



Children should be offered vaccination against COVID-19

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Since the start of the COVID-19 pandemic, there has been conflicting evidence on SARS-CoV-2 infection and transmission in children ([Stawicki et al. 2020](#); [Bialek et al. 2020](#); [Wu and Mcgoogan 2020](#)). Early studies reported only anecdotal outbreaks in school settings and low case numbers in children ([Danis et al. 2020](#)), driving speculation that the virus may not be as easily spread in this age group ([Cao et al. 2020](#); [Goldstein et al. 2020](#); [Ludvigsson 2020b](#)). However, these reports are unlikely to have represented the true frequency of infections, given the widespread school closures implemented to cut transmission opportunities and limitations of swab testing in children (lower uptake, swab volumes) resulting in missed cases ([Corman et al. 2021](#); [Han et al. 2021](#)). Indeed, subsequent studies measuring viral load in children reveal similar levels and trajectories as adults, indicating that children can readily transmit the virus ([Jones et al. 2021](#); [Jacot et al. 2020](#), [Yonker et al. 2020](#); [Baggio et al. 2021](#)). Moreover, in children under 5 years, significantly higher levels of SARS-CoV-2 viral nucleic acid have been detected ([Heald-Sargent et al. 2020](#)), while those under 3 years of age are more likely to transmit the infection compared to older siblings ([Paul et al. 2021](#)). Together, current available evidence confirms that children, even if asymptomatic or with mild disease, are an important source of SARS-CoV-2 who can accelerate infections throughout communities.

The highly contagious B.1.617.2 (delta) variant, first identified in December 2020 in India ([ECDC 2021](#)), has

now been detected in 130 countries worldwide. The delta variant is more transmissible than earlier SARS-CoV-2 strains and confers greater risk of hospitalization, ICU admission and death, particularly in those who are unvaccinated ([Sheikh et al. 2021](#); [Fisman and Tuite 2021](#)). In response to a recent outbreak in Massachusetts, U.S., where 74% (346/469) of delta variant-infected cases were found to be fully vaccinated and 79% of those (274/346) were asymptomatic ([Brown et al. 2021a](#)), the U.S. Centers for Disease Control and Prevention updated their guidance to recommend masking indoors (28th July 2021 ([CDC 2021](#))).

Vaccination against COVID-19, currently authorized for those 12 years and older, remains the most effective way to prevent symptomatic disease and more severe outcomes ([Lopez Bernal et al. 2021b](#); [Hall et al. 2021](#); [Shrotri et al. 2021](#); [Dagan et al. 2021](#)). In Canada, there are presently 4 COVID-19 vaccines available, two based on mRNA technology (Pfizer-BioNTech (BNT162b2), Moderna (mRNA-1273)), and two utilizing viral-vector platforms (AstraZeneca (ChAdOx1-S), Janssen (Ad26.COV2.S)). A newly developed COVID-19 vaccine by Novavax (NVX-CoV2373), based on the more traditional 'protein-subunit' approach (similar to the pertussis and hepatitis B vaccines), recently reported results of its phase III trials in adults ([Heath et al. 2021](#)). Unlike the mRNA or viral-vector COVID-19 vaccines, NVX-CoV2373 contains parts of the recombinant SARS-CoV-2 spike protein and an adjuvant to stimulate host immune responses. The overall efficacy for preventing

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Submitted 18 August 2021
Accepted 19 August 2021
Available online 20 August 2021

LymphoSign Journal 8:75–80 (2021)
[dx.doi.org/10.14785/lymphosign-2021-0025](https://doi.org/10.14785/lymphosign-2021-0025)

symptomatic disease was shown to be comparable to mRNA vaccines (89%), with the benefit of both fewer and milder adverse effects — an important consideration when deciding among vaccines for children. While not yet authorized for use in Canada, it is expected that NVX-CoV2373 will become available within the coming months.

Since the start of the vaccination program in Canada, SARS-CoV-2 infections have occurred predominately in the unvaccinated population (89.4% versus 0.6% in those who are fully protected). Similarly, of those who were hospitalized or died, unvaccinated individuals accounted for 84.8% and 82.1%, respectively (Goldstein et al. 2020). For the delta variant, studies estimating vaccine efficacy after 2 doses suggest reduced levels of protection against symptomatic disease compared to the original SARS-CoV-2 strain (Pfizer-BioNTech vaccine: 88% vs. 93.7%, respectively; AstraZeneca COVID-19 vaccine: 67% vs. 74.5%, respectively) (Lopez Bernal et al. 2021a). Additionally, over a 7-month period in which the predominant SARS-CoV-2 strains changed from the alpha to delta variant, a separate study reported a 2-fold risk reduction against breakthrough infections in those vaccinated with the Moderna compared to the Pfizer-BioNTech vaccines (Puranik et al. 2021). Together with the observed decline of antibody levels over time, a strong argument for a booster shot can be made (Roifman and Vong 2021a).

Now, as Canada enters a fourth wave with a strong resurgence of cases, it is children who are most vulnerable to infection and should be fast-tracked for vaccination. Early reports that children don't develop severe symptoms of COVID-19 disease are being surpassed by evidence of long-term effects, some lasting months after the initial infection (Thomson 2021; Buonsenso et al. 2021; Ludvigsson 2020a). Serious complications, including multi-system inflammatory syndrome, have also been reported (Riphagen et al. 2020; Waltuch et al. 2020), and there are likely other effects that have yet to be accounted for.

In May 2021, the delta variant accounted for just 8% of positive cases in Ontario, while in July those cases jumped to 78% (Brown et al. 2021b). Documentation of 72,000 new pediatric COVID-19 cases in the U.S., the largest weekly increase since the start of the pandemic (American Academy of Pediatrics 2021), prompted the American Academy of Pediatrics and Children's

Hospital Association to urge the FDA to fast-track the review of COVID-19 vaccines for pediatric cohorts (<12 years) (Beers 2021). Especially concerning are reports of increased hospitalizations of children infected with the delta variant, with pediatric ICU beds at maximum capacity in numerous hospitals across the U.S. (Conlen et al. 2020). Although the numbers are low compared to adult admissions, to date, they are the highest recorded for children from the start of the pandemic.

Taken together, it is imperative that COVID-19 vaccines are made available for children under 12 years of age as soon as possible. With children returning to school in a matter of weeks, the lack of protection exposes them not only to greater risk of infection and complications, but also of spreading the virus throughout communities and potentially becoming a source for new variants. For those who have compromised immune systems, including children and adults with primary immunodeficiency (Roifman 2020), gatherings among unvaccinated individuals (particularly in the classroom setting) poses a high risk for SARS-CoV-2 transmission (Roifman and Vong 2021a, 2021b).

Recommendations

1. We urge Health Canada to approve the use of COVID-19 vaccines in school-aged children (5–12 years).
2. We support the recommendations of the American Academy of Pediatrics and Children's Hospital Association in urging the FDA to approve COVID-19 vaccines for school-aged children.
3. Pediatricians should be given the ability to provide off-label COVID-19 vaccine doses for children aged 10–12, if developmentally appropriate.
4. The planned one third dosage of the Pfizer-BioNTech vaccine (10 micrograms compared to 30 micrograms currently administered in adults) for children aged 10–12 may not be sufficient for protection against SARS-CoV-2 and should be investigated further.
5. Given the high reported efficacy and relatively lower side effects identified in clinical studies of the Novavax vaccine, it may, in the future, be considered for use in children. Because it is a more traditional type of vaccine, it could also be preferred by both parents as well as caregivers.
6. The decision to vaccinate children should be made in consultation with your physician/healthcare

provider. Meanwhile, protective measures including social distancing, hand hygiene, and masking should continue as the mainstay for protection against COVID-19.

REFERENCES

- American Academy of Pediatrics. 2021. Children and COVID-19: State-Level Data Report [Online]. Available from <https://www.aap.org/en/pages/2019-novel-coronavirus-covid-19-infections/children-and-covid-19-state-level-data-report> [accessed 2021].
- Baggio, S., L'huillier, A.G., Yerly, S., Bellon, M., Wagner, N., Rohr, M., Huttner, A., Blanchard-Rohner, G., Loevy, N., Kaiser, L., Jacquerioz, F., and Eckerle, I. 2021. Severe Acute respiratory syndrome coronavirus 2 (SARS-CoV-2) viral load in the upper respiratory tract of children and adults with early acute Coronavirus Disease 2019 (COVID-19). *Clin. Infect. Dis.* **73**: 148–150. PMID: [32761228](#). doi: [10.1093/cid/ciaa1157](#).
- Beers, L. 2021. Open letter to FDA [Online]. Available from https://downloads.aap.org/DOFA/AAP%20Letter%20to%20FDA%20on%20Timeline%20for%20Authorization%20of%20COVID-19%20Vaccine%20for%20Children_08_05_21.pdf.
- Bialek, S., Gierke, R., Hughes, M., Mcnamara, L.A., Pilishvili, T., and Skoff, T. 2020. Coronavirus Disease 2019 in Children — United States, February 12 – April 2, 2020. *MMWR Morb. Mortal. Wkly. Rep.* **69**: 422–426. doi: [10.15585/mmwr.mm6914e4](#).
- Brown, C., Vostok, J., Johnson, H., Burns, M., Gharpure, R., Sami, S., Sabo, R., Hall, R., Foreman, A., Schubert, P., Gallagher, G.T.F., Madoff, L., Gabriel, S., Macinnis, B., Park, D., Siddie, K., Harik, V., Arvidson, D., Brock-Fisher, T., Dunn, M., Kearns, A., and Laney, A. 2021a. Outbreak of SARS-CoV-2 Infections, Including COVID-19 Vaccine Breakthrough Infections, Associated with Large Public Gatherings — Barnstable County, Massachusetts, July 2021. *MMWR Morb. Mortal. Wkly. Rep.* **70**(31): 1059–1062. doi: [10.15585/mmwr.mm7031e2](#).
- Brown, K.A., Joh, E., Buchan, S.A., Daneman, N., Mishra, S., Patel, S., and Day, T. 2021b. Inflection in prevalence of SARS-CoV-2 infections missing the N501Y mutation as a marker of rapid Delta (B.1.617.2) lineage expansion in Ontario, Canada. *medRxiv*, 2021.06.22.21259349. doi: [10.1101/2021.06.22.21259349](#).
- Buonsenso, D., Munblit, D., De Rose, C., Sinatti, D., Ricchiuto, A., Carfi, A., and Valentini, P. 2021. Preliminary evidence on long COVID in children. *Acta Paediatr.* **110**: 2208–2211. PMID: [33835507](#). doi: [10.1111/apa.15870](#).
- Cao, Q., Chen, Y.-C., Chen, C.-L., and Chiu, C.-H. 2020. SARS-CoV-2 infection in children: Transmission dynamics and clinical characteristics. *J. Formosan Med. Assoc.* **119**: 670–673. PMID: [32139299](#). doi: [10.1016/j.jfma.2020.02.009](#).
- CDC. 2021. Interim public health recommendations for fully vaccinated people [Online]. Available from <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html>.
- Conlen, M., Keefe, J., Sun, A., Leatherby, L., and Smart, C. 2020. How full are hospital I.C.U.s near you? [Online]. Available from <https://www.nytimes.com/interactive/2020/us/covid-hospitals-near-you.html>.
- Corman, V.M., Haage, V.C., Bleicker, T., Schmidt, M.L., Mühlemann, B., Zuchowski, M., Jo, W.K., Tscheak, P., Möncke-Buchner, E., Müller, M.A., Krumbholz, A., Drexler, J.F., and Drosten, C. 2021. Comparison of seven commercial SARS-CoV-2 rapid point-of-care antigen tests: a single-centre laboratory evaluation study. *Lancet Microbe.* **2**: e311–e319. PMID: [33846704](#). doi: [10.1016/S2666-5247\(21\)00056-2](#).
- Dagan, N., Barda, N., Kepten, E., Miron, O., Perchik, S., Katz, M.A., Hernán, M.A., Lipsitch, M., Reis, B., and Balicer, R.D. 2021. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. *N. Engl. J. Med.* **384**: 1412–1423. PMID: [33626250](#). doi: [10.1056/NEJMoa2101765](#).
- Danis, K., Epaulard, O., Bénét, T., Gaymard, A., Campoy, S., Botelho-Nevers, E., Bouscambert-Duchamp, M., Spaccaferri, G., Ader, F., Mailles, A., Boudalaa, Z., Tolsma, V., Berra, J., Vaux, S., Forestier, E., Landelle, C., Fougere, E., Thabuis, A., Berthelot, P., Veil, R., Levy-Bruhl, D., Chidiac, C., Lina, B., Coignard, B., Saura, C., Brottet, E., Casamatta, D., Gallien, Y., George, S., Viriot, D., Ait Belghiti, F., Bernard-Stoecklin, S., Desenclos, J.-C., Giese, C., Ghislain, D., Gounon, M., Grangeret, N., Marie, C., Morel, B., Deher, M., Ronnaux Baron, A.-S., Courbis, G., Ragozin, N., Wolska, M., Serange, E., Mercatello, D., Aiouaz, S., Valette, M., Frobert, E., Josset, L., Escuret, V., Morfin, F., Billaud, G., Blanc, M., Arata-Bardet, J., Froidure, M., Le Maréchal, M., Pavese, P., Pierre, I., Becker, A., Chauvelot, P., Conrad, A., Ferry, T., Mialhes, P., Perpoint, T., Pouderoux, C., Roux, S., Valour, F., Lutz, M.-F., Pouvaret, A., Vitrat, V., Maillet, M., Janssen, C., Piet, E., Bosch, A., Destrem, A.-L., Isnard, M., Challan-Belval, T., Wackenheim, C., Couturier, A., Gheno, G.,

- Roupioz, T., Lucet, N., Ayouni, S., Vincent, M., De Epidemiología, S., General De Salud Pública Del Gover Balear, D., Masserey Spicher, V., Bourquin, C., Stoll, J., Chaud, P., and Mounayar, A.-L. 2020. Cluster of Coronavirus Disease 2019 (COVID-19) in the French Alps, February 2020. *Clin. Infect. Dis.* **71**: 825–832. PMID: [32277759](#). doi: [10.1093/cid/ciaa424](#).
- ECDC. 2021. Threat Assessment Brief: Emergence of SARS-CoV-2 B.1.617 variants in India and situation in the EU/EEA [Online]. Available from <https://www.ecdc.europa.eu/en/publications-data/threat-assessment-emergence-sars-cov-2-b1617-variants>.
- Fisman, D.N., and Tuite, A.R. 2021. Progressive Increase in Virulence of Novel SARS-CoV-2 Variants in Ontario, Canada. *medRxiv*, 2021.07.05.21260050. doi: [10.1101/2021.07.05.21260050](#).
- Goldstein, E., Lipsitch, M., and Cevik, M. 2020. Government of Canada. 2021. COVID-19 daily epidemiology update [Online]. Available from <https://health-infobase.canada.ca/covid-19/epidemiological-summary-covid-19-cases.html#a5> [accessed 16 August 2021].
- Hall, V.J., Foulkes, S., Saei, A., Andrews, N., Oguti, B., Charlett, A., Wellington, E., Stowe, J., Gillson, N., Atti, A., Islam, J., Karagiannis, I., Munro, K., Khawam, J., Chand, M.A., Brown, C.S., Ramsay, M., Lopez-Bernal, J., Hopkins, S., Andrews, N., Atti, A., Aziz, H., Brooks, T., Brown, C.S., Camero, D., Carr, C., Chand, M.A., Charlett, A., Crawford, H., Cole, M., Conneely, J., D'arcangelo, S., Ellis, J., Evans, S., Foulkes, S., Gillson, N., Gopal, R., Hall, L., Hall, V.J., Harrington, P., Hopkins, S., Hewson, J., Hoschler, K., Ironmonger, D., Islam, J., Kall, M., Karagiannis, I., Kay, O., Khawam, J., King, E., Kirwan, P., Kyffin, R., Lackenby, A., Lattimore, M., Linley, E., Lopez-Bernal, J., Mabey, L., McGregor, R., Miah, S., Monk, E.J.M., Munro, K., Naheed, Z., Nissr, A., O'connell, A.M., Oguti, B., Okafor, H., Organ, S., Osbourne, J., Otter, A., Patel, M., Platt, S., Pople, D., Potts, K., Ramsay, M., Robotham, J., Rokadiya, S., Rowe, C., Saei, A., Sebbage, G., Semper, A., Shrotri, M., Simmons, R., Soriano, A., Staves, P., Taylor, S., Taylor, A., Tengbe, A., Tonge, S., Vusirikala, A., Wallace, S., Wellington, E., Zambon, M., Corrigan, D., Sartaj, M., Cromey, L., Campbell, S., Braithwaite, K., Price, L., Haahr, L., and Stewart, S. 2021. COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2 mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study. *Lancet*, **397**: 1725–1735. PMID: [33901423](#). doi: [10.1016/S0140-6736\(21\)00790-X](#).
- Han, M.S., Choi, E.H., Chang, S.H., Jin, B.-L., Lee, E.J., Kim, B.N., Kim, M.K., Doo, K., Seo, J.-H., Kim, Y.-J., Kim, Y.J., Park, J.Y., Suh, S.B., Lee, H., Cho, E.Y., Kim, D.H., Kim, J.M., Kim, H.Y., Park, S.E., Lee, J.K., Jo, D.S., Cho, S.-M., Choi, J.H., Jo, K.J., Choe, Y.J., Kim, K.H., and Kim, J.-H. 2021. Clinical characteristics and viral RNA detection in children with coronavirus disease 2019 in the Republic of Korea. *JAMA Pediatr.* **175**: 73. PMID: [32857112](#). doi: [10.1001/jamapediatrics.2020.3988](#).
- Heald-Sargent, T., Muller, W.J., Zheng, X., Rippe, J., Patel, A.B., and Kocielek, L.K. 2020. Age-Related Differences in Nasopharyngeal Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Levels in Patients With Mild to Moderate Coronavirus Disease 2019 (COVID-19). *JAMA Pediatr.* **174**: 902. PMID: [32745201](#). doi: [10.1001/jamapediatrics.2020.3651](#).
- Heath, P.T., Galiza, E.P., Baxter, D.N., Boffito, M., Browne, D., Burns, F., Chadwick, D.R., Clark, R., Cosgrove, C., Galloway, J., Goodman, A.L., Heer, A., Higham, A., Iyengar, S., Jamal, A., Jeanes, C., Kalra, P.A., Kyriakidou, C., Mcauley, D.F., Meyrick, A., Minassian, A.M., Minton, J., Moore, P., Munsoor, I., Nicholls, H., Osanlou, O., Packham, J., Pretswell, C.H., San Francisco Ramos, A., Saralaya, D., Sheridan, R.P., Smith, R., Soiza, R.L., Swift, P.A., Thomson, E.C., Turner, J., Viljoen, M.E., Albert, G., Cho, I., Dubovsky, F., Glenn, G., Rivers, J., Robertson, A., Smith, K., and Toback, S. 2021. Safety and efficacy of NVX-CoV2373 Covid-19 vaccine. *N. Engl. J. Med.* doi: [10.1056/NEJMoa2107659](#).
- Jacot, D., Greub, G., Jatton, K., and Opota, O. 2020. Viral load of SARS-CoV-2 across patients and compared to other respiratory viruses. *Microbe. Infect.* **22**: 617–621. doi: [10.1016/j.micinf.2020.08.004](#).
- Jones, T.C., Biele, G., Mühlemann, B., Veith, T., Schneider, J., Beheim-Schwarzbach, J., Bleicker, T., Tesch, J., Schmidt, M.L., Sander, L.E., Kurth, F., Menzel, P., Schwarzer, R., Zuchowski, M., Hofmann, J., Krumbholz, A., Stein, A., Edelmann, A., Corman, V.M., and Drosten, C. 2021. Estimating infectiousness throughout SARS-CoV-2 infection course. *Science*, **373**: eabi5273. PMID: [34035154](#). doi: [10.1126/science.abi5273](#).
- Lopez Bernal, J., Andrews, N., Gower, C., Gallagher, E., Simmons, R., Thelwall, S., Stowe, J., Tessier, E.,

- Groves, N., Dabrera, G., Myers, R., Campbell, C.N.J., Amirthalingam, G., Edmunds, M., Zambon, M., Brown, K.E., Hopkins, S., Chand, M., and Ramsay, M. 2021a. Effectiveness of Covid-19 Vaccines against the B.1.617.2 (Delta) Variant. *N. Engl. J. Med.* **385**: 585–594. doi: [10.1056/NEJMoa2108891](https://doi.org/10.1056/NEJMoa2108891).
- Lopez Bernal, J., Andrews, N., Gower, C., Robertson, C., Stowe, J., Tessier, E., Simmons, R., Cottrell, S., Roberts, R., O'doherty, M., Brown, K., Cameron, C., Stockton, D., Mcmenamin, J., and Ramsay, M. 2021b. Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on covid-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study. *BMJ*, 373: n1088. doi: [10.1136/bmj.n1088](https://doi.org/10.1136/bmj.n1088).
- Ludvigsson, J.F. 2020a. Case report and systematic review suggest that children may experience similar long-term effects to adults after clinical COVID-19. *Acta Paediatr.* **110**: 914–921. doi: [10.1111/apa.15673](https://doi.org/10.1111/apa.15673).
- Ludvigsson, J.F. 2020b. Children are unlikely to be the main drivers of the COVID-19 pandemic – A systematic review. *Acta Paediatr.* **109**: 1525–1530. doi: [10.1111/apa.15371](https://doi.org/10.1111/apa.15371).
- Paul, L.A., Daneman, N., Schwartz, K.L., Science, M., Brown, K.A., Whelan, M., Chan, E., and Buchan, S.A. 2021. Association of Age and Pediatric Household Transmission of SARS-CoV-2 Infection. *JAMA Pediatr.* doi: [10.1001/jamapediatrics.2021.2770](https://doi.org/10.1001/jamapediatrics.2021.2770).
- Puranik, A., Lenehan, P.J., Silvert, E., Niesen, M.J.M., Corchado-Garcia, J., O'horo, J.C., Virk, A., Swift, M.D., Halamka, J., Badley, A.D., Venkatakrishnan, A.J., and Soundararajan, V. 2021. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. *medRxiv*, 8.6.21261707. PMID: [34401884](https://pubmed.ncbi.nlm.nih.gov/34401884/). doi: [10.1101/2021.08.06.21261707](https://doi.org/10.1101/2021.08.06.21261707).
- Riphagen, S., Gomez, X., Gonzalez-Martinez, C., Wilkinson, N., and Theocharis, P. 2020. Hyperinflammatory shock in children during COVID-19 pandemic. *Lancet*, **395**: 1607–1608. PMID: [32386565](https://pubmed.ncbi.nlm.nih.gov/32386565/). doi: [10.1016/S0140-6736\(20\)31094-1](https://doi.org/10.1016/S0140-6736(20)31094-1).
- Roifman, C.M. 2020. Managing primary immunodeficiency during the COVID-19 pandemic. *LymphoSign J.* **7**: 85–89. doi: [10.14785/lymphosign-2020-0009](https://doi.org/10.14785/lymphosign-2020-0009).
- Roifman, C.M., and Vong, L. 2021a. COVID-19 post-vaccination recommendations in primary immunodeficiency. *LymphoSign J.* Just-IN doi: [10.14785/lymphosign-2021-0023](https://doi.org/10.14785/lymphosign-2021-0023).
- Roifman, C.M., and Vong, L. 2021b. COVID-19 vaccination for patients with primary immunodeficiency. *LymphoSign J.* **8**: 37–45. doi: [10.14785/lymphosign-2021-0020](https://doi.org/10.14785/lymphosign-2021-0020).
- Sheikh, A., Mcmenamin, J., Taylor, B., and Robertson, C. 2021. SARS-CoV-2 Delta VOC in Scotland: demographics, risk of hospital admission, and vaccine effectiveness. *Lancet*, **397**: 2461–2462. PMID: [34139198](https://pubmed.ncbi.nlm.nih.gov/34139198/). doi: [10.1016/S0140-6736\(21\)01358-1](https://doi.org/10.1016/S0140-6736(21)01358-1).
- Shrotri, M., Krutikov, M., Palmer, T., Giddings, R., Azmi, B., Subbarao, S., Fuller, C., Irwin-Singer, A., Davies, D., Tut, G., Bernal, J.L., Moss, P., Hayward, A., Copas, A., and Shallcross, L. 2021. Vaccine effectiveness of the first dose of ChAdOx1 nCoV-19 and BNT162b2 against SARS-CoV-2 infection in residents of Long-Term Care Facilities (VIVALDI study). *medRxiv*, 2021.03.26.21254391. doi: [10.1016/S1473-3099\(21\)00289-9](https://doi.org/10.1016/S1473-3099(21)00289-9).
- Stawicki, S., Jeanmonod, R., Miller, A., Paladino, L., Gaieski, D., Yaffee, A., De Wulf, A., Grover, J., Papadimos, T., Bloem, C., Galwankar, S., Chauhan, V., Firstenberg, M., Di Somma, S., Jeanmonod, D., Garg, S., Tucci, V., Anderson, H., Fatimah, L., Worlton, T., Dubhashi, S., Glaze, K., Sinha, S., Opara, I., Yellapu, V., Kelkar, D., El-Menyar, A., Krishnan, V., Venkataramanaiah, S., Leyfman, Y., Saoud Al Thani, H.B., Nanayakkara, P., Nanda, S., Cioè-Peña, E., Sardesai, I., Chandra, S., Munasinghe, A., Dutta, V., Dal Ponte, S., Izurieta, R., Asensio, J., and Garg, M. 2020. The 2019–2020 novel coronavirus (severe acute respiratory syndrome coronavirus 2) pandemic: A joint american college of academic international medicine-world academic council of emergency medicine multidisciplinary COVID-19 working group consensus paper. *J. Glob. Infect. Dis.* **12**: 47. PMID: [32773996](https://pubmed.ncbi.nlm.nih.gov/32773996/). doi: [10.4103/jgid.jgid_86_20](https://doi.org/10.4103/jgid.jgid_86_20).
- Thomson, H. 2021. Children with long covid. *New Sci.* **249**: 10–11. PMID: [33746327](https://pubmed.ncbi.nlm.nih.gov/33746327/).
- Waltuch, T., Gill, P., Zinns, L.E., Whitney, R., Tokarski, J., Tsung, J.W., and Sanders, J.E. 2020. Features of COVID-19 post-infectious cytokine release syndrome in children presenting to the emergency department. *Am. J. Emerg. Med.* **38**(10): 2246.e3–2246.e6. doi: [10.1016/j.ajem.2020.05.058](https://doi.org/10.1016/j.ajem.2020.05.058).
- Wu, Z., and Mcgoogan, J.M. 2020. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China. *Jama*, **323**: 1239. PMID: [32091533](https://pubmed.ncbi.nlm.nih.gov/32091533/). doi: [10.1001/jama.2020.2648](https://doi.org/10.1001/jama.2020.2648).
- Yonker, L.M., Neilan, A.M., Bartsch, Y., Patel, A.B., Regan, J., Arya, P., Gootkind, E., Park, G., Hardcastle, M., ST. John, A., Appleman, L., Chiu, M.L., Fialkowski, A., De La Flor, D., Lima, R., Bordt, E.A.,

Yockey, L.J., D'avino, P., Fischinger, S., Shui, J.E., Lerou, P.H., Bonventre, J.V., Yu, X.G., Ryan, E.T., Bassett, I.V., Irimia, D., Edlow, A.G., Alter, G., Li, J.Z., and Fasano, A. 2020. Pediatric Severe Acute

Respiratory Syndrome Coronavirus 2 (SARS-CoV-2): Clinical Presentation, Infectivity, and Immune Responses. *J. Pediatr.* **227**: 45–52.e5. PMID: [32827525](#). doi: [10.1016/j.jpeds.2020.08.037](#).