Economic Analysis of RSV Vaccination in Older Adults

David W. Hutton, PhD, MS
Associate Professor, Health Management and Policy, School of Public Health
Associate Professor of Global Public Health, School of Public Health
Associate Professor, Industrial and Operations Engineering, College of Engineering

University of Michigan
Research Team

University of Michigan
• David Hutton, PhD
• Lisa Prosser, PhD
• Angela Rose, MPH
• Kerra Mercon, MS

CDC
• Michael Melgar, MD
• Mila Prill, MSPH
• Jamison Pike, PhD
• Ismael Ortega-Sanchez, PhD
• Fiona Havers, MD
• Michael Whitaker, MPH
• Christopher Taylor, PhD
• Amadea Britton, MD
Conflicts of interest statements

– No known conflict of interests.
Methods: Study question

• Determine the cost-effectiveness of RSV vaccination by:
  • Evaluating the population burden of disease in the US population
  • Comparing vaccination to no vaccination using the incremental cost-effectiveness ratio
  • Scenario analyses exploring uncertainty.

• Perspective: Societal

• Major updates:
  • Update to base case incidence of RSV
  • Incorporation of season 2 efficacy of a single vaccine dose
  • Alignment of vaccine price with that assumed by manufacturers
**Methods: Intervention(s)**

- Target population: US adults, stratified by age
- Interventions: Pfizer and GSK vaccines
- Each compared to No Vaccination
- Base case assumes the age-based RSV vaccination recommendation is for ages ≥65
- Timeframe: 2 years
- Analytic horizon: lifetime
- Discounting rate: 3%
Methods: Decision Tree Model

No Vaccination

Vaccination

Infection

Hospitalization

ED

Outpatient

None of the above

Alive

Dead

Infection

Adverse Events

Systemic Reaction

Injection Site Reaction

Serious Adverse Event

None of the above

Serious Adverse Event

None of the above
Methods: Epidemiology

• Incidence of RSV
  – Raw reported incidence may be underreported because of imperfect PCR sensitivity
    ▪ Base case assumption: 1.5x multiplier was applied to crude incidence estimates
    ▪ Lower bound: lower multiplier assuming 95% PCR sensitivity (fewer missed cases)
    ▪ Higher bound: upper bound from base case assumption

For incidence of inpatient (RSV-NET), outpatient, and ED visits (McLaughlin et al. 2022), this applies the McLaughlin et al. multiplier of 1.5x to the crude incidence estimates.

  
Other studies speak directly to under-detection of RSV infection through use of upper respiratory PCR alone:
### Methods: Epidemiology

#### Hospitalization

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Range</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>age 60 to &lt;65 years</td>
<td>65.5</td>
<td>47.2 – 101.3</td>
<td>CDC RSV-NET</td>
</tr>
<tr>
<td>age 65 to &lt;70 years</td>
<td>93.8</td>
<td>65.9 – 149.1</td>
<td></td>
</tr>
<tr>
<td>age 70 to &lt;75 years</td>
<td>118.7</td>
<td>85.5 – 183.1</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>302.9</td>
<td>212.6 – 489</td>
<td></td>
</tr>
</tbody>
</table>

- Base value is based upon the average burden adjusted rate over those four seasons where “burden adjusted” means it is adjusted for 1.5x based on a reduced PCR test sensitivity *
- Range lower bound is based upon the average burden adjusted rate over those four seasons, but it uses a different “burden adjustment” multiplier of a "Standard" PCR test sensitivity of 95%**.
- Range upper bound is based on the upper 95% confidence limit for the base estimates


## Methods: Epidemiology

### ED and Outpatient

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Range</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Emergency Department</strong></td>
<td></td>
<td></td>
<td>McLaughlin 2022</td>
</tr>
<tr>
<td>RSV incidence, per 100,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age 60 to &lt;65 years</td>
<td>110.4</td>
<td>74 – 132</td>
<td></td>
</tr>
<tr>
<td>age 65 to &lt;74 years</td>
<td>200</td>
<td>133 – 478</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>200</td>
<td>133 – 478</td>
<td></td>
</tr>
<tr>
<td>RSV Incidence, per 100,000</td>
<td></td>
<td></td>
<td>McLaughlin 2022</td>
</tr>
<tr>
<td>age 60 to &lt;65 years</td>
<td>1722</td>
<td>1148 – 2041</td>
<td></td>
</tr>
<tr>
<td>age 65 to &lt;74 years</td>
<td>2278</td>
<td>1519 – 2893</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>2278</td>
<td>1519 – 2893</td>
<td></td>
</tr>
</tbody>
</table>

- McLaughlin et. al. is a Pfizer-sponsored meta-analysis

Methods: Incidence Seasonality

Source: NREVSS (2015-19)
Efficacy of a single vaccine dose over time: Pfizer

- Against medically-attended RSV-LRTI/LRTD (hospitalization and ED)
- Est. Against medically-attended RSV-LRTI/LRTD (hospitalization and ED)
- Against medically-attended RSV-associated ARI (outpatient)
- Est. Against medically-attended RSV-associated ARI (outpatient)

Efficacy over time:
- 84.6% at 0 months
- 75.0% at 1 year
- 65.2% at 2 years
- 55.0% at 3 years

Linear decay to 0% by 24 months.
Efficacy of a single vaccine dose over time: GSK

Against medically-attended RSV- LRTI/LRTD (hospitalization and ED)
- Estimated: 87.5%
- Linear decay to 0% by 24 months

Against medically-attended RSV-associated ARI (outpatient)
- 79.0%
- 52.9%
- 27.8%

Legend:
- Blue line: Against medically-attended RSV- LRTI/LRTD (hospitalization and ED)
- Dotted blue line: Estimated against medically-attended RSV- LRTI/LRTD (hospitalization and ED)
- Light blue line: Against medically-attended RSV-associated ARI (outpatient)
- Dotted light blue line: Estimated against medically-attended RSV-associated ARI (outpatient)
Upper and Lower Bound Efficacy Duration Scenarios

**Pfizer**
Against medically-attended RSV- LRTI/LRTD (hospitalization and ED)

**GSK**
Against medically-attended RSV- LRTI/LRTD (hospitalization and ED)
## Methods: RSV Medical Costs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Range</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Disease-specific hospitalization costs (per hospitalization)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age 60 to &lt;65 years</td>
<td>$21,417</td>
<td>9,288 – 45,454</td>
<td>Ackerson 2020*</td>
</tr>
<tr>
<td>age 65 to &lt;75 years</td>
<td>$21,417</td>
<td>10,491 – 43,619</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>$22,425</td>
<td>10,491 – 43,619</td>
<td></td>
</tr>
<tr>
<td><strong>Disease-specific ED costs (per ED visit)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age 60 to &lt;65 years</td>
<td>$1,210</td>
<td>-</td>
<td>2016 Marketscan*</td>
</tr>
<tr>
<td>age 65 to &lt;75 years</td>
<td>$1,210</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>$1,210</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Disease-specific outpatient costs (per outpatient visit)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age 60 to &lt;65 years</td>
<td>$117.58</td>
<td>65.88-145.38</td>
<td>MarketScan and Medicare FFS, 2020-2021 14</td>
</tr>
<tr>
<td>age 65 to &lt;75 years</td>
<td>$100.86</td>
<td>50.48-120.08</td>
<td></td>
</tr>
<tr>
<td>age ≥75 years</td>
<td>$100.86</td>
<td>50.48-120.08</td>
<td></td>
</tr>
</tbody>
</table>

*Updated to Q3 2022$ using GDP Deflator
Methods: Additional Inputs

• Also included
  – RSV mortality
  – RSV QALYs lost
  – RSV illness productivity costs
  – Vaccination healthcare and productivity costs
  – Vaccination adverse events
    • Systemic reactions
    • Injection site reactions
    • Serious adverse events
    • Medical costs
    • Productivity costs

• These assumption remain unchanged from February
Methods: Sensitivity analyses

- Sensitivity analyses conducted
  - One-Way and Two-Way
  - Age-based recommendation for RSV vaccination
    - age ≥65 years
    - age 60 to <65 years
  - Vaccine cost
    - $180-$340

- Scenario analysis: shorter and longer duration of efficacy
Results: Base Case

• Cohort of US adult population age 65+ as of 2020 Census

• Vaccine Cost:
  – Pfizer: $200
  – GSK: $270

• Two Year Timeframe
Number Needed to Vaccinate, Pfizer

Two Year Timeframe
# Net Cost per Outcome Averted, Pfizer

## Two Year Timeframe

Age-based vaccination recommendation: ≥65 years

Pfizer vaccine cost: $200

<table>
<thead>
<tr>
<th></th>
<th>Outpatient</th>
<th>ED</th>
<th>Hospitalizations</th>
<th>ICU Stays</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥65 years</td>
<td>$5,600</td>
<td>$48,000</td>
<td>$57,000</td>
<td>$280,000</td>
<td>$1,100,000</td>
</tr>
<tr>
<td>60 to &lt;65</td>
<td>$9,400</td>
<td>$110,000</td>
<td>$190,000</td>
<td>$930,000</td>
<td>$4,800,000</td>
</tr>
</tbody>
</table>
Number Needed to Vaccinate, GSK

Two Year Timeframe
Net Cost per Outcome Averted, GSK

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Outpatient</th>
<th>ED</th>
<th>Hospitalizations</th>
<th>ICU Stays</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥65 years</td>
<td>$9,300</td>
<td>$80,000</td>
<td>$94,000</td>
<td>$470,000</td>
<td>$1,800,000</td>
</tr>
<tr>
<td>60 to &lt;65</td>
<td>$14,000</td>
<td>$170,000</td>
<td>$290,000</td>
<td>$1,400,000</td>
<td>$7,300,000</td>
</tr>
</tbody>
</table>

Two Year Timeframe
Age-based vaccination recommendation: ≥65 years
GSK vaccine cost: $270
## Summary measure(s)

### Pfizer

<table>
<thead>
<tr>
<th>Age-based vaccination recommendation: ≥65 years</th>
<th>ICER ($/QALY)</th>
<th>ICER ($/LY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>94,673</td>
<td>112,806</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age-based vaccination recommendation: 60 to &lt;65 years</th>
<th>ICER ($/QALY)</th>
<th>ICER ($/LY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>218,350</td>
<td>313,379</td>
</tr>
</tbody>
</table>

QALY = Quality-Adjusted Life-Year  
ICER = Incremental Cost-Effectiveness Ratio  
LY = Life-Year  
ICER values do not depend on cohort size or uptake  
$200 vaccine cost  
Two Year Timeframe
### Summary measure(s)

**GSK**

<table>
<thead>
<tr>
<th>Age-based vaccination recommendation: ≥65 years</th>
<th>ICER ($/QALY)</th>
<th>ICER ($/LY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>167,301</td>
<td>187,853</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age-based vaccination recommendation: 60 to &lt;65 years</th>
<th>ICER ($/QALY)</th>
<th>ICER ($/LY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>372,656</td>
<td>478,947</td>
</tr>
</tbody>
</table>

QALY = Quality-Adjusted Life-Year  
ICER = Incremental Cost-Effectiveness Ratio  
LY = Life-Year  
ICER values do not depend on cohort size or uptake  
$270 vaccine cost  
Two Year Timeframe
Results: Sensitivity analyses,

• Tornado Diagrams
  – one parameter varied at a time
• Age and Vaccine Cost
• Vaccine Duration
Sensitivity analyses, Pfizer Tornado Diagram

Age ≥65

Vaccine Cost
VE against hospitalization and ED S2
Incidence of RSV hospitalization
VE against hospitalization and ED S1
Cost per Hospitalization
Outpatient QALYs Lost, Adult
Incidence of outpatient visits for RSV
Mortality, adults hospitalized with RSV
VE against outpatient illness S2
ED Incidence

$200 vaccine cost
Two Year Timeframe
Age-based vaccination recommendation: ≥65 years, VE=Vaccine Efficacy LRTD= Lower Respiratory Tract Disease, S1=Season 1, S2=Season 2.
Sensitivity analyses, GSK
Tornado Diagram

Age ≥65

ICER

$0 $50,000 $100,000 $150,000 $200,000 $250,000 $300,000

- Incidence of RSV hospitalization
- VE against hospitalization and ED S2
- Vaccine Cost
- Outpatient QALYs Lost, Adult
- Cost per Hospitalization
- VE against hospitalization and ED S1
- Incidence of outpatient visits for RSV
- Mortality, adults hospitalized with RSV
- VE against outpatient illness S2
- ED Incidence

Low Assumption  High Assumption

$270 vaccine cost
Two Year Timeframe
Age-based vaccination recommendation: ≥65 years, VE= Vaccine Efficacy, LRTD= Lower Respiratory Tract Disease, S1=Season 1, S2=Season 2.
Sensitivity analysis: Vaccine Cost, Pfizer

Two Year Timeframe
Sensitivity analysis: Vaccine Cost, GSK

Two Year Timeframe
Vaccine Efficacy Duration Scenarios

**Pfizer**
Against medically-attended RSV-LRTI/LRTD (hospitalization and ED)

---Base ---- Shorter --- Longer

**GSK**
Against medically-attended RSV-LRTI/LRTD (hospitalization and ED)

---Base ---- Shorter --- Longer
Sensitivity analyses, Pfizer: Varying Duration of Efficacy

Age-based vaccination recommendation: ≥65 years
Sensitivity analyses, GSK: Varying Duration of Efficacy

Age-based vaccination recommendation: ≥65 years
Limitations

- Model Structure
  - No risk groups
  - No dynamic transmission. No impact of the vaccine on transmission and indirect effects

- Uncertain inputs
  - Vaccine cost
  - RSV Incidence
  - Long-term efficacy
Summary

- Vaccination potentially Cost-Effective
- Results vary based on:
  - Vaccine Cost
    • ICER: 80,000–220,000 $/QALY
  - Incidence of RSV Hospitalization
    • $50,000 - 230,000 $/QALY
  - Vaccine Efficacy
    • ICER: ~80,000 - 270,000 $/QALY
  - Ages Vaccinated
    • ICER: ~50,000 - 370,000 $/QALY
  - Duration of Efficacy
    • ICER: ~80,000 - 170,000 $/QALY
Thank You

• Please send comments to:
  • dwhutton@umich.edu