


## CPD

## Skin manifestations of COVID-19 in children: Part 2

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## Summary

The current COVID-19 pandemic is caused by the SARS-CoV-2 coronavirus. The initial recognized symptoms were respiratory, sometimes culminating in severe respiratory distress requiring ventilation, and causing death in a percentage of those infected. As time has passed, other symptoms have been recognized. The initial reports of cutaneous manifestations were from Italian dermatologists, probably because Italy was the first European country to be heavily affected by the pandemic. The overall clinical presentation, course and outcome of SARS-CoV-2 infection in children differ from those in adults, as do the cutaneous manifestations of childhood. In this review, we summarize the current knowledge on the cutaneous manifestations of COVID-19 in children after thorough and critical review of articles published in the literature and from the personal experience of a large panel of paediatric dermatologists in Europe. In Part 1, we discussed one of the first and most widespread cutaneous manifestations of COVID-19, chilblain-like lesions. In this part of the review, we describe other manifestations, including erythema multiforme, urticaria and Kawasaki disease-like inflammatory multisystemic syndrome. In Part 3, we discuss the histological findings of COVID-19 manifestations, and the testing and management of infected children for both COVID-19 and any other pre-existing conditions.

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## Introduction

The current COVID-19 pandemic has affected almost all countries worldwide. The overall clinical presentation, course and outcome of SARS-CoV-2 infection, as well as the cutaneous manifestations of childhood COVID-19 differ from those of adults. Certain manifestations are more frequently seen in children and young patients. Below we describe some of the other manifestations of COVID-19, including erythema multiforme (EM), urticaria and Kawasaki disease (KD)-like inflammatory multisystemic syndrome.

## Erythema multiforme

EM is an acute, self-limiting hypersensitivity condition, which is characterized clinically by a distinctive skin eruption with symmetrical erythematous lesions called iris or target lesions.<sup>1,2</sup>

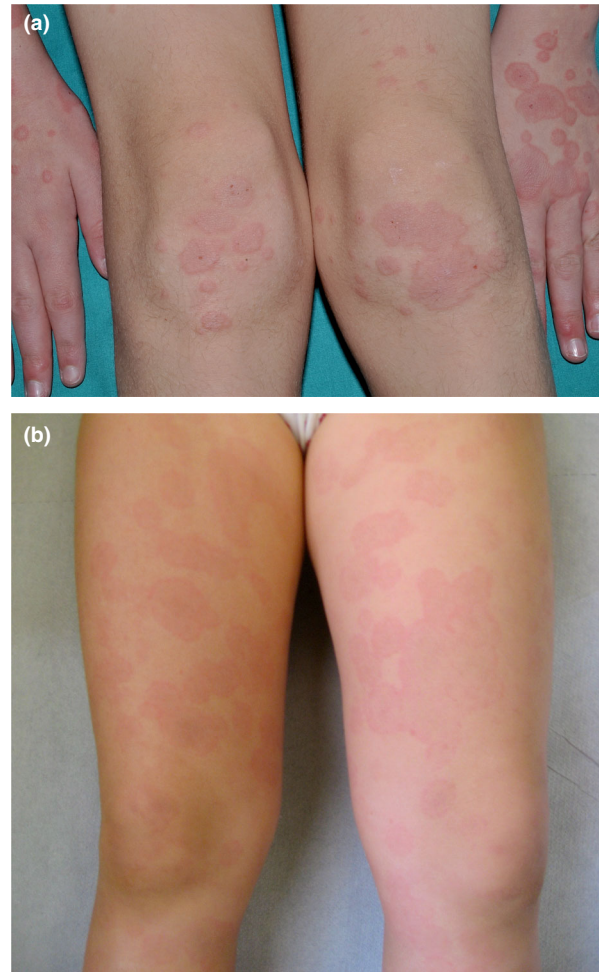
The most common cause of EM is systemic infection (up to 90%), while drug-associated EM is reported in < 10% of cases.<sup>3</sup> In children, the two pathogens most frequently involved in EM are herpes simplex virus (HSV) and *Mycoplasma pneumoniae*.<sup>4</sup>

An EM-like eruption has been observed in association with SARS-CoV-2 infection, both in adults and in children<sup>5,6</sup> (Fig. 1). In one report<sup>7</sup> a 17-year-old patient presented with discrete acral papules and targetoid lesions. In another report, four children (three boys and one girl) with chilblain-like lesions also had associated EM, with both true target lesions and targetoid lesions; one of these patients had a positive PCR result for SARS-CoV-2, and skin biopsies carried out in two of the cases demonstrated endothelial positive immunohistochemistry stain to SARS-CoV-2 spike protein.<sup>8</sup> A 6-year-old boy with acral target lesions of EM and severe, painful cheilitis and conjunctivitis had a positive COVID-19 PCR result.<sup>9</sup> Other cases of EM-like lesions on the heels of both feet in children can be better regarded as chilblains with central purpuric lesions and peripheral erythema.<sup>10</sup>

Children with EM in the setting of COVID-19 have been otherwise asymptomatic or have had only mild respiratory or gastrointestinal symptoms.<sup>8</sup>

## Urticaria

Urticaria presents with usually pruritic, circumscribed, raised weals, which characteristically last < 24 h. The most common causes of urticaria are allergens, food pseudoallergens, insect envenomation, drugs and infections. Viruses are a common cause of urticaria in



**Figure 1** (a,b) Typical target and targetoid lesions in COVID-19-related erythema multiforme.

children,<sup>11</sup> including parvovirus, rhinovirus, rotavirus, Epstein–Barr virus (EBV), hepatitis A, B and C viruses, and human immunodeficiency virus, among others. Bacterial infections (urinary tract infections, *Streptococcus*, *Mycoplasma*, *Helicobacter pylori*) and some parasites can also be associated with urticaria.

Urticaria represents about 10%–20% of the cutaneous manifestations in patients with COVID-19<sup>5,12–24</sup> (Fig. 2). Most reported cases of urticaria in COVID-19 were adults, and in our experience, children with urticaria and COVID-19 appear mostly asymptomatic apart from the urticarial rash. Additionally, most of the patients were not tested, but had household contact with confirmed or suspected patients with COVID-19. Only a minority of patients were biopsied, all of them adults.<sup>13,14</sup>

Viral infections may cause nonimmunological urticaria by mast cell activation via complement or vasculitis as COVID-19 virus binds angiotensin-converting enzyme (ACE)2 receptors on blood vessels. Antibodies may therefore deposit at vascular walls with ensuing immune reaction. Urticaria might be associated with bradykinin in the kinin–kallikrein system in conjunction with ACE2.<sup>15</sup>

### Vesicular exanthem

There is no consensus regarding the definition of 'COVID-19 vesicular rash'.<sup>25–27</sup> The vesicular exanthem was reported in 4% of 53 cases with dermatological symptoms and positive nasopharyngeal PCR for SARS-Cov-2 in a prospective multicentre study in China and Italy,<sup>28</sup> in 9% of confirmed or suspected COVID-19 cases with skin symptoms in Spain,<sup>5</sup> and in 15% of suspected or confirmed cases in France.<sup>26</sup>

Initially, the vesicular eruption reported in patients diagnosed with COVID-19 was a varicella-like papulovesicular rash.<sup>28</sup> This kind of rash may possibly be more frequent in middle-aged women,<sup>5,28</sup> but it has also been reported in adult men and

children. Vesicular lesions are thought to appear in the early stages of COVID-19 disease, and occasionally even before the onset of other manifestations,<sup>5,29</sup> compared with other skin manifestations occurring later.<sup>30</sup>

The eruption is monomorphic<sup>27</sup> with disseminated vesicles, appearing after a median latency of 3 days after first respiratory symptoms (Fig. 3) and persisting for around 8 days with no correlation with severity of infection.<sup>28,31–33</sup> Vesicles predominate on the trunk, but the limbs may also be affected<sup>34</sup> and papular, crusted<sup>34</sup> or haemorrhagic lesions<sup>35</sup> are also associated. Itch is common, but is usually mild.<sup>28</sup>

Most authors advise using PCR on vesicle fluid to test for HSV-1 and HSV-3 (varicella zoster virus; VZV) to exclude HSV and VZV. The histology of these also differs from that of COVID-19 vesicular rash.<sup>24,34,36,37</sup>

The pathogenesis of the vesicular exanthema is unknown and other viruses, such as HSV-1, HSV-2, human herpesvirus (HHV)-6 and HHV-7, VZV, parvovirus and EBV, have been simultaneously detected in some patients with COVID-19.<sup>5,32,38</sup>



**Figure 2** Urticaria in a child with COVID-19.



**Figure 3** Vesicular exanthem of COVID-19.

## Kawasaki disease-like inflammatory syndrome (paediatric inflammatory multisystem syndrome)

KD is the most common vasculitis in childhood<sup>39</sup> and its diagnosis is based on clinical and laboratory criteria.<sup>40,41</sup> The role of a nonspecific infection, such as seasonal coronavirus, as a trigger factor is classically suggested.<sup>41–43</sup>

Although COVID-19 affects children less severely than adults,<sup>44</sup> a temporospatial association between COVID-19 and a severe multisystemic condition has been observed in children in various countries.<sup>45–49</sup> This has been named paediatric inflammatory multisystem syndrome (PIMS) temporally associated with SARS-CoV-2 infection in Europe<sup>50</sup> and multisystem inflammatory syndrome in children in the USA.<sup>51</sup>

Around 40 articles have been published, including case reports (USA and Italy),<sup>52,53</sup> case series<sup>45</sup> and two cohort studies.<sup>48</sup>

### Demographics

The mean age of patients with PIMS is higher than that usually seen with classic KD, with age ranging from a mean  $\pm$  SD  $7.5 \pm 3$ – $5$ <sup>47</sup> to a median of 7.9 (range 3.7–16.6 years).<sup>48</sup> In the French cohort,<sup>48</sup> the proportion of patients with at least one parent originating from sub-Saharan Africa or a Caribbean island was about 57%. This was also highlighted in patients with hyperinflammatory shock syndrome,<sup>40</sup> with a high frequency of African-American patients affected by more severe COVID-19 forms.<sup>54,55</sup> In a French study, 14% of patients had at least one parent originating from Asia.<sup>49</sup>

Although overweight is a well-known risk factor for complications of COVID-19,<sup>44</sup> overweight was not underlined as a risk factor in severe and fatal forms of COVID-19 in children.<sup>56</sup>

### Clinical features

According to the American Heart Association criteria of KD<sup>33</sup> a complete form of KD was found in 50%–52% of cases,<sup>47,48</sup> and an incomplete form of the disease, according to the American Heart Association criteria<sup>57</sup> was seen in 48%–50% of cases.<sup>47,48</sup> The diagnosis of incomplete types was based on fever for > 5 days plus two or three classic criteria, considering laboratory anomalies and/or abnormal echocardiography (coronary aneurysms, left ventricular depression, mitral valve regurgitation,

pericardial effusion) as associated additional diagnostic criteria.<sup>47</sup>

Generally, however, in comparison with KD, children with PIMS display an over-representation of gastrointestinal (GI) symptoms, myocarditis and shock syndrome. GI symptoms were found in a large proportion of patients. Diarrhoea was present in 60% of an Italian cohort<sup>47</sup> and 100% of a French cohort,<sup>48</sup> hence the predominance of GI symptoms could lead to diagnostic and therapeutic delay as well as unnecessary surgical interventions.

Cardiovascular symptoms including hypotension or signs of hypoperfusion were present in 50%–57% of cases in two studies,<sup>47,48</sup> and myocarditis in 76% of patients in the French series.<sup>48</sup> Hyperinflammatory shock, showing similar features to atypical KD (KD shock syndrome; KDSS) have been described recently<sup>45</sup> and was described in a French study.<sup>58</sup>

KDSS is a rare syndrome, affecting 1.5%–7% of patients with KD, and is characterized by myocardial dysfunction associated with decreased peripheral vascular resistance, and a severe inflammatory syndrome with high levels of IgE, C-reactive protein (CRP) and procalcitonin.<sup>58</sup> A higher incidence has been found in western countries, i.e. Europe and America.<sup>59</sup>

### Skin and mucosal manifestations

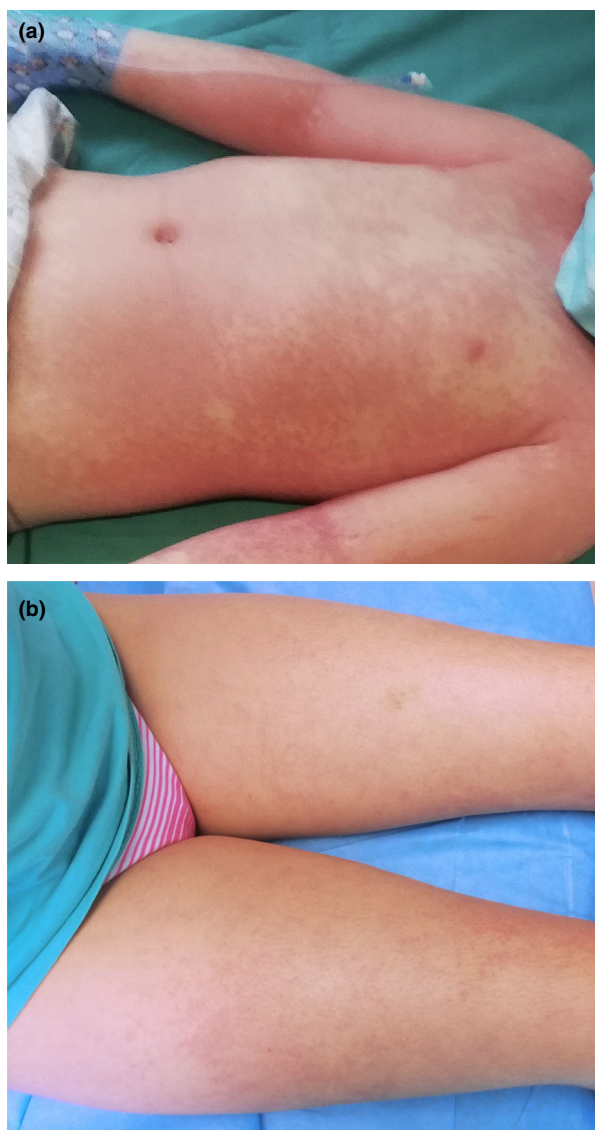
Currently, the cutaneous manifestations at the moment appear to be nonspecific to the pathogenesis, being similar to those usually described in KD or in viral infections (Fig. 4).

Cutaneous and mucosal manifestations are common in PIMS.<sup>46–48</sup> A nonexudative conjunctivitis was described in 50% of Italian patients with the complete form and 30% with the incomplete form,<sup>47</sup> and in 81% of French patients.<sup>48</sup> A 'polymorphic' rash was seen in 50% of Italian patients with the complete form and 30% with the incomplete form,<sup>47</sup> and in 76% and 20% of French patients with the complete and incomplete forms, respectively.<sup>48</sup> Perineal or face desquamation was observed in 19% of French patients.<sup>48</sup> Finally, hand and feet anomalies (erythema, firm induration or both) were described in 50% of Italian patients<sup>47</sup> and 48% of French patients.<sup>48</sup> The semiology of the cutaneous lesions had no apparent specificity.

### Laboratory studies

Inflammatory markers, including CRP, erythrocyte sedimentation rate, neutrophil count and ferritin were





**Figure 4** (a,b) Erythematous exanthem in paediatric inflammatory multisystem syndrome.

elevated in almost all cases, and pancytopenias have also been described along with other biochemical derangements.<sup>47,48</sup> Median interleukin-6 level was shown to be elevated<sup>48</sup> and cytokine storm has been reported.<sup>49,60,61</sup>

#### Echocardiography

In the Italian study,<sup>47</sup> 60% had abnormal heart ultrasonography results, including aneurysms (20%), decreased ejection fraction (50%), mitral valve regurgitation anomalies (40%) and pericardial effusion (40%).

In the French study,<sup>48</sup> 38% of patients had coronary artery abnormalities including dilatations and increased coronary visibility, but no coronary aneurysms.

#### Evidence of SARS-CoV-2 infection

The incidence of KD in 2020 has been much higher than expected and the number of severe cases of KD has been higher than at any time in the past 5 years.<sup>47</sup> Other members of the coronavirus family (such as HCoV-NH, very similar to HCoV-NL63) have previously been suspected to trigger or cause KD.<sup>41–43,62–64</sup>

In children with KD-like multisystem inflammatory syndrome during the COVID-19 pandemic, reverse transcription-PCR was positive in only 20%–38% of patients,<sup>47,48</sup> and IgG serology testing was positive in 80%–90%.<sup>47,48</sup> There are of course caveats with serology testing.<sup>65</sup>

#### Treatment

During the pandemic, > 80% of paediatric patients required admission to an intensive care unit<sup>48</sup> and received intravenous fluid resuscitation and/or vasoactive agents, plus systemic antibiotics.<sup>65,66</sup> All patients received aspirin (low- or high-dose) at admission and discharge, and were also treated with high-dose intravenous immunoglobulin infusion 2 g/kg, while over half required adjunctive steroids (methylprednisolone 2 mg/kg/day).<sup>47,48</sup>

#### Other manifestations

Several nonspecific viral exanthems have been putatively attributed to SARS-CoV-2. Vasculopathic rashes including purpuric thrombocytopenic purpura,<sup>67</sup> Dengue-like exanthem,<sup>68,69</sup> acro-ischaemia<sup>70</sup> and live-doid eruptions<sup>5,71</sup> have been linked to COVID-19 in adults and occasionally in children as well<sup>72,73</sup> (Fig. 5). As in other viral exanthems, a tendency for flexural involvement has been reported.<sup>69,74</sup> Histological findings range from thrombotic vasculopathy<sup>75</sup> to perivascular lymphocytic infiltrate with abundant red cell extravasation and dermal oedema without vascular occlusion,<sup>76</sup> pointing to a paucisymptomatic inflammatory peripheral vasculopathy as the basic pathogenic mechanism.

Maculopapular exanthems were reported in 47% of Spanish adult patients with skin manifestations (but 78% were on one or more drug)<sup>5</sup> and in 14 out of 18 Italian cases<sup>77</sup> (Fig. 6).

Pathology findings (see Part 3 of this series) do not differ from those of other viral infections and drug



**Figure 5** Purpuric rash in a child with suspected COVID-19.



**Figure 6** Maculopapular exanthem in COVID-19.



**Figure 7** (a,b) Pityriasis rosea-like eruption in two children with suspected COVID-19.

eruptions.<sup>78,79</sup> Despite thousands of patients with COVID-19 receiving therapy, available data on the prevalence of drug eruptions are lacking and only anecdotal reports suggesting such a possibility have been published to date.<sup>69,80</sup> Similarly, pityriasis rosea-like eruptions have been widely reported,<sup>5,81</sup> but whether this is a specific COVID-19 eruption or whether it is due to a reactivation of HHV-6<sup>82</sup> is not known (Fig. 7).

Oral mucosa findings have received little attention in all age groups. In a recent study performed in a field hospital in Spain, up to 25% of patients showed oral mucosa abnormalities, 18% of which had

macroglossia and anterior papillitis.<sup>83</sup> A 12-year-old girl with tongue swelling and prominent papillae with positive COVID-19 PCR test has been reported,<sup>72</sup> further supporting the potential involvement of the oral cavity in patients with COVID-19.

Some of these rashes may not be directly related to SARS-CoV-2,<sup>84</sup> and other aetiologies of cutaneous rashes should be kept in mind<sup>85</sup> even during the COVID-19 pandemic.

### Learning points

- Lesions indistinguishable from EM may occur in association with chilblains in children suspected of COVID-19.
- Urticaria occurs in 10%–20% of patients with skin lesions in COVID-19, and its incidence may be underestimated in children.
- A monomorphic vesicular or papulovesicular, disseminated exanthema has been described both in patients with PCR-proven and those with suspected COVID-19, mostly in adults.
- PIMS is a rare, but most severe form of COVID-19 in children; it resembles severe KDSS and presents with skin lesions that may mimic KD.
- Other forms of exanthems, whose relation to COVID-19 is unknown, have been reported during the COVID-19 outbreak; these include purpuric rashes, maculopapular exanthems, pityriasis rosea-like eruptions and oral findings, among others.

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## CPD questions

### Learning objective

To gain up-to-date knowledge about rarer manifestations of COVID-19-related skin diseases.

### Question 1

Which of the following statements about erythema multiforme in the setting of COVID-19 is true?

- (a) Lesions are mostly located on the face and trunk.
- (b) Lesions sometimes appear in association with chilblains.
- (c) A positive PCR result to SARS-CoV-2 has been reported in the majority of these cases.
- (d) All patients reported to date had systemic symptoms of COVID-19.
- (e) It has a severe and prolonged course.

### Question 2

Which of the following is the most common skin manifestation in patients with COVID-19?

- (a) Chilblains.
- (b) Urticaria.
- (c) Vesicular exanthem.
- (d) Maculopapular eruption.
- (e) Purpuric exanthem.

### Question 3

Which of the following skin signs is not characteristic of paediatric inflammatory multisystem syndrome?

- (a) Nonexudative conjunctivitis.
- (b) Erythematous rash.

- (c) Splinter haemorrhage of the fingernails.
- (d) Perineal desquamation.
- (e) Hand erythema and induration.

### Question 4

Which of the following signs is more frequent in paediatric inflammatory multisystem syndrome than in Kawasaki disease?

- (a) Prominent gastrointestinal symptoms.
- (b) Myocarditis.
- (c) Shock.
- (d) All of the above.
- (e) None of the above.

### Question 5

Which of the following skin manifestations has not been reported to be linked to COVID-19?

- (a) Lichen planus.
- (b) Livedoid eruptions.
- (c) Pityriasis rosea.
- (d) Macroglossia.
- (e) Retiform purpura.

## Instructions for answering questions

This learning activity is freely available online at <http://www.wileyhealthlearning.com/ced>

Users are encouraged to

- Read the article in print or online, paying particular attention to the learning points and any author conflict of interest disclosures.
- Reflect on the article.
- Register or login online at <http://www.wileyhealthlearning.com/ced> and answer the CPD questions.

- Complete the required evaluation component of the activity.

Once the test is passed, you will receive a certificate and the learning activity can be added to your RCP CPD diary as a self-certified entry.

This activity will be available for CPD credit for 2 years following its publication date. At that time, it will be reviewed and potentially updated and extended for an additional period.