



# A quickly, effectively screening process of novel corona virus disease 2019 (COVID-19) in children in Shanghai, China

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**Background:** A recent cluster of pneumonia cases in China was caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). We report the screening and diagnosis of corona virus disease 2019 (COVID-19) in our hospital.

**Methods:** Developed a procedure for the identification of children cases with COVID-19 in outpatient and emergency department of our hospital, then we observed how this process works.

**Results:** (I) There were 56 cases considered suspected cases, and 10 cases were confirmed as COVID-19. (II) Of the 10 confirmed COVID-19 cases admitted in our hospital, 5 were males and 5 were females, aged from 7 months to 11 years, the average age is  $6.0 \pm 4.2$  years, 6 cases were mild pneumonia, the others were upper respiratory tract infection. (III) We followed up 68 patients in isolation at home until symptoms disappeared. Non were missed in the patient's first visit. The sensitivity of this method is 100% and the specificity is 71.3%.

**Conclusions:** Our screening process works well, and it is also necessary to establish a screening network in the hospital.

**Keywords:** Corona virus disease 2019 (COVID-19); severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); child; diagnosis

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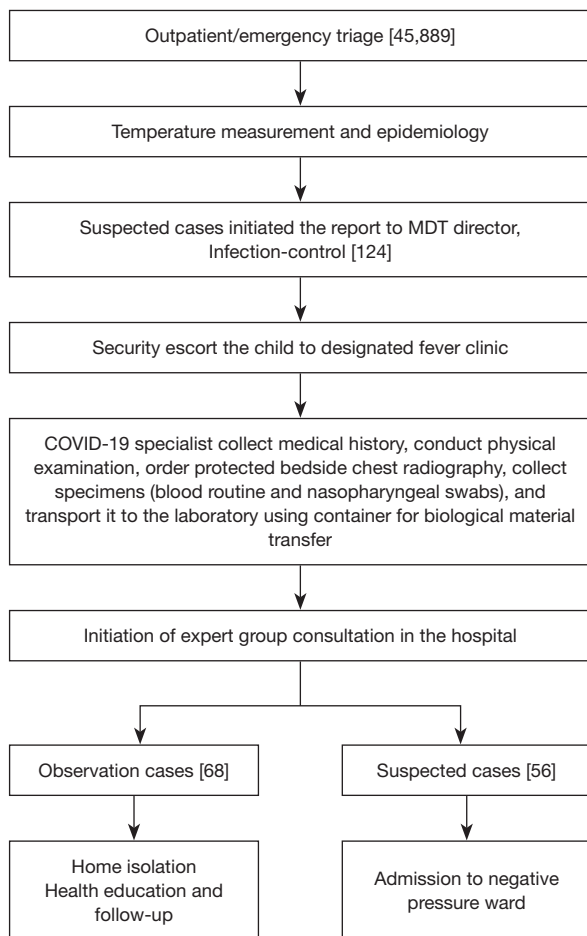
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## Introduction

In December, 2019, a series of pneumonia cases of unknown cause emerged in Wuhan, Hubei, China (1,2). The situation has continued to evolve rapidly since then and just one month later, as at 16 February, 68,594 laboratory-

confirmed cases and 1,667 deaths have been reported. Meanwhile, on 7 January 2020, the 2019 novel coronavirus (2019-nCov), currently named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), was officially announced as the causative agent by Chinese authorities (3). The corona virus disease 2019 (COVID-19) is considered



**Figure 1** Outpatient and emergency procedures for suspected patients. A case considered as an observation case or a suspected case is determined by the MDT director, infection-control. MDT, multidisciplinary team.

a relative of the deadly severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) coronaviruses, both of which are characterized by flu-like symptoms including fever, cough and anhelation and have the possibility of transmission from animal to humans (4). Updating the understanding of the disease caused by SARS-CoV-2 infection is currently urgently warranted. Recently, the number of children and neonate cases infected with SARS-CoV-2 has gradually increased (5,6). Although, the number of children infected with COVID-19 is far less than that of adults, situation report of confirmed childhood infection constantly raise public concerns. As of February 19, a total of 10 children have been diagnosed in Shanghai and all have been admitted to our hospital Children's

Hospital of Fudan University. The rapidly spreading of COVID-19 suggests that children cases should not be neglected from the epidemic control. Thus, we aim to describe quickly, effectively and calm outpatient process to deal with the disease. We hope our study findings will inform the global community of the emergence of this novel coronavirus and its clinical features.

## Methods

### Patients

From January 19 to February 15, 2020, we collected information on demographic characteristics, exposure history of SARS-CoV-2 among all visited patients in our outpatient/emergency department.

### Procedure

Based on the clinical guideline of 2019-nCoV released by Chinese Center for Disease Control and Prevention (China CDC) and the WHO's COVID-19 guideline, we developed a procedure for the identification of children cases with COVID-19 in outpatient and emergency department of our hospital (Children's Hospital of Fudan University). Our hospital was the only designated hospital for children's SARS-CoV-2 infection in Shanghai.

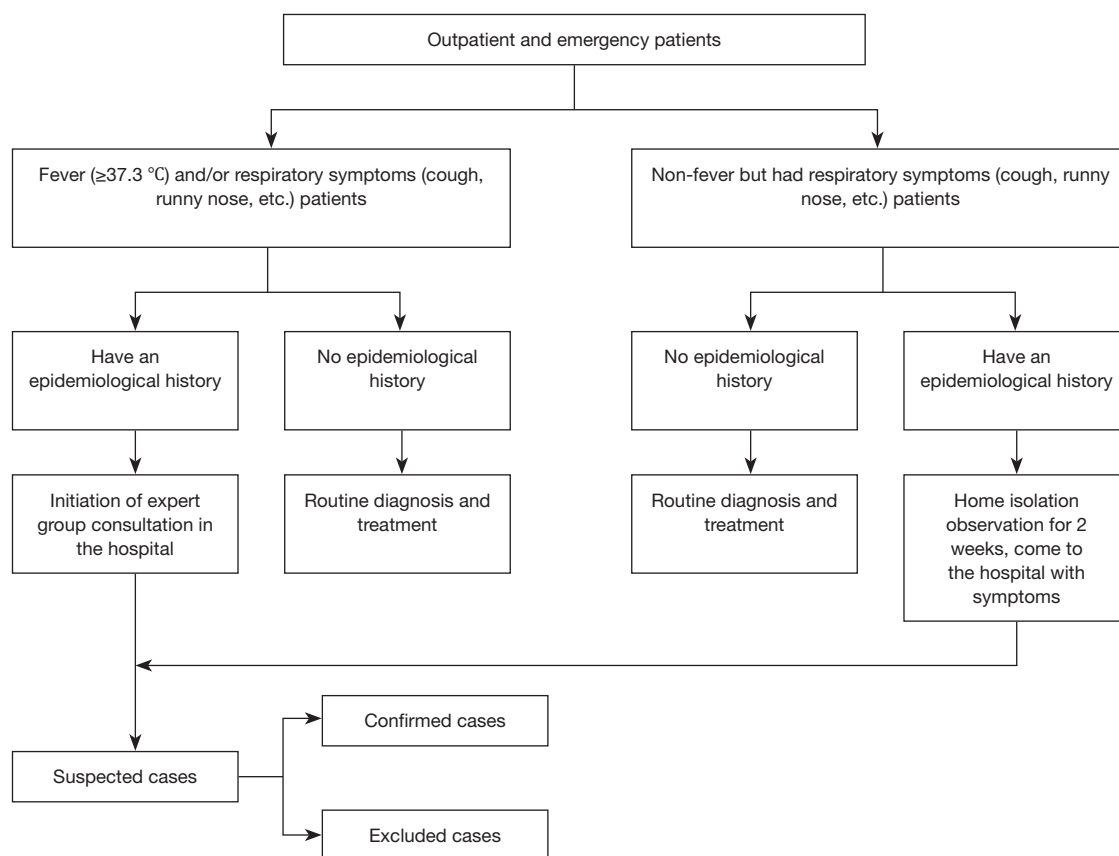
On January 17, 2020, a multidisciplinary team (MDT) was established to cope with the COVID-19 outbreak. Medical administrators and hospital administrators conduct daily consultations and discussions on new suspected cases and management of the diagnosed cases.

A suspected case entered the following process (Figure 1).

A rapid screening algorithm for COVID-19 cases suspected and confirmed in children was shown in Figure 2.

Once a suspected case was identified, the joint field epidemiology team comprising members from the China CDC together with provincial, local municipal CDCs and district CDCs would be informed to initiate detailed field investigations and collect respiratory specimens for centralized testing at the National Institute for Viral Disease Control and Prevention, China CDC, in Beijing. A joint team comprising staff from China CDC and local CDCs conducted detailed field investigations for all suspected and confirmed COVID-19 cases.

According to the 5th edition of the National Health and Health Commission of People's Republic of China's 2019-nCoV-infected pneumonia diagnosis and treatment



**Figure 2** Rapid screening algorithm for COVID-19 cases suspected and confirmed in children.

program (7) and the WHO's COVID-19 guideline (8), a screening criteria for suspected COVID-19 case was implemented in the outpatient and emergency department of our hospital. The suspected case was defined as presenting symptoms of fever or respiratory infection, along with any of the following significant epidemiology: (I) history of travel or residence in either Wuhan City and surrounding areas, or communities with confirmed COVID-19 cases within 14 days before the onset of symptoms; (II) direct person-to-person contact with confirmed COVID-19 infected individual (positive nucleic acid test) within 14 days before the onset of symptoms; (III) direct person-to-person contact with the patient with presenting symptoms of fever or respiratory infection from either Wuhan City and surrounding areas within 14 days before the onset of symptoms; (IV) cluster onset.

The above screening process was approved by the hospital's ethics committee and agreed that it will not infringe the rights of children visiting the clinic, minimizing the risk of COVID-19 in-hospital transmission.

## Results

From January 19 to February 8, 2020, there were 45,889 patients visited our outpatient/emergency clinics, among them the number of patients presenting symptoms of fever or respiratory infection was 18,432. Our COVID-19 screening procedure identified 124 patients with significant epidemiology and went through further MDT experts' consultation. There were 56 cases considered suspected cases, and 10 cases were confirmed as COVID-19. The diagnosis and epidemiology of these 56 patients were shown in *Tables 1* and *2*.

Of the 10 confirmed COVID-19 cases admitted in our hospital, 5 were males and 5 were females, aged from 7 months to 11 years, the average age is  $6.0 \pm 4.2$  years, 6 cases were mild pneumonia, the others were upper respiratory tract infection. The average hospitalization day is 10 days, 4 cases have been discharged. Five cases' epidemiology were direct person-to-person contact with confirmed COVID-19 infected individual (positive nucleic acid test) within 14 days before the onset of symptoms, 5 cases had history of travel or residence in either Wuhan City and surrounding areas,

**Table 1** Diagnosis of 56 suspected patients

Diagnosis	n	%
COVID-19	10	17.8
Upper respiratory infection (URI)	23	41.1*
Bronchitis	4	7.1
Pneumonia	16	28.6
Acute appendicitis	2	3.5
Mediastinal tumor	1	1.9
Total	56	100

\*, the proportion of URI was higher than COVID-19,  $P < 0.01$ .

**Table 2** Epidemiology of 56 suspected patients

Epidemiology	n	%
1	30	53.6*
2	19	33.9 <sup>#</sup>
3	7	12.5
4	0	0
Total	56	100

According to the 5th edition of National Health and Health Commission of People's Republic of China's 2019-nCoV-infected pneumonia diagnosis and treatment program. Epidemiology: 1, history of travel or residence in either Wuhan City and surrounding areas, or communities with confirmed COVID-19 cases within 14 days before the onset of symptoms; 2, direct person-to-person contact with confirmed COVID-19 infected individual (positive nucleic acid test) within 14 days before the onset of symptoms; 3, direct person-to-person contact with the patient with presenting symptoms of fever or respiratory infection from either Wuhan City and surrounding areas within 14 days before the onset of symptoms; 4, cluster onset. \*, the proportion of standard 1 was higher than standard 2,3,4,  $P < 0.05$ ; <sup>#</sup>, the proportion of standard 2 was higher than standard 3 and 4,  $P < 0.01$ .

**Table 3** Sensitivity and specificity of this procedure

Procedure	Gold standard		Total
	+	-	
+	10	46	56
-	0	114	114
Total	10	160	170

Sensitivity: 100%; specificity 71.3%; positive predictive value (PPV): 17.8%; negative predictive value (NPV): 100%.

or communities with confirmed COVID-19 cases within 14 days before the onset of symptoms.

We followed up 68 patients in isolation at home until symptoms disappeared. Non were missed in the patient's first visit. The sensitivity of this method is 100% and the specificity is 71.3% (Table 3).

## Discussion

We reported on our work in the COVID-19 outbreak and the identification of childhood COVID-19 cases in a tertiary children medical center. As the only designated hospital for children's SARS-CoV-2 infection in Shanghai, we have established a set of triage and mechanisms for the identification of cases with COVID-19. From January 19 to February 12, 2020, 56 children were treated with suspected COVID-19 and none was missed in the patient's first visit. It is important to ask about epidemiology, especially if you have contact with fever patients.

We found that children have mild clinical symptoms and less pneumonia, other research has shown that few of the early cases occurred in children, and almost half the 425 cases were in adults 60 years of age or older, although our case definition specified severe enough illness to require medical attention, which may vary according to the presence of coexisting conditions (9). Furthermore, children might be less likely to become infected or, if infected, may show milder symptoms, and either of these situations would account for underrepresentation in the confirmed case count (10). The possible cause is: children have a smaller range of activities than adults and have less chance of being exposed to public places. Other possible causes are children have fewer primary lung diseases and have weak immune responses. Some researchers have found that children under 6 years of age responded to natural infection with a relatively narrow response. Adults, however, have a much broader response (11).

Shanghai is a national metropolis with a population of more than 24 million. The central city densely populated especial for large shopping malls and restaurants. Therefore, it is very important to establish an isolation system from the root of human flow. The municipal government strictly requires the isolation system in the community. The community staff shall register one by one the personnel returning from other provinces and cities, measure their body temperature, and immediately guide them to the designated hospital for treatment in case of any abnormality. This has played a significant role in the overall prevention

and control of the city (12).

It is also necessary to establish a screening network in the hospital. In the outpatient department, from the pre examination and triage, the suspicious cases and ordinary cases are separated based on the epidemic history and patients' symptoms. The suspicious cases will enter the special consulting room and been collected the medical history in detail, also have some relevant auxiliary examination. The team of experts will make consultation for the judgement whether these patients would be admitted to the hospital for further nucleic acid detection. In the inpatient department, we also need to investigate the epidemic history before admission. The suspected cases should be admitted in the infectious ward directly. Only after the exclusion of the new coronavirus infection, these patients will be transferred to the general ward. Since there is no effective therapy or vaccine, the best measures now are to control the source of infection, early diagnosis, reporting, isolation, supportive treatments, and timely publishing epidemic information to avoid unnecessary panic (13).

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### Footnote

*Conflicts of Interest:* The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The above screening process was approved by the hospital's ethics committee [No. (2020)29] and agreed that it will not infringe the rights of children visiting the clinic, minimizing the risk of COVID-19 in-hospital transmission. Written informed consent was obtained from the patient for publication of this study and any accompanying images.

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### References

1. Eurosurveillance Editorial Team. Note from the editors: novel coronavirus (2019-nCoV). Euro Surveill 2020. doi: 10.2807/1560-7917.ES.2020.25.3.2001231.
2. Zhu N, Zhang D, Wang W, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med 2020;382:727-33.
3. Gralinski LE, Menachery VD. Return of the Coronavirus: 2019-nCoV. Viruses 2020. doi: 10.3390/v12020135.
4. Wang W, Tang J, Wei F. Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. J Med Virol 2020;92:441-7.
5. Zhu H, Wang L, Fang C, et al. Clinical analysis of 10 neonates born to mothers with 2019-nCoV pneumonia. Transl Pediatr 2020;9:51-60.
6. Hagino T, Hiryu S, Fujioka S, et al. editors. Adaptive SONAR sounds by echolocating bats. 5th International Symposium on Underwater Technology; 2007 APR 17-20; Tokyo, Japan: IEEE.
7. Teeling EC, Springer MS, Madsen O, et al. A molecular phylogeny for bats illuminates biogeography and the fossil record. Science 2005;307:580-4.
8. Chiu C, Xian W, Moss CF. Flying in silence: Echolocating bats cease vocalizing to avoid sonar jamming. Proc Natl Acad Sci U S A 2008;105:13116-21.
9. Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet 2020;395:497-506.
10. Li Q, Guan X, Wu P, et al. Early Transmission Dynamics in Wuhan, China, of Novel Coronavirus-Infected Pneumonia. N Engl J Med 2020. [Epub ahead of print].
11. Meade P, Kuan G, Strohmeier S, et al. Influenza Virus Infection Induces a Narrow Antibody Response in Children but a Broad Recall Response in Adults. mBio 2020. doi: 10.1128/mBio.03243-19.
12. Al-Amri S, Bharti R, Alsaleem SA, et al. Knowledge and practices of primary health care physicians regarding updated guidelines of MERS-CoV infection in Abha city. J Family Med Prim Care 2019;8:455-61.
13. Chen Y, Liu Q, Guo D. Emerging coronaviruses: Genome structure, replication, and pathogenesis. J Med Virol 2020;92:418-23.

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