitivity of SARI was lowest for those younger than three years and 65 years and older. Also, there was a dramatic increase in sensitivity when using the extended SARI definition, with the percentage increasing from 43.6–99.5% for individuals aged three years and younger and the percentage increasing from 53.9–96.4% for individuals aged 65 years and older.[291]

How Vaccines and Other Treatment Are Being Developed to Better Prevent and Manage RSV Infections

The Recent Advent of New RSV Vaccines

How Vaccination Can Better Protect Individuals from Infections and their Consequences

Our body may come across various bacteria, viruses or fungi that can cause diseases. These are known as pathogens. To fight off these disease-causing organisms, our body's immune system develops antibodies that are produced based on a part of the pathogen called an antigen. This helps create protection against the disease, which is known as immunity.[292]

In our body, we have thousands of different antibodies for specific pathogen-related antigens. However, when a body comes across a new pathogen for the first time, it will take time to produce the specific antibodies, which may make the individual susceptible to illness. It is important to note that our body also creates antibody-producing memory cells that remain even after the pathogen is removed by the antibodies to help our body respond faster to the same pathogen in the future.[293]

Vaccines contain weakened virus, inactive antigens or a blueprint to produce antigens that triggers an immune system response.[294] This allows our bodies to understand how to fight the pathogen when exposed to it in the future, thus establishing vaccine-induced immunity.[295,296]

The Community Benefits of Vaccines

The impact of vaccination extends beyond an individual, especially when numerous people are vaccinated. Having more vaccinated people makes it harder for a pathogen to circulate within a community. Therefore, if enough people are vaccinated, those people who are unable to receive vaccination (e.g., allergic reactions) or who do not respond well to vaccination (e.g., because they are immunocompromised) are less likely to be exposed to someone infected with the pathogen and thus less likely to be infected. This phenomenon is called herd immunity.[297]

The impact of herd immunity has already been seen with the implementation of other vaccines in Canada. For example, when Prevnar®13 (PCV13) was initially introduced in pediatric immunization programs in Canada, not only did it decrease the prevalence of PCV13-serotype invasive pneumococcal

infections among children younger than five years (from 67% to 18%), but also among adults aged 65 years and older (from 50% to 23%).[298]

The potential health and economic benefits that could be achieved through RSV vaccination have been noted across various outcomes studies. Recently, an economic model looked into the outcomes of RSV infections among adults aged 60 years and older during one US RSV season in response to a potential vaccine. Some of the vaccine attributes assumed were an efficacy of 50% against overall RSV disease and an efficacy of 65% against moderate-to-severe LRTD. Also, predicted coverage was assumed to equal the coverage of the influenza vaccine among adults 65 years and older in the US. It was found that compared to no vaccination, around a third of medically attended RSV cases, RSV hospitalizations and RSV-attributable deaths could be prevented annually. This would also prevent a third of quality-adjusted life years (QALYS) from being lost and a third of direct medical costs, with the latter ranging between US$557 million to US$1.02 billion (Table 4).[299] The substantial decrease in health and economic RSV burden among adults 60 years and older was also estimated in a Belgian study, with its reported benefits being found to increase with a longer vaccine duration of protection (e.g., three and five years).[300]

Table 4: Results of One Study Predicting Annual Health and Cost Reductions across One Season from RSV Vaccination in the United States[301]

Outcome	Difference Value	Difference %
Medically Attended RSV Cases	322,542 – 395,541	32.65 – 34.31
RSV Hospitalizations	43,730 – 81,522	34.31 – 37.09
RSV-Attributable Deaths	7,996 – 14,906	34.31 – 37.09
QALYs Lost due to Acute RSV Cases	1,828 – 3,908	33.48 – 34.07
QALYs Lost due to RSV-Attributable Deaths	71,008 – 132,375	34.31 – 37.09
Direct Medical Costs (2019 US$ millions) due to Acute RSV Cases	US$557.3 – $1,024.2	34.30 – 36.65

The History of the Development of RSV Vaccines

Development of RSV vaccines first began in the 1960s; however, a formalin-inactivated RSV vaccine caused a severe response among infants experiencing their first natural RSV infection known as vaccine-associated enhanced respiratory disease. The concerns over the formalin-inactivated RSV vaccine thus slowed research around other alternatives.[302]

The recent rapid development of RSV vaccines and monoclonal antibodies began through the development of a better level of understanding around the prefusion form of the RSV F protein (prefusion F). Specifically, regarding the structure of the prefusion F protein, improvements in the understanding on how to stabilize it and the impact it plays in the virus's actions have all been important developments.[303] This led to the finding that antibodies directed at prefusion F were effective at blocking RSV infections.[304]

This enhanced recent understanding of the RSV prefusion F protein actually fuelled the development of the mRNA COVID-19 vaccines, which had stabilized versions of the prefusion-F spike protein from the SARS-CoV-2 virus.[305] The success of the COVID-19 vaccines has now propelled RSV vaccine development for older adults.[306] As noted in Table 5, one of the nucleic acid (mRNA) RSV vaccines that is currently being tested uses the same formulation as the SpikeVax (Moderna) COVID-19 vaccine.[307]

The RSV G protein is another part of the virus that has been targeted in vaccine development efforts. Higher amounts of Anti-G and anti-prefusion-F antibodies have been found to correlate with lower disease severity. However, there have been difficulties in developing these vaccines, including the increased variability of this protein compared to the prefusion F protein.[308]

There are numerous types of RSV vaccines that are currently being developed, which can be categorized into the four following groups: live-attenuated/chimeric; protein subunit or particle-based; nucleic acid; and recombinant vectors (Table 5). These vaccines are currently being targeted for three population groups in particular — pediatric, maternal and older adults.[309] Pregnant women are a specific focus in RSV vaccine development efforts as it has been found that RSV neutralizing antibodies are passed to the fetus during both natural infections and vaccination.[310,311,312] In the coming years, based on the results of ongoing clinical studies, there may be the possibility of RSV vaccines also targeted toward adults with underlying conditions, similar to other vaccine-preventable diseases,[313] and being combined with other vaccines (e.g., COVID-19 and/or influenza).[314]

Table 5: A Summary of the Types of RSV Vaccines under Development

Type	Description	Target Populations[315]	Highest Phase of Vaccine Candidates[316]
Live-Attenuated Vaccines (including Chimeric Vaccines)	These vaccines are developed with modified RSV that can replicate, but have also been weakened to not cause serious disease. These vaccines can be provided through the nose.[317]	Pediatric	Currently undergoing Phase 2 trials
Subunit-Based Vaccines	These vaccines are made up of RSV protein fragments, given on its own or with adjuvant (to boost immune response).[318]	Pediatric Maternal Older adults	Older adults vaccines market approved in Canada, the European Union, the United Kingdom and the US Maternal vaccine market approved in the European Union and the US
Particle-Based Vaccines	These vaccines boost immune response by presenting multiple copies of an antigen through particle assembly.[319]	Older adults	Currently undergoing Phase 1 trials
Nucleic Acid	These vaccines use the RSV pre-fusion F protein and the same formulation as the Moderna SpikeVax COVID-19 vaccine to create an immune response.[320]	Pediatric Maternal Older adults	Currently undergoing Phase 3 trials
Recombinant Vectors	These vaccines use a modified virus that is not able to replicate to create immunity by delivering genes for RSV antigens.[321]	Pediatric Older adults	Currently undergoing Phase 3 trials

Despite these recent advancements, it is important to highlight the various challenges still influencing RSV vaccine development. Some of the factors include the diversity of antigens within RSV itself and how infection in response to the virus can reduce immune responses.[322] Also, although various body processes have been associated with protection (e.g., neutralizing antibodies, cell-mediated immunity),[323] it is still unclear what the correlate or definitive mechanism of protection for RSV is among infants and older adults.[324,325] Another challenge is distinguishing the best clinical indicators that can be used to evaluate the impact of vaccine candidates,[326] as certain indicators have low rates (e.g., RSV-related hospitalizations).[327] Also, beyond vaccine approval, stable and reproducible immunogenicity assays aligning with the vaccine will need to be created to further evaluate the vaccine's overall effectiveness.[328]

As noted earlier, a further challenge specifically around the development of vaccines for older adults is the issue of immunosenescence or the waning immune system associated with ageing.[329]

To find regularly updated information on the development RSV vaccines and monoclonal antibodies, please visit the following links:

- RSV Vaccine and mAb Snapshot — provides a summary of the status of various candidates and products[330]
- RSV and mAb Trial Tracker — provides detailed information on clinical trials of various candidates and products[331]

The Current State of Development of RSV Vaccines

With the rapid development of RSV vaccines, the WHO has supported these efforts with the development of guidelines and standards. This includes the October 2019 *Guidelines on the Quality, Safety and Efficacy of Respiratory Syncytial Virus Vaccines*. This document provides guidance on the development processes and evaluation of human RSV vaccines for vaccine manufacturers and national regulatory authorities.[332] There is also the 2017 *Antiserum to Respiratory Syncytial Virus WHO 1st International Standard*, which was developed to enable the standardization of RSV neutralization testing regardless of testing method and ultimately allow the comparison of immunogenicity between RSV vaccines.[333]

Recently, two protein subunit-based RSV vaccines have received market approval in the US. Arexvy, developed by GSK, first received its approval in May 2023 from the US Food and Drug Administration (FDA) for the prevention of RSV-LRTD for those 60 years and older.[334] Abrysvo™, developed by Pfizer, also received approval a few weeks later in May 2023 by the US FDA for the prevention of RSV-LRTD for those 60 years and older as well.[335] Moderna announced in July 2023 that they have begun a rolling submission of a Biologics License Application for their mRNA-based RSV vaccine, mRNA-1345 with the US FDA.[336]

With regard to approval of RSV vaccines in other countries for older populations, European Marketing Authorisation was granted to Arexvy in June 2023,[337] and Abrysvo™ in August 2023.[338] Abrysvo™

has also received authorization from the Medicines and Healthcare products Regulatory Agency (United Kingdom) in July 2023, for the prevention of RSV-LRTD in adults 60 years and older.[339] A new drug application for this vaccine has been accepted by the Japanese Ministry of Health, Labour and Welfare in October 2022.[340] In terms of mRNA-1345, marketing authorization applications have been submitted with the European Medicines Agency, Swissmedic (Switzerland) and the Therapeutic Goods Administration (Australia).[341]

For Canada, Arexvy has received approval from Health Canada in August 2023,[342] while an application for Abrysvo™ has been under review since April 2023.[343]

It is expected Abrysvo™ will be approved for use in Canada as early as fall 2023. Currently, Arexvy is only funded in Ontario for adults 60 years and older living in long-term care homes, Elder Care Lodges and for certain retirement home residents.[344]

For use in other populations, Abrysvo™ was approved by the European Commission and US FDA in August 2023 as a maternal vaccine to protect infants up to six months of age.[345,346] Also, applications for this vaccine's use in this population have been accepted for review by Health Canada in April 2023 and filed with Japan's Ministry of Health, Labour and Welfare in February 2023.[347]

A Review of the Three Currently Promising RSV Vaccines for Older Adults

There are three RSV vaccines for older adults that either already have or currently are seeking market approval in Canada and other countries. These include GSK's Arexvy, Pfizer's Abrysvo™ and Moderna's mRNA-1345.

The Arexvy Vaccine (GSK)

Arexvy (RSVPreF3 OA) is the first market-approved RSV vaccine for older adults in the world.[348] This subunit protein vaccine contains the prefusion F glycoprotein antigen and an adjuvant.[349] The latter is used to boost an individual's immune response to the vaccine.[350] It is administered through a single dose as an intramuscular injection.[351]

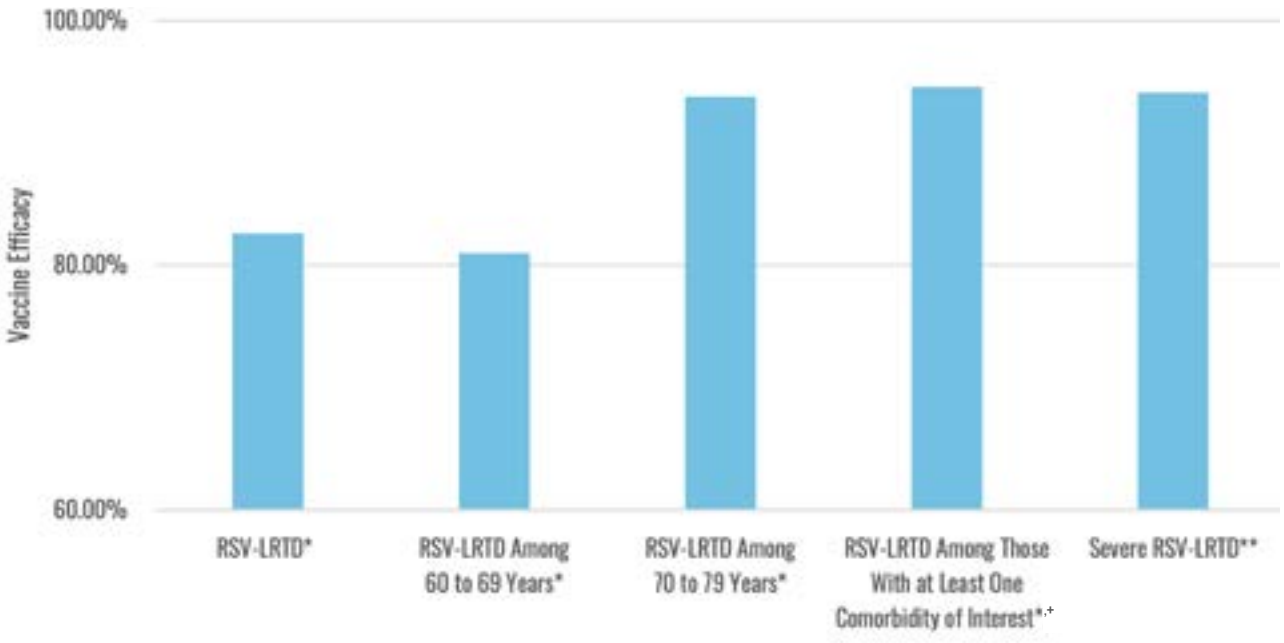
The study results that provided this vaccine with market approval by the US FDA and European Marketing Authorisation is the AReSVi-006 Phase 3 trial (NCT04886596).[352,353] This ongoing multi-year, randomized, placebo-controlled and observer-blind trial is taking place to test the impact of one dose of the vaccine among individuals 60 years and older among 24,966 participants across 17 countries.[354]

In the study's findings, the primary outcome of interest was the occurrence of RSV-LRTD, which was defined as having at least two lower respiratory symptoms/signs for at least 24 hours including at least one lower respiratory sign or having at least three lower respiratory symptoms for at least 24 hours. The study also looked into the occurrence of severe RSV-LRTD, which was defined as

the appearance of LRTD with at least two respiratory signs or assessed as severe by the investigator.[355]

What was found was that at the end of the trial's first RSV season, the vaccine's efficacy against the occurrence of RSV-LRTD was 82.6%, with similar rates across age groups 60 to 69 years (81%) and 70 to 79 years (93.8%). The vaccine efficacy against RSV-LRTD was 72.5% in those who were healthy and 94.6% in those with at least one underlying condition. The vaccine's efficacy against the occurrence of severe RSV-LRTD was 94.1%. The vaccine's efficacy was also found to be consistent for both RSV-A and RSV-B subtypes (84.6% and 80.9%).

Figure 7: Vaccine Efficacy of Single Dose of Arexvy against RSV-LRTD and Severe RSV-LRTD in the First RSV Season[356]



* *RSV-LRTD was defined as at least two lower respiratory symptoms/signs for at least 24 hours including at least one lower respiratory sign, or at least three respiratory symptoms for at least 24 hours during the first RSV season.*

** *Severe RSV-LRTD was defined as LRTD with at least two LRTD signs or through investigator assessment or a need for mechanical ventilation during the first RSV season.*

\+ *Comorbidities of interest include diabetes type 1 or type 2, CHF, advanced liver disease, chronic pulmonary disease, chronic respiratory disease, COPD, asthma or advanced renal disease.*

Among these study findings, it was noted that the incidence of solicited local adverse reactions and systemic adverse reactions within four days of vaccination were higher among the vaccine group compared to the placebo group. It is important to highlight that these reactions lasted on average one to two days and were mild to moderate in severity. Similar rates between groups were found with respect to serious adverse events within six months of vaccination.[357]

Recently, GSK provided the ongoing AReSVi-006 phase III trial's findings of vaccine efficacy rates over two full RSV seasons.[358] The Arexvy vaccine appears to have maintained efficacy from the first RSV season to the middle of the second RSV season, with vaccine efficacy being 77.3% against RSV-LRTD and 84.67% against severe RSV-LRTD. The cumulative vaccine efficacy over two RSV seasons was 67.2% against RSV-LRTD and 78.8% against severe RSV-LRTD. A similar trend over two RSV seasons were noted for adults with underlying conditions and older age groups. However, cumulative vaccine efficacy over two RSV seasons was only 67.1% in those who received a second dose of the vaccine after 12 months, indicating that revaccination may not appear to provide additional benefit. Similar to the first season's findings, the vaccine had a favourable safety profile with adverse events being generally short-term and mild to moderate in severity.[359]

It is important to note that despite there being three other Phase 3 studies evaluating Arexvy on individuals 60 years and older, the AreSVi-006 study was the only one that was placebo-controlled.[360] One of these trials (NCT05879107) noted the consistency of immune response across three lots of the vaccine. Another trial (NCT04841577, known as RSV-007 study) examined the impact of administering Arexvy and Fluarix Quadrivalent vaccines concomitantly amongst 885 participants. There appeared to be no interference in the impact of the two vaccines and a favourable safety profile was again observed. An ongoing trial (NCT04732871, known as AreSVi-004 study) is evaluating the impact of administering Arexvy across different vaccination schedules among 1,653 participants.[361]

In terms of safety, it was found that two participants of the RSV-007 study developed acute disseminated encephalomyelitis, a rare inflammation impacting the brain and spinal cord, with one participant passing away.[362] The AreSVi-004 study also found one participant had developed Guillain-Barré syndrome, a rare disorder where the immune system damages nerve cells.[363] These serious adverse events were considered to be causally related to the vaccine provided, with the former noted to be causally related to the Fluarix Quadrivalent vaccines.[364]

Moving forward, there are other active Phase 3 trials among older adults that look into co-administration of the Arexvy with the high-dose influenza vaccine (NCT05559476), adjuvanted quadrivalent influenza vaccine (NCT05568797) and 20-valent pneumococcal conjugate vaccine (NCT05879107).[365]

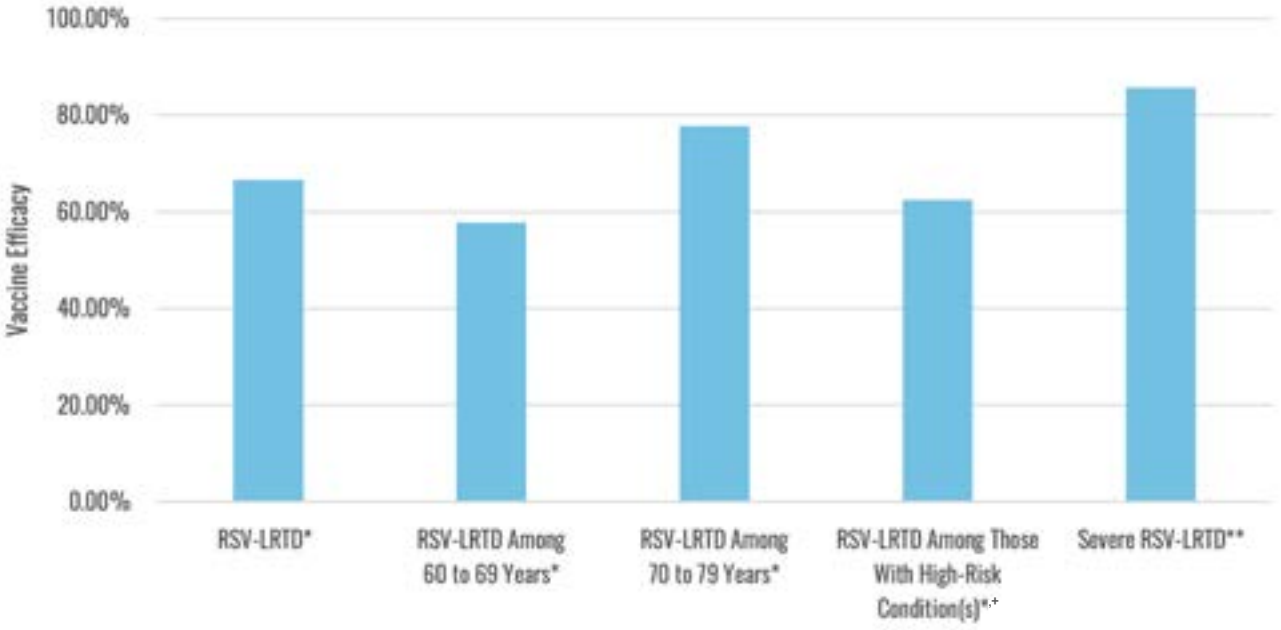
The Abrysvo™ Vaccine (Pfizer)

Abrysvo™ is an unadjuvanted bivalent RSV prefusion F subunit protein vaccine, made up of two prefusion F proteins to enable protection from both RSV/A and RSV/B strains.

The decision for this vaccine's market approval by the US FDA was based on the results of the Phase 3 RENOIR (**R**SV vaccine **E**fficacy study i**N** **O**lder adults Immunized against **R**SV disease) trial (NCT05035212). This ongoing randomized placebo-controlled and double-blind trial is taking place is seeking to test the impact of the vaccine among individuals 60 years and older. Already, this trial has enrolled approximately 37,000 participants.[366]

This trial, whose primary outcome of interest was the occurrence of RSV-LRTD, found that at the end of the first RSV season, the vaccine's efficacy against RSV-LRTD (two or more symptoms) was 66.7%, with similar rates across age groups: 60 to 69 years (57.9%); 70 to 79 years (77.8%); and more than 80 years (80%). The vaccine efficacy against RSV-LRTD was 70.6% in those who were healthy and 62.5% in those with at least one high-risk condition. The vaccine efficacy against severe RSV-LRTD (three or more symptoms) was 85.7%, with similar rates across age groups: 60 to 69 years (77.8%); 70 to 79 years (100%); and more than 80 years (100%). Also, the vaccine efficacy against severe RSV-LRTD was 100% in those who were healthy and 75% in those with at least one high-risk conditions. The study also noted the vaccine efficacy against RSV-ARI which was 62.1%.[367]

Figure 8: Vaccine Efficacy of Single Dose of Abrysvo™ against RSV-LRTD and Severe RSV-LRTD in the First RSV Season[368]



* *RSV-LRTD defined as having at least two signs or symptoms for more than 24 hours and RSV infection confirmed by testing during the first RSV season.*

** *Severe RSV-LRTD defined as having at least three signs or symptoms for more than 24 hours and RSV infection confirmed by testing during the first RSV season.*

\+ *High-risk conditions include tobacco use, diabetes, heart disease, liver disease, lung disease and renal disease.*

Among these study findings, it was noted that despite the incidence of solicited local adverse reactions within seven days of vaccination being higher among the vaccine group, the incidence of solicited systemic events within seven days of vaccination was similar between the vaccine and placebo group. It is important to highlight that these reactions lasted, on average, one to two days and were mild to moderate in severity.[369] Similar rates between groups were also found with respect to serious adverse events at the data cut-off date (average of seven months of surveillance).[370] However, the following three serious adverse events noted in the vaccine group were considered to be related to vaccination: delayed allergic reaction, myocardial infarction (later diagnosis consistent with Guillain-Barré syndrome) and Miller Fisher Syndrome.[371]

Recently, Pfizer provided the ongoing Phase 3 RENOIR trial's findings of vaccine efficacy rates for the middle of the second RSV season in the Northern Hemisphere. The Abrysvo™ vaccine appears to have maintained efficacy from the end of the first RSV season to the middle of the second RSV season with vaccine efficacy across these six months being 48.9% against RSV-LRTD and 78.6% against severe RSV-LRTD. With these findings, no additional adverse events were reported.[372]

In another Phase 3 randomized, placebo-controlled and double-blind study, non-published positive results have been reported by Pfizer on the safety and immunogenicity of the vaccine when co-administered with seasonal inactivated influenza vaccine was found among individuals 65 years and older. The study showed non-inferiority for all four flu strains and two RSV groups.[373]

Moving forward, the Phase 3 RENOIR trial will continue to assess the safety, immunogenicity and efficacy of one dose of Abrysvo™ to the end of the second RSV season. Two sub-studies are also part of this trial evaluating the safety and immunogenicity of a second dose of Abrysvo™ administered after one or two years from the first dose of the vaccine.[374] Another ongoing study is a Phase 3 master protocol (MONET), which is evaluating Abrysvo™ among adults at high risk of severe RSV disease, including adults 60 years and older with weakened immune systems.[375]

The mRNA-1345 Vaccine (Moderna)

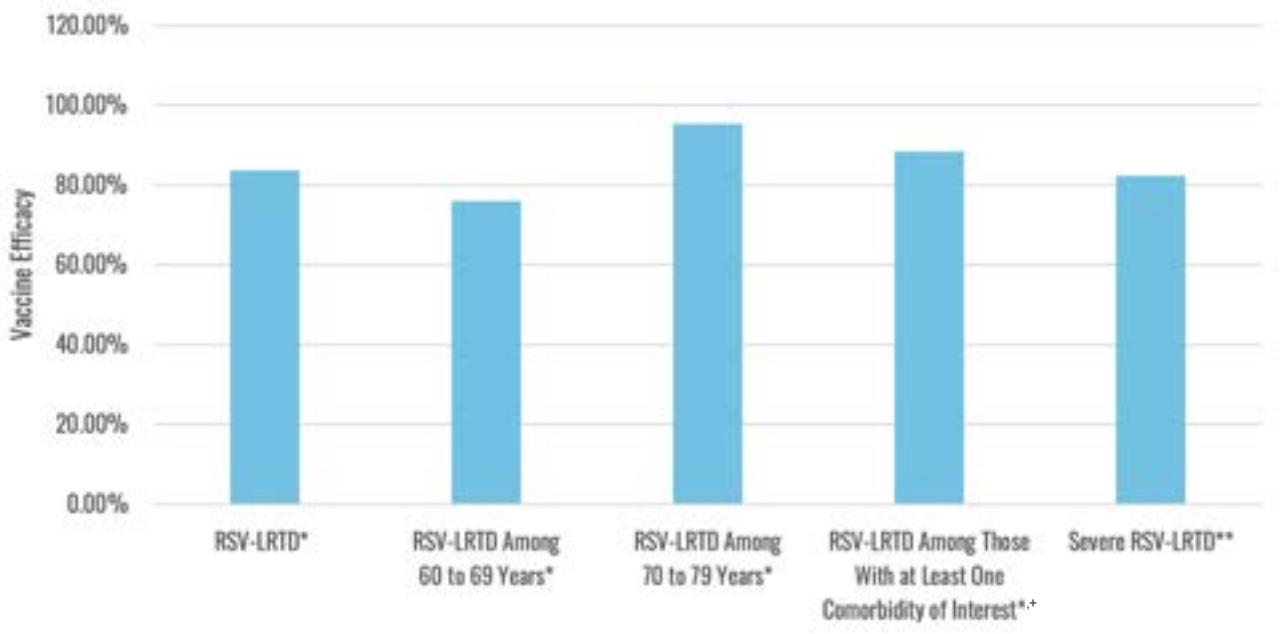
The mRNA-1345 vaccine by Moderna has a mRNA sequence that encodes for a stabilized prefusion F glycoprotein. It also has the same lipid nanoparticles (LNPs) as Moderna's COVID-19 vaccines.[376] LNPs are used to assist with the delivery of the mRNA sequence, protecting it from degradation.[377] This vaccine has been developed for the prevention of both RSV-LRTD and acute respiratory disease among adults 60 years and older.

The recent regulatory submissions across various countries are based on the ongoing Phase 2/3 ConquerRSV trial.[378] This is a randomized, placebo-controlled, double-blind trial focused the safety and efficacy of the vaccine on adults 60 years and older, involving approximately 37,000 participants from across 22 countries.[379,380]

The ConquerRSV trial has looked into the mRNA-1345 vaccine's efficacy to prevent one case of RSV-LRTD with either at least

two or three symptoms between 14 days to 12 months following vaccination.[381] It was found that the vaccine efficacy of the mRNA-1345 vaccine in preventing one case of RSV LRTD with at least two symptoms was 83.7%, with the rate found to increase from the 60 to 69 years age group (76%) to the 70 to 79 years age group (95.4%). The vaccine efficacy against RSV-LRTD was 81.6% in those who were healthy and 88.4% in those with at least one comorbidity of interest. In terms of the mRNA-1345 vaccine efficacy of preventing one case of RSV LRTD with at least three symptoms was 82.4%, with the rate similarly increasing from the 60 to 69 years age group (72.9%) to the 70 to 79 years age group (100%). However, despite the vaccine rate being high (90.1%) among those who were healthy, it was only 71.8% among those with at least one comorbidity of interest.[382]

Figure 9: Vaccine Efficacy of Single Dose of mRNA-1345 against RSV-LRTD and Severe RSV-LRTD in the First RSV Season[383]



* *RSV-LRTD defined as having at least two lower respiratory symptoms during the first year after vaccination.*

** *Severe RSV-LRTD defined as having at least three lower respiratory symptoms during the first year after vaccination.*

\+ *Comorbidities of interest include diabetes, CHF, advanced liver disease, advanced renal disease, COPD, chronic respiratory disease or asthma.*

Among these study findings, it was noted that the incidence of solicited local adverse reactions and solicited systemic adverse reactions within seven days of vaccination were higher among the vaccine group compared to the placebo group. It is important to highlight that these reactions were mild to moderate in severity.[384] However, compared to Pfizer's Abrysvo™ vaccine, which also has data on the total solicited adverse reactions in the same time frame, it appears the mRNA-1345 vaccine leads to more solicited adverse reactions (local and systemic). This has been seen in a systematic review of COVID-19 vaccines as well, with mRNA vaccines generally having higher risk of adverse events.[385]

Moving forward, the ConquerRSV trial will be evaluating different types of adverse events and measurements of RSV antibodies for up to 24 months since vaccination.[386] There is also another ongoing Phase 3 trial of the mRNA-1345 vaccine focused on adults 50 years and older, called the RSVictory trial. This is a randomized and observer-blind study with two parts: Part A focuses on the co-administration of the mRNA-1345 vaccine with a seasonal influenza vaccine; whereas Part B focuses on the co-administration of the mRNA-1345 vaccine with Moderna's COVID-19 vaccine (mRNA-1273).[387]

National Recommendations

Currently, it is expected that NACI will be releasing recommendations on RSV vaccines for adult Canadians 60 years and older in 2024. However, other national expert committees have released their recommendations on the use of the RSV vaccines for older adults.

The US Advisory Committee on Immunization Practices (ACIP) issued guidance in June 2023 that adults 60 years and older may receive one dose of the currently-available RSV vaccines, using shared clinical decision-making.[388] Unlike other types of recommendations (e.g., routine, catch-up), recommendations based on shared clinical decision-making implies that the vaccine is not recommended for the entire population group identified but more so for use on an individual basis. Therefore, this recommendation encourages an informed decision-making process between the health care professional and patient based on various factors (e.g., best available evidence, individual's characteristics and clinical discretion).[389] The rationale for this recommendation is based on how current evidence indicates vaccination may prevent morbidity, and that the cause currently remains unknown behind the six cases of inflammatory neurologic events that have been reported in RSV vaccine trials.[390] An individual-based recommendation may not create large change in overall vaccination coverage and schedules across the US compared to other types of recommendations; however, as these vaccines are recommended by the ACIP, private health insurance may cover the costs, along with Medicare Part D recipients being covered.[391]

The ACIP has also noted that the RSV vaccine should be offered as early as possible and co-administration with other adult vaccines is acceptable. However, it was indicated that there is limited data on immunogenicity from such coadministration and providers should consider various factors (e.g., vaccine reactogenicity profiles, patient preferences).[392]

The United Kingdom's Joint Committee on Vaccination and Immunisation (JCVI) issued a statement in June 2023 indicating that a RSV vaccination program could be cost effective for adults 75 years and older.[393] The committee further noted that they favour an initial one-time campaign for various age groups to obtain the vaccine, and then an annual program for individuals who turn 75 years of age. JCVI currently considers any of the RSV vaccines equally suitable for the vaccination program based on their fairly similar vaccine efficacy results and the lack of comparison studies.[394]

The Development of Monoclonal Antibodies to Prevent Serious RSV Infections

Human immunity can be categorized as both active and passive. The former occurs through coming into contact with a disease-causing organism in our environment (natural immunity) or through a weakened/partial version of the bacteria or virus through vaccination (vaccine-induced immunity).[395] As noted above, this exposure causes our body to combat a pathogen by creating antibodies and remembering this process moving forward by establishing immunity.[396]

Passive immunity on the other hand, occurs when an individual is provided the antibodies themself, either from another person or animal. Examples include full-term babies receiving their mother's antibodies near the end of a pregnancy or individuals receiving antibody-containing blood products. Passive immunity provides immediate protection in comparison to active immunity but subsides in a few weeks or months.[397]

Within the RSV landscape, two monoclonal antibodies are available which can provide passive immunity and protect against severe disease. These products have been developed by understanding the types of antibody that are developed in individuals who recover from the infection.[398] These products prevent RSV infection and severe disease.[399,400] They can help prevent the development of LRTD in severely immunocompromised patients (see above).[401] These are also only used in children however, as dosing is weight based[402] and requires repeat dosing throughout a season, making their use prohibitive in adults.[403,404,405]

Both monoclonal antibodies are approved for use in Canada. The first product approved for use was Synagis™ (palivizumab) in 2002 for the prevention of serious RSV-LRTD among infants at high risk of serious disease. The National Advisory Committee on Immunization (NACI) has recommended this product specifically for use with various high-risk pediatric populations under two years of age. Palivizumab is given as monthly injections during the RSV season.[406] Recently in April 2023, Health Canada also approved a new monoclonal

antibody, Beyfortus™ (nirsevimab), for the prevention of RSV-LRTD in not only all newborns and infants during their first RSV season, but also those children (up to two years) who are at high risk for severe RSV disease in their second RSV season. This is the only monoclonal antibody product that can provide protection across an entire RSV season with just one injection.[407] In the coming months, the NACI will be releasing recommendations for the use of this product.[408]

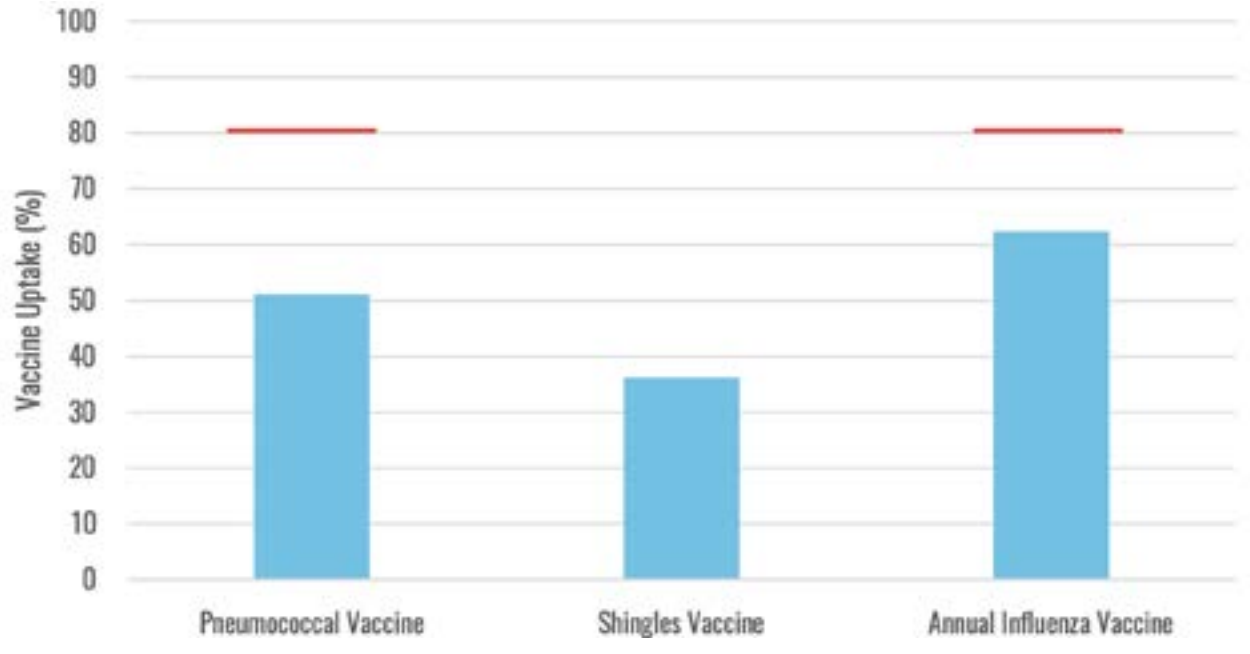
Vaccination Barriers and Opportunities for Older Canadians

Older Adult Vaccination Rates for Other Diseases

While Health Canada has approved the use of one highly effective RSV vaccine and is actively reviewing the use of another,[409,410] it is important to note that there is a lot more work to be done beyond achieving a vaccine's approval for administration.

The NIA and several other organizations continue to observe how, despite ample evidence that Canadians understand the importance of prevention and vaccination against infectious diseases,[411,412] Figure 10 helps to demonstrate how rates of vaccination among older Canadians across all vaccine-preventable diseases have remained underwhelming at best. The PHAC has long-established a target vaccination rate of 80% against both influenza and pneumococcal disease among older Canadians.[413,414] Nevertheless, while older adults remain a highly vulnerable group for shingles, pneumococcal and influenza infections, the percentages of vaccinated older Canadians have never met national vaccination coverage goals.

Figure 10: Shingles, Pneumococcal and Influenza National Vaccine Rates among Canadians 65 Years and Older



* *The red line indicates the national vaccination coverage goals.*

** *National data only covers Canada's provinces and not its territories.*

These vaccination rates are even more concerning at the provincial level, with coverage levels ranging widely among Canada's 10 provinces (Table 6).

For example, with respect to vaccination rates against shingles, the coverage rate in Newfoundland and Labrador (20.3%) is less than half of the rate in Ontario (50.4%).[415]

Table 6: Shingles, Pneumococcal and Influenza Provincial Vaccine Rates among Canadians 65 Years and Older (2019/2020)[416]

Vaccine	Lowest Vaccine Rate	Highest Vaccine Rate	Variance
Pneumococcal	31.5% (Newfoundland and Labrador)	57.2% (Manitoba)	25.7%
Shingles	20.3% (Newfoundland and Labrador)	50.4% (Ontario)	30.1%
Annual Influenza	47.7% (Quebec)	73.0% (Nova Scotia)	25.3%

Understanding the Issues Behind Low Vaccination Levels Among Older Canadians

When discussing issues regarding low vaccination uptake, it is important to understand the term "vaccine hesitancy" and the factors that impact it. The SAGE Working Group on Vaccine Hesitancy has defined this term as the "delay in acceptance or refusal of vaccination despite availability of vaccination services."[417] There are five factors influencing this concept:[418,419]

1. **Complacency** — low perceived risk of disease and when vaccination is not viewed as a needed preventive measure.
2. **Confidence** — refers to trust in the vaccine (effectiveness, safety), in the health care system (e.g., health care providers, services), and in the agenda of policymakers.
3. **Convenience** — issues of accessibility (e.g., physical availability, cost, an individual's health literacy).
4. **Calculation** — referring to an individual's information search prior to deciding on vaccination.
5. **Collective Responsibility** — aim to protect others by vaccinating oneself.

The impact of complacency has been seen across studies by how the perceived risk of a disease is a vital predictor to vaccination behaviour.[420,421,422] Those with low perceived risks have more chances of being unvaccinated,[423,424,425,426] whereas those with higher perceived risk have higher vaccine uptake.[427,428] This is evident by how the most commonly reported reason for not receiving the influenza vaccine among older Canadians in the PHAC's 2021–2022 Seasonal Influenza Vaccination Coverage Survey was the belief that they are healthy and/or have never gotten the flu.[429] Another aspect of complacency is the belief that the vaccination is not necessary, which was the most commonly reported reason for not receiving the shingles and pneumococcal vaccines among Canadians.[430]

In terms of convenience, cost plays an important role, especially by how funding coverage of the shingles, pneumonia and influenza vaccines greatly varies across the country.[431,432,433] This has especially been seen with shingles vaccine, where certain Canadian jurisdictions provide the vaccine free for certain older adult populations, whereas other jurisdictions require individuals to pay over CA$400 to receive their shingles vaccinations.[434] In the 2021 PHAC survey, the cost of the shingles vaccine was a prominent reason cited among unvaccinated Canadian adults 50 years and older for not getting the vaccination.[435] For, the seasonal influenza vaccine, research has shown that vaccination rates are higher in populations who can access government-funded vaccines.[436] Additional factors among older Canadians such as the greater likelihood of living on fixed incomes (e.g., pensions),[437] and the lower likelihood of having access to adequate insurance to cover prescription medication magnify the influence of vaccine costs among this population.[438]

Another aspect related to convenience that plays a role in the Canadian vaccine landscape is physical availability. This has been well demonstrated through the

administration of pneumococcal vaccines, where even though most jurisdictions (apart from Northwest Territories and Nunavut) allow pharmacists to also administer pneumococcal vaccines, only three provinces permit pharmacists to administer publicly-funded pneumococcal vaccines.[439] These variances around both administration locations and cost may help explain the large jurisdictional variances noted in Table 6 for a vaccine that the PHAC wants at least 80% of all older Canadians to receive.[440] With an increasing lack of access to primary care services,[441] the mobilization of pharmacy administration of vaccination is becoming essential to ensure equitable access.

Confidence has also been seen to influence vaccination behaviour, especially regarding vaccine side effects and safety concerns. This is especially evident with the seasonal influenza vaccine, where a study found approximately half of the individuals who remained unvaccinated noted that this was due to perceived side effects or hearing about the perceived side effects of others. However, those who were vaccinated indicated that previous positive vaccination experiences influenced their behaviour.[442] For both COVID-19 and seasonal influenza vaccines, individuals' concerns over safety have been found as an important cause of vaccine hesitancy as well.[443]

Other Factors

The lack of overall knowledge and understanding Canadians appear to have about the vaccines recommended for them is also of concern. One of the most commonly reported reasons among older adults for not receiving the pneumococcal vaccines was never hearing about the vaccine.[444] Also, a 2016 PHAC survey found that despite 88% of Canadians thinking they were up-to-date on their vaccinations, only 3% were actually up-to-date based on the national recommendations.[445]

Another factor to consider relates to specific ethno-racial groups and immigrant populations that have been found in a recent NIA report to have considerable differences in influenza uptake. It was found that during the 2021-22 flu season, influenza vaccine rates ranged from 58% among South Asian Canadians to 27% among Black Canadians. Also, recent immigrants were reported to have slightly lower influenza vaccine uptake in comparison to the overall adult population in Canada.[446] In terms of immigrant groups, studies found that barriers to vaccination included cultural factors, knowledge and language barriers.[447,448]

Beyond patients, it is important to note other factors that influence vaccine uptake, especially with regard to the perspective of health care providers. Studies have noted for the influenza vaccine, there are worries about the safety and effectiveness of these vaccines among health care providers.[449,450] This is largely due to the annual development of these vaccines causing less time for testing and the impact of virus mutation.[451,452] Also, a Canadian study found an overwhelming number of health care providers have difficulty keeping up to date with their patient's vaccination histories,[453] which will only be compounded with the introduction of RSV vaccines.

In terms of knowledge surrounding RSV infections, survey findings of primary care providers have found that despite there being an understanding of some clinical aspects, clear gaps in knowledge of this infection exist.[454,455] One study found this was especially the case regarding the epidemiology of RSV infections, with 22% knowing that older adults made up the majority of RSV-associated deaths and only 39% knowing that this infection is not just limited to the pediatric population.[456] Among primary care providers who have treated adults with RSV infections, it is concerning that 86% agreed that they needed more information on the burden of RSV infections within this patient population.[457]

Opportunities to Improve Vaccination Rates among Older Canadians

The greatest opportunity to improve vaccination rates are via the recommendations of health care providers. It has been noted that 55–60% of Canadian adults would get vaccinated if recommended to do so by their health care providers.[458] Also, research has shown that health care provider recommendations significantly increase shingles vaccination rates of older adults.[459] A study of Canadian rheumatology patients found that physician recommendation was the most important predictor for receiving various vaccinations (e.g., influenza, pneumococcal).[460] Nevertheless, the evidence shows that this is not being done regularly or consistently, with just over 50% of individuals reporting that their provider recommended an influenza vaccine. This value dropped to just 13.8% for the pneumococcal vaccine.[461]

Through other research on promoting uptake of the influenza vaccination, other methods have been identified that health care providers can use to influence vaccination behaviour. One example is sending reminders in the form of text messages, letters or phone calls. Research have shown that reminders (generic or personalized) increase influenza vaccination among adults.[462,463] Also, interactions with patients (e.g., decision-making involvement, proactive conversations and regular check-ups) have been found to better improve vaccination behaviour.[464,465] This is in line with other findings that have noted the influential impact health care providers have can have on older adults in terms of improving their knowledge around a disease and available vaccines to prevent them.[466,467]

To assist health care providers, research has looked into the use of software reminders and tools. The use of these kinds of programs for primary care providers have significantly improved vaccination rates.[468,469] For example, the use of the electronic best practice alert method that gave reminders for primary care providers, significantly increased shingles vaccination rates among their rheumatoid arthritis patients aged 60 years and older (10.1–51.7%).[470] These types of programs along with clinician education have also been correlated with higher pneumococcal vaccination rates.[471,472]

As noted above, despite most jurisdictions in Canada allowing pharmacists to administer vaccines, this has not been necessarily the case for publicly-funded vaccines, especially for pneumococcal and shingles vaccines.[473,474] A focus on allowing pharmacists to administer all vaccines should be given, especially in the administration of publicly-funded vaccines. These health care professionals are accessible, conveniently located, have shorter wait times, do not necessarily require an appointment and are available for more hours than other health care providers.[475,476,477] The impact of these benefits is evident from how the involvement of pharmacists in the immunization process have consistently resulted in an increase in vaccine coverage, regardless of the vaccine administered.[478]

For individuals within ethno-racial groups and immigrant populations, it has been found that influenza vaccination programs that targeted knowledge and language barriers (e.g., through bilingual materials and staff) were effective.[479] Also, initiatives providing more communication and culturally inclusive resources have demonstrated their ability to significantly increase COVID-19 vaccine uptake among Black populations,[480] which had low COVID-19 and influenza vaccination rates in Canada.[481]

The recent COVID-19 pandemic has shown that achieving high vaccine rates among older Canadians is possible. As of summer 2023, 97% of Canadians aged 60 years and older have received at least one dose of the COVID-19 vaccine, with 96% having completed a primary series.[482,483,484] This was achieved through significant government-led efforts in increasing public awareness (e.g., vaccine information and access). It was found that almost all provinces and territories provided these materials in multiple languages. Governments also made vaccine appointments more accessible for older adults through a variety of providers (e.g., pharmacists, paramedics) locations (pharmacies, mass vaccination clinics, and even at home) and for free.[485] Indeed, all of these initiatives helped address several of the earlier noted issues surrounding complacency, convenience, and confidence of vaccines and helped Canada achieve one of the highest reported vaccination rates against COVID-19 in the world.

Beyond the COVID-19 vaccine, the NIA found that 31% of older Canadians reported having developed more positive views of vaccines since the pandemic started. Also, 73% of older Canadians were found to be willing to get a COVID-19 booster shot and flu vaccine at the same time.[486] These growing positive views around both vaccines and co-administration provides a great opportunity to ensure high vaccine uptake rates can be achieved for all vaccines and the forthcoming RSV vaccines.

Issues with Current Reporting and Monitoring of Vaccination Rates

Over the past few years, national uptake rates of various vaccines among older Canadians have been collected through two surveys: the PHAC's Seasonal Influenza Vaccination Coverage Survey and Statistics Canada's Canadian Health Survey on Seniors (CHSS). The PHAC's

Seasonal Influenza Vaccination Coverage Survey only recently started gathering coverage data on various vaccines, apart from influenza, on a bi-yearly basis.[487,488] Data surrounding non-influenza vaccines is differentiated based on risk group (e.g., adults 65 years and older, adults 18 to 64 years with chronic medical conditions) and sex. The survey also collects information surrounding reasons for non-vaccination.[489] Statistics Canada's CHSS collects data on an occasional basis (in 2019 and 2020). Data is differentiated not only by age group and sex, but also by provincial jurisdiction (apart from the territories). For this reason, the CHSS provides provincial-level information on vaccination rates.[490]

Despite there being two national surveys to collect national vaccination rates, an evident gap is not differentiating the type of vaccine, especially when different vaccines (such as for pneumococcal vaccination) are being recommended for different population groups.[491] Also, as both surveys are done over the phone, they omit responses from those experiencing homelessness,[492,493] who are a vulnerable or high-risk group.[494] Specifically for the CHSS, not only does it not collect data from Canada's three territories, but also omits those living in First Nations and other Indigenous settlements.[495] For certain infections, Indigenous populations have been found to be at high risk.[496] In regards to the PHAC's survey, in addition to its low response rate,[497] a lot more information is collected on the vaccine behaviour surrounding influenza vaccines compared to other vaccines. This is seen through the various iterations of the survey by how respondents are asked various topics specifically on the influenza vaccine such as timing and place of vaccination, impact of experiencing the infection on getting the vaccine.[498,499] These are topics that would be beneficial for the other vaccines as well, including with respect to the forthcoming RSV vaccines.

At the national level, another monitoring mechanism include Canada's vaccination coverage goals and vaccine preventable disease reduction targets. These are benchmarks developed based on best practices and international standards that are aspired to be met by 2025. Despite there being vaccination coverage goals for pneumococcal and seasonal influenza vaccines, this does not appear to be the case for shingles, tetanus or the COVID-19 vaccines.[500]

Immunization registers, also known as immunization information systems, are electronic systems used in Canada to keep note of administered vaccines and vaccination histories. A comprehensive immunization registry would provide various benefits, including timely recording of vaccination information, identifying individuals who require certain vaccines, allow public health officials to assess immunization coverage, enabling planning and evaluation of various initiatives.[501] However, not only is there no national immunization registry, but it has been found that at the provincial/territorial level, there are varying immunization information systems that have different reporting capabilities, features and data collection systems. This impacts the ability to compare immunization coverage across jurisdictions and potentially develop accurate national coverage values.[502]

The Canadian government has taken various steps to improve the reporting and monitoring of vaccination rates. As part of the National Immunization Strategy, one of its objectives focuses on understanding un-immunized populations and the determinants of vaccine uptake. Currently, the government is working on improving how national vaccination coverage surveys are conducted.[503] Also, the COVID-19 pandemic has resulted in more funding for vaccination initiatives, including a combined $78 million provided to the Immunization Partnership Fund since 2020. This funding has been used for various projects including enhancement of electronic vaccination registries.[504] The government has released new Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 to support the various immunization registries across Canada. This document provides standards to allow for accurate and complete record collection.[505] This follows the release of the updated National Immunization Data Elements (NIDE) in 2018, which stated categories for all immunization registries to focus on to enable interoperability.[506]

Evidence-Based Recommendations

From the review of research surrounding RSV and other vaccine-preventable diseases, more work remains to be done to improve the prevention of RSV infections in Canada. The following recommendations have thus been developed to provide evidence-informed policy and practice approaches that can be used by the PHAC, provincial/territorial health authorities and organizations, to better support vaccination efforts. This would further improve national prevention efforts and prepare for the anticipated availability of RSV vaccines across Canada.

1. Promote General Preventive Practices

In addition to vaccination, there are additional ways to prevent the transmission of RSV and other respiratory viruses. Thus, it is important to continue to encourage the implementation of these practices in addition to vaccination, especially for those at high risk or those who interact with individuals at high risk for severe RSV infection.

Other Means to Prevent RSV:[507]

- Wash hands often and properly
- Cover your mouth and nose with a tissue or sleeve when coughing and sneezing
- Avoid close contact with individuals who are ill
- Stay home if feeling ill
- Clean frequently touched surfaces

2. Improve the Surveillance of RSV Infections and Mortality Across Canada and Understanding of Its Impact on Canadian Health Care Systems

Despite RSV infections not currently being reportable in Canada,[508] there presently exist three national surveillance systems collecting information on RSV cases.[509,510] Within these systems, experts have noted various data gaps exist, including those that pertain to high-risk populations. For individuals under 17 years, as catchment areas for some locations in the sentinel surveillance system (IMPACT) are not aligned with Canadian population data, there exists no denominator data to accurately calculate disease incidence and prevalence. Also, it was found that the current systems do not offer an accurate estimation of the burden of illness among older adults and Indigenous and remote communities. Specifically with older adults, RSV case underestimation has been due to several issues related to both being limited to CIHI's hospital administrative data and incompleteness of viral testing, creating an overall lack of accurate data surrounding case incidence and virus strains of RSV infection in this age group.[511]

Across the three surveillance systems, there predominantly exists a focus on gathering medically attended RSV infection data. To enable better RSV-related modelling and studies, non-

medically attended RSV infection data would need to be collected as well.[512] Also, Canadian RSV surveillance systems must look into ensuring a standard syndromic case definition for RSV infection is used. The NIA recommends they apply the case definitions developed through the WHO's RSV surveillance pilot, especially due to how these definitions substantially helped to increase the number of RSV cases that are accurately detected through its related initiatives.

3. Continue to Work on the Development of RSV Vaccines

Despite the fact that three highly effective RSV vaccines for older adults either have or are currently seeking market approval, there still remains a lot more work to be done surrounding the further development of RSV vaccines. All Phase 3 trial results for these vaccines, apart from Pfizer's and GSK's recent findings,[513,514] have only shown results for the vaccine efficacy and safety across one year/season.[515,516,517] One vaccine has also shown its potential for being safely co-administered with seasonal influenza vaccines.[518] However, further understanding the efficacy of each of these vaccines over multiple RSV seasons and the required need for booster doses to ensure continued immunity will be of help. In addition, few frail older adults were included in the recent trials, and data establishing vaccine efficacy in this population is essential. Many of the Phase 3 trials discussed in this report remain ongoing to understand these outcomes along with other trial objectives (e.g., impact on immunocompromised individuals, co-administration with other vaccines).[519,520,521,522]

4. Promote a Life-Course Vaccination Schedule that Includes Older Adults

A life-course vaccination schedule focuses on immunization and reducing the prevalence of vaccine-preventable diseases in all age groups, beyond just children.[523] Despite the Canadian Immunization Guide providing a recommended immunization schedule for all age groups,[524] provincial and territorial immunization schedules vary, especially with respect to vaccinations for older adults.[525]

As the first RSV vaccine for this age group has been approved by Health Canada and recommendations from NACI are expected to be released in 2024, it is important that Canada's provinces and territories avoid creating a large discrepancy in the availability and coverage of these vaccines for older Canadians.

5. Provide RSV Vaccinations Free of Cost to Populations for which RSV Vaccination is Cost-Effective

As noted earlier, vaccine costs play a vital factor in vaccination behaviour. This is especially seen with the ongoing low uptake of the recommended shingles vaccines, where a prominent reason for not receiving the vaccine among eligible Canadian adults was the cost itself.[526] Research has shown that uptake of shingles and pneumococcal vaccination is more likely to happen when funded, with a US study finding that the shingles vaccination rates were three times higher when the vaccine was covered through health insurance programs.[527]

It will be vital for funded vaccines to be focused on populations that will achieve the greatest benefits with respect to health care outcomes and their associated costs. Among older adults, studies have shown that RSV vaccination would result in a substantial decrease in the economic burden of RSV infections among adults 60 years and older.[528,529]

6. Promote Following NACI Statements for RSV Vaccination

Canada's NACI statements provide recommendations using the best available scientific knowledge.[530] Once these statements have been released for RSV vaccination, the NIA recommends that they are followed across provincial and territorial jurisdictions.

In the absence of guidance from NACI, the NIA recommends that health care providers and older Canadians follow the current ACIP recommendations on RSV vaccination. The ACIP have noted that adults 60 years and older may receive one dose of the currently available RSV vaccines, using shared decision-making.[531] This implies that the vaccine is not currently recommended for all 60 years and older, but more so for use on an individual basis, taking into consideration various factors (e.g., best available evidence, an individual's characteristics and clinical discretion).[532]

7. Provide Clinician Education and Support for Pharmacists, Primary Care and Other Health Care Providers to Deliver RSV Vaccinations

It has been found that across various vaccines, the main reasons for non-vaccination was low perceived risk and/or that the vaccine was not necessary.[533,534] Also, it has been noted how Canadians are not usually fully informed around the vaccines recommended for them.[535] In addition to public education efforts, education and support initiatives should also be focused on health care providers, as their impact on vaccination behaviour has been consistently demonstrated across various studies. For example, 55–60% of Canadian adults have indicated that they would get vaccinated if recommended to do so by their health care providers.[536] Providers interactions with patients (e.g., decision-making involvement) have been shown to improve overall vaccination behaviour as well.[537,538] Given the NIA's findings that 31% of older Canadians had reported developing more positive views of vaccines since the pandemic started and that 73% are interested in co-administration opportunities,[539] ensuring health care providers are also aware of this may also encourage their own efforts to promote more vaccination opportunities with their patients.

8. Harmonize Vaccination Administration across and within Canada's Provinces/ Territories

Currently, there are multiple avenues to obtain and have vaccines administered in Canada. Vaccines may be obtained from physician offices, travel clinics, public health clinics and/or pharmacies.[540,541] Also, various professions may be able to administer vaccines including physicians, nurses and/or pharmacists as well as paramedics. However, depending on the provinces or territories, all these avenues may not be available. This is seen especially with pneumococcal vaccines, where despite pharmacists being able to administer the vaccine in all jurisdictions (apart from Northwest Territories and Nunavut), only three provinces permit pharmacists to administer publicly-funded pneumococcal vaccines.[542,543] Also, it has been found that in provinces that enable pharmacists to administer shingles vaccines, not all pharmacies are administering the vaccine.[544]

Harmonization of vaccine administration practices (i.e., where vaccines can be administered and who can administer them) will allow for less confusion, more consistent communication and greater ease in the ability of individuals to receive their recommended vaccines. Therefore, as RSV vaccines become available in Canada, it is further recommended that not only are vaccination practices harmonized across Canada, but also within each jurisdiction.

9. Establish Accurate Reporting and Monitoring of RSV Vaccination Rates

With the introduction of RSV vaccines, it will be vital to have clear mechanisms to report and monitor RSV vaccination rates across Canada.

One potential avenue to achieve this would be to include questions within the existing PHAC's Seasonal Influenza Vaccination Coverage Survey and Statistics Canada's CHSS. Both surveys may provide information on the target population, with the PHAC survey enabling a better understanding of the reasons behind non-vaccination behaviour and the Statistics Canada survey enabling a better understanding of provincial variance.[545,546]

Furthermore, there are issues that should be additionally targeted to ensure more accurate reporting of RSV vaccination rates. The PHAC's Seasonal Influenza Vaccination Coverage Survey has been found to have a low response rate, which could impact the generalizability of its findings.[547] Also, it does not provide a comprehensive understanding of factors that impact vaccination uptake by simply looking into gender and reasons for non-vaccination across most vaccines.[548] Despite the CHSS having a larger number of respondents, the survey only focuses on vaccination coverage rates. The CHSS also does not provide data for the three territories and focuses specifically on adults 65 years and older.[549] This may be an issue if the NACI recommendations focus on a slightly different population (e.g., adults 60 years and older), especially as the vaccines are currently

being evaluated specifically for this age group.[550,551,552]

Another avenue of change is to improve the patchwork of immunization information systems across Canadian provinces and territories.[553] This is especially important for the various benefits immunization information systems could provide both at the individual and system level, including the timely recording of vaccination information, identifying individuals who require certain vaccines and allowing public health officials to assess immunization coverage.[554] Governments could look to enforce the Canadian IRFS and NIDE to improve immunization registries. This will allow for greater accurate vaccination record collection, support interoperability across jurisdictions[555] and assist in developing accurate national vaccination estimates in the future.

Finally, these surveillance systems should be complemented with a national vaccination coverage goal, similar to what is done for pneumococcal and influenza vaccination in Canada.[556] This would allow a greater level of accountability to exist and a more focused approach to be pursued in ensuring Canada achieves an appropriate level of RSV vaccination coverage to better support the health and well-being of older Canadians.

References

1 Ministry of Health. (2023, July 19). Respiratory syncytial virus. Government of Ontario. Retrieved July 30, 2023, from: https://www.ontario.ca/page/respiratory-syncytial-virus

2 Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

3 Public Health Agency of Canada. (2022, December 19). Respiratory syncytial virus (RSV): Symptoms and treatment. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv.html

4 Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

5 Belongia, E. A., King, J. P., Kieke, B. A., Pluta, J., Al-Hilli, A., Meece, J. K., & Shinde, V. (2018). Clinical features, severity, and incidence of RSV illness during 12 consecutive seasons in a community cohort of adults ≥60 years old. Open Forum Infectious Diseases, 5(12). Retrieved from: https://doi.org/10.1093/ofid/ofy316

6 Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

7 Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

8 Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

9 Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

10 Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

11 Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[12] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[13] Ontario Agency for Health Protection and Promotion (Public Health Ontario). (2021). Key features of influenza, SARS-CoV-2 and other common respiratory viruses. Retrieved July 30, 2023, from: https://www.publichealthontario.ca/-/media/documents/ncov/ipac/2020/09/key-features-influenza-covid-19-respiratory-viruses.pdf?sc_lang=en

[14] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[15] Maggi, S., Veronese, N., Burgio, M., Cammarata, G., Ciuppa, M. E., Ciriminna, S., Di Gennaro, F., Smith, L., Trott, M., Dominguez, L. J., Giammanco, G. M., De Grazia, S., Costantino, C., Vitale, F., & Barbagallo, M. (2022). Rate of hospitalizations and mortality of respiratory syncytial virus infection compared to influenza in older people: A systematic review and meta-analysis. Vaccines, 10(12). Retrieved from: https://doi.org/10.3390/vaccines10122092

[16] Zheng, Z., Warren, J. L., Shapiro, E. D., Pitzer, V. E., & Weinberger, D. M. (2022). Estimated incidence of respiratory hospitalizations attributable to RSV infections across age and socioeconomic groups. Pneumonia (Nathan Qld.), 14(1). Retrieved from: https://doi.org/10.1186/s41479-022-00098-x

[17] Rozenbaum, M. H., Judy, J., Tran, D., Yacisin, K., Kurosky, S. K., & Begier, E. (2023). Low levels of RSV testing among adults hospitalized for lower respiratory tract infection in the United States. Infectious Diseases and Therapy, 12(2). Retrieved from: https://doi.org/10.1007/s40121-023-00758-5

[18] McLaughlin, J. M., Khan, F., Begier, E., Swerdlow, D. L., Jodar, L., & Falsey, A. R. (2022). Rates of medically attended RSV among US adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 9(7). Retrieved from: https://doi.org/10.1093/ofid/ofac300

[19] McLaughlin, J. M., Khan, F., Begier, E., Swerdlow, D. L., Jodar, L., & Falsey, A. R. (2022). Rates of medically attended RSV among US adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 9(7). Retrieved from: https://doi.org/10.1093/ofid/ofac300

[20] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[21] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[22] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[23] Biagi, C., Dondi, A., Scarpini, S., Rocca, A., Vandini, S., Poletti, G., & Lanari, M. (2020). Current state and challenges in developing respiratory syncytial virus vaccines. Vaccines, 8(4). Retrieved from: https://doi.org/10.3390/vaccines8040672

[24] Jenkins, V. A., Hoet, B., Hochrein, H., & De Moerlooze, L. (2023). The quest for a respiratory syncytial virus vaccine for older adults: Thinking beyond the F protein. Vaccines, 11(2). Retrieved from: https://doi.org/10.3390/vaccines11020382

[25] Foley, D. A., Phuong, L. K., & Englund, J. A. (2020). Respiratory syncytial virus immunisation overview. Journal of Paediatrics and Child Health, 56(12). Retrieved from: https://doi.org/10.1111/jpc.15232

[26] PATH. (2023, June). RSV vaccine and mAb snapshot. Retrieved July 30, 2023, from: https://media.path.org/documents/RSV-snapshot_02JUN2023_clinical-stage_dBtD8W3.pdf?_gl=1*eewcb1*_gcl_au*NDU2N-TI2MzA2LjE2OTAzMzY0NzU.*_ga*MTQx-NjA1ODMzMi4xNjkwMzM2NDc1*_ga_YB-SE7ZKDQM*MTY5MDMzNjQ3NS4xL-jEuMTY5MDMzNjUzNi42MC4wLjA

[27] GSK plc. (2023, June 7). European Commission authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/european-commission-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/#:~:text=GSK%20plc%20(LSE%2FNYSE%3A,years%20of%20age%20and%20older

[28] Moderna, Inc. (2023, July 5). Moderna announces global regulatory submissions for its respiratory syncytial virus (RSV) vaccine, mRNA-1345. Retrieved July 30, 2023, from: https://investors.modernatx.com/news/news-details/2023/Moderna-Announces-Global-Regulatory-Submissions-For-Its-Respiratory-Syncytial-Virus-RSV-Vaccine-MRNA-1345/default.aspx

[29] Pfizer Inc. (2023, June 22). Pfizer's ABRYSVO™ receives recommendation for use in older adults from Advisory Committee on Immunization Practices. Retrieved July 30, 2023, from: https://www.pfizer.com/news/announcements/pfizers-abrysvotm-receives-recommendation-use-older-adults-advisory-committee

[30] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[31] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[32] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[33] GlaxoSmithKline Inc. (2023, August). Product monograph including patient medication information: Arexvy. Government of Canada. Retrieved September 1, 2023, from: https://pdf.hres.ca/dpd_pm/00071904.PDF

[34] Pfizer Inc. (2023, April 14). Pfizer Canada initiates submission to Health Canada for its bivalent respiratory syncytial virus (RSV) vaccine. Retrieved July 30, 2023, from: https://www.pfizer.ca/en/media-centre/pfizer-canada-initiates-submission-to-health-canada-for-its-bivalent-respiratory-syncytial-virus-rsv-vaccine

[35] GSK plc. (2023, May 3). US FDA approves GSK's Arexvy, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[36] GSK plc. (2023, June 7). European Commission authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/european-commission-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/#:~:text=GSK%20plc%20(LSE%2FNYSE%3A,years%20of%20age%20and%20older

[37] Pfizer Inc. (2023, May 31). U.S. FDA approves ABRYSVO™, Pfizer's vaccine for the prevention of respiratory syncytial virus (RSV) in older adults. Retrieved July 30, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/us-fda-approves-abrysvotm-pfizers-vaccine-prevention#:~:text=On%20March%2024%2C%202022%2C%20Pfizer,years%20of%20age%20and%20older

[38] Pfizer Inc. (2023, August 24). European Commission approves Pfizer's ABRYSVO™ to help protect infants through maternal immunization and older adults from RSV. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/european-commission-approves-pfizers-abrysvotm-help-protect

[39] GSK plc. (2023, July 10). Medicines and Healthcare products Regulatory Agency authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved September 1, 2023, from: https://www.gsk.com/en-gb/media/press-releases/medicines-and-healthcare-products-regulatory-agency-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[40] Pfizer Inc. (2023, August 24). European Commission approves Pfizer's ABRYSVO™ to help protect infants through maternal immunization and older adults from RSV. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/european-commission-approves-pfizers-abrysvotm-help-protect

[41] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[42] Public Health Agency of Canada. (2018, July). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved July 30, 2023, from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[43] Marra, F., Kaczorowski, J., Gastonguay, L., Marra, C. A., Lynd, L. D., & Kendall, P. (2014). Pharmacy-based Immunization in Rural Communities Strategy (PhICS): A community cluster-randomized trial. Canadian Pharmacists Journal : CPJ = Revue des Pharmaciens du Canada : RPC, 147(1). Retrieved from: https://doi.org/10.1177/1715163513514020

[44] Public Health Agency of Canada. (2023, January). Seasonal influenza vaccination coverage in Canada, 2021–2022. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/seasonal-influenza-survey-results-2021-2022/full-report.html

[45] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[46] National Institute on Ageing. (2023). As one of Canada's top killers, why isn't pneumonia taken more seriously? Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/64666f42b34ce05072c1b27c/1684434755822/Pneumonia_Report+-+Revised.pdf

[47] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[48] Public Health Agency of Canada. (2022, August 16). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[49] Riccò, M., Ferraro, P., Peruzzi, S., Zaniboni, A., & Ranzieri, S. (2022). Respiratory syncytial virus: Knowledge, attitudes and beliefs of general practitioners from north-eastern Italy (2021). Pediatric Reports, 14(2). Retrieved from: https://doi.org/10.3390/pediatric14020021

[50] Hurley, L. P., Allison, M. A., Kim, L., O'Leary, S. T., Crane, L. A., Brtnikova, M., Beaty, B. L., Allen, K. E., Poser, S., Lindley, M. C., & Kempe, A. (2019). Primary care physicians' perspectives on respiratory syncytial virus (RSV) disease in adults and a potential RSV vaccine for adults. Vaccine, 37(4). Retrieved from: https://doi.org/10.1016/j.vaccine.2018.12.031

[51] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[52] Ministry of Health. (2023, July 19). Respiratory syncytial virus. Government of Ontario. Retrieved July 30, 2023, from: https://www.ontario.ca/page/respiratory-syncytial-virus

[53] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[54] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[55] Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

[56] Cantú-Flores, K., Rivera-Alfaro, G., Muñoz-Escalante, J. C., & Noyola, D. E. (2022). Global distribution of respiratory syncytial virus A and B infections: A systematic review. Pathogens and Global Health, 116(7). Retrieved from: https://doi.org/10.1080/20477724.2022.2038053

[57] Ontario Agency for Health Protection and Promotion (Public Health Ontario). (2021). Key features of influenza, SARS-CoV-2 and other common respiratory viruses. Retrieved July 30, 2023, from: https://www.publichealthontario.ca/-/media/documents/ncov/ipac/2020/09/key-features-influenza-covid-19-respiratory-viruses.pdf?sc_lang=en

[58] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[59] Lessler, J., Reich, N. G., Brookmeyer, R., Perl, T. M., Nelson, K. E., & Cummings, D. A. (2009). Incubation periods of acute respiratory viral infections: A systematic review. The Lancet. Infectious Diseases, 9(5). Retrieved from: https://doi.org/10.1016/S1473-3099(09)70069-6

[60] Wu, Y., Kang, L., Guo, Z., Liu, J., Liu, M., & Liang, W. (2022). Incubation period of COVID-19 caused by unique SARS-CoV-2 strains: A systematic review and meta-analysis. JAMA Network Open, 5(8). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.28008

[61] National Center for Immunization and Respiratory Diseases. (2023, April 26). RSV transmission. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/transmission.html

[62] National Center for Immunization and Respiratory Diseases. (2023, April 26). RSV transmission. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/transmission.html

[63] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[64] McCormick, W., & Mermel, L. A. (2021). The basic reproductive number and particle-to-plaque ratio: Comparison of these two parameters of viral infectivity. Virology Journal, 18(1). Retrieved from: https://doi-org.ezproxy.lib.torontomu.ca/10.1186/s12985-021-01566-4

[65] Liu, Y., & Rocklöv, J. (2022). The effective reproductive number of the omicron variant of SARS-CoV-2 is several times relative to delta. Journal of Travel Medicine, 29(3). Retrieved from: https://doi.org/10.1093/jtm/taac037

[66] Reis, J., & Shaman, J. (2016). Retrospective parameter estimation and forecast of respiratory syncytial virus in the United States. PLoS Computational Biology, 12(10). Retrieved from: https://doi.org/10.1371/journal.pcbi.1005133

[67] Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

[68] World Health Organization. (2023). Respiratory syncytial virus (RSV) disease. Retrieved July 30, 2023, from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/respiratory-syncytial-virus-disease

[69] Public Health Agency of Canada. (2022, December 19). Respiratory syncytial virus (RSV): Symptoms and treatment. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv.html

[70] Public Health Agency of Canada. (2022, December 19). Respiratory syncytial virus (RSV): Symptoms and treatment. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv.html

[71] Walsh, E. E., Peterson, D. R., & Falsey, A. R. (2007). Is clinical recognition of respiratory syncytial virus infection in hospitalized elderly and high-risk adults possible? The Journal of Infectious Diseases, 195(7). Retrieved from: https://doi.org/10.1086/511986

[72] Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

[73] Walsh, E. E., Peterson, D. R., & Falsey, A. R. (2007). Is clinical recognition of respiratory syncytial virus infection in hospitalized elderly and high-risk adults possible? The Journal of Infectious Diseases, 195(7). Retrieved from: https://doi.org/10.1086/511986

[74] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[75] World Health Organization. (2020). Annex 2: Guidelines on the quality, safety and efficacy of respiratory syncytial virus vaccines. Retrieved July 30, 2023, from: https://cdn.who.int/media/docs/default-source/biologicals/vaccine-standardization/respiratory-syncytial-virus-(rsv)-vaccines/annex_2_rsv_vaccines_trs_1024.pdf?sfvrsn=5d7aefa7_3&download=true

[76] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[77] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[78] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[79] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[80] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[81] Stein, R. T., Bont, L. J., Zar, H., Polack, F. P., Park, C., Claxton, A., Borok, G., Butylkova, Y., & Wegzyn, C. (2017). Respiratory syncytial virus hospitalization and mortality: Systematic review and meta-analysis. Pediatric Pulmonology, 52(4). Retrieved from: https://doi.org/10.1002/ppul.23570

[82] Tin Tin Htar, M., Yerramalla, M. S., Moïsi, J. C., & Swerdlow, D. L. (2020). The burden of respiratory syncytial virus in adults: A systematic review and meta-analysis. Epidemiology and Infection, 148. Retrieved from: https://doi.org/10.1017/S0950268820000400

[83] Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

[84] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[85] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[86] Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

[87] Shi, T., Denouel, A., Tietjen, A. K., Campbell, I., Moran, E., Li, X., Campbell, H., Demont, C., Nyawanda, B. O., Chu, H. Y., Stoszek, S. K., Krishnan, A., Openshaw, P., Falsey, A. R., Nair, H., & RESCEU Investigators (2020). Global disease burden estimates of respiratory syncytial virus-associated acute respiratory infection in older adults in 2015: A systematic review and meta-analysis. The Journal of Infectious Diseases, 222(Suppl 7). Retrieved from: https://doi.org/10.1093/infdis/jiz059

[88] Shi, T., Denouel, A., Tietjen, A. K., Campbell, I., Moran, E., Li, X., Campbell, H., Demont, C., Nyawanda, B. O., Chu, H. Y., Stoszek, S. K., Krishnan, A., Openshaw, P., Falsey, A. R., Nair, H., & RESCEU Investigators (2020). Global disease burden estimates of respiratory syncytial virus-associated acute respiratory infection in older adults in 2015: A systematic review and meta-analysis. The Journal of Infectious Diseases, 222(Suppl 7). Retrieved from: https://doi.org/10.1093/infdis/jiz059

[89] National Institute of Allergy and Infectious Diseases. (2022, July 22). Respiratory syncytial virus (RSV). Retrieved July 30, 2023, from: https://www.niaid.nih.gov/diseases-conditions/respiratory-syncytial-virus-rsv

[90] Maggi, S., Veronese, N., Burgio, M., Cammarata, G., Ciuppa, M. E., Ciriminna, S., Di Gennaro, F., Smith, L., Trott, M., Dominguez, L. J., Giammanco, G. M., De Grazia, S., Costantino, C., Vitale, F., & Barbagallo, M. (2022). Rate of hospitalizations and mortality of respiratory syncytial virus infection compared to influenza in older people: A systematic review and meta-analysis. Vaccines, 10(12). Retrieved from: https://doi.org/10.3390/vaccines10122092

[91] Auvinen, R., Syrjänen, R., Ollgren, J., Nohynek, H., & Skogberg, K. (2022). Clinical characteristics and population-based attack rates of respiratory syncytial virus versus influenza hospitalizations among adults- an observational study. Influenza and Other Respiratory Viruses, 16(2). Retrieved from: https://doi.org/10.1111/irv.12914

[92] Falsey, A. R., Walsh, E. E., House, S., Vandenijck, Y., Ren, X., Keim, S., Kang, D., Peeters, P., Witek, J., & Ispas, G. (2021). Risk factors and medical resource utilization of respiratory syncytial virus, human metapneumovirus, and influenza-related hospitalizations in adults-a global study during the 2017-2019 epidemic seasons (Hospitalized Acute Respiratory Tract Infection [HARTI] study). Open Forum Infectious Diseases, 8(11). Retrieved from: https://doi.org/10.1093/ofid/ofab491

[93] Widmer, K., Zhu, Y., Williams, J. V., Griffin, M. R., Edwards, K. M., & Talbot, H. K. (2012). Rates of hospitalizations for respiratory syncytial virus, human metapneumovirus, and influenza virus in older adults. The Journal of Infectious Diseases, 206(1). Retrieved from: https://doi.org/10.1093/infdis/jis309

[94] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[95] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[96] National Center for Immunization and Respiratory Diseases. (2023, July 14). Older adults. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/high-risk/older-adults.html

[97] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[98] Kwong, J. C., Schwartz, K. L., Campitelli, M. A., Chung, H., Crowcroft, N. S., Karnauchow, T., Katz, K., Ko, D. T., McGeer, A. J., McNally, D., Richardson, D. C., Rosella, L. C., Simor, A., Smieja, M., Zahariadis, G., & Gubbay, J. B. (2018). Acute myocardial infarction after laboratory-confirmed influenza infection. The New England Journal of Medicine, 378(4). Retrieved from: https://doi.org/10.1056/NEJMoa1702090

[99] Blackburn, R., Zhao, H., Pebody, R., Hayward, A., & Warren-Gash, C. (2018). Laboratory-confirmed respiratory infections as predictors of hospital admission for myocardial infarction and stroke: Time-series analysis of English data for 2004-2015. Clinical Infectious Diseases : An Official Publication of the Infectious Diseases Society of America, 67(1). Retrieved from: https://doi.org/10.1093/cid/cix1144

[100] Blackburn, R., Zhao, H., Pebody, R., Hayward, A., & Warren-Gash, C. (2018). Laboratory-confirmed respiratory infections as predictors of hospital admission for myocardial infarction and stroke: Time-series analysis of English data for 2004-2015. Clinical Infectious Diseases : An Official Publication of the Infectious Diseases Society of America, 67(1). Retrieved from: https://doi.org/10.1093/cid/cix1144

[101] Ivey, K. S., Edwards, K. M., & Talbot, H. K. (2018). Respiratory syncytial virus and associations with cardiovascular disease in adults. Journal of the American College of Cardiology, 71(14). Retrieved from: https://doi.org/10.1016/j.jacc.2018.02.013

[102] Chatzis, O., Darbre, S., Pasquier, J., Meylan, P., Manuel, O., Aubert, J. D., Beck-Popovic, M., Masouridi-Levrat, S., Ansari, M., Kaiser, L., Posfay-Barbe, K. M., & Asner, S. A. (2018). Burden of severe RSV disease among immunocompromised children and adults: A 10 year retrospective study. BMC Infectious Diseases, 18(1). Retrieved from: https://doi.org/10.1186/s12879-018-3002-3

[103] Chatzis, O., Darbre, S., Pasquier, J., Meylan, P., Manuel, O., Aubert, J. D., Beck-Popovic, M., Masouridi-Levrat, S., Ansari, M., Kaiser, L., Posfay-Barbe, K. M., & Asner, S. A. (2018). Burden of severe RSV disease among immunocompromised children and adults: A 10 year retrospective study. BMC Infectious Diseases, 18(1). Retrieved from: https://doi.org/10.1186/s12879-018-3002-3

[104] Lee, N., Lui, G. C., Wong, K. T., Li, T. C., Tse, E. C., Chan, J. Y., Yu, J., Wong, S. S., Choi, K. W., Wong, R. Y., Ngai, K. L., Hui, D. S., & Chan, P. K. (2013). High morbidity and mortality in adults hospitalized for respiratory syncytial virus infections. Clinical Infectious Diseases : An Official Publication of the Infectious Diseases Society of America, 57(8). Retrieved from: https://doi.org/10.1093/cid/cit471

[105] Chatzis, O., Darbre, S., Pasquier, J., Meylan, P., Manuel, O., Aubert, J. D., Beck-Popovic, M., Masouridi-Levrat, S., Ansari, M., Kaiser, L., Posfay-Barbe, K. M., & Asner, S. A. (2018). Burden of severe RSV disease among immunocompromised children and adults: A 10 year retrospective study. BMC Infectious Diseases, 18(1). Retrieved from: https://doi.org/10.1186/s12879-018-3002-3

[106] Li, Y., Pillai, P., Miyake, F., & Nair, H. (2020). The role of viral co-infections in the severity of acute respiratory infections among children infected with respiratory syncytial virus (RSV): A systematic review and meta-analysis. Journal of Global Health, 10(1). Retrieved from: https://doi.org/10.7189/jogh.10.010426

[107] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[108] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[109] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[110] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[111] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[112] National Center for Immunization and Respiratory Diseases. (2023, July 21). For healthcare providers. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/clinical/index.html#clinical

[113] National Center for Immunization and Respiratory Diseases. (2023, July 21). For healthcare providers. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/clinical/index.html#clinical

[114] Chartrand, C., Tremblay, N., Renaud, C., & Papenburg, J. (2015). Diagnostic accuracy of rapid antigen detection tests for respiratory syncytial virus infection: Systematic review and meta-analysis. Journal of Clinical Microbiology, 53(12). Retrieved from: https://doi.org/10.1128/JCM.01816-15

[115] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[116] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[117] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[118] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[119] Walsh, E. E., Peterson, D. R., & Falsey, A. R. (2007). Is clinical recognition of respiratory syncytial virus infection in hospitalized elderly and high-risk adults possible? The Journal of Infectious Diseases, 195(7). Retrieved from: https://doi.org/10.1086/511986

[120] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[121] National Center for Immunization and Respiratory Diseases. (2023, July 21). For healthcare providers. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/clinical/index.html#clinical

[122] National Center for Immunization and Respiratory Diseases. (2023, July 21). For healthcare providers. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/clinical/index.html#clinical

[123] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[124] National Center for Immunization and Respiratory Diseases. (2023, July 21). For healthcare providers. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/clinical/index.html#clinical

[125] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[126] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[127] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[128] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[129] Chartrand, C., Tremblay, N., Renaud, C., & Papenburg, J. (2015). Diagnostic accuracy of rapid antigen detection tests for respiratory syncytial virus infection: Systematic review and meta-analysis. Journal of Clinical Microbiology, 53(12). Retrieved from: https://doi.org/10.1128/JCM.01816-15

[130] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[131] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[132] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[133] Prendergast, C., & Papenburg, J. (2013). Rapid antigen-based testing for respiratory syncytial virus: moving diagnostics from bench to bedside? Future Microbiology, 8(4). Retrieved from: https://doi.org/10.2217/fmb.13.9

[134] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[135] Haber N. (2018). Respiratory syncytial virus infection in elderly adults. Medecine et Maladies Infectieuses, 48(6). Retrieved from: https://doi.org/10.1016/j.medmal.2018.01.008

[136] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[137] Talbot, H. K., & Falsey, A. R. (2010). The diagnosis of viral respiratory disease in older adults. Clinical Infectious Diseases : An Official Publication of the Infectious Diseases Society of America, 50(5). Retrieved from: https://doi.org/10.1086/650486

[138] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[139] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[140] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[141] Branche, A. R., Walsh, E. E., Formica, M. A., & Falsey, A. R. (2014). Detection of respiratory viruses in sputum from adults by use of automated multiplex PCR. Journal of Clinical Microbiology, 52(10). Retrieved from: https://doi.org/10.1128/JCM.01523-14

[142] Jeong, J. H., Kim, K. H., Jeong, S. H., Park, J. W., Lee, S. M., & Seo, Y. H. (2014). Comparison of sputum and nasopharyngeal swabs for detection of respiratory viruses. Journal of Medical Virology, 86(12). Retrieved from: https://doi.org/10.1002/jmv.23937

[143] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[144] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[145] Rozenbaum, M. H., Judy, J., Tran, D., Yacisin, K., Kurosky, S. K., & Begier, E. (2023). Low levels of RSV testing among adults hospitalized for lower respiratory tract infection in the United States. Infectious Diseases and Therapy, 12(2). Retrieved from: https://doi.org/10.1007/s40121-023-00758-5

[146] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[147] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[148] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[149] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[150] Bausch Health, Canada Inc. (2020, September 28). Product monograph: PrVIRAZOLE®. Retrieved July 30, 2023, from: https://pdf.hres.ca/dpd_pm/00058173.PDF

[151] Bausch Health, Canada Inc. (2020, September 28). Product monograph: PrVIRAZOLE®. Retrieved July 30, 2023, from: https://pdf.hres.ca/dpd_pm/00058173.PDF

[152] Bausch Health, Canada Inc. (2020, September 28). Product monograph: PrVIRAZOLE®. Retrieved July 30, 2023, from: https://pdf.hres.ca/dpd_pm/00058173.PDF

[153] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[154] Beaird, O. E., Freifeld, A., Ison, M. G., Lawrence, S. J., Theodoropoulos, N., Clark, N. M., Razonable, R. R., Alangaden, G., Miller, R., Smith, J., Young, J. A., Hawkinson, D., Pursell, K., & Kaul, D. R. (2016). Current practices for treatment of respiratory syncytial virus and other non-influenza respiratory viruses in high-risk patient populations: A survey of institutions in the Midwestern Respiratory Virus Collaborative. Transplant Infectious Disease : An Official Journal of the Transplantation Society, 18(2). Retrieved from: https://doi.org/10.1111/tid.12510

[155] Bausch Health, Canada Inc. (2020, September 28). Product monograph: PrVIRAZOLE®. Retrieved July 30, 2023, from: https://pdf.hres.ca/dpd_pm/00058173.PDF

[156] Beaird, O. E., Freifeld, A., Ison, M. G., Lawrence, S. J., Theodoropoulos, N., Clark, N. M., Razonable, R. R., Alangaden, G., Miller, R., Smith, J., Young, J. A., Hawkinson, D., Pursell, K., & Kaul, D. R. (2016). Current practices for treatment of respiratory syncytial virus and other non-influenza respiratory viruses in high-risk patient populations: A survey of institutions in the Midwestern Respiratory Virus Collaborative. Transplant Infectious Disease : An Official Journal of the Transplantation Society, 18(2). Retrieved from: https://doi.org/10.1111/tid.12510

[157] Marcelin, J. R., Wilson, J. W., Razonable, R. R., & Mayo Clinic Hematology/Oncology and Transplant Infectious Diseases Services (2014). Oral ribavirin therapy for respiratory syncytial virus infections in moderately to severely immunocompromised patients. Transplant Infectious Disease : An Official Journal of the Transplantation Society, 16(2). Retrieved from: https://doi.org/10.1111/tid.12194

[158] Tejada, S., Martinez-Reviejo, R., Karakoc, H. N., Peña-López, Y., Manuel, O., & Rello, J. (2022). Ribavirin for treatment of subjects with respiratory syncytial virus-related infection: A systematic review and meta-analysis. Advances in Therapy, 39(9). Retrieved from: https://doi.org/10.1007/s12325-022-02256-5

[159] Tejada, S., Martinez-Reviejo, R., Karakoc, H. N., Peña-López, Y., Manuel, O., & Rello, J. (2022). Ribavirin for treatment of subjects with respiratory syncytial virus-related infection: A systematic review and meta-analysis. Advances in Therapy, 39(9). Retrieved from: https://doi.org/10.1007/s12325-022-02256-5

[160] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[161] AstraZeneca. (2021, November 11). Understanding the difference between antibodies and vaccines. Retrieved July 30, 2023, from: https://www.astrazeneca.com/what-science-can-do/topics/covid-19/covid-19-difference-between-antibodies-and-vaccines.html

[162] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[163] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[164] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[165] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[166] Gonçalves, A., Bertrand, J., Ke, R., Comets, E., de Lamballerie, X., Malvy, D., Pizzorno, A., Terrier, O., Rosa Calatrava, M., Mentré, F., Smith, P., Perelson, A. S., & Guedj, J. (2020). Timing of antiviral treatment initiation is critical to reduce SARS-CoV-2 viral load. CPT: Pharmacometrics & Systems Pharmacology, 9(9), 509–514. https://doi.org/10.1002/psp4.12543

[167] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[168] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[169] Pera, A., Campos, C., López, N., Hassouneh, F., Alonso, C., Tarazona, R., & Solana, R. (2015). Immunosenescence: Implications for response to infection and vaccination in older people. Maturitas, 82(1). Retrieved from: https://doi.org/10.1016/j.maturitas.2015.05.004

[170] Talbot, H. K., Belongia, E. A., Walsh, E. E., & Schaffner W. (2016). Respiratory syncytial virus in older adults: A hidden annual epidemic. Infectious Diseases in Clinical Practice, 24(6). Retrieved from: https://doi.org/10.1097/IPC.0000000000000455

[171] Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

[172] Tin Tin Htar, M., Yerramalla, M. S., Moïsi, J. C., & Swerdlow, D. L. (2020). The burden of respiratory syncytial virus in adults: A systematic review and meta-analysis. Epidemiology and Infection, 148. Retrieved from: https://doi.org/10.1017/S0950268820000400

[173] Mac, S., Shi, S., Millson, B., Tehrani, A., Eberg, M., Myageri, V., Langley, J. M., & Simpson, S. (2023). Burden of illness associated with respiratory syncytial virus (RSV)-related hospitalizations among adults in Ontario, Canada: A retrospective population-based study. Vaccine, S0264-410X(23)00774-0. Advance online publication. Retrieved from: https://doi.org/10.1016/j.vaccine.2023.06.071

[174] Tin Tin Htar, M., Yerramalla, M. S., Moïsi, J. C., & Swerdlow, D. L. (2020). The burden of respiratory syncytial virus in adults: A systematic review and meta-analysis. Epidemiology and Infection, 148. Retrieved from: https://doi.org/10.1017/S0950268820000400

[175] Bosco, E., van Aalst, R., McConeghy, K. W., Silva, J., Moyo, P., Eliot, M. N., Chit, A., Gravenstein, S., & Zullo, A. R. (2021). Estimated cardiorespiratory hospitalizations attributable to influenza and respiratory syncytial virus among long-term care facility residents. JAMA Network Open, 4(6). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2021.11806

[176] Zheng, Z., Warren, J. L., Shapiro, E. D., Pitzer, V. E., & Weinberger, D. M. (2022). Estimated incidence of respiratory hospitalizations attributable to RSV infections across age and socioeconomic groups. Pneumonia (Nathan Qld.), 14(1). Retrieved from: https://doi.org/10.1186/s41479-022-00098-x

[177] Rozenbaum, M. H., Judy, J., Tran, D., Yacisin, K., Kurosky, S. K., & Begier, E. (2023). Low levels of RSV testing among adults hospitalized for lower respiratory tract infection in the United States. Infectious Diseases and Therapy, 12(2). Retrieved from: https://doi.org/10.1007/s40121-023-00758-5

[178] McLaughlin, J. M., Khan, F., Begier, E., Swerdlow, D. L., Jodar, L., & Falsey, A. R. (2022). Rates of medically attended RSV among US adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 9(7). Retrieved from: https://doi.org/10.1093/ofid/ofac300

[179] McLaughlin, J. M., Khan, F., Begier, E., Swerdlow, D. L., Jodar, L., & Falsey, A. R. (2022). Rates of medically attended RSV among US adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 9(7). Retrieved from: https://doi.org/10.1093/ofid/ofac300

[180] McLaughlin, J. M., Khan, F., Begier, E., Swerdlow, D. L., Jodar, L., & Falsey, A. R. (2022). Rates of medically attended RSV among US adults: A systematic review and meta-analysis. Open Forum Infectious Diseases, 9(7). Retrieved from: https://doi.org/10.1093/ofid/ofac300

[181] Onwuchekwa, C., Moreo, L. M., Menon, S., Machado, B., Curcio, D., Kalina, W., Atwell, J. E., Gessner, B. D., Siapka, M., Agarwal, N., Rubbrecht, M., Nair, H., Rozenbaum, M., Aponte-Torres, Z., Vroling, H., & Begier, E. (2023). Underascertainment of respiratory syncytial virus infection in adults due to diagnostic testing limitations: A systematic literature review and meta-analysis. The Journal of Infectious Diseases, 228(2). Retrieved from: https://doi.org/10.1093/infdis/jiad012

[182] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[183] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[184] Mac, S., Shi, S., Millson, B., Tehrani, A., Eberg, M., Myageri, V., Langley, J. M., & Simpson, S. (2023). Burden of illness associated with respiratory syncytial virus (RSV)-related hospitalizations among adults in Ontario, Canada: A retrospective population-based study. Vaccine, S0264-410X(23)00774-0. Advance online publication. Retrieved from: https://doi.org/10.1016/j.vaccine.2023.06.071

[185] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[186] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[187] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[188] Chatzis, O., Darbre, S., Pasquier, J., Meylan, P., Manuel, O., Aubert, J. D., Beck-Popovic, M., Masouridi-Levrat, S., Ansari, M., Kaiser, L., Posfay-Barbe, K. M., & Asner, S. A. (2018). Burden of severe RSV disease among immunocompromised children and adults: A 10 year retrospective study. BMC Infectious Diseases, 18(1). Retrieved from: https://doi.org/10.1186/s12879-018-3002-3

[189] Chatzis, O., Darbre, S., Pasquier, J., Meylan, P., Manuel, O., Aubert, J. D., Beck-Popovic, M., Masouridi-Levrat, S., Ansari, M., Kaiser, L., Posfay-Barbe, K. M., & Asner, S. A. (2018). Burden of severe RSV disease among immunocompromised children and adults: A 10 year retrospective study. BMC Infectious Diseases, 18(1). Retrieved from: https://doi.org/10.1186/s12879-018-3002-3

[190] Belongia, E. A., King, J. P., Kieke, B. A., Pluta, J., Al-Hilli, A., Meece, J. K., & Shinde, V. (2018). Clinical features, severity, and incidence of RSV illness during 12 consecutive seasons in a community cohort of adults ≥60 years old. Open Forum Infectious Diseases, 5(12). Retrieved from: https://doi.org/10.1093/ofid/ofy316

[191] Schmidt, H., Das, A., Nam, H., Yang, A., & Ison, M. G. (2019). Epidemiology and outcomes of hospitalized adults with respiratory syncytial virus: A 6-year retrospective study. Influenza and Other Respiratory Viruses, 13(4). Retrieved from: https://doi.org/10.1111/irv.12643

[192] ElSherif, M., Andrew, M. K., Ye, L., Ambrose, A., Boivin, G., Bowie, W., David, M. P., Gruselle, O., Halperin, S. A., Hatchette, T. F., Johnstone, J., Katz, K., Langley, J. M., Loeb, M., MacKinnon-Cameron, D., McCarthy, A., McElhaney, J. E., McGeer, A., Poirier, A., … LeBlanc, J. J. (2023). Leveraging influenza virus surveillance from 2012 to 2015 to characterize the burden of respiratory syncytial virus disease in Canadian adults ≥50 years of age hospitalized with acute respiratory illness. Open Forum Infectious Diseases, 10(7). Retrieved from: https://doi.org/10.1093/ofid/ofad315

[193] Volling, C., Hassan, K., Mazzulli, T., Green, K., Al-Den, A., Hunter, P., Mangat, R., Ng, J., & McGeer, A. (2014). Respiratory syncytial virus infection-associated hospitalization in adults: A retrospective cohort study. BMC Infectious Diseases, 14. Retrieved from: https://doi.org/10.1186/s12879-014-0665-2

[194] Colosia, A. D., Yang, J., Hillson, E., Mauskopf, J., Copley-Merriman, C., Shinde, V., & Stoddard, J. (2017). The epidemiology of medically attended respiratory syncytial virus in older adults in the United States: A systematic review. PloS One, 12(8). Retrieved from: https://doi.org/10.1371/journal.pone.0182321

[195] Belongia, E. A., King, J. P., Kieke, B. A., Pluta, J., Al-Hilli, A., Meece, J. K., & Shinde, V. (2018). Clinical features, severity, and incidence of RSV illness during 12 consecutive seasons in a community cohort of adults ≥60 years old. Open Forum Infectious Diseases, 5(12). Retrieved from: https://doi.org/10.1093/ofid/ofy316

[196] Belongia, E. A., King, J. P., Kieke, B. A., Pluta, J., Al-Hilli, A., Meece, J. K., & Shinde, V. (2018). Clinical features, severity, and incidence of RSV illness during 12 consecutive seasons in a community cohort of adults ≥60 years old. Open Forum Infectious Diseases, 5(12). Retrieved from: https://doi.org/10.1093/ofid/ofy316

[197] Tin Tin Htar, M., Yerramalla, M. S., Moïsi, J. C., & Swerdlow, D. L. (2020). The burden of respiratory syncytial virus in adults: A systematic review and meta-analysis. Epidemiology and Infection, 148. Retrieved from: https://doi.org/10.1017/S0950268820000400

[198] Zwaans, W. A., Mallia, P., van Winden, M. E., & Rohde, G. G. (2014). The relevance of respiratory viral infections in the exacerbations of chronic obstructive pulmonary disease—a systematic review. Journal of Clinical Virology : The Official Publication of the Pan American Society for Clinical Virology, 61(2). Retrieved from: https://doi.org/10.1016/j.jcv.2014.06.025

[199] Zheng, X. Y., Xu, Y. J., Guan, W. J., & Lin, L. F. (2018). Regional, age and respiratory-secretion-specific prevalence of respiratory viruses associated with asthma exacerbation: A literature review. Archives of Virology, 163(4). Retrieved from: https://doi.org/10.1007/s00705-017-3700-y

[200] Volling, C., Hassan, K., Mazzulli, T., Green, K., Al-Den, A., Hunter, P., Mangat, R., Ng, J., & McGeer, A. (2014). Respiratory syncytial virus infection-associated hospitalization in adults: A retrospective cohort study. BMC Infectious Diseases, 14. Retrieved from: https://doi.org/10.1186/s12879-014-0665-2

[201] Boonyaratanakornkit, J., Ekici, S., Magaret, A., Gustafson, K., Scott, E., Haglund, M., Kuypers, J., Pergamit, R., Lynch, J., & Chu, H. Y. (2019). Respiratory syncytial virus infection in homeless populations, Washington, USA. Emerging Infectious Diseases, 25(7). Retrieved from: https://doi.org/10.3201/eid2507.181261

[202] Hamilton, M. A., Liu, Y., Calzavara, A., Sundaram, M. E., Djebli, M., Darvin, D., Baral, S., Kustra, R., Kwong, J. C., & Mishra, S. (2022). Predictors of all-cause mortality among patients hospitalized with influenza, respiratory syncytial virus, or SARS-CoV-2. Influenza and Other Respiratory Viruses, 16(6). Retrieved from: https://doi.org/10.1111/irv.13004

[203] Schmidt, H., Das, A., Nam, H., Yang, A., & Ison, M. G. (2019). Epidemiology and outcomes of hospitalized adults with respiratory syncytial virus: A 6-year retrospective study. Influenza and Other Respiratory Viruses, 13(4). Retrieved from: https://doi.org/10.1111/irv.12643

[204] Chorazka, M., Flury, D., Herzog, K., Albrich, W. C., & Vuichard-Gysin, D. (2021). Clinical outcomes of adults hospitalized for laboratory confirmed respiratory syncytial virus or influenza virus infection. PloS One, 16(7). Retrieved from: https://doi.org/10.1371/journal.pone.0253161

[205] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[206] Rafferty, E., Paulden, M., Buchan, S. A., Robinson, J. L., Bettinger, J. A., Kumar, M., Svenson, L. W., MacDonald, S. E., & Canadian Immunization Research Network (CIRN) investigators (2022). Evaluating the individual healthcare costs and burden of disease associated with RSV across age groups. PharmacoEconomics, 40(6). Retrieved from: https://doi.org/10.1007/s40273-022-01142-w

[207] National Center for Immunization and Respiratory Diseases. (2022, October 24). Symptoms and care. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/about/symptoms.html

[208] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[209] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[210] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[211] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[212] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[213] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[214] World Health Organization. (2020). Annex 2: Guidelines on the quality, safety and efficacy of respiratory syncytial virus vaccines. Retrieved July 30, 2023, from: https://cdn.who.int/media/docs/default-source/biologicals/vaccine-standardization/respiratory-syncytial-virus-(rsv)-vaccines/annex_2_rsv_vaccines_trs_1024.pdf?sfvrsn=5d7aefa7_3&download=true

[215] Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

[216] World Health Organization. (2020). Annex 2: Guidelines on the quality, safety and efficacy of respiratory syncytial virus vaccines. Retrieved July 30, 2023, from: https://cdn.who.int/media/docs/default-source/biologicals/vaccine-standardization/respiratory-syncytial-virus-(rsv)-vaccines/annex_2_rsv_vaccines_trs_1024.pdf?sfvrsn=5d7aefa7_3&download=true

[217] Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

[218] World Health Organization. (2020). Annex 2: Guidelines on the quality, safety and efficacy of respiratory syncytial virus vaccines. Retrieved July 30, 2023, from: https://cdn.who.int/media/docs/default-source/biologicals/vaccine-standardization/respiratory-syncytial-virus-(rsv)-vaccines/annex_2_rsv_vaccines_trs_1024.pdf?sfvrsn=5d7aefa7_3&download=true

[219] Garg, I., Shekhar, R., Sheikh, A. B., & Pal, S. (2022). Impact of COVID-19 on the changing patterns of respiratory syncytial virus infections. Infectious Disease Reports, 14(4). Retrieved from: https://doi.org/10.3390/idr14040059

[220] World Health Organization. (2020). Annex 2: Guidelines on the quality, safety and efficacy of respiratory syncytial virus vaccines. Retrieved July 30, 2023, from: https://cdn.who.int/media/docs/default-source/biologicals/vaccine-standardization/respiratory-syncytial-virus-(rsv)-vaccines/annex_2_rsv_vaccines_trs_1024.pdf?sfvrsn=5d7aefa7_3&download=true

[221] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[222] Schanzer, D. L., Saboui, M., Lee, L., Nwosu, A., & Bancej, C. (2018). Burden of influenza, respiratory syncytial virus, and other respiratory viruses and the completeness of respiratory viral identification among respiratory inpatients, Canada, 2003-2014. Influenza and Other Respiratory Viruses, 12(1). Retrieved from: https://doi.org/10.1111/irv.12497

[223] Hansen, C. L., Chaves, S. S., Demont, C., & Viboud, C. (2022). Mortality associated with influenza and respiratory syncytial virus in the US, 1999-2018. JAMA Network Open, 5(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2022.0527

[224] Hamilton, M. A., Liu, Y., Calzavara, A., Sundaram, M. E., Djebli, M., Darvin, D., Baral, S., Kustra, R., Kwong, J. C., & Mishra, S. (2022). Predictors of all-cause mortality among patients hospitalized with influenza, respiratory syncytial virus, or SARS-CoV-2. Influenza and Other Respiratory Viruses, 16(6). Retrieved from: https://doi.org/10.1111/irv.13004

[225] Park, K. Y., Seo, S., Han, J., & Park, J. Y. (2021). Respiratory virus surveillance in Canada during the COVID-19 pandemic: An epidemiological analysis of the effectiveness of pandemic-related public health measures in reducing seasonal respiratory viruses test positivity. PloS One, 16(6). Retrieved from: https://doi.org/10.1371/journal.pone.0253451

[226] Public Health Agency of Canada. (2023, July 13). Respiratory virus report, week 27 - ending July 8, 2023. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/surveillance/respiratory-virus-detections-canada/2022-2023/week-27-ending-july-8-2023.html

[227] Park, K. Y., Seo, S., Han, J., & Park, J. Y. (2021). Respiratory virus surveillance in Canada during the COVID-19 pandemic: An epidemiological analysis of the effectiveness of pandemic-related public health measures in reducing seasonal respiratory viruses test positivity. PloS One, 16(6). Retrieved from: https://doi.org/10.1371/journal.pone.0253451

[228] Achangwa, C., Park, H., Ryu, S., & Lee, M. S. (2022). Collateral impact of public health and social measures on respiratory virus activity during the COVID-19 pandemic 2020-2021. Viruses, 14(5). Retrieved from: https://doi.org/10.3390/v14051071

[229] Garg, I., Shekhar, R., Sheikh, A. B., & Pal, S. (2022). Impact of COVID-19 on the changing patterns of respiratory syncytial virus infections. Infectious Disease Reports, 14(4). Retrieved from: https://doi.org/10.3390/idr14040059

[230] Public Health Agency of Canada. (2023, July 13). Respiratory virus report, week 27 - ending July 8, 2023. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/surveillance/respiratory-virus-detections-canada/2022-2023/week-27-ending-july-8-2023.html

[231] Garg, I., Shekhar, R., Sheikh, A. B., & Pal, S. (2022). Impact of COVID-19 on the changing patterns of respiratory syncytial virus infections. Infectious Disease Reports, 14(4). Retrieved from: https://doi.org/10.3390/idr14040059

[232] Garg, I., Shekhar, R., Sheikh, A. B., & Pal, S. (2022). Impact of COVID-19 on the changing patterns of respiratory syncytial virus infections. Infectious Disease Reports, 14(4). Retrieved from: https://doi.org/10.3390/idr14040059

[233] Weeks, C. (2022, November 14). Children's hospitals are overwhelmed across Canada. Experts weigh in on what's to blame – and what's not. The Globe and Mail Inc. Retrieved July 30, 2023, from: https://www.theglobeandmail.com/canada/article-kids-hospitals-rsv-infections/

[234] Public Health Agency of Canada. (2023, July 13). Respiratory virus report, week 27 - ending July 8, 2023. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/surveillance/respiratory-virus-detections-canada/2022-2023/week-27-ending-july-8-2023.html

[235] Lapid, N. (2022, October 26). Doctors warn of 'tripledemic' this winter, with COVID, flu and respiratory infections on the rise. National Post. Retrieved July 30, 2023, from: https://nationalpost.com/health/covid-flu-and-rsv-this-u-s-winter-why-experts-are-worried

[236] The Canadian Press. (2022, November 25). RSV appears to be slowing in Ontario, health minister says. CP24. Retrieved July 30, 2023, from: https://www.cp24.com/news/rsv-appears-to--be-slowing-in-ontario-health-minister-says-1.6168980?cache=yesclipId-10406200text%2Fhtml%3Bcharset%-3Dutf-80404%2F7.626236%2F7.62623-6%2F7.626236%2F7.626236%-2F7.281562%2F7.281562%2F7.281562

[237] DeLaire, M. (2022, November 8). 'We are so overwhelmed': Children's hospitals across Canada stretched as RSV cases, flu-like illnesses spike. CTV News. Retrieved July 30, 2023, from: https://www.ctvnews.ca/health/we-are-so-overwhelmed-children-s-hospitals-across-canada-stretched-as-rsv-cases-flu-like-illnesses-spike-1.6139599

[238] Weeks, C. (2022, November 14). Children's hospitals are overwhelmed across Canada. Experts weigh in on what's to blame – and what's not. The Globe and Mail Inc. Retrieved July 30, 2023, from: https://www.theglobeandmail.com/canada/article-kids-hospitals-rsv-infections/

[239] DeLaire, M. (2022, November 8). 'We are so overwhelmed': Children's hospitals across Canada stretched as RSV cases, flu-like illnesses spike. CTV News. Retrieved July 30, 2023, from: https://www.ctvnews.ca/health/we-are-so-overwhelmed-children-s-hospitals-across-canada-stretched-as-rsv-cases-flu-like-illnesses-spike-1.6139599

[240] Mac, S., Shi, S., Millson, B., Tehrani, A., Eberg, M., Myageri, V., Langley, J. M., & Simpson, S. (2023). Burden of illness associated with respiratory syncytial virus (RSV)-related hospitalizations among adults in Ontario, Canada: A retrospective population-based study. Vaccine, S0264-410X(23)00774-0. Advance online publication. Retrieved from: https://doi.org/10.1016/j.vaccine.2023.06.071

[241] Mac, S., Shi, S., Millson, B., Tehrani, A., Eberg, M., Myageri, V., Langley, J. M., & Simpson, S. (2023). Burden of illness associated with respiratory syncytial virus (RSV)-related hospitalizations among adults in Ontario, Canada: A retrospective population-based study. Vaccine, S0264-410X(23)00774-0. Advance online publication. Retrieved from: https://doi.org/10.1016/j.vaccine.2023.06.071

[242] Mac, S., Shi, S., Millson, B., Tehrani, A., Eberg, M., Myageri, V., Langley, J. M., & Simpson, S. (2023). Burden of illness associated with respiratory syncytial virus (RSV)-related hospitalizations among adults in Ontario, Canada: A retrospective population-based study. Vaccine, S0264-410X(23)00774-0. Advance online publication. Retrieved from: https://doi.org/10.1016/j.vaccine.2023.06.071

[243] Rafferty, E., Paulden, M., Buchan, S. A., Robinson, J. L., Bettinger, J. A., Kumar, M., Svenson, L. W., MacDonald, S. E., & Canadian Immunization Research Network (CIRN) investigators (2022). Evaluating the individual healthcare costs and burden of disease associated with RSV across age groups. PharmacoEconomics, 40(6). Retrieved from: https://doi.org/10.1007/s40273-022-01142-w

[244] Rafferty, E., Paulden, M., Buchan, S. A., Robinson, J. L., Bettinger, J. A., Kumar, M., Svenson, L. W., MacDonald, S. E., & Canadian Immunization Research Network (CIRN) investigators (2022). Evaluating the individual healthcare costs and burden of disease associated with RSV across age groups. PharmacoEconomics, 40(6). Retrieved from: https://doi.org/10.1007/s40273-022-01142-w

[245] Rafferty, E., Paulden, M., Buchan, S. A., Robinson, J. L., Bettinger, J. A., Kumar, M., Svenson, L. W., MacDonald, S. E., & Canadian Immunization Research Network (CIRN) investigators (2022). Evaluating the individual healthcare costs and burden of disease associated with RSV across age groups. PharmacoEconomics, 40(6). Retrieved from: https://doi.org/10.1007/s40273-022-01142-w

[246] ElSherif, M., Andrew, M. K., Ye, L., Ambrose, A., Boivin, G., Bowie, W., David, M. P., Gruselle, O., Halperin, S. A., Hatchette, T. F., Johnstone, J., Katz, K., Langley, J. M., Loeb, M., MacKinnon-Cameron, D., McCarthy, A., McElhaney, J. E., McGeer, A., Poirier, A., … LeBlanc, J. J. (2023). Leveraging influenza virus surveillance from 2012 to 2015 to characterize the burden of respiratory syncytial virus disease in Canadian adults ≥50 years of age hospitalized with acute respiratory illness. Open Forum Infectious Diseases, 10(7). Retrieved from: https://doi.org/10.1093/ofid/ofad315

[247] Rafferty, E., Paulden, M., Buchan, S. A., Robinson, J. L., Bettinger, J. A., Kumar, M., Svenson, L. W., MacDonald, S. E., & Canadian Immunization Research Network (CIRN) investigators (2022). Evaluating the individual healthcare costs and burden of disease associated with RSV across age groups. PharmacoEconomics, 40(6). Retrieved from: https://doi.org/10.1007/s40273-022-01142-w

[248] ElSherif, M., Andrew, M. K., Ye, L., Ambrose, A., Boivin, G., Bowie, W., David, M. P., Gruselle, O., Halperin, S. A., Hatchette, T. F., Johnstone, J., Katz, K., Langley, J. M., Loeb, M., MacKinnon-Cameron, D., McCarthy, A., McElhaney, J. E., McGeer, A., Poirier, A., … LeBlanc, J. J. (2023). Leveraging influenza virus surveillance from 2012 to 2015 to characterize the burden of respiratory syncytial virus disease in Canadian adults ≥50 years of age hospitalized with acute respiratory illness. Open Forum Infectious Diseases, 10(7). Retrieved from: https://doi.org/10.1093/ofid/ofad315

[249] ElSherif, M., Andrew, M. K., Ye, L., Ambrose, A., Boivin, G., Bowie, W., David, M. P., Gruselle, O., Halperin, S. A., Hatchette, T. F., Johnstone, J., Katz, K., Langley, J. M., Loeb, M., MacKinnon-Cameron, D., McCarthy, A., McElhaney, J. E., McGeer, A., Poirier, A., … LeBlanc, J. J. (2023). Leveraging influenza virus surveillance from 2012 to 2015 to characterize the burden of respiratory syncytial virus disease in Canadian adults ≥50 years of age hospitalized with acute respiratory illness. Open Forum Infectious Diseases, 10(7). Retrieved from: https://doi.org/10.1093/ofid/ofad315

[250] Lefebvre, M-A., Robinson, J., & Winters, N. (2017). Validation of RSV infections in pediatric transplant recipients reported to a national surveillance program: A PICNIC study. Official Journal of the Association of Medical Microbiology and Infectious Disease Canada, 2(1). Retrieved from: https://doi.org/10.3138/jammi.2.1.003

[251] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[252] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[253] Satia, I., Cusack, R., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2020). Prevalence and contribution of respiratory viruses in the community to rates of emergency department visits and hospitalizations with respiratory tract infections, chronic obstructive pulmonary disease and asthma. PloS One, 15(2). Retrieved from: https://doi.org/10.1371/journal.pone.0228544

[254] Satia, I., Cusack, R., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2020). Prevalence and contribution of respiratory viruses in the community to rates of emergency department visits and hospitalizations with respiratory tract infections, chronic obstructive pulmonary disease and asthma. PloS One, 15(2). Retrieved from: https://doi.org/10.1371/journal.pone.0228544

[255] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[256] Groves, H. E., Piché-Renaud, P. P., Peci, A., Farrar, D. S., Buckrell, S., Bancej, C., Sevenhuysen, C., Campigotto, A., Gubbay, J. B., & Morris, S. K. (2021). The impact of the COVID-19 pandemic on influenza, respiratory syncytial virus, and other seasonal respiratory virus circulation in Canada: A population-based study. Lancet Regional Health. Americas, 1. Retrieved from: https://doi.org/10.1016/j.lana.2021.100015

[257] Satia, I., Cusack, R., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2020). Prevalence and contribution of respiratory viruses in the community to rates of emergency department visits and hospitalizations with respiratory tract infections, chronic obstructive pulmonary disease and asthma. PloS One, 15(2). Retrieved from: https://doi.org/10.1371/journal.pone.0228544

[258] Public Health Agency of Canada. (2023, August 24). Respiratory virus detections in Canada. Government of Canada. Retrieved September 1, 2023, from: https://www.canada.ca/en/public-health/services/surveillance/respiratory-virus-detections-canada.html

[259] Martin, L. J., Lee, B. E., & Yasui, Y. (2016). Google Flu Trends in Canada: A comparison of digital disease surveillance data with physician consultations and respiratory virus surveillance data, 2010-2014. Epidemiology and Infection, 144(2). Retrieved from: https://doi.org/10.1017/S0950268815001478

[260] Satia, I., Adatia, A., Cusack, R. P., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2021). Influence of age, sex and respiratory viruses on the rates of emergency department visits and hospitalisations with respiratory tract infections, asthma and COPD. ERJ Open Research, 7(2). Retrieved from: https://doi.org/10.1183/23120541.00053-2021

[261] Satia, I., Adatia, A., Yaqoob, S., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2020). Emergency department visits and hospitalisations for asthma, COPD and respiratory tract infections: What is the role of respiratory viruses, and return to school in September, January and March? ERJ Open Research, 6(4). Retrieved from: https://doi.org/10.1183/23120541.00593-2020

[262] Satia, I., Adatia, A., Cusack, R. P., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2021). Influence of age, sex and respiratory viruses on the rates of emergency department visits and hospitalisations with respiratory tract infections, asthma and COPD. ERJ Open Research, 7(2). Retrieved from: https://doi.org/10.1183/23120541.00053-2021

[263] Satia, I., Adatia, A., Yaqoob, S., Greene, J. M., O'Byrne, P. M., Killian, K. J., & Johnston, N. (2020). Emergency department visits and hospitalisations for asthma, COPD and respiratory tract infections: What is the role of respiratory viruses, and return to school in September, January and March? ERJ Open Research, 6(4). Retrieved from: https://doi.org/10.1183/23120541.00593-2020

[264] Canadian Paediatric Society. (2023, May 30). Surveillance. Retrieved September 1, 2023, from: https://cps.ca/en/impact

[265] Canadian Paediatric Society. (2023, May 30). Surveillance. Retrieved September 1, 2023, from: https://cps.ca/en/impact

[266] Groves, H. E., Papenburg, J., Mehta, K., Bettinger, J. A., Sadarangani, M., Halperin, S. A., Morris, S. K., & for members of the Canadian Immunization Monitoring Program Active (IMPACT) (2022). The effect of the COVID-19 pandemic on influenza-related hospitalization, intensive care admission and mortality in children in Canada: A population-based study. Lancet Regional Health. Americas, 7. Retrieved from: https://doi.org/10.1016/j.lana.2021.100132

[267] Top, K. A., Macartney, K., Bettinger, J. A., Tan, B., Blyth, C. C., Marshall, H. S., Vaudry, W., Halperin, S. A., McIntyre, P., & IMPACT and PAEDS investigators (2020). Active surveillance of acute paediatric hospitalisations demonstrates the impact of vaccination programmes and informs vaccine policy in Canada and Australia. Euro Surveillance : Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin, 25(25). Retrieved from: https://doi.org/10.2807/1560-7917.ES.2020.25.25.1900562

[268] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[269] Canadian Institute for Health Information. (2023). Hospital Morbidity Database (HMDB) metadata [metadata]. Retrieved July 30, 2023, from: https://www.cihi.ca/en/hospital-morbidity-database-hmdb-metadata

[270] Canadian Institute for Health Information. (2023). Hospital Morbidity Database (HMDB) metadata [metadata]. Retrieved July 30, 2023, from: https://www.cihi.ca/en/hospital-morbidity-database-hmdb-metadata

[271] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[272] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[273] National Center for Immunization and Respiratory Diseases. (2023, July 18). The National Respiratory and Enteric Virus Surveillance System (NREVSS). Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/surveillance/nrevss/index.html

[274] National Center for Immunization and Respiratory Diseases. (2023, July 18). RSV-NET overview and methods. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/research/rsv-net/overview-methods.html

[275] National Center for Immunization and Respiratory Diseases. (2022, October 25). Respiratory syncytial virus (RSV) surveillance. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/surveillance/nrevss/rsv/index.html

[276] National Center for Immunization and Respiratory Diseases. (2023, July 17). RSV surveillance & research. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/research/index.html#:~:text=58%2C000%2D80%2C000%20hospitalizations%20among%20children%20younger%20than%205%20years%20old-.&text=60%2C000%2D160%2C000%20hospitalizations%20among%20adults%2065%20years%20and%20older.&text=6%2C000%2D10%2C000%20deaths%20among%20adults%2065%20years%20and%20older.&text=100–300%20deaths%20in%20children%20younger%20than%205%20years%20old

[277] Mollers, M., Barnadas, C., Broberg, E. K., Penttinen, P., European Influenza Surveillance Network, Teirlinck, A. C., Fischer, T. K., & Members of the European Influenza Surveillance network (EISN) (2019). Current practices for respiratory syncytial virus surveillance across the EU/EEA Member States, 2017. Euro Surveillance : Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin, 24(40). Retrieved from: https://doi.org/10.2807/1560-7917.ES.2019.24.40.1900157

[278] Mollers, M., Barnadas, C., Broberg, E. K., Penttinen, P., European Influenza Surveillance Network, Teirlinck, A. C., Fischer, T. K., & Members of the European Influenza Surveillance network (EISN) (2019). Current practices for respiratory syncytial virus surveillance across the EU/EEA Member States, 2017. Euro Surveillance : Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin, 24(40). Retrieved from: https://doi.org/10.2807/1560-7917.ES.2019.24.40.1900157

[279] Hirve, S., Crawford, N., Palekar, R., Zhang, W., & WHO RSV surveillance Group (2020). Clinical characteristics, predictors, and performance of case definition-interim results from the WHO global respiratory syncytial virus surveillance pilot. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12688

[280] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[281] Mollers, M., Barnadas, C., Broberg, E. K., Penttinen, P., European Influenza Surveillance Network, Teirlinck, A. C., Fischer, T. K., & Members of the European Influenza Surveillance network (EISN) (2019). Current practices for respiratory syncytial virus surveillance across the EU/EEA Member States, 2017. Euro Surveillance : Bulletin Europeen sur les Maladies Transmissibles = European Communicable Disease Bulletin, 24(40). Retrieved from: https://doi.org/10.2807/1560-7917.ES.2019.24.40.1900157

[282] Hirve, S., Crawford, N., Palekar, R., Zhang, W., & WHO RSV surveillance Group (2020). Clinical characteristics, predictors, and performance of case definition-interim results from the WHO global respiratory syncytial virus surveillance pilot. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12688

[283] Hirve, S., Crawford, N., Palekar, R., Zhang, W., & WHO RSV surveillance Group (2020). Clinical characteristics, predictors, and performance of case definition-interim results from the WHO global respiratory syncytial virus surveillance pilot. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12688

[284] World Health Organization. (2023). Global influenza programme: RSV surveillance case definitions. Retrieved July 30, 2023, from: https://www.who.int/teams/global-influenza-programme/global-respiratory-syncytial-virus-surveillance/case-definitions

[285] Hirve, S., Crawford, N., Palekar, R., Zhang, W., & WHO RSV surveillance Group (2020). Clinical characteristics, predictors, and performance of case definition-interim results from the WHO global respiratory syncytial virus surveillance pilot. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12688

[286] World Health Organization. (2023). Global influenza programme: Respiratory syncytial virus surveillance. Retrieved July 30, 2023, from: https://www.who.int/teams/global-influenza-programme/global-respiratory-syncytial-virus-surveillance

[287] World Health Organization. (2023). Global influenza programme: Respiratory syncytial virus surveillance. Retrieved July 30, 2023, from: https://www.who.int/teams/global-influenza-programme/global-respiratory-syncytial-virus-surveillance

[288] World Health Organization. (2023). Global influenza programme: RSV data reporting and outputs. Retrieved July 30, 2023, from: https://www.who.int/teams/global-influenza-programme/global-respiratory-syncytial-virus-surveillance/rsv-data-reporting-and-outputs

[289] Chadha, M., Hirve, S., Bancej, C., Barr, I., Baumeister, E., Caetano, B., Chittaganpitch, M., Darmaa, B., Ellis, J., Fasce, R., Kadjo, H., Jackson, S., Leung, V., Pisareva, M., Moyes, J., Naguib, A., Tivane, A., Zhang, W., & WHO RSV Surveillance Group (2020). Human respiratory syncytial virus and influenza seasonality patterns-early findings from the WHO global respiratory syncytial virus surveillance. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12726

[290] Hirve, S., Crawford, N., Palekar, R., Zhang, W., & WHO RSV surveillance Group (2020). Clinical characteristics, predictors, and performance of case definition-interim results from the WHO global respiratory syncytial virus surveillance pilot. Influenza and Other Respiratory Viruses, 14(6). Retrieved from: https://doi.org/10.1111/irv.12688

[291] Davis, W., Duque, J., Huang, Q. S., Olson, N., Grant, C. C., Newbern, E. C., Thompson, M., Waite, B., Prasad, N., Trenholme, A., & Azziz-Baumgartner, E. (2022). Sensitivity and specificity of surveillance case definitions in detection of influenza and respiratory syncytial virus among hospitalized patients, New Zealand, 2012-2016. The Journal of Infection, 84(2). Retrieved from: https://doi.org/10.1016/j.jinf.2021.12.012

[292] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[293] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[294] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[295] National Center for Immunization and Respiratory Diseases. (2023, May 24). Explaining how vaccines work. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/hcp/conversations/understanding-vacc-work.html

[296] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[297] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[298] Dion, S. B., Major, M., Gabriela Grajales, A., Nepal, R. M., Cane, A., Gessner, B., Vojicic, J., & Suaya, J. A. (2021). Invasive pneumococcal disease in Canada 2010-2017: The role of current and next-generation higher-valent pneumococcal conjugate vaccines. Vaccine, 39(22). Retrieved from: https://doi.org/10.1016/j.vaccine.2021.02.069

[299] Herring, W. L., Zhang, Y., Shinde, V., Stoddard, J., Talbird, S. E., & Rosen, B. (2022). Clinical and economic outcomes associated with respiratory syncytial virus vaccination in older adults in the United States. Vaccine, 40(3). Retrieved from: https://doi.org/10.1016/j.vaccine.2021.12.002

[300] Postma, M. J., Cheng, C. Y., Buyukkaramikli, N. C., Hernandez Pastor, L., Vandersmissen, I., Van Effelterre, T., Openshaw, P., & Simoens, S. (2023). Predicted public health and economic impact of respiratory syncytial virus vaccination with variable duration of protection for adults ≥60 years in Belgium. Vaccines, 11(5). Retrieved from: https://doi.org/10.3390/vaccines11050990

[301] Herring, W. L., Zhang, Y., Shinde, V., Stoddard, J., Talbird, S. E., & Rosen, B. (2022). Clinical and economic outcomes associated with respiratory syncytial virus vaccination in older adults in the United States. Vaccine, 40(3). Retrieved from: https://doi.org/10.1016/j.vaccine.2021.12.002

[302] World Health Organization. (2023). Respiratory syncytial virus (RSV) disease. Retrieved July 30, 2023, from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/respiratory-syncytial-virus-disease

[303] Simões E. A. F. (2022). Respiratory syncytial virus disease in young children and older adults in Europe: A burden and economic perspective. The Journal of Infectious Diseases, 226(Suppl 1). Retrieved from: https://doi.org/10.1093/infdis/jiac252

[304] Pfizer Inc. (2022, August 25). Pfizer announces positive top-line data from Phase 3 trial of older adults for its bivalent respiratory syncytial virus (RSV) vaccine candidate. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/pfizer-announces-positive-top-line-data-phase-3-trial-older

[305] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[306] Simões E. A. F. (2022). Respiratory syncytial virus disease in young children and older adults in Europe: A burden and economic perspective. The Journal of Infectious Diseases, 226(Suppl 1). Retrieved from: https://doi.org/10.1093/infdis/jiac252

[307] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[308] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[309] PATH. (2023, June). RSV vaccine and mAb snapshot. Retrieved July 30, 2023, from: https://media.path.org/documents/RSV-snapshot_02JUN2023_clinical-stage_dBtD8W3.pdf?_gl=1*eewcb1*_gcl_au*NDU2NTI2MzA2LjE2OTAzMzY0NzU.*_ga*MTQxNjA1ODMzMi4xNjkwMzM2NDc1*_ga_YBSE7ZKDQM*MTY5MDMzNjQ3NS4xLjEuMTY5MDMzNjUzNi42MC4wLjA

[310] Chu, H. Y., Steinhoff, M. C., Magaret, A., Zaman, K., Roy, E., Langdon, G., Formica, M. A., Walsh, E. E., & Englund, J. A. (2014). Respiratory syncytial virus transplacental antibody transfer and kinetics in mother-infant pairs in Bangladesh. The Journal of Infectious Diseases, 210(10). Retrieved from: https://doi.org/10.1093/infdis/jiu316

[311] Chu, H. Y., Newman, K. L., Englund, J. A., Cho, S., Bull, C., Lacombe, K., Carlin, K., Bulkow, L. R., Rudolph, K., DeByle, C., Berner, J., Klejka, J., & Singleton, R. (2021). Transplacental respiratory syncytial virus and influenza virus antibody transfer in Alaska Native and Seattle mother-infant pairs. Journal of the Pediatric Infectious Diseases Society, 10(3). Retrieved from: https://doi.org/10.1093/jpids/piaa040

[312] Koivisto, K., Nieminen, T., Mejias, A., Capella Gonzalez, C., Ye, F., Mertz, S., Peeples, M., Ramilo, O., & Saxén, H. (2022). Respiratory syncytial virus (RSV)-specific antibodies in pregnant women and subsequent risk of RSV hospitalization in young infants. The Journal of Infectious Diseases, 225(7). Retrieved from: https://doi.org/10.1093/infdis/jiab315

[313] Public Health Agency of Canada. (2023, March 22). Pneumococcal vaccine: Canadian Immunization Guide. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/page-16-pneumococcal-vaccine.html#a4

[314] Miller, A. (2022, November 12). Moderna is banking on a combined COVID, flu and RSV vaccine. Will it work? CBC. Retrieved July 30, 2023, from: https://www.cbc.ca/news/health/moderna-covid-flu-rsv-vaccine-1.6647447

[315] PATH. (2023, June). RSV vaccine and mAb snapshot. Retrieved July 30, 2023, from: https://media.path.org/documents/RSV-snapshot_02JUN2023_clinical-stage_dBtD8W3.pdf?_gl=1*eewcb1*_gcl_au*NDU2NTI2MzA2LjE2OTAzMzY0NzU.*_ga*MTQxNjA1ODMzMi4xNjkwMzM2NDc1*_ga_YBSE7ZKDQM*MTY5MDMzNjQ3NS4xLjEuMTY5MDMzNjUzNi42MC4wLjA

[316] PATH. (2023, June). RSV vaccine and mAb snapshot. Retrieved July 30, 2023, from: https://media.path.org/documents/RSV-snapshot_02JUN2023_clinical-stage_dBtD8W3.pdf?_gl=1*eewcb1*_gcl_au*NDU2NTI2MzA2LjE2OTAzMzY0NzU.*_ga*MTQxNjA1ODMzMi4xNjkwMzM2NDc1*_ga_YBSE7ZKDQM*MTY5MDMzNjQ3NS4xLjEuMTY5MDMzNjUzNi42MC4wLjA

[317] Biagi, C., Dondi, A., Scarpini, S., Rocca, A., Vandini, S., Poletti, G., & Lanari, M. (2020). Current state and challenges in developing respiratory syncytial virus vaccines. Vaccines, 8(4). Retrieved from: https://doi.org/10.3390/vaccines8040672

[318] Killikelly, A., Tunis, M., House, A., Quach, C., Vaudry, W., & Moore, D. (2020). Overview of the respiratory syncytial virus vaccine candidate pipeline in Canada. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a01

[319] Killikelly, A., Tunis, M., House, A., Quach, C., Vaudry, W., & Moore, D. (2020). Overview of the respiratory syncytial virus vaccine candidate pipeline in Canada. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a01

[320] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[321] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[322] Killikelly, A., Tunis, M., House, A., Quach, C., Vaudry, W., & Moore, D. (2020). Overview of the respiratory syncytial virus vaccine candidate pipeline in Canada. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a01

[323] Mazur, N. I., Terstappen, J., Baral, R., Bardají, A., Beutels, P., Buchholz, U. J., Cohen, C., Crowe, J. E., Jr, Cutland, C. L., Eckert, L., Feikin, D., Fitzpatrick, T., Fong, Y., Graham, B. S., Heikkinen, T., Higgins, D., Hirve, S., Klugman, K. P., Kragten-Tabatabaie, L., … Bont, L. (2023). Respiratory syncytial virus prevention within reach: The vaccine and monoclonal antibody landscape. The Lancet. Infectious Diseases, 23(1). Retrieved from: https://doi.org/10.1016/S1473-3099(22)00291-2

[324] Killikelly, A., Tunis, M., House, A., Quach, C., Vaudry, W., & Moore, D. (2020). Overview of the respiratory syncytial virus vaccine candidate pipeline in Canada. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a01

[325] Roberts, J. N., Graham, B. S., Karron, R. A., Munoz, F. M., Falsey, A. R., Anderson, L. J., Marshall, V., Kim, S., & Beeler, J. A. (2016). Challenges and opportunities in RSV vaccine development: Meeting report from FDA/NIH workshop. Vaccine, 34(41). Retrieved from: https://doi.org/10.1016/j.vaccine.2016.07.057

[326] Roberts, J. N., Graham, B. S., Karron, R. A., Munoz, F. M., Falsey, A. R., Anderson, L. J., Marshall, V., Kim, S., & Beeler, J. A. (2016). Challenges and opportunities in RSV vaccine development: Meeting report from FDA/NIH workshop. Vaccine, 34(41). Retrieved from: https://doi.org/10.1016/j.vaccine.2016.07.057

[327] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[328] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[329] Killikelly, A., Tunis, M., House, A., Quach, C., Vaudry, W., & Moore, D. (2020). Overview of the respiratory syncytial virus vaccine candidate pipeline in Canada. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a01

[330] PATH. (2023, June). RSV vaccine and mAb snapshot. Retrieved July 30, 2023, from: https://www.path.org/resources/rsv-vaccine-and-mab-snapshot/

[331] PATH. (2023, January). RSV clinical trial tracker. Retrieved July 30, 2023, from: https://www.path.org/resources/rsv-and-mab-trial-tracker/

[332] World Health Organization. (2023). Respiratory syncytial virus (RSV) disease. Retrieved July 30, 2023, from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/respiratory-syncytial-virus-disease

[333] World Health Organization. (2023). Respiratory syncytial virus (RSV) disease. Retrieved July 30, 2023, from: https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/vaccine-standardization/respiratory-syncytial-virus-disease

[334] GSK plc. (2023, May 3). US FDA approves GSK's Arexvy, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[335] Pfizer Inc. (2023, May 31). U.S. FDA approves ABRYSVO™, Pfizer's vaccine for the prevention of respiratory syncytial virus (RSV) in older adults. Retrieved July 30, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/us-fda-approves-abrysvotm-pfizers-vaccine-prevention#:~:text=On%20March%2024%2C%202022%2C%20Pfizer,years%20of%20age%20and%20older

[336] Moderna, Inc. (2023, July 5). Moderna announces global regulatory submissions for its respiratory syncytial virus (RSV) vaccine, mRNA-1345. Retrieved July 30, 2023, from: https://investors.modernatx.com/news/news-details/2023/Moderna-Announces-Global-Regulatory-Submissions-For-Its-Respiratory-Syncytial-Virus-RSV-Vaccine-MRNA-1345/default.aspx

[337] GSK plc. (2023, June 7). European Commission authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/european-commission-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/#:~:text=GSK%20plc%20(LSE%2FNYSE%3A,years%20of%20age%20and%20older

[338] Pfizer Inc. (2023, August 24). European Commission approves Pfizer's ABRYSVO™ to help protect infants through maternal immunization and older adults from RSV. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/european-commission-approves-pfizers-abrysvotm-help-protect

[339] GSK plc. (2023, July 10). Medicines and Healthcare products Regulatory Agency authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved September 1, 2023, from: https://www.gsk.com/en-gb/media/press-releases/medicines-and-healthcare-products-regulatory-agency-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[340] GSK plc. (2022, October 21). GSK regulatory submission accepted by Japanese regulator for respiratory syncytial virus older adult vaccine candidate. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/gsk-regulatory-submission-accepted-by-japanese-regulator-for-respiratory-syncytial-virus-older-adult-vaccine-candidate/

[341] Moderna, Inc. (2023, July 5). Moderna announces global regulatory submissions for its respiratory syncytial virus (RSV) vaccine, mRNA-1345. Retrieved July 30, 2023, from: https://investors.modernatx.com/news/news-details/2023/Moderna-Announces-Global-Regulatory-Submissions-For-Its-Respiratory-Syncytial-Virus-RSV-Vaccine-MRNA-1345/default.aspx

[342] GlaxoSmithKline Inc. (2023, August). Product monograph including patient medication information: Arexvy. Government of Canada. Retrieved September 1, 2023, from: https://pdf.hres.ca/dpd_pm/00071904.PDF

[343] Pfizer Inc. (2023, April 14). Pfizer Canada initiates submission to Health Canada for its bivalent respiratory syncytial virus (RSV) vaccine. Retrieved July 30, 2023, from: https://www.pfizer.ca/en/media-centre/pfizer-canada-initiates-submission-to-health-canada-for-its-bivalent-respiratory-syncytial-virus-rsv-vaccine

[344] Government of Ontario. (2023, September 14). Connecting Ontarians to the tools they need to stay healthy this respiratory illness season. Retrieved September 27, 2023, from: https://news.ontario.ca/en/release/1003504/connecting-ontarians-to-the-tools-they-need-to-stay-healthy-this-respiratory-illness-season

[345] Pfizer Inc. (2023, August 21). U.S. FDA approves ABRYSVO™, Pfizer's vaccine for the prevention of respiratory syncytial virus (RSV) in infants through active immunization of pregnant individuals 32-36 weeks of gestational age. Retrieved July 30, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/us-fda-approves-abrysvotm-pfizers-vaccine-prevention-0

[346] Pfizer Inc. (2023, August 24). European Commission approves Pfizer's ABRYSVO™ to help protect infants through maternal immunization and older adults from RSV. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/european-commission-approves-pfizers-abrysvotm-help-protect

[347] Pfizer Inc. (2023, August 24). European Commission approves Pfizer's ABRYSVO™ to help protect infants through maternal immunization and older adults from RSV. Retrieved September 1, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/european-commission-approves-pfizers-abrysvotm-help-protect

[348] GSK plc. (2023, May 3). US FDA approves GSK's Arexvy, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[349] GSK plc. (2023, May 3). US FDA approves GSK's AREXVY, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://us.gsk.com/en-us/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[350] European Medicines Agency. (2023, April 26). First vaccine to protect older adults from respiratory syncytial virus (RSV) infection. Retrieved July 30, 2023, from: https://www.ema.europa.eu/en/news/first-vaccine-protect-older-adults-respiratory-syncytial-virus-rsv-infection

[351] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[352] GSK plc. (2023, May 3). US FDA approves GSK's Arexvy, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[353] GSK plc. (2023, June 7). European Commission authorises GSK's Arexvy, the first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/european-commission-authorises-gsk-s-arexvy-the-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/#:~:text=GSK%20plc%20(LSE%2FNYSE%3A,years%20of%20age%20and%20older

[354] GSK plc. (2022, October 13). GSK's older adult respiratory syncytial virus (RSV) vaccine candidate shows 94.1% reduction in severe RSV disease and overall vaccine efficacy of 82.6% in pivotal trial. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/gsk-s-older-adult-respiratory-syncytial-virus-rsv-vaccine-candidate/

[355] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[356] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[357] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[358] GSK plc. (2023, June 21). GSK shares positive data for Arexvy, its respiratory syncytial virus (RSV) older adult vaccine, indicating protection over two RSV seasons. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/gsk-shares-positive-data-for-arexvy-its-respiratory-syncytial-virus-older-adult-vaccine-indicating-protection-over-two-rsv-seasons/

[359] GSK plc. (2023, June 21). GSK shares positive data for Arexvy, its respiratory syncytial virus (RSV) older adult vaccine, indicating protection over two RSV seasons. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/gsk-shares-positive-data-for-arexvy-its-respiratory-syncytial-virus-older-adult-vaccine-indicating-protection-over-two-rsv-seasons/

[360] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[361] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[362] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[363] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[364] European Medicines Agency. (2023, April 26). CHMP assessment report. Retrieved July 30, 2023, from: https://www.ema.europa.eu/en/documents/assessment-report/arexvy-epar-public-assessment-report_.pdf

[365] SK plc. (2023, July 26). Press release: Second quarter 2023. Retrieved August 30, 2023, from: https://www.gsk.com/media/10423/q2-2023-results-announcement.pdf

[366] Pfizer Inc. (2023, May 31). U.S. FDA approves ABRYSVO™, Pfizer's vaccine for the prevention of respiratory syncytial virus (RSV) in older adults. Retrieved July 30, 2023, from: https://www.pfizer.com/news/press-release/press-release-detail/us-fda-approves-abrysvotm-pfizers-vaccine-prevention#:~:text=On%20March%2024%2C%202022%2C%20Pfizer,years%20of%20age%20and%20older

[367] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[368] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[369] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[370] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[371] Pfizer Inc. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://labeling.pfizer.com/ShowLabeling.aspx?id=19589

[372] Pfizer Inc. (2023, June 22). Pfizer's ABRYSVO™ receives recommendation for use in older adults from Advisory Committee on Immunization Practices. Retrieved July 30, 2023, from: https://www.pfizer.com/news/announcements/pfizers-abrysvotm-receives-recommendation-use-older-adults-advisory-committee

[373] Pfizer Inc. (2023, May 2). Pfizer reports first-quarter 2023 results. Retrieved July 30, 2023, from: https://s28.q4cdn.com/781576035/files/doc_financials/2023/q1/Q1-2023-PFE-Earnings-Release.pdf

[374] Pfizer. (2023, July 19). Study to evaluate the efficacy, immunogenicity, and safety of RSVpreF in adults. (RENOIR). ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05035212?term=RSVpreF&phase=2&draw=2&rank=6

[375] Pfizer. (2023, July 12). A study to assess the safety, tolerability, and immunogenicity of RSVpreF in adults at high risk of severe RSV disease (MONET). ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05842967?term=RSVpreF&phase=2&draw=2&rank=10

[376] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[377] Reichmuth, A. M., Oberli, M. A., Jaklenec, A., Langer, R., & Blankschtein, D. (2016). mRNA vaccine delivery using lipid nanoparticles. Therapeutic Delivery, 7(5). Retrieved from: https://doi.org/10.4155/tde-2016-0006

[378] Moderna, Inc. (2023, July 5). Moderna announces global regulatory submissions for its respiratory syncytial virus (RSV) vaccine, mRNA-1345. Retrieved July 30, 2023, from: https://investors.modernatx.com/news/news-details/2023/Moderna-Announces-Global-Regulatory-Submissions-For-Its-Respiratory-Syncytial-Virus-RSV-Vaccine-MRNA-1345/default.aspx

[379] Moderna, Inc. (2023, July 5). Moderna announces global regulatory submissions for its respiratory syncytial virus (RSV) vaccine, mRNA-1345. Retrieved July 30, 2023, from: https://investors.modernatx.com/news/news-details/2023/Moderna-Announces-Global-Regulatory-Submissions-For-Its-Respiratory-Syncytial-Virus-RSV-Vaccine-MRNA-1345/default.aspx

[380] ModernaTX, Inc. (2023, January 31). A study to evaluate the safety and efficacy of mRNA-1345 vaccine targeting respiratory syncytial virus (RSV) in adults ≥60 years of age. ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05127434

[381] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[382] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[383] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[384] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[385] Sutton, N., San Francisco Ramos, A., Beales, E., Smith, D., Ikram, S., Galiza, E., Hsia, Y., & Heath, P. T. (2022). Comparing reactogenicity of COVID-19 vaccines: A systematic review and meta-analysis. Expert Review of Vaccines, 21(9). Retrieved from: https://doi.org/10.1080/14760584.2022.2098719

[386] ModernaTX, Inc. (2023, January 31). A study to evaluate the safety and efficacy of mRNA-1345 vaccine targeting respiratory syncytial virus (RSV) in adults ≥60 years of age. ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05127434

[387] ModernaTX, Inc. (2023, June 2). A study of mRNA-1345 vaccine targeting respiratory syncytial virus (RSV) in adults ≥50 years of age (RSVictory). ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05330975

[388] National Center for Immunization and Respiratory Diseases. (2023, June 30). ACIP recommendations. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/recommendations.html

[389] National Center for Immunization and Respiratory Diseases. (2020, February 10). ACIP shared clinical decision-making recommendations. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/acip-scdm-faqs.html

[390] Melgar, M., Britton, A., Roper, L. E., Talbot, H. K., Long, S. S., Kotton, C. N., & Havers, F. P. (2023). Use of respiratory syncytial virus vaccines in older adults: Recommendations of the Advisory Committee on Immunization Practices - United States, 2023. MMWR. Morbidity and Mortality Weekly Report, 72(29). Retrieved from: https://doi.org/10.15585/mmwr.mm7229a4

[391] Appleby, J. (2023, August 23). Timing and cost of new vaccines vary by virus and health insurance status. What to know. Retrieved September 1, 2023, from: https://www.usatoday.com/story/news/nation/2023/08/23/vaccines-covid-rsv-flu-vary-on-timing-cost-insurance/70620867007/

[392] Melgar, M., Britton, A., Roper, L. E., Talbot, H. K., Long, S. S., Kotton, C. N., & Havers, F. P. (2023). Use of respiratory syncytial virus vaccines in older adults: Recommendations of the Advisory Committee on Immunization Practices - United States, 2023. MMWR. Morbidity and Mortality Weekly Report, 72(29). Retrieved from: https://doi.org/10.15585/mmwr.mm7229a4

[393] Department of Health & Social Care. (2023, June 22). Respiratory syncytial virus (RSV) immunisation programme: JCVI advice, 7 June 2023. GOV.UK. Retrieved July 30, 2023, from: https://www.gov.uk/government/publications/rsv-immunisation-programme-jcvi-advice-7-june-2023/respiratory-syncytial-virus-rsv-immunisation-programme-jcvi-advice-7-june-2023

[394] Department of Health & Social Care. (2023, June 22). Respiratory syncytial virus (RSV) immunisation programme: JCVI advice, 7 June 2023. GOV.UK. Retrieved July 30, 2023, from: https://www.gov.uk/government/publications/rsv-immunisation-programme-jcvi-advice-7-june-2023/respiratory-syncytial-virus-rsv-immunisation-programme-jcvi-advice-7-june-2023

[395] National Center for Immunization and Respiratory Diseases. (2023, May 24). Explaining how vaccines work. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/hcp/conversations/understanding-vacc-work.html

[396] World Health Organization. (2020, December 8). How do vaccines work? Retrieved July 30, 2023, from: https://www.who.int/news-room/feature-stories/detail/how-do-vaccines-work#:~:text=Vaccines%20contain%20weakened%20or%20inactive,rather%20than%20the%20antigen%20itself

[397] National Center for Immunization and Respiratory Diseases. (2023, May 24). Explaining how vaccines work. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/hcp/conversations/understanding-vacc-work.html

[398] AstraZeneca. (2021, November 11). Understanding the difference between antibodies and vaccines. Retrieved July 30, 2023, from: https://www.astrazeneca.com/what-science-can-do/topics/covid-19/covid-19-difference-between-antibodies-and-vaccines.html

[399] Sun, M., Lai, H., Na, F., Li, S., Qiu, X., Tian, J., Zhang, Z., & Ge, L. (2023). Monoclonal antibody for the prevention of respiratory syncytial virus in infants and children: A systematic review and network meta-analysis. JAMA Network Open, 6(2). Retrieved from: https://doi.org/10.1001/jamanetworkopen.2023.0023

[400] Turalde-Mapili, M. W. R., Mapili, J. A. L., Turalde, C. W. R., & Pagcatipunan, M. R. (2023). The efficacy and safety of nirsevimab for the prevention of RSV infection among infants: A systematic review and meta-analysis. Frontiers in Pediatrics, 11. Retrieved from: https://doi.org/10.3389/fped.2023.1132740

[401] Nam, H. H., & Ison, M. G. (2019). Respiratory syncytial virus infection in adults. BMJ (Clinical Research Ed.), 366. Retrieved from: https://doi.org/10.1136/bmj.l5021

[402] Health Canada. (2023, February 1). Cost-effectiveness of palivizumab prophylaxis for respiratory syncytial virus (RSV): A systematic review. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/cost-effectiveness-palivizumab-prophylaxis-respiratory-syncitial-virus.html

[403] Biagi, C., Dondi, A., Scarpini, S., Rocca, A., Vandini, S., Poletti, G., & Lanari, M. (2020). Current state and challenges in developing respiratory syncytial virus vaccines. Vaccines, 8(4). Retrieved from: https://doi.org/10.3390/vaccines8040672

[404] Foley, D. A., Phuong, L. K., & Englund, J. A. (2020). Respiratory syncytial virus immunisation overview. Journal of Paediatrics and Child Health, 56(12). Retrieved from: https://doi.org/10.1111/jpc.15232

[405] Jenkins, V. A., Hoet, B., Hochrein, H., & De Moerlooze, L. (2023). The quest for a respiratory syncytial virus vaccine for older adults: Thinking beyond the F protein. Vaccines, 11(2). Retrieved from: https://doi.org/10.3390/vaccines11020382

[406] Public Health Agency of Canada. (2022, June 1). Recommended use of palivizumab to reduce complications of respiratory syncytial virus infection in infants. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/palivizumab-respiratory-syncitial-virus-infection-infants.html

[407] Sanofi Canada. (2023, April 24). Health Canada approves BEYFORTUS™ (nirsevimab) for the prevention of RSV disease in infants. Retrieved July 30, 2023, from: https://sanoficanada.mediaroom.com/2023-04-24-Health-Canada-approves-BEYFORTUS-TM-nirsevimab-for-the-prevention-of-RSV-disease-in-infants

[408] Government of Canada. (2023, May 10). Respiratory syncytial virus: Canadian Immunization Guide. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-4-active-vaccines/respiratory-syncytial-virus.html

[409] GlaxoSmithKline Inc. (2023, August). Product monograph including patient medication information: Arexvy. Government of Canada. Retrieved September 1, 2023, from: https://pdf.hres.ca/dpd_pm/00071904.PDF

[410] Pfizer Inc. (2023, April 14). Pfizer Canada initiates submission to Health Canada for its bivalent respiratory syncytial virus (RSV) vaccine. Retrieved July 30, 2023, from: https://www.pfizer.ca/en/media-centre/pfizer-canada-initiates-submission-to-health-canada-for-its-bivalent-respiratory-syncytial-virus-rsv-vaccine

[411] National Institute on Ageing. (2021). The underappreciated burden of influenza among Canada's older population. And what we need to do about it. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63bc3ab40d82c92f1c388470/1673280185059/Burden+of+Influenza+-+Dec+2022.pdf

[412] National Institute on Ageing (2022). A Goal within our reach: What the COVID-19 pandemic has taught us about improving the uptake of influenza vaccinations in Canada. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/6385fbf18cd7a156622addc7/1669725171981/Final+Report+-+A+Goal+Within+Our+Reach+-+Influenza+Vaccination2+.pdf

[413] Public Health Agency of Canada. (2022, August 16). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[414] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[415] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[416] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[417] MacDonald, N. E., & SAGE Working Group on Vaccine Hesitancy (2015). Vaccine hesitancy: Definition, scope and determinants. Vaccine, 33(34). Retrieved from: https://doi.org/10.1016/j.vaccine.2015.04.036

[418] MacDonald, N. E., & SAGE Working Group on Vaccine Hesitancy (2015). Vaccine hesitancy: Definition, scope and determinants. Vaccine, 33(34). Retrieved from: https://doi.org/10.1016/j.vaccine.2015.04.036

[419] Oduwole, E., Pienaar, E., Mahomed, H., & Wiysonge, C. (2019). Current tools available for investigating vaccine hesitancy: A scoping review protocol. BMJ Open, 9(12). Retrieved from: https://doi.org/10.1136/bmjopen-2019-033245

[420] Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PloS One, 13(12). Retrieved from: https://doi.org/10.1371/journal.pone.0208601

[421] Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of influenza vaccination intention and behavior–a systematic review of influenza vaccine hesitancy, 2005–2016. PloS One, 12(1). Retrieved from: https://doi.org/10.1371/journal.pone.0170550

[422] Thomson, A., Robinson, K., & Vallée-Tourangeau, G. (2016). The 5As: A practical taxonomy for the determinants of vaccine uptake. Vaccine, 34(8). Retrieved from: https://doi.org/10.1016/j.vaccine.2015.11.065

[423] Betsch, C., Schmid, P., Heinemeier, D., Korn, L., Holtmann, C., & Böhm, R. (2018). Beyond confidence: Development of a measure assessing the 5C psychological antecedents of vaccination. PloS One, 13(12). Retrieved from: https://doi.org/10.1371/journal.pone.0208601

[424] Bish, A., Yardley, L., Nicoll, A., & Michie, S. (2011). Factors associated with uptake of vaccination against pandemic influenza: A systematic review. Vaccine, 29(38). Retrieved from: https://doi.org/10.1016/j.vaccine.2011.06.107

[425] Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-analysis of the relationship between risk perception and health behavior: The example of vaccination. Health Psychology, 26(2). Retrieved from: https://doi.org/10.1037/0278-6133.26.2.136

[426] Thomson, A., Robinson, K., & Vallée-Tourangeau, G. (2016). The 5As: A practical taxonomy for the determinants of vaccine uptake. Vaccine, 34(8). Retrieved from: https://doi.org/10.1016/j.vaccine.2015.11.065

[427] Caserotti, M., Girardi, P., Rubaltelli, E., Tasso, A., Lotto, L., & Gavaruzzi, T. (2021). Associations of COVID-19 risk perception with vaccine hesitancy over time for Italian residents. Social Science & Medicine, 272. Retrieved from: https://doi.org/10.1016/j.socscimed.2021.113688

[428] Dubé, E., Laberge, C., Guay, M., Bramadat, P., Roy, R., & Bettinger, J. A. (2013). Vaccine hesitancy: An overview. Human Vaccines & Immunotherapeutics, 9(8). Retrieved from: https://doi.org/10.4161/hv.24657

[429] Public Health Agency of Canada. (2023, January). Seasonal influenza vaccination coverage in Canada, 2021–2022. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/seasonal-influenza-survey-results-2021-2022/full-report.html

[430] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[431] National Institute on Ageing. (2021). The underappreciated burden of influenza among Canada's older population. And what we need to do about it. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63bc3ab40d82c92f1c388470/1673280185059/Burden+of+Influenza+-+Dec+2022.pdf

[432] National Institute on Ageing. (2022). The overlooked issue of shingles infections in older Canadians and how to address it! Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[433] National Institute on Ageing. (2023). As one of Canada's top killers, why isn't pneumonia taken more seriously? Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/64666f42b34ce05072c1b27c/1684434755822/Pneumonia_Report+-+Revised.pdf

[434] National Institute on Ageing. (2022). The overlooked issue of shingles infections in older Canadians and how to address it! Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[435] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[436] Kelly, D. A., Macey, D. J., & Mak, D. B. (2014). Annual influenza vaccination. Human Vaccines & Immunotherapeutics, 10(7). Retrieved from: https://doi.org/10.4161/hv.29071

[437] Statistics Canada. (2023, August 30). Sources of income of senior census families by family type and age of older partner, parent or individual (Table 11-10-0053-01) [Data table]. Retrieved from: https://doi.org/10.25318/1110005301-eng

[438] Cortes, K., & Smith, L. (2022, November 2). Insights on Canadian society: Pharmaceutical access and use during the pandemic. Statistics Canada. Retrieved July 30, 2023, from: https://www150.statcan.gc.ca/n1/pub/75-006-x/2022001/article/00011-eng.htm#tbl01

[439] National Institute on Ageing. (2023). As one of Canada's top killers, why isn't pneumonia taken more seriously? Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/64666f42b34ce05072c1b27c/1684434755822/Pneumonia_Report+-+Revised.pdf

[440] Public Health Agency of Canada. (2022, August 16). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[441] Ontario College of Family Physicians. (2023, February 9). More Than 2.2 Million Ontarians Left Without a Family Doctor. https://www.ontariofamilyphysicians.ca/news-features/news/~287-More-Than-2-2-Million-Ontarians-Left-Without-a-Family-Doctor

[442] McIntrye, A., Zecevic, A., & Diachun, L. (2014). Influenza vaccinations: Older adults' decision-making process. Canadian Journal on Aging, 33(1). Retrieved from: https://doi.org/10.1017/S0714980813000640

[443] Kumar, S., Shah, Z., & Garfield, S. (2022). Causes of vaccine hesitancy in adults for the influenza and COVID-19 vaccines: A systematic literature review. Vaccines, 10(9). Retrieved from: https://doi.org/10.3390/vaccines10091518

[444] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[445] Public Health Agency of Canada. (2018, July). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved July 30, 2023, from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[446] National Institute on Ageing (2022). A Goal within our reach: What the COVID-19 pandemic has taught us about improving the uptake of influenza vaccinations in Canada. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/6385fbf18cd7a156622addc7/1669725171981/Final+Report+-+A+Goal+Within+Our+Reach+-+Influenza+Vaccination2+.pdf

[447] Deal, A., Crawshaw, AC., Salloum, M., Hayward, S. E., Knights, F., Goldsmith, L. P., Carter, J., Rustage, K., Mounier-Jack, S., & Hargreaves, S. (2022). Strategies to increase catch-up vaccination among migrants: A qualitative study and rapid review: Anna Deal. European Journal of Public Health, 32(3, Suppl.). Retrieved from: https://doi.org/10.1093/eurpub/ckac131.116

[448] Wilson, L., Rubens-Augustson, T., Murphy, M., Jardine, C., Crowcroft, N., Hui, C., & Wilson, K. (2018). Barriers to immunization among newcomers: A systematic review. Vaccine, 36(8). Retrieved from: https://doi.org/10.1016/j.vaccine.2018.01.025

[449] Pless, A., McLennan, S.R., Nicca, D., Shaw, D.M., & Elger, B.S. (2017). Reasons why nurses decline influenza vaccination: A qualitative study. BMC Nursing, 16(20). Retrieved from: https://doi.org/10.1186/s12912-017-0215-5

[450] Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of influenza vaccination intention and behavior–a systematic review of influenza vaccine hesitancy, 2005–2016. PloS One, 12(1). Retrieved from: https://doi.org/10.1371/journal.pone.0170550

[451] Pless, A., McLennan, S.R., Nicca, D., Shaw, D.M., & Elger, B.S. (2017). Reasons why nurses decline influenza vaccination: A qualitative study. BMC Nursing, 16(20). Retrieved from: https://doi.org/10.1186/s12912-017-0215-5

[452] Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of influenza vaccination intention and behavior–a systematic review of influenza vaccine hesitancy, 2005–2016. PloS One, 12(1). Retrieved from: https://doi.org/10.1371/journal.pone.0170550

[453] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: Attitudes and beliefs of the Canadian public and healthcare providers. BMJ Open, 5(9). Retrieved from: https://doi.org/10.1136/bmjopen-2015-009062

[454] Riccò, M., Ferraro, P., Peruzzi, S., Zaniboni, A., & Ranzieri, S. (2022). Respiratory syncytial virus: Knowledge, attitudes and beliefs of general practitioners from north-eastern Italy (2021). Pediatric Reports, 14(2). Retrieved from: https://doi.org/10.3390/pediatric14020021

[455] Hurley, L. P., Allison, M. A., Kim, L., O'Leary, S. T., Crane, L. A., Brtnikova, M., Beaty, B. L., Allen, K. E., Poser, S., Lindley, M. C., & Kempe, A. (2019). Primary care physicians' perspectives on respiratory syncytial virus (RSV) disease in adults and a potential RSV vaccine for adults. Vaccine, 37(4). Retrieved from: https://doi.org/10.1016/j.vaccine.2018.12.031

[456] Riccò, M., Ferraro, P., Peruzzi, S., Zaniboni, A., & Ranzieri, S. (2022). Respiratory syncytial virus: Knowledge, attitudes and beliefs of general practitioners from north-eastern Italy (2021). Pediatric Reports, 14(2). Retrieved from: https://doi.org/10.3390/pediatric14020021

[457] Hurley, L. P., Allison, M. A., Kim, L., O'Leary, S. T., Crane, L. A., Brtnikova, M., Beaty, B. L., Allen, K. E., Poser, S., Lindley, M. C., & Kempe, A. (2019). Primary care physicians' perspectives on respiratory syncytial virus (RSV) disease in adults and a potential RSV vaccine for adults. Vaccine, 37(4). Retrieved from: https://doi.org/10.1016/j.vaccine.2018.12.031

[458] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: Attitudes and beliefs of the Canadian public and healthcare providers. BMJ Open, 5(9). Retrieved from: https://doi.org/10.1136/bmjopen-2015-009062

[459] Kizmaz, M., Kumtepe Kurt, B., Çetin Kargin, N., & Döner, E. (2019). Influenza, pneumococcal and herpes zoster vaccination rates among patients over 65 years of age, related factors, and their knowledge and attitudes. Aging Clinical and Experimental Research, 32(11). Retrieved from: https://doi.org/10.1007/s40520-019-01423-z

[460] Qendro, T., de la Torre, M. L., Panopalis, P., Hazel, E., Ward, B. J., Colmegna, I., & Hudson, M. (2020). Suboptimal immunization coverage among Canadian rheumatology patients in routine clinical care. The Journal of Rheumatology, 47(5). Retrieved from: https://doi.org/10.3899/jrheum.181376

[461] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: Attitudes and beliefs of the Canadian public and healthcare providers. BMJ Open, 5(9). Retrieved from: https://doi.org/10.1136/bmjopen-2015-009062

[462] Okoli, G. N., Reddy, V. K., Lam, O., Abdulwahid, T., Askin, N., Thommes, E., Chit, A., Abou-Setta, A. M., & Mahmud, S. M. (2021). Interventions on health care providers to improve seasonal influenza vaccination rates among patients: A systematic review and meta-analysis of the evidence since 2000. Family Practice, 38(4). Retrieved from: https://doi.org/10.1093/fampra/cmaa149

[463] Thomas, R. E., & Lorenzetti, D. L. (2018). Interventions to increase influenza vaccination rates of those 60 years and older in the community. The Cochrane Database of Systematic Reviews, 5(5). Retrieved from: https://doi.org/10.1002/14651858.CD005188.pub4

[464] Murray, E., Bieniek, K., Del Aguila, M., Egodage, S., Litzinger, S., Mazouz, A., Mills, H., & Liska, J. (2021). Impact of pharmacy intervention on influenza vaccination acceptance: A systematic literature review and meta-analysis. International Journal of Clinical Pharmacy, 43(5). Retrieved from: https://doi.org/10.1007/s11096-021-01250-1

[465] Sanftenberg, L., Kuehne, F., Anraad, C., Jung-Sievers, C., Dreischulte, T., & Gensichen, J. (2021). Assessing the impact of shared decision making processes on influenza vaccination rates in adult patients in outpatient care: A systematic review and meta-analysis. Vaccine, 39(2). Retrieved from: https://doi.org/10.1016/j.vaccine.2020.12.014

[466] Gates, A., Gates, M., Rahman, S., Guitard, S., MacGregor, T., Pillay, J., Ismail, S. J., Tunis, M. C., Young, K., Hardy, K., Featherstone, R., & Hartling, L. (2021). A systematic review of factors that influence the acceptability of vaccines among Canadians. Vaccine, 39(2). Retrieved from: https://doi.org/10.1016/j.vaccine.2020.10.038

[467] Nasreen, S., Gebretekle, G. B., Lynch, M., Kurdina, A., Thomas, M., Fadel, S., Houle, S., Waite, N. M., Crowcroft, N. S., & Allin, S. (2022). Understanding predictors of pneumococcal vaccine uptake in older adults aged 65 years and older in high-income countries across the globe: A scoping review. Vaccine, 40(32). Retrieved from: https://doi.org/10.1016/j.vaccine.2022.06.056

[468] Chaudhry, R., Schietel, S., North, F., Dejesus, R., Kesman, R., & Stroebel, R. (2013). Improving rates of herpes zoster vaccination with a clinical decision support system in a primary care practice. Journal of Evaluation in Clinical Practice, 19(2). Retrieved from: https://doi.org/10.1111/j.1365-2753.2011.01814.x

[469] Sheth, H., Moreland, L., Peterson, H., & Aggarwal, R. (2017). Improvement in herpes zoster vaccination in patients with rheumatoid arthritis: A quality improvement project. Journal of Rheumatology, 44(1). Retrieved from: https://doi.org/10.3899/jrheum.160179

[470] Sheth, H., Moreland, L., Peterson, H., & Aggarwal, R. (2017). Improvement in herpes zoster vaccination in patients with rheumatoid arthritis: A quality improvement project. Journal of Rheumatology, 44(1). Retrieved from: https://doi.org/10.3899/jrheum.160179

[471] Lau, D., Hu, J., Majumdar, S. R., Storie, D. A., Rees, S. E., & Johnson, J. A. (2012). Interventions to improve influenza and pneumococcal vaccination rates among community-dwelling adults: A systematic review and meta-analysis. Annals of Family Medicine, 10(6). Retrieved from: https://doi.org/10.1370/afm.1405

[472] Schneeberg, A., Bettinger, J. A., McNeil, S., Ward, B. J., Dionne, M., Cooper, C., Coleman, B., Loeb, M., Rubinstein, E., McElhaney, J., Scheifele, D. W., & Halperin, S. A. (2014). Knowledge, attitudes, beliefs and behaviours of older adults about pneumococcal immunization, a Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) investigation. BMC Public Health, 14. Retrieved from: https://doi.org/10.1186/1471-2458-14-442

[473]National Institute on Ageing. (2022). The overlooked issue of shingles infections in older Canadians and how to address it! Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[474] National Institute on Ageing. (2023). As one of Canada's top killers, why isn't pneumonia taken more seriously? Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/64666f42b34ce05072c1b27c/1684434755822/Pneumonia_Report+-+Revised.pdf

[475] Buchan, S. A., Rosella, L. C., Finkelstein, M., Juurlink, D., Isenor, J., Marra, F., Patel, A., Russell, M. L., Quach, S., Waite, N., Kwong, J. C., & Public Health Agency of Canada/Canadian Institutes of Health Research Influenza Research Network (PCIRN) Program Delivery and Evaluation Group (2017). Impact of pharmacist administration of influenza vaccines on uptake in Canada. CMAJ : Canadian Medical Association journal = Journal de l'Association Medicale Canadienne, 189(4). Retrieved from: https://doi.org/10.1503/cmaj.151027

[476] Marra, F., Kaczorowski, J., Gastonguay, L., Marra, C. A., Lynd, L. D., & Kendall, P. (2014). Pharmacy-based Immunization in Rural Communities Strategy (PhICS): A community cluster-randomized trial. Canadian Pharmacists Journal : CPJ = Revue des Pharmaciens du Canada : RPC, 147(1). Retrieved from: https://doi.org/10.1177/1715163513514020

[477] Penchansky, R., & Thomas, J. W. (1981). The concept of access: Definition and relationship to consumer satisfaction. Medical Care, 19(2). Retrieved from: https://doi.org/10.1097/00005650-198102000-00001

[478] Isenor, J. E., Edwards, N. T., Alia, T. A., Slayter, K. L., MacDougall, D. M., McNeil, S. A., & Bowles, S. K. (2016). Impact of pharmacists as immunizers on vaccination rates: A systematic review and meta-analysis. Vaccine, 34(47). Retrieved from: https://doi.org/10.1016/j.vaccine.2016.08.085

[479] Yong, A. G., Lemyre, L., Farrell, S. J., & Young, M. Y. (2016). Acculturation in preventive health for immigrants: A systematic review on influenza vaccination programs in a socioecological framework. Canadian Psychology = Psychologie Canadienne, 57(4). Retrieved from: https://doi.org/10.1037/cap0000075

[480] Adeagbo, M., Olukotun, M., Musa, S., Alaazi, D., Allen, U., Renzaho, A., Sekyi-Otu, A., & Salami, B. (2022). Improving COVID-19 vaccine uptake among Black populations: A systematic review of strategies. International Journal of Environmental Research and Public Health, 19(19). Retrieved from: https://doi.org/10.3390/ijerph191911971

[481] National Institute on Ageing (2022). A Goal within our reach: What the COVID-19 pandemic has taught us about improving the uptake of influenza vaccinations in Canada. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/6385fbf18cd7a156622addc7/1669725171981/Final+Report+-+A+Goal+Within+Our+Reach+-+Influenza+Vaccination2+.pdf

[482] Statistics Canada. (2023, July 26). Population estimates on July 1st, by age and sex (Table 17-10-0005-01) [Data table]. Retrieved from: https://doi.org/10.25318/1710000501-eng

[483] Public Health Agency of Canada. (2023, June 23). Canadian COVID-19 vaccination coverage report. Government of Canada. Retrieved July 30, 2023, from: https://health-infobase.canada.ca/covid-19/vaccination-coverage/

[484] VaccineTrackerQC. (2023, August 30). How many people in Quebec have been vaccinated against COVID-19? Retrieved September 1, 2023, from: https://vaccintrackerqc.ca/en/#by-age-group-1

[485] National Institute on Ageing (2021). A cautionary tale: Canada's vaccine rollout among older adults. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/61547af13a9f1844db32a984/1632926506051/Vaccine+Rollout+-+Final+-+Sept+29.pdf

[486] National Institute on Ageing (2022). A Goal within our reach: What the COVID-19 pandemic has taught us about improving the uptake of influenza vaccinations in Canada. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/6385fbf18cd7a156622addc7/1669725171981/Final+Report+-+A+Goal+Within+Our+Reach+-+Influenza+Vaccination2+.pdf

[487] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[488] Public Health Agency of Canada. (2022, July 11). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[489] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[490] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[491] Public Health Agency of Canada. (2023, February 24). Public health level recommendations on the use of pneumococcal vaccines in adults, including the use of 15-valent and 20-valent conjugate vaccines. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/public-health-level-recommendations-use-pneumococcal-vaccines-adults-including-use-15-valent-20-valent-conjugate-vaccines.html

[492] Leger. (2021). Seasonal influenza vaccination coverage survey, 2020–2021: Final report. Public Health Agency of Canada. Retrieved July 30, 2023, from: https://publications.gc.ca/collections/collection_2021/aspc-phac/H14-315-2021-eng.pdf

[493] Statistics Canada. (2019). Canadian Health Survey on Seniors. Retrieved July 30, 2023, from: https://www23.statcan.gc.ca/imdb/p3Instr.pl?Function=assembleInstr&lang=en&Item_Id=1261582

[494] Boonyaratanakornkit, J., Ekici, S., Magaret, A., Gustafson, K., Scott, E., Haglund, M., Kuypers, J., Pergamit, R., Lynch, J., & Chu, H. Y. (2019). Respiratory syncytial virus infection in homeless populations, Washington, USA. Emerging Infectious Diseases, 25(7). Retrieved from: https://doi.org/10.3201/eid2507.181261

[495] Statistics Canada. (2021, September 29). Canadian Health Survey on Seniors (CHSS). Retrieved July 30, 2023, from: https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=5267

[496] Huang, G., Martin, I., Tsang, R. S., Demczuk, W. H., Tyrrell, G. J., Li, Y. A., Dickson, C., Reyes-Domingo, F., & Squires, S. G. (2021). Invasive bacterial diseases in northern Canada, 1999 to 2018. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 47(11). Retrieved from: https://doi.org/10.14745/ccdr.v47i11a09

[497] Public Health Agency of Canada. (2022, July 11). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[498] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[499] Public Health Agency of Canada. (2022, July 11). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[500] Public Health Agency of Canada. (2022, August 16). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

[501] Public Health Agency of Canada. (2016, September 1). Immunization records: Canadian Immunization Guide. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-1-key-immunization-information/page-12-immunization-records.html#:~:text=Immunization%20registries%20are%20centralized%2C%20confidential,and%20maintain%20electronic%20immunization%20registries

[502] Wilson, S. E., Quach, S., MacDonald, S. E., Naus, M., Deeks, S. L., Crowcroft, N. S., Mahmud, S. M., Tran, D., Kwong, J. C., Tu, K., Johnson, C., & Desai, S. (2017). Immunization information systems in Canada: Attributes, functionality, strengths and challenges. A Canadian Immunization Research Network study. Canadian Journal of Public Health = Revue Canadienne de Sante Publique, 107(6). Retrieved from: https://doi.org/10.17269/cjph.107.5679

[503] Public Health Agency of Canada. (2022, August 12). National Immunization Strategy. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy.html

[504] Public Health Agency of Canada. (2022, January 21). Government of Canada invests in community-based projects to support COVID-19 vaccine uptake. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/news/2022/01/government-of-canadainvests-in-community-based-projects-tosupport-covid-19-vaccine-uptake.html

[505] Public Health Agency of Canada. (2021, January 6). Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 - Recommendations from the Canadian Immunization Registry and Coverage Network (CIRC). Government of Canada. https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/canadian-immunization-registry-functional-standards-2020-2024.html

[506] Public Health Agency of Canada. (2021, January 6). Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 - recommendations from the Canadian Immunization Registry and Coverage Network (CIRC). Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/canadianimmunization-registry-functionalstandards-2020-2024.html

[507] National Center for Immunization and Respiratory Diseases. (2023, July 14). Older adults. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/rsv/high-risk/older-adults.html

[508] Lefebvre, M-A., Robinson, J., & Winters, N. (2017). Validation of RSV infections in pediatric transplant recipients reported to a national surveillance program: A PICNIC study. Official Journal of the Association of Medical Microbiology and Infectious Disease Canada, 2(1). Retrieved from: https://doi.org/10.3138/jammi.2.1.003

[509] Government of Canada. (2023, April 14). Respiratory syncytial virus (RSV): For health professionals. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/diseases/respiratory-syncytial-virus-rsv/health-professionals.html

[510] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[511] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[512] Killikelly, A., Shane, A., Yeung, M. W., Tunis, M., Bancej, C., House, A., Vaudry, W., Moore, D., & Quach, C. (2020). Gap analyses to assess Canadian readiness for respiratory syncytial virus vaccines: Report from an expert retreat. Canada Communicable Disease Report = Releve des Maladies Transmissibles au Canada, 46(4). Retrieved from: https://doi.org/10.14745/ccdr.v46i04a02

[513] GSK plc. (2023, June 21). GSK shares positive data for Arexvy, its respiratory syncytial virus (RSV) older adult vaccine, indicating protection over two RSV seasons. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/gsk-shares-positive-data-for-arexvy-its-respiratory-syncytial-virus-older-adult-vaccine-indicating-protection-over-two-rsv-seasons/

[514] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[515] GlaxoSmithKline. (2023, May). Full prescribing information. Retrieved July 30, 2023, from: https://gskpro.com/content/dam/global/hcpportal/en_US/Prescribing_Information/Arexvy/pdf/AREXVY.PDF

[516] Pfizer Inc. (2023, May 2). Pfizer reports first-quarter 2023 results. Retrieved July 30, 2023, from: https://s28.q4cdn.com/781576035/files/doc_financials/2023/q1/Q1-2023-PFE-Earnings-Release.pdf

[517] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[518] Pfizer Inc. (2023, May 2). Pfizer reports first-quarter 2023 results. Retrieved July 30, 2023, from: https://s28.q4cdn.com/781576035/files/doc_financials/2023/q1/Q1-2023-PFE-Earnings-Release.pdf

[519] GSK plc. (2023, May 3). US FDA approves GSK's Arexvy, the world's first respiratory syncytial virus (RSV) vaccine for older adults. Retrieved July 30, 2023, from: https://www.gsk.com/en-gb/media/press-releases/us-fda-approves-gsk-s-arexvy-the-world-s-first-respiratory-syncytial-virus-rsv-vaccine-for-older-adults/

[520] ModernaTX, Inc. (2023, January 31). A study to evaluate the safety and efficacy of mRNA-1345 vaccine targeting respiratory syncytial virus (RSV) in adults ≥60 years of age. ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05127434

[521] ModernaTX, Inc. (2023, June 2). A study of mRNA-1345 vaccine targeting respiratory syncytial virus (RSV) in adults ≥50 years of age (RSVictory). ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05330975

[522] Pfizer. (2023, July 19). Study to evaluate the efficacy, immunogenicity, and safety of RSVpreF in adults. (RENOIR). ClinicalTrials.gov. Retrieved July 30, 2023, from: https://classic.clinicaltrials.gov/ct2/show/NCT05035212?term=RSVpreF&phase=2&draw=2&rank=6

[523] Philip, R. K., Attwell, K., Breuer, T., Di Pasquale, A., & Lopalco, P. L. (2018). Life-course immunization as a gateway to health. Expert Review of Vaccines, 17(10). Retrieved from: https://doi.org/10.1080/14760584.2018.1527690

[524] Public Health Agency of Canada. (2023, July 7). Recommended immunization schedules: Canadian Immunization Guide. Government of Canada. Retrieved July 20, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-1-key-immunization-information/page-13-recommended-immunization-schedules.html

[525] Public Health Agency of Canada. (2023, July 24). Provincial and territorial routine vaccination programs for healthy, previously immunized adults. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/provincial-territorial-immunization-information/routine-vaccination-healthy-previously-immunized-adult.html

[526] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[527] Lu, P. J., O'Halloran, A., & Williams, W. W. (2015). Impact of health insurance status on vaccination coverage among adult populations. American Journal of Preventive Medicine, 48(6). Retrieved from: https://doi.org/10.1016/j.amepre.2014.12.008

[528] Herring, W. L., Zhang, Y., Shinde, V., Stoddard, J., Talbird, S. E., & Rosen, B. (2022). Clinical and economic outcomes associated with respiratory syncytial virus vaccination in older adults in the United States. Vaccine, 40(3). Retrieved from: https://doi.org/10.1016/j.vaccine.2021.12.002

[529] Postma, M. J., Cheng, C. Y., Buyukkaramikli, N. C., Hernandez Pastor, L., Vandersmissen, I., Van Effelterre, T., Openshaw, P., & Simoens, S. (2023). Predicted public health and economic impact of respiratory syncytial virus vaccination with variable duration of protection for adults ≥60 years in Belgium. Vaccines, 11(5). Retrieved from: https://doi.org/10.3390/vaccines11050990

[530] Public Health Agency of Canada. (2023, April 12). National Advisory Committee on Immunization (NACI): Methods and process. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/methods-process.html

[531] National Center for Immunization and Respiratory Diseases. (2023, June 30). ACIP recommendations. Centers for Disease Control and Prevention. Retrieved July 20, 2023, from: https://www.cdc.gov/vaccines/acip/recommendations.html

[532] National Center for Immunization and Respiratory Diseases. (2020, February 10). ACIP shared clinical decision-making recommendations. Centers for Disease Control and Prevention. Retrieved July 20, 2023, from: https://www.cdc.gov/vaccines/acip/acip-scdm-faqs.html

[533] Public Health Agency of Canada. (2023, January). Seasonal influenza vaccination coverage in Canada, 2021–2022. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/seasonal-influenza-survey-results-2021-2022/full-report.html

[534] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[535] Public Health Agency of Canada. (2018, July). Vaccine uptake in Canadian adults: Results from the 2016 adult National Immunization Coverage Survey (aNICS). Government of Canada. Retrieved July 30, 2023, from: https://publications.gc.ca/collections/collection_2018/aspc-phac/HP40-222-2018-eng.pdf

[536] MacDougall, D. M., Halperin, B. A., MacKinnon-Cameron, D., Li, L., McNeil, S. A., Langley, J. M., & Halperin, S. A. (2015). The challenge of vaccinating adults: Attitudes and beliefs of the Canadian public and healthcare providers. BMJ Open, 5(9). Retrieved from: https://doi.org/10.1136/bmjopen-2015-009062

[537] Murray, E., Bieniek, K., Del Aguila, M., Egodage, S., Litzinger, S., Mazouz, A., Mills, H., & Liska, J. (2021). Impact of pharmacy intervention on influenza vaccination acceptance: A systematic literature review and meta-analysis. International Journal of Clinical Pharmacy, 43(5). Retrieved from: https://doi.org/10.1007/s11096-021-01250-1

[538] Sanftenberg, L., Kuehne, F., Anraad, C., Jung-Sievers, C., Dreischulte, T., & Gensichen, J. (2021). Assessing the impact of shared decision making processes on influenza vaccination rates in adult patients in outpatient care: A systematic review and meta-analysis. Vaccine, 39(2). Retrieved from: https://doi.org/10.1016/j.vaccine.2020.12.014

[539] National Institute on Ageing (2022). A Goal within our reach: What the COVID-19 pandemic has taught us about improving the uptake of influenza vaccinations in Canada. Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/6385fbf18cd7a156622addc7/1669725171981/Final+Report+-+A+Goal+Within+Our+Reach+-+Influenza+Vaccination2+.pdf

[540] ImmunizeBC. (2023, July 27). Where to get immunized. Retrieved July 20, 2023, from: https://immunizebc.ca/children/where-get-immunized

[541] Niagara Region. (n.d.). Where to get vaccinated. Retrieved July 20, 2023, from: https://www.niagararegion.ca/health/vaccinations/general/default.aspx

[542] Canadian Pharmacists Association. (2023, August 30). Pharmacists' scope of practice in Canada. Retrieved September 10, 2023, from: https://www.pharmacists.ca/cpha-ca/function/utilities/pdf-server.cfm?thefile=/cpha-on-theissues/Immunization_Authority_Chart.pdf

[543] National Institute on Ageing. (2023). As one of Canada's top killers, why isn't pneumonia taken more seriously? Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/64666f42b34ce05072c1b27c/1684434755822/Pneumonia_Report+-+Revised.pdf

[544] National Institute on Ageing. (2022). The overlooked issue of shingles infections in older Canadians and how to address it! Retrieved July 30, 2023, from: https://static1.squarespace.com/static/5c2fa7b03917eed9b5a436d8/t/63fd20a0bdda7910d3fe50b8/1677533345259/Shingles+Report+-+Final3.pdf

[545] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[546] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[547] Public Health Agency of Canada. (2022, July 11). Vaccine uptake in Canadian adults 2019. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/2018-2019-influenza-flu-vaccine-coverage-survey-results.html

[548] Public Health Agency of Canada. (2022, March 25). Vaccine uptake in Canadian adults 2021. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccines/vaccination-coverage/highlights-2020-2021-seasonal-influenza-survey/full-report.html

[549] Statistics Canada. (2023, July 26). Health characteristics of seniors aged 65 and over, Canadian Health Survey on Seniors, two-year period estimates (Table 13-10-0850-01) [Data table]. Retrieved from: https://doi.org/10.25318/1310085001-eng

[550] Rizkalla, B. (2022, October 20). GSK RSV OA candidate vaccine clinical development [Presentation slides]. Centers for Disease Control and Prevention. Retrieved July 30, 2023, from: https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2022-10-19-20/02-RSV-Adults-Rizkalla-508.pdf

[551] Walsh, E. E., Pérez Marc, G., Zareba, A. M., Falsey, A. R., Jiang, Q., Patton, M., Polack, F. P., Llapur, C., Doreski, P. A., Ilangovan, K., Rämet, M., Fukushima, Y., Hussen, N., Bont, L. J., Cardona, J., DeHaan, E., Castillo Villa, G., Ingilizova, M., Eiras, D., … RENOIR Clinical Trial Group (2023). Efficacy and safety of a bivalent RSV prefusion F vaccine in older adults. The New England Journal of Medicine, 388(16). Retrieved from: https://doi.org/10.1056/NEJMoa2213836

[552] Wilson, E., Goswami, J., Stoszek, S. K., Mithani, R., Mehta, S., Kapoor, A., Huang, W., Lan, L., Asmar, L. E., Panozzo, C. A., Ghaswalla, P., August, A., Shaw, C. A., Miller, J., & Chen, G. L. (2023, February 23). Safety and efficacy of mRNA-1345, an mRNA-based vaccine against respiratory syncytial virus, in adults 60 years and older [Conference slides]. Moderna, Inc. Retrieved July 30, 2023, from: https://s29.q4cdn.com/435878511/files/doc_presentations/2023/03/rsvvw-p301-ia-oral-presentation_final.pdf

[553] Wilson, S. E., Quach, S., MacDonald, S. E., Naus, M., Deeks, S. L., Crowcroft, N. S., Mahmud, S. M., Tran, D., Kwong, J. C., Tu, K., Johnson, C., & Desai, S. (2017). Immunization information systems in Canada: Attributes, functionality, strengths and challenges. A Canadian Immunization Research Network study. Canadian Journal of Public Health = Revue Canadienne de Sante Publique, 107(6). Retrieved from: https://doi.org/10.17269/cjph.107.5679

[554] Public Health Agency of Canada. (2016, September 1). Immunization records: Canadian Immunization Guide. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/healthy-living/canadian-immunization-guide-part-1-key-immunization-information/page-12-immunization-records.html#:~:text=Immunization%20registries%20are%20centralized%2C%20confidential,and%20maintain%20electronic%20immunization%20registries

[555] Public Health Agency of Canada. (2021, anuary 6). Canadian Immunization Registry Functional Standards (IRFS) 2020-2024 - recommendations from the Canadian Immunization Registry and Coverage Network (CIRC). Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/publications/vaccines-immunization/canadianimmunization-registry-functionalstandards-2020-2024.html

[556] Public Health Agency of Canada. (2022, August 16). Vaccination coverage goals and vaccine preventable disease reduction targets by 2025. Government of Canada. Retrieved July 30, 2023, from: https://www.canada.ca/en/public-health/services/immunization-vaccine-priorities/national-immunization-strategy/vaccination-coverage-goals-vaccine-preventable-diseases-reduction-targets-2025.html

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