Characteristic of COVID-19 infection in pediatric patients: early findings from two Italian Pediatric Research Networks

Nicolò Parri1 · Anna Maria Magistà2 · Federico Marchetti3 · Barbara Cantoni4 · Alberto Arrighini5 · Marta Romanengo6 · Enrico Felicij7 · Antonio Urbino8 · Liviana Da Dalt9 · Lucio Verdini10 · Benedetta Armocida11 · Benedetta Coví11 · Ilaria Mariani11 · Roberta Giacchero12 · Anna Maria Musolino13 · Marco Binotti14 · Paolo Biban15 · Silvia Fasoli16 · Chiara Pilotto17 · Flavia Nicoloso18 · Massimiliano Raggi19 · Elisabetta Miorin20 · Danilo Buonsenso21,22 · Massimo Chiossi23 · Rino Agostiniani24 · Anna Plebani25 · Maria Antonietta Barbieri13 · Marcello Lanari26 · Serena Arrigo27 · Elena Zoia28 · Matteo Lenge29,30,31 · Stefano Masj1 · Egidio Barbi11,32 · Marzia Lazzerini11 · on behalf of the CONFIDENCE and COVID-19 Italian Pediatric Study Networks

Received: 14 April 2020 / Revised: 6 May 2020 / Accepted: 9 May 2020 / Published online: 3 June 2020 © The Author(s) 2020

Abstract
Detailed data on clinical presentations and outcomes of children with COVID-19 in Europe are still lacking. In this descriptive study, we report on 130 children with confirmed COVID-19 diagnosed by 28 centers (mostly hospitals), in 10 regions in Italy, during the first months of the pandemic. Among these, 67 (51.5%) had a relative with COVID-19 while 34 (26.2%) had comorbidities, with the most frequent being respiratory, cardiac, or neuromuscular chronic diseases. Overall, 98 (75.4%) had an asymptomatic or mild disease, 11 (8.5%) had moderate disease, 11 (8.5%) had a severe disease, and 9 (6.9%) had a critical presentation with infants below 6 months having significantly increased risk of critical disease severity (OR 5.6, 95% CI 1.3 to 29.1). Seventy-five (57.7%) children were hospitalized, 15 (11.5%) needed some respiratory support, and nine (6.9%) were treated in an intensive care unit. All recovered.

Conclusion: This descriptive case series of children with COVID-19, mostly encompassing of cases enrolled at hospital level, suggest that COVID-19 may have a non-negligible rate of severe presentations in selected pediatric populations with a relatively high rates of comorbidities. More studies are needed to further understand the presentation and outcomes of children with COVID-19 in children with special needs.

What is Known:
• There is limited evidence on the clinical presentation and outcomes of children with COVID-19 in Europe, and almost no evidence on characteristics and risk factors of severe cases.

What is New:
• Among a case series of 130 children, mostly diagnosed at hospital level, and with a relatively high rate (26.2%) of comorbidities, about three-quarter had an asymptomatic or mild disease.
• However, 57.7% were hospitalized, 11.5% needed some respiratory support, and 6.9% were treated in an intensive care unit.

Keywords COVID-19 · Children · Adolescents · Italy

Abbreviations
ARDS Acute respiratory distress syndrome
ED Emergency department
ICU Intensive care unit

Background
The worldwide outbreak of a new type of coronavirus disease (COVID-19) originated in Wuhan, China, in December 2019...
and has rapidly spread in most countries in the world, despite governments’ containment measures trying to minimize impact [1, 2]. However, despite global spread, the full clinical spectrum and epidemiological features of COVID-19, particularly in children, are still poorly described [3]. The largest Chinese case series included 2143 children, but of these, only 34.1% (731) were laboratory-confirmed [4]. Very few studies described COVID-19 among children in countries outside China. So far, only two contributes, in the form of research letters, on COVID-19 case series among children from European countries—specifically, Italy and Spain—have been released, and they included small samples and limited details on children characteristics [5, 6]. Although preliminary surveillance data on COVID-19 pediatric cases in the USA has been published, information on clinical presentation was available only in 9% of cases [7]. In general, data from the national surveillance systems [7–9] often miss details on key clinical characteristics of children and their outcomes.

In this retrospective study, we aimed at describing the clinical presentation, diagnostic findings, type of respiratory support, and outcomes of a cohort of pediatric patients with confirmed COVID-19 virus infection in Italy, collected through two large collaborative research networks.

**Methods**

**Population and settings**

Data were collected through two large collaborative research networks, including a group of pediatric Emergency Departments coordinated by Meyer Hospital in Florence, and a research network of pediatric hospitals/departments and family pediatricians, coordinated by the Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy. Overall, the two networks comprised 61 centers: 53 (86.9%) hospitals and 8 (13.1%) outpatient centers. All children (aged 0–18 years) who presented to any of the recruiting centers between the 3rd and 26th of March 2020 and were diagnosed with COVID-19 were included in the study. Only three of the cases reported within the research network, all referred with very mild disease, could not be retrieved due to unavailability (sick leave) of the doctor who took in charge of them.

Cases were screened for COVID-19 virus infection based on national recommendations during the study period [10]. COVID-19 virus infection was diagnosed using nasal or nasopharyngeal swab specimens collected by trained personnel in line with national recommendations and tested for COVID-19 virus nucleic acid in regional referral laboratories using WHO-recommended real-time reverse transcriptase polymerase chain reaction (RT-PCR) assays.

**Data collection**

Data were collected with a predefined, standardized, field-tested form. Clinical, laboratory, and imaging data were obtained from official medical records and entered in the form by staff at each hospital. Information for health workers on how to complete the form was embedded in the form itself. Data collection forms were checked in real time for internal consistency or missing data by trained personnel. Additional cross-check and data cleaning were done before data analysis, by an expert statistician (IM). Disease severity was classified adapting a previous published classification [4], based on predefined criteria, as reported in Table 1.

**Data analysis**

Categorical variables were reported as absolute numbers and percentages and compared using the χ², Fisher exact test, or Mantel-Haenszel correction as appropriate, and by calculating odds ratios (OR) with confidence intervals of 95% (95% CI). The significance level was set at 0.05 (two-tailed test). Continuous variables were expressed as means and standard deviations or as median and inter-quartile ranges (IQR), if not normally distributed. An exploratory subgroup analysis was performed on disease severity by age group. Data were analyzed with STATA 15.

**Table 1  Disease severity**

| Disease severity | Asymptomatic: all the following must be present |
|------------------|-----------------------------------------------|
|                  | 1. No signs or symptoms                        |
|                  | 2. AND negative chest X-ray                    |
|                  | 3. AND absence of criteria for other cases     |
| Mild: any of the following (AND absence of criteria for more severe cases) | |
|                  | 1. Symptoms of upper respiratory tract infection |
|                  | 2. AND absence of pneumonia at chest X-ray     |
| Moderate: all the following (AND absence of criteria for more severe cases) | |
|                  | 1. Cough AND (sick appearing OR pneumonia at chest X-ray) |
| Severe: any of the following (AND absence of criteria as for critical case) | |
|                  | 1. Oxygen saturation < 92%                     |
|                  | 2. OR difficult breathing or other signs of severe respiratory distress (apnea, gasping, head nodding) |
|                  | 4. OR need for any respiratory support         |
| Critical: Any of the following | |
|                  | 1. Patient in ICU                              |
|                  | 2. OR intubated                                |
|                  | 3. OR multiorgan failure                       |
|                  | 4. OR shock, encephalopathy, myocardial injury or heart failure, coagulation dysfunction, acute kidney injury. |

Adapted from Dong Y et al. [4]
Results

Overall, 130 children and adolescents with confirmed COVID-19 virus infection were included in the study from 28 centers within the participating networks covering 10 regions in Italy (Fig. 1). One hundred twelve (86.2%) cases were recruited at hospital level, and 18 (13.8%) at outpatient level.

Notably, among patients younger than 2 years, 35/41 (85.3%) were less than 6 months of age (Table 2). Distribution by sex showed a slight male predominance (OR 1.63, 95% CI 1.00 to 2.68, \( p = 0.47 \)). Overall, 70 (53.8%) of children had contact with a COVID-19 case, with most of these (67/70 (95.7%) reporting a relative with COVID-19. Thirty-four (26.2%) patients had comorbidities, with the most frequent being respiratory, cardiac, or neuromuscular chronic diseases (12% of all children).

Most children were either asymptomatic (13.1%) or presented with mild disease (62.3%), while 11 (8.5%) had moderate disease, 11 (8.5%) had a severe disease, and 9 (6.9%) had a critical presentation.

Fever was recorded in 67 children (51.5%). The most common other symptom was cough, either dry (29.2%) or productive (12.3%). Rhinorrhea was observed in 25 (19.2%).

Respiratory distress was observed in 17 (13.0%). Two (1.6%) children were hypoxemic at presentation. Vomiting was reported in 15 (11.5%) and diarrhea in 10 (7.6%). Among children with vomiting, one had hematic vomit. Other signs or symptoms included sore throat (6.9%), thoracic pains (3%), hypo-reactivity (e.g., somnolence) or hyper-reactivity (e.g., excessive crying) (3%), febrile convulsions (1.5%), and pain in lower limbs (1.5%).

Out of the total sample of 130 children, 71 (54.6%) underwent laboratory testing. Among these patients, leucopenia and lymphopenia were detected in 36.8% and 15.7%, respectively, while increases in aspartate aminotransferase and alanine aminotransferase were reported in 18.3% and 11.8%, respectively.

Among the 41 (31.5%) children with chest X-ray, 17 (41.5%) showed ground-glass opacity, 15 (36.6%) presented a negative X-ray, and 4 (9.8%) had a focal consolidation.

Fifty-five (42.3%) children were treated at home and 75 (57.7%) were hospitalized.

Fifteen children needed some respiratory support: 8 (6.1%) needed oxygen, 3 (2.3%) high-flow oxygen, 2 (1.5%) non-invasive ventilation (CPAP), and 2 (1.5%) intubation and mechanical ventilation. Overall, nine (12.0%) children were admitted to intensive care unit (ICU).
Further characteristics of the children in the ICU are reported in Supplement 1. Out of the nine cases in the ICU, six had an age below 6 months, and three were adolescents; seven were males. All children in the ICU were given some respiratory support, except for three cases, which were infants below 2 months of age (18, 31, and 41 days of life) with fever, and had either diarrhea, respiratory distress, or congenital conditions (anemia, congenital kidney malformation) plus a consolidation at chest X-ray. One adolescent with cerebral palsy, epilepsy tracheotomy, and enteral nutrition required mechanical ventilation. All children recovered, and none died.

Table 2 (continued)

| N=130 | p values |
|-------|----------|
| Oxygen | 8/130 (6.1%) |
| High flow oxygen | 3/130 (2.3%) |
| Non-invasive ventilation | 2/130 (1.5%) |
| Intubation | 2/130 (1.5%) |
| Cases in ICU | 9/130 (6.9%) |
| Outcome | NA |
| Cured | 130/ (100%) |
| Dead | 0 (0%) |

Subgroup analysis (Table 3) revealed that children below 6 months of age had a significantly increased risk of “critical” disease severity when compared with older children (6/35 (17.1%) vs 3/86 (3.5%), two-tailed Fisher test p = 0.034, OR 5.6, 95% CI 1.3 to 29.1).

Discussion

This paper adds to previous knowledge on COVID-19 in children, describing the characteristics and outcomes of a sample of children diagnosed with the disease in Italy. Official national statistics in Italy, when the study recruitment ended, reported 704 cases of COVID-19 among patients below 20 years, accounting for 1% of total cases diagnosed country-wide [9]. The national surveillance system [9] recorded, at time of study end, only 49 cases of children with COVID-19 hospitalized, compared with the 75 hospitalized cases reported by our research networks and described in this study. Furthermore, national reports in Italy only provide a description of cases by age, and no further details on other children characteristics are available [9]. Major gaps in national surveillance data

Further characteristics of the children in the ICU are reported in Supplement 1. Out the nine cases in the ICU, six had an age below 6 months, and three were adolescents; seven were males. All children in the ICU were given some respiratory support, except for three cases, which were infants below 2 months of age (18, 31, and 41 days of life) with fever, and had either diarrhea, respiratory distress, or congenital conditions (anemia, congenital kidney malformation) plus a consolidation at chest X-ray. One adolescent with cerebral palsy, epilepsy tracheotomy, and enteral nutrition required mechanical ventilation. All children recovered, and none died.

Subgroup analysis (Table 3) revealed that children below 6 months of age had a significantly increased risk of “critical” disease severity when compared with older children (6/35 (17.1%) vs 3/86 (3.5%), two-tailed Fisher test p = 0.034, OR 5.6, 95% CI 1.3 to 29.1).

Discussion

This paper adds to previous knowledge on COVID-19 in children, describing the characteristics and outcomes of a sample of children diagnosed with the disease in Italy. Official national statistics in Italy, when the study recruitment ended, reported 704 cases of COVID-19 among patients below 20 years, accounting for 1% of total cases diagnosed country-wide [9]. The national surveillance system [9] recorded, at time of study end, only 49 cases of children with COVID-19 hospitalized, compared with the 75 hospitalized cases reported by our research networks and described in this study. Furthermore, national reports in Italy only provide a description of cases by age, and no further details on other children characteristics are available [9]. Major gaps in national surveillance data

Further characteristics of the children in the ICU are reported in Supplement 1. Out the nine cases in the ICU, six had an age below 6 months, and three were adolescents; seven were males. All children in the ICU were given some respiratory support, except for three cases, which were infants below 2 months of age (18, 31, and 41 days of life) with fever, and had either diarrhea, respiratory distress, or congenital conditions (anemia, congenital kidney malformation) plus a consolidation at chest X-ray. One adolescent with cerebral palsy, epilepsy tracheotomy, and enteral nutrition required mechanical ventilation. All children recovered, and none died.

Subgroup analysis (Table 3) revealed that children below 6 months of age had a significantly increased risk of “critical” disease severity when compared with older children (6/35 (17.1%) vs 3/86 (3.5%), two-tailed Fisher test p = 0.034, OR 5.6, 95% CI 1.3 to 29.1).

Discussion

This paper adds to previous knowledge on COVID-19 in children, describing the characteristics and outcomes of a sample of children diagnosed with the disease in Italy. Official national statistics in Italy, when the study recruitment ended, reported 704 cases of COVID-19 among patients below 20 years, accounting for 1% of total cases diagnosed country-wide [9]. The national surveillance system [9] recorded, at time of study end, only 49 cases of children with COVID-19 hospitalized, compared with the 75 hospitalized cases reported by our research networks and described in this study. Furthermore, national reports in Italy only provide a description of cases by age, and no further details on other children characteristics are available [9]. Major gaps in national surveillance data

Further characteristics of the children in the ICU are reported in Supplement 1. Out the nine cases in the ICU, six had an age below 6 months, and three were adolescents; seven were males. All children in the ICU were given some respiratory support, except for three cases, which were infants below 2 months of age (18, 31, and 41 days of life) with fever, and had either diarrhea, respiratory distress, or congenital conditions (anemia, congenital kidney malformation) plus a consolidation at chest X-ray. One adolescent with cerebral palsy, epilepsy tracheotomy, and enteral nutrition required mechanical ventilation. All children recovered, and none died.

Subgroup analysis (Table 3) revealed that children below 6 months of age had a significantly increased risk of “critical” disease severity when compared with older children (6/35 (17.1%) vs 3/86 (3.5%), two-tailed Fisher test p = 0.034, OR 5.6, 95% CI 1.3 to 29.1).

Discussion

This paper adds to previous knowledge on COVID-19 in children, describing the characteristics and outcomes of a sample of children diagnosed with the disease in Italy. Official national statistics in Italy, when the study recruitment ended, reported 704 cases of COVID-19 among patients below 20 years, accounting for 1% of total cases diagnosed country-wide [9]. The national surveillance system [9] recorded, at time of study end, only 49 cases of children with COVID-19 hospitalized, compared with the 75 hospitalized cases reported by our research networks and described in this study. Furthermore, national reports in Italy only provide a description of cases by age, and no further details on other children characteristics are available [9]. Major gaps in national surveillance data
Children below 6 months of age had a significantly increased risk of “critical” disease severity when compared with older children (6/35 (17.1%) vs 3/86 (3.5%)

have been highlighted also in other countries, including the USA, with missing data on the variable of interest ranging from 9 to 91% of cases [7, 8]. This study, therefore, has the merit to identify a not negligible pediatric sample of COVID-19 cases in Italy, and characterized children by sociodemographic variables, comorbidities, severity of disease, clinical presentations, laboratory test, X-ray, and need of ventilatory support.

Case distribution across regions reflects voluntary participation of centers in the networks involved but is quite in line with the national distribution of cases of COVID-19, with Lombardy and Emilia-Romagna regions presenting the highest incidence of cases [9].

The hospitalization rate in the sample of this study was significantly higher than what is reported in the official [9] Italian statistics (57.7% vs 11.0%, p < 0.05). Also, 26.2% of children in the sample of this study had comorbidities, a rate which is likely to be higher than the expected within the general pediatric population. Based on these observations, we believe that our sample is biased toward a more fragile population with more severe presentation, consistently with a network mostly including hospitals. When making comparison across different studies on pediatric COVID-19 case series, it is important to acknowledge differences in the characteristics of the sample and enrollment site [4, 8, 11]. Specifically, in the largest study from China, most cases were diagnosed outpatient, and only 34.1% of cases were laboratory-confirmed [4]. Conversely, the only existing reports on children from Spain [5] are similar to our study, in the sense that children were mostly enrolled at hospital level; not surprisingly, hospitalization rate (60%) was similar to the rate observed in our study (57.7%). Early reports from the USA are difficult to interpret given the very high number of missing information [7]. When comparing across populations, it is critical to remember that, so far, the real number of COVID-19 virus–positive cases in each of the countries of the world is currently unknown, and most probably heavily underestimated [12]. Testing strategies and availability of diagnostic tests are largely variable across the globe, with Italy being among one of the countries with more test being performed, per million people [13]. Additionally, the validity of the diagnostic test currently used (PCR on nasal or pharyngeal swab) is subject of debate [14]. Therefore, the real incidence of COVID-19 severe and critical cases among the overall population, as well as the real hospitalization rate and the rate of cases in the ICU, is currently impossible to establish.

Results of this study confirm that COVID-19 in children is mostly a mild disease, however may have a not negligible rate of severe presentation in selected population of pediatric patients. Infants aged less than 6 months, especially males, seem significantly more susceptible to severe forms of the disease, in line with the previous Chinese case series [4]. Specific risk factors, including specific underlying diseases, for hospitalization and treatment in ICU in children are currently poorly described. Evidence need to be generated to further establish the incidence of severe presentation of COVID-19 in infants and in children with pre-existing diseases. Additionally, criteria for hospitalization and for admission in ICU, which may vary by setting, should be further documented.

When compared with existing literature, this case series identifies few novel presentations of COVID-19 in children, including thoracic pain, hypo-reactivity or hyper-reactivity, febrile convulsions, and pain in lower limbs. Other possible rare manifestations of the diseases in children, such as liver and heart injury [15], or skin rash [16], or isolated gastrointestinal symptoms [17], have been reported anecdotaly and warrant further investigation.

Acknowledgments CorOnavirus iNFection In pEDiatric EmerGEncY dEpartments (CONFIDENCE) research group:
Idanna Sforzi, MD1, Martina Giacalone, MD1, Maria Carmela Leo, PhD34, Martina Falconi34, Giuseppe Indolfi, Prof35, Lorenzo D’Antiga, MD10, Angelo Mazza, MD10, Donatella De Martiis, MD54, Caterina Sabatini MD,12 Giuseppe Bertolozzi, MD36, Paola Marchisio, MD7,28, Giovanna Chidini, MD39, Edoardo Calderini, MD39, Carlo Agostoni,

| Age group | Asymptomatic | Mild | Moderate | Severe | Critical | Missing | Total |
|-----------|--------------|------|----------|--------|----------|---------|-------|
| < 6 months | 2 (11.8%) | 20 (24.7%) | 4 (36.4%) | 3 (30.0%) | 6 (60.0%) | 0 (0.0%) | 35 (26.9%) |
| 6–24 months | 1 (5.9%) | 4 (4.9%) | 0 (0.0%) | 1 (10.0%) | 0 (0.0%) | 0 (0.0%) | 6 (4.6%) |
| 2–9 years | 7 (41.2%) | 21 (25.9%) | 4 (36.4%) | 3 (27.3%) | 0 (0.0%) | 0 (0.0%) | 35 (26.9%) |
| 10–19 years | 7 (41.2%) | 27 (33.3%) | 3 (27.3%) | 4 (36.4%) | 3 (33.3%) | 1 (100%) | 45 (34.6%) |
| Missing | 0 (0.0%) | 9 (11.1%) | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 9 (6.9%) |
| Total | 17 (100%) | 81 (100%) | 11 (100%) | 11 (100%) | 9 (100%) | 1 (100%) | 130 (100%) |
Authors' Contributions ML: conceptualization, writing-original draft, writing-review and editing, read and approved the final manuscript. NP: writing-originial draft, writing-review and editing, read and approved the final manuscript. FM: acquisition of data, read and approved the final manuscript. BC: acquisition of data, read and approved the final manuscript. AA: acquisition of data, read and approved the final manuscript. MR: acquisition of data, read and approved the final manuscript. EF: acquisition of data, read and approved the final manuscript. AU: acquisition of data, read and approved the final manuscript. LDP: acquisition of data, read and approved the final manuscript. LV: acquisition of data, read and approved the final manuscript. BA: data analysis, read and approved the final manuscript. LB: acquisition of data, read and approved the final manuscript. PM: acquisition of data, read and approved the final manuscript. PB: acquisition of data, read and approved the final manuscript. SF: acquisition of data, read and approved the final manuscript. CP: acquisition of data, read and approved the final manuscript. FN: acquisition of data, read and approved the final manuscript. MR: acquisition of data, read and approved the final manuscript. EM: acquisition of data, read and approved the final manuscript. DB: acquisition of data, read and approved the final manuscript. MC: acquisition of data, read and approved the final manuscript. RA: acquisition of data, read and approved the final manuscript. AP: acquisition of data, read and approved the final manuscript. MAB: acquisition of data, read and approved the final manuscript. ML: acquisition of data, read and approved the final manuscript. SA: acquisition of data, read and approved the final manuscript. MC: acquisition of data, read and approved the final manuscript. EZ: acquisition of data, read and approved the final manuscript. AMM: acquisition of data, read and approved the final manuscript. BC: acquisition of data, read and approved the final manuscript. BA: data analysis, read and approved the final manuscript. LV: acquisition of data, read and approved the final manuscript. AU: acquisition of data, read and approved the final manuscript. EF: acquisition of data, read and approved the final manuscript. AA: acquisition of data, read and approved the final manuscript. MR: acquisition of data, read and approved the final manuscript.

References

1. Grasselli G, Pesenti A, Ccecconi M (2020) Critical care utilization for the COVID-19 outbreak in Lombardy, Italy: early experience.
and forecast during an emergency response. JAMA 323:1545. https://doi.org/10.1001/jama.2020.4031

2. World Health organization. Coronavirus disease (COVID-19) situation reports 79. Available at (accessed on March 27, 2020) https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports

3. Castagnoli R, Votto M, Licari A, Brambilla I, Bruno R, Perlini S, Rovida F, Baldanti F, Marseglia GL (2020) Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection in children and adolescents: a systematic review. JAMA Pediatr Published online April 22. https://doi.org/10.1001/jamapediatrics.2020.1467

4. Dong Y, Mo X, Hu Y, Qi X, Jiang F, Jiang Z, Tong S. Epidemiological characteristics of 2143 pediatric patients with 2019 coronavirus disease in China. Pediatrics. 2020 Mar 16

5. Tagarro A, Epalza C, Santos M, Sanz-Santaeufemia FJ, Otheo E, Moraleda C, Calvo C. Screening and severity of coronavirus disease 2019 (COVID-19) in children in Madrid, Spain. JAMA Pediatr Published online April 08, 2020. doi:https://doi.org/10.1001/jamapediatrics.2020.1346

6. Parri N, Lenge M, Buonsenso D (2020) Children with Covid-19 in pediatric emergency departments in Italy. NEJM; May 1. https://doi.org/10.1056/NEJMep2007617

7. Coronavirus Disease 2019 in Children — United States, February 12–April 2, 2020. MMWR Morb Mortal Wkly Rep. ePub: 6 April 2020. DOI: https://doi.org/10.15585/mmwr.mm6914e4external

8. DC COVID-19 Response Team. Severe outcomes among patients with coronavirus disease 2019 (COVID-19) — United States, February 12–March 16, 2020. MMWR Morb Mortal Wkly Rep. 2020 Mar 27:69(12):343–346

9. Istituto superiore di Sanità. Epidemia COVID-19. Aggiornamento nazionale 23 marzo 2020. Available at https://www.epicentro.iss.it/coronavirus/bollettino/Bollettino-sorveglianza-integrita-COVID-19_23-marzo2020.pdf (accessed March 30, 2020)

10. Ministero della Salute. Circolare 9 March 2020. Available at http://www.trovanorme.salute.gov.it/norme/renderNormsanPdf?anno=2020&codLeg=73669&parte=1%20&serie=null (accessed Mach 27, 2020)

11. Wu Z, McGoogan JM (2020) Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA.

12. Maxmen A (2020) How much is coronavirus spreading under the radar? Nature. https://doi.org/10.1038/d41586-020-00760-8

13. Our World in Data COVID-19 tests per million people (as of 20 March 2020 18:00). Available at https://ourworldindata.org/coronavirus-testing-source-data (accessed April 3)

14. Wang W, Xu Y, Gao R, Lu R, Han K, Wu G, Tan W (2020) Detection of SARS-CoV-2 in different types of clinical specimens. JAMA. https://doi.org/10.1001/jama.2020.3786

15. Cui Y, Tian M, Huang D, Wang X, Huang Y, Fan L, Wang L, Chen Y, Liu W, Zhang K, Wu Y, Yang Z, Tao J, Feng J, Liu K, Ye X, Wang R, Zhang X, Zha Y. A 55-Day-Old Female Infant infected with COVID 19: presenting with pneumonia, liver injury, and heart damage. J Infect Dis. 2020 Mar 17. pii: jiaa113. doi: https://doi.org/10.1093/infdis/jiaa113

16. Recalcati S (2020) Cutaneous manifestations in COVID-19: a first perspective. J Eur Acad Dermatol Venereol. https://doi.org/10.1111/jdv.16387

17. Jiatong S, Lanqin L, Wenjun L (2020) COVID-19 epidemic: disease characteristics in children. J Med Virol. https://doi.org/10.1002/jmv.25807

Publisher’s note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Affiliations

Niccolò Parri 1 · Anna Maria Magistà 2 · Federico Marchetti 3 · Barbara Cantoni 4 · Alberto Arrighini 5 · Marta Romanengo 6 · Enrico Felici 7 · Antonio Urbino 8 · Liviana Da Dalt 9 · Lucio Verdoni 10 · Benedetta Armocida 11 · Benedetta Covi 11 · Ilaria Mariani 11 · Roberta Giacchero 12 · Anna Maria Musolino 13 · Marco Binotti 14 · Paolo Biban 15 · Silvia Fasoli 16 · Chiara Pilotto 17 · Flavia Nicoloso 18 · Massimiliano Raggi 19 · Elisabetta Miorin 20 · Danilo Buonsenso 21,22 · Massimo Chiossi 23 · Rino Agostiniani 24 · Anna Plebani 25 · Antonio Urbino 8 · Liviana Da Dalt 9 · Lucio Verdoni 10 · Benedetta Armocida 11 · Benedetta Covi 11 · Ilaria Mariani 11 · Roberta Giacchero 12 · Anna Maria Musolino 13 · Marco Binotti 14 · Paolo Biban 15 · Silvia Fasoli 16 · Chiara Pilotto 17 · Flavia Nicoloso 18 · Massimiliano Raggi 19 · Elisabetta Miorin 20 · Danilo Buonsenso 21,22 · Massimo Chiossi 23 · Rino Agostiniani 24 · Anna Plebani 25 · Maria Antonietta Barbieri 13 · Marcello Lanari 26 · Serena Arrigo 27 · Elena Zoia 28 · Matteo Lenge 29,30,31 · Stefano Masi 1 · Egidio Barbi 11,32 · Marzia Lazzerini 1 · on behalf of the CONFIDENCE and COVID-19 Italian Pediatric Study Networks

Niccolò Parri
niccolo.parri@meyer.it

Anna Maria Magistà
annamaria.magista@auslromagna.it

Federico Marchetti
federico.marchetti@auslromagna.it

Barbara Cantoni
barbara.cantoni@policlinico.mi.it

Alberto Arrighini
alberto.arrighini@asst-spedalicivili.it

Marta Romanengo
marta.romanengo@gmail.com

Enrico Felici
enrico.felici@ospedale.al.it

Antonio Urbino
aturbino@icloud.com

Liviana Da Dalt
liviana.dadalt@unipd.it

Lucio Verdoni
lverdoni@asst-pg23.it

Benedetta Armocida
benedetta.armocida@burlo.trieste.it

Benedetta Covi
benedetta.covi@burlo.trieste.it
Ilaria Mariani
ilaria.mariani@burlo.trieste.it

Roberta Giacchero
Roberta.Giacchero@asst-lodi.it

Anna Maria Musolino
annamaria.musolino@opbg.net

Marco Binotti
marco.binotti@med.uniupo.it

Paolo Biban
paolo.biban@aovr.veneto.it

Silvia Fasoli
silvia.fasoli@asst-mantova.it

Chiara Pilotto
chiara.pilotto@asufc.sanita.fvg.it

Flavia Nicoloso
flavianicoloso@gmail.com

Massimiliano Raggi
massimiliano.raggi@aps.s.tn.it

Elisabetta Miorin
elisabetta.miorin@asufc.sanita.fvg.it

Danilo Buonsenso
danilobuonsenso@gmail.com

Massimo Chiossi
max.chiossi@gmail.com

Rino Agostiniani
rinoagostiniani@gmail.com

Anna Plebani
annamaria.plebani@asst-settelaghi.it

Maria Antonietta Barbiere
mantonietta.barbiere@opbg.net

Marcello Lanari
marcello.lanari@unibo.it

Serena Arrigo
arrigoserena@gmail.com

Elena Zoia
elena.zoia@asst.fbf.sacco.it

Matteo Lenge
matteo.lenge@meyer.it

Stefano Masi
stefano.masi@meyer.it

Egidio Barbi
egidio.barbi@burlo.trieste.it

1 Department of Emergency Medicine and Trauma Center, Meyer University Children’s Hospital, Florence, Italy
2 Department of Pediatrics, Community Pediatrics, Ravenna, Italy
3 Department of Pediatrics, Ravenna Hospital, Ravenna, Italy
4 Healthcare Professional Department Fondazione IRCCS Ca’ Granda, Ospedale Maggiore Policlinico, Milan, Italy
5 Pediatric Emergency Department, Presidio Ospedale dei Bambini, ASST Spedali Civili, Brescia, Italy
6 IRCCS Istituto Gaslini, Genoa, Italy
7 Pediatric and Pediatric Emergency Unit, The Children Hospital, Azienda Ospedaliera SS Antonio e Biagio e Cesare Arrigo, Alessandria, Italy
8 Department of Pediatric Emergency, Regina Margherita Children’s Hospital - A.O.U. Città della Salute e della Scienza di Torino, Turin, Italy
9 Department for Woman and Child Health-Pediatric Emergency Department, University of Padua, Padua, Italy
10 Department of Pediatrics, Papa Giovanni XXIII Hospital, Bergamo, Italy
11 Institute for Maternal and Child Health - IRCCS “Burlo Garofolo”, Trieste, Italy
12 Department of Pediatrics, Lodi Hospital, Lodi, Italy
13 Department of Pediatric Emergency Medicine, Bambino Gesù Children’s Hospital, IRCCS, Rome, Italy
14 Neonatal and Pediatric Intensive Care Unit, Maggiore della Carità University Hospital, Novara, Italy
15 Department of Neonatal and Paediatric Critical Care, Verona University Hospital, Verona, Italy
16 Paediatric Unit, Carlo Poma Hospital, Mantua, Italy
17 Division of Paediatrics, Department of Medicine DAME, Academic Hospital Santa Maria della Misericordia, University of Udine, Udine, Italy
18 Family Pediatrician, Udine, Italy
19 ICU, Pain Therapy Unit, Rovereto Hospital, Trento, Italy
20 Department of Pediatrics, Latisana-Palmanova, ASUFC, Udine, Italy
21 Department of Woman and Child Health and Public Health, Fondazione Policlinico Universitario A. Gemelli IRCCS, Rome, Italy
22 Università Cattolica del Sacro Cuore, Rome, Italy
23 Department of Pediatrics, ASL 4 Liguria, Lavagna, Italy
24 Department of Pediatrics, Ospedale San Jacopo, Pistoia, Italy
25 Pediatric Emergency Unit, Filippo Del Ponte Hospital, ASST-Settelaghi, Varese, Italy
Pediatric Emergency Unit, S. Orsola Hospital, University of Bologna, Bologna, Italy

Department of Pediatrics, Hospital Filippo Del Ponte, Varese, Italy

Department of Pediatrics, Hospital V. Buzzi, Milan, Italy

Clinical Trial Office, Children’s Hospital A. Meyer-University of Florence, Florence, Italy

Child Neurology Unit and Laboratories, Neuroscience Department, Children’s Hospital A. Meyer-University of Florence, Florence, Italy

Functional and Epilepsy Neurosurgery Unit, Neurosurgery Department, Children’s Hospital A. Meyer-University of Florence, Florence, Italy

Department of Medicine, Surgery and Health Science, Department of Pediatrics, University of Trieste, Trieste, Italy