Effectiveness of COVID-19 vaccines

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October 23, 2024

Agenda – COVID-19 vaccine effectiveness (VE)

- **VE data to inform need for:**
  - Additional doses in immunocompromised
    - What's known about VE in immunocompromised vs. non-immunocompromised adults, including waning by time since dose
  - Additional dose for adults ≥65 years
    - What's known about waning of a single dose in healthy adults ≥65 years, including against more severe outcomes
    - Benefits of an additional dose in past seasons

Some key issues in COVID-19 vaccine effectiveness (VE)

1. **Time since dose impacts protection**
   - How much and over what time period?

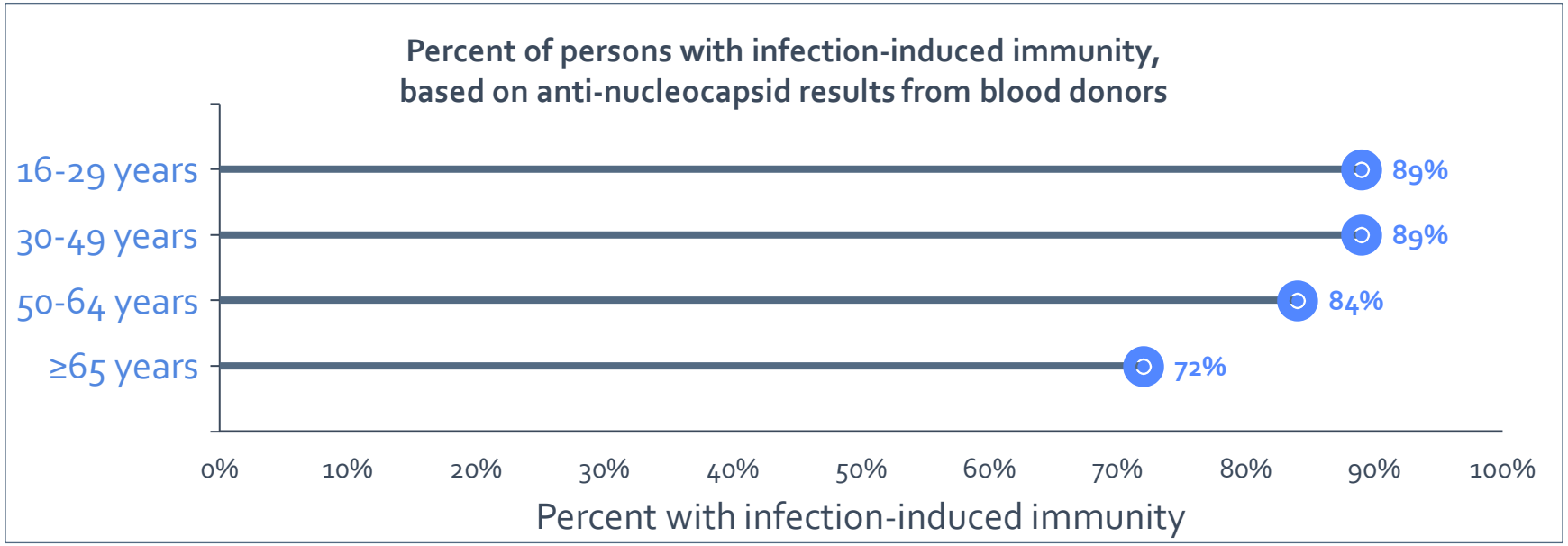
2. **SARS-CoV-2 variants change over time**
   - Variant/vaccine match may impact effectiveness

3. **Surges in disease, seroprevalence, and time since last SARS-CoV-2 infection impact measured VE**

Difficult to disentangle time since dose (true “waning”) vs. impact of changes in variants vs. impact of time since prior infection

Context for interpreting COVID-19 VE across age groups: SARS-CoV-2 seroprevalence before 2023-2024 respiratory virus season

- High rates of SARS-CoV-2 infection-induced immunity by July – August 2023.*



VE findings should be interpreted as the added benefit provided by COVID-19 vaccination in a population with a high prevalence of vaccine- and infection-induced immunity.

* Internal CDC data. Data on persons aged ≥16 years is from a longitudinal, national cohort of >35,000 blood donors.
Methods and prior data available at: https://covid.cdc.gov/covid-data-tracker/#nationwide-blood-donor-seroprevalence-2022

Measuring COVID-19 VE

Measure	Definition	Example vaccinated group	Example comparison group
Absolute VE	Compares frequency of health outcomes in vaccinated and unvaccinated people	Received original monovalent COVID-19 vaccine	Received no COVID-19 vaccines ever
Relative VE	Compares frequency of health outcomes in people who received one type of vaccine to people who received a different vaccine	Received bivalent COVID-19 vaccine	Eligible for, but did not receive, bivalent COVID-19 vaccine, but received original monovalent COVID -19 vaccine
VE of 2023-2024 COVID-19 vaccines	Compares people who received 2023-2024 COVID-19 vaccine to people who did not, regardless of past vaccination	Received updated (2023-24) dose	Eligible for, but did not receive, an updated (2023 -24) dose, regardless of past vaccination history

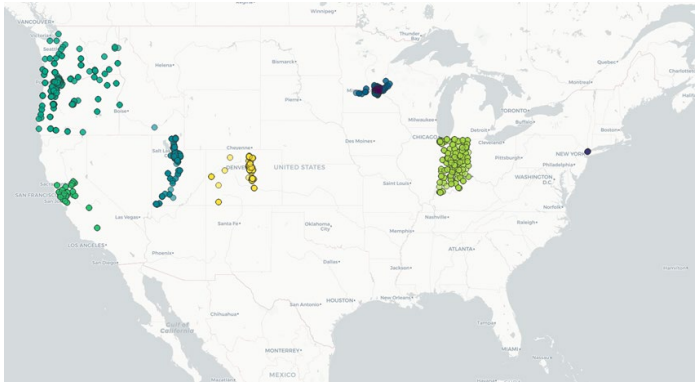
Methods

VISION Multi-Site Network of Electronic Health Records

>300 emergency departments and urgent cares and >200 hospitals

- **Design:** Test-negative design

- **Population:** Adults visiting a participating emergency department or urgent care (ED/UC) or hospitalized with COVID-19-like illness (CLI) with a SARS-CoV-2 NAAT test result within 10 days before or 72 hours after encounter
  - **Cases**: CLI with *positive* NAAT for SARS-CoV-2 and no positive NAAT for RSV or influenza
  - **Controls**: CLI with *negative* NAAT for SARS-CoV-2 and no positive NAAT for influenza



- **Vaccination data:** Documented by electronic health records and state and city registries

IVY Network — 26 hospitals, 20 U.S. States

- **Design**: Test-negative, case-control design
- **Population**: Adults aged ≥18 years hospitalized with COVID-like illness (CLI)* and SARS-CoV-2 test results within 10 days of illness onset and 3 days of admission
  - **Cases:** CLI and test *positive* for SARS-CoV-2 by NAAT or antigen
  - **Controls**: CLI and test *negative* for SARS-CoV-2 and influenza by RT-PCR
- **Vaccination data:** Electronic medical records (EMR), state and city registries, and plausible self-report
- **Specimens:** Nasal swabs obtained on all patients for central RT-PCR testing and whole genome sequencing

IVY

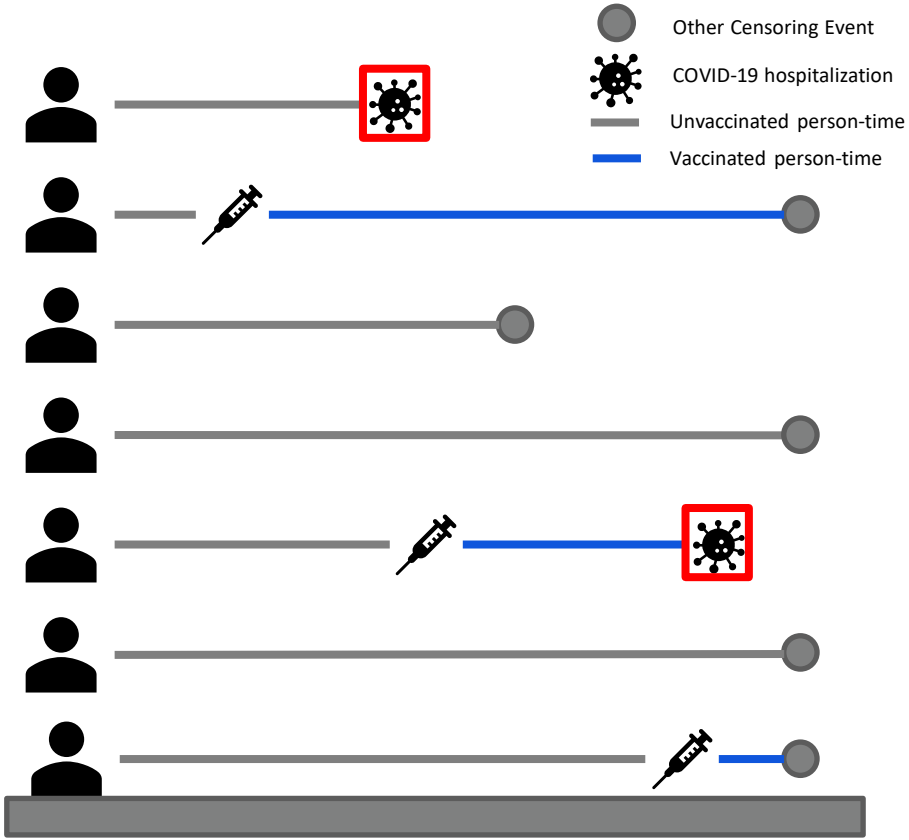
INVESTIGATING RESPIRATORY VIRUSES IN THE ACUTELY ILL

*CLI is defined as presence of any one of the following: fever, cough, shortness of breath, chest imaging consistent with pneumonia, or hypoxemia

Medicare data

- **Design:** Retrospective cohort
- **Data source:** Medicare fee-for-service claims data*
- **Population:** Persons aged ≥65
- **Censoring events:**
  - COVID-19-related thromboembolic event
  - Death
  - Disenrollment in Medicare Parts A/B
  - Enrollment in Medicare Part C
  - Nursing home stay lasting ≥100 days
  - Admission to hospice facility
  - Dialysis encounter
  - Receipt of multiple bivalent booster doses
  - Bivalent booster dose < 60 days from the last COVID-19 vaccine dose
  - End of study period
- **VE = (1 - adjusted hazard ratio) x 100%**

where adjusted hazard ratio = $\frac{rate\ of\ RSV\ hospitalization_{vaccinated}}{rate\ of\ RSV\ hospitalization_{unvaccinated}}$

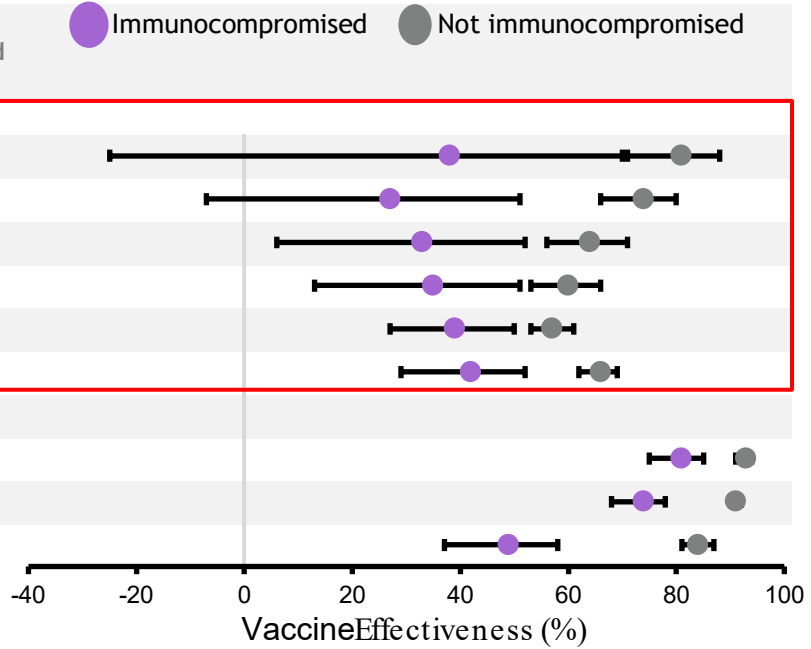


*Data sources included Medicare Enrollment Database (EDB) and Common Medicare Environment (CME), Common Working File (CWF) and Shared System Data (SSD) Medicare Parts A/B claims data, Minimum Data Set (MDS), and CDC/ATSDR Social Vulnerability Index (SVI). Events identified from Medicare claims data using International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10 CM) and common procedural terminology (CPT) codes.

COVID-19 VE data to inform need for additional doses in persons with immunocompromise

VISION: *Original monovalent vs. unvaccinated* mRNA VE for COVID-19-associated hospitalization by number of doses and time since last dose receipt for adults ≥50 years, Dec 2021–Mar 2022, by immunocompromised status

Vaccination status/days since dose	Adjusted VE% (95% CI) Immunocompromised	Not immunocompromised
2 doses		
14-59 days	38 (-25-71)	81 (70-88)
60-119 days	27 (-7-51)	74 (66-80)
120-179 days	33 (6-52)	64 (56-71)
180-239 days	35 (13-51)	60 (53-61)
240-299 days	39 (27-50)	57 (53-61)
300+ days	42 (29-52)	66 (62-69)
3 doses		
14-59 days	81 (75-85)	93 (91-94)
60-119 days	74 (68-78)	91 (90-92)
120-179 days	49 (37-58)	84 (81-87)



VE of original mRNA doses vs. unvaccinated persons during Delta and early Omicron was higher among non-immunocompromised adults. An additional dose restored/increased protection in immunocompromise and non-immunocompromised, with some waning apparent.

Adapted from Britton et al. MMWR: https://www.cdc.gov/mmwr/volumes/71/wr/mm7142a4.htm. Individuals with prior infections excluded. Logistic regression conditioned on calendar week and geographic area, and adjusted for age, sex, race, ethnicity, local virus circulation, respiratory or nonrespiratory underlying medical conditions, and propensity to be vaccinated

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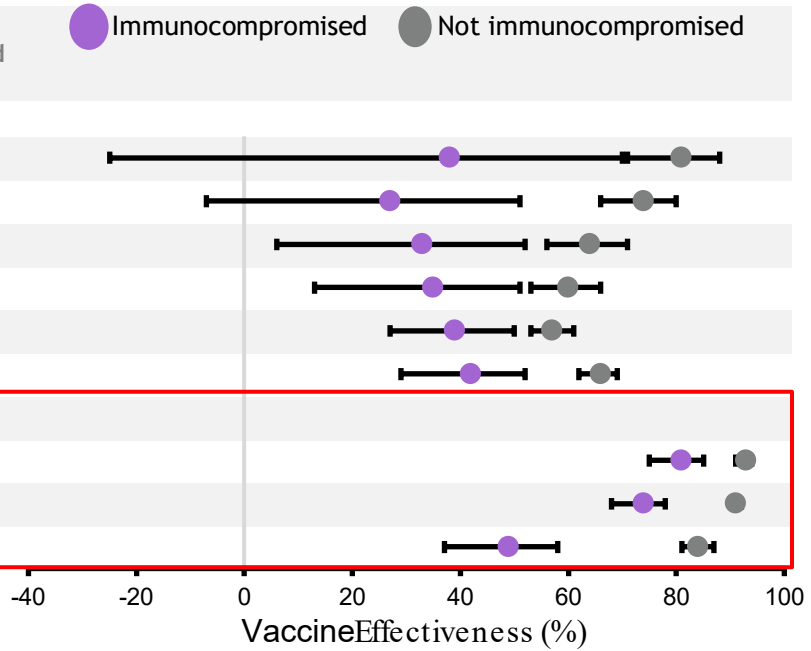

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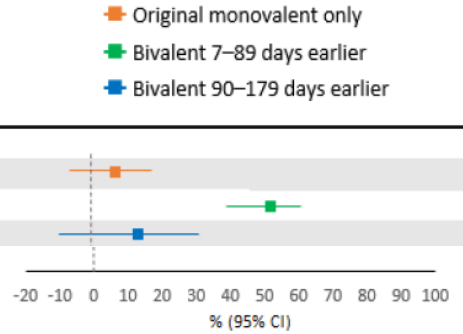
IVY: Original monovalent and *bivalent vs. unvaccinated* mRNA VE against COVID-19-associated hospitalization by time since last dose receipt for adults ≥18 years, September 2022–August 2023, by immunocompromised status

Group	Vaccination status	No. of vaccinated COVID-19 case-patients/total no. of COVID-19 case-patients (%)	No. of vaccinated control-patients/ total no. of control-patients (%)	Median days since last dose (IQR)	Absolute vaccine effectiveness, % (95% CI)
Without immunocompromising conditions					
Overall	Original monovalent only	1811/2471 (73)	2380/3265 (73)	421 (304–571)	6 (-7 to 17)
	Bivalent 7–89 days earlier	184/844 (22)	463/1348 (34)	53 (30–69)	52 (39 to 61)
	Bivalent 90–179 days earlier	269/929 (29)	376/1261 (30)	133 (110–153)	13 (-10 to 31)



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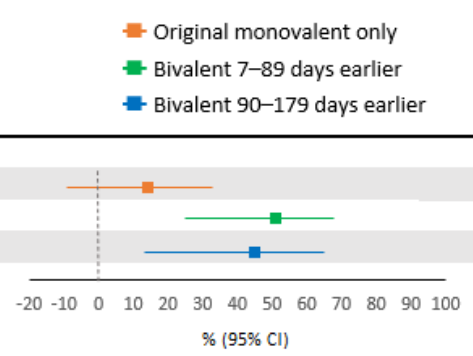
With immunocompromising conditions					
Overall	Original monovalent only[a]	645/802 (80)	915/1128 (81)	405 (279–553)	14 (-9 to 33)
	Bivalent 7–89 days earlier	64/221 (29)	165/378 (44)	47 (27–72)	51 (25 to 68)
	Bivalent 90–179 days earlier	78/235 (33)	158/371 (43)	128 (109–156)	45 (13 to 65)[b]



A dose of bivalent vaccine added protection among those >1 year from their last original monovalent dose during Omicron predominance.

DeCuir J. medRxiv 2024.01.07.24300910; doi: https://doi.org/10.1101/2024.01.07.24300910

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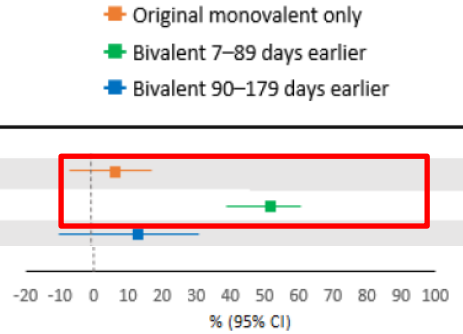

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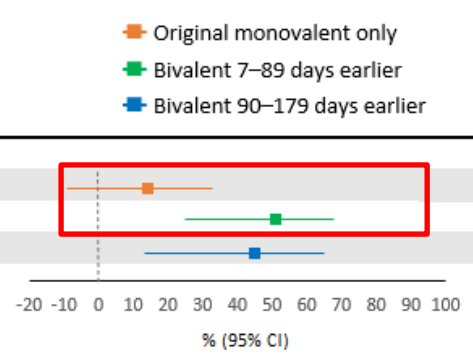

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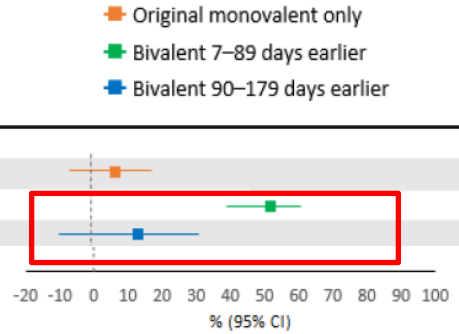

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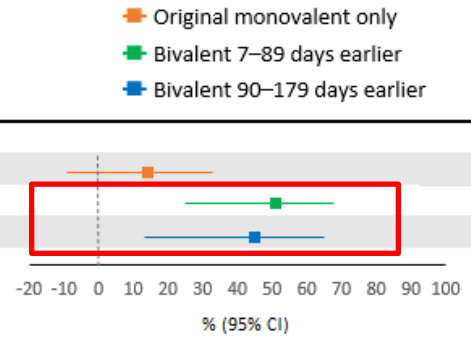

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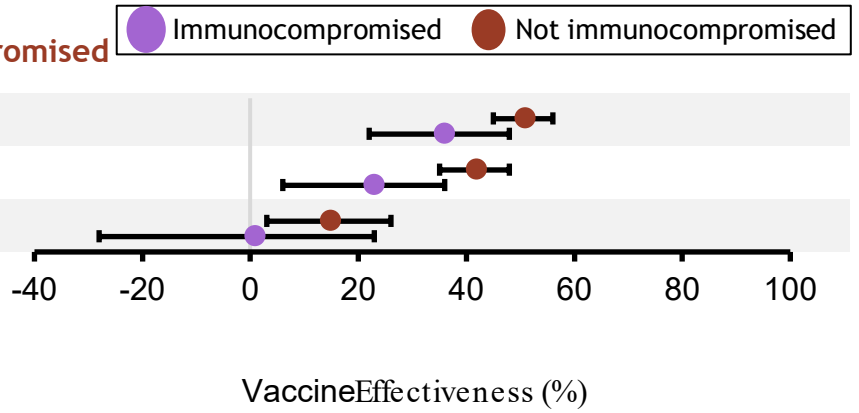
VISION: VE of *2023-2024 vs. no 2023-2024* COVID-19 vaccine against COVID-19-associated *hospitalization* among adults aged ≥18 years, by immunocompromise status

September 2023 – August 2024

Days since vaccination	Adjusted VE% (95% CI) Immunocompromised	Not immunocompromised
7-59 days	36 (22-48)	51 (45-56)
60-119 days	23 (6-36)	42 (35-48)
120-179 days	1 (-28-23)*	15 (3-26)



During the 2023-2024 season, VE appeared somewhat lower in immunocompromised individuals, though waning patterns were similar to those in non-immunocompromised individuals.

CDC, preliminary unpublished data. Individuals with prior infections excluded. Logistic regression conditioned on calendar week and geographic area, and adjusted for age, sex, race, ethnicity, local virus circulation, respiratory or nonrespiratory underlying medical conditions, and propensity to be vaccinated

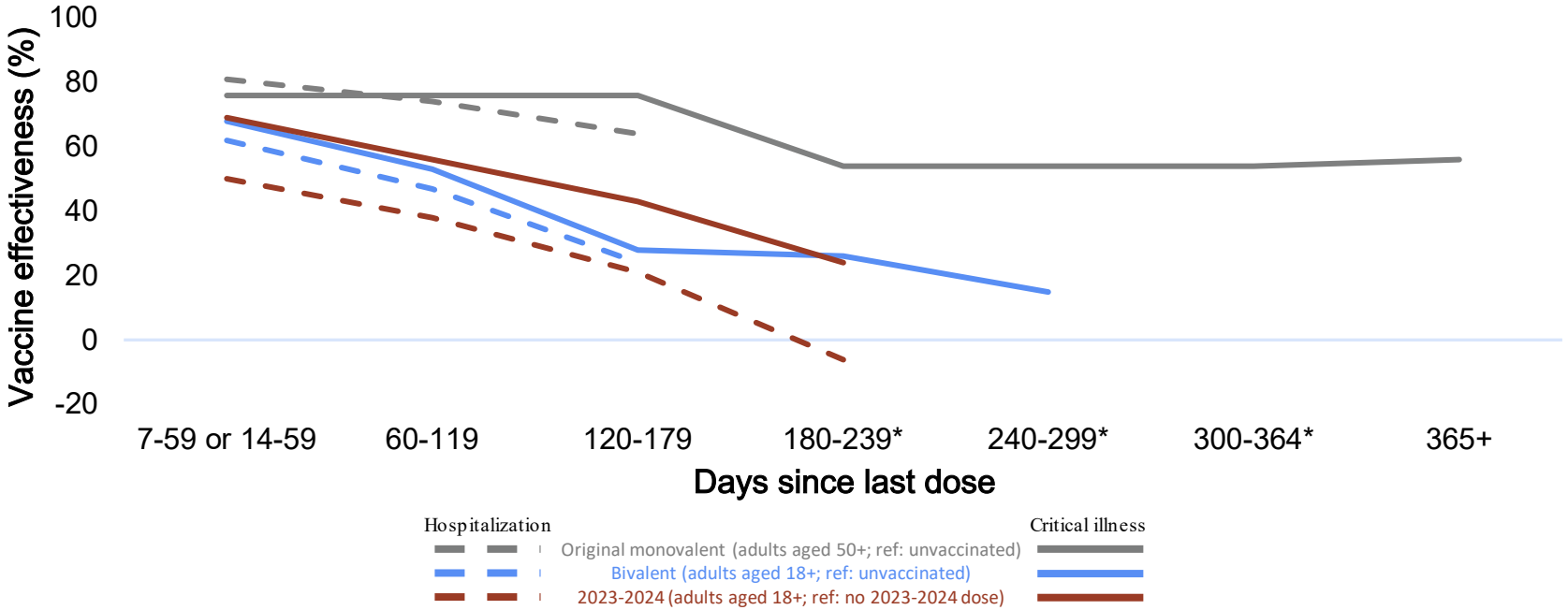
Conclusions: VE among those with immunocompromising conditions

- COVID-19 vaccines provided protection for both persons with and without immunocompromise.
- Patterns of COVID-19 VE in immunocompromised were different season-to-season, with generally lower VE compared to non-immunocompromised, but inconsistent waning patterns.
  - During 2023-2024, VE against hospitalization in immunocompromised waned to 0 by ~4-6 months.
- **This inconsistency is likely multifactorial, including:**
  - Heterogeneity among those classified as immunocompromised
  - Variation in underlying immunity and response to prior infection
  - Differing health behaviors (e.g., masking, social distancing) over time and by immunocompromise status

COVID-19 VE data to inform need for an additional COVID-19 vaccine dose for adults aged ≥65 years

COVID-19 VE against COVID-19-associated hospitalization wanes over time, but is more sustained against COVID-19-associated critical illness, though some waning is evident

Data from VISION and IVY showing VE by vaccine formulation of most recent dose.



Recipients of bivalent and 2023-2024 doses included in this analysis received a single dose of the most recent formulation.

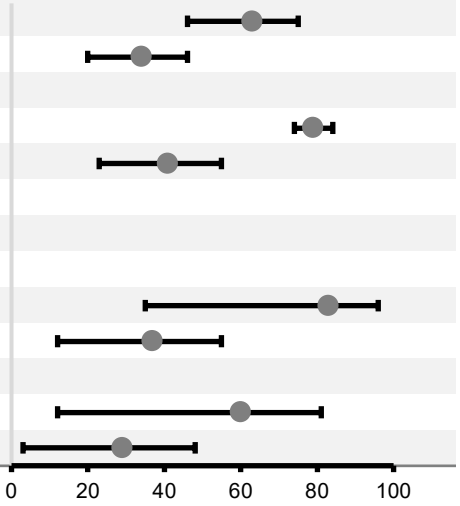
Sources: DeCuir, et al., MMWR 2023/ Link-Gelles, ACIP Slides, April 20, 2022; CDC unpublished data updated from Link-Gelles, ACIP Slides, June 23, 2023; CDC unpublished data updated from: Link-Gelles, ACIP Slides, June 27, 2024

* For original monovalent doses, VE for hospitalization was for 180-364 days from last dose combined. For 2023-2024 doses, VE for hospitalization was for ≥180 days combined, with a median of 228 days (IQR: 202-259).

IVY: Original monovalent vs. unvaccinated VE against COVID-19-associated hospitalization among immunocompetent adults ≥18 years, by Omicron sublineage period

December 2021-August 2022

SARS-CoV-2 variant period/ mRNA dosage pattern/ days since dose	Median (IQR) days from last dose	Vaccinated case-patients no./total no. (%)	Vaccinated control -patients, no./total no. (%)	Adjusted VE (95% CI)
BA.1/BA.2 period				
2 original monovalent doses				
14-150 days	111 (87–130)	62/771 (8)	79/514 (15)	**63 (46–75)**
>150 days	290 (241–351)	471/1,180 (40)	404/839 (48)	**34 (20–46)**
3 original monovalent doses				
7-120 days	80 (55–100)	167/876 (19)	393/828 (47)	**79 (74–84)**
>120 days	180 (154–208)	265/974 (27)	301/736 (41)	**41 (23–55)**
BA.4/BA.5 period				
2 original monovalent doses				
14-150 days	102 (77–123)	3/189 (2)	13/168 (8)	**83 (35–96)**
>150 days	430 (329–471)	128/314 (41)	168/323 (52)	**37 (12–55)**
3 original monovalent doses				
7-120 days	74 (33–110)	13/199 (7)	24/179 (13)	**60 (12–81)**
>120 days	237 (204–269)	219/405 (54)	208/363 (57)	**29 (3–48)**



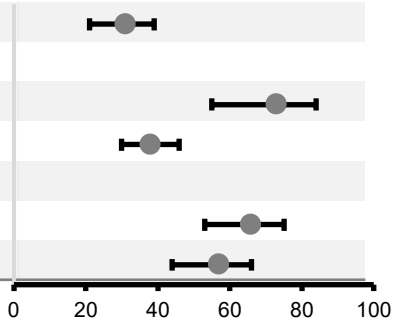
VE of an additional original monovalent dose provided increased protection during Omicron with similar waning patterns for 2 and 3 doses.

Surie and Bonnell, et al. MMWR, https://www.cdc.gov/mmwr/volumes/71/wr/mm7142a3.htm

VISION: Original monovalent vs. unvaccinated VE against COVID-19-associated *hospitalization* among immunocompetent adults ≥65 years

June-August 2022

SARSCoV-2 variant period/ mRNA dosage pattern/ days since dose	Total	SARSCoV-2-test-positive, N (%)	Median interval since last dose, days (IQR)	Adjusted VE (95% CI)
BA.4/BA.5 period				
Unvaccinated (ref)	2,971	743 (25)	--	
2 original monovalent doses				
14-149 days	77	14 (18)	80 (57-105)	--
≥150 days	2828	556 (20)	473 (422-503)	**31 (21-39)**
3 original monovalent doses				
7-119 days	289	26 (9)	72 (42-98)	**73 (55-84)**
≥120 days	4838	913 (19)	240 (211-266)	**38 (30-46)**
4 original monovalent doses				
7-59 days	765	89 (12)	38 (23-50)	**66 (53-75)**
≥60 days	1549	210 (14)	88 (75-105)	**57 (44-66)**



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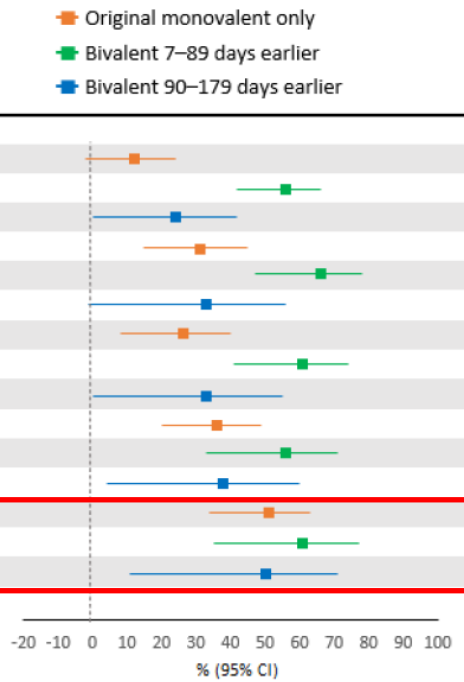
Link-Gelles, et al. JAMA Network Open, https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2802473, 2023

IVY: Original monovalent and bivalent vs. unvaccinated VE against COVID-19-associated *severe in-hospital outcomes* among adults aged ≥18 years without immunocompromising conditions

Group	Vaccination status	No. of vaccinated COVID-19 case-patients/total no. of COVID-19 case-patients (%)	No. of vaccinated control-patients/ total no. of control-patients (%)	Median days since last dose (IQR)	Absolute vaccine effectiveness, % (95% CI)
Severe in-hospital outcomes					
Supplemental oxygen therapy	Original monovalent only	1086/1492 (73)	2369/3251 (73)	419 (304–567)	12 (-2 to 24)
	Bivalent 7–89 days earlier	120/526 (23)	461/1343 (34)	52 (30–69)	56 (42 to 66)
	Bivalent 90–179 days earlier	163/569 (29)	376/1258 (30)	133 (111–153)	24 (0 to 42)
Advanced respiratory support	Original monovalent only	323/482 (67)	2369/3251 (73)	417 (297–562)	31 (15 to 45)
	Bivalent 7–89 days earlier	34/193 (18)	461/1343 (34)	52 (30–68)	66 (47 to 78)
	Bivalent 90–179 days earlier	52/211 (25)	376/1258 (30)	132 (111–152)	33 (-1 to 56)[a]
Acute organ failure	Original monovalent only	371/539 (69)	2380/3265 (73)	417 (297–563)	26 (8 to 40)
	Bivalent 7–89 days earlier	39/207 (19)	463/1348 (34)	52 (30–68)	61 (41 to 74)
	Bivalent 90–179 days earlier	54/222 (24)	376/1261 (30)	132 (111–152)	33 (0 to 55)[a]
ICU admission	Original monovalent only	281/434 (66)	2380/3265 (73)	417 (297–565)	36 (20 to 49)
	Bivalent 7–89 days earlier	38/191 (20)	463/1348 (34)	52 (30–68)	56 (33 to 71)
	Bivalent 90–179 days earlier	42/195 (22)	376/1261 (30)	132 (110–153)	38 (4 to 60)[a]
IMV or death	Original monovalent only	141/233 (61)	2380/3265 (73)	416 (297–564)	51 (34 to 63)
	Bivalent 7–89 days earlier	25/117 (21)	463/1348 (34)	52 (30–68)	61 (35 to 77)
	Bivalent 90–179 days earlier	23/115 (20)	376/1261 (30)	130 (111–153)	50 (11 to 71)[a]



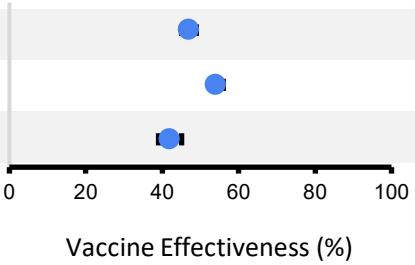
VE of COVID-19 vaccines was most durable against the most severe outcomes.

DeCuir et al., 2024, under review

Medicare: VE of *bivalent* vs. original monovalent COVID-19 vaccine against COVID-19-related *thromboembolic events* among immuno*competent* Medicare beneficiaries aged ≥65 years

September 2022 – March 2023

mRNA Dosage Pattern/time since dose	No. of beneficiaries	No. of COVID-19 related TE	Total no. of person-days	Median follow-up days contributed to category	Adjusted VE (95% CI)
Original monovalent vaccine dose (ref)	7,022,968	17,746	1,505,533,898	181	**Ref**
Bivalent dose	5,683,208	4,255	694,184,995	130	**47 (45–49)**
Bivalent dose 7-59 days earlier	350,021	1,492	294,516,234	53	**54 (51–56)**
Bivalent dose ≥60 days earlier	5,333,187	2,763	399,668,761	77	**42 (39–45)**



*A COVID-19–related thromboembolic event was defined as presence of an *International Classification of Disease, 10th Edition* (ICD-10) or common procedural terminology (CPT) code indicating ischemic stroke, venous thromboembolism, or myocardial infarction from 7 days before through 30 days after a medical claim indicating a COVID–19 diagnosis.

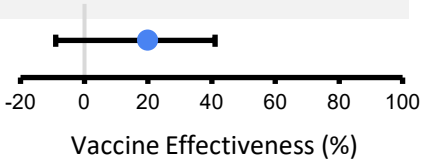
VE estimates adjusted for age, sex, race and ethnicity, geographic region, and calendar time. Updated from: Link-Gelles et al., MMWR, https://www.cdc.gov/mmwr/volumes/72/wr/mm7221a3.htm

TE = thromboembolic event

VISION: VE of *2 vs. 1 bivalent* doses against COVID-19-associated *hospitalization* among immuno*competent* adults aged ≥65 years

September 2022 – September 2023

mRNA Dosage Pattern	Total encounters	SARSCoV-2-test-positive, N (%)	Median interval since last dose, days (IQR)	Adjusted VE (95% CI)
Hospitalization, 2 vs. 1 bivalent dose (at least 4 months apart)				
1 bivalent dose (ref)	21,825	1,894 (8)	--	Ref
2 bivalent doses	599	50 (8)	50 (26-76)	**20 (-9 to 41)**



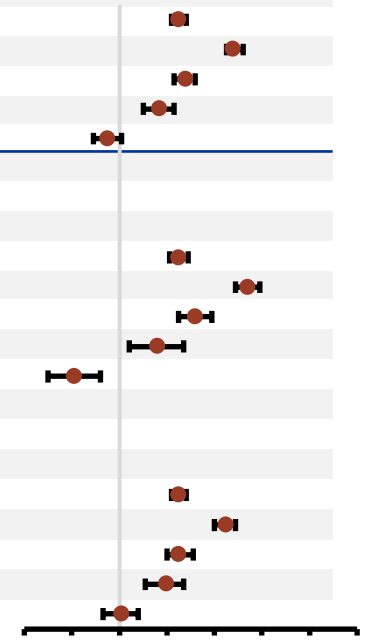
VE of an additional bivalent dose at least 4 months after the original bivalent dose appeared to provide some protection, though the confidence interval was wide and crossed 0.

CDC unpublished data

VISION: VE of *2023-2024 COVID-19 vaccine* against COVID-19-associated *ED/UC encounters* among immunocompetent adults aged ≥18 years, by age group

September 2023 – August 2024

Age group/2023 -2024 COVID-19 vaccination status/days since dose	Total encounters	SARSCoV-2-test-positive, N (%)	Median interval since last dose among vaccinated, days (IQR)	Adjusted VE (95% CI)
≥18 years				
No 2023-2024 COVID19 dose (ref)	266,148	29,492 (11)	750 (534-912)	Ref
2023-2024 COVID-19 dose, 7-299 days earlier	59,366	5,079 (9)	115 (60-185)	25 (22 to 28)
2023-2024 COVID-19 dose, 7-59 days earlier	14,801	1,112 (8)	34 (21-47)	48 (45 to 52)
2023-2024 COVID-19 dose, 60-119 days earlier	16,101	1,338 (8)	88 (73-103)	28 (23 to 32)
2023-2024 COVID-19 dose, 120-179 days earlier	12,636	766 (6)	147 (133-163)	17 (10 to 23)
2023-2024 COVID-19 dose, 180-299 days earlier	15,828	1,863 (12)	229 (203-258)	-5 (-11 to 1)
18-64 years				
No 2023-2024 COVID-19 dose (ref)	189,980	19,809 (10)	783 (617-928)	Ref
2023-2024 COVID-19 dose, 7-299 days earlier	20,563	1,545 (8)	112 (58-182)	25 (21 to 29)
2023-2024 COVID-19 dose, 7-59 days earlier	5,341	318 (6)	34 (20-47)	54 (49 to 59)
2023-2024 COVID-19 dose, 60-119 days earlier	5,566	366 (7)	88 (74-104)	32 (25 to 39)
2023-2024 COVID-19 dose, 120-179 days earlier	4,387	227 (5)	147 (133-163)	16 (4 to 27)
2023-2024 COVID-19 dose, 180-299 days earlier	5,269	634 (12)	228 (202-256)	-19 (-30 to -8)
≥65 years				
No 2023-2024 COVID-19 dose (ref)	76,168	9,683 (13)	661 (431-860)	Ref
2023-2024 COVID-19 dose, 7-299 days earlier	38,803	3,534 (9)	116 (61-187)	25 (22 to 28)
2023-2024 COVID-19 dose, 7-59 days earlier	9,460	794 (8)	34 (21-47)	45 (40 to 49)
2023-2024 COVID-19 dose, 60-119 days earlier	10,535	972 (9)	88 (73-103)	25 (20 to 31)
2023-2024 COVID-19 dose, 120-179 days earlier	8,249	539 (7)	148 (133-163)	20 (11 to 27)
2023-2024 COVID-19 dose, 180-299 days earlier	10,559	1,229 (12)	230 (203-259)	1 (-7 to 8)

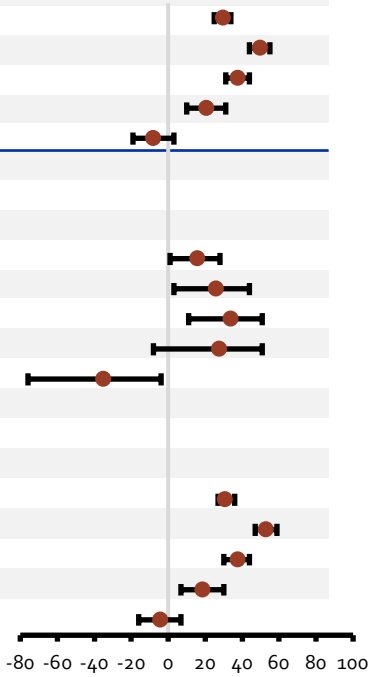


https://www.cdc.gov/mmwr/volumes/73/wr/mm7308a5.htm (Results updated with additional data since publication.) VE was calculated as (1 – odds ratio) x 100%, estimated using a test-negative case-control design, with the odds ratio adjusted for age, sex, race and ethnicity, geographic region, and calendar time.

VISION: VE of *2023-2024 COVID-19 vaccine* against COVID-19-associated *hospitalization* among immunocompetent adults aged ≥18 years, by age group

September 2023 – August 2024

Age group/2023 -2024 COVID-19 vaccination status/days since dose	Total encounters	SARS-CoV-2-test-positive, N (%)	Median interval since last dose among vaccinated, days (IQR)	Adjusted VE (95% CI)
≥18 years				
No 2023-2024 COVID-19 dose (ref)	83,596	8,025 (10)	728 (499-911)	**Ref**
2023-2024 COVID-19 dose, 7-299 days earlier	21,468	1,664 (8)	120 (62-189)	**30 (25 to 34)**
2023-2024 COVID-19 dose, 7-59 days earlier	5,095	382 (8)	34 (21-47)	**50 (44 to 55)**
2023-2024 COVID-19 dose, 60-119 days earlier	5,623	431 (8)	88 (74-104)	**38 (31 to 44)**
2023-2024 COVID-19 dose, 120-179 days earlier	4,754	268 (6)	148 (134-164)	**21 (10 to 31)**
2023-2024 COVID-19 dose, 180-299 days earlier	5,996	583 (10)	227 (202-257)	**-8 (-19 to 3)**
18-64 years				
No 2023-2024 COVID-19 dose (ref)	33,335	2,076 (6)	783 (600-934)	**Ref**
2023-2024 COVID-19 dose, 7-299 days earlier	3,694	201 (5)	116 (61-182)	**16 (1 to 28)**
2023-2024 COVID-19 dose, 7-59 days earlier	903	57 (6)	33 (21-45)	**26 (3 to 44)**
2023-2024 COVID-19 dose, 60-119 days earlier	999	47 (5)	89 (75-104)	**34 (11 to 51)**
2023-2024 COVID-19 dose, 120-179 days earlier	834	26 (3)	148 (135-164)	**28 (-8 to 51)***
2023-2024 COVID-19 dose, 180-299 days earlier	958	71 (7)	226 (199-254)	**-35 (-76 to -4)***
≥65 years				
No 2023-2024 COVID-19 dose (ref)	50,261	5,949 (12)	692 (460-890)	**Ref**
2023-2024 COVID-19 dose, 7-299 days earlier	17,774	1463 (8)	121 (63-190)	**31 (27 to 36)**
2023-2024 COVID-19 dose, 7-59 days earlier	4,192	325 (8)	34 (21-47)	**53 (47 to 59)**
2023-2024 COVID-19 dose, 60-119 days earlier	4,624	384 (8)	88 (74-104)	**38 (30 to 44)**
2023-2024 COVID-19 dose, 120-179 days earlier	3,920	242 (6)	148 (134-164)	**19 (7 to 30)**
2023-2024 COVID-19 dose, 180-299 days earlier	5,038	512 (10)	228 (202-257)	**-4 (-16 to 7)**



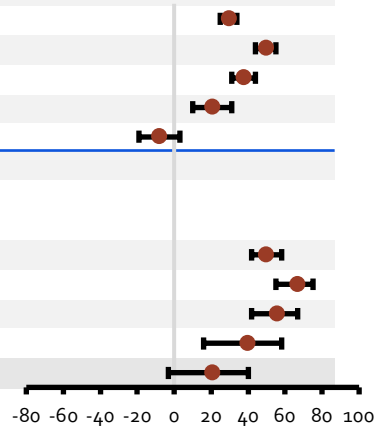
*Some estimates are imprecise, which might be due to a relatively small number of persons in each level of vaccination or case status. This imprecision indicates that the actual VE could be substantially different from the point estimate shown, and estimates should therefore be interpreted with caution. Additional data accrual could increase precision and allow more precise interpretation.

https://www.cdc.gov/mmwr/volumes/73/wr/mm7308a5.htm (Results updated with additional data since publication.) VE was calculated as (1 – odds ratio) x 100%, estimated using a test-negative case-control design, adjusted for age, sex, race and ethnicity, geographic region, and calendar time.

VISION: VE of *2023-2024 COVID-19 vaccine* against COVID-19-associated *hospitalization and critical illness* among adults aged ≥18 years

September 2023 – August 2024

Age group/2023 -2024 COVID-19 vaccination status/days since dose	Total encounters	SARS-CoV-2-test-positive, N (%)	Median interval since last dose among vaccinated, days (IQR)	Adjusted VE (95% CI)
≥18 years, hospitalization				
No 2023-2024 COVID-19 dose (ref)	83,596	8,025 (10)	728 (499-911)	**Ref**
2023-2024 COVID-19 dose, 7-299 days earlier	21,468	1,664 (8)	120 (62-189)	**30 (25 to 34)**
2023-2024 COVID-19 dose, 7-59 days earlier	5,095	382 (8)	34 (21-47)	**50 (44 to 55)**
2023-2024 COVID-19 dose, 60-119 days earlier	5,623	431 (8)	88 (74-104)	**38 (31 to 44)**
2023-2024 COVID-19 dose, 120-179 days earlier	4,754	268 (6)	148 (134-164)	**21 (10 to 31)**
2023-2024 COVID-19 dose, 180-299 days earlier	5,996	583 (10)	227 (202-257)	**-8 (-19 to 3)**
≥18 years, critical illness				
No 2023-2024 COVID-19 dose (ref)	76,965	1,394 (2)	730 (503-913)	**Ref**
2023-2024 COVID-19 dose, 7-299 days earlier	20,010	206 (1)	119 (62-187)	**50 (42-58)**
2023-2024 COVID-19 dose, 7-59 days earlier	4,758	45 (1)	34 (21-46)	**67 (55-75)**
2023-2024 COVID-19 dose, 60-119 days earlier	5,248	56 (1)	89 (74-104)	**56 (42-67)**
2023-2024 COVID-19 dose, 120-179 days earlier	4,523	37 (1)	149 (134-164)	**40 (16-58)**
2023-2024 COVID-19 dose, 180-299 days earlier	5,481	68 (1)	226 (201-256)	**21 (-3-40)**

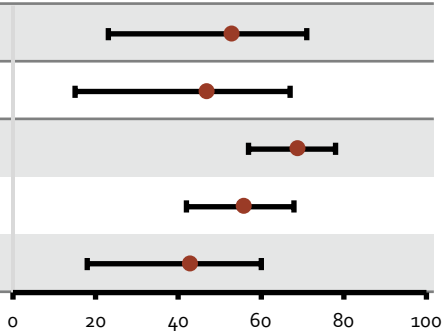


Additional methods, including definition of immunocompromised available: https://www.cdc.gov/mmwr/volumes/73/wr/mm7308a5.htm (Results updated with additional data since publication.) VE was calculated as (1 – odds ratio) x 100%, estimated using a test-negative case-control design, with odds ratios adjusted for age, sex, race and ethnicity, geographic region, and calendar time.

* Some estimates are imprecise, which might be due to a relatively small number of persons in each level of vaccination or case status. This imprecision indicates that the actual VE could be substantially different from the point estimate shown, and estimates should therefore be interpreted with caution. Additional data accrual could increase precision and allow more precise interpretation.

Effectiveness of 2023-2024 COVID-19 vaccines against COVID-19-associated *critical outcomes* in immunocompetent adults ≥65 years, Medicare and VISION data

Outcome	Analysis	Vaccine effectiveness, % (95% CI)
Thromboembolic events*	Medicare, ESKD adults ≥65y, 2023-2024 vaccine, median follow-up days=74	53 (23-71)
Death	Medicare, ESKD adults ≥65y, 2023-2024 vaccine, median follow-up days=104	47 (15-67)
ICU admission/death	VISION, adults ≥65y, 2023-2024 vaccine, median follow-up days=34	69 (57-78)
	VISION, adults ≥65y, 2023-2024 vaccine, median follow-up days=89	56 (42-68)
	VISION, adults ≥65y, 2023-2024 vaccine, median follow-up days=149	43 (18-60)



Abbreviations: ESKD = end stage kidney disease; y = years; IMV = invasive mechanical ventilation; ICU = intensive care unit

*A COVID-19–related thromboembolic event was defined as presence of an *International Classification of Disease, 10th Edition* (ICD-10) or common procedural terminology (CPT) code indicating ischemic stroke, venous thromboembolism, or myocardial infarction from 7 days before through 30 days after a medical claim indicating a COVID–19 diagnosis.

CDC unpublished data. Medicare analysis includes only Medicare fee-for-service beneficiaries.

Conclusions: COVID-19 VE in adults ≥65 years

- VE findings should be interpreted as the added benefit provided by COVID-19 vaccination in a population with a high prevalence of vaccine- and infection-induced immunity at the start of the 2023-2024 respiratory virus season.
- 2023-2024 COVID-19 vaccination provided increased protection against COVID-19-associated ED/UC visits and hospitalizations compared to no 2023-2024 vaccine dose.
  - Protection waned to 0 against COVID-19-associated ED/UC visits and hospitalization by ~4-6 months.
- Waning patterns of 2023-2024 COVID-19 vaccines appeared similar to previous COVID-19 vaccine formulations; most durable protection appeared to be for critical illness
  - VE against critical illness remained above 40% at 5 months after vaccination among those ≥65 years
- As with previous COVID-19 vaccine formulations, effectiveness was similar across age groups
- Data from prior seasons show that an additional dose of the same formula appeared to provide additional protection.

Acknowledgements

CDC

Amanda B. Payne
Katherine E. Fleming-Dutra
Lakshmi Panagiotakopoulos
Lauren Roper

Amadea Britton
Allison Ciesla
Fatimah Dawood
Jennifer DeCuir
Monica Dickerson
Sascha Ellington
Shikha Garg
Amber Kautz
Nathaniel M. Lewis
Kevin Ma
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Jarrod M. Mosier
Ithan D. Peltan
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