

Survival in pediatric patients with cancer during the COVID-19 pandemic: scoping systematic review

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Abstract

Background: Coronavirus disease (COVID)-19 has currently affected 8,015,502 million people worldwide with global mortality around 5%. Information in pediatric cancer patients is still limited, but it is emerging day by day. The objective of this scoping review was to analyze the available data associated with COVID-19 infection and mortality in pediatric cancer patients and to provide useful information to plan and design strategies in this group. **Methods:** A search was conducted, and eight articles were obtained for qualitative analysis; 110 patients were included, all from cross-sectional studies. At the time of publication, all the analyzed documents reported no deaths associated with COVID-19. **Results:** According to the information, COVID-19 infection appears to be less severe in the pediatric population in comparison with adults and does not appear to be a cause of mortality in patients with childhood cancer. **Conclusions:** Given the nature of preliminary reports and a short follow-up in cancer patients, it is necessary to have medium- and long-term follow-up studies to determine the effects of infection and modifications to the treatments of these patients.

Key words: Coronavirus disease-19. Cancer. Children. Systematic review. Mortality.

Sobrevida en pacientes pediátricos con cáncer durante la pandemia de COVID-19: revisión sistemática exploratoria

Resumen

Introducción: La enfermedad conocida como COVID-19 ha afectado ya a 8,015,502 millones de personas en el mundo, con una mortalidad global de aproximadamente el 5%. La información en pacientes pediátricos con cáncer es aún limitada y está surgiendo día a día. El objetivo de esta revisión sistemática fue conocer los datos disponibles sobre la COVID-19 y la mortalidad en los pacientes pediátricos con cáncer, y aportar información útil para planear y diseñar estrategias en este grupo. **Métodos:** Se llevó a cabo una búsqueda y se seleccionaron ocho artículos para realizar un análisis cuantitativo; se incluyeron 110 pacientes, todos provenientes de estudios transversales. Al momento de las publicaciones, no se documentaron fallecimientos asociados a la COVID-19 en los documentos analizados. **Resultados:**

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De acuerdo con la información de esta revisión sistemática, la COVID-19 parece ser menos grave que en los adultos y no parece ser causa de mortalidad en pacientes pediátricos con cáncer. **Conclusiones:** Dada la naturaleza de los reportes preliminares y el corto seguimiento en los pacientes con cáncer, es necesario contar con estudios de seguimiento a mediano y largo plazo para conocer los efectos de la infección y de las modificaciones del tratamiento en estos pacientes.

Palabras clave: COVID-19. Cáncer infantil. Revisión sistemática exploratoria. Mortalidad.

Introduction

On June 15, 2020, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) disease (coronavirus disease [COVID]-19), which emerged in China, has resulted in 8,015,502 infections and 436,319 deaths¹. Although the exact number of affected children < 18 years of age is not precise, a frequency of 1-5% of total infections has been estimated. Therefore, there may be approximately 80,000-350,000 children infected by this virus.

People over 60 are especially susceptible to severe complications of the disease. Consequently, there are significantly fewer reports on pediatric populations in scientific journals. A systematic review that analyzed clinical presentation in different age groups showed that the frequency of hospitalizations, mechanical ventilation support requirements, and mortality is higher in minors².

Newborns, infants, and preschoolers are unable to have self-isolation and self-care, which represent a public health problem in terms of controlling the spread of the virus. These age groups are particularly sensitive and complex, as some international hospitals have banned visits to comply with social distance and quarantine protocol, as the primary caregiver may become infected. In other centers where primary caregivers are allowed, there are logistical challenges of controlling infections and increasing resources of these hospitals serving children³.

Although it seems that children are less likely to develop severe complications, recent studies have identified that children < 5 years of age can develop severe clinical manifestations, perhaps explained by the immaturity of their immune system. There are only a few reports in the literature on the impact of COVID-19 on the pediatric population. Dong et al. described the epidemiology of the first pediatric series affected by the pandemic, consisting of 2143 suspected or confirmed cases in children in China, with an average age of 7 years⁴. Regarding symptoms, 4.4% were classified as asymptomatic, while most showed moderate to severe symptoms. Children < 1 year of age presented

the most severe clinical forms and accounted for the only death in the series. No association or comorbidity with childhood cancer is mentioned in this report⁴.

In the United States of America, a report on a case series examining the characteristics of 5700 New York City patients between March and April 2020, the average age was 63 years, ranging from 0 to 107 years at admission. There was male predominance (60.3%), and the most common comorbidity was high blood pressure (56.6%). In this study, cancer was present in only 6% of patients. Thirty-four patients under the age of 18 were identified in this study, of which no deaths occurred, or cancer coexistence was reported⁵.

Another US publication on pediatric intensive care units (ICUs) described the characteristics of 74 children who required critical care. The study covered from March 18 to April 6. It was estimated that 176,190 individuals were infected, from which 30% of the cases were children < 2 years of age and 46% of children between 12 and 17 years of age. The US epidemiologists project that, if 25% of the US population is infected by the end of 2020, there might be 50,000 children with severe COVID-19, and 5400 may need mechanical ventilation⁶.

The situation becomes particularly complicated when analyzing data on children with cancer and their management during the pandemic. Chen et al. described the first report of a child with cancer and COVID-19, a patient with high-risk acute lymphoblastic leukemia (ALL) who developed fever (F) and neutropenia (N) with cough in late January 2020. Initially, the patient was positive for influenza, but due to the persistence of the symptoms and epidemiological suspicion, the child was tested for COVID-19, giving a positive result. This patient was treated with umifenovir, ribavirin, and recombinant gamma-1b interferon, but the clinical outcome is unknown⁷.

Balduzzi et al. published the experience of a pediatric hemato-oncology and transplant center in Italy, where five cancer patients were reported positive for COVID-19: three were managed at home, two required hospitalization, and all of these patients showed moderate symptoms and survived⁸.

The speed at which contagion spreads and the increased demand on health systems has forced large cooperative centers at the international level to identify people in vulnerable conditions, who could be harmed if infected with COVID-19. These organizations have drawn up useful expert management recommendations and are urgently calling for collaboration and sharing of expertise among centers that care for pediatric cancer patients⁹. In this context, the St. Jude group has created a virtual space for collaboration¹⁰.

To date, only a few publications have reported on clinical monitoring and outcomes of pediatric patients with COVID-19 and cancer, which is likely to change rapidly.

Methods

We conducted a systematic exploratory review of the literature from December 2019 to June 10, 2020, to compare survival in patients < 18 years of age with cancer, with or with no SARS-CoV-2 infection. Since only a few reports were published in letters-to-editor sections in the first month, articles with the following characteristics were included: observational (included in opinion sections or letters to the editor), cross-sectional, or longitudinal studies. The used sources of information were MEDLINE, TRIP Database, International Clinical Trials Registry Platform (WHO), The Cochrane Library, Wiley, LILACS, and Google Scholar.

In addition, we searched directly (snowball method) in the following journals: *Nature*, *New England Journal of Medicine*, *Science*, *JAMA*, *ELSEVIER*, *Oxford University Press*, *The Lancet*, and medRxiv. MEDLINE searches were conducted using keywords and terms, without methodological filters by type of article (Table 1).

The reference lists of retrieved full-text articles were also searched to identify additional relevant studies. Furthermore, a search of classified gray literature was performed within the registers of the Hospital Infantil de México Federico Gómez¹¹.

The search terms used were keywords or MeSH terms (for the pediatric stage: pediatrics, children, child, infancy, infant, scholar, and adolescent; for cancer disease: oncology, hemato-oncology, cancer, solid tumors, and hematologic cancer; for SARS-CoV-2 disease: SARS-COV-2, COVID-19, and coronavirus 19; and for death: mortality, survivance, and death).

The articles that included patients with cancer < 18 years of age infected with SARS-CoV-2 and data on their survival were selected. Case reports or those in which the pediatric populations studied had only one

subject with cancer or those that determined other families of coronaviruses were excluded.

In those publications where the outcomes were not indicated, the corresponding author was contacted. If data were clarified, the document was included.

The variables identified were defined as follows:

- SARS-CoV-2 infection: confirmation by polymerase chain reaction (PCR) test.
- Cancer: consideration when the article referred to this condition within the population context or when the population was classified according to the type of cancer.
- Survival: in cross-sectional studies, survival was considered when the outcome of patients up to the time of analysis was clarified. In those publications where mortality was not reported, the corresponding authors were contacted by e-mail to clarify the variables of interest.

For data collection and extraction, two reviewers assessed the inclusion eligibility of studies independently. Relevant studies were retrieved, and the necessary information on the characteristics of the selected studies (methodological aspects) was extracted: participants, type of intervention, outcome variable, and outcome data. In both phases (study selection and data extraction), the reviewers resolved disagreements by consensus; if disagreement persisted, a third reviewer was consulted.

Data obtained were integrated into evidence tables with validation by both reviewers. The following information was considered: country of origin, type of design, the purpose of the study, results of the study, phase of treatment the patient was undergoing when presenting COVID-19 infection, and the clinical outcome.

Studies with information on the management or mortality of pediatric patients (< 18 years) with cancer and SARS-CoV-2 were included. Articles with information only on adults were excluded from the study.

Statistical analysis

The results were qualitative synthesized. The frequencies of the clinical variables and the outcome were expressed in frequencies and percentages.

Results

Initially, 2685 articles were identified from scientific journal searches and eight from other sources, of which 55 manuscripts were duplicated. Then, 63 abstracts were reviewed to select those that met eligibility

Table 1. MeSH terms used for MEDLINE search strategies

– (((("neoplasms"[MeSH Terms] OR "neoplasms"[All Fields]) OR "oncology"[All Fields]) OR "oncology"[All Fields]) AND (((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields])) AND ((((((("COVID-19"[All Fields] OR "COVID-2019"[All Fields]) OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "2019 nCoV"[All Fields]) OR "SARS-CoV-2"[All Fields]) OR "2019 nCoV"[All Fields]) OR ("Wuhan"[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND (2019/12/1:2019/12/31[Date - Publication] OR 2020/1/1:2020/12/31[Date - Publication]))))
– (((("severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "SARS-CoV-2"[All Fields]) AND (((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields])) AND ((((((("cancers"[All Fields] OR "cancerated"[All Fields]) OR "canceration"[All Fields]) OR "cancerization"[All Fields]) OR "cancerized"[All Fields]) OR "cancerous"[All Fields]) OR "neoplasms"[MeSH Terms]) OR "neoplasms"[All Fields]) OR "cancer"[All Fields]) OR "cancers"[All Fields])) AND (((("intensive care units"[MeSH Terms] OR ("intensive"[All Fields] AND "care"[All Fields]) AND "units"[All Fields])) OR "intensive care units"[All Fields]) OR ("intensive"[All Fields] AND "care"[All Fields]) AND "unit"[All Fields])) OR "intensive care unit"[All Fields])
– ((("COVID"[All Fields] AND (((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields])) AND ((((((("cancers"[All Fields] OR "cancerated"[All Fields]) OR "canceration"[All Fields]) OR "cancerization"[All Fields]) OR "cancerized"[All Fields]) OR "cancerous"[All Fields]) OR "neoplasms"[MeSH Terms]) OR "neoplasms"[All Fields]) OR "cancer"[All Fields]) OR "cancers"[All Fields])) AND (((("intensive care units"[MeSH Terms] OR ("intensive"[All Fields] AND "care"[All Fields]) AND "units"[All Fields])) OR "intensive care units"[All Fields]) OR ("intensive"[All Fields] AND "care"[All Fields]) AND "unit"[All Fields])) OR "intensive care unit"[All Fields])
– (((("severe acute respiratory syndrome coronavirus 2"[Supplementary Concept] OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "SARS-CoV-2"[All Fields]) AND (((("child"[MeSH Terms] OR "child"[All Fields]) OR "children"[All Fields]) OR "child's"[All Fields]) OR "children's"[All Fields]) OR "children's"[All Fields])) AND ((((((("cancers"[All Fields] OR "cancerated"[All Fields]) OR "canceration"[All Fields]) OR "cancerization"[All Fields]) OR "cancerized"[All Fields]) OR "cancerous"[All Fields]) OR "neoplasms"[MeSH Terms]) OR "neoplasms"[All Fields]) OR "cancer"[All Fields]) OR "cancers"[All Fields])
– ((((((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields]) AND ((((((("COVID-19"[All Fields] OR "COVID-2019"[All Fields]) OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "2019 nCoV"[All Fields]) OR "SARS-CoV-2"[All Fields]) OR "2019 nCoV"[All Fields]) OR ("Wuhan"[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND (2019/12/1:2019/12/31[Date - Publication] OR 2020/1/1:2020/12/31[Date - Publication])))) AND ((((((("cancers"[All Fields] OR "cancerated"[All Fields]) OR "canceration"[All Fields]) OR "cancerization"[All Fields]) OR "cancerized"[All Fields]) OR "cancerous"[All Fields]) OR "neoplasms"[MeSH Terms]) OR "neoplasms"[All Fields]) OR "cancer"[All Fields]) OR "cancers"[All Fields])
– ((((((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields]) AND ((((((("COVID-19"[All Fields] OR "COVID-2019"[All Fields]) OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "2019 nCoV"[All Fields]) OR "SARS-CoV-2"[All Fields]) OR "2019 nCoV"[All Fields]) OR ("Wuhan"[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND (2019/12/1:2019/12/31[Date - Publication] OR 2020/1/1:2020/12/31[Date - Publication])))) AND (((("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields]) OR "coronaviruses"[All Fields]) AND (((("mortality"[MeSH Terms] OR "mortality"[All Fields]) OR "mortalities"[All Fields]) OR "mortality"[MeSH Subheading]))
– ("cancer"[All Fields] AND ("coronavirus"[All Fields] AND "19"[All Fields])) AND "pediatric"[All Fields]
– (((("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields]) OR "coronaviruses"[All Fields]) AND ((((((("COVID-19"[All Fields] OR "COVID-2019"[All Fields]) OR "severe acute respiratory syndrome coronavirus 2"[Supplementary Concept]) OR "severe acute respiratory syndrome coronavirus 2"[All Fields]) OR "2019 nCoV"[All Fields]) OR "SARS-CoV-2"[All Fields]) OR "2019 nCoV"[All Fields]) OR ("Wuhan"[All Fields] AND ("coronavirus"[MeSH Terms] OR "coronavirus"[All Fields])) AND (2019/12/1:2019/12/31[Date - Publication] OR 2020/1/1:2020/12/31[Date - Publication])))) AND (((("pediatrics"[All Fields] OR "pediatrics"[MeSH Terms]) OR "pediatrics"[All Fields]) OR "pediatric"[All Fields]) OR "pediatric"[All Fields])) AND (((("neoplasms"[MeSH Terms] OR "neoplasms"[All Fields]) OR "oncology"[All Fields]) OR "oncology"[All Fields])

criteria; 27 were identified and were read completely (Fig. 1).

Excluded articles

Articles were excluded for the following criteria: seven articles which involved a single cancer patient (Gonzalez et al., 2020¹², Liguoro et al., 2020¹³, Sun et

al., 2020¹⁴, Wu et al., 2020¹⁵, Chao et al., 2020¹⁶, Sieni et al., 2020¹⁷, Lu et al., 2020¹⁸) and four articles that included an adult population but no pediatric cases (Molica et al., 2020¹⁹, Dai et al., 2020²⁰, Mehta et al., 2020²¹, Zhang et al., 2020²²). In three articles (Dong et al., 2020⁴, Lu et al., 2020²², Yang et al., 2020²³), the reported population met the age criteria; however, since no selection criteria were

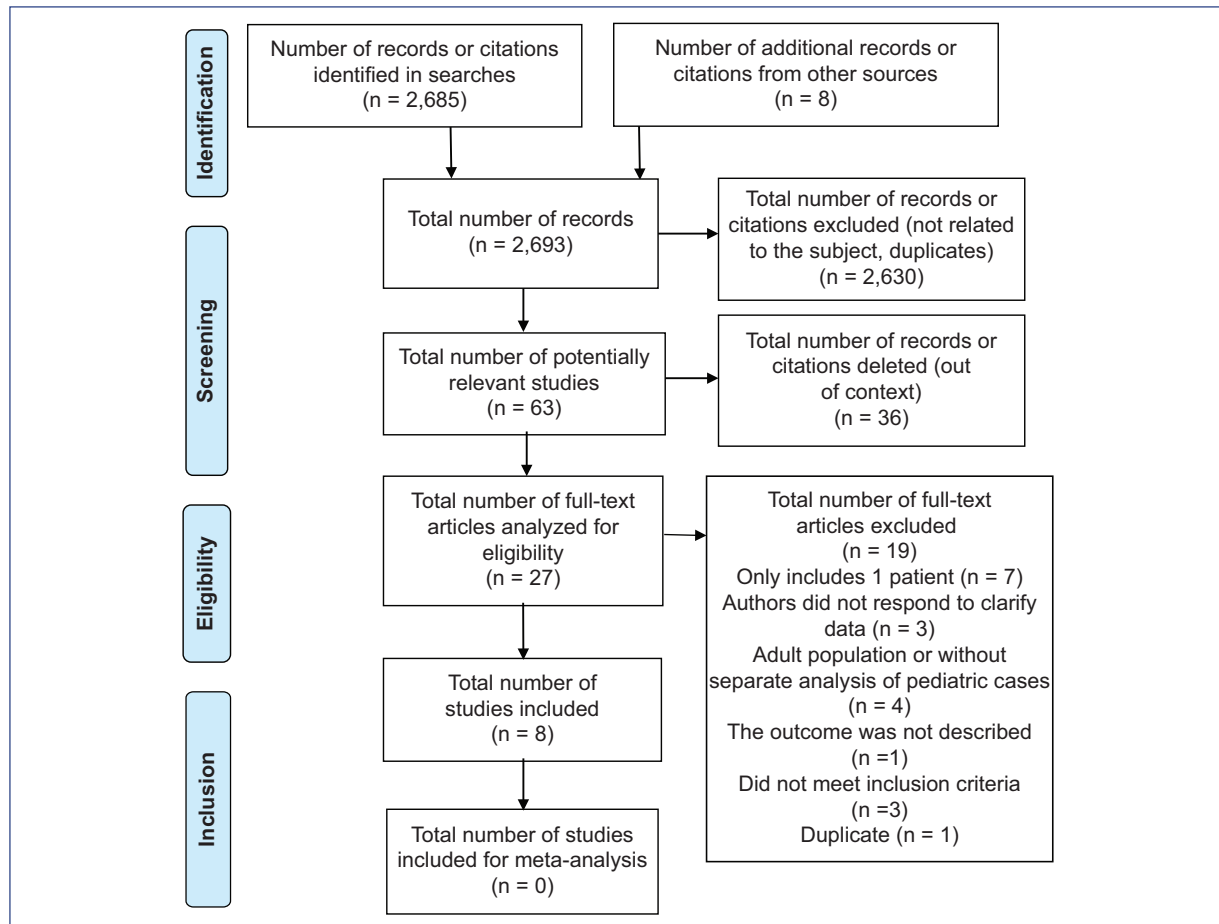


Figure 1. Flowchart of the systematic review according to the PRISMA guidelines.

available, it was not possible to identify whether any of these cases simultaneously presented cancer. In these cases, the corresponding authors were contacted; if there was no response, the articles were excluded. Furthermore, one report was discarded for not including an outcome (Terenziani, 2020²⁴), and three more did not meet the inclusion criteria (Baruchel, 2020²⁵; Sullivan, 2020²⁶; Shekerdeman, 2019²⁷); finally, one duplicated study was excluded as well (Ruggiero, 2020²⁸).

Included articles

Eight articles were included (Table 2): Andre et al., 2020²⁹, Balduzzi et al., 2020⁸, Boulad et al., 2020³⁰, de Rojas et al., 2020³¹, Ferrari et al., 2020³², Hrusak et al., 2020³³, Zachariah et al., 2020³⁴, and Garazzino et al., 2020³⁵. A total of 110 patients were included in the analysis, all from cross-sectional studies.

Although some patients were seriously ill in an ICU, at the time of publication, no deaths associated with COVID-19 were documented.

In addition, 14 patients from the hospital census at the Hospital Infantil de México Federico Gómez were included; seven of them required hospitalization, but none was critically ill or required intensive care at the time of publication.

Discussion

Regarding the evidence on COVID-19, scientific journals have given priority for disseminating the published information so that these manuscripts reach a higher number of readers. However, in some cases, the reports are preliminary, with heterogeneous populations, partial follow-ups, and scenarios that make it difficult to adjust for confounding variables.

In this systematic review, it was not possible to complete a meta-analysis because most of the included

Table 2. Description of studies of pediatric cancer patients infected with coronavirus disease (COVID-19)

Author, year [reference]	Country	Design	Objective	Results	Stage of treatment	Outcome
André et al., 2020* ²⁹	France	A multicentric descriptive cross-sectional study	Reporting the diagnosis in pediatric cancer patients and their clinical characteristics	In 19 cancer centers, 33 cases were confirmed by PCR, five of which required hospitalization in ICUs	One of the patients who required ICU management coincided the episode with the administration of chemotherapy	100% survival
Balduzzi et al., 2020 ⁸	Italy	Descriptive cross-sectional study	A review by experts and the reporting of positive cases from a hospital facility	PCR diagnosis of five cases: ALL (1 case), osteosarcoma (2 cases), hepatoblastoma (2 cases), rhabdoid tumor (1 case).	—	100% survival
Boulad et al., 2020* ³⁰	United States	Descriptive cross-sectional study [‡]	A study that evaluated the diagnosis of COVID-19 in children and caregivers at a New York hospital attending population with cancer	Of 335 PCR tests performed on patients and primary caregivers, 20 (11.5%) were confirmed, five of which showed moderate symptoms that required hospitalization	Three of the hospitalized patients presented fever and neutropenia and required modifications to their chemotherapy treatment	100% survival
de Rojas et al., 2020* ³¹	Spain	Descriptive cross-sectional study [§]	To report the clinical characteristics of children with cancer and COVID-19 in Madrid	In 2 months, 1140 PCR tests were performed, of which 1.3% were positive. There were 15 cases of children, with a median age of 10.6 years, presenting with the following types of cancer: 11 (73%) hematological neoplasms, 4 (27%) solid tumors, and 4 with transplants	60% presented the infection during the following 15 days after chemotherapy	100% survival
Ferrari et al., 2020* ³²	Italy	Multicentric descriptive cross-sectional study [‡]	Reporting the characteristics of Italian patients in the region of Lombardy, Italy	Of 4485 PCR tests, 286 patients were positive, identifying 21 cases of COVID-19 with cancer (number of cases): leukemia (10) sarcomas (5), lymphomas (2), hepatoblastomas (2), central nervous system tumors (1), and colon cancer (1)	15 cases were present during the 1 st day of chemotherapy courses; in 10 cases, it was necessary to adjust the chemotherapy	100% survival
Hrusak et al., 2020 ³³	Italy	Multicentric descriptive cross-sectional study [‡]	A brief report of the participation of 32 pediatric hospital centers	There were 200 cancer patients tested with PCR, and eight positive cases were reported. The types of cancer (number of cases) were ALL (2), hepatoblastoma (2), osteosarcoma (1), rhabdoid tumor (1), Ewing's sarcoma (1), Wilms' tumor (1). This study includes five patients also reported by Balduzzi et al. ⁸	Seven of the cases occurred during chemotherapy and were accompanied by fever and neutropenia	100% survival
Zachariah et al., 2020 ³⁴	United States	Comparative cross-sectional study	To compare the clinical characteristics of patients infected by COVID-19 who required and did not require hospitalization in intensive care	Fifty cases were confirmed by PCR, of which nine required hospitalizations in ICU. The cases with cancer were (number of patients) solid organ tumors (2), hematological neoplasms (2)	—	100% survival
Garazzino et al., 2020 ³⁵	Italy	Cross-sectional study	Preliminary report of confirmed cases in Italy	168 confirmed cases were obtained, of which 110 required hospitalization, of which four had cancer as a comorbidity	—	100% survival
HIMFG (report up to June 13, 2020)	Mexico	Hospital Census Report	Patients of the hematology and oncology department	14 cases were confirmed, of which seven required hospitalization	—	100% survival

ALL: acute lymphoblastic leukemia; F: fever; N: neutropenia; HIMFG: Hospital Infantil de México Federico Gómez; ICU: intensive care unit; PCR: polymerase chain reaction.
*Letter to the editor describing a population that met the selection criteria; †patients from cancer hospitals; ‡data were retrieved from a national registry of children with cancer.

articles were part of cross-sectional studies or early cohorts included in letters to the editor. For this reason, the case series obtained at the time the search was completed did not contain reports of deaths associated with COVID-19 infection. As expected, given the epidemiology of pediatric stage neoplasms, the highest number of cases occurred in patients with ALL³⁶. Fever and neutropenia were frequently observed in most cases requiring hospitalization or ICU care. Furthermore, it should be considered that in non-pandemic scenarios, up to half of fever and neutropenia events require intensive care, and mortality from septic shock may increase up to 33%³⁷.

As shown in table 2, most of the publications included are reported by cancer centers that have the infrastructure and expertise to address these complications, including COVID-19 infection. The absence of deaths can be explained by the fact that experts in the field maintained the lead in medical care.

The strength of this exploratory review lies in the fact that the chronology of the pandemic is represented through the most affected countries, with a predominance of cases from Italy, Spain, France, and the United States. The low representation of China is noteworthy, probably due to a language bias³⁸.

In this systematic review, the articles included for the analysis were those in which COVID-19 was confirmed by PCR and not by clinical criteria since this test is the gold standard. However, criteria for screening the pediatric population are not yet well defined.

As in any exploratory review, the following biases of the present review are mentioned:

- a. Selection bias: selected publications included patients with various neoplasms and therapeutic phases.
- b. Repeated information bias: some authors shared patients in their publications^{8,33}.
- c. Follow-up bias: the cross-sectional nature of the articles included does not allow to know whether these subjects could subsequently die in the following weeks or if they presented complications in the subsequent chemotherapies.
- d. Reporting bias: the principal authors of the articles are experts in their fields, so there may be hospitals with related deaths that have not published their cases.

Regarding Mexico, it was not possible to identify information on these patients up to the time of the search. Therefore, reports from a concentration hospital in Mexico City, which is a reference center for the treatment of childhood cancer, are included as

gray literature. The National Public Access Database provided by the *Secretaría de Salud* (Ministry of Health) reported 100 deaths in 6220 infected children, but it was not possible to identify any association with cancer, because the variable recorded was immunocompromise.

Regardless of some isolated efforts, there is a need to standardize diagnostic and management guidelines, for which the information in this systematic review may be useful.

Although data in the literature are limited, this systematic review shows that COVID-19 does not impact on infant mortality in the pediatric cancer population. Furthermore, the severe form of COVID-19 infection seems to occur less in children than in adults, which is consistent with the isolated opinions of other authors. It might be possible that the biology of the disease is different between both age groups and that distinct management guidelines will have to be developed shortly.

The medium- and long-term impact of interrupting chemotherapy as a result of COVID-19 is not clear. Therefore, studies are needed to follow up and analyze this situation. In addition, many questions remain to be answered. For example, how long chemotherapy should be postponed when the infection is detected, which will be the recovery parameters, and if it is correct to screen the population with cancer.

The information above exposes the need for collaboration not only between different hospitals but also between different disciplines. This effort should be directed at protocolizing management and conducting clinical trials for the treatment of the disease. Moreover, education to patients and families about the disease, the consequences of isolation, prevention, and diagnostic methods should be protocolized. These actions will undoubtedly impact the care of this sensitive group, pediatric cancer patients.

Given the nature of preliminary reports and a short follow-up in cancer patients, it is necessary to have medium- and long-term follow-up studies to determine the effects of infection and modifications to the treatments of these patients.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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