New Vaccines in Development

May 10, 2023
Dr. Melinda Wharton
Phyllis Arthur

Session Agenda

• Welcome – Dr. Melinda Wharton
• Focus on RSV
  • Impact of RSV Disease in Adults
    • Dr. Katherine Fleming-Dutra, Medical Officer, CDC
  • Preventive Vaccines in late-stage development – Intro – Phyllis Arthur
    • Dr. Leonard Friedland, VP, Scientific Affairs and Public Health, Vaccines, GSK
    • Dr. Annaliesa Anderson, SVP, Head of Vaccine Research & Development, Pfizer
    • Dr. Christine Shaw, VP, Portfolio Head, Respiratory Vaccines, Moderna
  • Respiratory syncytial virus (RSV) illness prevention: Prevention products under ACIP consideration
    • Dr. Michael Melgar, Medical Officer, CDC
  • Q&A
• Vaccines & Immunizations in the Pipeline – Phyllis Arthur
Epidemiology of Respiratory Syncytial Virus (RSV)

May 10, 2023
Katherine Fleming-Dutra, MD
Co-Lead, ACIP Work Group for Maternal/Pediatric RSV
National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention

RSV is the leading cause of hospitalization in U.S.
infants

- Most (68%) infants are infected in the first
  year of life and nearly all (97%) by age 2
- 79% of children hospitalized with RSV
  aged <2 years had no underlying medical
  conditions
- 2-3% of all infants will be hospitalized for
  RSV

Each year among U.S. children aged less than 5 years, RSV is associated with...

- **100-300** deaths
- **58,000-80,000** hospitalizations
- **~520,000** emergency department visits
- **~1,500,000** outpatient visits

1Thompson et al, JAMA, 2003; 2Hansen et al, JAMA Network Open, 2022; 3Hall et al, NEJM, 2009; 4Rha et al., Peds, 2020; 5McLaughlin et al, J Infect Dis, 2022; [*estimate 80,000 hospitalizations in infants <1y]*

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Estimated annual rate of RSV hospitalizations among children aged <5 and adults aged ≥18 years, United States

![Graph showing annual hospitalizations per 1,000 persons by age group and year.](#)

New Vaccine Surveillance Network, 2016–2020
Presented at ACIP meeting; McMorrow MA; 2022 Jun 22–23; Atlanta, GA.  
[https://www.cdc.gov/vaccines/acip/meetings/index.html](https://www.cdc.gov/vaccines/acip/meetings/index.html)

RSV-NET, 2018–2020
Presented at 12th International RSV Symposium; Havers FP; 2022 Sep 29 – Oct 2; Belfast, United Kingdom.
Among adults ≥65 years of age in the United States, RSV is associated with*...

*There is substantial uncertainty in burden of disease, reflected in wide ranges here.

6,000–10,0001–3 deaths/year

60,000–160,0004–8 hospitalizations/year

0.9–1.4 million5 medical encounters/year

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8. CDC RSV-NET data 2016–2020 (unpublished)

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Adults with certain underlying medical conditions are at higher risk of RSV hospitalization

- Immune compromise, especially hematopoietic stem cell transplant and solid organ transplant
- Cardiovascular disease (e.g., congestive heart failure)
- Diabetes mellitus
- Chronic obstructive pulmonary disease (COPD)
- Asthma

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During 2011-2020, RSV circulation was highly seasonal in the U.S. with predictable peak activity during December – February annually.

RSV Hospitalizations in adults ≥65 by season: RSV-NET 2017–2020

RSV-NET: unpublished data. Surveillance for 2015-16 through 2019-20 seasons were conducted from October – April; for 2020-21 and 2021-22 surveillance was conducted continuously from October – September. Data shown for 2022-23 season is from October – December 2022.
RSV Hospitalizations in adults ≥65 by season: RSV-NET 2017–2023

COVID-19 pandemic affected RSV in 2020-21, 2021-22, and 2022-23

Acknowledgements

- Michael Melgar
- Amadea Britton
- Fiona Havers
- Jefferson Jones
- Meredith McMorrow
- Mila Prill
- Lauren Roper
- Diya Surie
Focus on RSV
RSV Vaccines in Late-Stage Development

- Dr. Leonard Friedland, VP, Scientific Affairs and Public Health, Vaccines, GSK
- Dr. Annaliesa Anderson, SVP, Head of Vaccine Research & Development, Pfizer
- Dr. Christine Shaw, VP, Portfolio Head, Respiratory Vaccines, Moderna
- Dr. Michael Melgar, Medical Officer, CDC

- Q&A

GSK’s RSV Adult Vaccine

Leonard Friedland, MD
Vice President, Director Scientific Affairs and Public Health, GSK

National Adult and Influenza Immunization Summit
Session on RSV Vaccines
May 10, 2023
This presentation is provided in response to the request from the organizers of NAIIS.

This response was developed according to the principles of evidence-based medicine and, therefore, references may not be all-inclusive.

Disclosure: Leonard Friedland is employed by GSK where he is a vaccine research scientist.

**AREXVY (Respiratory Syncytial Virus Vaccine, Adjuvanted)**  
FDA Approval received May 3, 2023

<table>
<thead>
<tr>
<th>Indication</th>
<th>AREXVY is a vaccine indicated for active immunization for the prevention of lower respiratory tract disease (LRTD) caused by respiratory syncytial virus in individuals 60 years of age and older.</th>
</tr>
</thead>
</table>
| Dosage & Administration | For intramuscular injection only.  
Administer a single dose (0.5 mL) as an intramuscular injection. |

Prescribing Information for AREXVY.
**AREXVY (Respiratory Syncytial Virus Vaccine, Adjuvanted)**

Mechanism of Action: AREXVY induces an immune response against RSVpreF3 that protects against LRTD caused by RSV.1

AREXVY Description

- **RSVPreF3 antigen (120 µg)**
- **AS01E adjuvant system**

1. Prescribing Information for AREXVY.


*AS01E adjuvant system is composed of two immunostimulants (MPL [3-O-desacyl-4'-monophosphoryl lipid A] and QS-21 [a saponin purified from plant extract Quillaja saponaria Molina]).

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**Ongoing Phase 3 clinical efficacy trial**

A randomized, placebo-controlled, observer-blind, multi-country efficacy study

<table>
<thead>
<tr>
<th>RSV season 1</th>
<th>RSV season 2</th>
<th>RSV season 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Randomization (1:1)</strong></td>
<td><strong>Randomization (1:1)</strong></td>
<td><strong>Randomization (1:1)</strong></td>
</tr>
<tr>
<td>AREXVY group</td>
<td>RSV annual group</td>
<td>RSV 1 dose group</td>
</tr>
<tr>
<td><strong>N = 12,467</strong></td>
<td><strong>RSV season 1</strong></td>
<td><strong>RSV season 2</strong></td>
</tr>
<tr>
<td>Placebo group</td>
<td><strong>N = 12,499</strong></td>
<td><strong>N = 12,499</strong></td>
</tr>
</tbody>
</table>

The primary objective was to demonstrate the efficacy of AREXVY in the prevention of a first episode of confirmed RSV-A and/or B-associated LRTD during the first season.

1. Prescribing Information for AREXVY.

Confirmed RSV cases were determined by quantitative Reverse Transcription Polymerase Chain Reaction (qRT-PCR) on a nasopharyngeal swab. LRTD was defined based on the following criteria: the participant must have experienced at least 2 lower respiratory symptoms/signs, including at least 1 lower respiratory sign for at least 24 hours, or experienced at least 3 lower respiratory symptoms for at least 24 hours. Lower respiratory signs included: new or increased wheezing, crackles/rhonchi, respiratory rate ≥20 respirations/min, low or decreased oxygen saturation (O2 saturation <95% or ≤90% if baseline is <95%), need for oxygen supplementation.

LRTD = lower respiratory tract disease; RSV = respiratory syncytial virus; RSVPreF3 = recombinant respiratory syncytial virus glycoprotein F stabilized in pre-fusion conformation.
Vaccine efficacy in prevention of RSV-LRTD (primary endpoint) and severe RSV-LRTD

- Prescribing Information for AREXVY
  Confirmed RSV cases were determined by quantitative Reverse Transcription Polymerase Chain Reaction (qRT-PCR) on a nasopharyngeal swab. LRTD was defined based on the following criteria: the participant must have experienced at least 2 lower respiratory symptoms/signs, including at least 1 lower respiratory sign for at least 24 hours, or experienced at least 3 lower respiratory symptoms at least 24 hours. Lower respiratory symptoms included: new or increased sputum, new or increased cough, new or increased dyspnea (shortness of breath). Lower respiratory signs included: new or increased wheezing, crackles/rhonchi, respiratory rate ≥ 20 respirations/min, low or decreased oxygen saturation (O2 saturation <95% or ≤ 90% if baseline is <95%), need for oxygen supplementation.

- Severe LRTD was defined as an RT-PCR confirmed RSV-associated LRTD with at least 2 lower respiratory signs, or as an RT-PCR confirmed RSV-associated LRTD episode preventing normal, everyday activities.

CI = confidence interval; LRTD = lower respiratory tract disease; RT-PCR = reverse-transcriptase polymerase chain reaction; RSV = respiratory syncytial virus

Vaccine efficacy in age subgroup 70-79 years and for participants with at least one comorbidity of interest

- Prescribing Information for AREXVY
  Confirmed RSV cases were determined by quantitative Reverse Transcription Polymerase Chain Reaction (qRT-PCR) on a nasopharyngeal swab. LRTD was defined based on the following criteria: the participant must have experienced at least 2 lower respiratory symptoms/signs, including at least 1 lower respiratory sign for at least 24 hours, or experienced at least 3 lower respiratory symptoms at least 24 hours. Lower respiratory symptoms included: new or increased sputum, new or increased cough, new or increased dyspnea (shortness of breath). Lower respiratory signs included: new or increased wheezing, crackles/rhonchi, respiratory rate ≥ 20 respirations/min, low or decreased oxygen saturation (O2 saturation <95% or ≤ 90% if baseline is <95%), need for oxygen supplementation.

- *Comorbidities included COPD, asthma, any chronic respiratory/pulmonary disease, diabetes type 1 or type 2, congestive heart failure, advanced liver or renal disease.

CI = confidence interval; LRTD = lower respiratory tract disease; RT-PCR = reverse-transcriptase polymerase chain reaction; RSV = respiratory syncytial virus; YOA = year of age
Vaccine efficacy against RSV A- and RSV B-associated LRTD disease

Vaccine efficacy, % (CI)

RSV-B LRTD

RSV-A LRTD

80.9% (95% CI, 49.4-94.3)

84.6% (95% CI, 49.4-94.3)

Safety and reactogenicity results

Solicited AEs (Any & Grade 3) reported within 4 days of vaccination (Solicited Safety Set)

Mean duration (solicited AEs): 1–2 days

Most frequent local AE

Pain: 60.9%

Most frequent systemic AE

Fatigue: 33.6%

1. Prescribing Information for AREXVY.

Confirmed RSV cases were determined by quantitative Reverse Transcription Polymerase Chain Reaction (qRT-PCR) on a nasopharyngeal swab. A LRTD was defined based on the following criteria: the participant must have experienced at least 2 lower respiratory symptoms/signs, including at least 1 lower respiratory sign for at least 24 hours, or experienced at least 3 lower respiratory symptoms for at least 24 hours. Lower respiratory symptoms included: new or increased sputum, new or increased cough, new or increased dyspnea (shortness of breath). Lower respiratory signs included: new or increased wheezing, crackles/rhonchi, respiratory rate \( \geq \) 20 respirations/min, low or decreased oxygen saturation (O2 saturation <95% or \( \leq \) 90% if baseline is <95%), need for oxygen supplementation.

CI = confidence interval; LRTD = lower respiratory tract disease; RSV = respiratory syncytial virus.
AREXVY (Respiratory Syncytial Virus Vaccine, Adjuvanted)

How Supplied

AREXVY is supplied as 2 components: A single-dose vial of lyophilized antigen component (powder) and a single-dose vial of adjuvant suspension component (liquid) (packaged without syringes or needles).

Dosage and Administration

Administer a single dose (0.5 mL) as an intramuscular injection.

Storage

Storage before reconstitution: Store refrigerated between 2°C and 8°C (36°F and 46°F). Store in the original package in order to protect vials from light. Do not freeze. Discard if the adjuvant suspension component has been frozen.

Storage after reconstitution: Administer immediately or store in the refrigerator between 2°C and 8°C (36°F to 46°F) or at room temperature (up to 25°C (77°F)) for up to 4 hours prior to use. Protect vials from light. Discard reconstituted vaccine if not used within 4 hours. Do not freeze. Discard if the vaccine has been frozen.

Presentation

<table>
<thead>
<tr>
<th>Presentation</th>
<th>Carton NDC Number</th>
<th>Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer carton of 10 doses</td>
<td>58160-848-11</td>
<td>Adjuvant Suspension Component (liquid) 10 vials, NDC 58160-744-03</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lyophilized Antigen Component (powder) 10 vials, NDC 58160-723-03</td>
</tr>
</tbody>
</table>

1. Prescribing Information for AREXVY

Respiratory syncytial virus (RSV) illness prevention: Prevention products under ACIP consideration

May 10, 2023
Michael Melgar, MD

Co-Lead, ACIP Work Group for RSV in Adults
National Center for Immunization and Respiratory Diseases
Centers for Disease Control and Prevention
Disclosures

- Dr. Melgar has no financial relationship(s) with companies whose primary business is producing, marketing, selling, reselling, or distributing healthcare products used by or on patients
- The findings and conclusions in this presentation are those of the author and do not necessarily represent the official position of the Centers for Disease Control and Prevention

Maternal RSV vaccination
Maternal vaccination: Policy question being considered by ACIP

- Should the Pfizer RSV bivalent prefusion F vaccine be recommended for all pregnant people as a single dose given at 24–36 weeks gestation?

- This recommendation would be considered in the context of the current standard of care for prevention of RSV disease in infants at the time of ACIP vote.

Key consideration for RSV bivalent prefusion F vaccine: Number of total lifetime doses

- All pregnant people in the trial received their first and only dose of RSV vaccine

- Currently there are no data available on
  - Efficacy of the first lifetime dose during subsequent pregnancies
  - Safety of additional doses given in subsequent pregnancies
Next steps for Pfizer RSV bivalent prefusion F vaccine (tentative)

- June 2023
  - Summary of GRADE
  - Cost effectiveness analysis
  - EtR
- October 2023
  - ACIP vote (if product is licensed by this time)

Older adult RSV vaccination
Older adult vaccination:  
Policy question being considered by ACIP

- Should vaccination with **GSK RSVpreF3 vaccine** (120 μg antigen + AS01E adjuvant, 1 dose IM) be recommended for all older adults*?

- Should vaccination with **Pfizer RSVpreF vaccine** (120 μg antigen, 1 dose IM) be recommended for all older adults*?

*Age ≥60 years? Age ≥65 years? Other?

### Phase 3 trial vaccine efficacy estimates, by age group

<table>
<thead>
<tr>
<th>Age in years</th>
<th>GSK: RSV LRTD</th>
<th>Pfizer: RSV LRTI; ≥2 symptoms</th>
<th>Pfizer: RSV LRTI; ≥3 symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VE (%) (96.95% CI)b</td>
<td>VE (%) (96.66% CI)d</td>
<td>VE (%) (96.66% CI)d</td>
</tr>
<tr>
<td></td>
<td>Case split: vaccine/placebo</td>
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<tr>
<td>≥60</td>
<td>82.6 (57.9, 94.1) 7/40</td>
<td>66.7 (28.8, 85.8) 11/33</td>
<td>85.7 (32.0, 98.7) 2/14</td>
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<td>60–69</td>
<td>81.0 (43.6, 95.3)e 4/21</td>
<td>57.9 (–7.4, 85.3) 8/19</td>
<td>77.8 (–18.7, 98.1) 2/9</td>
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<tr>
<td>70–79</td>
<td>93.8 (60.2, 99.9)e 1/16</td>
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<td>100.0 (–573.8, 100.0) 0/2</td>
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<tr>
<td>≥80</td>
<td>33.8 (–477.7, 94.5) 2/3</td>
<td>80.0 (–104.3, 99.7) 1/5</td>
<td>100.0 (–191.2, 100.0) 0/3</td>
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*Lower respiratory tract disease: ≥2 lower respiratory symptoms/signs for ≥24 hours including ≥1 lower respiratory sign OR ≥3 lower respiratory symptoms for ≥24 hours. Events diagnosed on or after day 15 post-injection (vaccine or placebo). Median follow up 6.7 months.

Efficacy estimated using the Poisson method, adjusted for age and geographic location. Age group-specific efficacy adjusted for geographic location only.

*Lower respiratory tract illness: ≥2 (or ≥3) lower respiratory symptoms/signs lasting more than 1 day. Events diagnosed on or after day 15 post-injection (vaccine or placebo). Mean duration of surveillance 7 months.

Efficacy based on case count ratio. Confidence interval based on the conditional exact test based on the binomial distribution, adjusted by Pocock error spending.

*95% confidence interval. Not adjusted for multiplicity and cannot be used in place of a hypothesis test.


### Phase 3 trial vaccine efficacy estimates, by age group

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<th>Age in years</th>
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*Efficacy estimated using the Poisson method, adjusted for age and geographic location. Age group-specific efficacy adjusted for geographic location only.  
*Lower respiratory tract illness: ≥2 (or ≥3) lower respiratory symptoms/signs lasting more than 1 day. Events diagnosed on or after day 15 post-injection (vaccine or placebo). Mean duration of surveillance 7 months.  
*Efficacy based on case count ratio. Confidence interval based on the conditional exact test based on the binomial distribution, adjusted by Pocock error spending.  
*95% confidence interval. Not adjusted for multiplicity and cannot be used in place of a hypothesis test.


### Phase 3 trial vaccine efficacy estimates, by risk group

<table>
<thead>
<tr>
<th>Population</th>
<th>GSK: RSV LRTD&lt;sup&gt;a&lt;/sup&gt; VE (%) (96.95% CI)&lt;sup&gt;b&lt;/sup&gt; Case split: vaccine/placebo</th>
<th>Pfizer: RSV LRTI&lt;sup&gt;c&lt;/sup&gt;; ≥2 symptoms VE (%) (96.66% CI)&lt;sup&gt;d&lt;/sup&gt; Case split: vaccine/placebo</th>
<th>Pfizer: RSV LRTI&lt;sup&gt;c&lt;/sup&gt;; ≥3 symptoms VE (%) (96.66% CI)&lt;sup&gt;d&lt;/sup&gt; Case split: vaccine/placebo</th>
</tr>
</thead>
<tbody>
<tr>
<td>All participants</td>
<td>82.6 (57.9, 94.1) 7/40</td>
<td>66.7 (28.8, 85.8) 11/33</td>
<td>85.7 (32.0, 98.7) 2/14</td>
</tr>
<tr>
<td>≥1 high-risk condition</td>
<td>94.6 (65.9, 99.9)&lt;sup&gt;e&lt;/sup&gt; 1/18</td>
<td>62.5 (–8.4, 89.1) 6/16</td>
<td>75.0 (–39.1, 97.9) 2/8</td>
</tr>
<tr>
<td>Pre-frail&lt;sup&gt;f&lt;/sup&gt;</td>
<td>92.9 (53.4, 99.8)&lt;sup&gt;e&lt;/sup&gt; 1/14</td>
<td>Not evaluated</td>
<td>Not evaluated</td>
</tr>
<tr>
<td>Frail&lt;sup&gt;f&lt;/sup&gt;</td>
<td>14.9 (–6638.7, 98.9)&lt;sup&gt;e&lt;/sup&gt; 1/1</td>
<td>Not evaluated</td>
<td>Not evaluated</td>
</tr>
</tbody>
</table>

*Lower respiratory tract disease: ≥2 lower respiratory symptoms/signs for ≥24 hours including ≥1 lower respiratory sign OR ≥3 lower respiratory symptoms for ≥24 hours. Events diagnosed on or after day 15 post-injection (vaccine or placebo). Median follow up 6.7 months.  
*Efficacy estimated using the Poisson method, adjusted for age and geographic location.  
*Lower respiratory tract illness: ≥2 (or ≥3) lower respiratory symptoms/signs lasting more than 1 day. Events diagnosed on or after day 15 post-injection (vaccine or placebo). Mean duration of surveillance 7 months.  
*Efficacy based on case count ratio. Confidence interval based on the conditional exact test based on the binomial distribution, adjusted by Pocock error spending.  
*95% confidence interval. Not adjusted for multiplicity and cannot be used in place of a hypothesis test.  
*Baseline frailty status was assessed with use of a gait speed test. Walking speed <0.4 m/s or inability to complete test indicated frail status. Walking speed <0.9 m/s indicated prefrail status.
Vaccine efficacy may be higher against more severe outcomes

<table>
<thead>
<tr>
<th>GSK RSVpreF3</th>
<th>Pfizer RSVpreF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td><strong>Efficacy point estimate</strong></td>
</tr>
<tr>
<td>RSV acute respiratory illness&lt;sup&gt;a&lt;/sup&gt;</td>
<td>71.7%</td>
</tr>
<tr>
<td>RSV lower respiratory tract disease&lt;sup&gt;c&lt;/sup&gt;</td>
<td>82.6%</td>
</tr>
<tr>
<td>RSV lower respiratory tract disease with ≥2 lower respiratory signs&lt;sup&gt;e&lt;/sup&gt; or assessed as ‘severe’ by investigator</td>
<td>94.1%</td>
</tr>
</tbody>
</table>

<sup>a</sup> Acute respiratory illness: ≥2 respiratory symptoms/signs for ≥24 hours OR ≥1 respiratory symptom/sign +1 systemic sign for ≥24 hours

<sup>b</sup> Acute respiratory illness: ≥1 respiratory symptom lasting more than 1 day

<sup>c</sup> Lower respiratory tract disease: ≥2 lower respiratory symptoms/signs for ≥24 hours including ≥1 lower respiratory sign OR ≥3 lower respiratory symptoms for ≥24 hours

<sup>d</sup> Lower respiratory tract illness: ARI with ≥2 or ≥3 lower respiratory signs/symptoms

Cases of Guillain Barré syndrome (GBS) were reported after vaccination with both investigational vaccines

<table>
<thead>
<tr>
<th>GSK</th>
<th>Pfizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cases of GBS observed in main phase 3 trial (N=24,966 participants, 12,467 received investigational vaccine)</td>
<td>2 cases of GBS (1 case Miller-Fisher syndrome) observed in main phase 3 trial (N=34,283 participants, 17,214 received investigational vaccine)</td>
</tr>
<tr>
<td>1 case of GBS was reported in a randomized open-label study evaluating safety &amp; long-term immunogenicity of different revaccination intervals (N=1,633 vaccinees) • Onset 9 days after receipt of investigational vaccine</td>
<td>• Onset 8 and 9 days after receipt of investigational vaccine</td>
</tr>
</tbody>
</table>

Total: 1 case of GBS / ~15,000 older adults who received the investigational vaccine
Total: 2 cases of GBS / ~20,000 older adults who received the investigational vaccine
**GSK: Acute Disseminated Encephalomyelitis (ADEM)**

- 71-year-old male (Co-Ad group):
  - Found lying on the floor shaking and shivering requiring hospitalization with a blood glucose reading of 1.4mmol/L seven days post co-administration of the study vaccines.
  - Reported as ADEM based on CT scan, Brighton Collaboration Level 3
  - The participant died 22 days after co-administration of the study vaccines.

- 71-year-old female (Co-Ad group):
  - Medical history of hyperlipidemia and hypertension
  - Tiredness and headaches with intermittent double vision, forgetfulness, confusion, hand shaking, gait ataxia and clumsiness 22 days after the co-administration of the study vaccines
  - Reported as ADEM based on symptomatology, Brighton Collaboration Level 3
  - The participant demonstrated improvement, but the outcome was reported as not resolved by the time of receipt of the study report.

**ACIP interpretation: Efficacy and safety**

- **GSK**’s adjuvanted RSVpreF3 and **Pfizer**’s bivalent RSVpreF vaccines both have demonstrated significant efficacy against lower respiratory tract illness caused by RSV among older adults
  - Trials underpowered to show efficacy against RSV hospitalization
  - Trials underpowered to show efficacy among adults at highest risk of severe RSV disease
- Cases of inflammatory neurologic events have been observed among recipients of each investigational vaccine
- If licensed, post licensure surveillance for both safety and vaccine effectiveness will be critical

https://www.fda.gov/media/165731/download
ACIP interpretation:
Duration of protection from RSV vaccination among older adults is unknown

- Trials are ongoing, with multiple years of follow up planned
- There is no established immunologic correlate of protection for RSV
- Need for revaccination, and the time interval, are yet to be determined

ACIP interpretation:
If approved, uptake of a novel RSV vaccine among older adults will depend on patient and clinician education

- Adult immunization schedule is becoming more complex
  - Primary series only: pneumococcal vaccines, recombinant zoster vaccine
  - Revaccination: influenza vaccine, COVID-19 vaccine, Td/Tdap, RSV?
- RSV is less well known as a pathogen in adults, compared with influenza* and SARS-CoV-2
- Safety and efficacy of coadministration of influenza, COVID-19, and RSV vaccines should be established

Acknowledgements

- Amadea Britton
- Katherine Fleming-Dutra
- Fiona Havers
- Jefferson Jones
- Meredith McMorrow
- Mila Prill
- Lauren Roper
- Diya Surie

For more information, contact CDC
1-800-CDC-INFO (232-4636)

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.
Questions

Vaccines and Immunizations Pipeline Review
## Vaccines

### Vaccines in Late-Stage Development – Filed with FDA (BLA)

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Products</th>
<th>Under FDA Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory Syncytial Virus (RSV)</td>
<td>2</td>
<td>Maternal and older adult indications – slides follow</td>
</tr>
<tr>
<td>Men ABCWY</td>
<td>2</td>
<td>Adding conjugated Meningitis B vaccine to the ACWY vaccine for adolescents</td>
</tr>
<tr>
<td>Chikungunya</td>
<td>2</td>
<td>Live-attenuated vaccine; Travel and possible use for outbreak control in areas of the U.S.</td>
</tr>
<tr>
<td>Dengue</td>
<td>1</td>
<td>Live-attenuated vaccine; Travel and possible pediatric use in endemic areas in the U.S.</td>
</tr>
</tbody>
</table>
This summer we anticipate that the FDA will conduct a meeting of their Advisory Committee to determine the best variants to include in the current Covid vaccines in the fall. These potentially updated vaccines would be used for both primary and booster vaccination. The current vaccine makers (Pfizer, Moderna and Novavax) would then produce and submit for FDA review these updated vaccines in time for the fall influenza season. Once approved, the CDC Advisory Committee on Immunization Practices (ACIP) would issue a set of recommendations advising clinicians and the public on the best use and appropriate populations who should get vaccinated / boosted.

### Vaccines in Late-Stage Development – COVID Updated Vaccines

| COVID / SARS CoV-2 | 3 | - This summer we anticipate that the FDA will conduct a meeting of their Advisory Committee to determine the best variants to include in the current Covid vaccines in the fall.  
|-|---|---|
|  |  | - These potentially updated vaccines would be used for both primary and booster vaccination.  
|  |  | - The current vaccine makers (Pfizer, Moderna and Novavax) would then produce and submit for FDA review these updated vaccines in time for the fall influenza season.  
|  |  | - Once approved, the CDC Advisory Committee on Immunization Practices (ACIP) would issue a set of recommendations advising clinicians and the public on the best use and appropriate populations who should get vaccinated / boosted.  

### Vaccines in Late-Stage (Phase III) Development

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Products</th>
<th>Phase III or FDA Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>SARS CoV-2</td>
<td>4</td>
<td>Multiple vaccines using other platform technologies; partnership between US and Indian company</td>
</tr>
<tr>
<td>RSV</td>
<td>4</td>
<td>Multiple types of vaccines in development for adults and pregnant women, including mRNA and other novel platforms</td>
</tr>
<tr>
<td>Seasonal Influenza</td>
<td>2</td>
<td>New mRNA and protein-based vaccines for seasonal flu prevention; potentially available for this upcoming flu season</td>
</tr>
<tr>
<td>Chikungunya</td>
<td>1</td>
<td>Live-attenuated vaccine for travelers</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>1</td>
<td>21-valent pneumonia conjugate vaccine for older adults</td>
</tr>
<tr>
<td>Cytomegalovirus (CMV)</td>
<td>1</td>
<td>mRNA based vaccine for healthy young adult women 16-40 to prevent disease in the mother and newborn</td>
</tr>
<tr>
<td>Ebola / Marburg</td>
<td>1</td>
<td>Outbreak response in Africa and protection from known bio-threat for the military</td>
</tr>
<tr>
<td>Lyme Disease</td>
<td>1</td>
<td>Partnership between two companies; multivalent, recombinant; potentially children and adults</td>
</tr>
</tbody>
</table>
### Vaccines in Phase II Development – Part 1

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Products</th>
<th>Phase III or FDA Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>SARS CoV-2</td>
<td>3</td>
<td>Updates to existing vaccines; Multiple vaccines using other platform technologies, including next generation mRNA and tablet form</td>
</tr>
<tr>
<td>RSV</td>
<td>2</td>
<td>Various platforms deployed targeting infant RSV vaccination</td>
</tr>
<tr>
<td>Seasonal Influenza</td>
<td>5</td>
<td>Includes mRNA flu vaccines, a live universal flu vaccine, a tablet platform and another universal flu approach</td>
</tr>
<tr>
<td>Pneumococcal</td>
<td>3</td>
<td>New mechanisms for developing higher valency pneumococcal vaccines</td>
</tr>
<tr>
<td>Pertussis</td>
<td>1</td>
<td>Live, attenuated nasal vaccine</td>
</tr>
<tr>
<td>Varicella</td>
<td>1</td>
<td>Updated strains</td>
</tr>
<tr>
<td>Zoster</td>
<td>1</td>
<td>New mRNA vaccine for older adults</td>
</tr>
<tr>
<td>Chikungunya</td>
<td>1</td>
<td>Recombinant vaccine</td>
</tr>
<tr>
<td>Norovirus</td>
<td>2</td>
<td>Bi-valent vaccine VLP protein vaccine for infants</td>
</tr>
</tbody>
</table>

### Vaccines in Phase II Development – Part 2

<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Products</th>
<th>Phase III or FDA Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV</td>
<td>2</td>
<td>Includes vaccines based on adeno and modified vaccinia platforms</td>
</tr>
<tr>
<td>Malaria</td>
<td>3</td>
<td>New approaches leveraging mosquitos for malaria vaccines; adjuvanted version of existing vaccine</td>
</tr>
<tr>
<td>Group B Streptococcus (GBS)</td>
<td>1</td>
<td>Vaccine focused or pregnant persons for maternal immunization</td>
</tr>
<tr>
<td>Cytomegalovirus (CMV)</td>
<td>1</td>
<td>Vaccine focused on healthy young women</td>
</tr>
</tbody>
</table>
**Trends is Earlier Stage R&D**

- Over the next few years we will see new strategies for COVID-19 vaccines as well as possible seasonal respiratory combination vaccines – SARS CoV2 + Influenza + RSV.
- Several companies are working on vaccines for:
  - HPV, Herpes Simplex, pediatric combination vaccines
  - Hospital-acquired bacterial infections
  - Group B Strep
  - STI vaccines like Gonorrhea
  - New approaches to universal influenza vaccination

**Monoclonal Antibodies**
Monoclonal Antibodies in Development – Trends

• Increasing research of this new preventive / treatment modality is leading to a deep pipeline of possible products
• Many may be indicated for both prevention of severe disease in specific populations as well as treatment of early-stage disease
• The following therapeutic areas have mAbs on interest in development:
  • RSV
  • COVID
  • Influenza
  • HIV (Prep and prevention of severe disease)
  • Hospital-acquired infections for those at risk
  • Treatment and prevention of Sepsis

Questions