Available Research on COVID-19 and Pediatric Populations

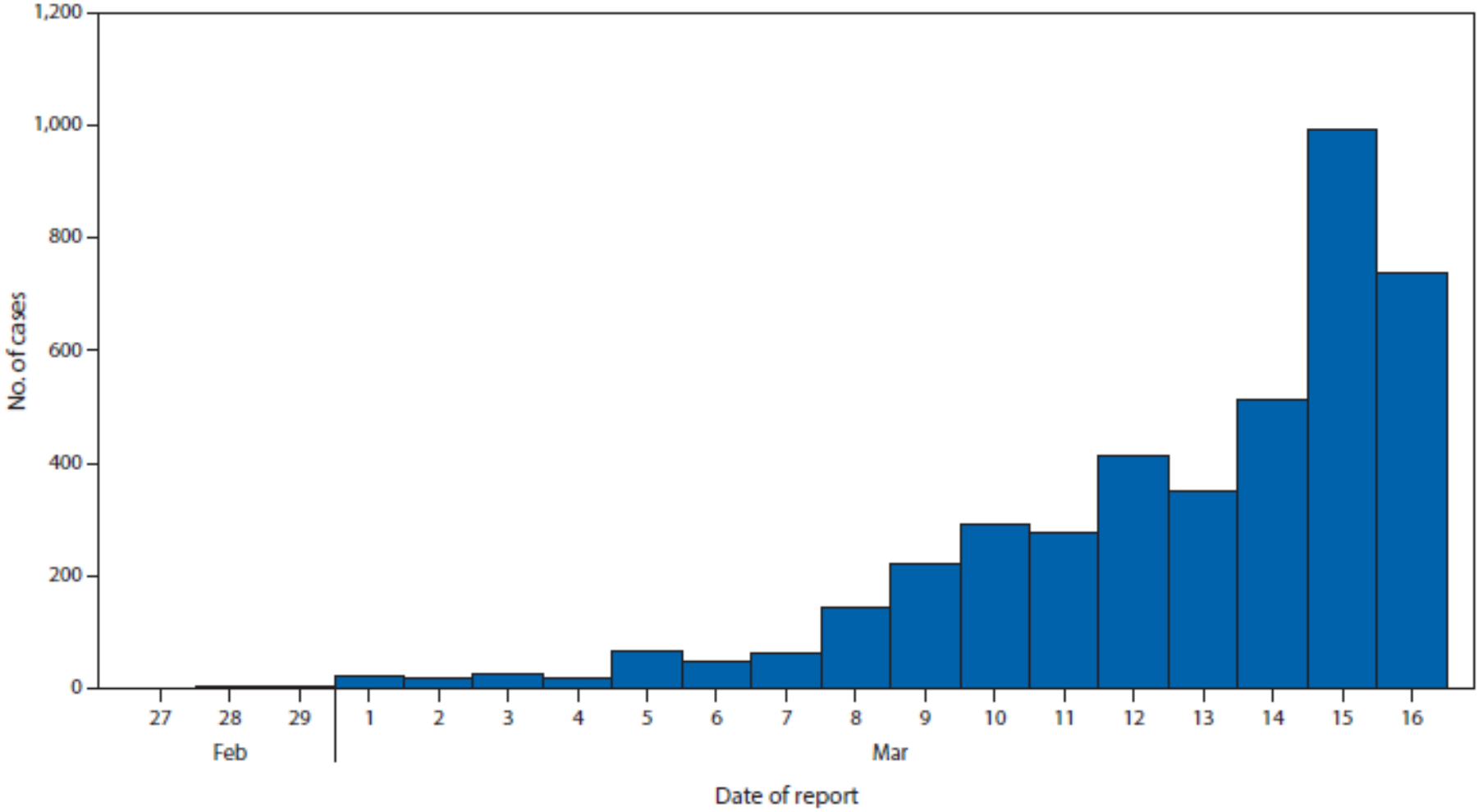
Summary Compiled by American Academy of Pediatrics

Research identified as of 3/23/20

CDC MMWR - March 18, 2020

- “Severe Outcomes Among Patients with Coronavirus Disease 2019 (COVID-19) — United States, February 12–March 16, 2020”
- Data from 4,226 COVID-19 cases reported in the United States
- Link: https://www.cdc.gov/mmwr/volumes/69/wr/pdfs/mm6912e2-H.pdf

FIGURE 1. Number of new coronavirus disease 2019 (COVID-19) cases reported daily*,† (N = 4,226) — United States, February 12–March 16, 2020

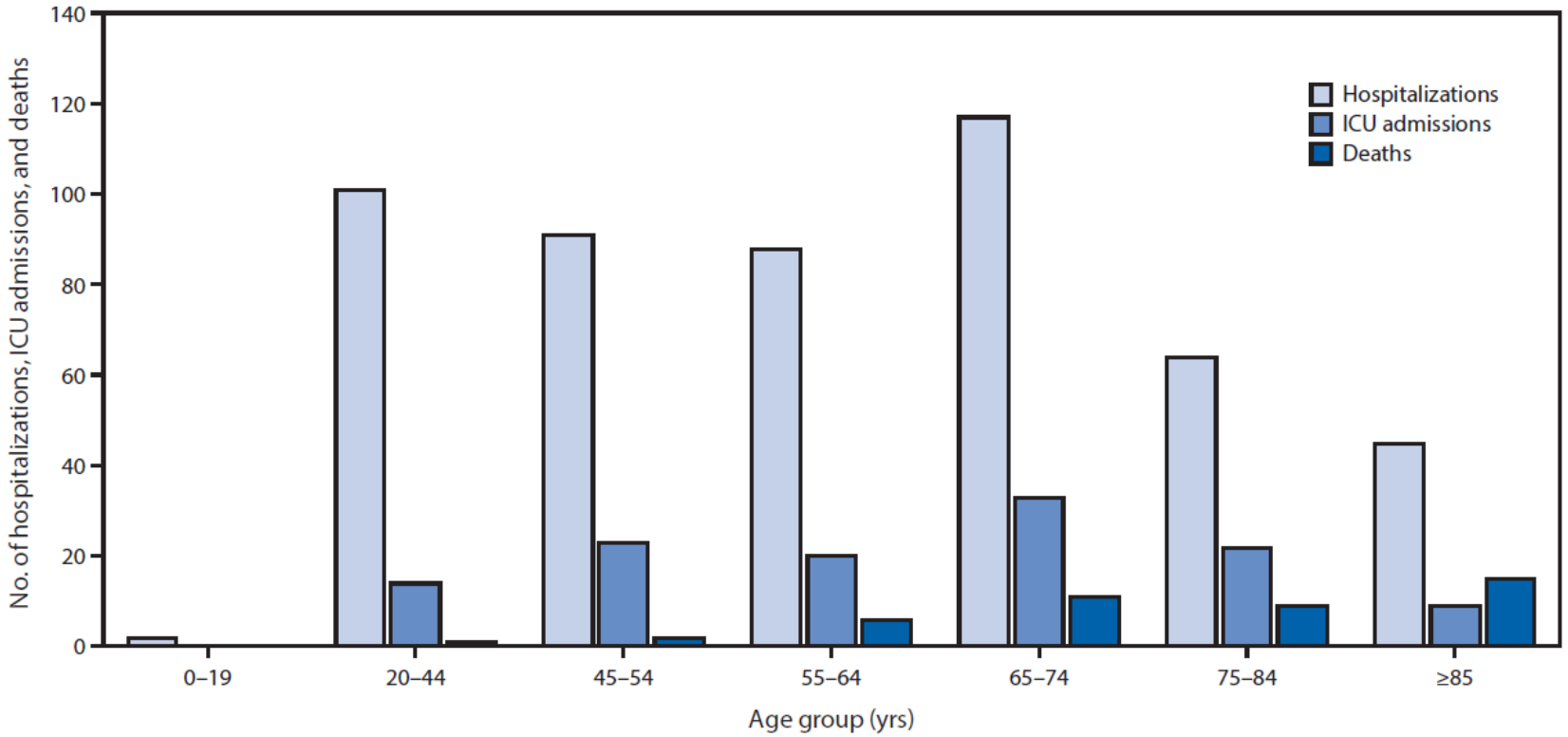


* Includes both COVID-19 cases confirmed by state or local public health laboratories, as well as those testing positive at the state or local public health laboratories and confirmed at CDC.

† Cases identified before February 28 were aggregated and reported during March 1–3.

Note: Age data not available for 42% of COVID-19 cases

FIGURE 2. COVID-19 hospitalizations,* intensive care unit (ICU) admissions,† and deaths,§ by age group — United States, February 12–March 16, 2020



* Hospitalization status missing or unknown for 1,514 cases.
† ICU status missing or unknown for 2,253 cases.
§ Illness outcome or death missing or unknown for 2,001 cases.

- Fatality was highest in persons aged ≥85, ranging from 10% to 27%, followed by 3% to 11% among persons aged 65–84 years, 1% to 3% among persons aged 55-64 years, <1% among persons aged 20–54 years

- No fatalities among persons aged ≤19 years.

TABLE. Hospitalization, intensive care unit (ICU) admission, and case–fatality percentages for reported COVID–19 cases, by age group — United States, February 12–March 16, 2020

Age group (yrs) (no. of cases)	%*		
	Hospitalization	ICU admission	Case-fatality
0–19 (123)	1.6–2.5	0	0
20–44 (705)	14.3–20.8	2.0–4.2	0.1–0.2
45–54 (429)	21.2–28.3	5.4–10.4	0.5–0.8
55–64 (429)	20.5–30.1	4.7–11.2	1.4–2.6
65–74 (409)	28.6–43.5	8.1–18.8	2.7–4.9
75–84 (210)	30.5–58.7	10.5–31.0	4.3–10.5
≥85 (144)	31.3–70.3	6.3–29.0	10.4–27.3
Total (2,449)	**20.7–31.4**	**4.9–11.5**	**1.8–3.4**

* Lower bound of range = number of persons hospitalized, admitted to ICU, or who died among total in age group; upper bound of range = number of persons hospitalized, admitted to ICU, or who died among total in age group with known hospitalization status, ICU admission status, or death.

Ji et al, 2020

- “Clinical features of pediatric patients with COVID-19: a report of two family cluster cases”
- Ji, L., Chao, S., Wang, Y. *et al.* Clinical features of pediatric patients with COVID-19: a report of two family cluster cases. *World J Pediatr* (2020). https://doi.org/10.1007/s12519-020-00356-2

- To improve the recognition of COVID-19 infection in children, we retrospectively reviewed two confirmed pediatric cases from two family clusters. Both clinical features and laboratory examination results of the children and their family members were described.
- The two confirmed children only presented with mild respiratory or gastrointestinal symptoms. Both of them had normal chest CT images. After general and symptomatic treatments, both children recovered quickly. Both families had travel histories to Hubei Province.
- Pediatric patients with COVID-19 are mostly owing to family cluster or with a close contact history. Infected children have relatively milder clinical symptoms than infected adults. We should attach importance to early recognition, early diagnosis, and early treatment of infected children.

Wu et al, 2020

- “Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China”
- WHO Collaborating Centre for Infectious Disease Epidemiology and Control, School of Public Health, LKS Faculty of Medicine, The University of Hong Kong, Hong Kong SAR, China
- Wu, J.T., Leung, K., Bushman, M. et al. Estimating clinical severity of COVID-19 from the transmission dynamics in Wuhan, China. Nat Med (2020). https://doi.org/10.1038/s41591-020-0822-7

- We estimate that the overall symptomatic case fatality risk (the probability of dying after developing symptoms) of COVID-19 in Wuhan was 1.4% (0.9–2.1%)

- Compared to those aged 30–59 years, those aged below 30 and above 59 years were 0.6 (0.3–1.1) and 5.1 (4.2–6.1) times more likely to die after developing symptoms.

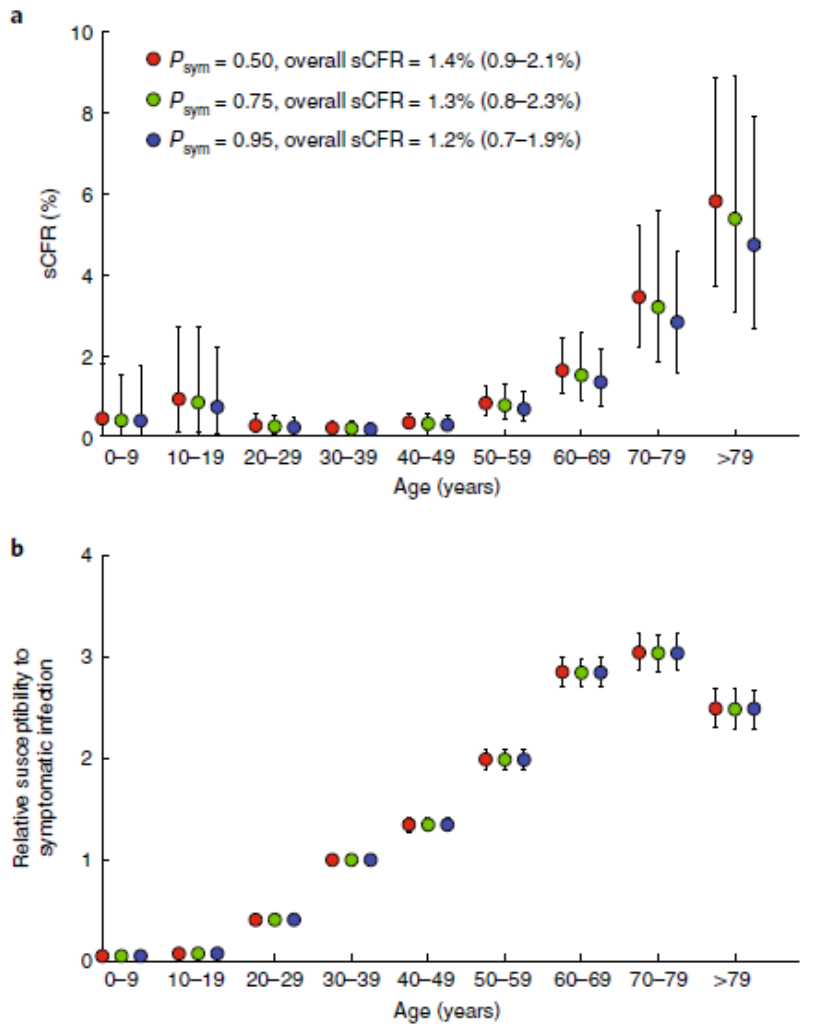


Fig. 2 | Estimates of age-specific sCFR and susceptibility to symptomatic infection for COVID-19 in Wuhan. a, Estimates of age-specific sCFRs assuming P_{sym} is 0.50 (red), 0.75 (green) and 0.95 (blue). **b**, Estimates of relative susceptibility to symptomatic infection by age assuming P_{sym} is 0.50 (red), 0.75 (green) and 0.95 (blue). The markers in both panels show the posterior means and the bars show 95% credible intervals (CrIs).

)

Fan et al, 2020

- “Anal swab findings in an infant with COVID-19”
- Department of Pediatrics, the First Affiliated Hospital of Yangtze University, Jingzhou, Hubei province, China
- Fan Q, Pan Y, Wu Q, Liu S, Song X, Xie Z, et al. Anal swab findings in an infant with COVID-19. Pediatr Invest. 2019;4:48-50. https://doi.org/10.1002/ped4.12186

ABSTRACT

Introduction: The transmission pathways of coronavirus disease 2019 (COVID-19) remain not completely clear. In this case study the test for the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in pharyngeal swab and anal swab were compared.

Case presentation: A 3-month-old girl was admitted to our hospital with COVID-19. Her parents had both been diagnosed with COVID-19. The results of pharyngeal swab and anal swab of the little girl were recorded and compared during the course of the disease. The oropharyngeal specimen showed negative result for SARS-CoV-2 on the 14th day after onset of the illness. However, the anal swab was still positive for SARS-CoV-2 on the 28th day after the onset of the illness.

Conclusion: The possibility of fecal-oral transmission of COVID-19 should be assessed. Personal hygiene during home quarantine merits considerable attention.

Lu et al, 2020

- “SARS-CoV-2 Infection in Children”
- Wuhan Children’s Hospital, Wuhan, China
- Analysis of children assessed and tested for COVID from 1/28-2/26 in Wuhan Central Hospital
- https://www.nejm.org/doi/full/10.1056/NEJMc2005073

- The median age of the infected children was 6.7 years (range: 1 day to 15 yrs)
- Fever was present in 41.5% of the children at any time during the illness; median duration of fever = 3 days.
- Other common signs and symptoms included cough and pharyngeal erythema
- In contrast with infected adults, most infected children appear to have a milder clinical course; 16% asymptomatic
- One death as of March 8 - A 10-month-old child with intussusception had multiorgan failure and died 4 weeks after admission.

Table 1. Epidemiologic Characteristics, Clinical Features, and Radiologic Findings of 171 Children with SARS-CoV-2 Infection.*

Characteristic	Value
Age	
Median (range)	6.7 yr (1 day–15 yr)
Distribution — no. (%)	
<1 yr	31 (18.1)
1–5 yr	40 (23.4)
6–10 yr	58 (33.9)
11–15 yr	42 (24.6)
Sex — no. (%)	
Male	104 (60.8)
Female	67 (39.2)
Diagnosis — no. (%)	
Asymptomatic infection	27 (15.8)
Upper respiratory tract infection	33 (19.3)
Pneumonia	111 (64.9)

Signs and symptoms	
Cough — no. (%)	83 (48.5)
Pharyngeal erythema — no. (%)	79 (46.2)
Fever — no. (%)	71 (41.5)
Median duration of fever (range) — days	3 (1–16)
Highest temperature during hospitalization — no. (%)	
<37.5°C	100 (58.5)
37.5–38.0°C	16 (9.4)
38.1–39.0°C	39 (22.8)
>39.0°C	16 (9.4)
Diarrhea — no. (%)	15 (8.8)
Fatigue — no. (%)	13 (7.6)
Rhinorrhea — no. (%)	13 (7.6)
Vomiting — no. (%)	11 (6.4)
Nasal congestion — no. (%)	9 (5.3)
Tachypnea on admission — no. (%)†	49 (28.7)
Tachycardia on admission — no. (%)‡	72 (42.1)
Oxygen saturation <92% during period of hospitalization — no. (%)	4 (2.3)

Xie, 2020

- “Pay attention to SARS-CoV-2 infection in children”
- Beijing Children’s Hospital
- Xie Z. Pay attention to SARS-CoV-2 infection in children. Pediatr Invest. 2020;4:1-4. https://doi.org/10.1002/ped4.12178

- Children are presumably equally susceptible to infection with SARS-CoV-2. Possible explanations for the lower rate of SARS-CoV-2 infections in children are as follows: a) children are less likely to be exposed to the virus, due to their daily activities; and b) pediatric patients did not undergo laboratory tests because of mild symptoms
- The potential for SARS-CoV-2 infection in children is of particular concern. Further investigation and research are needed to explore the reasons for the fewer number of cases and the mild clinical manifestations in children with SARS-CoV-2 infection.

Dong Y, Mo X, Hu Y, et al, 2020

- “Epidemiology of COVID-19 Among Children in China”
- Pre-pub before print article
- Researchers from medical centers across China
- Nation wide case series of 2143 pediatric patients with COVID-19 reported to the Chinese Center for Disease Control and Prevention from January 16 to February 8, 2020
- Link: https://pediatrics.aappublications.org/content/pediatrics/early/2020/03/16/peds.2020-0702.full.pdf

- 731 (34.1%) lab confirmed cases and 1412 (65.9%) suspected cases
- Over half of cases (56.6%) were boys though no significant gender differences were found
- >90% of pediatric patients experienced asymptomatic, mild, or moderate cases
- While children experienced less severe illness than adults, young children, especially infants, are more vulnerable to disease
- Median time from onset to diagnosis was 2 days

Table 1 Characteristics of Children' COVID-19 Cases in China

Characteristics	All cases	Different Category		
		Confirmed	Suspected	*P* Value
Median age (Interquartile range)	7.00 (11.0)	10.00(11.0)	6.00(10.0)	<0.001
Age group				
<1	379(17.7)	86(11.8)	293(20.8)	
1-5	493(23.0)	137(18.7)	356(25.2)	
6-10	523(24.4)	171(23.4)	352(24.9)	<0.001
11-15	413(19.3)	180(24.6)	233(16.5)	
>15	335(15.6)	157(21.5)	178(12.6)	
Gender				
Boy	1213(56.6)	420(57.5)	793(56.2)	0.567
Girl	930(43.4)	311(42.5)	619(43.8)	
Severity of illness				
Asymptomatic	94(4.4)	94(12.9)	0(0.0)	
Mild	1091(50.9)	315(43.1)	776(54.9)	
Moderate	831(38.8)	300(41.0)	531(37.6)	
Severe	112(5.2)	18(2.5)	94(6.7)	<0.001
Critical	13(0.6)	3(0.4)	10(0.7)	
Missing	2(0.1)	1(0.1)	1(0.1)	
Days from symptom onset to diagnosis				
Median days (Interquartile range)	2(4.0)	3(4.0)	2(4.0)	<0.001
Range	0-42	0-42	0-36	
Province				
Hubei	984(45.9)	229(31.3)	755(53.5)	
Surrounding areas*	397(18.5)	155(21.2)	242(17.1)	<0.001
Others	762(35.6)	347(47.5)	415(29.4)	
Total	2143	731(34.1)	1412(65.9)	

Data are presented with median (Interquartile range) and n (%).

*Surrounding areas are the provinces and Municipality bordering Hubei, they are Anhui, Henan, Hunan, Jiangxi, Shaanxi and Chongqing.

Table 2 Different Severity of Illness by Age Group

Age group*	Asymptomatic	Mild	Moderate	Severe	Critical	Total
<1	7(7.4)	205(18.8)	127(15.3)	33(29.5)	7(53.8)	379(17.7)
1-5	15(16.0)	245(22.5)	197(23.7)	34(30.4)	2(15.4)	493(23.0)
6-10	30(31.9)	278(25.5)	191(23.0)	22(19.6)	0(0)	521(24.3)
11-15	27(28.7)	199(18.2)	170(20.5)	14(12.5)	3(23.1)	413(19.3)
>15	15(16.0)	164(15.0)	146(17.5)	9(8.0)	1(7.7)	335(15.7)
Total	94	1091	831	112	13	2141(100)

Data were presented with number and percent (%);*Two cases had missing values.

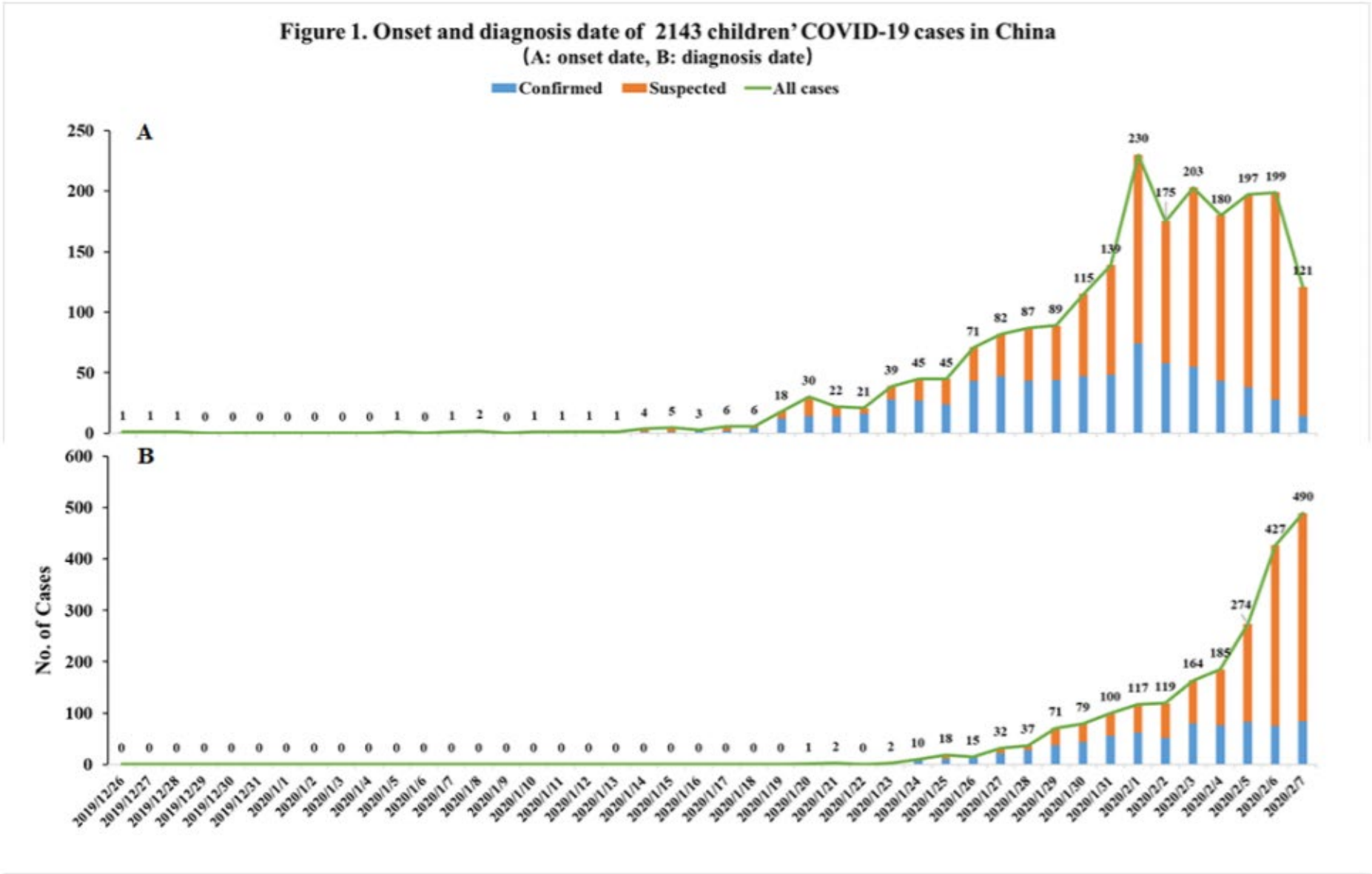


Fig 1 Onset and Diagnosis Date of 2143 children's COVID-19 Cases in China. A: onset date; B: diagnosis date

Wei M, Yuan J, Liu Y, et al, 2020

- “Novel Coronavirus Infection in Hospitalized Infants Under 1 Year of Age in China”
- E-pub before print
- Retrospective study of all hospitalized infants with COVID-19 between December 8, 2019 and February 6, 2020 in China
- Link: https://jamanetwork.com/journals/jama/fullarticle/2761659

- 9 patients were identified, and all were hospitalized
- 4 patients had fever, 2 had mild upper respiratory tract symptoms, 1 was asymptomatic but tested positive for COVID-19
- Time from admission to diagnosis was 3 days
- All infants were exposed to at least 1 family member with the illness; with the infant's illness occurring after the family member was infected

Table. Characteristics of 9 Hospitalized Infants Infected With Coronavirus Disease 2019

Characteristic	Patient 1	2	3	4	5	6	7	8	9
Demographics									
Age	9 mo	11 mo	8 mo	10 mo	7 mo	1 mo 26 d	3 mo	3 mo 22 d	6 mo
Sex	Female	Female	Female	Male	Female	Female	Female	Female	Male
Symptoms at onset	Fever, peaking at 38.8 °C	Mild fever	None	NA	Fever	Runny nose; cough	Cough; sputum production	Fever	NA
Time between admission and diagnosis, d	1	1	3	3	1	1	1	1	2
Epidemiologic history									
No. of family members infected	2	1	5	1	2	2	2	1	1
Linkage to Wuhan	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	No
Treatment									
Intensive unit care	No	No	No	No	No	No	No	No	No
Mechanical ventilation	No	No	No	No	No	No	No	No	No
Severe complications	No	No	No	No	No	No	No	No	No

Abbreviation: NA, not available.

Liu W, et al, 2020

- “Detection of Covid-19 in Children in Early January 2020 in Wuhan, China”
- Letter to the editor NEJM
- Retrospective study of respiratory infections at three branches of Tongji Hospital
- Link: https://www.nejm.org/doi/pdf/10.1056/NEJMc2003717?articleTools=true

- Findings indicate that COVID-19 occurred in children early in the epidemic

- Patients were treated with antiviral agents, antibiotics, and supportive therapies

- All patients recovered after hospitalization (range of days hospitalized, 5 to 13)

Table 1. Summary of the Clinical Characteristics of Six Children with Covid-19.*

Characteristic	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Age (yr)	3	7	3	1	3	4
Sex	Female	Female	Female	Male	Female	Male
CT findings	Patchy ground-glass opacities in both lungs	NA	Patchy shadows in both lungs	Patchy shadows in both lungs	Patchy shadows in both lungs	Normal
Treatments						
Ribavirin	Yes	No	No	No	No	Yes
Oseltamivir	Yes	Yes	Yes	Yes	Yes	Yes
Glucocorticoids	Yes	No	Yes	Yes	Yes	No
Supplemental oxygen	Yes	No	No	No	No	No
Intravenous immune globulin	Yes	No	No	No	No	No
Clinical course						
ICU admission	Yes	No	No	No	No	No
Duration of fever (days)	11	3	7	6	4	6
Duration of hospitalization (days)	13	7	7	5	10	8
City of residence	Wuhan	Wuhan	Huangshi	Wuhan	Wuhan	Wuhan

* Covid-19 denotes coronavirus disease 2019, CT computed tomography, ICU intensive care unit, and NA not available.

Chen F, Liu Z, Zhang F, et al, 2020

- “First case of severe childhood novel coronavirus pneumonia in China”
- Pre-pub online ahead of print
- Case study of initial case of novel coronavirus pneumonia in a child
- Link: http://rs.yiigle.com/yufabiao/1180144.htm

Table 1 Changes of Infection Indicators and Cellular Immunity in Children with Critical New Coronavirus Pneumonia

Admission time	Index of infection						cellular immunity					
	WBC ($\times 10^9$ / L)	NEU ($\times 10^9$ / L)	LYM ($\times 10^9$ / L)	MONO ($\times 10^9$ / L)	CRP (mg / L)	PCT (mg / L)	$CD3^+$ T	$CD8^+$ T	$CD4^+$ T	$CD16^+CD56^+$	$CD19^+$ B	$CD4^+/CD8^+$ T
Day 1	11.96	7.77	2.48	1.69	24.8	0.43	0.381	0.167	0.202	0.062	0.513	1.21
3rd day	3.64	1.78	1.61	0.25	36.5	1.85	0.642	0.315	0.309	0.027	0.301	0.98
Day 5	10.74	8.04	1.84	0.86	59.7	0.66	0.348	0.173	0.186	0.003	0.593	1.07
Day 9	7.99	3.88	3.36	0.58	5.4	0.06	0.736	0.274	0.441	0.008	0.240	1.61
Day 11	9.19	3.7	2.70	0.74	3.6	0.06	0.610	0.265	0.335	0.022	0.363	1.26

Note: WBC is white blood cell count, the reference value range is $5.50 \times 10^9 \sim 12.20 \times 10^9$ / L, NEU is neutrophil count, the reference value range is $1.08 \times 10^9 \sim 3.90 \times 10^9$ / L, LYM is lymph Cell count, reference value range is 1.15×10^9 to 6.00×10^9 / L, MONO is monocyte count, reference value range is 0.26×10^9 to 2.40×10^9 / L, CRP is C-reactive protein, reference value The range is 0 ~ 3.0 mg / L, PCT is procalcitonin, and the reference value range is 0 ~ 0.05 mg / L; the reference value range of $CD3^+$ T lymphocyte percentage is 0.386 ~ 0.700, and the reference value range of $CD8^+$ T lymphocyte percentage 0.132 ~ 0.385, $CD4^+$ T lymphocyte percentage reference value range is 0.142 ~ 0.370, $CD16^+$ CD56 cell percentage reference value range is 0.079 ~ 0.340, $CD19^+$ B lymphocyte percentage reference value range is 0.109 ~ 0.280, $CD4^+/CD8^+$ T lymphocyte ratio reference value range 0.96 ~ 2.05

Table 2 Changes of humoral immunity and cytokines in children with severe new-type coronavirus pneumonia

Admission time	Humoral immunity (g / L)					Cytokine (ng / L)					
	IgG	IgA	IgM	Complement C3	Complement C4	IL-2	IL-4	IL-6	IL-10	TNF-α	IFN-γ
Day 1	4.43	0.66	1.18	0.66	0.10	1.03	4.02	120.31	33.38	4.47	1.92
3rd day	10.20	0.48	0.48	0.36	0.04	0.99	2.93	90.85	6.10	1.31	3.23
Day 5	12.80	0.93	0.75	0.47	0.09	1.42	1.64	65.86	3.95	1.23	2.42
Day 9	10.30	0.99	1.20	0.53	0.09	1.37	2.74	12.81	3.08	2.12	3.01
Day 11	10.40	0.99	1.34	0.56	0.09	1.16	1.28	4.64	2.48	0.97	1.29

Note: IgG reference value range is 4.00 ~ 10.39 g / L, IgA reference value range is 0.28 ~ 1.08 g / L, IgM reference value range is 0.42 ~ 1.73 g / L, complement C3 reference value range is 0.70 ~ 1.12 g / L Reference range of complement C4 is 0.10 ~ 0.38 g / L; IL is interleukin; reference range of IL-2 is 0 ~ 11.40 ng / L, reference range of IL-4 is 0 ~ 12.90 ng / L, IL- 6 Reference value range is 0 ~ 20.9 ng / L, IL-10 reference value range is 0 ~ 5.9 ng / L, TNF-α is tumor necrosis factor α, reference value range is 0 ~ 5.50 ng / L, IFN-γ is Interferon gamma, reference value range is 0 ~ 17.30 ng / L

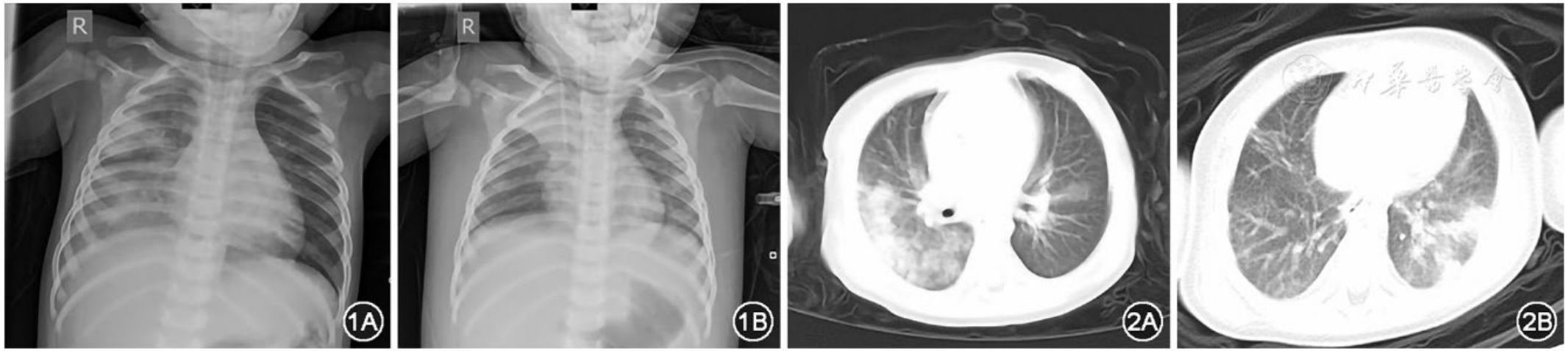


figure 1 Chest X-rays of children with severe new-type coronavirus pneumonia. A: Large blurred images of right upper and lower right lungs (on admission); B: partial absorption of right lower lobe pneumonia, right upper lobe atelectasis (day 6 of treatment)

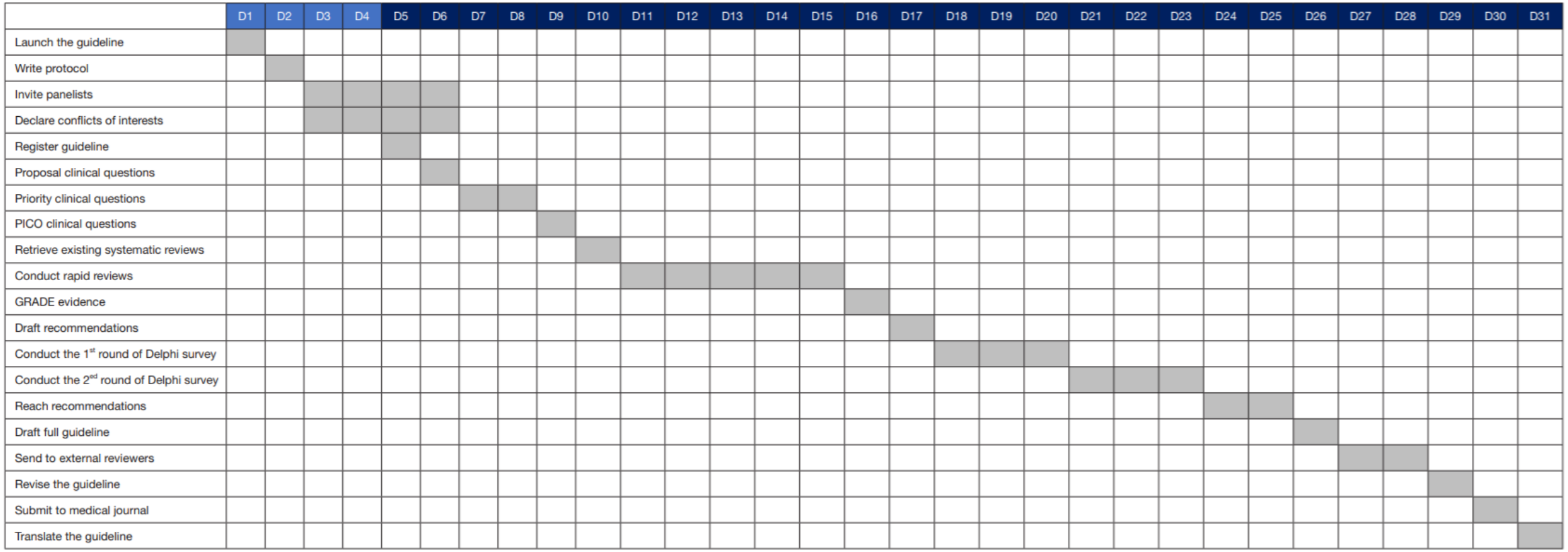
figure 2 Chest CT picture of children with severe new-type coronavirus pneumonia. A: The texture of the two lungs is enhanced, and large consolidating shadows can be seen in the right lung, with ground glass shadows (on the day of admission); B: the right lung lesions are significantly improved, and the left lung lesions are somewhat improved. Progress (11th day of admission)

Li W, et al, 2020

- “Protocol for the development of a rapid advice guidelines for management of children with SARS-CoV-2 infection”
- Online publication
- COVID-19 Evidence and Recommendations Working Group
- Guideline; Informative guideline for infection prevention practices
- Link: http://apm.amegroups.com/article/view/36766

- Step-by-step guide on how to create a protocol for COVID-19 that follows WHO requirements for rapid advice guideline development

Supplementary



Note: D1=Jan 28, D31=Feb 29 (from Jan 28 to Feb 29).

Figure S1 Gantt Chart: key steps and timeline.

Wang Y, Zhu LQ, 2020

- “Pharmaceutical care recommendations for antiviral treatments in children with coronavirus disease 2019”
- Online publication
- Department of Pharmacy, Tianjin Children’s Hospital
- Clinical practice guideline
- Link: https://link.springer.com/content/pdf/10.1007/s12519-020-00353-5.pdf

Table 1 Dosage regimen and precaution of antiviral drugs in children

Drugs	Age available	Dosage regimen of COVID-19 in children	Precaution/contraindication
IFN-α	Nebulization: using with caution in neonates and infants younger than 2 months	Nebulization: 200,000–400,000 IU/kg or 2–4 μg/kg in 2 mL sterile water, twice daily for 5–7 days Spray: 1–2 sprays on each nostril and 8–10 sprays on the oropharynx, once every 1–2 h, 8–10 sprays/day for 5–7 days	Contraindication: CrCl < 50 mL/min; histories of mental illness, severe or unstable heart disease, or aplastic anemia
LPVr	China: OS ≥ 6 months, T ≥ 2 years USA: OS ≥ 14 days, T ≥ 6 months	Body weight (kg) 7–15: 12 mg/3 mg/kg/time, twice daily for 1–2 weeks 15–40: 10 mg/2.5 mg/kg/time, twice daily for 1–2 weeks > 40: 400 mg/100 mg/time, twice daily for 1–2 weeks	Contraindication: patients with severe hepatic insufficiency Not be recommended: children with jaundice
Ribavirin	China: oral dosage forms ≥ 6 years USA and Europe: oral dosage forms ≥ 3 years	Intravenous infusion at a dose of 10 mg/kg every time (maximum 500 mg every time), 2–3 times daily	Not be recommended: CrCl < 50 mL/min Should be discontinued: SCr > 2 mg/dL Warning: hemolytic anemia
CD	Using with caution	No recommendation	Acute poisoning is usually fatal with a dose of 50 mg/kg
Arbidol	≥ 2 years for influenza in Russia	No recommendation	Using with caution in patients with liver dysfunction

IFN-α interferon-α, *LPVr* lopinavir/ritonavir, *CD* chloroquine diphosphate, *COVID-19* coronavirus disease 2019, *CrCl* creatinine clearance, *SCr* serum creatinine, *OS* oral solutions, *T* tablets

Wang G, et al, 2020

- “Mitigate the effects of home confinement on children during the COVID-19 outbreak”
- Online publication
- Recommendation
- Link: https://www.thelancet.com/action/showPdf?pii=S0140-6736%2820%2930547-X

- Government and school systems should provide guidelines on effective online learning strategies

- Health promotional videos should be used to motivate children and adolescents to maintain physical fitness, healthy eating habits, and regular sleep schedules

- Psychologists and social workers can interact with both children and parents virtually to provide psychosocial support

- Parents should provide open communication with children on age-appropriate COVID-19 information and model healthy behaviors

Hong H, Wang Y, Chung H-T, Chen C-J, 2020

- “Clinical characteristics of novel coronavirus disease 2019 (COVID-19) in newborns, infants and children”
- Journal pre-proof
- Descriptive information on epidemiological and clinical presentation in children
- Link: https://www.sciencedirect.com/science/article/pii/S1875957220300267

- Most childhood cases emerge from family clusters; with most having epidemiological links to infected adults

- Children are more likely to asymptomatic or have a fever, dry cough, and fatigue with few upper respiratory symptoms; some experience abdominal discomfort, nausea, vomiting, abdominal pain, and diarrhea

- Most symptomatic pediatric cases are mild, and recovery occurs within 1-2 weeks of onset

- Cases of neonatal infection with SARS-CoV-2 have been reported in China, with the youngest being 30 h after birth. However, there is currently no evidence of intrauterine infection caused by vertical transmission from mother to child. Newborns may still acquire infection through close contact with infected mothers

Lee PI, et al, 2020

- “Are children less susceptible to COVID-19?”
- Journal pre-proof
- Narrative review of underlying factors as to why children are less likely to be infected
- Link: https://www.sciencedirect.com/science/article/pii/S1684118220300396?via%3Dihub

- Recent data reported from the Chinese Centers for Diseases Control and Prevention indicated that among the 44,672 confirmed cases of COVID-19 as of February 11, 2020, 416 (0.9%) were aged 0-10 years and 549 (1.2%) aged 10-19 years

- Children may be less likely to contract the virus due to them being less likely to participate in outdoor activities and travel internationally

- Children have a more active innate immune response and healthier respiratory tracks due to less prolonged exposure to cigarette smoke and air pollution as compared to adults

- A difference in the distribution, maturation, and functioning of viral receptors may also play a role. Prior research of HCoV-NL63 infections suggest that this infection is more common in adults than children due to immune reactions; indicating relative resistance of SARS-CoV-2 in children

Shen K, et al, 2020

- “Diagnosis, treatment, and prevention of 2019 novel coronavirus infection in children: experts’ consensus statement”
- Online publication
- Narrative review
- Link: https://link.springer.com/article/10.1007%2Fs12519-020-00343-7

- The consensus statement summarizes strategies on diagnosis, treatment and prevention of COVID-19 in children

- Infection should be suspected in patients who meet one of the criteria in the epidemiological history and any two criteria in the clinical manifestation category

- Treatment considerations include where to treat the patient, general treatment strategies, symptom management, and pharmaceutical interventions and psychosocial support as needed

- Prevention can be done through utilizing all infection prevention protocols, controlling sources of infection, blocking transmission pathways and maintaining optimal health to boost immunity

Shen KL, Yang YH, 2020

- “Diagnosis and treatment of 2019 novel coronavirus infection in children: a pressing issue”
- Online publication
- Case study/case series
- Link:

https://link.springer.com/article/10.1007%2Fs12519-020-00344-6

- Close contact with an infected person is the main transmission route in children
- Limited number of pediatric cases but still should follow prevention, diagnosis, and treatment protocols in children
- People of all ages are susceptible to COVID-19 and children can be more susceptible to viral respiratory illness due to respiratory tract characteristics and immature immune systems
- Children are susceptible to viral infections because of their immature immune function and relatively low levels of specific humoral and cellular immunity and IFN secretion.
- It is unknown if interferon treatment in children will be effective in children with COVID-19
- Most pediatric patients had mild symptoms and recovered within 1–2 weeks after disease onset

Kam KQ, et al, 2020

- “A Well Infant with Coronavirus Disease 2019 (COVID-19) with High Viral Load”
- Accepted manuscript; released online before official print
- Case study
- Link: https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciaa201/5766416

- A well 6-month-old infant with coronavirus disease 2019 (COVID-19) had positive nasopharyngeal swabs to day 16 of hospital admission

- Infant had close exposure to two parents who were suspected to have COVID-19. Apart from a single fever that lasted for an hour, the infant had no clinical signs or symptoms, despite having a high viral load for 16 days

- This case highlights the difficulties in establishing the true incidence of COVID-19 as asymptomatic individuals can excrete the virus for prolonged periods of time

- Asymptomatic patients play a role in human to human transmission

Lu Q, Shi Y, 2020

- “Coronavirus disease (COVID-19) and neonate: What neonatologist need to know.”
- Early view publication
- Review of current understanding of COVID-19 infection in neonates and children
- Link: https://onlinelibrary.wiley.com/doi/full/10.1002/jmv.25740

- Three neonates and more than 230 children cases have been reported, with no pediatric deaths
- Neonatologists need to assess newborn babies delivered by COVID-19 infected mothers or neonates in contact with infected caregivers
- Vertical mother-to-neonate transmission has not been detected
- Diagnostic tools include nasopharyngeal swabbing but repeat testing is needed after initial collection due to the rate of positive detection being less than 50%
- Neonatologists must wear proper protective equipment (hats, goggles, protective suits, gloves, N95 masks)
- If a neonate tests positive they should be placed in negative pressure or filtered rooms with no visitors to contain the spread of the virus

Feng Kai, et al, 2020

- “Analysis of CT features of 15 Children with 2019 novel coronavirus infection”
- Pre-publication online ahead of print
- Retrospective analysis of clinical data
- Link: http://rs.yiigle.com/yufabiao/1181979.htm

- 15 children were examined after being admitted to Shenzhen Third People's Hospital from January 16 to February 6 2020
- CT images showed distribution and features of lung lesions in children infected with COVID-19
- At the initial diagnosis of the CT image of the chest, no lesions were found in 6 cases; 9 cases showed pulmonary inflammation, including 7 cases of ground nodules in small nodules and 2 cases of ground opacities
- After 3 to 5 days of treatment review, 2 cases of chest CT inflammation were reduced compared to the previous, 3 cases had no lesions in the chest, and 1 case had no obvious changes; 9 cases were still positive for nucleic acid, among them, 6 cases of chest CT showed no significant changes in inflammation, and 3 cases of chest CT showed new inflammation. All of them showed ground glass nodules
- CT findings in this group of infected children are not typical and early imagining indicates that small nodular ground glass lesions are seen in the lungs

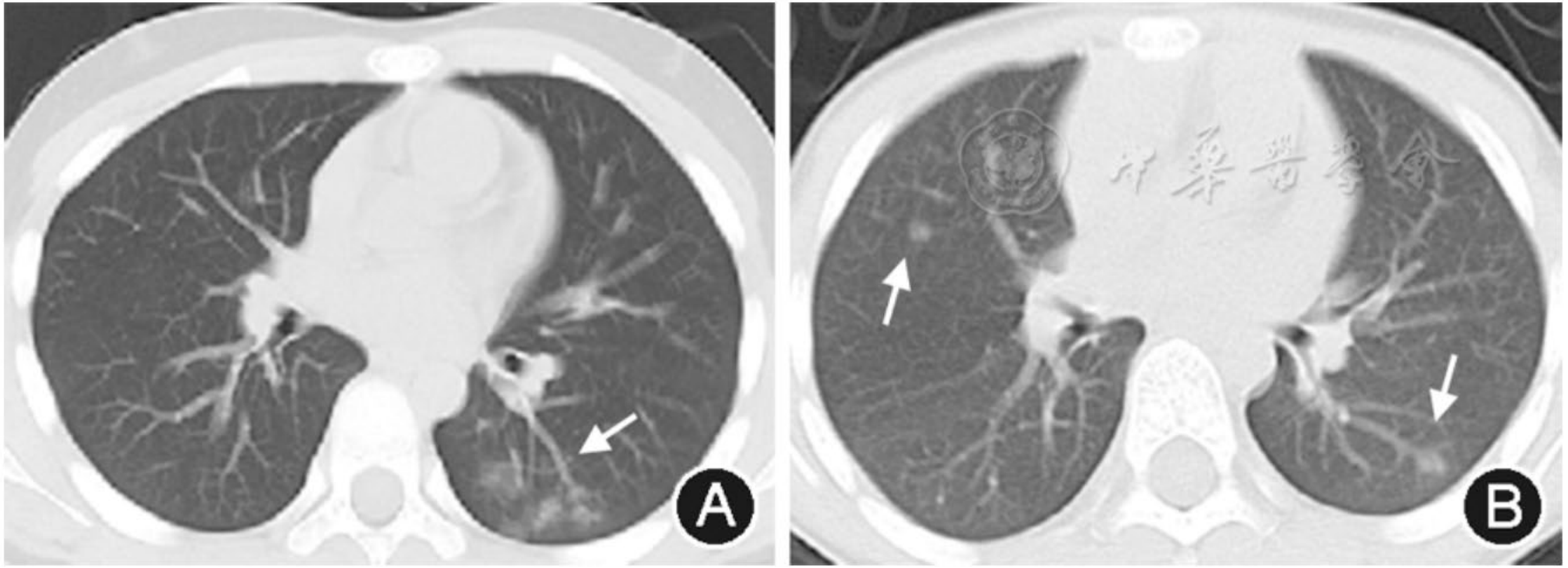


figure 1 Chest CT image of children with new type of coronavirus pneumonia on the day of admission A: Case 1 (male, 10 years old, no fever), sub-pleural patchy shadows on the dorsal segment of the left lower lobe, with blurred edges (indicated by arrows) ; B: Case 3 children (female, 10 years old, admitted to hospital for 1 d), the ground glass shadow of the subpleural nodules of the left lower lobe and the right upper anterior lobe can be seen (indicated by arrows)

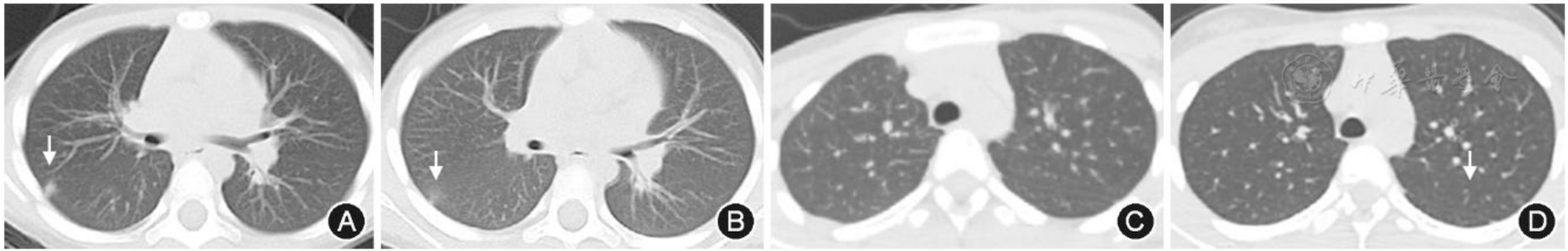


figure 2 Changes in CT images before and after treatment of children with new type of coronavirus pneumonia A: Example 5 (female) On the day of admission, ground nodules were seen under the pleura in the upper lobe of the right lung (indicated by arrows); B: Example 5 (female) was treated for 3 days After review, the nucleic acid test turned negative, and the ground nodules of the small nodules were reduced compared to the previous absorption and the density was reduced (indicated by the arrow); C: Example 4 (female) On the day of admission, no clear lesion was found in the left upper lobe; D: Example 4 (Female) After 5 days of treatment, the nucleic acid re-examination was still positive. Newly seen small glass nodules were seen under the pleura in the posterior segment of the upper lobe of the left lung.

Tang A, et al, 2020

- “Detection of Novel Coronavirus by RT-PCR in Stool Specimen from Asymptomatic Child, China.”
- Online research article
- Case study of a 10-year-old asymptomatic child
- Link: https://wwwnc.cdc.gov/eid/article/26/6/20-0301_article

- 10-year-old male had no fever or cough but had close contact with two individuals with laboratory-confirmed SARS-CoV-2

- 10-year-old male was isolated in the community and during the period from January 9-31 he had no signs or symptoms of SARS-CoV-2

- Nasopharyngeal swab and sputum samples were collected and came back negative

- A stool sample was collected 17 days after his last contact with infected individuals and the stool sample was positive, which resulted in the patient being hospitalized in isolation for monitoring

- SARS-CoV-2 is transmitted usually through respiratory droplets and close contact but indirect transmission may occur through stool

Figure

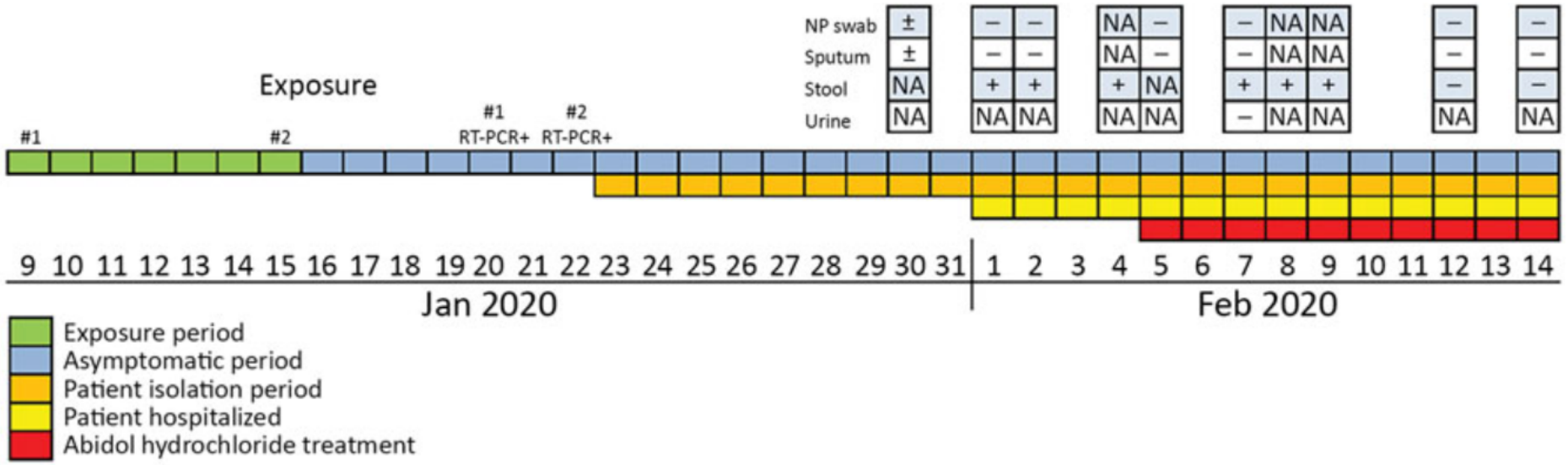


Figure. Timeline for detection of novel coronavirus by RT-PCR in stool specimen from asymptomatic child, China, January 9–February 14, 2020. NA, not available; NP, nasopharyngeal; RT-PCR, reverse transcription PCR; +, positive for novel coronavirus RNA by RT-PCR; ±, equivocal for novel coronavirus RNA by RT-PCR; –, negative for novel coronavirus RNA by RT-PCR.

Cai, J, et al, 2020

- “A Case Series of children with 2019 novel coronavirus infection: clinical and epidemiological features”
- Accepted manuscript
- Case series of children with COVID-19 outside of Wuhan, China
- Link: https://academic.oup.com/cid/advance-article/doi/10.1093/cid/ciaa198/5766430

- Between January 19th and February 3rd, a total of ten children with confirmed 2019-nCoV infection were admitted to the Children's Hospital in Shanghai, Hainan, Hefei in Anhui province, and Qingdao in Shandong province

- Preliminary results demonstrate that children present with mild respiratory symptoms, as compared to adults; fever and mild cough are common at disease onset in children

- Virus shedding in respiratory specimens is longer in children with mild COVID-19, which poses a challenge for infection control; extended viral shedding is seen in both respiratory and stool samples of children in the convalescent stage

- Most pediatric cases occurring outside of Wuhan were secondary exposures to the virus after being in contact with an adult within their household or an adult who recently traveled

Table. Epidemiological and clinical features among 2019-nCoV infected children

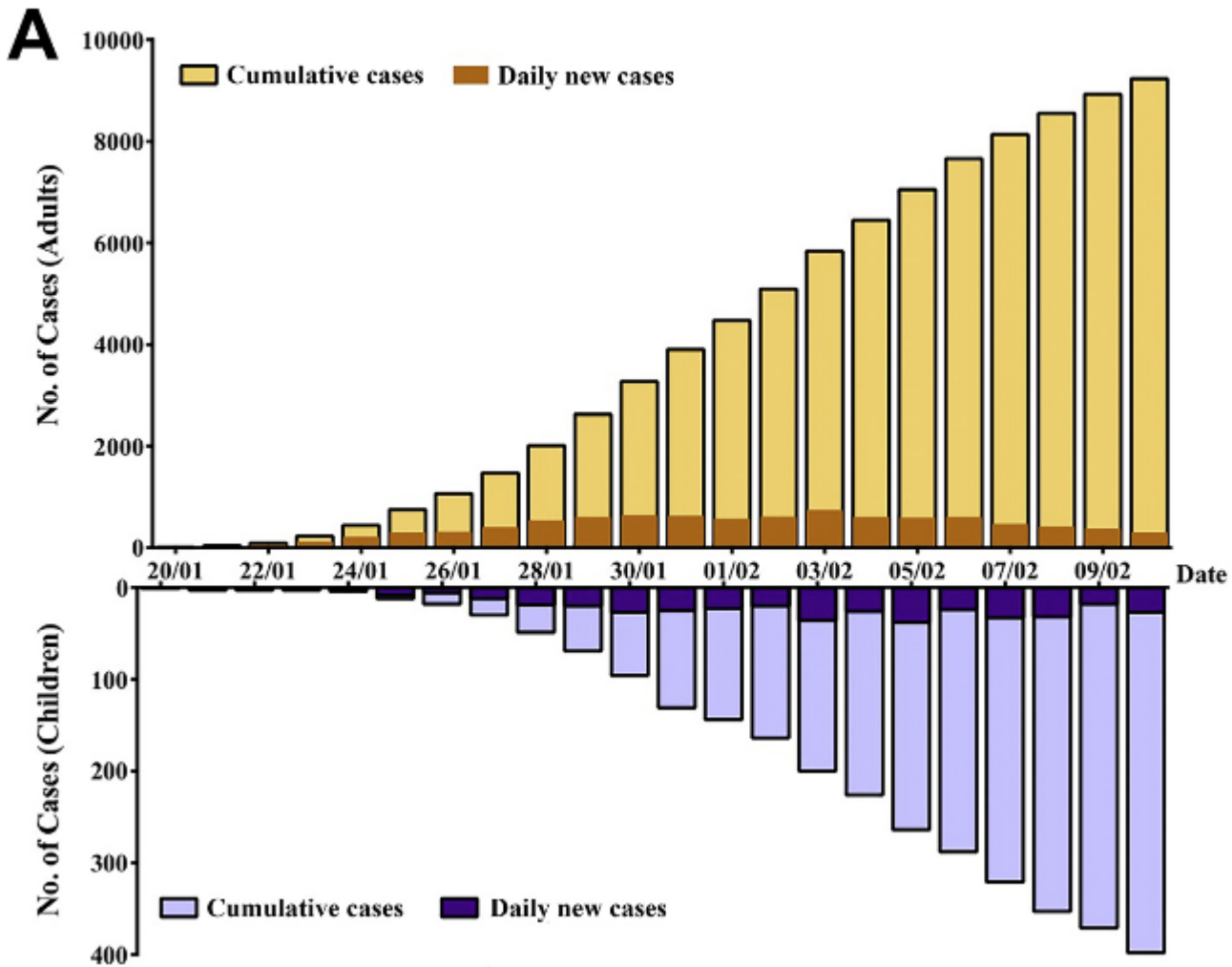
	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7	Patient 8	Patient 9	Patient 10
Basic information										
Admission date	19 Jan	25 Jan	31 Jan	1 Feb	3 Feb	30 Jan	26 Jan	1 Feb	27 Jan	27 Jan
City	Shanghai	Shanghai	Shanghai	Shanghai	Shanghai	Qingdao	Haikou	Sanya	Sanya	Hefei
Age (month)	84	131	131	108	7	72	3	48	96	60
Sex	Male	Female	Female	Male	Female	Female	Female	Female	Male	Male
Epidemiological history										
Exposure setting	Household	Household	Epidemic area	Bus travelling*	Household	Household	Epidemic area	Household	Household	Household
Contact with index case directly	**Yes**	**Yes**	Unknown	**Yes**	**Yes**	**Yes**	Unknown	**Yes**	**Yes**	**Yes**
Index case	Father	Adult sister	Unknown	Wuhan Travellers	Grandfather	Grandmother	Unknown	Friends	Mother	Grandmother
The interval between symptom onset and exposure to index case (days)	8	7	Unknown	8	7	3	Unknown	10	2	7
Number of secondary										

symptomatic cases including the child [&]	1	1	1	1	3	4	3	3	3	2
Clinical characteristics										
Peak of fever (°C)	38·0	38.4	37.7	39.2	afebrile	38.5	38.2	afebrile	38.6	38.5
Duration of fever (days)	1	1	1	1		1	1			1
Cough	**Yes**		**Yes**	**Yes**	**Yes**			**Yes**		**Yes**
Sneezing				**Yes**	**Yes**					
Stuffy nose		**Yes**	**Yes**		**Yes**					
Rhinorrhea				**Yes**	**Yes**					
Sore throat		**Yes**	**Yes**	**Yes**					**Yes**	
Dyspnea										
Diarrhea										
Treatment										
Symptomatic treatment	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Antibiotic						**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Radiographic findings										

Cao Q, et al, 2020

- “SARS-CoV-2 infection in children: Transmission dynamics and clinical characteristics”
- Online publication
- Descriptive review
- Link: https://www.sciencedirect.com/science/article/pii/S092966462030067X?via%3Dihub

- The first confirmed pediatric case of SARS-CoV-2 infection was reported in Shenzhen on January 20, 2020
- With SARS-CoV-2 as the number of adults with infections increase, so do the number of pediatric infections due to children's proximity with infected adults
- Respiratory droplets are the most common transmission pathway, but the virus can spread through contaminated objects, such as toys and doorknobs
- If the virus is not controlled and the epidemic enters an explosion stage, infected and asymptomatic children could further become the main spreader of illness throughout the population


A
10000
8000
6000
4000
2000
0
Cumulative cases
Daily new cases
No. of Cases (Adults)
20/01
22/01
24/01
26/01
28/01
30/01
01/02
03/02
05/02
07/02
09/02
Date
0
100
200
300
400
No. of Cases (Children)
Cumulative cases
Daily new cases

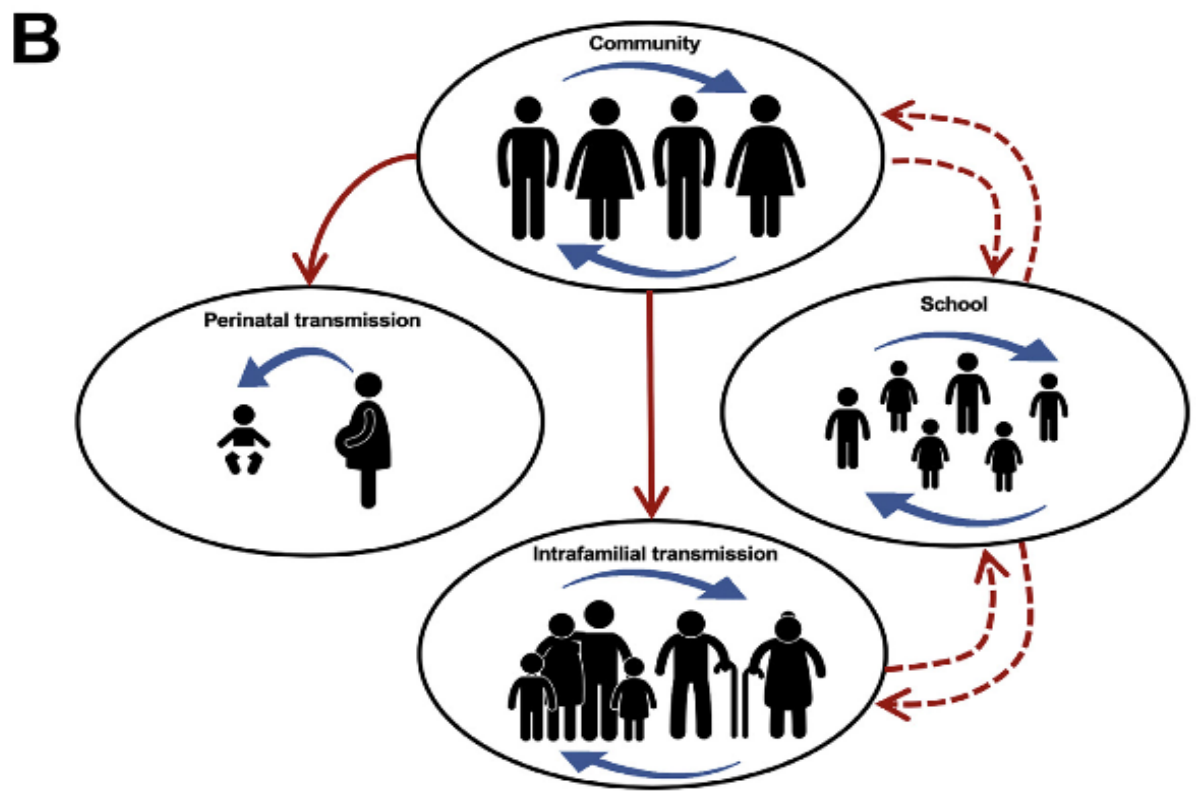


Figure. 1 Accumulated and daily new case numbers of laboratory-confirmed COVID-19 in children in China and the transmission dynamics. **(A)** Accumulated and daily new case numbers in China outside Hubei province between January 20 and February 10, 2020. Upper panel shows total case number of adults; lower panel the case number of children. **(B)** Transmission dynamics of SARS-CoV-2 infection in children. During the emerging stage of the COVID-19, the infection starts from person-to-person transmission in the community, almost exclusively in adults. The virus further spreads to the family to cause intrafamilial transmission, especially to the elderly and children, who are vulnerable to the infection. Perinatal infection can occur if the baby is born to a pregnant woman with confirmed infection via vaginal delivery. If the disease further extends without being contained, the outbreak may go into the explosion stage, when the school transmission mixed with a wider community spread can occur. The children at that stage can become a main spreader of the virus. The red lines indicate the transmission route with confirmed evidence in the SARS-CoV-2 outbreak in China, and the red dotted lines indicate the transmission route that may happen if the outbreak becomes more extensive afterwards.

Wang, J, et al, 2020

- “A contingency plan for the management of the 2019 novel coronavirus outbreak in neonatal intensive care units”
- Online publication
- Commentary on how neonatal intensive care units can best prepare for the virus
- Link: https://www.sciencedirect.com/science/article/pii/S2352464220300407?via%3Dihub

- By February 5th, 100 children were infected with COVID-19, with the youngest infected being 30 hours old
- Neonates are susceptive to the virus due to non well-developed immune systems
- Diagnosis of the virus in neonates must meet all of the following criteria:
  - Showing at least one of the clinical symptoms listed
  - Showing abnormal findings on chest radiograph
  - Being at high risk of infection due to close contact with an infected adult, or had close contact with someone who had pneumonia of unknown cause, or are living in or traveling to epidemic areas, or been in animal markets or close contact with wild animals, within 14 days before the onset of illness
- If criteria is met, neonatologists should follow standard and additional precautions listed in the included panel

Panel
Strategies to be implemented during screening of neonates for 2019-nCoV infection

- Standard precautions include signage at the entrance, strict hand and respiratory hygiene, daily cleaning and disinfection of the environment, and provision of gloves, mask, and goggles for all medical staff
- Additional enhanced contact precautions and respiratory droplet precautions include patients' own dedicated equipment, limited parents' visits, gown and glove change after procedures, and opening window regularly to change air
- Avoid breastfeeding from mothers with probable or laboratory-confirmed 2019-nCoV infection until the recovery of confirmed mothers or rejection of probable infection
- Medical waste generated during medical service should be collected into a double-layer infectious waste bag, which should be treated with chlorine-containing preparation for at least 10 min, then disposed of in the same way as infectious medical waste
- Terminal disinfection of the patient's room is preferentially done using hydrogen peroxide atomisation or a chlorine-containing preparation spray

Wang, D, et al, 2020

- “Clinical analysis of 31 cases of new coronavirus infection in children in six provinces (autonomous regions) of northern China in 2019”
- Pre-published online
- Retrospective review of case data of 31 infected children
- Link: http://rs.yiigle.com/yufabiao/1183296.htm

- An analysis of 31 pediatric patients diagnosed with 2019-nCOV between January 25th and February 21st, across 21 hospitals

- Average age of children was 7 years 1 month (range of 6 months to 17 years) and 90% of the patients (n=28) were a result of family cluster cases

- 13% (n=4) of patients were asymptomatic, 42% (n=13) had mild cases, 45% (n=14) had ordinary cases, and there were no severe or critical infections

- All children were given general treatment protocols after admission and prognosis was good

- None of the 31 children had a history of underlying disease, and none experienced severe symptoms, implying that infections are less severe in children than adults

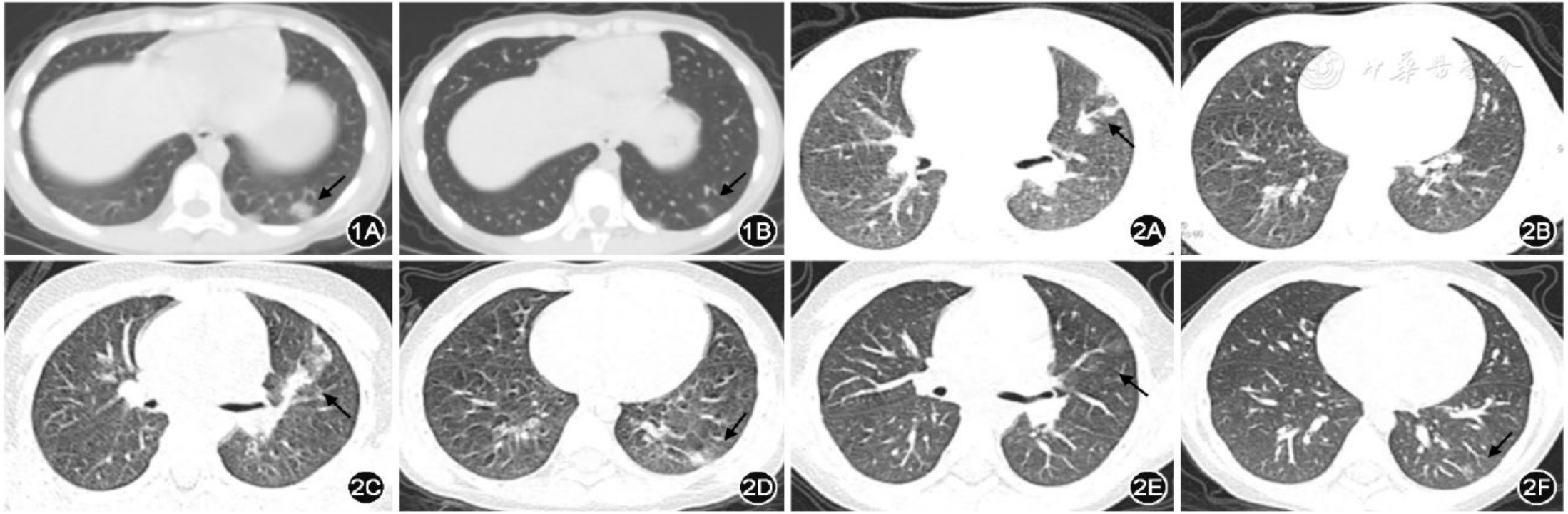


figure 1 Comparison of chest CT images before and after treatment of children with new coronavirus pneumonia (female, 9 years, 6 months old) 1A: Day 4 of the course, multiple ground glass shadows with nodules near the pleura near the lower lobe of the left lung (indicated by arrows); 1B: treatment After 10 days of re-examination, the lesions in the left lower lobe were significantly absorbed and the density became lighter (indicated by the arrow).

figure 2 High-resolution CT manifestations of the chest of children with new-type coronavirus pneumonia at different stages (female, 3 years and 3 months old) 2A: On the 5th day (early stage) of the left lung, a patchy density increase was seen in the middle and outer bands of the left lung, and some were ground Changes (indicated by arrows); 2B: On the fifth day of disease course (early stage), no obvious lesions were found in the lower lobe of the left lung; 2C: On the 9th day of disease course (progression stage), the patchy ground glass shadow of the upper left lobe and the appearance The range of change is enlarged (indicated by the arrow); 2D: on the 9th day of the disease course (progressive phase), a new nodule in the left lower lobe is adjacent to the pleura, and the edges are blurred (indicated by the arrow); 2E, 2F: 14th day of the disease course (recovery phase)), The upper lobe of the left lung (2E) and the lower lobe (2F) have multiple ground glass shadows, consolidation and nodules are apparently absorbed, and the density becomes lighter (indicated by the arrow).

Li Y, et al, 2020

- “Lack of Vertical Transmission of Severe Acute Respiratory Syndrome Coronavirus 2, China”
- Early release article
- Case study/research article
- Link: https://wwwnc.cdc.gov/eid/article/26/6/20-0287_article

- February 6th, 2020 a 30-year-old, 35-week-old pregnant woman sought treatment at a hospital due to a 2-day history of dry cough, without fever, chills, or shortness of breath
- The patient had a positive sputum sample for SARS-CoV-2 infection
- On delivery day, only the woman's sputum sample was positive for the virus; the rest of the samples remained negative
- The infant was born with no complications via cesarean section in a negative pressure operating room and tested negative for SARS-CoV-2
- This case matches other research which suggests mother-to-child vertical transmission is unlikely
- Implementing appropriate infection prevention procedures during delivery may also prevent infants from acquiring the virus after birth

Cui Y, et al, 2020

- “A 55-Day-Old Female Infant infected with COVID 19: presenting with pneumonia, liver injury, and heart damage”
- Accepted manuscript
- Case study
- Link: https://academic.oup.com/jid/advance-article/doi/10.1093/infdis/jiaa113/5807961?searchresult=1

- 55-day old infant was brought into the hospital with a runny nose and dry cough and the infant was exposed to COVID-19 infected caregivers

- Infant was found to have abnormal labs and CT imaging and due to their exposure to the virus, the infant was suspected of having COVID-19 and was placed in isolation

- Over the course of the illness, the infant got worse and experienced lung, liver, and cardiac damage

- After appropriate medical interventions, the infant started to recover on day 7 and was drastically improved by day 12 but the infant still had samples testing positive and remained in isolation until they tested negative for COVID-19

- Children can still present with multiple organ damage and rapid decline, even if they are less likely to as compared to adults

Measure	Reference Range	Illness Day 6 Hospital Day1	Illness Day9, Hospital Day4	Illness Day15, Hospital Day10
White-cell count ($\times 10^9$/L)	6-18	7.96	10.04	9.46
Lymphocyte count ($\times 10^9$/L)	1.1-3.2	5.22#	6.59#	6.25#
Neutrophil count ($\times 10^9$/L)	1.8-6.3	1.87	2.44	2.01
Platelet count ($\times 10^9$/L)	125-350	406#	449#	604#
Hemoglobin (g/l)	95-145	112	91*	101
Erythrocyte sedimentation rate (mm/h)	0-20	7	2	-
C-reactive protein (mg/L)	0-5	0.56	0.63	0.32
Procalcitonin(ng/ml)	0-0.046	0.15#	0.11#	-
Alanine aminotransferase (U/L)	7-40	84#	49#	33
Aspartate aminotransferase (Ul/L)	13-35	100#	47#	35
Total bilirubin (μmol/L)	3.4-20.5	33.7#	20.1#	10.9
Direct bilirubin (μmol/L)	0-8.6	25.2#	16.6#	7
Total bile acid (μmol/L)	0-10	154.4#	89.8#	46.4#
Creatine kinase isoenzyme (U/L)	0-25	46#	-	25
α-hydroxybutyrate dehydrogenase (U/L)	44-148	237#	-	143
Troponin I (μg/L)	0-0.0156	-	0.025#	-
Creatinine(μmol/L)	15-45	20	19	21
Blood urea nitrogen(mmol/L)	1.8-6	3.61	2.09	2.15
Serum Immunoglobulin M (g/L)	0.06-0.21	0.66#	-	-
$CD8^+$ T cell count (cell/μl)	400-1700	2208#	-	-
D-dimer(μg/ml)	0-1.5	0.54	-	-
Activated partial thromboplastin time(sec)	21.1-36.5	30.6	-	-
Prothrombin time(sec)	9.2-12.2	9.7	-	-
Rotavirus in stool	Negative	Negative		
Cytomegalovirus DNA in blood	Negative	Negative		

The value in the patient was above normal.

*The value in the patient was below normal.

Chen ZM, et al, 2020

- “Diagnosis and treatment recommendations for pediatric respiratory infection caused by the 2019 novel coronavirus”
- Pre-pub online ahead of print
- Clinical recommendation
- Link: https://link.springer.com/content/pdf/10.1007/s12519-020-00345-5.pdf

- The National Clinical Research Center for Child Health, National Children's Regional Medical Center, Children's Hospital, Zhejiang University School of Medicine drafted a standardized protocol to treat respiratory infection in children caused by COVID-19

- Protocol follows latest National recommendations for diagnosis and treatment of COVID-19 and current clinical practice status in Zhejiang Province, China

- The protocol details the etiology, epidemiology, diagnostic criteria, clinical manifestations, differential diagnoses, treatment modalities, and discharge criteria

Yang C, Li C, Wang S, 2020

- “Clinical strategies for treating pediatric cancer during the outbreak of 2019 novel coronavirus infection”
- Online publication
- Narrative review/recommendation
- Link: https://onlinelibrary.wiley.com/doi/epdf/10.1002/pbc.28248

- Children with cancer are presumed to be more suspectable to COVID-19 due to immunosuppression

- This recommendation is to provide guidance on treatment strategies between epidemic prevention and providing cancer treatment during the epidemic

- The recommendation discusses screening measures, the positives and negatives of certain cancer treatment modalities during the epidemic phase, and follow-up care

- Due to limited knowledge currently on pediatric cancer patients and COVID-19, pediatric oncologists should continually update their knowledge on how to prevent and treat COVID-19 in this population

Guan et al 2020

- “Clinical Characteristics of Coronavirus Disease 2019 in China”
- The New England Journal of Medicine
- Link: https://www.nejm.org/doi/full/10.1056/NEJMoa2002032

- Data regarding 1099 patients with laboratory-confirmed Covid-19 from 552 hospitals in 30 provinces, autonomous regions, and municipalities in mainland China through January 29, 2020.
- The median age of the patients was 47 years (interquartile range, 35 to 58); **0.9% of the patients were younger than 15 years of age.**

Qun Li et al 2020

- “Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus–Infected Pneumonia”
- The New England Journal of Medicine
- Link: https://www.nejm.org/doi/full/10.1056/NEJMoa2001316?query=featured_home

- We collected information on demographic characteristics, exposure history, and illness timelines of laboratory-confirmed cases of NCIP that had been reported by January 22, 2020.
- The median age of the patients was 59 years (range, 15 to 89), and 240 of the 425 patients (56%) were male. **There were no cases in children below 15 years of age.**

Italian Society of Medical Radiology, 2020

- “COVID-19: case 48 pediatric mini review”
- Data/results posted on their website
- Researchers at the Italian Radiology Society
- Link: https://www.sirm.org/2020/03/16/covid-19-caso-48-mini-review-pediatrica/

Italian Society of Medical Radiology, 2020

- Review of 4 COVID-19+ pediatric cases at their facility
- All children previously healthy
- Average age 4.2 years
- 2 out of 4 children had high fever (39 °);
- 1 out of 4 history of malaise and loss of appetite;
- 1 out of 4 completely asymptomatic, assessed as the child of Covid-19 + parents both hospitalized, then hospitalized accordingly for reasons of assistance.
- This study shows, albeit the small number of cases, that even children can become infected with SARS-CoV-2, but with negative or minor respiratory pictures, in line with the data of the Literature collected so far, and in our experience, with hospitalization performed for an almost precautionary purpose.

Riou et al, 2020

- “ADJUSTED AGE-SPECIFIC CASE FATALITY RATIO DURING THE COVID-19 EPIDEMIC IN HUBEI, CHINA, JANUARY AND FEBRUARY 2020”
- Pre-print article
- Researchers from University of Bern
- Link: https://www.medrxiv.org/content/10.1101/2020.03.04.20031104v1.full.pdf

- We estimated the age-specific case fatality ratio (CFR) by fitting a transmission model to data from China, accounting for underreporting of cases and the time delay to death.

- Overall CFR among all infections was 1.6% (1.4-1.8%) and increased considerably for the elderly, highlighting the expected burden for populations with further expansion of the COVID-19 epidemic around the globe.

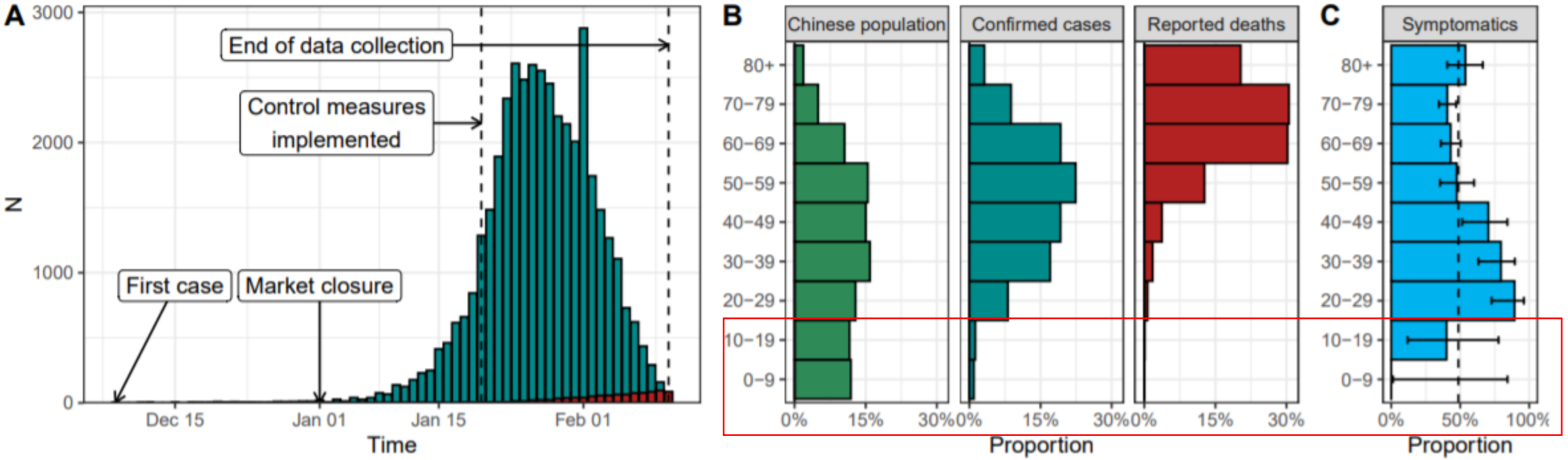


Figure 1: (A) Reported confirmed cases of COVID-19 in Hubei by date of disease onset (blue) and reported deaths (red) from 8 December, 2019 until 11 February, 2020. (B) Age distribution of the Chinese population compared to that of confirmed cases of and deaths due to COVID-19. (C) Proportion of individuals infected by COVID-19 showing symptoms among passengers of the Diamond Princess ship (with 95% credible interval).

Table 1: Estimates of case fatality ratio during the COVID-19 epidemic in Hubei, overall and by age group (median posterior and 95% credible interval).

	Overall	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Case fatality ratio among symptomatic infections										
Crude	2.4% (2.1-2.8)	0% (0-1.3)	0.25% (0-1.3)	0.22% (0.054-0.51)	0.26% (0.12-0.45)	0.48% (0.28-0.73)	1.4% (1-1.8)	3.8% (3.1-4.7)	8.5% (6.9-10)	15% (12-18)
Adjusted for delayed mortality	6% (5.3-6.9)	0.44% (0-2.8)	0.78% (0-2.9)	0.54% (0.18-1.2)	0.64% (0.34-1.1)	1.2% (0.77-1.7)	3.4% (2.7-4.2)	9.4% (7.9-11)	21% (17-25)	36% (30-44)
Adjusted for unidentified symptomatic cases	1.3% (1.2-1.5)	0% (0-0.055)	0.014% (0-0.076)	0.076% (0.019-0.17)	0.15% (0.069-0.26)	0.34% (0.19-0.51)	1.1% (0.84-1.4)	3.8% (3.1-4.6)	8.2% (6.7-9.8)	15% (12-18)
Adjusted for both	3.3% (2.9-3.8)	0.019% (0-0.12)	0.046% (0-0.17)	0.19% (0.061-0.41)	0.38% (0.2-0.62)	0.82% (0.54-1.2)	2.7% (2.1-3.4)	9.4% (7.9-11)	20% (17-24)	36% (30-44)
Case fatality ratio among all symptomatic and asymptomatic infections										
Adjusted for both	1.6% (1.4-1.8)	0.0094% (0-0.058)	0.022% (0-0.082)	0.091% (0.03-0.2)	0.18% (0.096-0.3)	0.4% (0.26-0.58)	1.3% (1-1.6)	4.6% (3.8-5.4)	9.8% (8.2-12)	18% (14-22)

Chinese CDC, 2020

- “The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19) — China, 2020”
- Chinese CDC Weekly Report
- Exploratory analysis of all cases diagnosed as of February 11, 2020
- Link: https://github.com/jriou/covid_adjusted_cfr/blob/master/data/china/chineseCDC2020.pdf

TABLE 1. Patients, deaths, and case fatality rates, as well as observed time and mortality for n=44,672 confirmed COVID-19 cases in Mainland China as of February 11, 2020.

Baseline Characteristics	Confirmed Cases, N (%)	Deaths, N (%)	Case Fatality Rate, %	Observed Time, PD	Mortality, per 10 PD
Overall	44,672	1,023	2.3	661,609	0.015
Age, years					
0–9	416 (0.9)	–	–	4,383	–
10–19	549 (1.2)	1 (0.1)	0.2	6,625	0.002
20–29	3,619 (8.1)	7 (0.7)	0.2	53,953	0.001
30–39	7,600 (17.0)	18 (1.8)	0.2	114,550	0.002
40–49	8,571 (19.2)	38 (3.7)	0.4	128,448	0.003
50–59	10,008 (22.4)	130 (12.7)	1.3	151,059	0.009
60–69	8,583 (19.2)	309 (30.2)	3.6	128,088	0.024
70–79	3,918 (8.8)	312 (30.5)	8.0	55,832	0.056
≥80	1,408 (3.2)	208 (20.3)	14.8	18,671	0.111

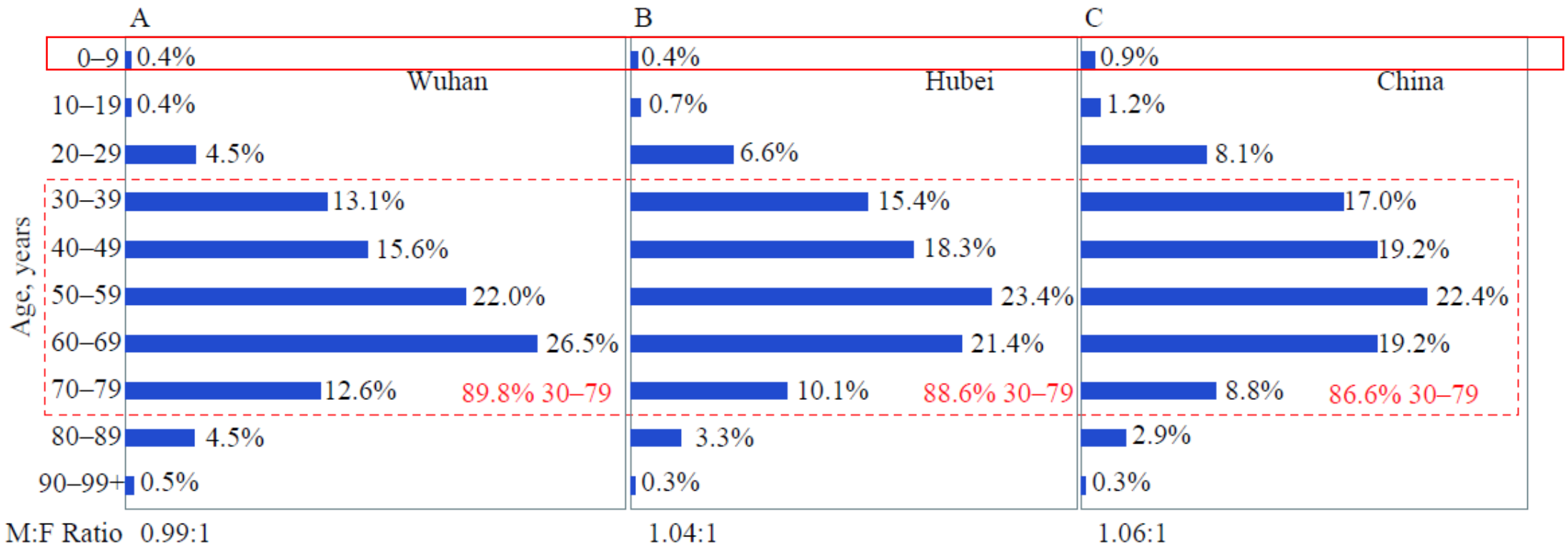


FIGURE 1. Age distribution and sex ratio of all confirmed COVID-19 cases in China through February 11, 2020. (A) patients diagnosed in the city of Wuhan only; (B) patients diagnosed in Hubei Province, which includes Wuhan as its capital city; and (C) patients diagnosed in China overall, including Hubei Province and all 30 other provincial-level administrative divisions (PLADs). Dashed red line highlights the proportion of patients in the 30–79 years age range. Sex ratio (i.e. male-to-female [M:F] ratio) is shown below each graph.

Lou et al, 2020

- “Three children who recovered from novel coronavirus 2019 pneumonia”
- Lou, X.X., Shi, C.X., Zhou, C.C. and Tian, Y.S. (2020), Three children who recovered from novel coronavirus 2019 pneumonia. J Paediatr Child Health. doi:10.1111/jpc.14871.org/content/10.1101/2020.03.04.20031104v1.full.pdf

- Two were sisters, aged 6 and 8 years old and one was a 6-month-old boy.
- All three patients had fever, and two had nasal congestion and rhinitis, associated with fatigue, diarrhea and headache.
- The 6-year-old girl mainly had cough.
- None had dyspnea or cyanosis.
- Their computerized tomographic scans are shown in Figures 1-3. None of the children required intensive care or mechanical ventilation or had any severe complications.

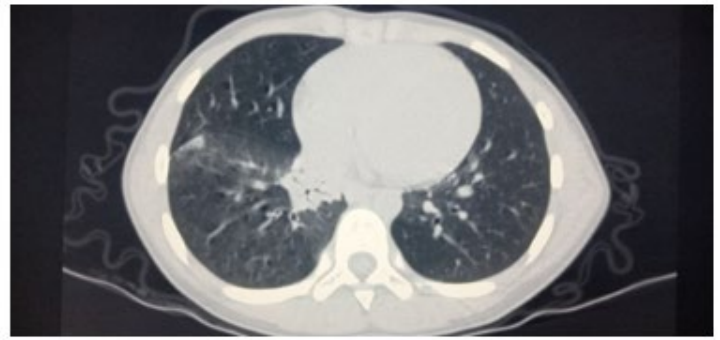


Figure 1 Open in figure viewer | PowerPoint

Computerised tomographic scan of 8-year-old girl.

Figure 2 Open in figure viewer | PowerPoint

Computerised tomographic scan of 6-year-old girl.

Figure 3 Open in figure viewer | PowerPoint

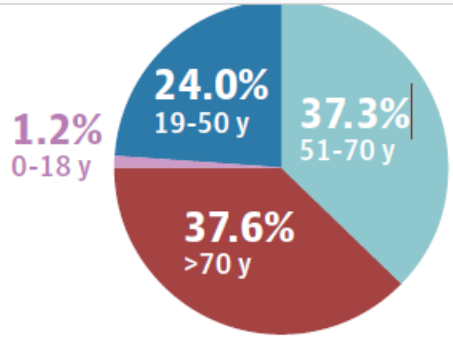
Li et al, 2020

- “Insight into COVID-2019 for pediatricians”
- Li, Y, Guo, F, Cao, Y, Li, L, Guo, Y. Insight into COVID-2019 for pediatricians. Pediatric Pulmonology. 2020; 1– 4. https://doi.org/10.1002/ppul.24734

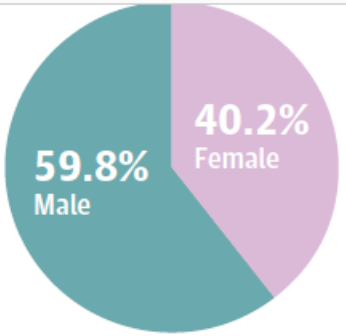
- The incubation period of SARSCoV-2 infection in children is 1 to 14 days, generally 3 to 7 days.
- The clinical manifestations are asymptomatic or include fever, fatigue, and dry cough; a few patients have upper respiratory tract symptoms, such as nasal obstruction, runny nose, and sore throat; and a few patients have gastrointestinal symptoms, such as abdominal discomfort, nausea, vomiting, stomachache, and diarrhea.
- From the current situation of pediatric cases, most of the clinical manifestations are relatively mild, with no fever or pneumonia, and have a good prognosis. Most children have recovered within 1 to 2 weeks, but some pediatric cases may progress to lower respiratory tract infection.

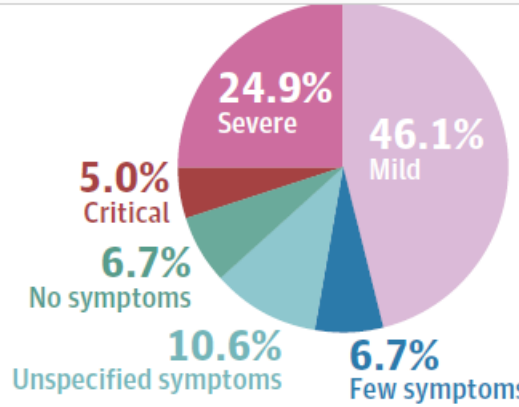
Livingston and Bucher, 2020

- “Coronavirus Disease 2019 (COVID-19) in Italy”
- Livingston E, Bucher K. Coronavirus Disease 2019 (COVID-19) in Italy. *JAMA.* Published online March 17, 2020. doi:10.1001/jama.2020.4344



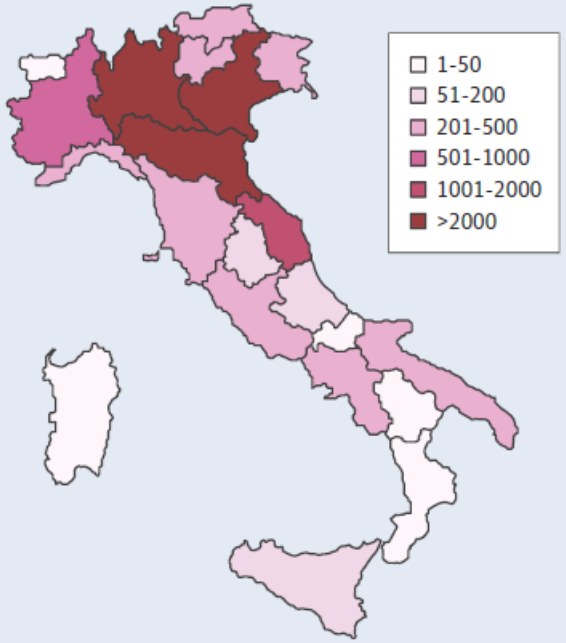
Median age, 64 y





Age, y	Deaths, No. (% of total)	Case-fatality rate, %
0-9	0	0
10-19	0	0
20-29	0	0
30-39	4 (0.25)	0.3
40-49	10 (0.62)	0.4
50-59	43 (2.65)	1.0
60-69	139 (8.55)	3.5
70-79	578 (35.57)	12.5
80-89	694 (42.71)	19.7
≥90	156 (9.6)	22.7
Not reported	1 (0.06)	0.6
Total	**1625 (100)**	**7.2**

Cases by region/province of diagnosis



Authors: Edward Livingston, MD; Karen Bucher, MA, CMI

Sources: Adapted from the COVID-19 Task Force of the Department of Infectious Diseases and the IT Service Instituto Superiore di Sanità. https://www.iss.it/infografiche
Please cite as: *JAMA*. Published online March 17, 2020. doi:10.1001/jama.2020.4344