



Brigham and Women's Hospital

Founding Member, Mass General Brigham

Vaccines in 2024: Promise and Perils

Daniel A. Solomon, M.D.

Division of Infectious Diseases

Brigham and Women's Hospital

Assistant Professor of Medicine

Harvard Medical School





Daniel A. Solomon, MD

- Yale University School of Medicine
- Residency at Brigham and Women's Hospital
- Infectious Disease Fellowship at BWH/MGH combined program
- Assistant Professor of Medicine at Harvard Medical School
- Associate Program Director, MGH/BWH Infectious Diseases Fellowship
- Associate Director of Clinical Learning in Health Sciences and Technology Track at Harvard Medical School

Disclosures

I have no financial disclosures.

I love vaccines.

Key resources

- CDC ACIP adult vaccine schedules
- Immunize.org “Ask the Experts”

Table 1 Recommended Adult Immunization Schedule by Age Group, United States, 2021

Vaccine	19–26 years	27–49 years	50–64 years	≥65 years
Influenza inactivated (IIV) or Influenza recombinant (RIV4) ^{or} Influenza live, attenuated (LAIV4)	1 dose annually			
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap each pregnancy; 1 dose Td/Tdap for wound management (see notes)			
Measles, mumps, rubella (MMR)	1 dose Tdap, then Td or Tdap booster every 10 years			
Varicella (VAR)	1 or 2 doses depending on indication (if born in 1957 or later)			
Zoster recombinant (RZV)	2 doses (if born in 1980 or later)			
Human papillomavirus (HPV)	2 or 3 doses depending on age at initial vaccination or condition	27 through 45 years		
Pneumococcal conjugate (PCV13)	1 dose			
Pneumococcal polysaccharide (PPSV23)	1 or 2 doses depending on indication			
Hepatitis A (HepA)	2 or 3 doses depending on vaccine			
Hepatitis B (HepB)	2 or 3 doses depending on vaccine			
Meningococcal A, C, W, Y (MenACWY)	1 or 2 doses depending on indication, see notes for booster recommendations			
Meningococcal B (MenB)	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations			
Haemophilus influenzae type b (Hib)	19 through 23 years	1 or 3 doses depending on indication		

■ Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection
■ Recommended vaccination for adults with an additional risk factor or another indication
■ Recommended vaccination based on shared clinical decision-making
■ No recommendation/Not applicable



Meet the Experts from the Immunization Action Coalition



Kelly L. Moore, MD, MPH
President and Chief Executive Officer



Carolyn B. Bridges, MD, FACP
Director for Adult Immunization



Iyabode Beysolow, MD, MPH, FAAP
Physician Consultant

The Immunization Action Coalition acknowledges with gratitude **Deborah L. Wexler, MD**, executive director emerita, who established “Ask the Experts” more than 25 years ago, and **William L. Atkinson, MD, MPH**, who contributed his expertise to this popular feature over many years while he was at the Centers for Disease Control and Prevention and later at IAC.

Learning Objectives

Upon completion of this activity, participants will be able to:

- Advise patients regarding new vaccine recommendations
- Explain the reasoning behind changes
- Evaluate data behind recent changes in vaccine guidelines
- Assess areas of controversy



FDA approves first vaccine for RSV, a moment six decades in the making

By Brenda Goodman, CNN

Updated 3:56 PM EDT, Wed May 3, 2023



WHO recommends R21/Matrix-M vaccine for malaria prevention in updated advice on immunization

2 October 2023 | News release | Geneva | Reading time: 5 min (1351 words)

The Updated COVID Vaccines Are Here: 10 Things to Know

BY [KATHY KATELLA](#) OCTOBER 4, 2023

Pfizer and Valneva Initiate Phase 3 Study of Lyme Disease Vaccine Candidate VLA15

Monday, August 08, 2022 - 04:45pm

NEWS | 02 October 2023

Pioneers of mRNA COVID vaccines win medicine Nobel

Katalin Karikó and Drew Weissman laid the groundwork for immunizations that were rolled out during the pandemic at record-breaking speed.

[Ewen Callaway](#) & [Miryam Naddaf](#)



Drew Weissman (left) and Katalin Karikó (right). Credit: PixelPro/Alamy



Not everyone
loves vaccines as
much as I do

*"I'm right there in the room, and no
one even acknowledges me."*



Measles

- Vaccine implemented in 1957
- Two-dose series implemented in response to outbreak in 1989
- Eliminated in the United States in 2000!



We all know how that story goes...

- 2019: 1,282 measles cases United States
- 2022: 9 million cases (18% increase) and 136,000 deaths (43% increase) worldwide



Number of measles cases reported by week

2023-2024* (as of March 21, 2024)

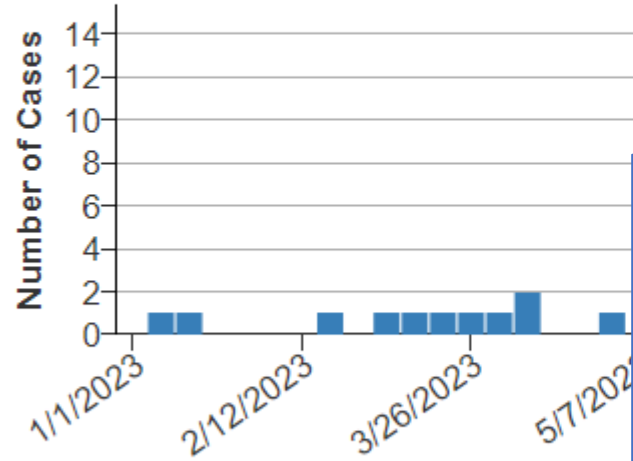
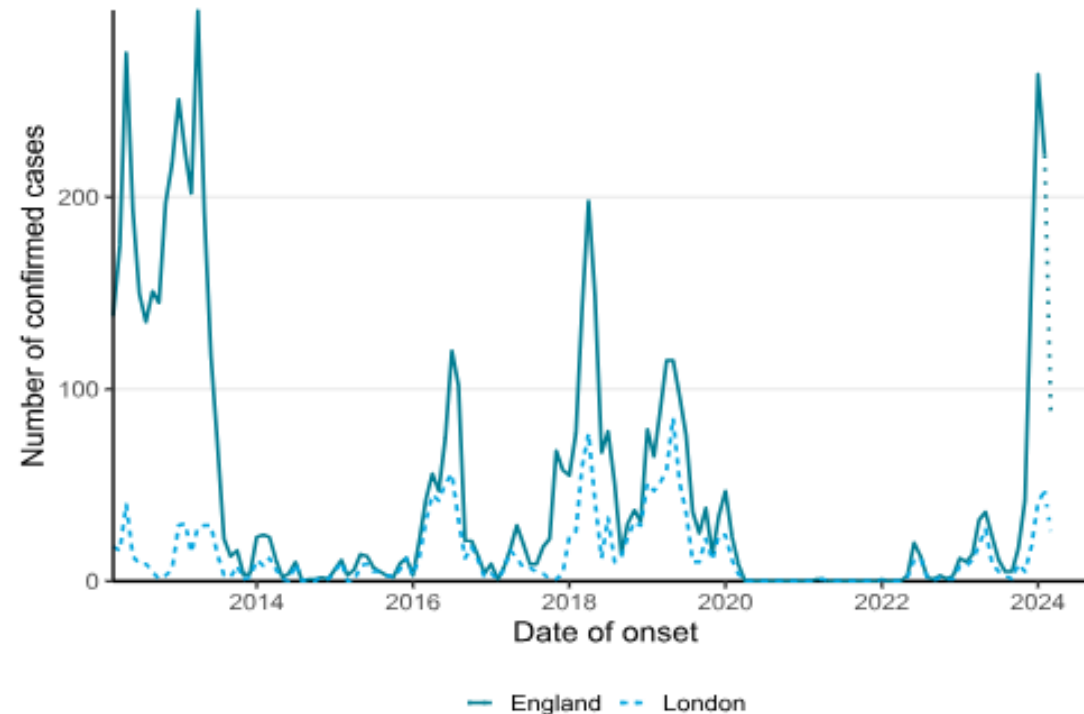


Figure 1. Laboratory confirmed cases of measles by month of onset of rash or symptoms reported, London and England: 01 March 2012 to 18 March 2024 [note 1 and 2]





A REPORTER AT LARGE SEPTEMBER 2, 2019 ISSUE

THE MESSAGE OF MEASLES

By Nick Paumgarten August 26, 2019

“Vaccination has been the victim of its own success. Eradication has afforded [us] the luxury of equivocation.”

“The virus we are fighting isn’t so much measles as it is vaccine hesitancy and refusal.”

“Vaccine hesitancy”



Survey reveals low trust in US public health agency information amid pandemic

Mary Van Beusekom, MS, March 7, 2023

Topics: [COVID-19](#)

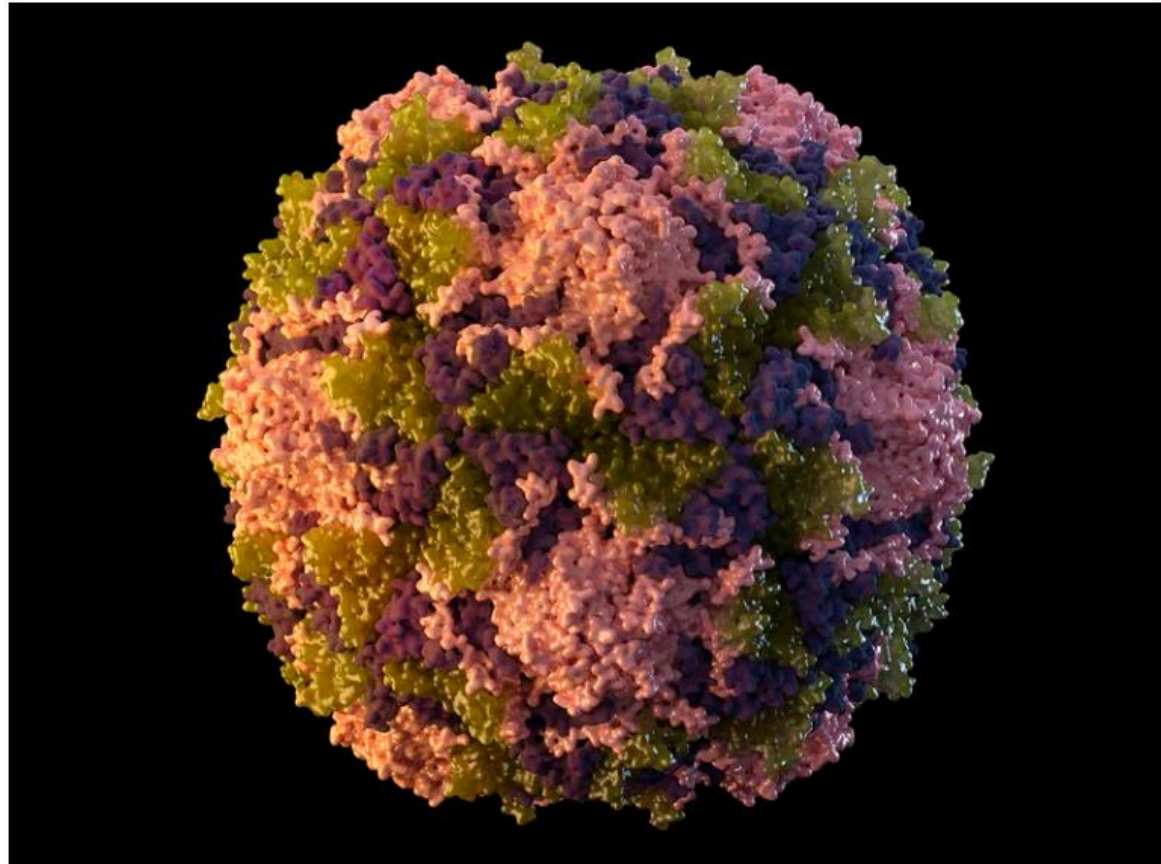
HEALTH

Poliovirus detected in more wastewater near New York City

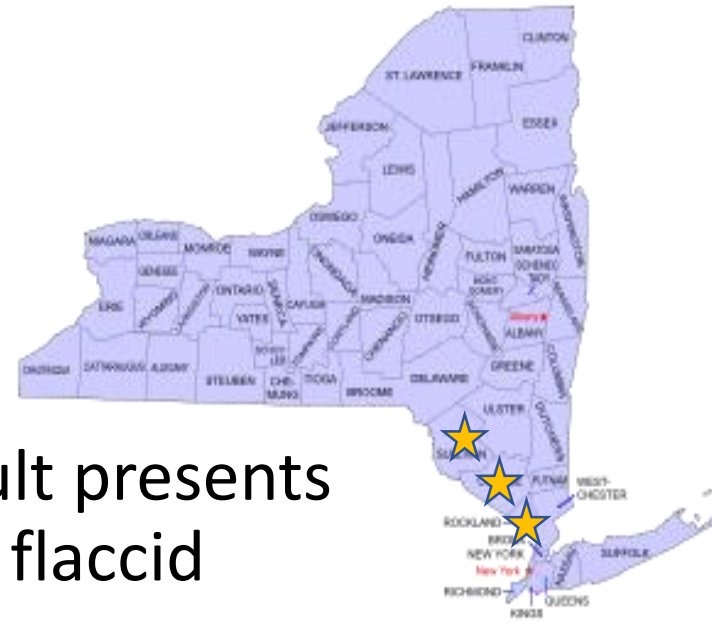
September 10, 2022 - 5:17 AM ET

THE ASSOCIATED PRESS

“Those who do not remember the past are condemned to repeat it.”



Poliovirus in New York State

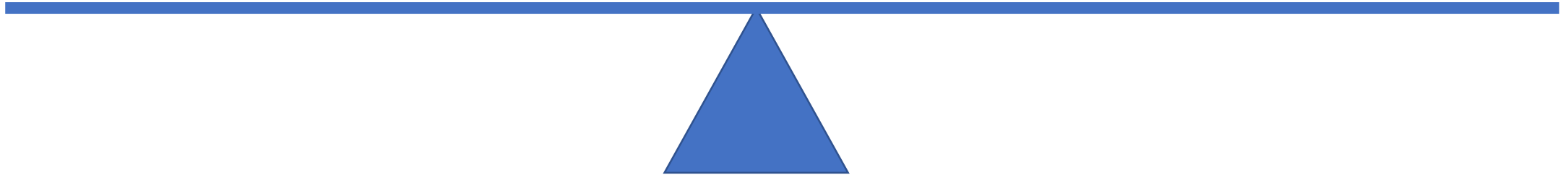


- June 2022: Immunocompetent un-vaccinated young adult presents with fever, neck stiffness, back and abdominal pain, and flaccid weakness
- Stool specimen revealed poliovirus, confirmed by CDC
- First case of poliomyelitis in US since 2013
- Rockland County has reported overall low vaccine coverage for over 20 years
 - In summer 2022, 60% of children under 2 years of age had received 3 doses of IPV (zip code level as low as 37%)

Vaccines in 2024: Promise and Perils

- Vaccine development is happening at the fastest pace in history
- Vaccines continue to be the most impactful tool for disease prevention worldwide

- Trust in public health agencies is tenuous
- The anti-vaccine and anti-science movement in the United States is stronger than ever



Roadmap

- MMR
- Polio
- RSV
- COVID-19
- HBV
- Teaser



Case

My patient was born in 1986. He is going to a new graduate program, so I checked a measles titer which was negative. His immunization record shows that he had one dose of MMR in childhood. What do you advise?

- A. Give booster MMR
- B. Give booster MMR then recheck titer 1-2 months later
- C. Documentation of 1 vaccine supersedes negative titers, no need for another shot

What counts as presumptive immunity?

ANY of the following

- Birth before 1957
- Laboratory confirmation of measles
(verbal history does not count)
- Laboratory evidence of immunity
- Written documentation of adequate
vaccination*



<https://www.medinaction.com/your-immune-system-vaccines-and-traveling/>


Adults – One Dose or Two?

- 1957-1989: one dose
- 1989: changed to two dose series

Number of doses	Seroprotection
1	93%
2	97%

One dose is considered sufficient, except for:

- Healthcare personnel
- International travelers

- Persons  **Camille Nelson Kotton** @KottonNelson · Mar 8 ...
Time to consider getting a second dose of MMR if you were born between 1957 and approximately 1980 and never had a second dose of measles vaccine. Not for moderate to severely immunocompromised as it's a live viral vaccine.

E-consult

My patient was born in 1986. He is going to a new graduate program, so I checked a measles titer which was negative. His immunization record shows that he had one dose of MMR in childhood. What do you advise?

- A. Give booster MMR
- B. Give booster MMR then recheck titer 1-2 months later
- C. Documentation of 1 vaccine supersedes negative titers, no need for another shot

What to do with negative serologies?

**IGNORE
MODE**



<http://mylifepath.info/>

- Sensitivity of serology only ~80%
- Probably less sensitive to detect vaccine-induced immunity
- Age-appropriate documented vaccination, trumps post-vaccination titers

POLIO

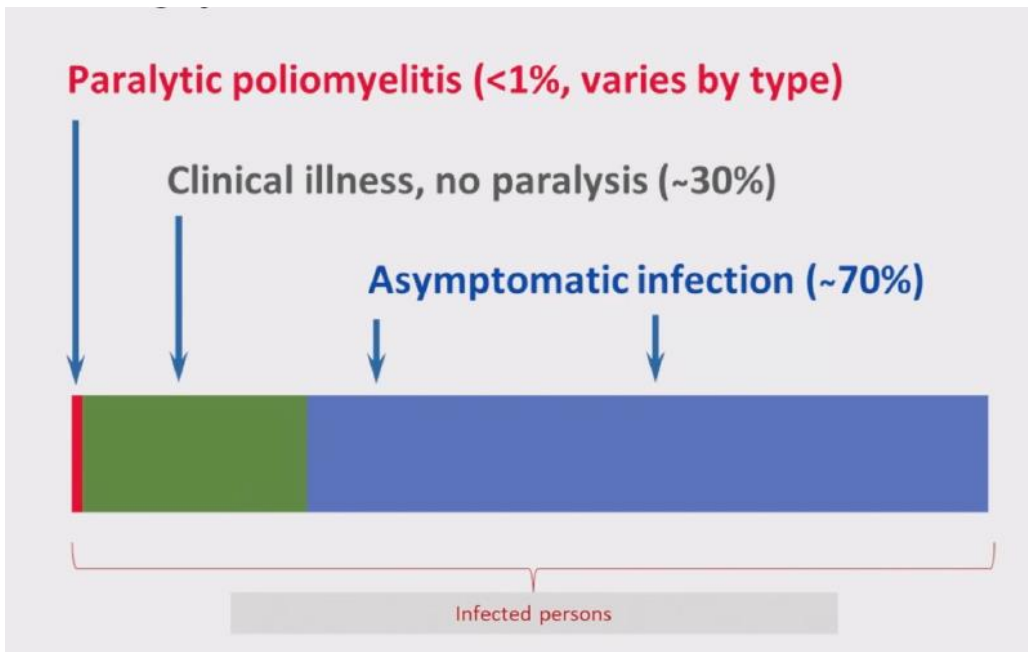
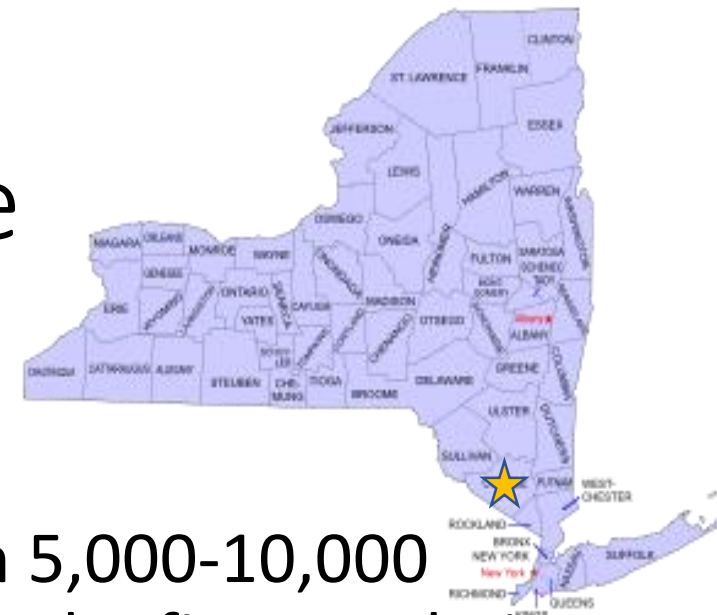


E-consult

My patient is a 47-year-old man in Boston who is traveling to Rockland County, NY to visit family for Memorial Day and wonders if he needs polio vaccine. He was born in the United States and had routine healthcare but does not have a copy of his pediatric immunization records. Should he receive the polio vaccine?

- A. Yes, he should restart the series
- B. Yes, he should get a single booster dose
- C. No, he can assume he was vaccinated in childhood and he is not considered high risk

June 2022: Polio case detection in New York State



- There may have been 5,000-10,000 infections by the time the first paralytic case was detected
- Could see up to 10-20 paralytic cases/year
- Importance of increased vaccine coverage
- Wastewater surveillance ongoing – last positive sample Feb 2023

Summary of problem

- US remains at risk of poliovirus importations as long as there is ongoing transmission of poliovirus globally
- Data indicate that most US adults have serologic immunity
- However, unvaccinated and incompletely vaccinated adults remain susceptible to paralytic polio if exposed to poliovirus



Who needs polio vaccine?

ACIP June 2023

Adults who are known or suspected to be unvaccinated or incompletely vaccinated against polio should complete a primary vaccination series with IPV.

Adults can assume they were vaccinated for polio as children, unless there are specific reasons to believe they were not vaccinated

Who should receive a polio booster?

- Adults who have received a primary series who are at increased risk of poliovirus exposure may receive another dose of IPV
- Available data do not indicate the need for more than a single lifetime booster dose with IPV for adults

Who should receive a polio booster?

- Travelers who are going to countries where polio is epidemic or endemic
 - Haajj/Umra pilgrimage
 - Nigeria
 - Afghanistan
- Laboratory and healthcare workers who handle specimens that might contain polioviruses
- Healthcare workers or other caregivers who have close contact with a person who could be infected with poliovirus



E-consult

My patient is a 47-year-old man in Boston who is traveling to Rockland County, NY to visit family for Memorial Day and wonders if he needs polio vaccine? He was born in the United States and had routine healthcare but does not have a copy of his pediatric immunization records. Should he receive the polio vaccine?

- A. Yes, he should restart the series
- B. Yes, he should get a single booster dose
- C. No, he can assume he was vaccinated in childhood and he is not considered high risk

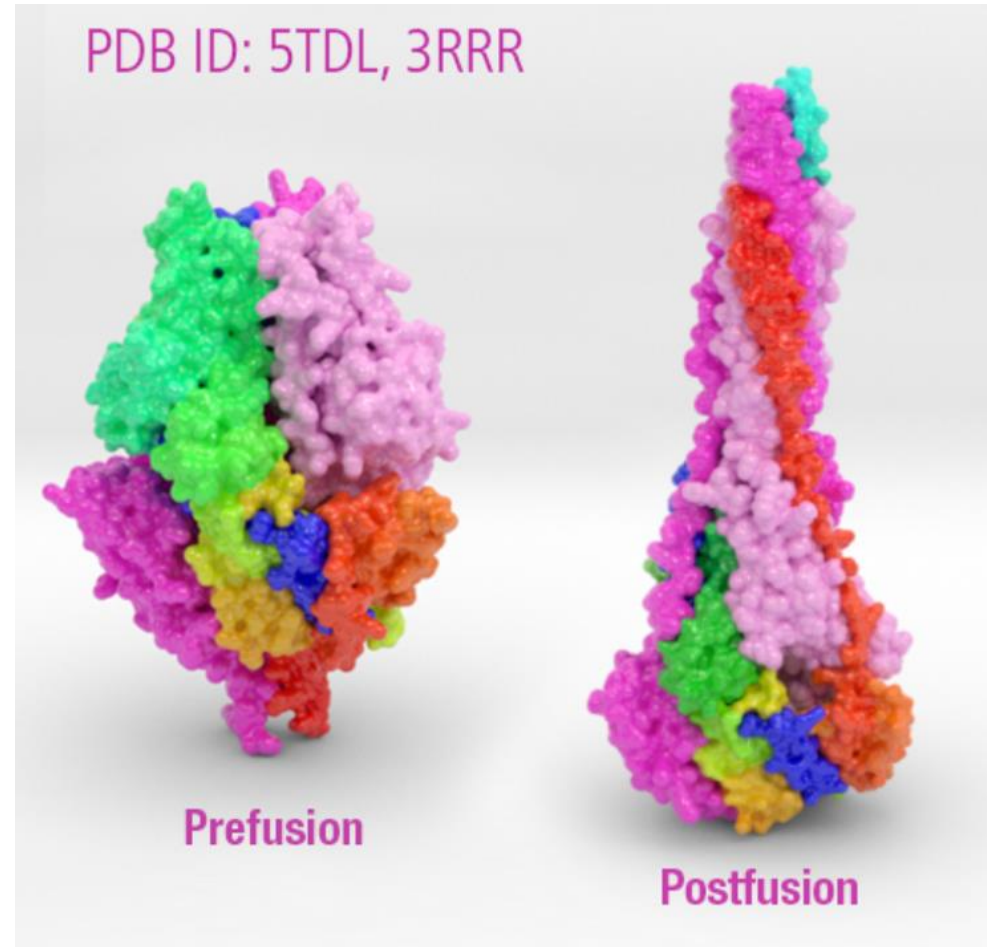
Case



For which of the following patients would you recommend the RSV vaccine?

- A. 61-year-old with no medical problems, exercises 7 days/week
- B. 71-year-old with no medical problems, exercises 7 days/week
- C. 65-year-old with history of ESRD s/p renal transplant on tacrolimus, MMF, prednisone
- D. 58-year-old with DM2, COPD and CHF
- E. 32-year-old pregnant woman with no medical problems at 33 weeks gestation
- F. 38-year-old pregnant woman with SLE on prednisone at 14 weeks gestation

RSV F-protein



Respiratory Syncytial Virus Prefusion F Protein Vaccine in Older Adults

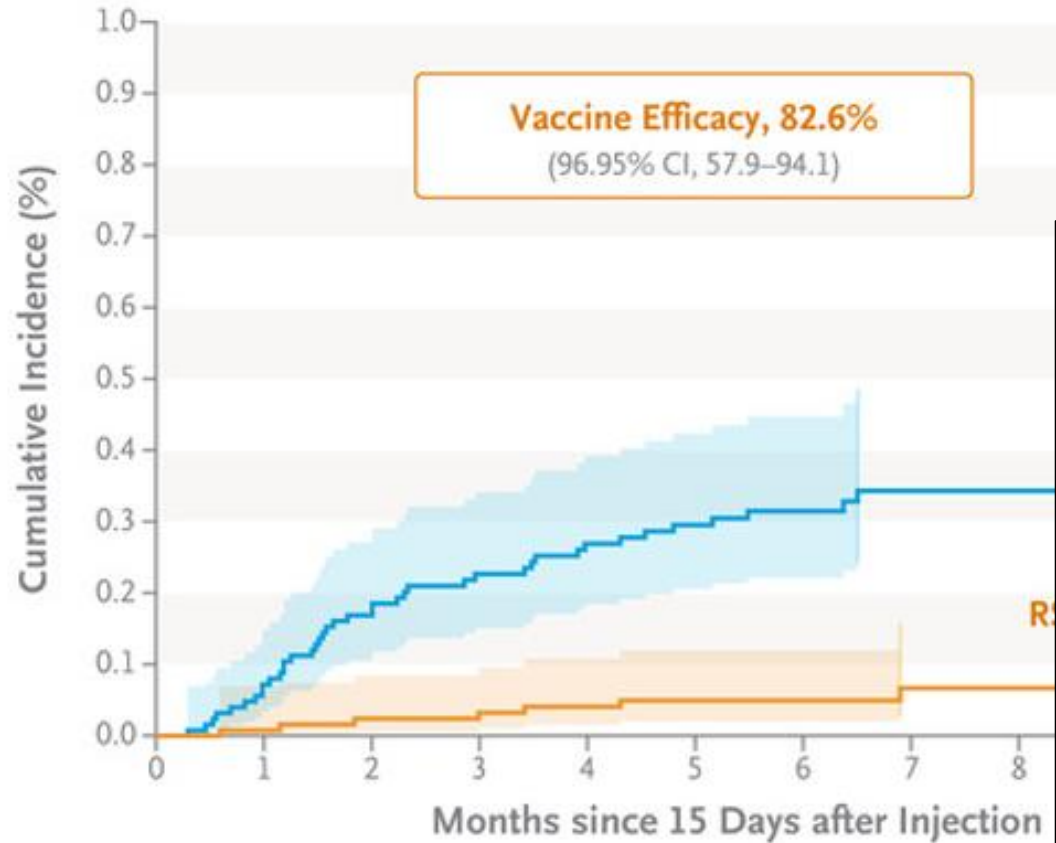
Alberto Papi, M.D., Michael G. Ison, M.D., Joanne M. Langley, M.D., Dong-Gun Lee, M.D., Ph.D., Isabel Leroux-Roels, M.D., Ph.D., Federico Martinon-Torres, M.D., Ph.D., Tino F. Schwarz, M.D., Ph.D., Richard N. van Zyl-Smit, M.D., Ph.D., Laura Campora, M.D., Nancy Dezutter, Ph.D., Nathalie de Schrevel, Ph.D., Laurence Fissette, M.S., *et al.*, for the AReSVi-006 Study Group*

- Monovalent vaccine (GSK)
- Uses same adjuvant as RZV (Shingrix), but lower dose
- Adults ≥ 60
- 25,000 participants from 17 countries
- Randomized to vaccine vs placebo before RSV season
- Immunocompromised patients excluded

Age range	% participants
60-69	56
70-79	36
≥ 80	8

Frailty status	% participants
Fit	60
Pre-frail	38
Frail	1.5

RSV-Related Lower Respiratory Tract Disease



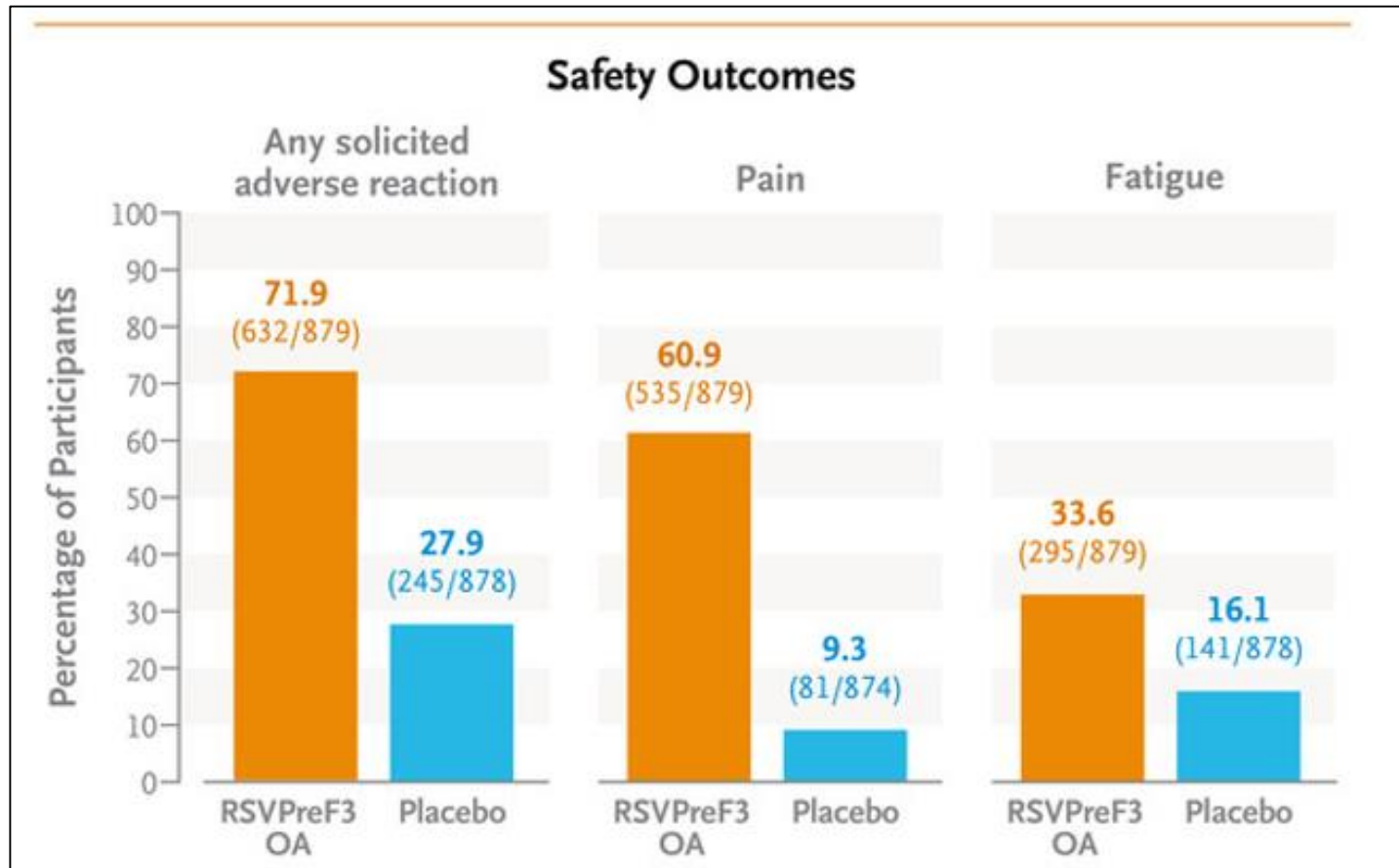
Case definition

Lower respiratory symptoms

- New or increased sputum
- New or increased cough
- New or increased dyspnea (shortness of breath)

Lower respiratory signs

- New or increased wheezing^c
- New or increased crackles/ronchi^d based on chest auscultation
- Respiratory rate ≥ 20 respirations/min^d
- Low or decreased oxygen saturation (= oxygen saturation $< 95\%$ or $\leq 90\%$ if pre-season baseline is $< 95\%$)^d
- Need for oxygen supplementation^d



3 Inflammatory neurologic events

- 1 case of GBS
- 2 cases of ADEM

RENOIR: RSV vaccine Efficacy study in Older adults Immunized against RSV disease



- Bivalent vaccine (Pfizer)
- No adjuvant
- Individuals 60 years and older
- ~34,000 participants
- Randomized to vaccine vs placebo before RSV season
- Immunocompromised patients excluded

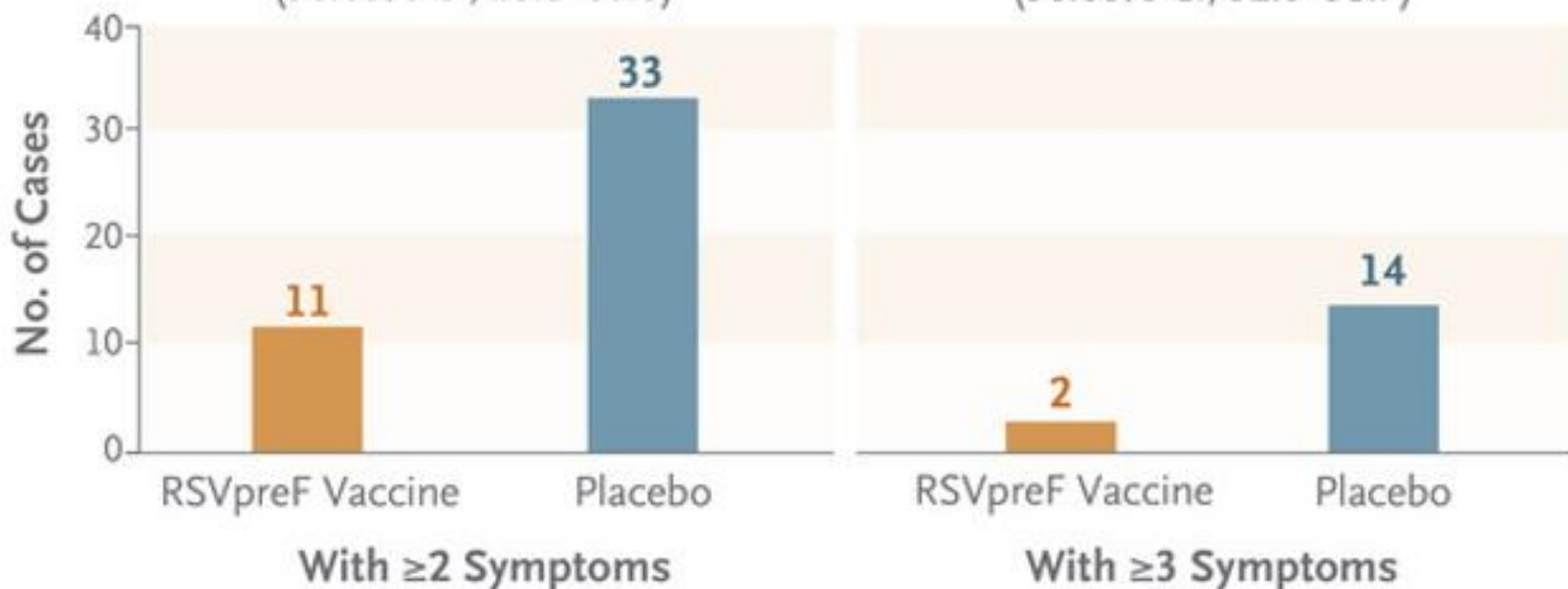
Age range	% participants
60-69	62
70-79	32
≥ 80	6

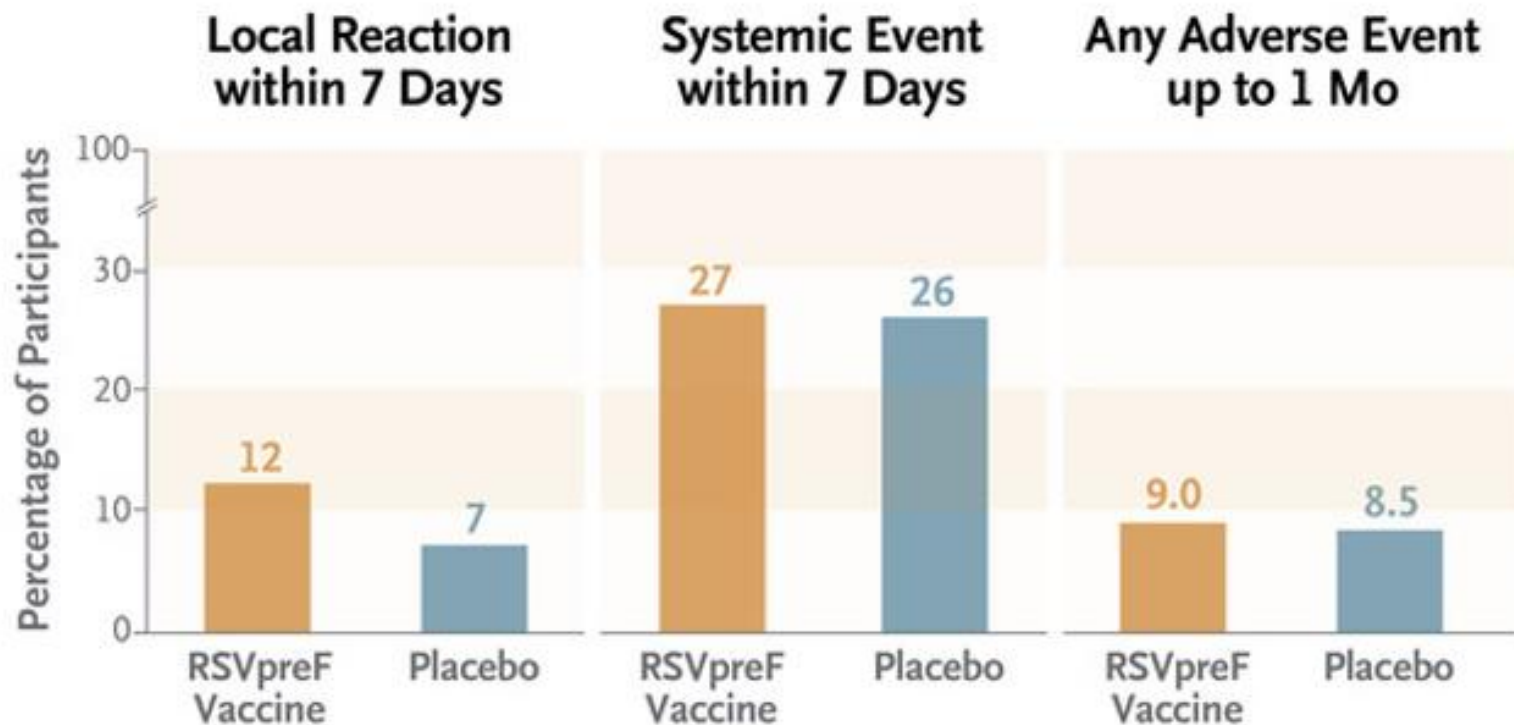
≥ 1 High risk condition	% participants
Yes	51.5
No	48.5

RSV-Associated Lower Respiratory Tract Illness

Vaccine efficacy, 66.7%
(96.66% CI, 28.8–85.8)

Vaccine efficacy, 85.7%
(96.66% CI, 32.0–98.7)





3 Inflammatory neurologic events

- 1 case of GBS
- 1 case of Miller-Fisher syndrome
- 1 case of undifferentiated lower motor neuron disease

May 3, 2023



CNN

health

Life, But Better

Fitness

Food

Sleep

Mindfulness

Relationships

FDA approves first vaccine for RSV, a moment six decades in the making

By Brenda Goodman, CNN

Updated 3:56 PM EDT, Wed May 3, 2023



June 21-23, 2023



RSV working group recommendation:

- Ages 60-65 → shared decision making
- Ages >65 → advised

ACIP Advisory panel vote:

- **Shared decision making for anyone ≥ 60**

Adults most likely to benefit include:



Chronic lung diseases
such as COPD and
asthma



Chronic cardiovascular
diseases such as congestive
heart failure and coronary
artery disease



Immune
compromise



Hematologic
disorders



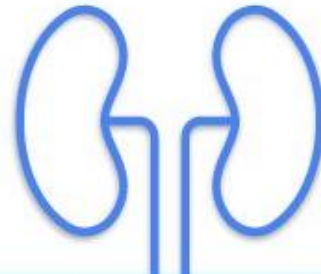
Residents of nursing
homes and other long-
term care facilities



Neurologic disorders



Endocrine disorders
such as diabetes



Kidney and liver
disorders



Other underlying conditions that
the provider determines might
increase the risk of severe
respiratory illness

RSV vaccine: limitations

- Immunocompromised patients not included in studies
- Did not include many participants >75 (group at highest risk)
- Safety:
 - What to make of the inflammatory neurologic events in each study?
- Protection drops in the second season
 - A second shot booster did not seem to help
 - Boosters after 2 years under investigation

MATISSE: MATernal Immunization Study for Safety and Efficacy



- Same Bivalent vaccine candidate (Pfizer)
- Maternal immunization at 24-36 weeks gestation → passive immunity to infants
- Primary outcome: RSV in infants
- 7392 participants
- Healthy, uncomplicated, singleton pregnancies
- Women with high-risk pregnancies were excluded

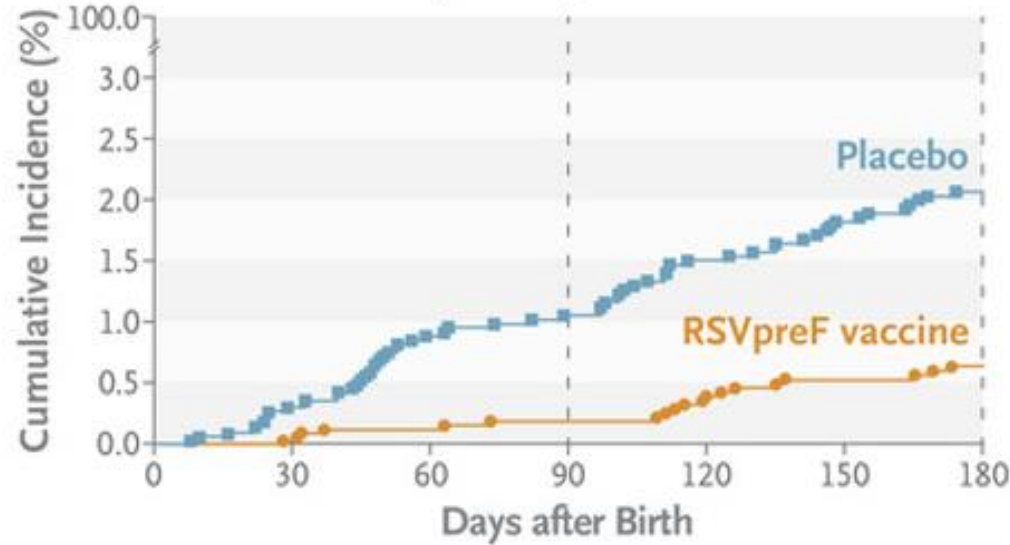
Severe RSV-Associated Lower Respiratory Tract Illness



Vaccine efficacy at 90 days, 81.8%
(99.5% CI, 40.6–96.3)



Vaccine efficacy at 180 days, 69.4%
(97.58% CI, 44.3–84.1)

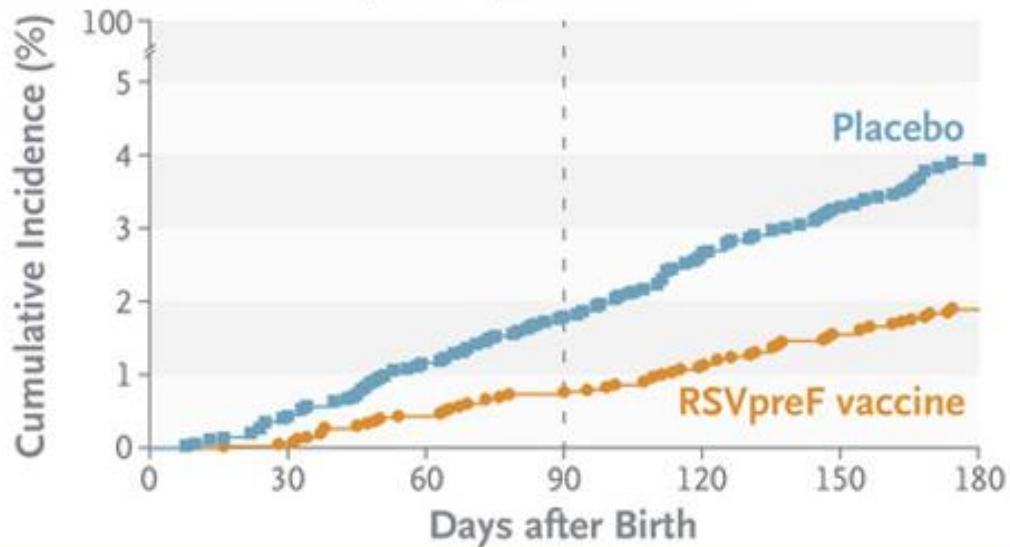


Severe disease:
Vaccine efficacy 82%

RSV-Associated Lower Respiratory Tract Illness



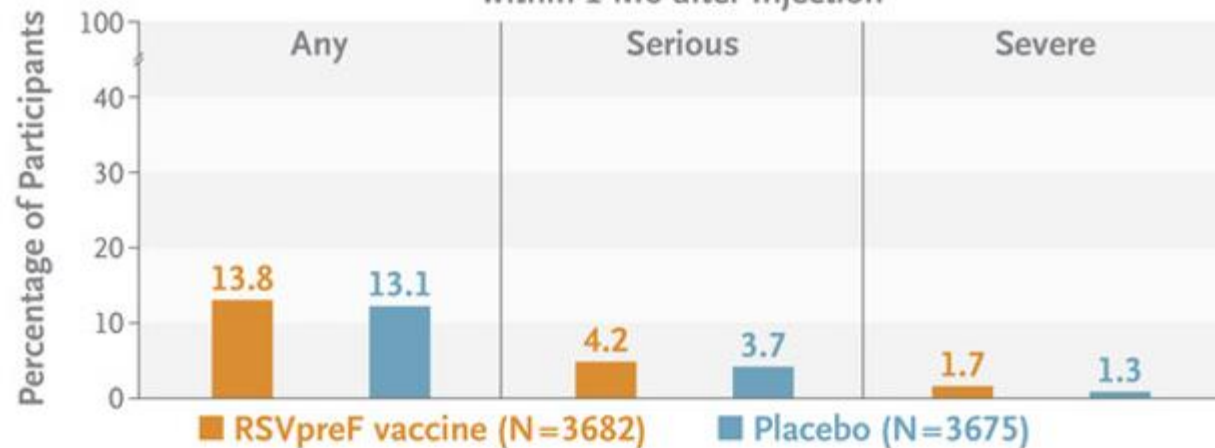
Vaccine efficacy at 90 days, 57.1%
(99.5% CI, 14.7–79.8)



Any LRTI:
Vaccine efficacy 57.1%

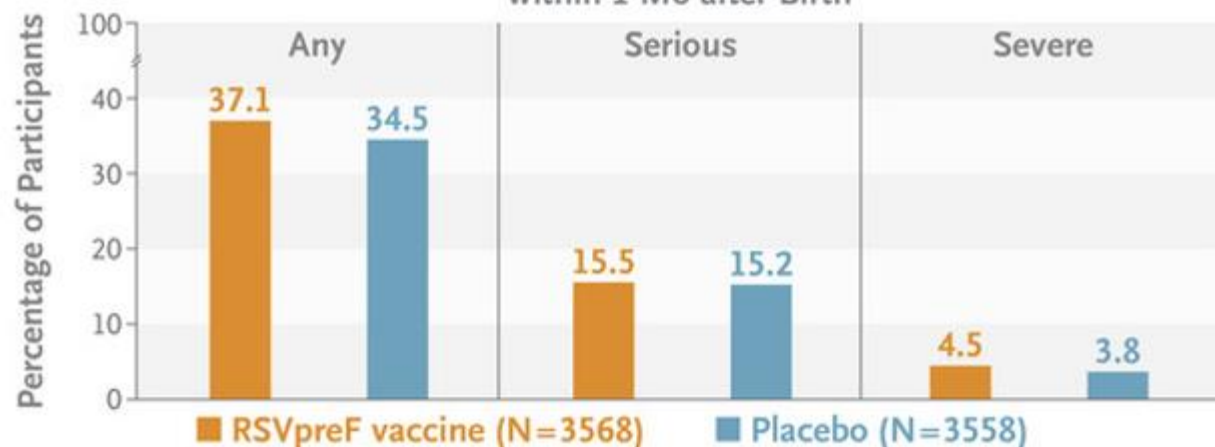
≥1 Adverse Event in Maternal Participants

within 1 Mo after Injection



≥1 Adverse Event in Infant Participants

within 1 Mo after Birth



No safety signal in maternal participants or in newborns/toddlers up to 24 months after birth

Sept 2023

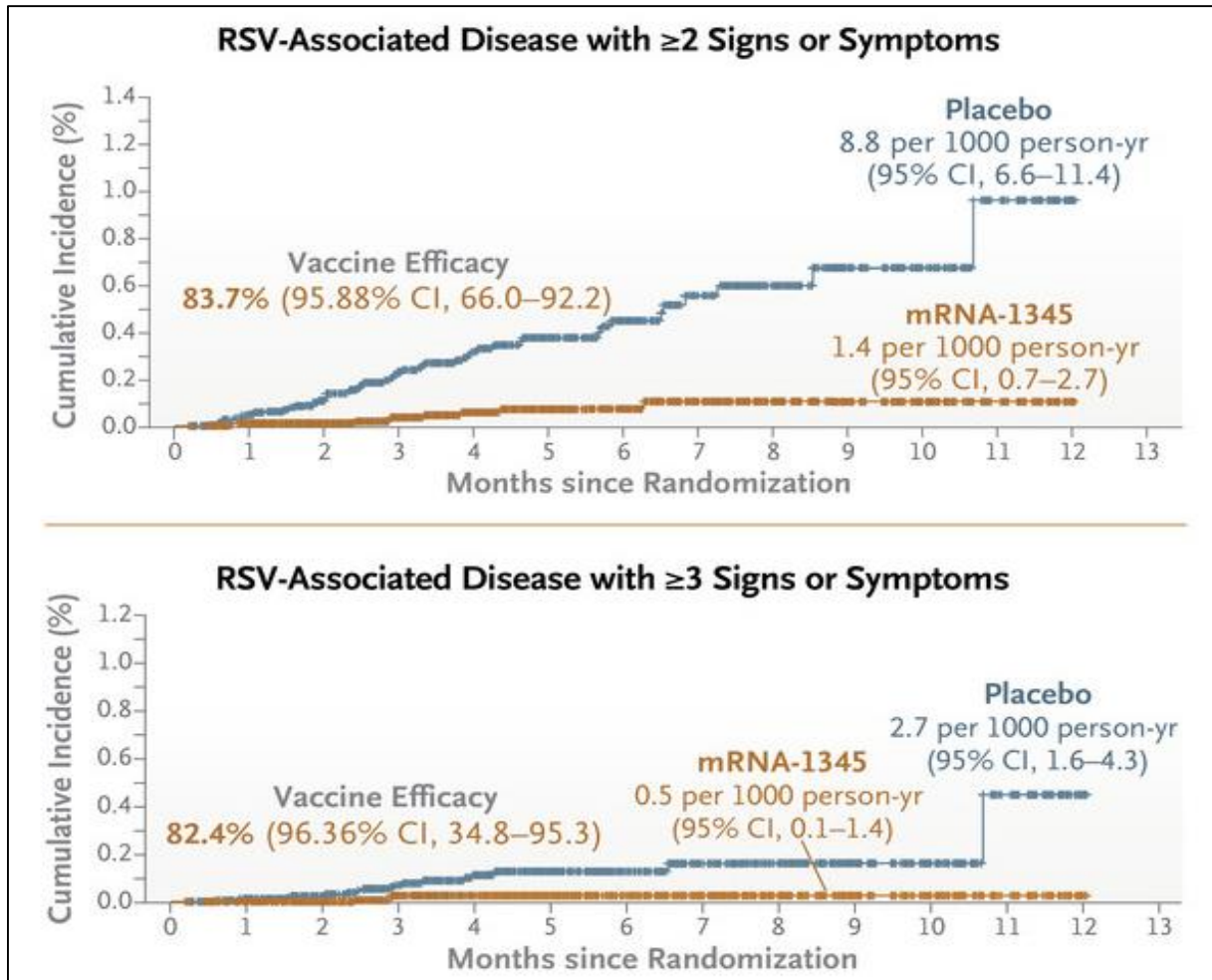
For pregnant women, CDC and ACOG *recommend*:

Seasonal administration of one dose of RSV vaccine for pregnant people during weeks 32 through 36 of pregnancy between September to January.

Who should get RSV vaccine vs who should get new monoclonal antibody nirsevimab-alip (Beyfortus)?



ConquerRSV trial: mRNA vaccine candidate not far behind



- 35,000+ participants
- Vaccine efficacy >80%
- Immunocompromised excluded
- Few participants >80, frail
- Ongoing follow up will assess duration of protection, boosters

Case



For which of the following patients would you recommend the RSV vaccine?

- A. 61-year-old with no medical problems, exercises 7 days/week
- B. 71-year-old with no medical problems, exercises 7 days/week
- C. 65-year-old with history of ESRD s/p renal transplant on tacrolimus, MMF, prednisone
- D. 58-year-old with DM2, COPD and CHF
- E. 32-year-old pregnant woman with no medical problems at 33 weeks gestation
- F. 38-year-old pregnant woman with SLE on prednisone at 14 weeks gestation

Case



A healthy 24-year-old man presents for yearly physical. He has received 3 doses of mRNA vaccine and has had COVID twice. Last infection was 3 months ago. Courses were mild. Do you recommend the updated COVID vaccine?

- A. Yes, give it now
- B. Yes, but wait until at least 3 months from last infection
- C. Yes, but wait until Novavax is available
- D. No

Sept 2023

“CDC recommends everyone 6 months and older get an updated COVID-19 vaccine to protect against the potentially serious outcomes of COVID-19 illness this fall and winter.”



Dec 2023

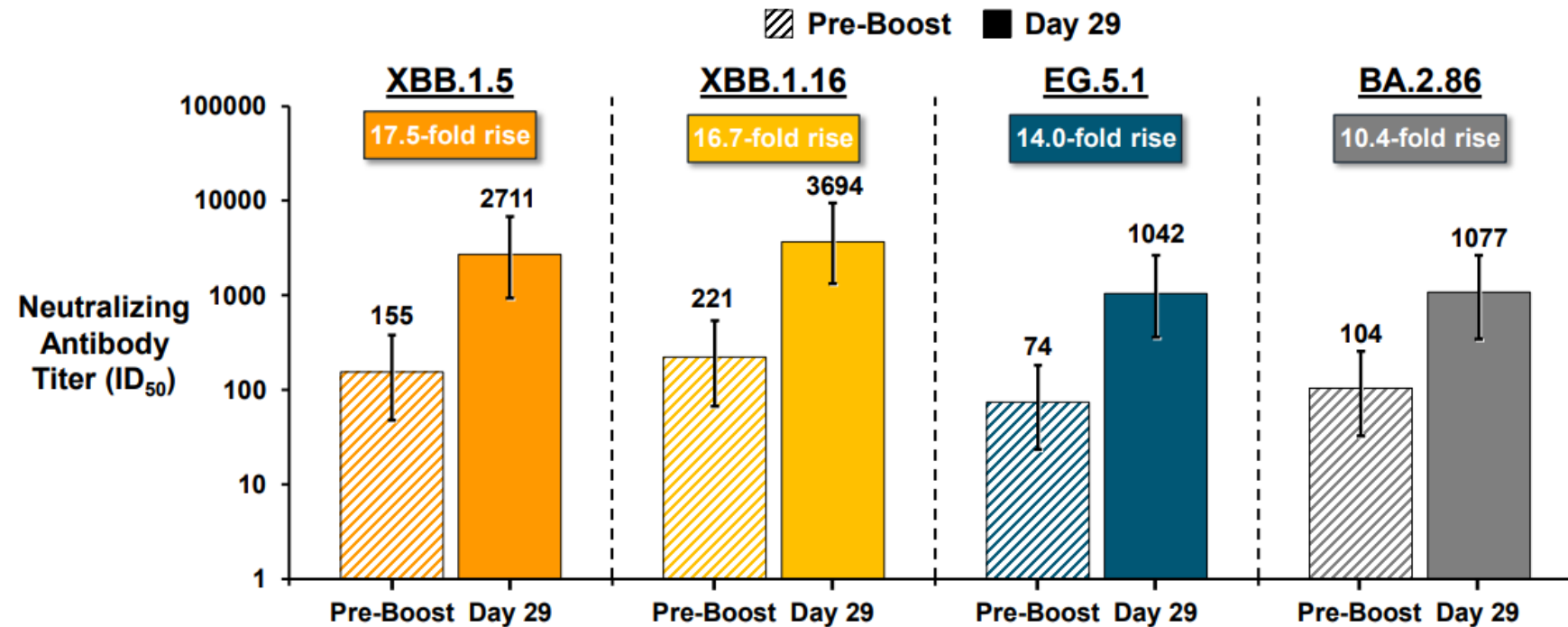
“As of December 23, 2023, 18.9% of adults reported having received an updated 2023-24 COVID-19 vaccine”

Variant-specific boosters result in higher concentration of neutralizing antibodies

Cross Neutralization Results (Day 29) After XBB.1.5 Vaccine in Adults – *Duke Assay*

Study 205J, Per-Protocol Immunogenicity Set - All Participants

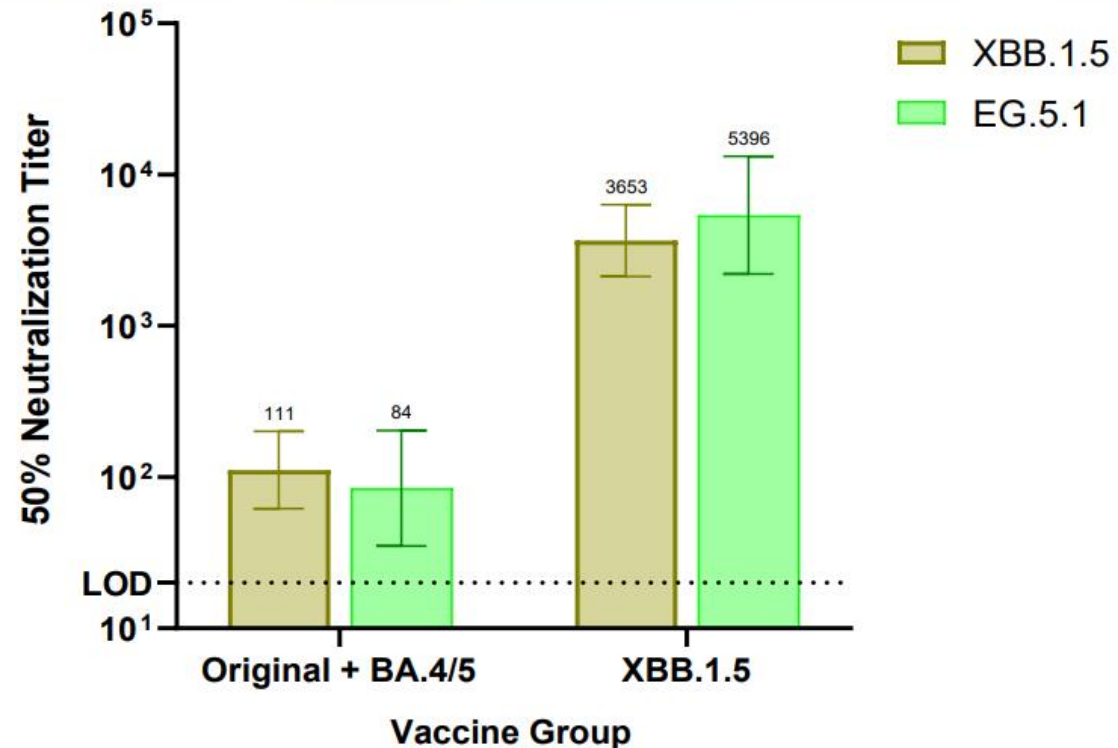
N=101



Substantial fold rise demonstrated across newer variants

Variant-specific boosters result in higher concentration of neutralizing antibodies

Monovalent XBB.1.5 BNT162b2 Primary Series Effectively Neutralized EG.5.1 and XBB.1.5



N=20...mice

October 3, 2023

FDA NEWS RELEASE

FDA Authorizes Updated Novavax COVID-19 Vaccine Formulated to Better Protect Against Currently Circulating Variants

[f Share](#) [X Post](#) [in LinkedIn](#) [✉ Email](#) [🖨 Print](#)

For Immediate Release: October 03, 2023

Public Health Value of Novavax?

- Only protein-based COVID-19 vaccine in US
- Non-clinical data support use:
 - Robust antibody response against XBB variants
 - Polyfunctional cellular immune response
- Ease of use, refrigerator stable, no mixing, diluting or thawing



**Novavax
2023-2024 vaccine**

Neutralizing Responses in Macaques: Primary Vaccination Bivalent BA.5 Vaccine and Boost with XBB.1.5

Boosting with XBB.1.5 induces robust neutralizing responses against emerging XBB subvariants

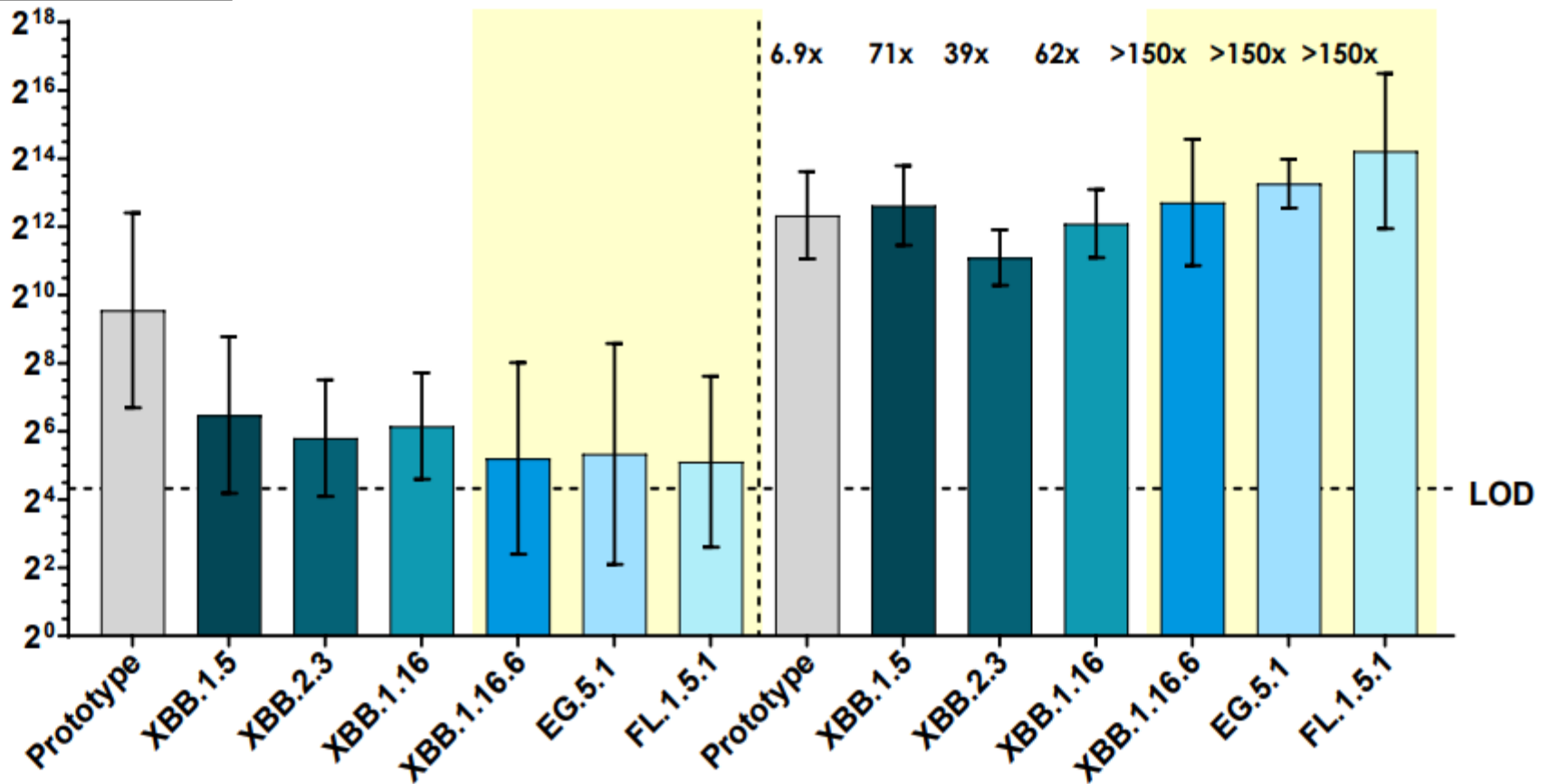
N=10...macaques

Bivalent Primary and XBB.1.5 Booster Dose

5 weeks Pre Booster

2 weeks Post XBB.1.5 Boost

Pseudovirus Neutralization (ID50, GMT) 95% CI



N = 4-5

Boosters for young healthy individuals: Summary/Considerations

- No clinical data on effectiveness – inferred from neutralizing antibody response
- Antibody titers wane after 60-90 days
- Risk of severe outcome is very low in young healthy individuals who have been previously vaccinated and/or infected (hybrid immunity)
- Vaccine is very safe; low, but non-zero risk of post-vaccine myocarditis especially in young men

United States is now an outlier

- UK, Sweden, Germany, Norway, Finland recommend only for those at highest risk
- WHO: “Although additional boosters are safe for this group, we do not routinely recommend them, given the comparatively low public health returns.”



Does Everyone Need a Yearly Covid Booster?

The most recent recommendation by the CDC has come under question.



PAUL OFFIT
SEP 18, 2023

Outstanding questions...

- Does the vaccine decrease risk of long COVID?
- Will mixing and matching with mRNA + protein vaccine (Novavax) have clinical benefit?
- Does the risk of myocarditis persist with additional doses?
- What about lower doses in younger individuals?
- How frequently should we administer boosters to immunocompromised patients?

E-consult



My patient is a 52-year-old woman with a history of kidney transplant on tacrolimus, prednisone and MMF. She has previously completed a 3 dose hepatitis B series in childhood, but her titer is non-reactive. What do you recommend?

- A. Do nothing, 3 doses is sufficient regardless of post-vaccine titers
- B. Restart the 3 shot series of the double-dose standard HBV vaccine
- C. Restart the series with adjuvanted HBV Vaccine (Heplisav-B)
- D. Stop MMF, then restart the series

Who should get the HBV vaccine?



- All infants and children <19
- Adults aged 19-59
- Adults aged ≥ 60 with risk factors for HBV
 - Sexual exposure
 - Percutaneous or mucosal exposure to blood
 - International travelers to countries with HBsAg prevalence $\geq 2\%$
 - Persons with HCV
 - Persons with chronic liver disease
 - Persons with HIV
 - Persons who are incarcerated

Who needs titers after vaccination?

- Infants born to HBsAg-positive women
- Healthcare professionals
- Patients on hemodialysis
- HIV-infection or other immunocompromised
- Sex partners of HBsAg-positive persons



Titers may wane over time, but will boost with re-exposure. Any positive hep B titer in the past counts.



If there is a delay, there is no need to restart the vaccine series. Just pick up where you left off!

Adjuvanted HBV vaccine (Heplisav-B)

- Contains immunostimulatory adjuvant to boost immune response
- Approved by FDA November 2017, included as vaccine option by ACIP

Parameter	Standard vaccines*	Adjuvanted vaccine
Schedule	3 doses (0, 1 mo, 6 mo)	2 doses (0, 1 mo)
Efficacy (% achieving seroprotection)	65-81%	90-95%
Dosing for HD, immunocompromise	High-dose (2-4 times standard dose)	No change
Side effects	No significant difference	No significant difference
Covered by insurance?	Yes	Usually

*Engerix-B, Recombivax, PreHevbrio



E-consult

My patient is a 52-year-old woman with a history of kidney transplant on tacrolimus, prednisone and MMF. She has previously completed a 3 dose hepatitis B series in childhood, but her titer is non-reactive. What do you recommend?

- A. Do nothing, 3 doses is sufficient regardless of post-vaccine titers
- B. Restart the 3 shot series of the “high dose” standard HBV vaccine
- C. Restart the series with adjuvanted HBV Vaccine (Heplisav-B)
- D. Stop MMF, then restart the series

Vaccine considerations in IC patients

- Low efficacy during periods intense immunosuppression
- Vaccinate BEFORE the need for immunosuppression (when possible)
- Ideally 2 weeks before initiation or resumption of immunosuppression
- B-cell depleting therapies: aim for 4 weeks prior to the next scheduled dose
- Some data support lightening immunosuppression leads to higher efficacy
- Live viral vaccines (MMR, Varicella): suspend immunosuppression x1 month, give vaccine, wait another month, restart immunosuppression
- Make sure to vaccinate household contacts



What's new and what's on the horizon?

Recently approved vaccines:

- Pentavalent Meningococcal vaccine (ABCWY)
- Chikungunya
- Dengue
- Malaria (WHO)

On the horizon:

- mRNA RSV vaccine
- Lyme vaccine – phase 3 trial completed enrollment, expected to end Dec 2025

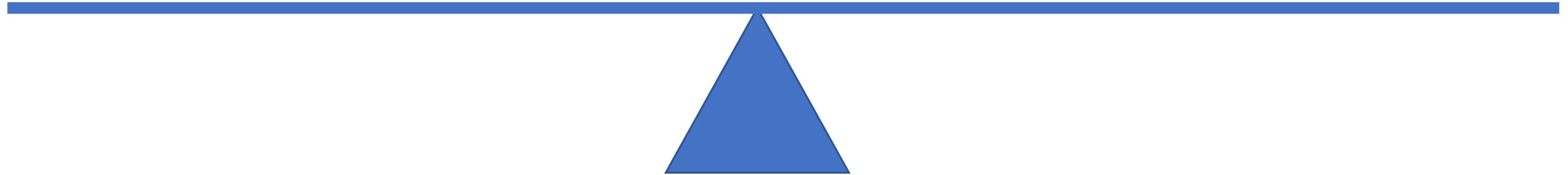
In the future?

- Next generation influenza vaccines
- TB vaccine
- HIV vaccine

Vaccines beyond 2024

- Vaccine development is happening at the fastest pace in history
- Vaccines continue to be the most impactful tool for disease prevention worldwide

- Trust in public health agencies is tenuous
- The anti-vaccine and anti-science movement in the United States is stronger than ever



Key Points

- Polio: most important to give vaccine to un- or under-vaccinated individuals
- RSV vaccine is here! Post-marketing surveillance studies will help guide practice
- Everyone should get HBV vaccine; key populations need post-vaccine titers
- Lots of exciting vaccine developments on the horizon

Selected References

- Rosenberg ES and Lutter Loh E. IDWeek, October 2022
- Papi A, Ison MG, Langley JM, et al. Respiratory Syncytial Virus Prefusion F Protein Vaccine in Older Adults. *N Engl J Med*. 2023;388(7):595-608.
- Walsh EE, Pérez Marc G et al. RENOIR Clinical Trial Group. Efficacy and Safety of a Bivalent RSV Prefusion F Vaccine in Older Adults. *N Engl J Med*. 2023 Apr 20;388(16):1465-1477. doi: 10.1056/NEJMoa2213836. Epub 2023 Apr 5. PMID: 37018468.
- Kampmann B, Madhi SA, Munjal I et al. MATISSE Study Group. Bivalent Prefusion F Vaccine in Pregnancy to Prevent RSV Illness in Infants. *N Engl J Med*. 2023 Apr 20;388(16):1451-1464. doi: 10.1056/NEJMoa2216480. Epub 2023 Apr 5. PMID: 37018474.
- Wilson E, Goswami J, Baqui AH et al. ConquerRSV Study Group. Efficacy and Safety of an mRNA-Based RSV PreF Vaccine in Older Adults. *N Engl J Med*. 2023 Dec 14;389(24):2233-2244. doi: 10.1056/NEJMoa2307079. PMID: 38091530.
- Kühn T, Speer C, Morath C, Immune Response to COVID-19 mRNA Vaccination in Previous Nonresponder Kidney Transplant Recipients After Short-term Withdrawal of Mycophenolic Acid 1 and 3 Months After an Additional Vaccine Dose. *Transplantation*. 2023 May 1;107(5):1139-1150. doi: 10.1097/TP.0000000000004516. Epub 2023 Jan 9. PMID: 36617671; PMCID: PMC10125015.
- Clinicaltrials.gov ID NCT05477524
- <https://www.cdc.gov/vaccines/schedules/index.html>
- <https://www.immunize.org/ask-experts/overview/>