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Level of awareness regarding MIS-C among medical students and surgeons in Switzerland

Sebastiano Brazzola ,[1] Laura Guglielmetti ,[2] Stephanie Gros ,[1] Stefan Holland-Cunz ,[1] Raphael Vuille-dit-Bille ,[1] Julian Louis Muff [1]

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[1]Department of Pediatric Surgery, University Children's Hospital Basel, Basel, Switzerland
[2]Department of Visceral and Thoracic Surgery, Cantonal Hospital of Winterthur, Winterthur, Switzerland

Correspondence to
Mr Julian Louis Muff; mail@jlmuff.com

ABSTRACT

Background Multisystem inflammatory syndrome in children (MIS-C) is a disease that emerged during the COVID-19 pandemic. Patients exhibit symptoms mimicking the clinical presentation of an acute abdomen, representing a novel differential diagnosis, particularly in the young generation. This study aims to investigate the current level of awareness of MIS-C among surgeons and medical students.

Methods We conducted an anonymous online questionnaire among members of the Swiss Surgical Society and Swiss medical students. The questionnaires collected participants' baseline demographics and their awareness regarding MIS-C.

Results Both students and surgeons obtained very low scores in the self-assessment and had a low score in the section with awareness questions (true score). In medical students, we observed a positive correlation between self-assessment and true scores (ρ=0.422, p=0.001), while surgeons had a negative correlation (ρ=-0.243, p<0.001). Furthermore, there was a positive correlation between gender and self-assessment (ρ=0.245, p<0.001), depicting a higher self-assessed score in female surgeons (median female self-assesment=5, IQR: 2-7). Likewise, board-certified pediatric surgeons and surgeons treating both children and adults had a higher self-assessment compared with non-pediatric surgeons. In both populations (surgeons and students), the true scores were similar in all the variables analyzed. Two-thirds of surgeons stated that MIS-C should be considered a differential diagnosis, and about half of surgeons indicated MIS-C being part of their differential diagnosis already.

Conclusion The results show an insufficient level of awareness concerning MIS-C among students and surgeons, warranting implementation in students' curriculum and surgeons' continuous training.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Multisystem inflammatory syndrome in children (MIS-C) is a disease that emerged during the COVID-19 pandemic.

WHAT THIS STUDY ADDS

⇒ There is an insufficient level of awareness concerning MIS-C among medical students and surgeons.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ We strongly advise for an implementation in students' curriculum and surgeons' continuous training.

INTRODUCTION

Multisystem inflammatory syndrome in children (MIS-C) and pediatric inflammatory multisystem syndrome temporally associated with COVID-19 (PIMS-TS) describe the same disease manifestation despite slight variations. It can occur in children and adolescents under 21 years of age in whom an infection with SARS-CoV-2 has been detected or in whom there is evidence of close contact with positive patients.[1 2] MIS-C/PIMS-TS typically occurs at the earliest within 1–2 weeks, but in most cases 4–6 weeks after a COVID-19 infection.[2–4] It is characterized by multiple organs being affected. In particular, the gastrointestinal tract, including diarrhea, vomiting and abdominal pain, has been reported in 60.5%–82.0% of cases,[5–7] skin and mucous membranes symptoms, including rashes, conjunctivitis and mucosal lesions, occur in 42% of cases,[7] the heart, with various forms of myocardial dysfunction, is observed in 35%–100% of cases[5–8] and the hematological system, including hypotension, shock or coagulopathy, is reported in 20%–100% of cases.[8 9] Furthermore, a study conducted by Valitutti *et al*. recommends performing an analysis of cardiac function including laboratory parameters such as troponin, B-type natriuretic peptide, D-dimers and ferritin and echocardiography, given the frequent involvement of the heart.[10] By the definition of the WHO, at least two of these categories must be involved. In addition, fever and elevated C reactive protein must be present.[11] Other inflammatory indicators such as procalcitonin, neutrophilia and lymphopenia may be present. Finally, to fulfill the diagnostic criteria, other microbial causes of inflammation such as bacterial sepsis, staphylococcal

Table 1 Baseline characteristics

Variable	Students (*n*=13 810)	Surgeons (*n*=1362)
Number of answer, *n* (%)	1885 (13.6)	256 (18.8)
Mean age (years), mean±SD	22.7±3.6	54.5±11.5
Number of male, *n* (%)	595 (31.6)	184 (71.9)
Years of experience, mean±SD	–	26.4±10.7

SD, standard deviation.

or streptococcal shock syndromes and enterovirus-associated myocarditis must be excluded as a possible alternative diagnosis. MIS-C/PIMS-TS is therefore mainly a diagnosis by exclusion.[11–13] Online supplemental table 1 illustrates the three main diagnostic criteria definitions.

Some of the possible differential diagnoses are appendicitis, gastroenteritis, inflammatory bowel disease, Kawasaki disease, toxic shock syndrome and severe COVID-19 infection without the presence of MIS-C/PIMS-TS.[14 15] Despite the possibility of sonography or CT to exclude surgical causes of an acute abdomen (such as appendicitis or cholecystitis), a definitive differentiation from MIS-C/PIMS-TS is not always possible. Often, only an exploratory laparoscopy can provide a definitive diagnosis.[15]

At the moment, there is no available data regarding the specific epidemiological situation of MIS-C/PIMS-TS in Switzerland. However, some studies conducted in the neighboring countries of Germany and Italy are available. In the region of Liguria, Italy, between March 2020 and June 2021, a rate of 10.3 per 100 000 was detected among patients under 19 years of age,[16] while in a second study conducted in the area of Nuremberg-Erlangen, Germany, between January 2021 and December 2022, an incidence of 2.14 per 100 000 children was reported.[17]

The possible overlapping of clinical manifestations of MIS-C/PIMS-TS with acute abdominal pathologies could represent a pitfall for the physician and therefore lead to a misinterpretation of the clinical representation and to a delay in the correct treatment, which differs largely from the one necessary in cases such as acute appendicitis. Main reasons for possible missed diagnoses are the novelty and rarity of the disease, combined with decreasing awareness for COVID-19-related differential diagnoses. This study aims to investigate the current level of awareness of MIS-C/PIMS-TS among surgeons working in Switzerland and medical students at Swiss universities.

MATERIAL AND METHODS

Participants

The invitation for student participation was sent to students enrolled in a study program of human medicine from all 11 universities in Switzerland which offer a medical degree. For this, we contacted the administrative offices of the universities by email. They then redirected us to the preferred methods of distribution for the questionnaire. The different methods included official faculty-mailing lists, posts on students' association notice boards, newsletters and group chats. The questionnaire for surgeons was sent to the members of the Swiss Surgical Society (SGC),[18] representing the vast majority of surgeons working in Switzerland. This included the 118 board-certificated pediatric surgeons active in Switzerland.[19] In this case, the questionnaire was sent systematically through the SGC with an email invitation. A short description of the study and a link to the online survey was always present. After 4 weeks (students) and 8 weeks (surgeons), a reminder email was sent. The survey directed to medical students was open from March 2023 to July 2023 (145 days), and the one for surgeons from March 2023 to September 2023 (190 days). Due to the lack of patient-related data and the type of participants (*i.e.*, medical students and surgeons) who participated on a voluntary basis and were not affected by a possible physician–patient relationship, an ethical evaluation was not necessary.

Questionnaire

Two anonymous online surveys were conducted. The surveys were distributed in three languages: German, French and Italian. The language could be chosen by the participant himself or herself. The questionnaire was conducted with the software Evasys V.9.0 (evasys GmbH, Lüneburg, Germany). The questionnaire to the students consisted of 13 questions divided into two sections. The first one consisting of eight questions about baseline demographics of the participants, followed by a second one containing four questions about students' awareness concerning MIS-C/PIMS-TS. Students' awareness was tested using four technical multiple-choice questions regarding the disease. The students could hereby score from a minimum of 0 (none of the questions answered correctly) to a maximum of 4 points (all correct). Furthermore, students self-assessed their awareness regarding MIS-C/PIMS-TS on a Likert scale ranging from 0 (no awareness) to 10 (excellent awareness) with a sufficient result if the score was ≥6. Likewise, the questionnaire to the surgeons consisted of nine questions regarding baseline demographics, four questions about their MIS-C/PIMS-TS awareness, one question concerning their self-assessment and two questions about the role of MIS-C/PIMS-TS in their clinical routine. The scoring system for the questions about awareness on MIS-C/PIMS-TS and the self-assessment was identical to the one used in the case of the students. An English translation of the questionnaires is provided as online supplemental files 1 (students) and 2 (surgeons).

Statistics

Descriptive statistics were used to summarize baseline characteristics. Continuous variables were reported as mean and standard deviation (SD) or median and interquartile range (IQR). Categorical variables were summarized as number and percentage (%). For the assessment of the association between ranked variables, Spearman's

Table 2 Data analysis of students

Variables	Participants	Self-assessment (0–10)	True score (0–4)
Total	1885 (100.0%)	1 (0, 3)	0 (0, 1)
Age (years)			
<19	44 (2.3%)	0 (0, 2)	0 (0, 1)
19–25	1516 (80.4%)	1 (0, 3)	0 (0, 1)
26–30	167 (8.9%)	2 (1, 5)	0 (0, 1)
>30	30 (1.6%)	2 (0, 5)	0 (0, 1)
Sex			
Male	595 (31.6%)	1 (0, 3)	0 (0, 1)
Female	1269 (67.3%)	1 (0, 3)	0 (0, 1)
Study year			
1	416 (22.1%)	0 (0, 2)	0 (0, 1)
2	380 (20.2%)	1 (0, 2)	0 (0, 1)
3	341 (18.1%)	1 (0, 3)	0 (0, 1)
4	252 (13.4%)	2 (0, 4)	0 (0, 1)
5	268 (14.2%)	3 (1, 5)	1 (0, 1)
6	212 (11.2%)	3 (1, 6)	1 (0, 1)
Future board certification in			
Surgical	301 (16.0%)	2 (0, 3)	1 (0, 1)
Non-surgical	811 (43.0%)	2 (0, 4)	1 (0, 1)
Both	163 (8.6%)	2 (0, 4)	1 (0, 1)
I don't know yet	604 (32.0%)	1 (0, 3)	1 (0, 1)
Future treating			
Children	170 (9.0%)	2 (0, 5)	0 (0, 1)
Adults	785 (41.6%)	1 (0, 3)	0 (0, 1)
Both	492 (26.1%)	1 (0, 4)	0 (0, 1)
I don't know yet	432 (22.9%)	1 (0, 2)	0 (0, 1)

Data were presented as n (%) or median (IQR).
IQR, interquartile range.

rank order correlation was applied. SPSS V.28 was used for data analysis.

RESULTS

A total of 13810 students and 1362 surgeons were invited to fill out this questionnaire, and there were 1885 students (13.6%) and 256 surgeons (18.8%) completed the surveys, respectively (table 1).

Students

Baseline characteristics are depicted in tables 1 and 2. In general, both students' self-assessment and true score were very low with a median score of 1 and 0, respectively (table 2). A Spearman's rank-order correlation was performed to determine the relationship between the self-assessment and the true score. There was a fair, positive correlation between self-assessment and true scores, which was statistically significant (ρ=0.422, p=0.001). Whereas gender had no impact on self-assessment (ρ=0.002, p=0.938) or true score (ρ=–0.042, p=0.071).

Surgeons

Baseline characteristics are shown in tables 1 and 3. Similar to the students, surgeons' self-assessment and true score were very low with median scores of 2 and 1, respectively (table 3). Furthermore, surgeons' self-assessment showed a poor, negative correlation with the true score (ρ=–0.243, p<0.001). Interestingly, there was a poor to fair positive correlation between gender and self-assessment (ρ=0.245, p<0.001). Depicting the higher self-assessed scores of female surgeons (median female self-assessment: 5, IQR: 2–7) compared with their male colleagues (median male self-assessment: 2, IQR: 0–6). Nevertheless, the true scores were comparable between male and female surgeons and in different age groups (table 3).

Table 3 Data analysis of surgeons

Variable	Participants	Self-assessment (0–10)	True score (0–4)	Surgeons need to know MIS-C/PIMS-TS	MIS-C/PIMS-TS is part of my differential diagnosis
Total	256 (100.0)	2.0 (1.0, 6.0)	1.0 (0.0, 1.0)	66.0% (163/84)	50.4% (122/120)
Age (years)					
25–35	9 (3.5%)	2.0 (0.5, 7.0)	1.0 (0.0, 1.0)	55.6% (5/4)	66.7% (6/3)
36–45	52 (20.3%)	2.0 (1.0, 5.0)	1.0 (0.0, 1.0)	74.0% (37/13)	52.0% (26/24)
46–60	109 (42.6%)	3.0 (1.0, 6.0)	1.0 (0.0, 1.0)	67.9% (72/34)	51.9% (54/50)
>60	76 (29.7%)	3.5 (0.0, 7.0)	1.0 (0.0, 1.0)	60.8% (45/29)	45.1% (32/39)
Sex					
Male	184 (71.9%)	2.0 (0.0, 6.0)	1.0 (0.0, 1.0)	59.0% (105/73)	47.4% (83/92)
Female	60 (23.4%)	5.0 (2.0, 7.0)	1.0 (0.0, 1.0)	86.7% (52/8)	56.9% (33/25)
Clinic					
University hospital	53 (20.7%)	3.0 (0.0, 7.0)	1.0 (0.0, 1.0)	71.7% (38/15)	49.0% (25/26)
Non-university hospital	121 (47.3%)	2.0 (1.0, 6.0)	1.0 (0.0, 1.0)	70.4% (81/34)	50.9% (59/57)
Private hospital	29 (11.3%)	2.5 (0.3, 6.0)	1.0 (0.0, 1.0)	41.4% (12/17)	46.2% (12/14)
Medical practice	29 (11.3%)	1.0 (0.0, 5.0)	1.0 (0.0, 1.0)	57.1% (16/12)	48.1% (13/14)
Other	21 (8.2%)	5.0 (1.5, 7.5)	1.0 (0.0, 1.0)	71.4% (15/6)	57.1% (12/9)
Current position					
Resident	4 (1.6%)	4.5 (0.5, 9.3)	0.5 (0.0, 2.5)	50.0% (2/2)	50.0% (2/2)
Fellow	47 (18.4%)	3.0 (1.0, 6.0)	1.0 (0.0, 1.0)	80.9% (38/9)	63.8% (30/17)
Attending	120 (46.9%)	2.0 (1.0, 5.0)	1.0 (1.0, 1.0)	60.3% (70,46)	45.0% (50,61)
Surgeon in chief	47 (18.4%)	2.0 (0.0, 7.0)	1.0 (0.0, 1.0)	65.9% (29/15)	52.3% (23/21)
Self-employed	22 (8.6%)	2.5 (0.0, 6.3)	1.0 (0.0, 1.0)	59.1% (13/9)	40.9% (9/13)
Other	14 (5.5%)	2.5 (0.0, 7.5)	0.5 (0.0, 1.0)	78.6% (11/3)	57.1% (8/6)
Experience (years)					
<5	2 (0.8%)	6.0 (2.0, 10.0)	1.5 (0.0, 3.0)	50.0% (1/1)	1.7% (2/0)
5–10	16 (6.3%)	2.0 (1.0, 6.5)	1.0 (0.0, 1.0)	75.0% (12/4)	8.3% (10/6)
11–30	143 (55.9%)	2.0 (1.0, 6.0)	1.0 (0.0, 1.0)	71.0% (98/40)	59.2% (71/65)
>30	89 (34.8%)	3.0 (0.0, 6.0)	1.0 (0.0, 1.0)	56.3% (49/38)	30.8% (37/47)
Board certification					
General surgery	214 (83.6%)	2.0 (0.0, 5.0)	1.0 (0.0, 1.0)	62.3% (129/78)	45.3% (92/111)
Pediatric surgery	27 (10.5%)	7.0 (4.0, 8.0)	1.0 (0.0, 1.0)	88.9% (24/3)	85.2% (23/4)
General and pediatric surgery	3 (1.2%)	10.0 (9.5, 10.0)	0.0 (0.0, 0.5)	100.0% (3/0)	100.0% (3/0)
Other	9 (3.5%)	5.0 (0.5, 7.0)	1.0 (0.5, 1.0)	77.8% (7/2)	50.0% (4/4)
Treating					
Children	29 (11.3%)	7.0 (4.5, 9.0)	1.0 (0.0, 1.0)	89.7% (26/3)	86.2% (25/4)
Adults	109 (42.6%)	2.0 (0.0, 5.0)	1.0 (0.0, 1.0)	59.0% (62/43)	42.0% (42/58)
Children and adults	112 (43.8%)	2.0 (0.0, 6.0)	1.0 (0.0, 1.0)	65.1% (71/38)	47.7% (52/57)

Data were presented as number (%) or median (IQR) or % yes (yes/no).
MIS-C, multisystem inflammatory syndrome in children; PIMS-TS, pediatric inflammatory multisystem syndrome temporally associated with COVID-19.

A total of 163 surgeons (66.0%) of surgeons stated that surgeons need to know MIS-C/PIMS-TS, and about half (50.4%; 122/242) of surgeons indicated MIS-C/PIMS-TS being part of their differential diagnosis. Likewise, board-certified pediatric surgeons and surgeons treating both children and adults tended to have a higher self-assessment, while true scores were similar to non-pediatric surgeons (table 3).

DISCUSSION

This study found that the awareness regarding MIS-C/PIMS-TS appears to be insufficient, both on a level of university education and among surgeons. In case of the students, it is reassuring that the correlation between self-assessment and true score is positive, indicating a correct evaluation of their own (insufficient) awareness. However, this is not enough, as there was often an overestimation. As MIS-C/PIMS-TS does not currently appear to be part of the medical curriculum at Swiss universities, we recommend that it should be universally included in medical studies. Concerning surgeons, the results show a negative correlation within the two scores, indicating the tendency to an overestimation of their own awareness of the disease, which could lead to a systematic misrecognizing of MIS-C/PIMS-TS. Notably, half of the participants emphasized the importance of knowing MIS-C/PIMS-TS and including it in the differential diagnosis in case of symptoms of an acute abdomen. Only 28.4% of surgeons self-assessed at least a sufficient score (≥6), and a true score of at least two (out of four) was reached only by 42.6%. In the subgroups of pediatric surgeons and those who treat both adults and children, a tendency to higher self-assessment score was found. This could be since surgeons treating children are more directly in contact with cases of MIS-C/PIMS-TS and thus have a higher level of awareness on the topic. Nevertheless, true scores were similar to non-pediatric surgeons and surgeons treating adult patients only. At last, the observed discrepancy in self-assessment between residents and surgeons with <5 years of experience and surgeons with more experience should also be noted. Our main hypothesis for this is that younger surgeons could tend to be overconfident and overestimate their knowledge. It is important to note that there could be a possible different explanation, namely that the younger generation could be subjected to a higher involvement with this disease, for example, due to university education.

Of paramount interest to surgeons should be the possible similar presentation of patients with MIS-C/PIMS-TS and/or appendicitis. Symptoms such as acute vomiting and/or diarrhea could be typical for MIS-C/PIMS-TS.[20] Diagnoses such as terminal ileitis, ascites or mesenteric lymphadenitis seem to be present in MIS-C/PIMS-TS at a higher rate than in other pathologies with gastrointestinal symptoms.[20] There are descriptions of cases of MIS-C/PIMS-TS mimicking the symptoms of appendicitis, but also cases where the coexistence of both pathologies was present, posing a real challenge in the diagnostic procedure. It is to underline that it is not yet clear whether there is a causal relationship between the two.[15 20–23] A study conducted by Vansevičienė *et al.* investigated a possible set of criteria to help in the identification of MIS-C/PIMS-TS in cases of typical acute appendicitis symptoms. This includes the following criteria: CRP>55.8 mg, symptoms for more than 3 days, febrile fever and any other systems involved. Especially a known recent COVID-19 infection, contact or positive test should be a red flag.[21] Another method of assessment is suggested by Manz *et al.* Assessment should be divided into three categories based on the timeline of the patient's handling: first assessment, intraoperative assessment and postoperative assessment. In the first step, it is important to look for an atypical history of appendicitis, diffuse abdominal pain, persistent fever, vomiting, mucocutaneous manifestations and confirmed or suspected recent SARS-CoV-2 infection. Intraoperatively, the presence of macroscopically atypical appendicitis, generalized intestinal inflammation, and the absence of explanatory findings for abdominal pain could implicate a possible MIS-C/PIMS-TS symptom. Finally, postoperatively, a lack of clinical improvement and persistently elevated inflammatory markers should lead to the same conclusion.[15]

We are aware that our study is not without limitations. The answer rate is very low in both populations of students and surgeons. When the subgroup of pediatric surgeons active in Switzerland is taken as a reference,[19] the percentage of participants reached 22.9% (27/118). We can further not rule out that some participants used additional information about MIS-C/PIMS-TS during answering the questionnaire, increasing their score. Nevertheless, participants' rather poor performance does not indicate that. A further limitation is that in calculating the answer rate among students, we used the number of students enrolled in the faculty of human medicine across Switzerland for the year 2022/2023.[24] However, it is not possible to determine if this number reflects the actual number of students that the survey reached, as the way in which it was distributed was not centralized and varied among the different universities. Considering these factors, we find the results to be sufficiently indicative of a tendency of insufficient awareness of MIS-C/PIMS-TS among the populations tested.

A correct identification of the clinical framework is necessary for a swift and precise diagnostic process and adequate treatment. Additionally, it is important to consider that MIS-C/PIMS-TS is only one of the possible illnesses related to a SARS-CoV-2 infection which are just now emerging or that we have yet to discover. At the same time, SARS-CoV-2 may not be the only trigger, and that in the future, MIS-C/PIMS-TS could be associated with different viral infections. In both cases, a higher awareness of this illness could lead to caregivers being more likely to detect these new connections.

Attempts on possible diagnostic criteria for the differentiation of MIS-C/PIMS-TS from surgical disease such as appendicitis have been made. These criteria include emphasizing standard questions in the medical history, for example, duration of symptoms, recent COVID-19 infection or contacts, interpretation of laboratory results and overall attention to systems affected apart from the gastrointestinal tract, possibly showing inflammatory signs.[21]

In conclusion, this study concluded that the awareness of MIS-C/PIMS-TS is insufficient among both students and surgeons, highlighting the need for proper

multidisciplinary patient care and in-depth patient information. Improving awareness could help reduce unnecessary diagnostic procedures and minimize the hospitalization costs. Particular attention should be given to pediatric surgeons, who are often on the front lines in managing this condition. This study also strongly recommends incorporating related content into medical curricula and continuous professional training for surgeons.

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Contributors Study conception and design: SG, RV-d-B and JLM. Acquisition of data: SB and JLM. Analysis and interpretation of data: SB, LG and JLM. Drafting of manuscript: SB, RV-d-B and JLM. Critical revision of manuscript: LG, SG and SGH-C. The guarantor of this manuscript is JLM. During the preparation of this work, the authors used DeepL in order to translate certain parts of this manuscript from native language to English. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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ORCID iDs

Sebastiano Brazzola http://orcid.org/0009-0004-5010-8252
Laura Guglielmetti http://orcid.org/0000-0002-7414-693X
Stephanie Gros http://orcid.org/0000-0003-2213-4993
Stefan Holland-Cunz http://orcid.org/0000-0003-1358-3439
Raphael Vuille-dit-Bille http://orcid.org/0000-0002-0884-9493
Julian Louis Muff http://orcid.org/0000-0003-2032-7863

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