COVID-19 in 2022

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Objectives

• Prospects for COVID-19 vaccines for preschool children, updates on vaccines for those aged 5 years and older

• Management practices for children with acute COVID-19 in the ambulatory & inpatient settings

• Address the immune response to SARS-CoV-2, COVID-19 vaccines & boosters, and to better-understand the etiology of acute COVID-19 & Multi-System Inflammatory Syndrome, MIS-C
Content

• SARS-CoV-2 transmission in schools

• Testing

• COVID-19
  • Acute disease, risk factors for severe disease in children & teens, therapy
  • Multi-system inflammatory syndrome, MIS-C
  • ‘Long-COVID’ Safe return to in-person learning

• Vaccines

• Future pandemics...
COVID-19 IN WASHINGTON STATE

This chart shows the progression of the COVID-19 outbreak in Washington by cases, hospitalizations and deaths over time and is known as an epidemiologic curve. The epidemiologic curve is the curve referred to in the phrase, “flatten the curve.” Learn More

1,999 of 1,041,456 cases do not have an assigned county. Cases from the last 8 days may yet not be reported.
COVID-19 IN WASHINGTON STATE

Cases and Deaths by Specimen Collection Date, and Hospitalizations by Admission Date

This chart shows the progression of the COVID-19 outbreak in Washington by cases, hospitalizations, and deaths over time and is known as an epidemiologic curve. The epidemiologic curve is the curve referred to in the phrase, “flatten the curve.” Learn More

SELECT COUNTIES

SEARCH

Clallam County
Clark County
Columbia County
Cowlitz County
Douglas County
Ferry County
Franklin County
Garfield County
Grant County
Grays Harbor County
Island County
Jefferson County
King County
Kitsap County
Kittitas County

Click on “Tabular View” to see and download the data.

Tabular View

1,522 of 750,477 cases do not have an assigned county. Cases from the last 8 days may yet not be reported.
COVID case counts in King County
Omicron in the United Kingdom

Number of coronavirus disease 2019 (COVID-19) deaths by age

Total deaths from COVID-19: 825,083

- 0–17 years: 694
- 18–29 years: 5,034
- 30–39 years: 14,869
- 40–49 years: 35,798
- 50–64 years: 153,827
- 65–74 years: 188,222
- 75–84 years: 212,126
- 85 years and older: 214,513

- anxiety
- missed educational opportunity
- lost opportunity to celebrate life-events & achievements
- loss of team-working
- academic failure
- loss of parental employment
- child abuse
- death
- loss of lifetime earnings
- anxiety
- increased social disparities
- hunger, food insecurity
- domestic violence
- homelessness
- depression
- obesity
- hopelessness
- poverty
- family death, hospitalization & illness
- increased economic disparities
- long COVID
- lack of socialization & development
- delay behind on vaccines
- lack of physical exercise
- hospitalization
- lack of adult supervision
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Learn More

CASE COUNTS

- Probable Cases
- Confirmed Cases
- Incomplete (Probable Cases)
- Incomplete (Confirmed Cases)
- Total Cases (7 day avg.)
- Incomplete (7 day avg.)
COVID-19 can affect people of any age. However, age is a significant factor for developing serious outcomes following COVID-19 infection. Rates are not calculated for unknown age and some counts and rates are suppressed to protect individual privacy. Learn More

Select Age Group:
- K-12 Schooling Age Groups

Click on the legend to select a trend line.
Multiple Layers of Mitigation to Keep Kids Healthy in School

- Masking
- Vaccination
- Physical distancing
- Hand hygiene
- Ventilation
- Students & staff stay home when sick
- Expedited testing
- Contact tracing
What to do if a Person is Symptomatic at School

If a person has one or more of these symptoms:

- Fever (≥100.4°F) or chills
- Shortness of breath or difficulty breathing
- Muscle or body aches
- New loss of taste or smell
- Cough (new, changed, or worsening)

They should isolate at home AND get tested for COVID-19

- Congestion or runny nose
- Nausea, vomiting, or diarrhea
- Headache
- Fatigue
- Sore throat

They should isolate at home

Was only ONE symptom present?

- NO
- YES

Did the symptom resolve within 24 hours OR are they consistent with a diagnosed chronic illness?

If they do not receive an alternative named diagnosis from a health care provider:

- They test POSITIVE
- They test NEGATIVE for COVID-19

Identify and Care for Close Contacts at School

If there is a COVID-19 positive person at school:

- Is the exposed person (close contact) fully vaccinated OR have they tested positive in the past three months and recovered? NO
  - YES
  - Do they have symptoms?
  - NO
    - Remain at school
      - No need to quarantine but they should:
        1. Get tested five to seven days after known exposure
        2. Continue wearing a mask in all public indoor settings
  - YES
    - Test for COVID-19

- Do they have symptoms? NO
  - YES
    - Test for COVID-19
  - NO
    - Is the exposed person a student AND is the school offering Test to Stay?
      - They test negative for COVID-19 with an antigen test AND test negative with a confirmatory viral test

The SARS-CoV-2 Virus

Structural Proteins
S – spike
N – nucleocapsid
M – membrane
E – envelope
SARS-CoV-2 genome
COVID-testing (it’s all about timing)

Drain PK, NEJM 2022
COVID-19 in children

• Acute disease (‘COVID’)

• Multi-system inflammatory syndrome (MIS-C)

• Post-acute sequelae of SARS-CoV-2 (PASC) or ‘long-COVID’

• Secondary effects of the pandemic
Risk factors for Severe COVID-19

Background: Fewer than 1% of children & teens identified with SARS-CoV-2 infection require hospitalization, deaths occur, but are rare

• 55% of hospital admissions had one or more underlying condition (Woodruff)
• Infants/<2yrs with underlying medical conditions over-represented
• Age < 6 months at lowest risk for severe disease

Age 2-17yrs Risk Factors for severe COVID included
• Feeding tube-dependence (aRR 2.0)
• Diabetes (aRR 1.9)
• Obesity (aRR 1.2)
• Children w/ asthma, immune-compromise not at increased risk for severe dz

• ⅓ of patients aged <5 years hospitalized for COVID-19 had a viral coinfection (Wanga )

Woodruff RC, Pediatrics 2022
Wanga V, MMWR 2021
Therapeutics – limited role for children & teens

• Remdesivir - interferes with viral RNA polymerase (RdRp)
• Steroids
• Other immunomodulatory agents (tocilizumab (IL-6), baricitinib (JAK kinase), anakinra (IL-1R), IL-1β, CD6
• Monoclonal antibodies (for acute disease, post & pre-exposure ppx)
• Oral agents
  • Paxlovid® (nirmatrelvir/ritonavir) – PI; interferes w/viral protease(3CL\text{pro}/M\text{pro})
    • Molnupiravir
• Other proposed therapies (no NIH/IDSA approval)
  (fluvoxamine, inhaled budesonide, convalescent plasma, ivermectin, hydroxychloroquine, azithromycin, HIV protease inhibitors, colchicine, vitamin C, vitamin D, zinc...)
Multi-system inflammatory syndrome (MIS-C)

- Acute febrile illness following infection with SARS-COV-2
- Clinical features similar to Kawasaki Disease or Toxic Shock Syndrome
- Peak age 5-11 yrs
- Many with critical illness
- ~Equal #s of Hispanic, black & white Caucasian children in the US
Case Definition for MIS–C

As described in the CDC Health Advisory, “Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with Coronavirus Disease 2019 (COVID-19),” the case definition for MIS-C is:

- An individual aged <21 years presenting with fever*, laboratory evidence of inflammation**, and evidence of clinically severe illness requiring hospitalization, with multisystem (≥2) organ involvement (cardiac, renal, respiratory, hematologic, gastrointestinal, dermatologic or neurological); AND

- No alternative plausible diagnoses; AND

- Positive for current or recent SARS-CoV-2 infection by RT-PCR, serology, or antigen test; or exposure to a suspected or confirmed COVID-19 case within the 4 weeks prior to the onset of symptoms.

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Reporting Multisystem Inflammatory Syndrome in Children (MIS-C)

Report possible cases of MIS-C to your local, state, or territorial health department. Questions? Contact CDC’s 24-hour Emergency Operations Center at 770-488-7100. Download and print the Reporting MIS-C fact sheet [76 KB, 1 page] to learn more.

*Fever ≥38.0°C for ≥24 hours, or report of subjective fever lasting ≥24 hours

**Including, but not limited to, one or more of the following: an elevated C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), fibrinogen, procalcitonin, d-dimer, ferritin, lactic acid dehydrogenase (LDH), or interleukin 6 (IL-6), elevated neutrophils, reduced lymphocytes and low albumin
‘Long COVID’ or ‘Post-COVID’ or Post Acute Sequelae of Coronavirus infection (PASC)

• Hard to study

• Hard to define – (adults) ‘symptoms that develop during or after COVID & continue for >3 months’

• A significant proportion of adults & teens have physical & psychological symptoms that persist for weeks

• Case series or prospective cohorts have failed to establish a clear pattern of delayed recovery

• Symptoms that may reflect a ‘post-infectious’ syndrome are nonspecific and hard to disentangle from effects of the pandemic
Long COVID symptoms and duration in SARS-CoV-2 positive children — a nationwide cohort study

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Abstract
Most children have a mild course of acute COVID-19. Only few mainly non-controlled studies with small sample size have evaluated long-term recovery from SARS-CoV-2 infection in children. The aim of this study was to evaluate symptoms and duration of ‘long COVID’ in children. A nationwide cohort study of 37,522 children aged 0–17 years with RT-PCR verified SARS-CoV-2 infection (response rate 44.9%) and a control group of 78,037 children (response rate 21.3%). An electronic questionnaire was sent to all children from March 24th until May 9th, 2021. Symptoms lasting > 4 weeks were common among both SARS-CoV-2 children and controls. However, SARS-CoV-2 children aged 6–17 years reported symptoms more frequently than the control group (percent difference 0.8%). The most reported symptoms among pre-school children were fatigue Risk Difference (RD) 0.05 (CI 0.04–0.06), loss of smell RD 0.01 (CI 0.01–0.01), loss of taste RD 0.01 (CI 0.01–0.02) and muscle weakness RD 0.01 (CI 0.00–0.01). Among school children the most significant symptoms were loss of smell RD 0.12 (CI 0.12–0.13), loss of taste RD 0.10 (CI 0.09–0.10), fatigue RD 0.05 (CI 0.05–0.06), respiratory problems RD 0.03 (CI 0.03–0.04), dizziness RD 0.02 (CI 0.02–0.03), muscle weakness RD 0.02 (CI 0.01–0.02) and chest pain RD 0.01 (CI 0.01–0.01). Children in the control group experienced significantly more concentration difficulties, headache, muscle and joint pain, cough, nausea, diarrhea and fever than SARS-CoV-2 infected. In most children ‘long COVID’ symptoms resolved within 1–5 months.

Conclusions: Long COVID in children is rare and mainly of short duration.
Persistent symptoms following SARS-CoV-2 infection amongst children and young people: A meta-analysis of controlled and uncontrolled studies

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mRNA vaccines

The vaccines made by Moderna and Pfizer–BioNTech use mRNA that has been chemically modified to replace the uridine (U) nucleotide with pseudouridine (ψ). This change is thought to stop the immune system reacting to the introduced mRNA.

To help the body mount an effective immune response to later SARS-CoV-2 infections, the mRNA sequence is adapted to stabilize the spike protein in the shape it uses when fusing with human cells.
Where we are with Pediatric COVID vaccines?

• Only Pfizer with EUA* < age 18 yrs in US
• ‘Adult’ dose (30 μg) for each dose for age 12yrs+
  10 μg age 5-11 yrs
  • Potential for a 3rd dose (e.g. 4 weeks after 2nd) for immunocompromised
• 12yrs+ recommended to receive a booster
  • Schedule 0, 1, (5/6) mo - immediate protection & longer-term memory
• ‘Reactogenic’
  • myocarditis in teenage boys & young men (esp. age 16-24)
• Efficacy holding up, but future remains unclear
**COVID-19 Vaccine Dosing Recommendations**

### Primary Series

**Pfizer/BioNTech**
- ≥12 years old: 0.3 mL (30 mcg) IM at 0 and 3 weeks
- 5-11 years old: 0.2 mL (10 mcg) IM at 0 and 3 weeks
  (Immunocompromised persons ≥5 years old should receive a 3rd dose ≥4 weeks after the 2nd)

**Moderna**
- ≥18 years old: 0.5 mL (100 mcg) IM at 0 and 4 weeks
  (Immunocompromised persons should receive a 3rd dose ≥4 weeks after the 2nd)

**Johnson & Johnson**
- ≥18 years old: 0.5 mL (5x10^15 viral particles) IM once
  (CDC recommends preferential use of mRNA vaccines (Pfizer/BioNTech and Moderna) over the J&J vaccine)

### Booster Dose

**Pfizer/BioNTech 0.3 mL (30 mcg)**
- ≥5 months after 2nd primary dose (or 3rd for immunocompromised)

**Moderna 0.25 mL (50 mcg)**
- ≥5 months after 2nd primary dose (or 3rd for immunocompromised)

**Pfizer/BioNTech 0.3 mL (30 mcg)**
- OR
  - Moderna 0.25 mL (50 mcg)
  - ≥5 months after 2nd primary dose (or 3rd for immunocompromised)

**Pfizer/BioNTech 0.3 mL (30 mcg)**
- OR
  - Moderna 0.25 mL (50 mcg)
  - ≥2 months after primary immunization

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1. **Booster Dose “Mix and Match”:** Any available vaccine can be used for a booster dose in eligible persons who are ≥18 years old after completion of a primary series with a different vaccine. Pfizer/BioNTech or Moderna vaccines are preferred over J&J vaccine for booster doses. For patients who cannot receive the Pfizer/BioNTech or Moderna vaccines, a J&J vaccine booster dose (0.5 mL [5x10^15 viral particles]) can be used.

2. **Immunocompromised:** active cancer treatment (solid tumors or hematologic), organ transplant, stem cell transplant within the last 2 years, moderate or severe primary immunodeficiency, advanced or untreated HIV infection, high-dose corticosteroids (≥20 mg prednisone/day or equivalent), alkylating agents, antimetabolites, transplant-related immunosuppressive drugs, severely immunosuppressive chemotherapy, TNF blockers, other immunosuppressive or immunomodulatory biologic agents.

3. **CDC recommends everyone 18 years of age and older should receive a booster dose with any authorized vaccine and that persons 12 years of age and older should receive a Pfizer/BioNTech booster dose.**
Pfizer Vaccine Efficacy in Teens

• No severe COVID disease in the original Phase 2/3 studies, but efficacy of >90% against symptomatic infection

Since granting EUA:

• Vaccination almost-completely eliminated life-threatening disease in US study of PICU admissions (Olson)

• Vaccination prevents MIS-C (& MIS-A) (Zambrano)

• Prolonged symptoms (in adults) are less commonly reported in breakthrough infections (i.e. COVID after immunization) compared with those infected without prior immunization (ref?)

Olson SM, NEJM 2022
Zambrano L, MMWR 2022
Vaccine-Associated Myocarditis

- Median onset 2 days after dose #2
- Less common that COVID-related myocarditis
- Typically short-lived, minor symptoms, responding to NSAIDs, no deaths
- ACIP: benefit outweighs risk
- CDC estimates for every 1 million males 12-29 years old who receive mRNA vaccine, 560 hospitalizations due to COVID-19 would be prevented and 39-47 cases of myocarditis would occur
Other side-effects after immunization

• > 500 million COVID-19 mRNA vaccine doses given US

• ‘Minor’ temporarily-disabling symptoms are common in the 48 hrs after immunization

• No serious health concerns identified

• No reported increase in symptoms for those with post-acute COVID who subsequently receive a COVID vaccine (Arnold)
COVID-19 vaccine administration

• AAP & CDC support coadministration of routine immunizations with COVID-19 vaccines (or vaccination in the days before or after)
• Pediatricians are encouraged to promote vaccination through ongoing, proactive messaging (e.g. reminder recall, vaccine appointment/clinics) & use existing visits as an opportunity to promote and provide COVID-19 vaccines
• Encourage parents to register children with V-safe
• Report AEs through the Vaccine Adverse Event Reporting System (VAERS)

What we know about COVID vaccines age <5yrs?

• In Pfizer/BioNTech immunogenicity studies, 2-4 yr-olds given 2x 3mcg made less antibody than 16-25 yr-olds given 2x 30mcg dose

• No safety concerns or unusual adverse events following immunization

• Pfizer/BioNTech are evaluating a 3-dose schedule, with the 3rd dose given >2 months after the 2nd

• ?May roll-out age 2-4 year-olds first, followed by age 6-23 months

• ?Vaccine dose, ?number of doses, schedule
COVID-19 vaccines

mRNA vaccines:
• US FDA approval: Pfizer-BioNTech (Comirnaty®)
• FDA EUA: Moderna (Spikevax®), Janssen-J&J (Ad26.COV2.S®)

Others:
• AstraZeneca-Oxford (ChAdOx1®) (adenoviral vector)
• Novavax (recombinant protein, nanoparticle, saponin adjuvant)
• Corbevax® (recombinant protein, CpG 1018 adjuvant)
• Inactivated vaccines from Sinovac, Sinopharm, Bharat & others
Understanding the Impact of COVID-19 on Individuals, Children, & Families
What have we learned that might help us?

• Prevention of respiratory viral infections
• Need for investment in Public Health
• Preparation for the next pandemic
• New vaccine technology
mRNA vaccines for influenza

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Product name</th>
<th>Technology</th>
<th>Type</th>
<th>Flu antigen(s)</th>
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<tbody>
<tr>
<td>Moderna</td>
<td>mRNA-1010</td>
<td>mRNA</td>
<td>Quadrivalent</td>
<td>Haemagglutinin</td>
</tr>
<tr>
<td>Sanofi/Translate Bio</td>
<td>MRT-5400, MRT-5401</td>
<td>mRNA a</td>
<td>Monovalent (H3N2)</td>
<td>Haemagglutinin</td>
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<tr>
<td>Pfizer</td>
<td>PF-07252220</td>
<td>mRNA</td>
<td>Monovalent (H1N1) and monovalent (B/Yamagata), to be combined into bivalent and quadrivalent</td>
<td>Haemagglutinin</td>
</tr>
</tbody>
</table>

In the clinic

https://www.nature.com/articles/d41573-021-00176-7
Questions?
COVID-19 in children (AAP/CHA data)

> 500,000 cases per week in the US

> 30,000 admissions (24 States reporting)

  841 deaths (ranking COVID in the top 10 causes of death)

> 6,400 cases of MIS-C, 55 deaths