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Kawasaki-like illness following COVID-19 infection in a minor β-thalassemic girl

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Abstract

Multisystem inflammatory syndrome (MIS), also known as a Kawasaki-like illness, is a rare condition linked to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It presents with systemic inflammation and organ dysfunction, and it shares several clinical features with Kawasaki disease (KD). This case report describes an 8-year-old girl that developed symptoms suggestive of MIS or KD several weeks after a COVID-19 infection. She experienced a high fever lasting 4 days, followed by the appearance of itchy, erythematous patches on her legs, which later spread to her trunk and face. The inflammatory symptoms resolved spontaneously in less than 2 months without any lasting effects.

Keywords: multisystem inflammatory syndrome, Kawasaki-like illness, COVID-19, children, β-thalassemia

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Introduction

During the COVID-19 pandemic, some children infected with COVID-19 developed symptoms a few weeks after infection, including prolonged fever, conjunctivitis, oral mucosal alterations, cervical lymphadenopathy, and skin rashes. These symptoms can be classified under post-COVID-19 multisystem inflammatory syndrome (MIS) or Kawasaki-like illness (KLI), which is considered in the differential diagnosis of Kawasaki disease (KD) (1). Although these conditions share several symptoms, they differ notably in terms of the age of onset. MIS has been diagnosed in neonates (MIS-N) (2), children up to 8 years old (MIS-C), and older children up to 19 and 21 years old (MIS-A) (3), whereas the age of onset of KD is between 0 and 5 years.

The most widely accepted definition of MIS is the one proposed by the Centers for Disease Control and Prevention (CDC) (4), which includes clinical symptoms and signs developing within 60 days of COVID-19 detection. The diagnosis of MIS-C requires the fulfillment of the following criteria:

i) Fever (≥ 38 °C)
ii) Clinical severity necessitating hospitalization
iii) Evidence of systemic inflammation, indicated by a C-reactive protein (CRP) level ≥ 3.0 mg/dl
iv) New-onset manifestations in at least two of the following categories:
  a) Cardiac involvement
  b) Mucocutaneous involvement, characterized by oral mucosal inflammation, lip fissuring, strawberry tongue, and conjunctivitis
  c) Shock
  d) Gastrointestinal involvement
  e) Hematologic abnormalities, including a white blood cell count > 10,000/mm³, lymphopenia, and a platelet count < 150,000/µl
v) Detection of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) RNA via molecular amplification testing (PCR) in a clinical specimen within 60 days prior to or during medical evaluation
vi) Exclusion of alternative diagnoses (4, 5).

In addition to the clinical forms meeting all the abovementioned criteria, less serious cases have been reported as self-limiting MIS in children (6).

KD is a form of vasculitis, affecting medium-sized vessels. It is characterized by a fever lasting more than 5 days and at least four clinical criteria: bilateral non-exudative bulbar conjunctivitis, changes in the lips or oral cavity, non-suppurative cervical lymphadenopathy, polymorphic rash, erythema, and edema of the hands and feet (7–9). In rare cases, clinicians may establish the diagnosis with fewer than 5 days of fever. The etiology of KD remains unknown, but it is hypothesized that some viral infections, including adenoviruses and coronaviruses, may act as triggers (10) in genetically predisposed children (7). Cases of KD or KLI have been reported after COVID-19, even in asymptomatic forms (11). Although KD is similar to MIS, there are some differences, as outlined in Table 1 (12).

Case report

An 8-year-old girl presented in late November 2023 with flu-like symptoms, diffuse myalgia, mild fever, and a positive PCR-based swab test for COVID-19. She is affected by a mild form of β-thalassemia, inherited from her mother, previously diagnosed in the pediatrics department and documented by a consistently low Mentzer index (< 13). When she was 6 years old, she developed herpetic keratitis in her left eye, which was successfully treated with acyclovir.

In mid-November, she experienced mild flu-like symptoms, including a brief cold lasting a few days. Approximately 5 days later, a molecular swab test for COVID-19 was performed, yielding a positive result. However, 3 weeks later, she developed a high fever (39–40 °C) persisting for 4 days, accompanied by bilateral non-exudative conjunctivitis, inflammation of the lips and oral mucosa, strawberry tongue, and pruritic erythematous patches on her legs, as shown in Figure 1a. In the subsequent days, the erythematous patches on her legs expanded, and new lesions appeared on her face and trunk (Fig. 1b).

The patient was taken to the emergency department, where hospitalization was initially recommended but ultimately replaced by

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a 5-day observation stay. She experienced intense pruritus associated with her skin lesions, prompting the initiation of prednisone at 1 mg/kg per day for 3 weeks. However, this treatment did not provide relief because the lesions continued to expand over 3 weeks before gradually regressing and resolving within approximately 1 week.

The cutaneous manifestations included erythematous patches on the face, forehead, trunk, and lower limbs, as well as erythema

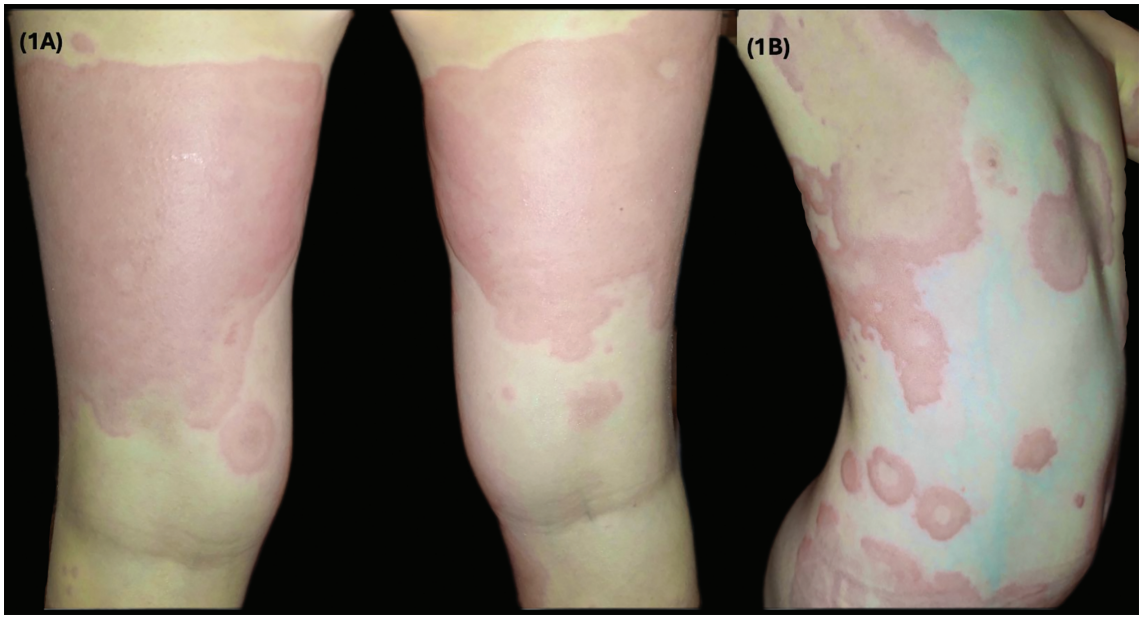

Figure 1 | Dermatological manifestations developed by the patient: erythematous patches on the legs (a) and trunk (b).

Table 1 | Symptoms of multisystem inflammatory syndrome (MIS) and Kawasaki disease (KD) and case report data.

	Clinical case	MIS-C	KD
Age (years)	8	6–11	‹ 5
Geographic area	Italy	Europe, North America, Africa, Asia; highest incidence in children of African and Hispanic heritage	Asia, Europe, North America; highest incidence in Japan, China, South Korea, Taiwan (35)
Fever	4 days	3–5 days	≥ 4 days
Clinical severity / hospitalization	Two emergency room visits, proposed hospitalization, emergency room observation	Hospitalization	Hospitalization, especially cases with cardiac involvement
Skin manifestations	Large patches of rash, telogen effluvium	Maculopapular rash, skin eruptions	Maculopapular diffuse erythroderma or erythema multiforme-like; less commonly urticarial or fine micropustular eruptions
Mucous involvement	Lip and oral inflammation, strawberry tongue	Lip and oral inflammation	Erythema and cracking of lips, strawberry tongue
Lymphadenopathy	Absent	Some cases	Acute, non-suppurative cervical lymphadenopathy
Ocular involvement	Bilateral non-purulent conjunctivitis especially on right	Non-purulent conjunctivitis	Bilateral non-exudative conjunctival infection, often limbic sparing
Changes in extremities	Erythema and edema of hands, especially thumbs	Erythema of hands and feet	Acute phase: erythema and edema of hands and feet; sub-acute phase: periungual desquamation
Cardiovascular manifestations	Echocardiography and troponin normal	Myocardial disfunction, coronary abnormalities, pericarditis	Myocardial disfunction, coronary abnormalities, pericarditis
Abdominal pain	Absent	Relatively high incidence of gastrointestinal symptoms and abdominal pain	Abdominal pain (not always)
C-reactive protein	3.94 mg/dl	≥ 3.0 mg/dl	≥ 3.0 mg/dl
White blood count	12,340/mm³, neutrophils = 77%	› 10,000/mm³, according to (36) › 20,000/mm³	› 15,000/mm³, neutrophilia
Platelets	Thrombocytosis: platelets = 580,000/mm³	Thrombocytopenia: platelets ‹ 150,000/mm³	Thrombocytosis: platelets › 450,000/mm³
ALT	Normal	Normal	Elevation above normal range
Autoimmunity	ANA = 1:160	Autoantibodies could be involved in pathogenesis (13)	Autoantibodies in 22% (14)
Trigger	Onset around 3–4 weeks after SARS-CoV-2 exposure	Onset around 3–6 weeks after SARS-CoV-2 exposure	Unknown but some data suggest possible preceding viral or bacterial infection
Detection of SARS-CoV-2 RNA	Yes	Yes	Some cases

MIS-C = Multisystem Inflammatory Syndrome-Children, KD = Kawasaki disease, SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, ANA = antinuclear antibody, ALT = alanine aminotransferase.

and edema of the hands, particularly affecting the thumbs. The lesions were persistent, with some on the thighs reaching up to 10 cm in diameter or larger. Physical examination revealed conjunctivitis, more pronounced in the right eye, along with a moderately swollen tongue, cheilitis, and hair loss. The patient experienced hair loss of approximately 15% to 20%, which developed 2 months after COVID-19 infection and 1 month following the onset of skin manifestations. This presentation was consistent with telogen effluvium, likely attributable to COVID-19 rather than the subsequent inflammatory syndrome.

Laboratory findings showed leukocytosis (white blood cell count = 12,340 cells/µl) with moderate neutrophilia (neutrophils = 76.9%, lymphocytes = 14.6%, monocytes = 8.2%, eosinophils = 0.1%, basophils = 0.2%). Additional hematologic values included red blood cell count = 5,690,000 cells/µl, hemoglobin = 11 g/dl, mean corpuscular volume = 64 fl, and a Mentzer index of 11.25. Platelet count was elevated at 580,000 cells/µl. Inflammatory markers included CRP = 3.94 mg/l and erythrocyte sedimentation rate = 30 mm/h. Liver function tests showed aspartate aminotransferase = 17 U/l and alanine aminotransferase = 14 U/l. Cardiac assessment revealed a troponin T level < 0.1 µg/l. Immunologic analysis demonstrated an elevated total immunoglobulin M level of 187.0 mg/dl, an antinuclear antibody (ANA) titer of 1:160, and anti-tissue transglutaminase IgA < 0.1 U/ml.

Serum iron levels were normal (64 µmol/l) in previous tests, including during the COVID-19 infection. However, these levels rose to 315 µmol/l in January 2024 before returning to normal in February 2024. The symptoms of the inflammatory syndrome resolved spontaneously by late January 2024, although the patient experienced sleeplessness for 3 consecutive nights following recovery. Platelet counts decreased to 437,000 cells/µl in December 2023 but returned to normal (323,000 cells/µl) in January 2024. An echocardiogram was performed, with normal results.

The COVID-19 infection and associated MIS/KD/KLI lasted less than 2 months, from the end of November 2023 to the end of January 2024.

At the follow-up in February 2024, her skin appeared normal. The mother reported that, during the previous week, on two or three non-consecutive mornings, the patient woke up very early, around 5:00 am, and was unable to sleep thereafter. However, the patient did not experience fatigue or other symptoms during the day. Echocardiography, troponin T (< 0.1 µg/l), and brachial artery blood pressure (100/50 mmHg) were all within normal limits.

Blood tests were normalized, showing an erythrocyte sedimentation rate = 2 mm/h, CRP = 0.69 mg/l, red blood cell count = 5,320,000 cells/µl, hemoglobin = 10.7 g/dl, mean corpuscular volume = 63 fl, Mentzer index of 11.84 (< 13), white blood cell count = 5,200 cells/µl (neutrophils = 48%, lymphocytes = 38.5%, monocytes = 8.5%, eosinophils = 4.4%, basophils = 0.6%), platelet count = 323,000 cells/µl, transferrin = 251 mg/dl, fibrinogen = 214 mg/dl, and D-dimer = 0.259 µg/ml fibrinogen equivalent units. Liver function tests showed aspartate aminotransferase = 21 U/l, alanine aminotransferase = 12 U/l, and lactate dehydrogenase = 216 U/l. The ANA test was negative, and molecular testing for COVID-19 was negative.

Discussion

In COVID-19, particularly in children, skin manifestations can emerge, making it difficult to determine whether they are directly attributable to the infection. During the post-infectious phase, a papulo-macular eruption may occur, often accompanied by urticaria and sometimes with vesicular components, which presents a clinical picture distinct from that observed in the girl described in this case. Other post-COVID skin manifestations include livedoid changes and lesions, such as purple discoloration on the toes, which are especially common among younger individuals (10).

The precise diagnosis of these systemic vasculitic forms can be challenging. There are overt forms of MIS-C as well as "self-limiting" forms that meet the criteria for KD (6, 15). Although MIS-C shares many similarities with KD, the classic symptoms of KD, such as bilateral conjunctival infection, strawberry tongue, and rash, are not always present. Laboratory findings indicate that MIS-C typically presents with significantly higher CRP levels, ferritin, and D-dimer, elevated cardiac enzymes, and a reduced lymphocyte count in the complete blood count, in contrast to KD (11). Pediatric patients with COVID-19 (especially those under 18, particularly those 5 years old or younger) are at an increased risk of developing MIS-C and KD (16). COVID-19 has also been linked to KLI (1, 17), even in patients with mild or paucisymptomatic infections, as seen in our case (11).

The diagnosis in this child is complex because she meets the criteria for both MIS-C and KD. She experienced fever for 4 days following a positive molecular test for COVID-19 3 weeks prior. The clinical presentation was significant enough to warrant hospitalization; however, at the parents' request, the child was instead observed in the emergency room. The girl exhibited CRP levels exceeding 3.0 mg/dl with mucocutaneous involvement, characterized by inflammation of the oral mucosa, fissuring of the lips, strawberry tongue, and conjunctivitis and abnormal blood test results (white blood cell count > 10,000 mm³ and platelet count > 500,000 mm³). These findings should be considered when evaluating other differential diagnoses.

Nevertheless, there are some aspects that can instead point toward a KD or KLI diagnosis: there was fever, bilaterality of conjunctivitis, fissures of the lips, changes of the oral cavity, strawberry tongue, polymorphic rash, and edema of the hands. The CRP value was weakly positive (in MIS-C it is usually higher than in KD), and the abdominal pain characteristic of MIS-C was absent in our patient. Another aspect supporting KD was the increase in platelets (580,000 cells/µl), which in MIS are normal or decreased. In contrast, the absence of lymphadenopathy points to a self-limiting MIS-C. The presence of ANA can be observed both in KD (22%) (14) and in MIS-C (13). The dermatological lesions developed by the patient were not discriminatory to support the diagnosis of MIS-C or KD. Taking this evidence into account, we believe that a post-COVID-19 inflammatory vasculitic form with a heterogeneous spectrum of clinical characteristics resembling both MIS-C and KD or KLI may have developed (18). The telogen effluvium observed in our patient is more likely a consequence of COVID-19 infection than a manifestation of inflammatory syndrome, as already reported (Table 2) (19, 20).

The transient iron overload observed in our patient after MIS

Table 2 | **Hair loss characteristics and case report data.**

Hair loss: clinical presentation	Telogen	Anagen	Clinical case
Onset of shedding after infection	2–4 months	1–4 weeks	2 months
Hair loss	20%–50%	80%–90%	20%
Hair shaft	Normal	Narrowed or fractured	Normal

could be related to β-thalassemic or autoimmune hemolysis (21), as supported by the detection of ANA (1:160) (22), which was negative in February 2024.

KD is a vasculitis of early childhood, and it is the most common cause of cardiac ischemia in this age group. The etiology of KD remains unknown (23). However, it seems to be due to an abnormal immunologic response due to exposure to infectious agents (24). This hypothesis is supported by the observed increase in KD cases during the winter months, when influenza viruses are more frequent (25). To date, the specific microorganism responsible has not been identified, although some authors have suggested viruses, such as adenoviruses (26) and coronaviruses (27), as potential etiological or triggering agents (17).

The clinical case described above can be interpreted as a post-COVID inflammatory syndrome with clinical and laboratory aspects resembling both MIS and KD (17).

Some studies before the COVID-19 pandemic showed that 7% of patients with symptoms of KD had tested positive for coronaviridae, particularly the Haven coronavirus (HCoV-NH), similar to HCoV NL-63, which has attracted more attention (28). Specifically, eight out of 11 KD patients (72.7%) tested positive for HCoV-NH by PCR (29). It is noteworthy that serological tests to detect the virus showed a higher infection rate than PCR-based detection (30). The potential causative role of COVID-19 in MIS/KLI is further supported by evidence that, during the pandemic, the number of patients affected by clinical manifestations similar to KD in an Italian province—an epicenter of the SARS-CoV-2 outbreak—was 30 times higher than usual (31).

The significant inflammatory response to the novel coronavirus, along with epidemiological studies, supports the theory of COVID-19 as a trigger for the immune system and as an etiological agent for MIS (32). The girl described above, as reported in other cases, was positive for COVID-19 some weeks before the development of MIS.

Conclusions

The incidence of children presenting with characteristics resembling MIS similar to KD increased during the COVID-19 pandemic. However, cases have also been observed in the post-pandemic phase (33), as for our patient. Although some criteria of the MIS were met, other criteria, such as bilaterality of conjunctivitis and platelet elevation, were more likely to be KD. Overall, the case here presented is borderline between a self-limiting MIS-C and KD, falling in the spectrum between these two diseases. Nevertheless, children presenting with the clinical features mentioned above require close monitoring of inflammatory indexes and cardiac parameters because cardiac complications can occur in some cases (34).

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