Briefing: Vaccines and Variants

A Briefing on Scientific Literature Focused on SARS-CoV-2 Vaccines and Variants
Dates of Search: 1 January 2021 to 15 March 2021
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This document synthesizes various studies and data; however, the scientific understanding regarding COVID-19 is continuously evolving. This material is being provided for informational purposes only, and readers are encouraged to review federal, state, tribal, territorial, and local guidance. The authors, sponsors, and researchers are not liable for any damages resulting from use, misuse, or reliance upon this information, or any errors or omissions herein.
INTRODUCTION
Purpose of This Briefing

- Access to the latest scientific research is critical as libraries, archives, and museums (LAMs) work to sustain modified operations during the continuing severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) pandemic.
- As an emerging event, the SARS-CoV-2 pandemic continually presents new challenges and scientific questions. At present, **SARS-CoV-2 vaccines and variants in the US** are two critical areas of focus. This briefing provides key information and results from the scientific literature to help inform LAMs making decisions related to these topics.

**How to Use This Briefing**: This briefing is intended to provide timely information about SARS-CoV-2 vaccines and variants to LAMs and their stakeholders. Due to the evolving nature of scientific research on these topics, the information provided here is not intended to be comprehensive or final. As such, this briefing should be used in conjunction with other timely resources to ensure decision-making reflects the latest scientific understanding. Continual re-evaluation of SARS-CoV-2 policies is highly recommended as new scientific discoveries are published.
About This Briefing

• Battelle conducted a systematic search of scientific literature about SARS-CoV-2 vaccines and variants. This briefing summarizes those findings.

• Research questions:
  1. What implications does SARS-CoV-2 vaccination in the US have for public health interventions and policies, especially related to indoor environments?
  2. What differences have been found for SARS-CoV-2 variants (compared to the original strain) in the US in terms of spread, transmissibility, surface attenuation, and effectiveness of public health interventions?

• Dates of search: 1 January 2021 to 15 March 2021

• Additional information about the methods used to conduct the literature search and create this briefing are included later in the document.
About REALM

REopening Archives, Libraries, and Museums (REALM) is a research project conducted by OCLC, the Institute of Museum and Library Services (IMLS), and Battelle to produce science-based information about how materials can be handled to mitigate COVID-19 exposure to staff and visitors of archives, libraries, and museums.

View reports published by REALM.
BACKGROUND INFORMATION: VACCINES AND VARIANTS
SARS-CoV-2 Vaccines

- Vaccination efforts in the US are underway.
- The CDC reports updated vaccination numbers daily on a COVID-19 data tracker.\(^1\)
- Three safe and effective vaccines are being distributed under the US FDA Emergency Use Authorization:\(^2\)
  - Pfizer-BioNTech: 2-dose series, 21 days apart\(^3\)
  - Moderna: 2-dose series, 28 days apart\(^4\)
  - Janssen (Johnson & Johnson): Single dose\(^5\)
- CDC recommends getting first vaccine available.\(^3\)
- However, on April 13, 2021, CDC and FDA recommended a pause in usage of the Janssen/Johnson & Johnson vaccine due to six cases of a serious side effect.\(^6\)

**Vaccination rates by county are also available**
SARS-CoV-2 Vaccines

US Distribution Plans

• Initial Recommendations (Dec 2020) for Allocation of COVID-19 Vaccine by CDC:7
  – Phase 1a: Health care personnel and long-term care facility residents;
  – Phase 1b: Ages 75+ and non-health care frontline essential workers;
  – Phase 1c: Ages 65-74, persons 16-64 with high-risk medical conditions, and essential workers not in Phase 1b.
    • Employees of libraries, archives, zoos, and nature parks are included in 1c.8

• The goal is for everyone who wants a vaccine to be able to get one as soon as possible when vaccines are available in their area.9

• Each state determines which groups of people are eligible for vaccines. Individuals can contact state and local health departments for more information.

• More information about finding vaccines available by zip code: VaccineFinder.org.
Variants of SARS-CoV-2

What is a Variant?

- Viruses inherently replicate, which can result in genetic changes or mutations. After enough mutations occur, the new version is called a variant. As expected, multiple SARS-CoV-2 variants have been found in the US and abroad during this pandemic.
- Sometimes new variants emerge and disappear, and other times new variants emerge and persist.\(^{10}\)

Types of Variants\(^{11}\)

- There are three types of variants. The types differ based on the possibility of the variant to affect people negatively, such as increased transmissibility. In order from least to most negative effects:
  - Variants of Interest (VoI)
  - Variants of Concern (VoC)
  - Variants of High Consequence (VoHC)
- As of this report, in the US there are three VoI, five VoC, and zero VoHC.

Why is it important to track variants?

Monitoring variants can help find out:
- How the virus changes over time into new variants
- How these changes affect aspects of the virus
- How the changes might impact health.\(^{12}\)
Variants of SARS-CoV-2

Variants of Concern (VOC)
"A variant for which there is evidence of an increase in transmissibility, more severe disease (increased hospitalizations or deaths), significant reduction in neutralization by antibodies generated during previous infection or vaccination, reduced effectiveness of treatments or vaccines, or diagnostic detection failures."¹³

Information about reported cases of variants by state is available from the CDC.

Current Variants of Concern in the US (as of 14 April 2021)

<table>
<thead>
<tr>
<th>Variant</th>
<th>First Detected</th>
<th>Other Names</th>
</tr>
</thead>
<tbody>
<tr>
<td>B.1.1.7</td>
<td>United Kingdom (UK)</td>
<td>20I/501Y.V1</td>
</tr>
<tr>
<td>P.1</td>
<td>Japan/Brazil</td>
<td>20J/501Y.V3</td>
</tr>
<tr>
<td>B.1.351</td>
<td>South Africa</td>
<td>20H/501.V2</td>
</tr>
<tr>
<td>B.1.427</td>
<td>US – California</td>
<td>20C/S:452R</td>
</tr>
<tr>
<td>B.1.429</td>
<td>US – California</td>
<td>20C/S:452R</td>
</tr>
</tbody>
</table>
SUMMARY OF FINDINGS: SYSTEMATIC SEARCH OF SCIENTIFIC LITERATURE ABOUT SARS-COV-2 VACCINES AND VARIANTS
Studies About SARS-CoV-2 Vaccines

Impact of Vaccines

• Long-term impacts of the vaccines are still being studied.

• Antibodies produced by the Moderna vaccine lasted for at least 119 days after the first vaccination.\(^\text{14}\)

• A study on response to the Pfizer-BioNTech mRNA vaccine showed that after a single dose, persons who had a prior COVID-19 infection saw an antibody response that was similar to that of persons without prior infection who received two doses.\(^\text{15}\)

• Results of an agent-based COVID-19 transmission model indicated that vaccination can help prevent COVID-19 outbreaks.\(^\text{16}\)
Studies About SARS-CoV-2 Vaccines

Vaccine Safety and Vaccine Hesitancy

• Though vaccine safety is studied and recorded during the development process,\textsuperscript{17,18} there continues to be high levels of people being unsure or not wanting the vaccine (vaccine hesitancy), mostly due to concerns over vaccine safety and side effects.\textsuperscript{19}

• Factors impacting people’s hesitancy to get a SARS-CoV-2 vaccine include perceived threat of COVID-19, concerns over vaccine safety/development, perceived political interference, education, and income.\textsuperscript{20-28}

Health Communication and Miscommunication

• Scientists have called for efforts to address miscommunication and misinformation on COVID-19 vaccines and restore trust in health authorities.\textsuperscript{29-31}

• Increasing vaccine acceptance will be impeded by vaccine misinformation and poor public health communication strategies.\textsuperscript{31-34}
Key CDC Resources About SARS-CoV-2 Vaccines

- CDC Vaccines for COVID-19 site
- COVID-19 Vaccination Toolkits (Community-Based Organizations)
- CDC Guidelines on How Fully Vaccinated People Can Visit Safely with Others
- Key Things to Know About COVID-19 Vaccines
- Facts about COVID-19 Vaccines:
  - English version
  - Spanish version
- COVID-19 Vaccinations in the United States
Studies About SARS-CoV-2 Variants

Spread, Transmissibility, and Infectivity

• Several studies suggested that emerging SARS-CoV-2 variants, specifically the B.1.1.7 (first detected in the UK) and B.1.351 variants (first detected in South Africa), are more transmissible than the early lineage variant.35-38
  – One study found that in the US, the B.1.1.7 variant has an increased transmission rate of 35-45% and a doubling rate of a week and a half. 39
  – Another study found that the B.1.1.7 variant has an estimated 43-90% higher reproduction number than preexisting variants in England, 45–66% higher than those in Denmark, and 56-63% higher than those in the US.40
• The B.1.1.7 and B.1.351 variants and SARS-CoV-2 substrains with certain mutations have been found to be linked with increased infectivity.41-43
• Findings have shown that the higher infectivity and rapid spread of the B.1.1.7 variant may be linked to the higher viral load found in samples from people with the variant.44
• A study of the spread of COVID-19 in the US by county found that regions with high proportions of two SARS-CoV-2 variants with a specific mutation (the G614 mutation) had higher spread rates than regions with lower proportions of those variants.45
Studies About SARS-CoV-2 Variants

Outcomes Severity for Variants (compared to original version of SARS-CoV-2)

- Research suggests that specific mutations that have been identified in SARS-CoV-2 variants are associated with varying severity of COVID-19 illness.
  - One study identified five mutations of the virus that were associated with mild outcomes and 17 mutations that were associated with severe outcomes.\(^46\)
  - A study indicated that a common mutation found in all currently identified VoCs (the D614G mutation) is not associated with more severe disease outcomes.\(^47\)
  - Two mutations identified in SARS-CoV-2 variants were found to have opposing outcomes. One mutation (in gene N [P13L]) was associated with decreased deaths and decreased cases per million, whereas another mutation (in gene ORF3a [Q57H]) was linked to decreased deaths and increased cases per million.\(^48\)

- Findings from a study examining global data showed a potential link between a variant with the S-D614G mutation and increased case severity.\(^49\)
Studies About SARS-CoV-2 Variants

Risk of Reinfection

- Case reports highlight instances of reinfection with the B.1.1.7 SARS-CoV-2 variant following previous infection with the early lineage virus.\textsuperscript{50-52}
- One study reported that the B.1.351 variant has an “unusually large number of mutations,” some of which might be linked to immunoescape (i.e., the virus escapes being stopped by the immune system). Thus, it is unclear whether infection for one SARS-CoV-2 strain offers protection against reinfection by another strain.\textsuperscript{53}
- A study found that the B.1.1.7 and B.1.351 variants are more resistant to neutralization (i.e., they are less likely to lose infectivity), which suggests there was evidence of the possibility of reinfection with these strains.\textsuperscript{54}
Studies About SARS-CoV-2 Variants

Impact of Therapies and Vaccines on the Variants

• A study showed that plitidepsin and ralimetinib, two host-directed drugs used in the treatment of SARS-CoV-2, as well has remdesivir have antiviral effects against both the early lineage and the B.1.1.7 variant of SARS-CoV-2.\textsuperscript{55}

• Vaccine BNT162b2 (Pfizer-BioNTech) appears to be highly effective against the B.1.1.7, B.1.351, and P.1 lineage variants of SARS-CoV-2.\textsuperscript{56}

• The Moderna mRNA-1273 vaccine has been shown to maintain neutralizing activity against all circulating SARS-CoV-2 variants except the B.1.351 variant for which it had reduced but significant neutralization.\textsuperscript{57}
Studies About SARS-CoV-2 Variants

Continued Use of Established Mitigation Strategies

• Studies show that it is critical to continue existing public health strategies (e.g., physical distancing, hand hygiene, mask wearing, quarantining) to reduce the transmission of SARS-CoV-2 variants while vaccine coverage expands.\textsuperscript{58,59}

• A study using an epidemiological model showed that accounting for variants, reinfection, and optimal control, relaxing mitigation measures early would lead to a sharp increase in new cases.\textsuperscript{60}
Key CDC Resources About SARS-CoV-2 Variants

- Variants of the Virus that Causes COVID-19
- About Variants of the Virus that Causes COVID-19
- Science Brief: Emerging SARS-CoV-2 Variants
- US COVID-19 Cases Caused by Variants
What is Still Unknown About SARS-CoV-2 Vaccines? \( ^2, ^61 \)

- How long immunity lasts for different vaccines.
- How well the vaccines keep people from spreading SARS-CoV-2 to others, even without symptoms.
- How and when vaccines will be available for children under 16 years old.
- How well different vaccines will protect against future SARS-CoV-2 variants.
- How dosing with two different vaccines for first and second doses can affect efficacy (e.g., Pfizer then Moderna).
What is Still Unknown About SARS-CoV-2 Variants?\textsuperscript{2,61}

- If some variants are more transmissible for certain demographics (e.g., older adults).
- The likelihood of reinfection due to SARS-CoV-2 variants.
- How the infectious dose (amount of virus needed for infection) differs among variants and in comparison to the early lineage.
HOW THIS BRIEFING WAS CREATED (METHODOLOGY)
In January 2021, REALM stakeholders developed Phase 3 research questions. Battelle developed search strings that included variations of the term “SARS-CoV-2” and novel terms for vaccine and variants using Boolean operators. The Boolean operator “AND” was used to separate SARS-CoV-2 and research question terms, while different variations of the virus name and keywords related to the research question were grouped by category using parentheses and the Boolean operator “OR” (e.g., ["SARS-CoV-2" OR "2019-nCoV" OR "COVID-19"] AND [vaccine OR variant]). Research question keywords were developed using ad hoc test searches and comparison against known relevant articles. The initial search string included a time criterion to capture articles published in January 2021. Subsequent searches were executed on two-week durations using the Scopus, SciTech, Web of Science, and MEDLINE databases. The databases were selected for their ability to provide comprehensive search capacity and inclusion of many smaller databases.
Battelle staff reviewed the titles and abstracts of search results to select those relevant to the research questions.

Selected popular press publications and the DHS Master Question List for COVID-19 were reviewed to verify the completeness of the search results (i.e., to double-check that relevant articles were not missed by the search).

Relevant articles presenting high-value findings were identified as “priority” articles (N=64 articles). A full list of these articles is included in the appendix.

Battelle staff analyzed the priority relevant articles to identify key subtopics. On a biweekly basis, summaries of the articles, organized by subtopic, were presented to OCLC, IMLS, and REALM working groups for feedback.

Battelle summarized the results for this briefing. Additional information was also added to provide context on the key topics.

Battelle will continue to review articles gathered by the search on a biweekly basis, and this briefing will be updated iteratively with new and updated information.
REFERENCES CITED IN THIS BRIEFING
References


References (cont.)


References (cont.)


References (cont.)


APPENDIX: FULL LIST OF PRIORITY ARTICLES FROM SYSTEMATIC SEARCH
References

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APPENDIX: SEARCH STRINGS
<table>
<thead>
<tr>
<th>Database</th>
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<td>Web of Science</td>
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| MEDLINE   | (TI ( coronavir* OR covid OR "COVID-19" OR "SARS-CoV-2" OR "2019-nCoV" ) ) AND TI ( spread* OR transmi* OR infect* OR reinfect* OR virulence OR neutraliz* OR sever* OR evad* OR airborne OR aerosol* OR occupation* OR infectiv* OR mortality OR morbidity OR death* ) ) ) AND TI ( variant OR vaccine OR mutat* OR mutant* OR lineage OR immun* OR strain ) ) ) AND NOT TI ( receptor OR inflamm* OR peptide* OR nanomaterial OR ace2 OR polymerase OR "IgA" OR patient* OR assay* OR ligand* OR protease OR hiv ) ) ) OR (AB ( coronavir* OR covid OR "COVID-19" OR "SARS-CoV-2" OR "2019-nCoV" ) ) ) AND AB ( spread* OR transmi* OR infect* OR reinfect* OR virulence OR neutraliz* OR sever* OR evad* OR airborne OR aerosol* OR occupation* OR infectiv* OR mortality OR morbidity OR death* ) ) ) AND AB ( variant OR vaccine OR mutat* OR mutant* OR lineage OR immun* OR strain ) ) ) NOT AB ( receptor OR inflamm* OR peptide* OR nanomaterial OR ace2 OR polymerase OR "IgA" OR patient* OR assay* OR ligand* OR protease OR hiv ) ) )
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