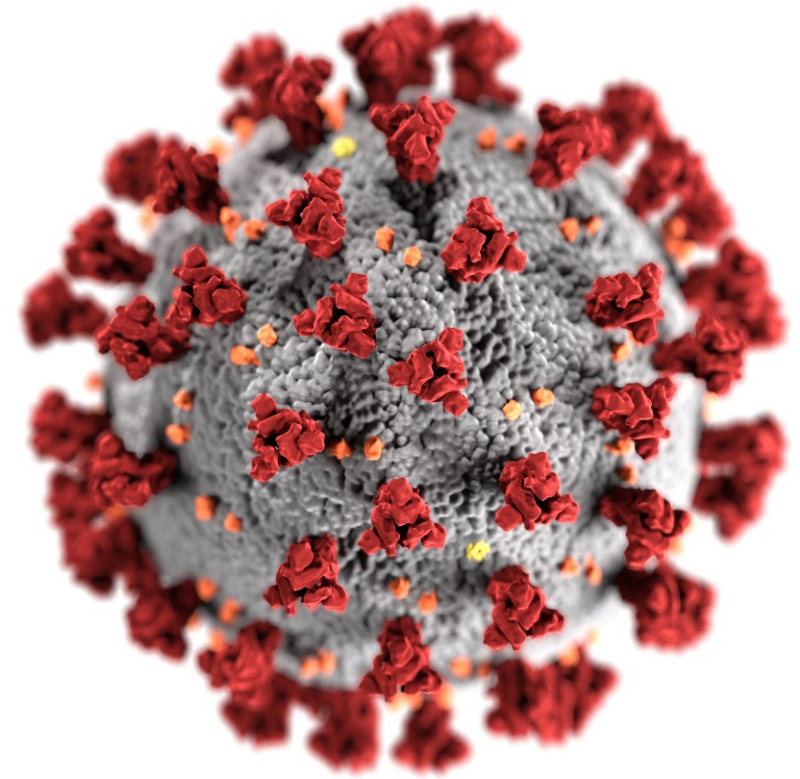


Framework for booster doses of COVID-19 vaccines

Sara Oliver MD, MSPH
ACIP Meeting
August 30, 2021



cdc.gov/coronavirus

Roles of an Additional Dose

There are two distinct potential uses for an additional dose:

- **Additional dose after an initial primary vaccine series**: administration of an additional vaccine dose when the initial immune response following a primary vaccine series is likely to be insufficient
- **Booster dose**: a dose of vaccine administered when the initial sufficient immune response to a primary vaccine series is likely to have waned over time

Booster doses of COVID-19 vaccines

- Are booster doses of COVID-19 vaccines needed for those previously vaccinated with a primary series?
- Policy on booster doses will be coordinated with **FDA** for regulatory allowance, and **ACIP** for recommendations for use

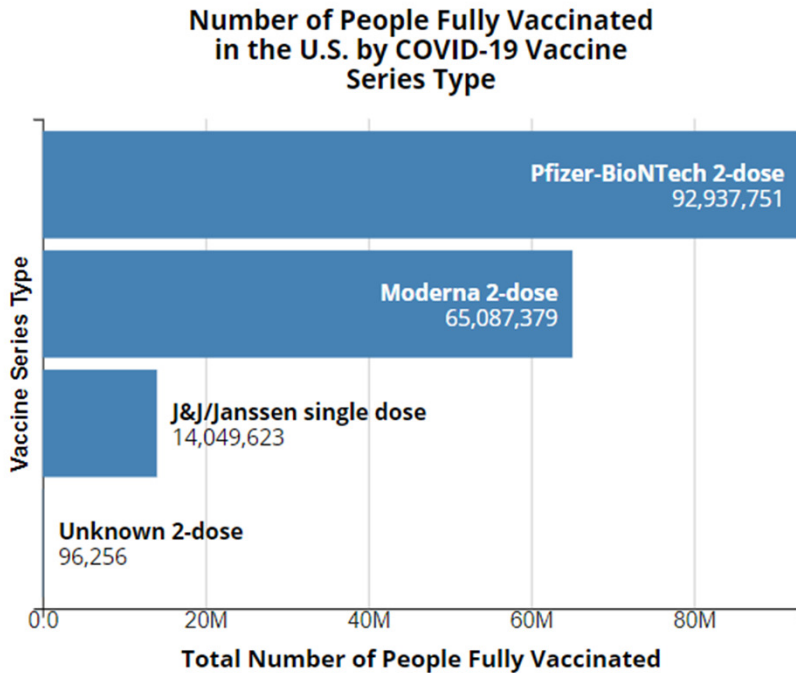


COVID-19 vaccines administered

As of August 26, 2021

**Total Vaccine Doses Administered:
365,767,674**

**% of Population
Fully Vaccinated:**



**≥12 years of age:
60.7%**



**≥18 years of age:
62.8%**

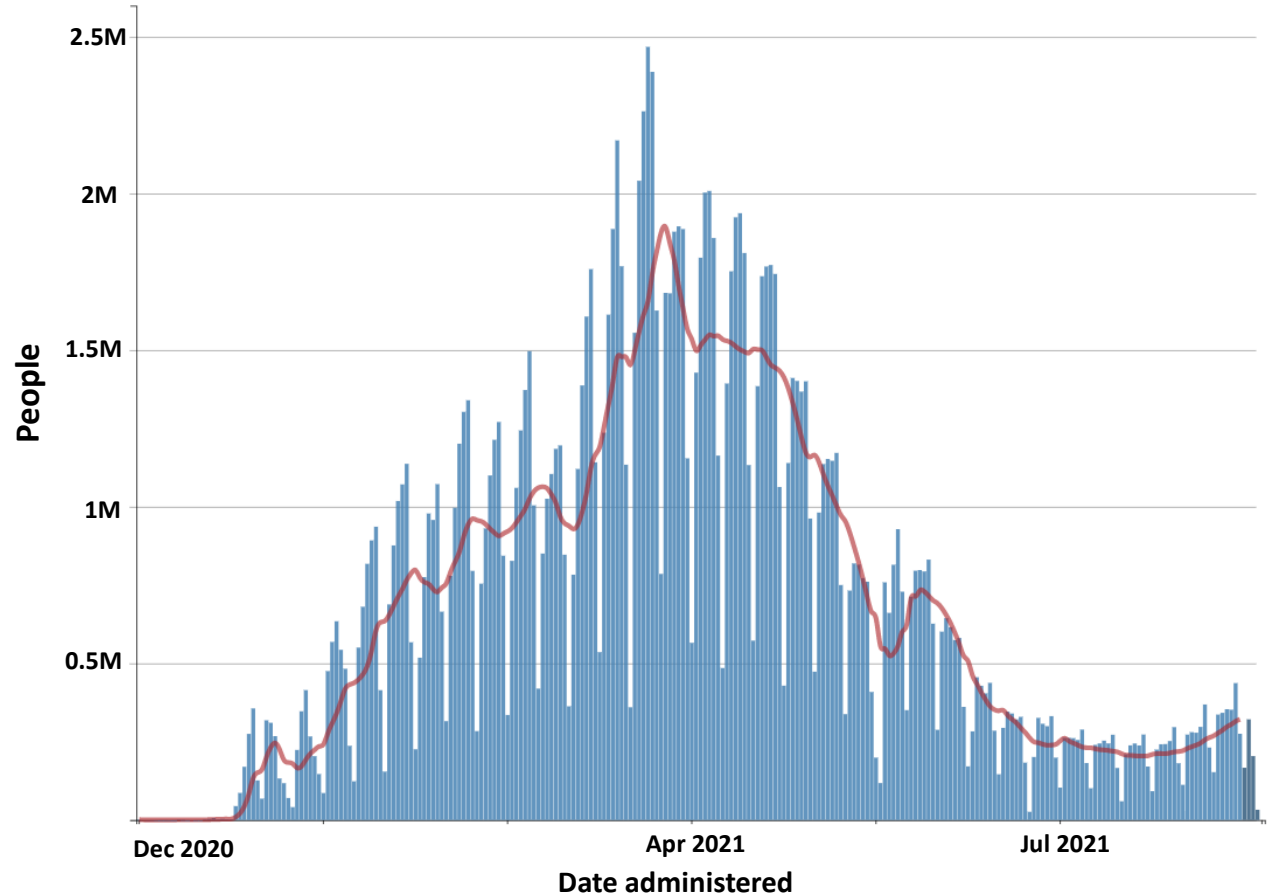


**≥65 years of age:
81.4%**

COVID-19 vaccines

As of August 26, 2021

Daily Count of Newly Fully Vaccinated People

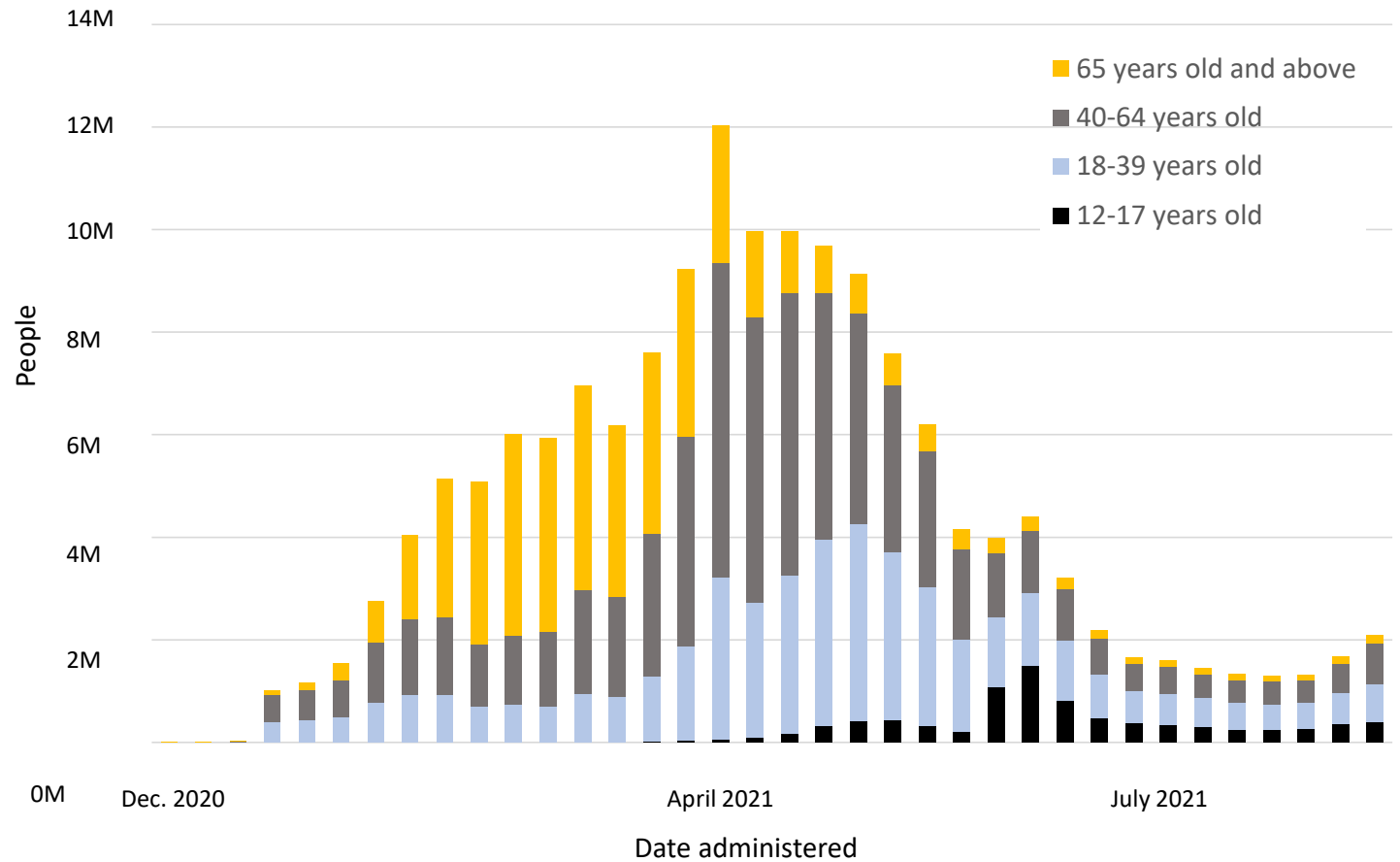


A person is considered fully vaccinated against COVID-19 ≥ 2 weeks after receipt of the second dose in a two-dose series (Pfizer-BioNTech and Moderna) or ≥ 2 weeks after receipt of the single dose of the Janssen vaccine; CDC. <https://covid.cdc.gov/covid-data-tracker>

COVID-19 vaccines

As of August 11, 2021

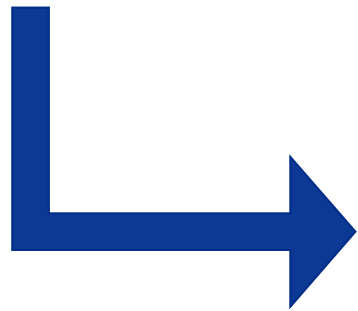
Weekly Count of Newly Fully Vaccinated People in US, by age group



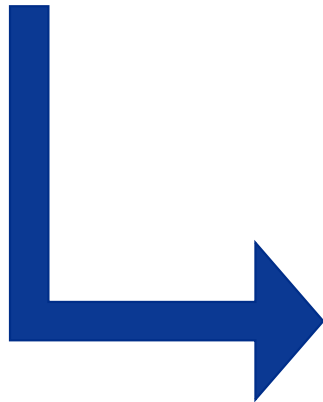
A person is considered fully vaccinated against COVID-19 ≥ 2 weeks after receipt of the second dose in a two-dose series (Pfizer-BioNTech and Moderna) or ≥ 2 weeks after receipt of the single dose of the Janssen vaccine; CDC. <https://covid.cdc.gov/covid-data-tracker>

Booster doses of COVID-19 vaccines

What are the **key considerations** for decision making?



What **data** are available for decision making?



Does ACIP **recommend** booster doses of COVID-19 vaccines in any populations?

Booster doses of COVID-19 vaccines

What are the **key considerations** for decision making?

ACIP Meeting Aug 13: Framework for COVID-19 booster doses presented



What **data** are available for decision making?

ACIP Meeting Aug 30: Begin to provide data to inform booster dose policy



Does ACIP **recommend** booster doses of COVID-19 vaccines in any populations?

Booster doses of COVID-19 vaccines

Do we need them?

Public
Health
Problem

Is vaccine effectiveness (VE) **waning** over time?

Is VE **reduced** for the **Delta variant**?

Does the need vary by **sub-population**?

Do they work?

Benefits
and
Harms

Are booster doses of COVID-19 vaccines **safe** and **immunogenic**?

Will booster doses reduce COVID-19 **incidence, hospitalization** and/or **mortality**?

Do booster doses **improve VE** against the Delta variant?

Booster doses of COVID-19 vaccines: Data to inform recommendations



Public
Health
Problem

Is vaccine effectiveness (VE) waning over time?

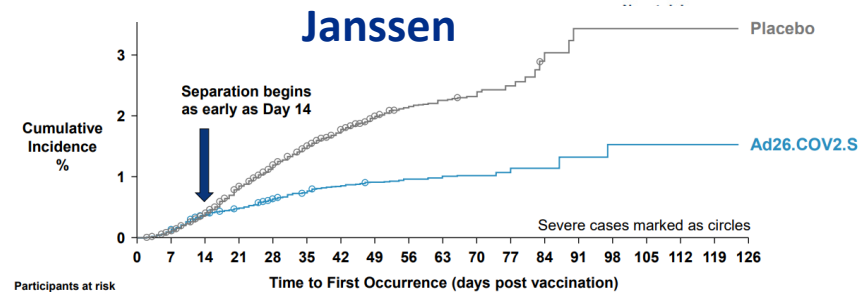
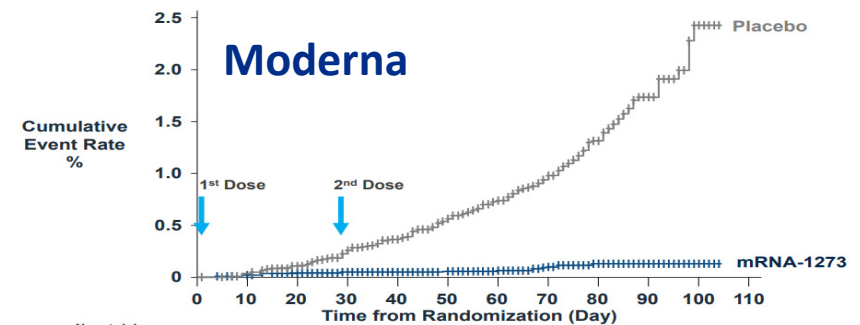
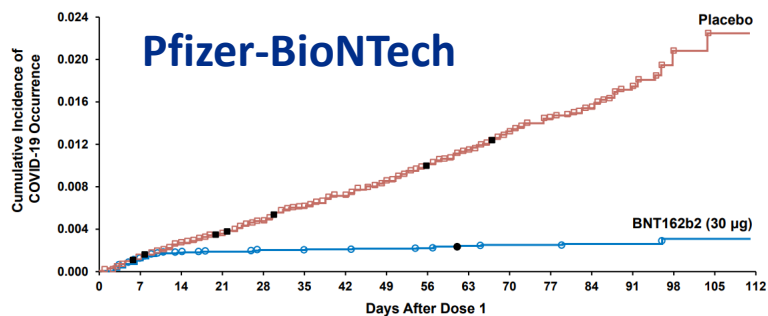
Is VE **recently** similar to what was noted at
2 months after vaccination?

How do these data vary by **severity** of disease?

How do these data vary by **vaccine**?

Booster doses of COVID-19 vaccines: Is vaccine effectiveness waning over time?

- Initial VE reviewed during EUA application



- Will work with manufacturers to review longer-term follow up from clinical trials

Recent U.S. Publications

Public Health Problem

Author	Publication (Date)	Population	Outcomes	Time Assessed
Tenforde et al.	MMWR (8/18/21)	Multi-state network of hospitalized adults	Hospitalization	March – July 2021
Rosenberg et al.	MMWR (8/18/21)	Adult residents of NY	Documented infection Hospitalization	May – July 2021
Nanduri et al.	MMWR (8/18/21)	Nursing home residents	Documented infection	March – July 2021
Fowlkes et al.	MMWR (8/25/21)	Healthcare workers and first responders in six states	Documented infection	Dec 2020 – July 2021
Puranik et al.	Preprint (8/9/21)	Adults within the Mayo Clinic health system	Documented infection Hospitalization	February – July 2021

Tenforde MW, Self WH, Naioti EA, et al. Sustained Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Associated Hospitalizations Among Adults — United States, March–July 2021. *MMWR Morb Mortal Wkly Rep.* ePub: 18 August 2021.

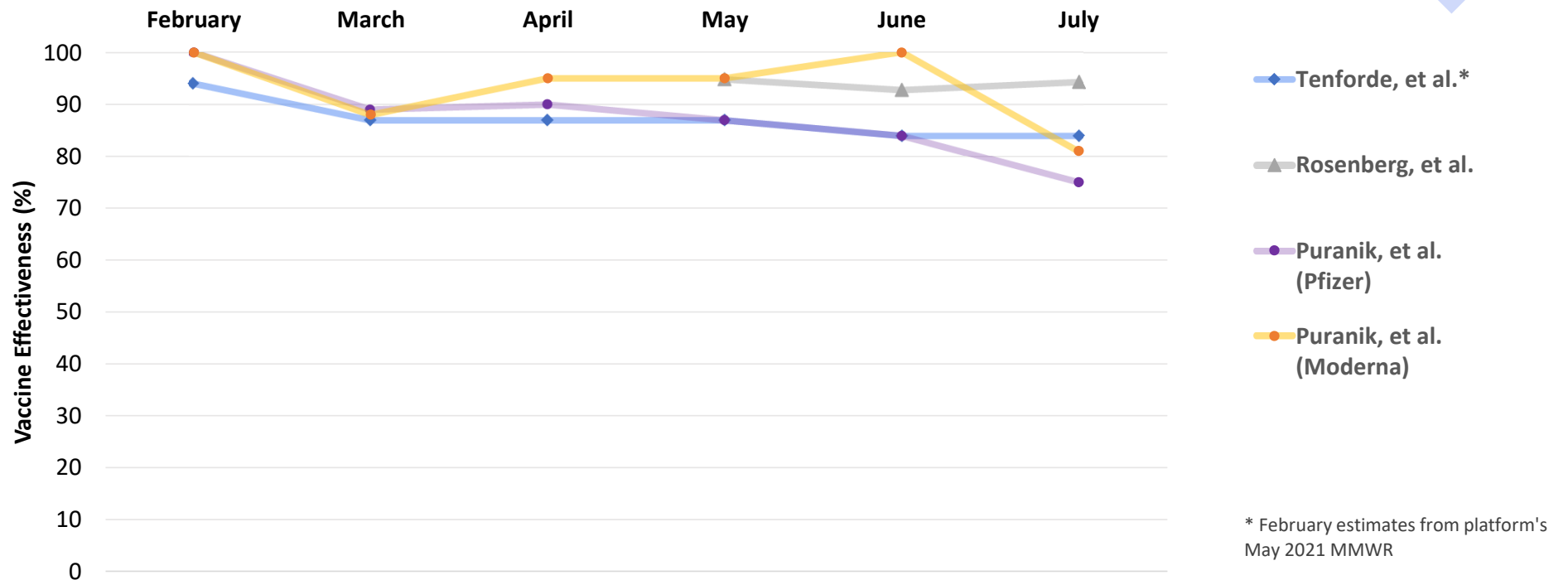
Rosenberg ES, Holtgrave DR, Dorabawila V, et al. New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021. *MMWR Morb Mortal Wkly Rep.* ePub: 18 August 2021.

Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. *MMWR Morbidity and Mortality Weekly Report.* 2021 2021;70.

Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021. *MMWR Morb Mortal Wkly Rep.* ePub: 24 August 2021.

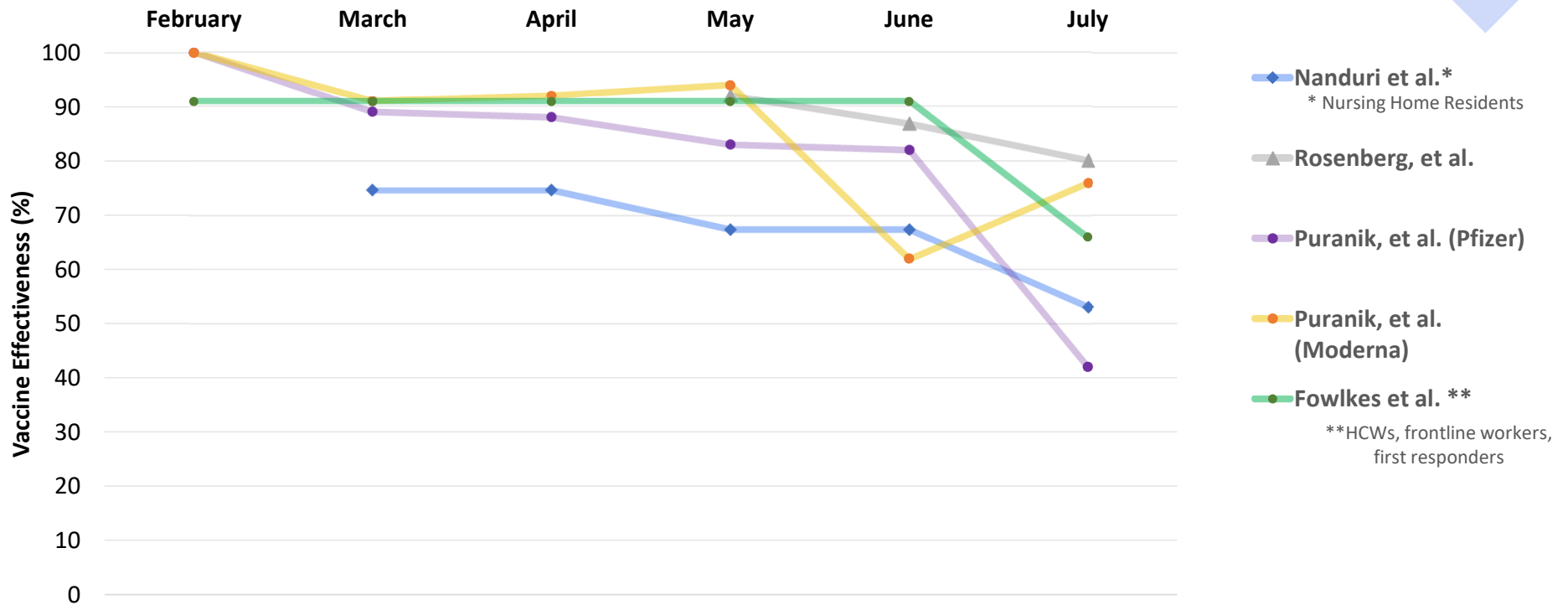
Puranik A, Lenehan PJ, Silvert E, et al. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. *medRxiv* 2021.08.06.21261707.

Booster doses of COVID-19 vaccines: Vaccine effectiveness against hospitalization



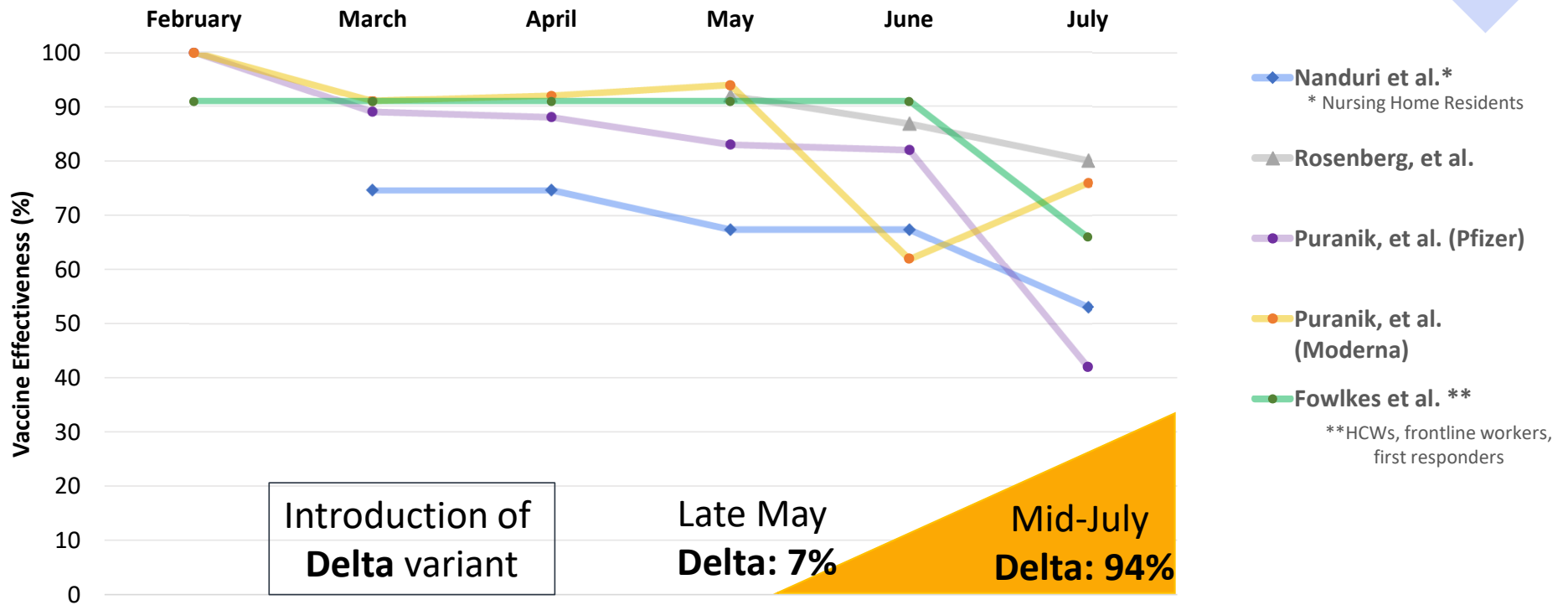
Tenforde MW, Self WH, Naioti EA, et al. Sustained Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Associated Hospitalizations Among Adults — United States, March–July 2021. MMWR Morb Mortal Wkly Rep. ePub: 18 August 2021.
 Tenforde MW, Olson SM, Self WH, et al. Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Among Hospitalized Adults Aged ≥65 Years — United States, January–March 2021. MMWR Morb Mortal Wkly Rep 2021;70:674–679.
 Rosenberg ES, Holtgrave DR, Dorabawila V, et al. New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021. MMWR Morb Mortal Wkly Rep. ePub: 18 August 2021.
 Puranik A, Lenehan PJ, Silvert E, et al. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. medRxiv 2021.08.06.21261707.

Booster doses of COVID-19 vaccines: Vaccine effectiveness against infection



Rosenberg ES, Holtgrave DR, Dorabawila V, et al. New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021. MMWR Morb Mortal Wkly Rep. ePub: 18 August 2021.
 Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. MMWR Morbidity and Mortality Weekly Report. 2021 2021;70.
 Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021. MMWR Morb Mortal Wkly Rep. ePub: 24 August 2021.
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Booster doses of COVID-19 vaccines: Vaccine effectiveness against infection



Rosenberg ES, Holtgrave DR, Dorabawila V, et al. New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021. MMWR Morb Mortal Wkly Rep. ePub: 18 August 2021.

Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. MMWR Morbidity and Mortality Weekly Report. 2021 2021;70.

Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021. MMWR Morb Mortal Wkly Rep. ePub: 24 August 2021.

Puranik A, Lenehan PJ, Silvert E, et al. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. medRxiv 2021.08.06.21261707.

Booster doses of COVID-19 vaccines: Data to inform recommendations



Public
Health
Problem

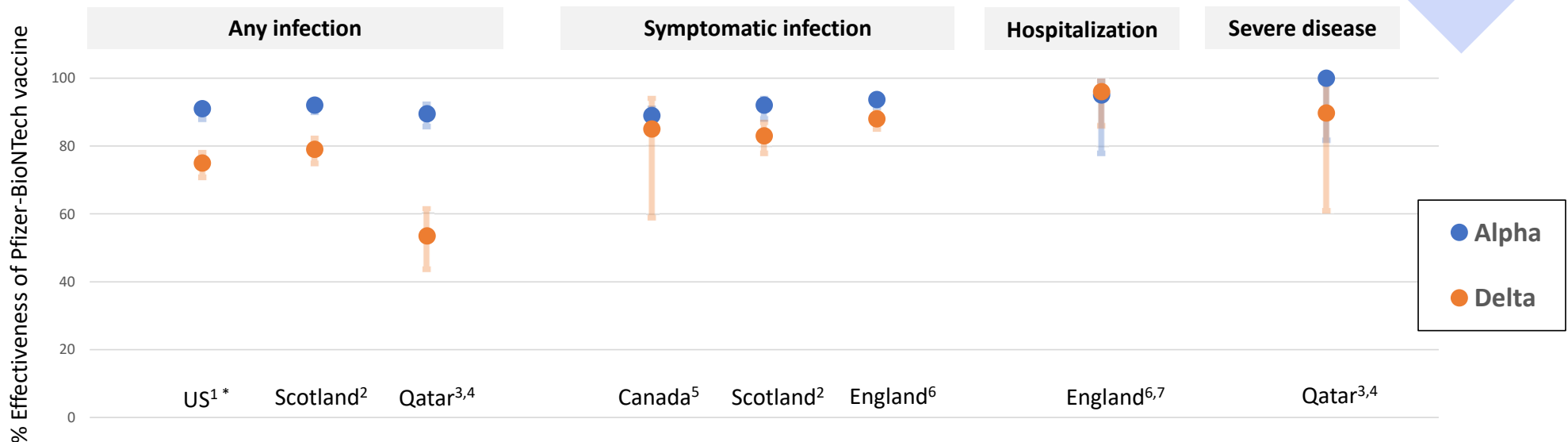
Is VE **reduced** for the **Delta variant**?

How does this vary by **severity** of disease?

How would this information impact VE
for **future variants**?

Booster doses of COVID-19 vaccines: Is effectiveness reduced because of the Delta variant?

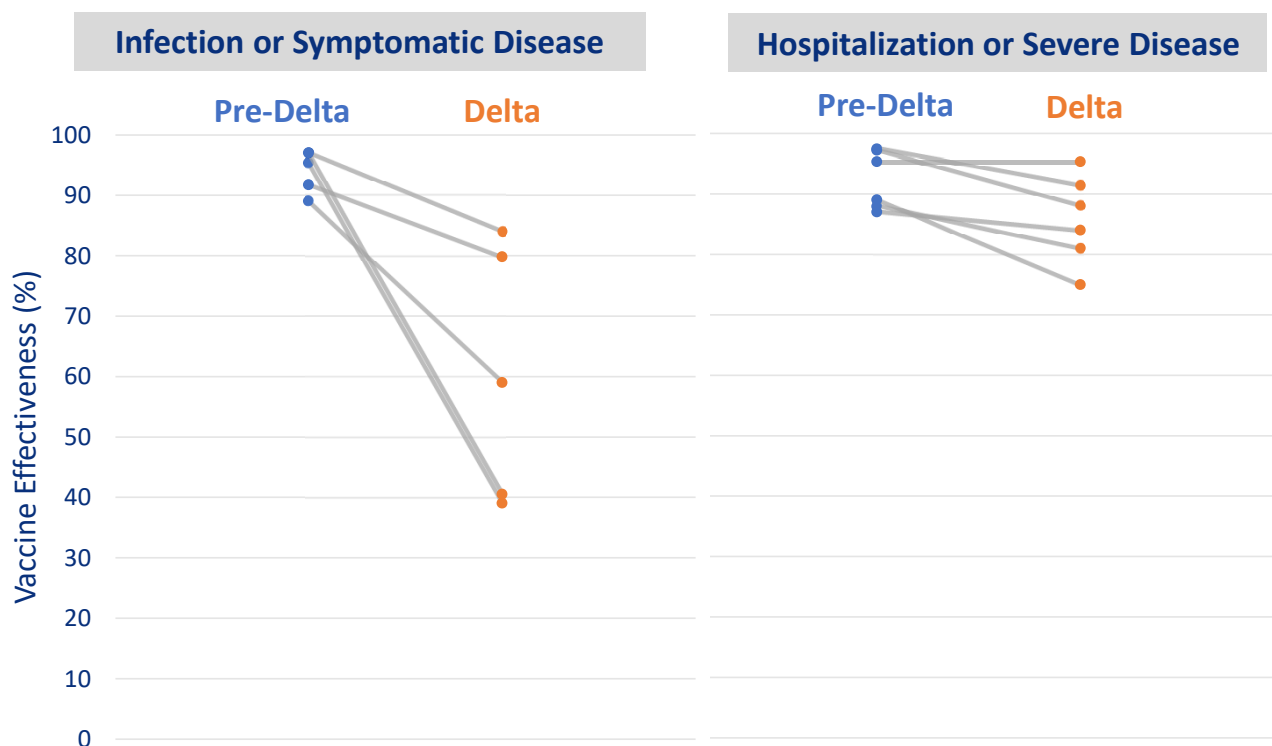
Public Health Problem



- Globally, among studies assessing infections with Alpha vs Delta: mild decrease in Delta VE¹⁻⁷
- Other factors may include study methods, **interval** between doses, and **timing** with vaccination and variant increases

References: 1. Tartof et al. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3909743 2. Sheikh A, et al. [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(21\)01358-1/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)01358-1/fulltext) 3. Tang et al. <https://www.medrxiv.org/content/10.1101/2021.08.11.21261885v1> 4. Abu-Raddad et al. <https://www.nejm.org/doi/full/10.1056/NEJMc2104974> 5. Nasreen S, et al. <https://www.medrxiv.org/content/10.1101/2021.06.28.21259420v2> 6. Bernal Lopez et al. <https://www.medrxiv.org/content/10.1101/2021.05.22.21257658v1> 7. Stowe et al. https://khub.net/web/ph-national/public-library/-/document_library/v2WsRK3ZIEig/view/479607266 *Included other variants

Vaccine effectiveness in the Pre-Delta and Delta Periods

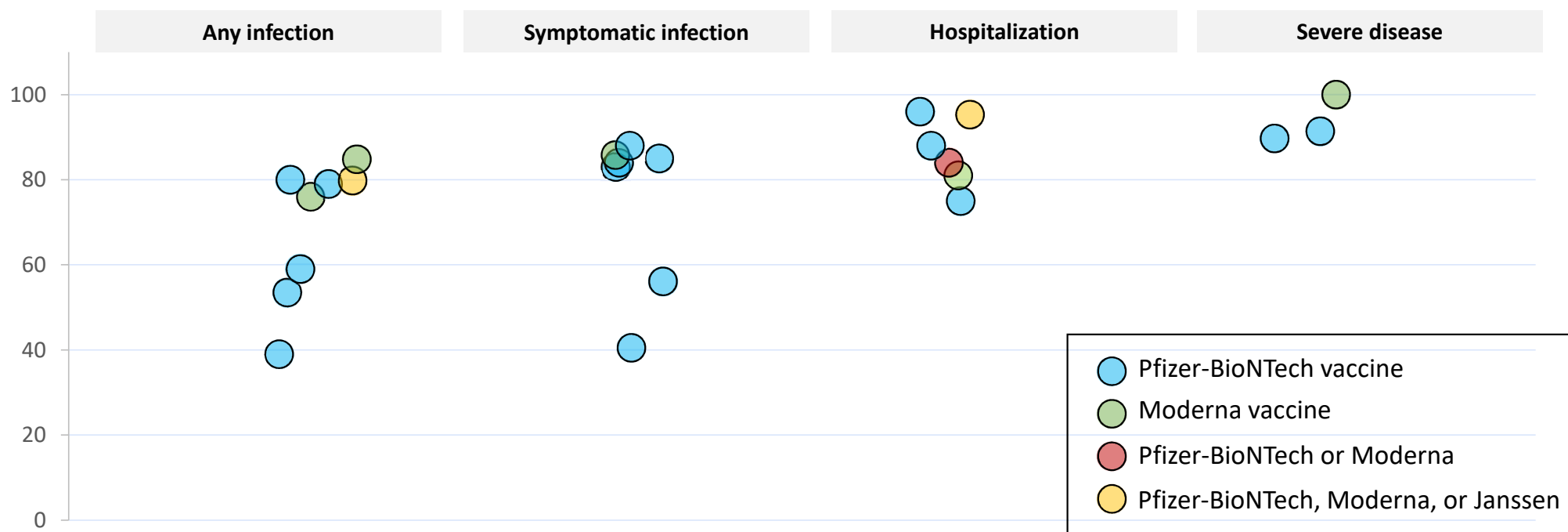


In studies comparing the 'Pre-Delta' and 'Delta' periods:

- Pre-Delta vaccine effectiveness estimates high (**87% or higher**)
- Since the introduction of the Delta variant (varies by region)
 - VE against **infection** ranges from **39–84%**
 - VE against **hospitalization** ranges from **75–95%**

References: 1. Israel Ministry of Health (committee/he/files_publications_corona_two-dose-vaccination-data.pdf) 2. Haas et al. (Israel) [https://doi.org/10.1016/S0140-6736\(21\)00947-8](https://doi.org/10.1016/S0140-6736(21)00947-8) 3. Pouwels et al. (UK) [survey/finalfinalcombinedve20210816.pdf](https://www.medrxiv.org/content/10.1101/2021.08.06.21261707v2) 4. Puranik <https://www.medrxiv.org/content/10.1101/2021.08.06.21261707v2> 5. Rosenberg (US) <https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e1.htm> 6. Tenforde (US) <https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e2.htm>

Summary of vaccine effectiveness estimates since introduction of the Delta variant



- Vaccines remain effective in preventing **hospitalization** and **severe disease** but might be less effective in preventing **infection** or milder symptomatic illness
- Reasons for lower effectiveness likely include both **waning over time** and **Delta variant**

See reference list in later slides

Booster doses of COVID-19 vaccines: Data to inform recommendations

Public
Health
Problem

Does the need vary by **sub-population**?

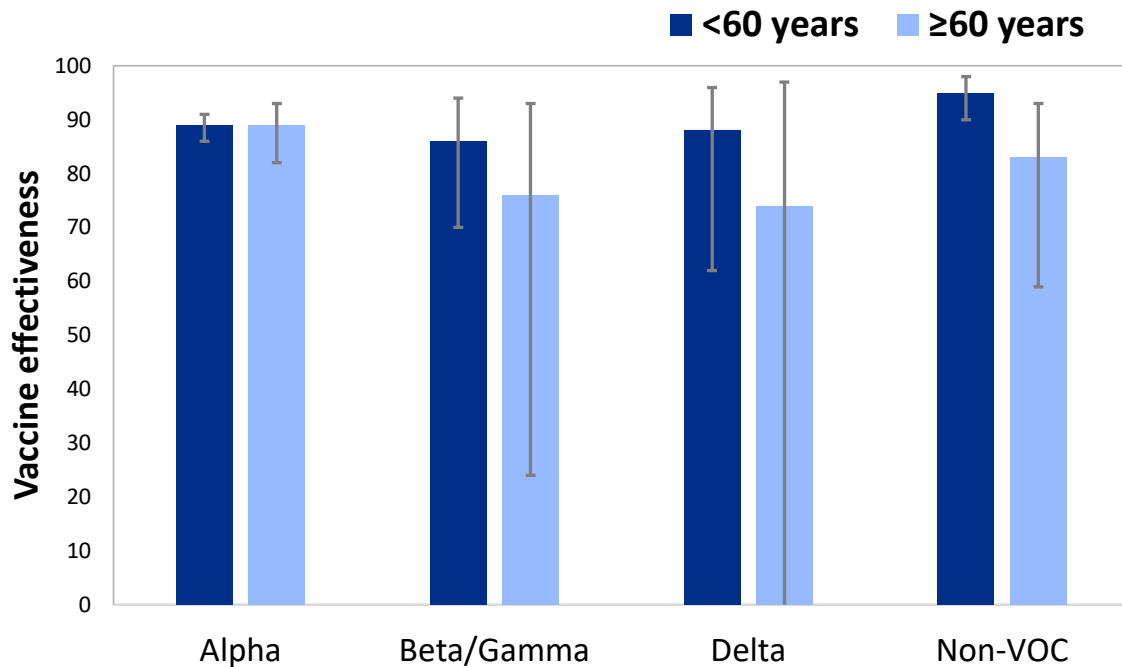
Adults ≥ 65
years of age

Residents of
long-term
care facilities

Healthcare
personnel

Booster doses of COVID-19 vaccines: Adults ≥ 60 years of age

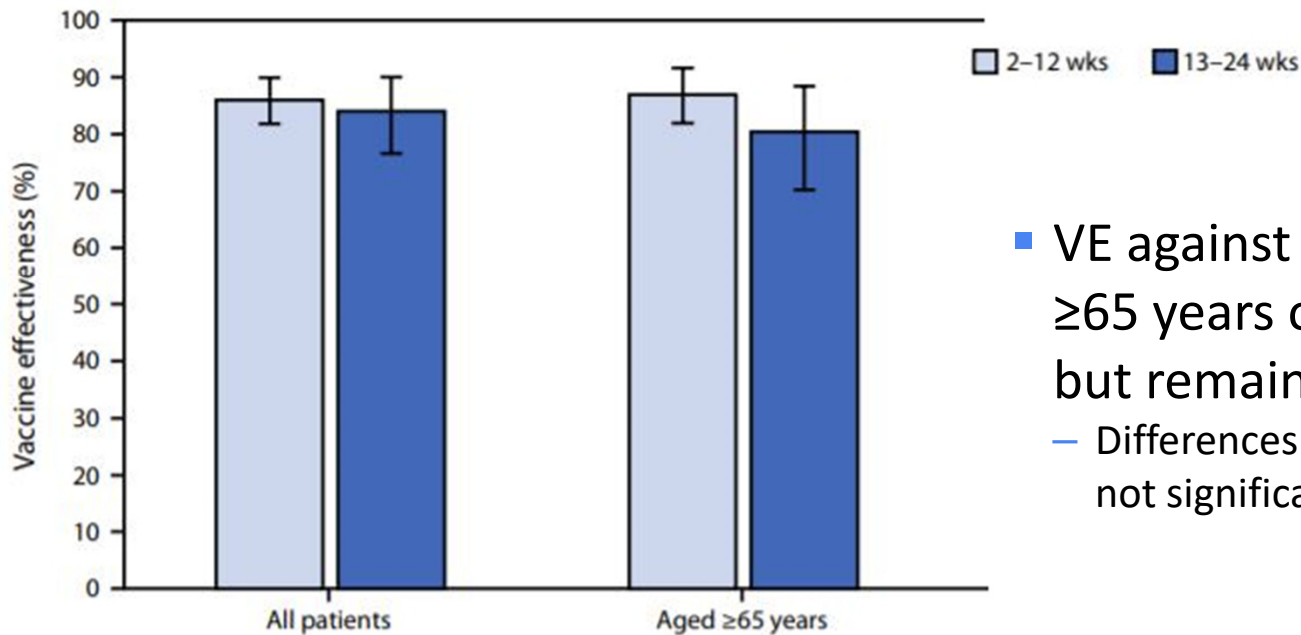
VE for **symptomatic infection**
 ≥ 7 days after dose 2, Pfizer-BioNTech vaccine



- VE against **symptomatic infection** in adults ≥ 60 years of age is high, but some decreases noted against VoC
 - Differences were not significantly different: small numbers and wide confidence intervals

Booster doses of COVID-19 vaccines: Adults ≥ 65 years of age

FIGURE 2. Sustained vaccine effectiveness* against COVID-19 among hospitalized adults, by patient status^{†,§} and interval since vaccination — 21 medical centers in 18 states,[¶] March–July 2021

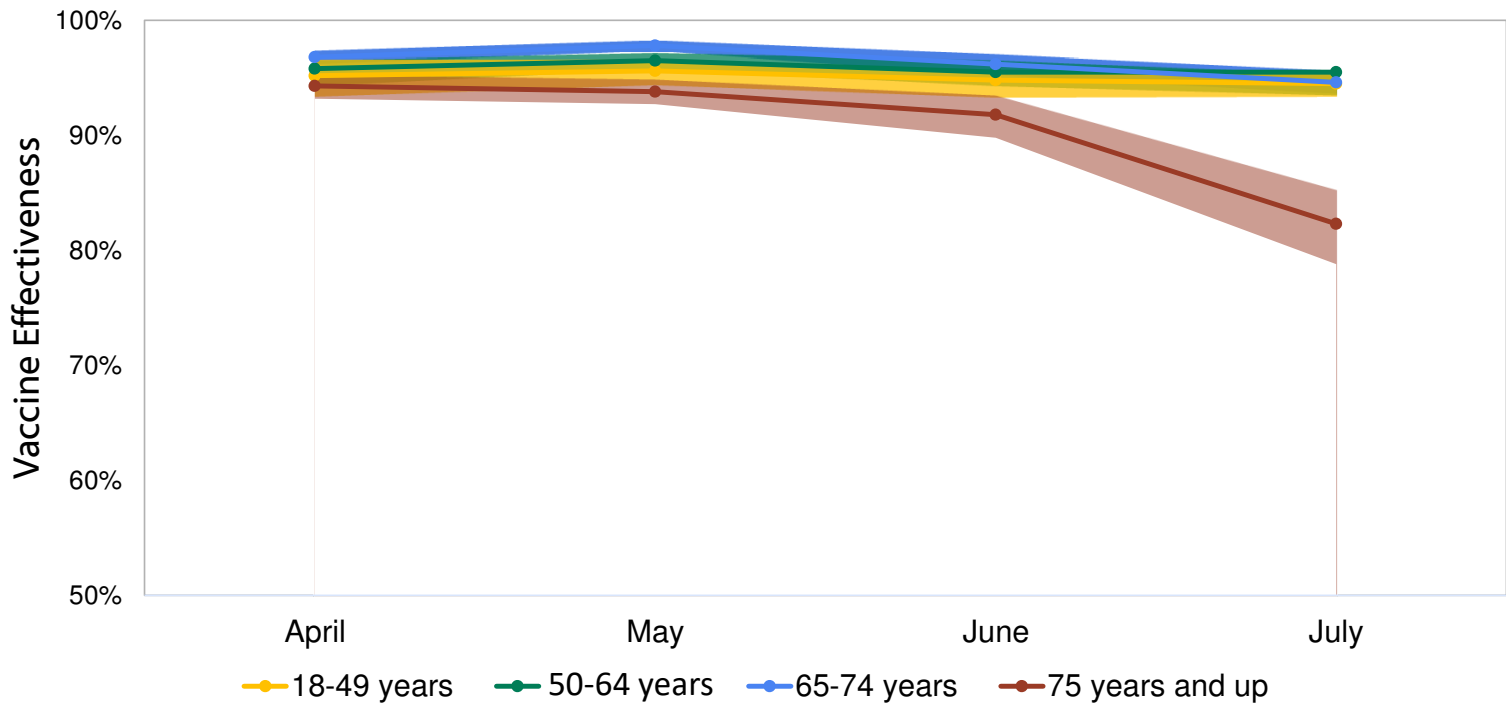


- VE against **hospitalization** in adults ≥ 65 years of age decreases over time but remained high
 - Differences by interval since vaccination were not significantly different

Booster doses of COVID-19 vaccines: Adults ≥65 years of age



Preliminary VE against COVID-19–associated **hospitalization** among fully vaccinated† patients aged ≥18 years by age group and month — COVID-NET



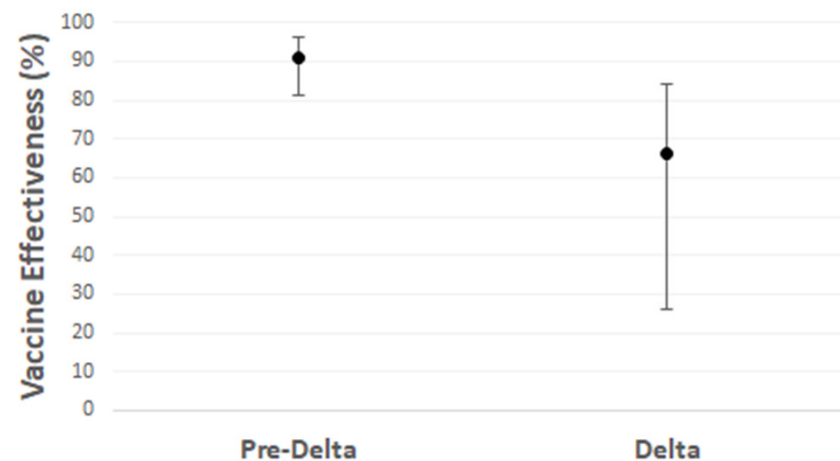
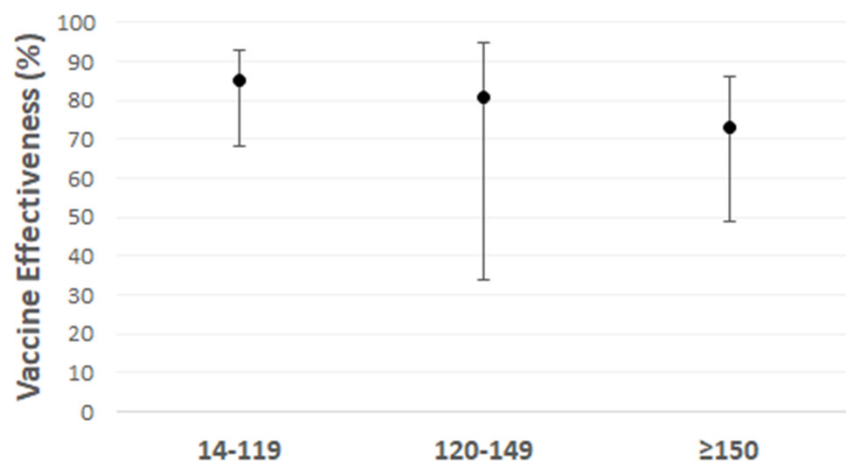
- Preliminary VE against **hospitalization** in adults ≥75 years of age decreased in July, but remains >80%

Source: Unpublished COVID-NET data

†Fully vaccinated patients received both doses of Moderna or Pfizer-BioNTech vaccine with second dose received ≥14 days before hospitalization or a single dose of Janssen (Johnson & Johnson) vaccine ≥14 days before hospitalization

Booster doses of COVID-19 vaccines: Healthcare personnel

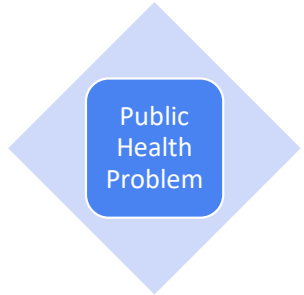
- VE against **infection** among **frontline workers** (including healthcare personnel) declined somewhat over time and from the pre-Delta period to Delta period
 - VEs were not significantly different



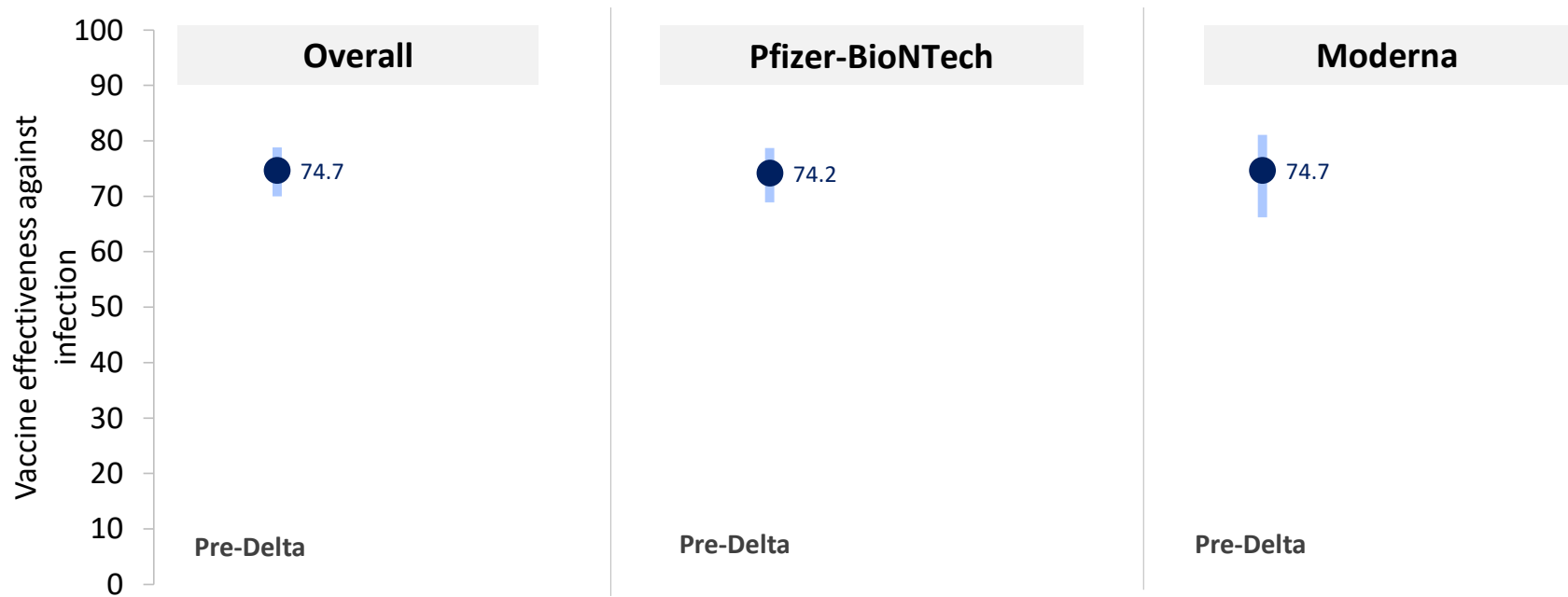
Data from HEROES-RECOVER Cohort

Fowlkes A, Gaglani M, Groover K, et al. Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021. MMWR Morb Mortal Wkly Rep. ePub: 24 August 2021. DOI: <http://dx.doi.org/10.15585/mmwr.mm7034e4>.

Booster doses of COVID-19 vaccines: Long-term care facility residents



- Initially, VE against **infection** among long-term care facility residents was high

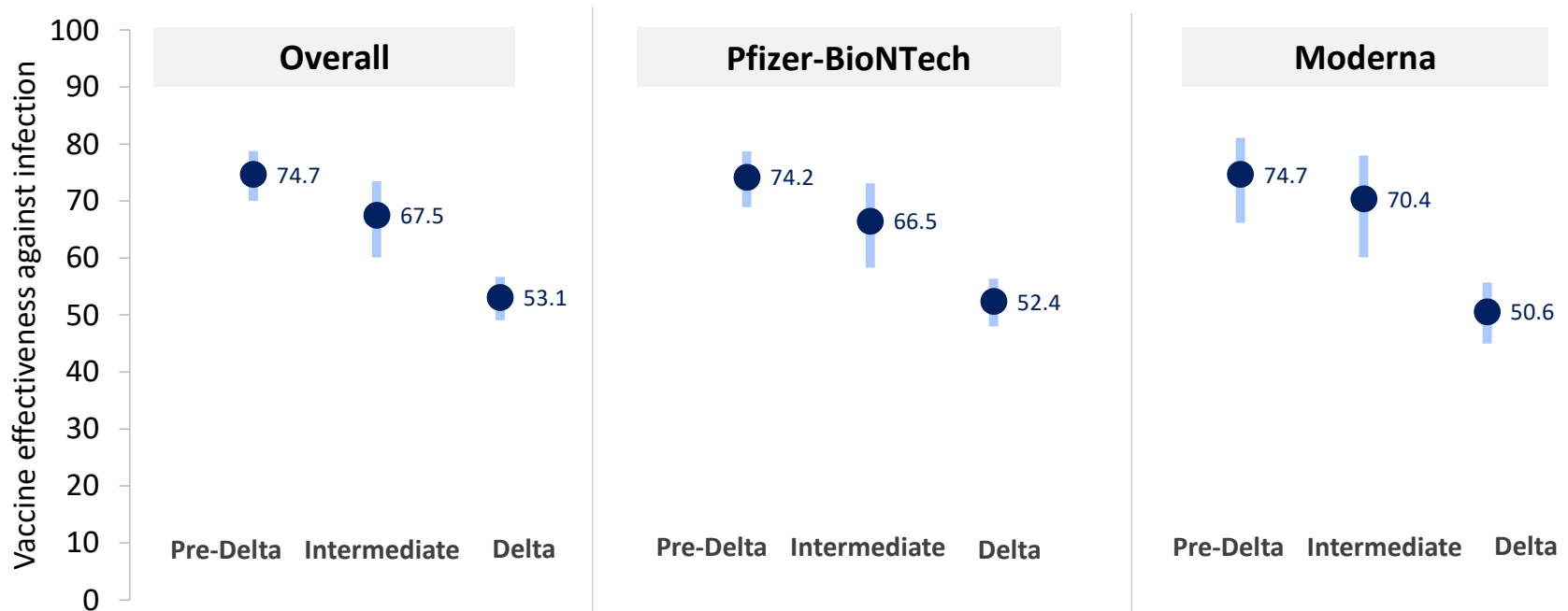


Data from National Healthcare Safety Network (NHSN)

Adapted from: Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. MMWR Morbidity and Mortality Weekly Report. 2021 2021;70. Slide courtesy of Ian Plumb.

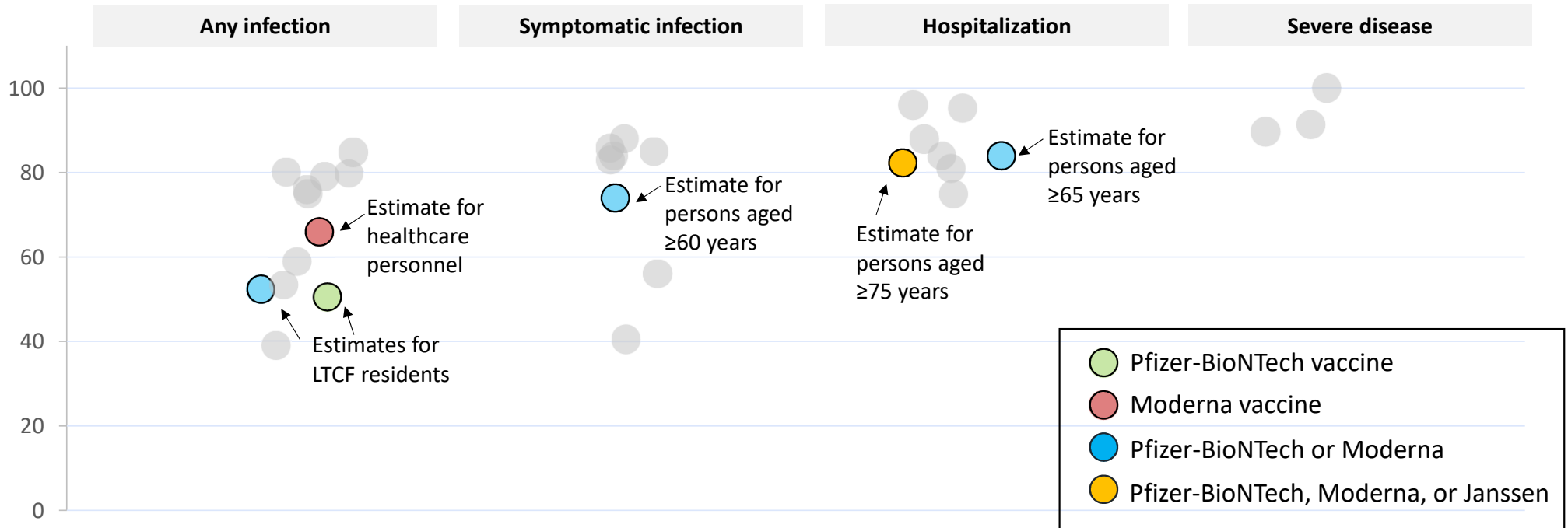
Booster doses of COVID-19 vaccines: Long-term care facility residents

- VE against **infection** among long-term care facility residents differed significantly from pre-Delta period to Delta period



Adapted from: Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. MMWR Morbidity and Mortality Weekly Report. 2021 2021;70. Slide courtesy of Ian Plumb.

Summary of vaccine effectiveness estimates since introduction of the Delta variant



- Lower vaccine effectiveness estimated against **infection** for long term care facility resident
- Vaccine effectiveness among older age groups and healthcare personnel comparable with other subgroups; follow up needed to monitor VE estimates over time

See reference list in later slides

Booster doses of COVID-19 vaccines: Data to inform recommendations

Are booster doses of COVID-19 vaccines **safe** and **immunogenic**?

Do COVID-19 vaccines provide a **boost** in neutralizing antibody response?

How do neutralizing antibodies correlate to **clinical protection** from COVID-19?



Benefits
and
Harms

Booster doses of COVID-19 vaccines: Are booster doses safe and immunogenic?



- Pfizer-BioNTech, Moderna, and Janssen (Johnson & Johnson) conducting studies to evaluate **safety** and **immunogenicity** of COVID-19 vaccine booster doses
- Important to include sufficient **safety** data for booster doses

Booster doses of COVID-19 vaccines: Data to inform recommendations

Will booster doses of COVID-19 vaccines reduce COVID-19 **incidence**, **hospitalization** and/or **mortality**?



Benefits
and
Harms

Booster doses of COVID-19 vaccines:

Will booster doses reduce COVID-19 morbidity and mortality?



Benefits
and
Harms

- Evaluating data available to assess the potential **impact** of COVID-19 booster doses in a variety of populations and settings

Booster doses of COVID-19 vaccines: Data to inform recommendations

Do boosters **improve VE** against the
Delta variant and other
variants of concern (VoC)?

How can we use this data to inform VE
for **future variants**?



Benefits
and
Harms

Booster doses of COVID-19 vaccines:

Do booster doses improve VE against Delta and other VoC?



Benefits
and
Harms

- **Immunogenicity** data (including sera from study participants who received a booster dose) can evaluate neutralizing antibody data for variants of concern (including Delta)
- No correlate of protection available, but growing understanding around impact of **neutralizing antibodies**
 - Can infer impact of booster doses on neutralizing antibodies to clinical protection (VE) against Delta and other VoC

Booster doses of COVID-19 vaccines: Data to inform recommendations



Feasibility

Are booster doses of COVID-19
feasible to implement?

Booster doses of COVID-19 vaccines: Are booster doses feasible to implement?



- Some aspects of implementation will be **more feasible** than primary series roll-out:
 - Supply and number of vaccination sites not a serious limitation
- Some aspects of implementation will be **more complex**:
 - Different primary series
 - Individuals received a variety of primary series
 - Upcoming data will evaluate booster response for same (homologous) and different (heterologous) series
 - Booster dose policy will need to address individuals who received **all primary series**
 - Different doses
 - Some COVID-19 vaccine booster studies have evaluated various doses for booster vaccines for the same product

Summary and Work Group Considerations



Booster doses of COVID-19 vaccines: Summary

- Not uncommon for a vaccine series to require several doses
- Vaccines that require >1 dose do not necessarily mean annual boosters needed
 - For many vaccines, the final dose is given at least 6 months after the initial dose

Sample of adult vaccines requiring >1 dose	1 st dose	2 nd dose	3 rd dose
Herpes zoster (shingles)	Initial	2-6 months	
Hepatitis A	Initial	6 months	
Hepatitis B	Initial	1-2 months	6-18 months
Human papillomavirus (HPV) (Age ≥15 at initial vaccination)	Initial	1-2 months	6 months

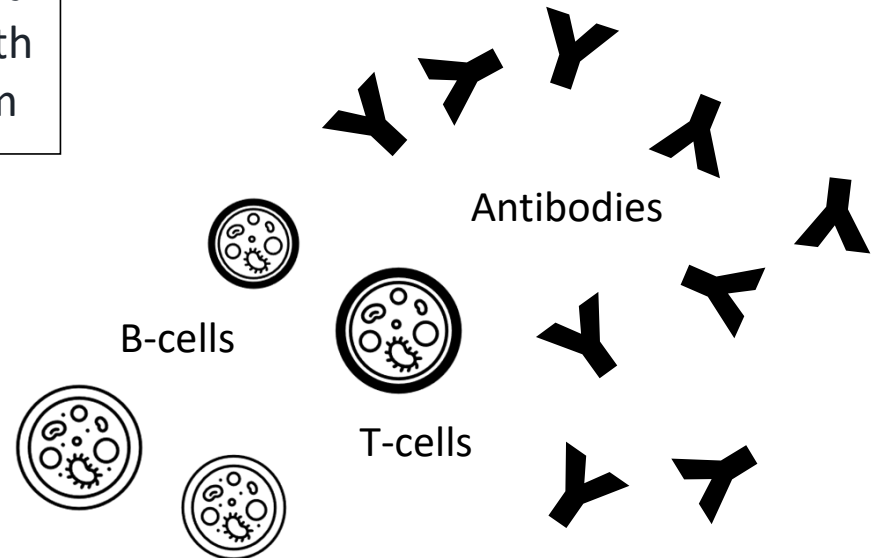
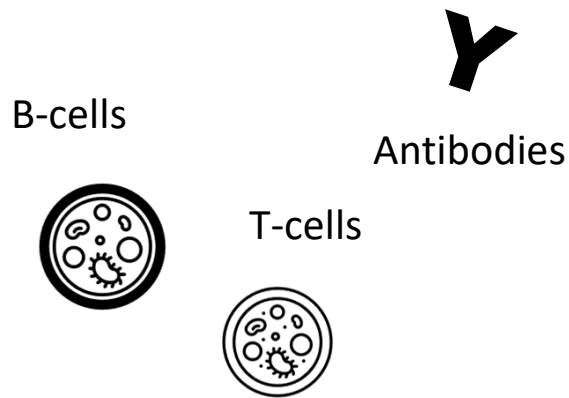
Booster doses of COVID-19 vaccines: Summary



Initial dose(s) of vaccine:
Prime

Time between the doses can allow for a 'boosting' effect with the immune system

Subsequent doses of vaccine:
'Boost' Effect



Booster doses of COVID-19 vaccines:

Summary

- COVID-19 vaccines continue to maintain **high protection** against severe disease, hospitalization, and death
- Protection against infection (including asymptomatic or mild infections) appears lower in recent months
 - Difficult to distinguish role of **time** since primary series and **Delta variant**
- Reported data through July; data through August shown at future ACIP meetings
 - Important to monitor **trends** of effectiveness by severity of disease over time
- Policy around booster doses requires **continued evaluation** of effectiveness, monitoring impact of both **time** and **variants**, and ability of booster doses to **improve** protection

Recommendations for Allocation of Initial Doses of COVID-19 Vaccines December 2020–Early 2021

Phase 1a

LTCF Residents
Healthcare Personnel

Phase 1b

Adults ≥ 75 years of age
Frontline Essential Workers

Phase 1c

Adults ≥ 65 years of age
All Essential Workers
Adults 16-64 years of age with
high-risk medical conditions



**Highest Risk
Individuals**

- Early in vaccine roll-out, ACIP voted for a **risk-based approach** to allocation of COVID-19 vaccines
- **Variation in implementation** across states/jurisdictions

Booster doses of COVID-19 vaccines: Work Group considerations

- **Top priority** should be **continued vaccination of unvaccinated individuals**
 - Planning for delivery of booster doses to vaccinated individuals should not deter outreach for delivery of primary series to unvaccinated individuals
- Priority for booster dose policy:
Prevention of **severe disease** in **at-risk populations**
- **Simplicity** and **flexibility** will be important to support equitable and efficient delivery of booster doses

Booster doses of COVID-19 vaccines: Work Group considerations

- Important to ensure **global vaccine availability**
 - Uncontrolled spread globally that could result in new variants threaten control of the pandemic everywhere
- Policy around booster doses should also consider **equity** in the U.S. population
 - Access to booster doses may vary by population and setting
 - **Lessons learned** around equitable access in early primary series roll-out

Booster doses of COVID-19 vaccines: Work Group considerations

- In addition to immunogenicity data, need to review available **safety** data for booster doses
- Balance of **benefits** and **risks** for booster doses may vary by age
 - Policy for booster doses needs to take this **benefit/risk balance** into account
- Critical to wait for additional **safety data** and **regulatory allowance** for booster doses

Booster doses of COVID-19 vaccines:

Work Group considerations

- At this time, the Work Group discussed a **risk-based approach** for booster dose recommendations
 - Prevent **severe disease** in the most at-risk populations:
 - LTCF residents
 - Older adults (≥ 65 or ≥ 75 years of age)
 - Support **strained healthcare infrastructure**:
 - Healthcare personnel with mild disease cannot work, so prevention of mild disease takes on greater importance as a public health goal in this population
- **Time since vaccination** with primary series also important
 - For many vaccines, a minimum interval beneficial for full ‘boosting effect’
 - Ability to benefit from ‘boosting effect’ extends well beyond the minimum interval

Booster doses of COVID-19 vaccines

Recommendations for Allocation of Initial Doses of COVID-19 Vaccines

Phase 1a

LTCF Residents
Healthcare Personnel

Phase 1b

Adults ≥ 75 years of age
Frontline Essential Workers

Phase 1c

Adults ≥ 65 years of age
All Essential Workers
Adults 16-64 years of age with
high-risk medical conditions

Highest Risk Individuals

Time since recommendation

Booster doses of COVID-19 vaccines

Recommendations for Allocation of Initial Doses of COVID-19 Vaccines

Phase 1a

LTCF Residents
Healthcare Personnel

Phase 1b

Adults ≥ 75 years of age
Frontline Essential Workers

Phase 1c

Adults ≥ 65 years of age
All Essential Workers
Adults 16-64 years of age with
high-risk medical conditions

Highest Risk Individuals

Time since recommendation

Possible Recommendations for Initial Booster Doses

Highest Risk Individuals

LTCF Residents
Healthcare Personnel
Adults $\geq 65/75$ years of age

Time interval since receipt of last dose

Booster doses of COVID-19 vaccines

- ACIP will continue to review additional data:
 - Manufacturer data on safety + immunogenicity of booster doses
 - Effectiveness, breakthrough infections and epi data through August
- Further discussions around feasibility, implementation, and balance of benefit and risks by age group and population

Booster doses of COVID-19 vaccines

What are the **key considerations** for decision making?

ACIP Meeting Aug 13: Framework for COVID-19 booster doses presented



What **data** are available for decision making?

ACIP Meeting Aug 30: Begin to provide data to inform booster dose policy



Does ACIP **recommend** booster doses of COVID-19 vaccines in any populations?

Booster doses of COVID-19 vaccines

What are the **key considerations** for decision making?

ACIP Meeting Aug 13: Framework for COVID-19 booster doses presented



What **data** are available for decision making?

ACIP Meeting Aug 30: Begin to provide data to inform booster dose policy

ACIP Meeting mid-September: Additional data to inform policy



Does ACIP **recommend** booster doses of COVID-19 vaccines in any populations?

ACIP Meeting after FDA authorization: Possible vote

Acknowledgements

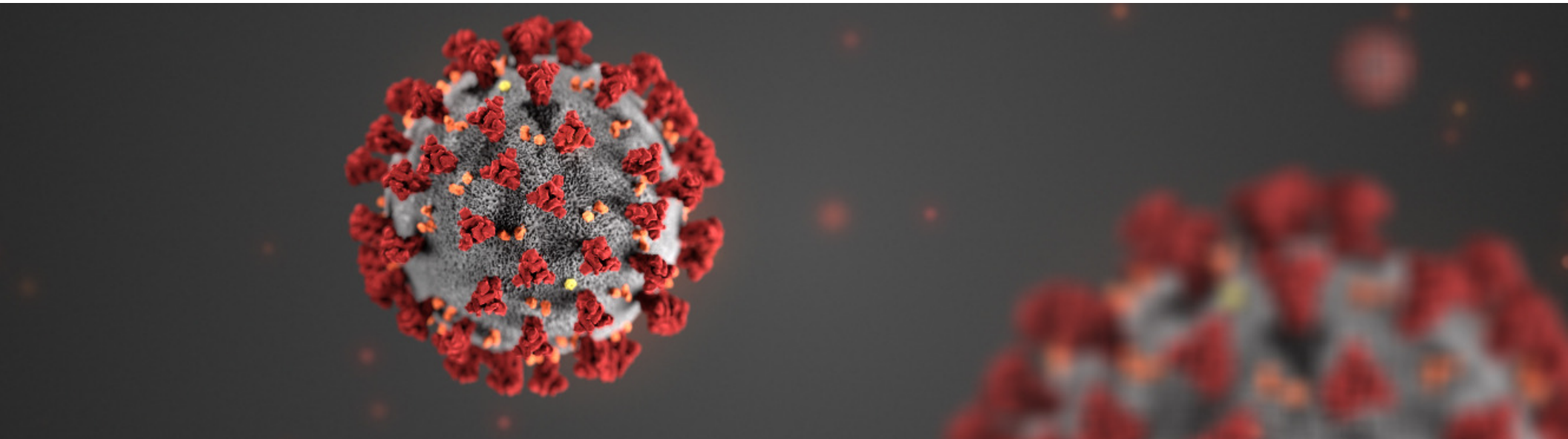
- Kathleen Dooling
- Heidi Moline
- Ian Plumb
- Danielle Moulia
- Amy Blain
- Mary Chamberland
- Jennifer Collins
- Julia Gargano
- Jack Gersten
- Monica Godfrey
- Stephen Hadler
- Hannah Rosenblum
- Heather Scobie
- Eddie Shanley
- Megan Wallace
- Neela Goswami
- Kristine Schmidt
- Vaccine Task Force
- Epi Task Force
- Respiratory Viruses Branch

Questions for ACIP

1. Does ACIP agree with the proposed risk-based approach for COVID-19 booster dose recommendations?
2. What other questions would be important for ACIP to address?

Reference list for recent estimates of vaccine effectiveness against the Delta variant

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The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

