Swiss Paediatric Surveillance Unit Report 2023 / 2024

SWISS PAEDIATRIC SURVEILLANCE UNIT

Foreword

The Swiss Pediatric Surveillance Unit (SPSU) was founded 30 years ago with the goal of documenting rare diseases or rare complications of more common diseases in paediatrics as part of a nationwide network. In collaboration with the Federal Office of Public Health (FOPH), Prof. Gregor Schubiger, Dr Daniel Desgrandchamps and Dr Hanspeter Zimmermann came up with the visionary idea to create a network of paediatric clinics and collect data throughout Switzerland to improve healthcare for children and adolescents.

Over the past three decades, the SPSU has supported the development of numerous Swiss recommendations for the diagnosis or treatment of illnesses in childhood and adolescence, drawing on the impressive power of data sourced from all paediatric clinics. One of the SPSU's greatest achievements is that all 29 paediatric clinics in Switzerland have reported data over each of the past 30 years. A total of 7,809 cases have been documented in 34 studies so far. Up to the end of 2024, 66 publications based on these projects have been shared with the national and international scientific communities. To this day, no similar nationwide system exists in Switzerland for gathering and analysing paediatric hospital data. The SPSU is open to all researchers in Switzerland and provides a platform in which project leaders can conduct projects and studies.

This biennial report for 2023/2024 documents the work of the SPSU and its project leaders during a period in which social and societal interactions in Switzerland were no longer subject to pandemic-related restrictions. For two infectious disease projects, this change was of significant relevance: the number of invasive streptococcal infections in 2023 was well above the pre-pandemic average, and the number of hospitalisations due to varicella-zoster virus (VZV) was also higher than in previous years. These two parallel studies benefited from synergies, as a VZV infection increases the risk of secondary skin or mucosal infections.

The systematic recording of SARS-CoV-2 infections requiring hospitalisation concluded in March 2023 following the nationwide suspension of pandemic measures. The study team led by Prof. Nicole Ritz and PD Dr Petra Zimmermann has published several papers on clinical presentation and progression as well as on PIMS-TS.

A new study on neonatal enterovirus infections led by Dr Jaboyedoff and Dr Altpeter was launched in September 2023. This project was initiated after a significant increase in severe infections with the enterovirus subtype Echovirus 11 was reported by the WHO in 2022.

Daniela Beeli, one of the key figures at the SPSU, retired this year. She was employed by the FOPH for 28 years and was responsible for both the coordination and quality assurance of reporting and data within the SPSU. As in all previous years, the report response rate for 2023 and 2024 stood at a remarkable 100%; this is in large part thanks to the dedication of Daniela Beeli. Structures such as the SPSU can only survive and have a meaningful impact if continuity among those responsible is maintained. The SPSU Committee, on behalf of all other SPSU stakeholders, would like to express its heartfelt thanks for her extraordinary commitment over such a long period of time.

Eveline Rolli, an experienced specialist, will now take over the coordination role within the SPSU. She brings with her extensive experience and a long-standing network comprising of various health institutions in Switzerland. The committee is confident that Eveline will continue the excellent work of her predecessor in performing the tasks assigned to her.

The positioning of the SPSU within the Swiss research landscape was the subject of an SPSU retreat in November 2024, during which its strategic direction was reviewed. A major strength of the SPSU lies in its anchoring with the Epidemics Act, as well is in its experience in national and international networking. Adaptation measures have been implemented with respect to data governance, and efforts

will be made to further improve the visibility of the SPSU offering, especially among younger researchers.
In 2023 and 2024, the number of reported cases stood at 578 and 269, respectively. We would like to extend our sincere thanks to all those responsible in the paediatric clinics for their reliable collaboration.
New studies within the SPSU are always welcome. We would be happy to advise you on any queries you may have regarding protocol and feasibility.

Dr Andreas Wörner
Chair of the SPSU
Steering Committee

Figure 1 – Back office employees

Pictured from left to right: Daniela Beeli, Eveline Rolli

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1. General information about the SPSU

The Swiss Paediatric Surveillance Unit (SPSU)[1] is a notification system for monitoring rare paediatric diseases and rare complications of more common illnesses among hospitalised children under 16 in Switzerland (Zimmermann et al. Soz Präventivmed 1995; 40: 392 – 5). The SPSU is operated by paediatric switzerland and the Federal Office of Public Health (FOPH).

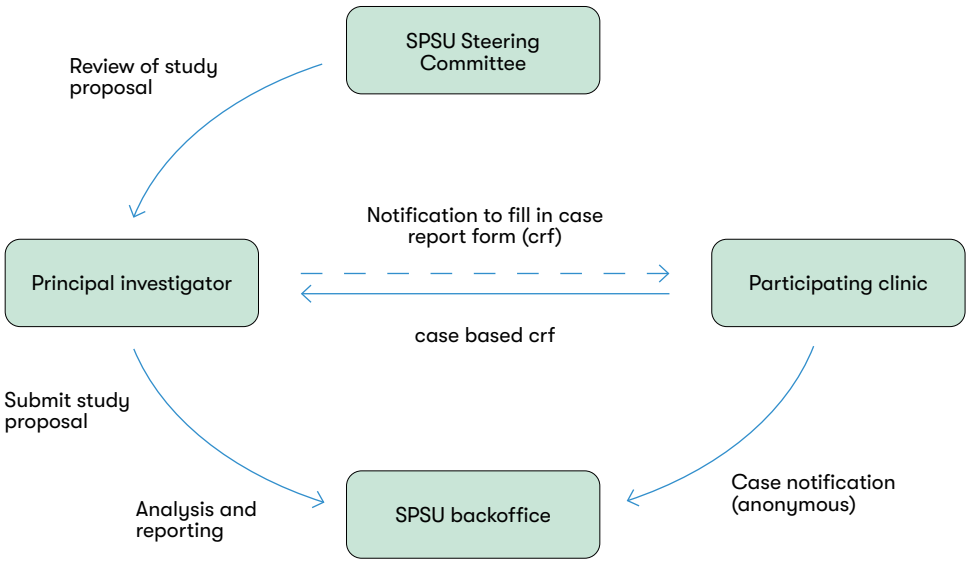
The notification system is:

- simple, as it involves minimal effort;
- flexible, as it permits rapid investigation of emerging epidemiological issues;
- comprehensive, as cases meeting the case definition are actively identified in every hospital;
- nationally representative, as all of Switzerland's paediatric hospitals participate.

The SPSU is designed to promote research on rare paediatric diseases and to monitor epidemiological trends. Worldwide, there are nine comparable data collection systems – in Australia, Belgium, Canada, England, Germany, Ireland, the Netherlands, New Zealand and Wales. These countries collaborate and share their experiences through the International Network of Paediatric Surveillance Units (INOPSU), www.inopsu.com (see "International activities").

The results of individual studies are also regularly published in scientific journals (see the list of publications). Guidelines on the inclusion of the SPSU in the list of authors and acknowledgements are available online at: www.spsu.ch. Proposals for new studies are to be addressed to the Chair of the SPSU Committee, Dr A. Wörner (Senior Physician, UKBB, Spitalstrasse 33, CH-4056 Basel, andreas.woerner@ukbb.ch). A description of the surveillance system and guidelines for the inclusion of studies are available from the SPSU secretariat (Communicable Diseases Division, FOPH, CH-3003 Bern, spsu@bag.admin.ch), or online at: www.spsu.ch.

Figure 2 – Overview of data collection

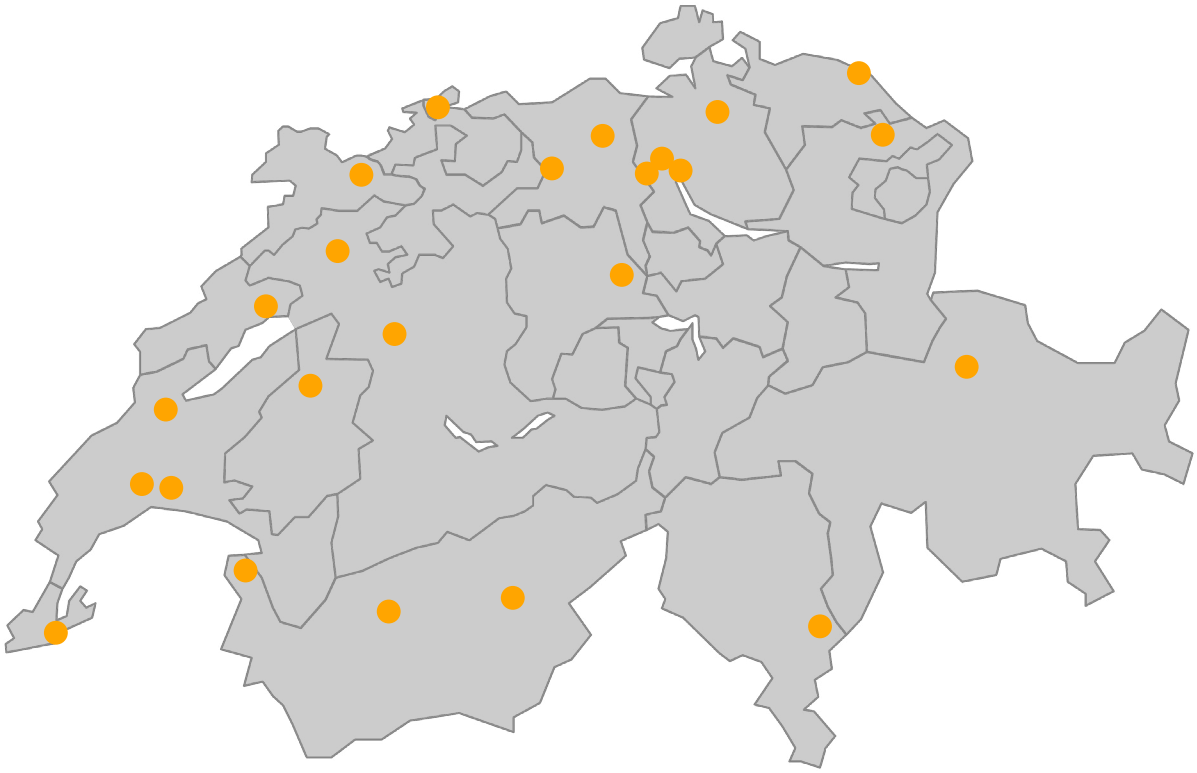


1 SPSU Committee: A. Wörner, Basel (Chair); B. Laubscher, Neuchâtel and Lausanne; G. Simonetti, Bellinzona; F. Stollar, Geneva; N. Schöbi, Bern; Ph. Baumann, Zurich; M. Mausezahl, Bern; D. Beeli, Bern; E. Rolli, Bern.

2. Participating hospitals

- Kinderspital, Kantonsspital, **Aarau**
- Klinik für Kinder und Jugendliche, Kantonsspital, **Baden**
- Universitäts-Kinderspital beider Basel, UKBB, **Basel**
- Istituto Pediatrico della Svizzera Italiana, **Bellinzona**
- Kinderklinik, Universitätsspital, **Bern**
- Neonatologie, Universitätsspital, **Bern**
- Kinderklinik Wildermeth, **Biel**
- Kinderklinik, Kantonsspital, **Chur**
- Service de Pédiatrie, Hôpital du Jura, **Delémont**
- Service de Pédiatrie, Hôpital Cantonal, **Fribourg**
- Hôpital des Enfants, Hôpitaux universitaires, **Genève**
- Service de Pédiatrie, CHUV, **Lausanne**
- Hôpital de l'Enfance, **Lausanne**
- Division de Néonatologie, CHUV, **Lausanne**
- Kinderspital Zentralschweiz, **Luzern**
- Service de Pédiatrie, Ensemble Hospitalier de la Côte, **Morges**
- Klinik für Kinder und Jugendliche, Spital Thurgau, **Münsterlingen**
- Département de Pédiatrie, Reseau Hospitalier Neuchâtelois, **Neuchâtel**
- Service de Pédiatrie, Centre hospitalier, **Rennaz**
- Neonatologie, Klinik für Geburtshilfe und Gynäkologie, Kantonsspital, **St. Gallen**
- Ostschweizer Kinderspital, **St. Gallen**
- Service de Pédiatrie, Hôpital du Valais, **Sion**
- Pädiatrische Klinik, Spital Wallis, **Visp**
- Zentrum für Kinder- und Jugendmedizin, Kantonsspital, **Winterthur**
- Service de Pädiatrie, Etablissement Hospitalisiers du Nord Vaudois, **Yverdon**
- Klinik für Neonatologie, **Zollikerberg**
- Universitäts-Kinderspital, **Zürich**
- Kinderklinik, Stadtspital Triemli, **Zürich**
- Klinik für Neonatologie, Universitätsspital, **Zürich**

Figure 3 – Overview of participating hospitals' location



3. Overview of the surveillance years 2023 / 2024

As in previous years, all paediatric teaching hospitals took part in the SPSU survey in 2023 and 2024. Once again, the return rate for report cards was 100%, i.e. all hospitals complied with their monthly notification responsibilities (Tables 1 and 2).

In 2023, 29 hospitals reported a total of 665 cases of disease for seven ongoing studies. Of these, 578 could be classified as confirmed cases. These can be broken down as follows:

233 cases of invasive group A streptococcal infection, 178 varicella-zoster virus associated hospitalisations, 133 cases of SARS-CoV-2-infection, 24 neonatal enterovirus infections, seven cases of acute flaccid paralysis as a polio surveillance indicator, two cases of acute paediatric hepatitis of unknown origin and one case of vitamin K deficiency bleeding.

Nine cases did not meet the case definitions or were identified as duplicate reports. Information for classification was missing in 78 cases (Table 1).

In 2024, 29 hospitals reported a total of 283 cases of disease for six ongoing studies. Of these, 269 could be classified as confirmed cases. These can be broken down as follows:

155 cases of invasive group A streptococcal infection, 70 neonatal enterovirus infections, 37 varicella-zoster virus associated hospitalisations, seven cases of acute flaccid paralysis as a polio surveillance indicator. No cases of acute paediatric hepatitis of unknown origin or vitamin K deficiency bleeding were reported.

Five cases did not meet the case definitions or were identified as duplicate reports. Information for classification was missing in nine cases (Table 2).

Table 1 – SPSU 2023: Overview of reported cases and return rate

	Data SPSU		Data Study investigators			
Study	No. of cases reported to SPSU	Return rate (%)	Total no. of cases	Confirmed cases	Not confirmed	Data un-available / questionnaires not received
Acute flaccid paralysis	9	100	7	7	0	2
Invasive Group A streptococcal infection	240	100	240	233	0	7
Vitamin K deficiency bleeding	1	100	1	1	0	0
SARS-CoV-2 infections*	204	100	138	133	5	66
Varicella-zoster virus (Including post-infectious complications)	180	100	180	178	2	0
Acute paediatric hepatitis of unknown origin	4	100	2	2	0	2
Neonatal enterovirus infections**	27	100	26	24	2	1

*Study ended on 31 March 2023.
**Study started 1 September 2023

Table 2 – SPSU 2024: Overview of reported cases and return rate

	Data SPSU		Data Study investigators			
Study	No. of cases reported to SPSU	Return rate (%)	No. of cases reported to SPSU	Return rate (%)	No. of cases reported to SPSU	Data un-available / questionnaires not received
Acute flaccid paralysis	11	100	7	7	0	4
Invasive Group A streptococcal infection	156	100	156	155	0	1
Vitamin K deficiency bleeding*	1	100	1	0	0	1
Varicella-zoster virus (Including post-infectious complications)	38	100	38	37	1	0
Acute paediatric hepatitis of unknown origin**	6	100	4	0	4	2
Neonatal enterovirus infections	71	100	70	70	0	1

*Study ended on 31 August 2024.
**Study ended on 28 February 2025. Number of reports and cases from January to February 2025 are included.

Table 3 – Ongoing and completed SPSU studies

	Duration	confirmed cases
Ongoing studies		
Acute flaccid paralysis	1/1995 (ongoing)	316
Invasive Group A streptococcal (iGAS) infection	12/2017 (ongoing)	616
Varicella-zoster virus associated hospitalisations (Including post-infectious complications)	7/2021 (ongoing)	306
Neonatal enterovirus infections	9/2023 (ongoing)	94
Completed studies		
Acute paediatric hepatitis of unknown origin	7/2022 – 2/2025	4
Vitamin-K deficiency bleeding	1/1995 – 12/2000 7/2005 – 6/2011 9/2018 – 8/2024	34
SARS-CoV-2 infections	3/2020 – 3/2023	3.195
Congenital cytomegalovirus	4/2016 – 3/2023	185
Neonatal listeriosis	6/2017 – 12/2020	9
Pertussis	4/2006 – 3/2010 and 1/2013 – 12/2020	323
Tuberculosis	12/2013 – 11/2019	138
Kawasaki disease	3/2013 – 2/2019	331
Symptomatic congenital toxoplasmosis	1/1995 – 12/1998 and 6/2009 – 5/2017	21
Congenital rubella	1/1995 – 12/2016	2
Urea cycle disorder	1/2012 – 12/2015	5
Mycoplasma pneumoniae encephalitis	7/2013 – 06/2015	0
Extended-spectrum beta-lactamase (ESBL) producing Gram negative bacilli	7/2008 – 6/2012	403
Severe hyperbilirubinaemia	10/2006 – 12/2011	172
Acute rheumatic fever	6/2000 – 5/2010	24
Anaphylaxis	5/2007 – 4/2010	58
Haemolytic-uraemic syndrome	4/1997 – 3/2003 and 4/2004 – 3/2010	249
Neonatal herpes	7/2002 – 6/2008	5
Neural tube defects	1/2001 – 12/2007	258
Shaken baby syndrome	7/2002 – 6/2007	50
Intussusception	4/2003 – 3/2006	243
Severe RSV infections	10/2001 – 9/2005	462
Varicella-zoster virus infections	1/2000 – 3/2003	235
Tick-borne encephalitis	3/2000 – 2/2003	23
Cystic periventricular leukomalacia	1/1996 – 12/1997	48

4. Results of ongoing studies

4.1 Acute flaccid paralysis

Background

Poliomyelitis, formerly known as infantile paralysis, is a viral disease that can result in lifelong disability and even death. In 1988, the World Health Organization (WHO) set itself the goal of eradicating polio worldwide. Switzerland already achieved this goal in 1983, when the last case of wild-type poliovirus was recorded by the Federal Office of Public Health (FOPH).

In 2002, the WHO declared the entire WHO European Region (including Switzerland) polio-free. The FOPH must provide evidence of this status to the WHO every year. For the WHO, detection of cases of acute flaccid paralysis where poliomyelitis can be excluded provides evidence of active polio surveillance. To supplement the mandatory notification system for polio, surveillance of acute flaccid paralysis (AFP) was established as part of the SPSU in Switzerland in 1995.

The WHO has defined two indicators for evaluating the sensitivity of surveillance:

- the annual non-polio AFP rate should be at least 1 per 100,000 in children under 15,
- the proportion of AFP cases where two stool specimens are collected 24 – 48 hours apart for poliovirus testing should be at least 80%.

Aims of the study

- To provide evidence that Switzerland is polio-free
- To raise awareness of poliomyelitis among medical professionals

All AFP cases are to be investigated for poliovirus infection [1], thus providing a description of the epidemiological, clinical and microbiological characteristics of AFP.

Case definition

Clinical symptoms in a child under 16:

- acute onset of flaccid paralysis in one or more limbs with decreased or absent tendon reflexes,
- acute onset of bulbar paralysis

Results

The inclusion criteria for the study do not fully match those of the WHO. The SPSU includes children under 16, whereas the WHO guidelines specify children under 15. This report therefore only includes AFP cases in children under 15.

In 2023, 9 cases of AFP were reported, of which 7 met the case definition criteria. The annualised AFP rate was therefore 0.49 cases per 100,000 population. In 2 cases, at least one stool specimen was tested. In 2024, 11 cases of AFP were reported, of which 7 met the case definition criteria. The annualised AFP rate was therefore 0.49 cases per 100,000 population. Stool specimens were tested for polio- or enteroviruses in 3 cases.

As in previous years, Switzerland failed to meet the WHO sensitivity requirements in both 2023 and 2024 (Table 4), with not enough stool specimens being tested for enteroviruses or polioviruses.

Conclusions

The spread of any imported polioviruses must be avoided in all circumstances. Therefore, in accordance with WHO guidelines, the FOPH recommends the following measures:

- achieve a high level of vaccination coverage
- maintain high-quality active surveillance to ensure rapid detection of any imported polioviruses or circulating vaccine-derived viruses
- secure storage and safe handling of polioviruses at laboratories with an appropriate biosafety level.

As Switzerland does not fulfil the quality requirements specified by the WHO with regard to stool testing, more efforts will be made to inform hospitals of the need to test at least one stool specimen for polioviruses in all cases meeting the inclusion criteria. In view of the high quality of Swiss laboratories, the FOPH considers the testing of one stool specimen to be adequate. The costs will be borne by the FOPH. Stool specimens are to be sent to the National Polio Reference Laboratory (Institute for Medical Microbiology, Petersplatz 10, CH-4003 Basel).

Polio vaccination is recommended for all non-immunised individuals regardless of age. People travelling to polio-endemic regions should check their immunity status and obtain any booster or catch-up vaccinations required. In 2024, Afghanistan and Pakistan were classified as polio-endemic countries.

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1. Bienz K, Bourquin C. Die Labordiagnostik von Polioviren nach der Eradikation der Poliomyelitis in Europa. Schweizerische Ärztezeitung 2003; 84: 407–8

Table 4 – Overview of data since 2015: confirmed cases of acute flaccid paralysis (AFP) in children <15 years

Year	Total AFP cases (<15 years)	Total "non-polio" AFP cases	AFP case rate per 100,000	Total AFP cases with 1/2 stool specimens	% of AFP cases with ≥ 1 stool specimen tested
2024	7	7	0.49	3/0	43
2023	7	7	0.49	2/0	29
2022	9	9	0.60	4/1	59
2021	8	8	0.54	4/0	50
2020	4	4	0.29	0/0	0
2019	12	12	0.86	4/4	67
2018	16	16	1.3	9/0	56
2017	8	8	0.6	2/0	25
2016	25	25	1.9	12/2	56
2015	8	8	0.7	1/2	38

4.2 Invasive Group A streptococcal (iGAS) infection

Background

Group A streptococcal (GAS) infections in children are generally mild and self-limiting but can, in rare cases, cause severe invasive infections (iGAS). The SPSU survey of iGAS cases [1], which has been running since 1 December 2017, was initially planned for a study duration of four years. In the context of the Covid-19 pandemic, a significant post-pandemic increase in reported iGAS cases was observed both in Switzerland and at an international level. For this reason, the SPSU approved an extension of the study duration until November 2024 to allow for continued monitoring of the situation [2]. As a relevant decline in iGAS cases was already evident in early 2024, a further extension of the study duration until 30 June 2026 was requested and approved by the SPSU Committee. This extension enables continued monitoring of iGAS case trends and facilitates the observation of the impact of the pandemic on the longer-term epidemiological course.

Aims of the study

Collection and analysis of data on iGAS in children in Switzerland aged ≤16 years with regard to:

- incidence
- seasonality
- age distribution
- clinical manifestations and complications
- treatment
- risk factors [underlying disease, varicella, drugs (e.g. ibuprofen, paracetamol)]
- relapse rate
- morbidity and mortality

The collection of iGAS strains is also planned, initially only for storage, but subsequently also for emm typing in a separate project.

Case definition

Confirmed case

Isolation of Group A streptococci = GAS = Streptococcus pyogenes (by culture, antigen or PCR) from a sterile site such as:

- blood
- cerebrospinal fluid
- puncture fluid (pleural, joint or pericardial fluid)
- muscle / bone tissue (deep tissue, surgical specimen)

Probable case

Severe clinical presentation* with no alternative diagnosis AND isolation of GAS (by culture, antigen or PCR) from a non-sterile site

*Severe clinical presentation:

1. Toxic shock syndrome
   Hypotension (systolic blood pressure <5th percentile for age)
   PLUS ≥2 of the following criteria:
   a) Renal insufficiency (creatinine >2 x upper limit of normal range for age)
   b) Coagulopathy (platelet count <100 G/L or clinical signs of disseminated intravascular coagulation = DIC)
   c) Hepatic insufficiency (ALT, AST or bilirubin >2 x upper limit of normal range for age)
   d) Generalised rash with or without desquamation
   e) Acute respiratory distress syndrome (ARDS)
2. Necrotising fasciitis

Results

Case numbers, age distribution and severity

In 2023, a total of 240 cases were reported. Of these, 233 were analysed, while seven cases could not be included in the analysis due to missing questionnaires. In 2024, 156 cases were reported, 155 of which could be analysed, with one questionnaire missing. With 173 reported cases, almost three-quarters of all iGAS cases in 2023 occurred between January and May.

During the same period in the following year, 104 cases (67% of total annual cases) were reported. With 19 cases reported between October and December, winter 2024 saw fewer cases than the same period in the previous year, which had 33 cases (Figure 4). The median age of the children affected was five years (range 0 – 15) in 2023 and increased slightly to six years (range 0 – 17) in 2024. The gender distribution was comparable across the two reporting years. In 2023, 97 cases (42%) were female and 124 (53%) were male. In 2024, 69 cases (45%) were female and 81 (52%) were male. Gender information was missing in 12 (5%) and 3 (3%) cases, respectively. Details regarding the severity of the disease, including the duration of hospitalisation, treatment in an intensive care unit, intubation, catecholamine requirement, surgical interventions and the outcomes, are summarised in Table 5.

Clinical presentation

The most common manifestation of iGAS was skin and soft tissue infection, which occurred in 87 cases (37%) in 2023 and 40 cases (26%) in 2024. Abscesses were observed in 88 cases (37%) in 2023 and in 55 cases (35%) in 2024. Upper respiratory tract infections were observed in 48 cases (20%) in 2023, while they were documented in 57 cases (37%) in connection with an iGAS infection in 2024. Pneumonia and pleural empyema occurred in 70 cases (29%) in 2023 and 40 cases (26%) in 2024. Sepsis and bacteraemia were present in 42 cases (18%) in 2023 and 39 cases (25%) in 2024. Other clinical manifestations included; osteoarticular infections with 43 cases (18%) in 2023 and 18 cases (12%) in 2024, lymphadenitis with four cases (2%) in 2023 and four cases (3%) in 2024, fasciitis with 14 cases (6%) in 2023 and one case (1%) in 2024, CNS infections with four cases (2%) in 2023 and nine cases (6%) in 2024 as well as toxic shock syndrome (TSS), which was documented in nine cases (4%) in 2023 and eight cases (5%) in 2024. Several children exhibited multiple concurrent clinical manifestations, meaning that the total number of reported clinical presentations exceeds the total number of children.

Risk factors

In 2023, 12 children (5%) had an active varicella infection compared to four children (3%) in 2024. Contact with a person infected with GAS was confirmed in eight cases (3%) in 2023 and four cases (3%) in 2024. A surgical procedure prior to the iGAS infection was documented in two cases (1%) in 2023 and in six cases (4%) in 2024. Chronic underlying conditions were present in 28 children (12%) in 2023 and 12 children (8%) in 2024. These conditions encompassed a range of diagnoses, including neurological, cardiac, respiratory, gastrointestinal, haematological, genetic, urological and immunological diseases.

Discussion and conclusions

While the number of reported iGAS cases in 2023 remained significantly above pre-pandemic levels, a substantial decline was seen in 2024, with the majority of cases documented in the first five months of the year and only a slight increase in numbers in the winter months of 2024. This trend suggests a return to pre-pandemic incidence. Compared to the previous period of 2021/2022, both current reporting years showed a slightly shorter average length of hospitalisation as well as a shorter stay in the intensive care unit, with a similar proportion of children requiring intubation, catecholamines or surgical intervention. Fortunately, the death rate also remained low at 1% in 2023 and 2% in 2024 and below the rates reported in other countries. With respect to risk factors, clinical presentation and severity of iGAS cases, there was no significant change in the two reporting years compared to the prior year. Thanks to the extension of the SPSU study until 30 June 2026, continued recording of the epidemiological trend, severity and risk factors of iGAS cases remains possible.

Figure 4 – Number of iGAS cases in 2023 and 2024

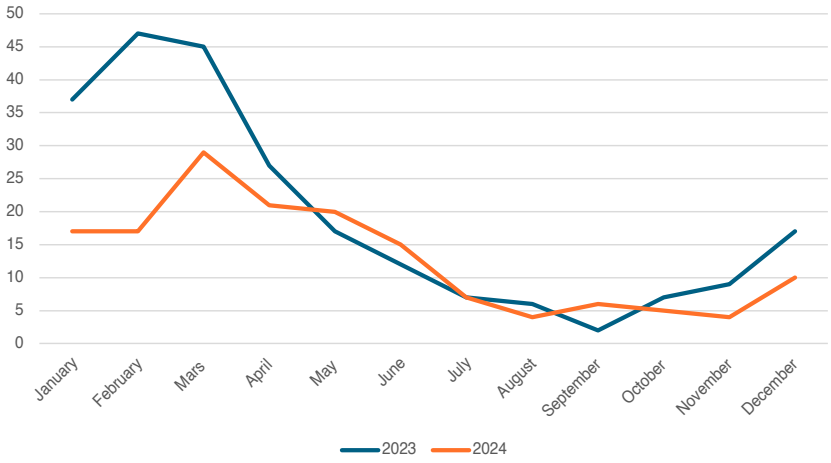

Table 5 – Severity of the disease with duration of hospitalisation

Year	2023	2024
Median length of hospital stay in days (range)	6 (1 – 37)	7 (1 – 86)
Cases with ICU treatment	70 (30%)	61 (39%)
Median length of ICU treatment in days (range)	3 (1 – 29)	4 (1 – 29)
Intubation	20 (9%)	27 (17%)
Catecholamine requirements	28 (12%)	21 (14%)
Surgical treatment	158 (68%)	107 (69%)
Complete recovery	160 (69%)	104 (67%)
Recovery with residual symptoms	53 (23%)	34 (22%)
Deaths	3 (1%)	3 (2%)
No information on residual symptoms at discharge	17 (7%)	14 (9%)

Principal investigators

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1. Swiss Paediatric Surveillance Unit, SPSU. Study Protocol Invasive Infections caused by Group A Streptococci (iGAS). 2017. https://spsu.ch/en/docs/media/273d46e0-5363-49c4-aec8-a2d190b75acf/94f9652a31b74ab189b76c0958fedd30

2. Swiss Paediatric Surveillance Unit, SPSU. Report 2021 / 2022. October 2023. https://www.spsu.ch/en/docs/media/5a5f1d38-6346-4d56-82c6-b3d9ff6418fa/6926c4a3937a45bd9221e5d906c70a57

4.3 Vitamin K deficiency bleeding

Aims of the study

Various measures are available for the prevention of vitamin K deficiency bleeding (VKDB) [1,2]. Since 2003, Switzerland [3] has recommended that newborns receive three oral doses of vitamin K (Konakion® MM, at 4 hours, 4 days and 4 weeks after birth) in order to prevent VKDB (official guidelines of paediatric switzerland). An earlier SPSU study showed that three oral doses of vitamin K offer adequate prophylaxis [4]. The most important current risk factors for VKDB are refusal of / failure to administer VK prophylaxis and undiagnosed hepatobiliary disease. The aim of this study is to determine the current epidemiology of VKDB, potential risk factors, and a possible increase or cluster effects. The study thus also aims to assess whether the prophylaxis recommended in 2003 remains appropriate in today's society.

Case definition

Bleeding in a newborn or infant aged ≤6 months (26 weeks):

- with an abnormal prothrombin time / Quick value <20% (international normalised ratio >4) in the presence of a normal (or increased) platelet count and normal fibrinogen (with no fibrin degradation products)
- with normalisation of prothrombin time / Quick value (and / or cessation of bleeding) within 30 – 120 minutes after administration of vitamin K.

Results

Between 1 January 2023 and 31 August 2024, 2 cases of VKDB were reported, of which only 1 case met the case definition.

Conclusions

The data analysis is still ongoing. A scientific publication is anticipated in 2025.

Principal investigator

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Table 6 – Overview of reports and cases 2018 – 2024

	No. of cases reported to SPSU	Total no. of cases	Confirmed cases	Not confirmed
2019	3*	3	2	1
2020	1	1	1	0
2021	1	1	1	0
2022	4	4	2	2
2023	1	1	1	0
2024**	1	0	0	1

*One report from November 2018 (study started on 1 September 2018).
**Study ended on 31 August 2024.

4.4 SARS-CoV-2 infections – final report

Background

In late 2019, COVID-19 emerged and rapidly spread worldwide, leading the WHO to declare it a pandemic on 11 March 2020. The spread of various SARS-CoV-2 variants shaped the pandemic's course. Vaccination and natural immunity have reduced severe illness, and on 5 May 2023, the WHO declared the pandemic no longer a global emergency. However, the virus persists, and new variants remain a critical concern, especially for paediatric health. Despite improved knowledge on managing the disease, ongoing surveillance is vital, particularly regarding new variants, waning immunity, and impacts on new birth cohorts.

Aim of the study

The aim of the study was to collect epidemiological data on SARS-CoV-2 infections and paediatric inflammatory multisystem syndrome temporally associated with SARS-CoV-2 (PIMS-TS) in children in Switzerland, to determine the following:

- epidemiology of disease in children with age stratified incidence, clinical spectrum, severity of the disease and mortality
- changes in epidemiology and clinical presentation with the emergence of new variants of concern (VOC)
- co-morbidity and risk factors for severe disease
- therapeutic approaches
- transmission patterns
- the effect of vaccination

Case definition

Children aged <18 years treated in a Swiss hospital for COVID-19 and / or PIMS-TS confirmed by one of the tests specified below:

- Detection of SARS-CoV-2 in a clinical specimen by a validated nucleic acid amplification test (PCR), serology or rapid antigen test.
- Diagnosis of PIMS-TS in accordance with the Swiss national recommendations (Schlapbach et al. Front. Pediatr., 26. Mai 2021; doi.org/10.3389/fped.2021.667507).

Changes occurring during the study period

From 1 March to 31 October 2020, both outpatient and hospitalised cases were reported. From 1 November 2020, onwards, only hospitalised cases were reported, but specifically also cases of PIMS-TS. PIMS-TS cases reported before 1 November 2020 were retrospectively identified. For all reported PIMS-TS cases, a follow-up questionnaire for data collection purposes was sent out 4 to 6 weeks after discharge. In June 2022, the questionnaire was shortened to make participation more feasible, given the large number of COVID-19 cases admitted during the Delta wave and to adjust it to the current state of research. The study was planned to continue until December 2024. In March 2023 the SPSU decided to shorten the study duration after a project review. This was justified by the fact that the Covid-19 pandemic had since been declared over, that the disease was not considered rare and that sufficient data was available for the scientific evaluation of the research questions.

Results

Study population

Over the entire study period (1 March 2020 to 31 March 2023), detailed data were collected for 3,880 cases. After excluding non-hospitalised cases and duplicates, a total of 3,195 cases were included in the final analysis. Among these, 1,933 children (61%) were admitted for suspected or confirmed COVID-19, 1,032 (32%) for other reasons, and 230 (7%) for possible PIMS-TS. The patient's age ranged from 2 days to 18 years (median 11 months, interquartile range [IQR] 2 months to 6.6 years). Most hospitalised children were Caucasian (1,205 [38%]), followed by Black (87 [3%]), Arabic (58 [2%]), or unknown race/ethnicity (1,845 [57%]).

From 1 January 2023 to 31 March 2023, a detailed dataset was collected for 138 cases, with 133 cases included in the final analysis after removing 5 duplicates. Of these, 117 children (88%) were admitted for suspected or confirmed COVID-19, while 16 children (12%) were hospitalised for other reasons. The age of the children ranged from 2 days to 16 years (median 5 months, interquartile range (IQR) 5 months – 2.2 years), (Table 7). Most hospitalised children were either Caucasian (45 [34%]) or of unknown race/ethnicity (88 [66%]).

Admission to intensive care unit and management

Over the entire study period, 320 children (10%) required admission to the intensive care unit (ICU), with respiratory failure being the leading cause in 103 cases (32%). Among all hospitalised children, 482 (15%) required oxygen therapy, 149 (5%) received inotropes, and 59 (2%) needed mechanical ventilation. Half of the children (1,593 [50%]) did not receive any medication during their hospital stay, while 416 (13%) were treated with corticosteroids. The median length of hospital stay was 2 days (IQR 1 – 4) for non-ICU patients and 7 days (IQR 4 – 13) for those admitted to the ICU.

In 2023, a total of 7 children (5%) required ICU admission, with respiratory failure accounting for 3 cases (43%) and other reasons for 4 cases (57%), including one case with renal failure and two post-operative cases. Among the hospitalised cases, 25 (19%) required oxygen, 6 (5%) inotropes and none had mechanical ventilation. Thirty-three children (25%) received no medication during their hospital stay, while 13 (10%) were treated with corticosteroids, and 67 (50%) received other anti-inflammatory medications. The median duration of hospitalisation was 2 days (IQR 1.0 – 3.0) for non-ICU patients and 16 days (IQR 10.5 – 29.5) for those admitted to the ICU.

Symptoms

Over the entire study period, fever was the most frequently reported symptom in children with SARS-CoV-2 infection (2229 [70%]), followed by rhinorrhea (1218 [38%]) and cough (1170 [37%]); (see full list of symptoms in Table 7).

Similarly, in 2023, fever was the most common symptom (102 [77%]), followed by rhinorrhea (73 (55%]), cough (62 [47%]), respiratory distress/tachypnoea (34 [26%]); (see full list of symptoms in Table 7).

Among the 7 children admitted to the ICU, fever was the most frequent symptom (3 [43%]). Other symptoms included respiratory distress/tachypnoea (2 [29%]), cough (2 [29%]), vomiting (2 [29%]), and rhinorrhea (2 [29%]).

Comorbidities and Co-Infections

Over the entire study period, 771 children (24%) had pre-existing medical conditions. The most common pre-existing medical conditions were respiratory (133 [4%]), cardiovascular (132 [4%]), and haemato-oncological comorbidities (116 [4%]). Among all hospitalised children, viral co-infections were reported in 125 children with RSV (4%), 41 children with influenza virus (1%), and 107 children with other viruses such as rhinovirus/enterovirus and picornavirus (3%).

In 2023, 16 (12%) children had pre-existing medical conditions. The most common comorbidities were reported in the following groups: cardiovascular (8 [6%]), and haemato-oncological (6 [5%]), and respiratory (2 [2%]). Among the children admitted to the ICU, 2 (29%) had pre-existing comorbidities, both of which were cardiovascular. Regarding viral co-infections among all hospitalised children, RSV was detected in 6 children (5%), influenza virus in 7 children (5%), and other viruses such as rhino-/enterovirus and picornavirus in 9 children (7%).

Among those admitted to the ICU, RSV and influenza virus were detected in one child each (14%).

Complications

Over the entire study period, complications occurred in 718 (22%) hospitalised children. The most frequent were respiratory (212 [7%]), bacterial co-/superinfection (122 [4%]), cardiovascular (73 [2%]), and neurological (103 [3%]). Eight deaths were reported (0.3%).

In 2023, complications were reported in 34 (26%) of the hospitalised children. The most frequent complications were respiratory (18 [14%]), bacterial co-/superinfection (3 [2%]), cardiovascular (2 [2%]), and neurological (3 [2%]). One death was recorded (1%).

Vaccination

Throughout the entire study period, 2,197 (69%) hospitalised children with SARS-CoV-2 infection were unvaccinated, 24 (1%) had received at least one dose, and for 974 (30%), the vaccination status was unknown or missing.

In 2023, 122 (92%) children were unvaccinated and for 11 (8%), the vaccination status was unknown.

Table 7 – Baseline characteristics, comorbidities, and symptoms of hospitalised children with SARS-CoV-2 infection by time period and ICU status (March 2020 – March 2023)

	All hospitalised 1 March 2020 – 31 March 2023 n (%) n = 3,195	All hospitalised 1 January 2023 – 31 March 2023 n (%) n = 133	ICU 1 January 2023 – 31 March 2023 n (%) n = 7
Age			
<2 years	1,890 (59)	98 (74)	5 (72)
2 to <5 years	348 (11)	11 (8)	0 (0)
5 to <10 years	369 (12)	12 (9)	1 (14)
≥10 years	539 (17)	10 (8)	1 (14)
Missing	49 (1)	2 (1)	0 (0)
Female	**1,401 (44)**	**58 (44)**	**3 (43)**
Comorbidities	**771 (24)**	**16 (12)**	**2 (29)**
Symptoms			
Fever	2,229 (70)	102 (77)	3 (43)
Cough	1,170 (37)	62 (47)	2 (29)
Rhinorrhoea	1,218 (38)	73 (55)	2 (29)
Pharyngitis	652 (20)	29 (22)	0 (0)
Anosmia/dysgeusia	16 (1)	0 (0)	0 (0)
Abdominal pain	338 (11)	7 (5)	0 (0)
Diarrhoea	410 (13)	9 (7)	0 (0)
Vomiting	628 (20)	23 (17)	2 (29)
Respiratory distress	738 (23)	34 (26)	2 (29)
Rash	264 (8)	6 (5)	0 (0)
Oxygen saturation <92%	403 (13)	21 (16)	1 (14)
Seizure	149 (5)	7 (5)	0 (0)
Conjunctivitis	41 (1)	2 (2)	0 (0)
Headache	75 (2)	3 (2)	0 (0)

Symptoms over the course of the pandemic

While most children experience a mild COVID-19 disease course, they may present with a diverse spectrum of symptoms affecting the respiratory, gastrointestinal, dermatological, and neurological systems. As the pandemic evolved, successive SARS-CoV-2 variants such as Alpha, Delta, and Omicron emerged.

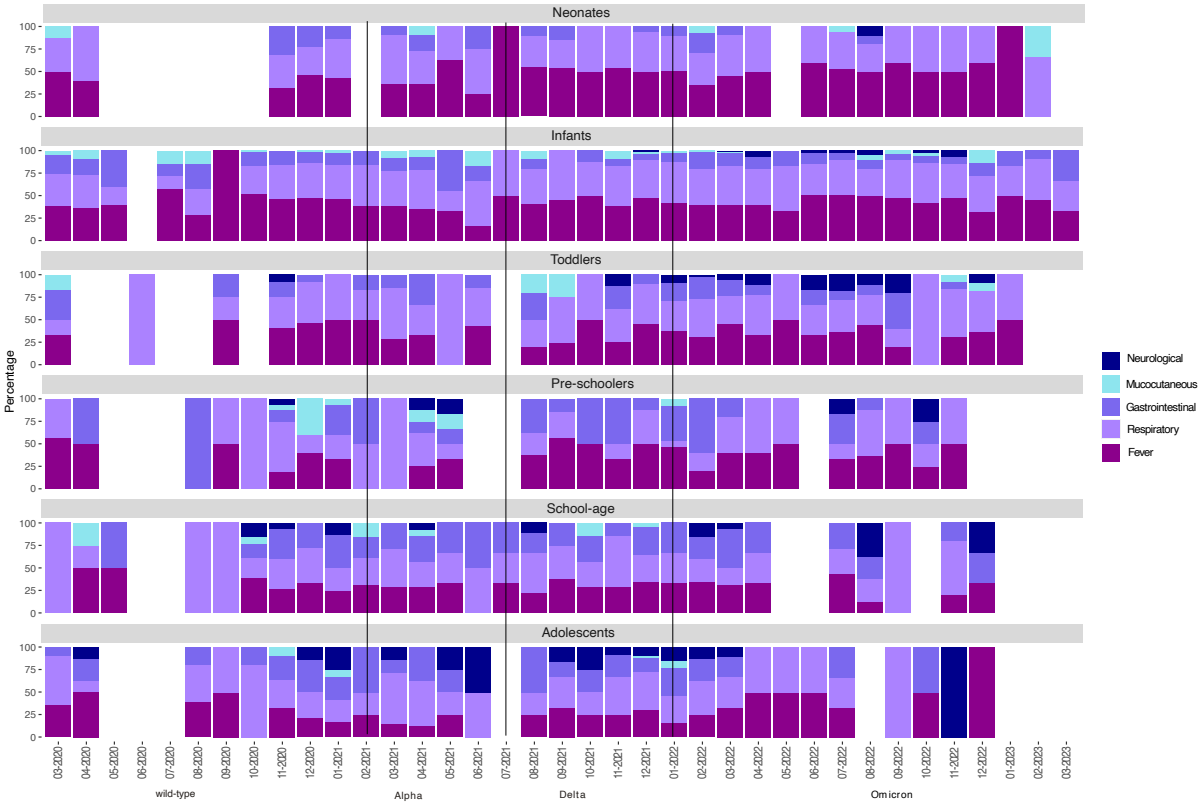
An independent analysis examined the symptoms of 1,323 children with COVID-19 from March 2020 to March 2023. The findings suggest that clinical manifestations evolved over time. During the wild-type period, respiratory symptoms were most common, while fever was predominant during the Alpha variant period. In the Omicron variant period an increase in both fever and neurological symptoms were found, and new symptoms such as conjunctivitis, laryngotracheitis, and seizures were described (Figure 5).

Pediatric Inflammatory Multisystem Syndrome Temporally related to SARS-CoV-2 (PIMS-TS)

PIMS-TS is a hyperinflammatory condition that typically occurs several weeks after SARS-CoV-2 infection in children.

Another independent analysis of 204 children with PIMS-TS from March 2020 to March 2022, investigated factors influencing disease severity. The aim was to identify factors associated with disease severity. To this end, children were categorised on their ICU admission status into three groups: non-ICU (48%), ICU-moderate (25%), and ICU-severe (27%), with the severe group defined by the need for invasive ventilation and/or inotropic support. The majority of PIMS-TS cases occurred in school-aged children (6 – 12 years, 39%) and pre-schoolers (4 – 5 years, 39%) and 70% of the cases were male. Most cases were unvaccinated and occurred during the wild-type and Delta variant periods (see Table 8 for a detailed description of the cohort). The analysis showed that children in the ICU-severe group had distinct clinical and laboratory features compared to those in the non-ICU group. Specifically, ICU-severe patients had lower lymphocyte and platelet counts, elevated neutrophil-to-lymphocyte ratios, and higher levels of C-reactive protein, N-terminal pro-B-type natriuretic peptide, troponin T, and creatinine. Low lymphocyte counts and elevated troponin T levels at admission were associated with a higher risk of requiring invasive ventilation and/or inotropic support. These findings may help to identify children at risk of severe PIMS-TS early in the clinical course.

Figure 5 – Evolution of symptoms between March 2020 and March 2023



Conclusions

COVID-19 is mostly a mild disease in children and adolescents with low mortality. Most cases involved infants and young children, with a small percentage requiring ICU admission, primarily due to respiratory issues. Fever, rhinorrhea, and cough were the most common symptoms. In 2023, pre-existing medical conditions, particularly cardiovascular and haemato-oncological, were prevalent among those admitted to the ICU. Respiratory complications were frequent, though mortality was low. In 2023, none of the hospitalised children were vaccinated.

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Table 8 – Baseline characteristics of hospitalised children with PIMS-TS by ICU status

	Total n (%) 204 (100)	Non-ICU n (%) 99 (48)	ICU-moderate n (%) 50 (25)	ICU-severe n (%) 55 (27)
Age category (years)				
Infants (0 – 1)	9 (4)	3 (3)	1 (2)	0 (0)
Toddlers (2 – 3)	30 (15)	12 (12)	4 (8)	3 (5)
Pre-schoolers (4 – 5)	80 (39)	18 (18)	3 (6)	8 (15)
School-age (6 – 12)	78 (39)	43 (44)	32 (64)	31 (56)
Adolescents (13 – 18)	7 (3)	23 (23)	10 (20)	13 (24)
Female	62 (30)	33 (33)	12 (24)	17 (31)
Race/Ethnicity				
Caucasian	128 (63)	68 (69)	30 (60)	30 (55)
Black	22 (11)	5 (5)	8 (16)	9 (16)
Asian	5 (2)	3 (3)	1 (2)	1 (2)
Hispanic	5 (2)	3 (3)	1 (2)	1 (2)
Other or unknown	44 (22)	20 (20)	10 (20)	14 (25)
Pre-existing medical conditions				
Respiratory disease	9 (4)	5 (5)	1 (2)	3 (6)
Cardiovascular disease	6 (3)	2 (2)	2 (4)	2 (4)
Other disease	23 (11)	12 (12)	7 (14)	4 (7)
Covid-19 vaccination				
One dose or more	0 (0)	0 (0)	0 (0)	0 (0)
No	88 (43)	50 (50)	14 (28)	24 (44)
Unknown	116 (57)	49 (50)	36 (72)	31 (56)
Viral variant*				
Wildtype	89 (44)	37 (38)	26 (52)	26 (47)
Alpha	37 (18)	13 (13)	12 (24)	12 (22)
Delta	50 (24)	32 (32)	7 (14)	11 (20)
Omicron	28 (14)	17 (17)	5 (10)	6 (11)

Non-ICU = child not admitted to ICU.
ICU-moderate = child admitted to ICU without need for mechanical ventilation and/or inotropic support.
ICU-severe = child admitted to ICU with need for mechanical ventilation and/or inotropic support.

Viral variant*: T1 (SARS-CoV-2 wild type): 01/03/2020 (start of study) to 06/03/2021. T2 (Alpha variant): 07/03/2021 to 24/06/2021. T3 (Delta variant): 25/06/2021 to 18/01/2022. T4 (Omicron variant): 19/01//2022 to 31/03/2023.

4.5 Varicella-zoster virus associated hospitalisations (Including post-infectious complications)

Background

Many individuals consider varicella (chickenpox), a prevalent infectious disease, to be a benign illness of childhood. While this holds true for most cases, significant and potentially life-threatening exceptions do occur [1]. In Switzerland, varicella-zoster virus (VZV)-associated hospitalisations were first reported to the Swiss Paediatric Surveillance Unit (SPSU) from 2000 to 2003. Over this four-year period, 335 cases were documented. The mean age of affected patients was 4.1 years (median: 3.5 years; range: 0 – 16 years), with 13% identified as immunocompromised. The most frequently observed complications among both immunocompetent and immunocompromised patients included secondary bacterial infections and central nervous system (CNS) involvement. Notably, 3% of cases required admission to intensive care units, and three patients succumbed to the disease. The estimated hospitalisation rate was 13 per 10^4 varicella cases [2]. Age-specific seroprevalence studies in Switzerland indicate that 37% of children under five years of age possess VZV antibodies, with this proportion increasing to approximately 96% by age 15 [3]. Approximately 5% of children and adolescents — particularly those without siblings — remain unexposed to VZV. In the absence of immunisation, these individuals remain susceptible to infection and may contract varicella during adulthood, a life stage associated with an elevated risk of severe complications [4 – 6].

A recent retrospective observational study was conducted at the Children's Hospital of Central Switzerland (KidZ), covering the period from 1 January 2010 to 31 March 2020 and encompassing approximately 10% of the national paediatric population [7]. The study identified 95 hospitalised patients with varicella-associated complications. The median age at disease onset was 4 years (range: 2 months to 13 years), with the highest incidence of complications occurring in children aged 1 to 4 years. Among these, 53 patients experienced mild complications, while 42 experienced severe complications (8 of whom had more than one severe manifestation). The most prevalent severe complications were bacterial skin and soft tissue infections (n = 28), invasive secondary bacterial infections (n = 18), and CNS complications (n = 12). Paediatric intensive care unit (PICU) admission and surgical intervention were required in 11 (12%) and 16 (17%) patients, respectively. Tragically, two previously healthy school-aged children died due to secondary bacterial infections.

When the current SPSU surveillance initiative commenced in July 2021, the Swiss national immunisation strategy recommended varicella vaccination for individuals up to 40 years of age who lacked evidence of prior infection, due to the increased risk of complications in adulthood. Consequently, catch-up vaccination was advised for all adolescents aged 11 to 15 years who were seronegative, as well as for unvaccinated adults up to 39 years of age [8]. However, data from the Swiss Federal Office of Public Health collected during 2014 – 2016 indicated that only 1% of 16-year-old adolescents had received the complete two-dose varicella vaccine regimen [9]. As of January 2023, Switzerland has implemented a universal varicella vaccination program (www.bag.admin.ch/impfplan). International data highlight the public health impact of such programs: in England, where universal vaccination has not yet been adopted, hospitalisations and complications due to varicella increased by 25% and 24%, respectively, between 2004 and 2017 [12]. In contrast, countries such as the United States [10] and Germany [11] have reported significant declines in both metrics following the introduction of universal varicella immunisation. Surveillance data from Australia and New Zealand (www.inopsu.com) similarly support the efficacy of national varicella vaccination initiatives. Currently, comprehensive data on varicella-related hospitalisations and complications in Switzerland are lacking. Such data are essential for establishing a baseline against which the impact of the recently introduced universal vaccination programs can be assessed. This project aims to evaluate the effectiveness of the new immunisation policy by quantifying reductions in hospitalisation rates compared to the pre-vaccination era.

Aims of the study

Surveillance of type and frequency of VZV associated complications leading to hospitalisation in Switzerland to review the epidemiology, risk factors, exposures, VZV vaccination, complications, clinical management, antibiotic exposure, hospital days (incl. ICU) and outcome during the implemented prevention strategies. Comparison with previous SPSU VZV surveillance data and international data.

Methods

Observational, multicentric surveillance with reporting of all children and adolescents ≤16 years of age hospitalised in one of the SPSU participating hospitals with VZV infections, i.e. varicella, herpes zoster or post infectious complications (e.g. stroke). Reporters are encouraged to report VZV associated ischemic stroke also to the Swiss Neuropediatric Stroke Registry (https://snpsr.neuropaediatrie.ch/) and reciprocally, we will be informed of cases reported to the Swiss Neuropediatric Stroke Registry during the study period. After notification to SPSU by participating hospitals / clinics an anonymised CRF (fillable pdf) is linked to the notifying center for data entry and returned.

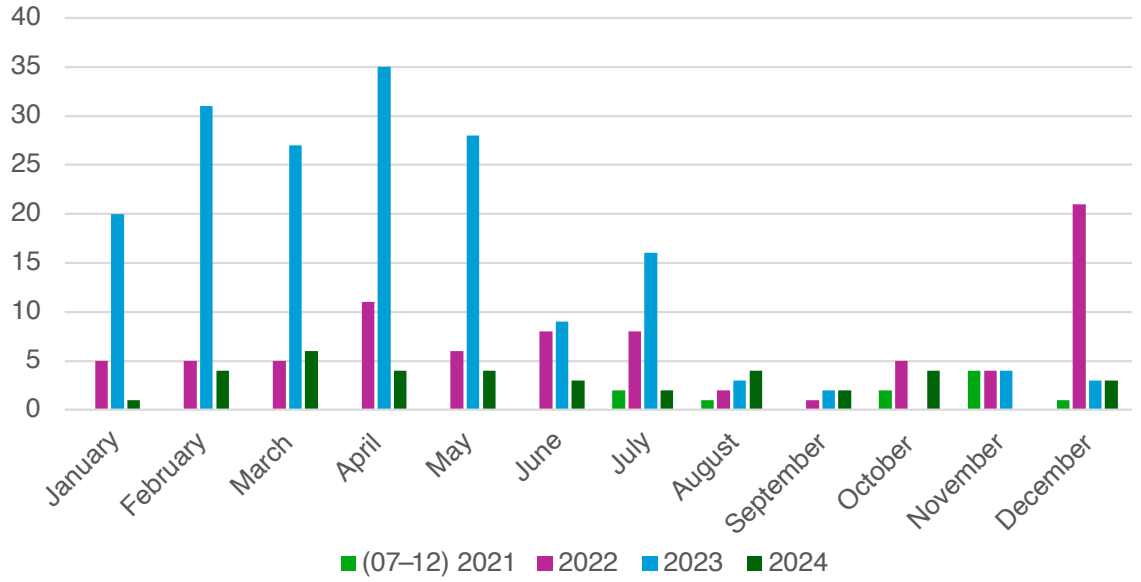
Case definition

All children <16 years with clinical manifestations of VZV infection (ICD-10: B01.-) leading to hospitalisation.

Results

In total, 178 and 37 fully completed case report forms were submitted to the study center in 2023 and 2024, respectively. The majority of varicella-zoster virus (VZV)-associated cases occurred in immunocompetent children aged 1 to 9 years, with a male predominance. Most exposures to VZV took place outside the household setting. Across all cases from 2021 to 2024, vaccination history for VZV was known in 94% of reports. Notably, none of the infected individuals had received prior VZV vaccination (see Table 9). In terms of clinical manifestations, 6 cases of herpes zoster were reported in 2023 and 8 in 2024. These cases primarily occurred in immunocompromised individuals and adolescents. No cases of congenital VZV were documented. Two cases of VZV-associated stroke were reported. The most frequently observed condition was primary varicella infection, accompanied by complications that led to hospitalisation. The mean duration of hospitalisation was 5.7 days in 2023 and 4.5 days in 2024. A notable increase in VZV-related hospitalisations began in December 2022, peaking in April 2023. Subsequently, case numbers declined, with monthly totals ranging from 0 to 6 through December 2024 (see Figure 6). During the 2023 – 2024 surveillance period, 18% of reported cases required intensive care management, and 10% underwent at least one surgical intervention. One fatal case was reported: a 6-year-old immunocompetent male who developed a severe invasive Group A streptococcal infection (S. pyogenes) presenting as necrotizing fasciitis with sepsis and multiorgan failure, concurrent with VZV infection. The majority of complications observed in hospitalised paediatric patients with VZV were secondary bacterial infections involving the skin, soft tissue, and muscle (see Table 10). Specifically, 43 cases of invasive Group A streptococcal infections were reported in 2023 and 4 in 2024.

Figure 6 – VZV hospitalisations (cases per month) from 2021* to 2024 (*surveillance started 1 July 2021).



Discussion

Since the initiation of the surveillance in July 2021, a marked increase in varicella-zoster virus (VZV)-associated hospitalisations was observed beginning in December 2022, with a pronounced peak in April 2023. Subsequently, a significant and sustained decline in reported hospitalisations has been documented, with monthly case numbers ranging between 0 and 6 from August 2023 onward. A similar surge in infection-related hospitalisations during the winter months of 2022/2023 was concurrently reported for other respiratory pathogens, such as respiratory syncytial virus (RSV), both in Switzerland and across [12,13]. This trend is likely attributable to the relaxation of COVID-19 non-pharmaceutical interventions beginning in 2021, which led to increased social interactions and transmission opportunities from 2022 onward.

Focusing on the current 2023–24 surveillance interval, the persistently low VZV hospitalisation rates observed between August 2023 and December 2024 are striking. These data strongly suggest the effectiveness of the universal varicella vaccination strategy implemented in January 2023, which includes 2 doses of MMR-VZV at 9 and 12 months of age and catch-up VZV vaccination for unimmunised individuals without a reliable history of varicella 13 months to 39 years of age. Overall, VZV-related hospitalisations decreased by 79% from 2023 to 2024. Notably, a decline in case numbers was particularly evident among children 1–9 years of age when compared to the corresponding data from 2022 and 2023. When contrasted with historical data from the Swiss Paediatric Surveillance Unit (SPSU) VZV monitoring conducted between 2000 and 2003, during which approximately 110 cases were reported annually [2], the current findings are highly encouraging and underscore the potential impact of varicella vaccination in reducing VZV-associated morbidity.

Tragically, one paediatric fatality due to invasive group A streptococcal (iGAS) infection was reported. Group A streptococcus continues to play a critical role in the pathogenesis of severe skin and soft tissue infections including sepsis. Further information is available in the SPSU iGAS surveillance summary and discussion. It is known that VZV is a predisposing risk factor for secondary bacterial infections, particularly iGAS. It will be of considerable interest to monitor the evolving epidemiological trends following the introduction of universal varicella immunisation in Switzerland in January 2023. The ongoing SPSU surveillance of VZV-related hospitalisations is scheduled to continue until June 2026.

Table 9 – Characteristics of the 2021* – 2024 reported VZV hospitalisation cases (* surveillance started 1 July 2021).

		2021* n (%)	2022 n (%)	2023 n (%)	2024 n (%)
Case reports		10	81	178	37
Manifestation	Primary VZV infection with complication(s)	7	73	146	23
	Zoster	3	7	6	8
	Stroke (post infectious complications)	0	1	2	0
	Congenital VZV infection	0	0	0	0
	Hospitalisation with VZV infection as non-primary diagnosis	0	0	24	6
Sex	Female	5	30	79	12
	Male	5	51	99	25
Age at admission	<1 year	4	11	8	4
	1 – 4 years	2	46	81	11
	5 – 9 years	2	18	75	15
	10 – 16 years	2	6	14	7
VZV exposure	Within family	3	27	56	8
	Outside of family	7	54	122	29
VZV vaccinated	Yes	0	0	0	0
	No	10	69	173	37
	Unknown	0	12	5	0
Immunocompromised (primary or secondary)		4	9	8	5
Intensive care unit treatment		1	15	20	1
Surgical intervention		0	13	28	3
Death		0	2	1	0
	In immunocompromised	0	0	0	0
Hospitalisation duration (d): median (range)		60 (1 – 16)	5 (1 – 20)	4 (1 – 33)	3 (1 – 20)

Table 10 – Main complications of the 2021* – 2024 reported VZV hospitalisation cases (*surveillance started 1 July 2021). Some cases had multiple complications.

Main complications	2021 n	2022 n	2023 n	2024 n
	n total = 10	n total = 81	n total = 178	n total = 37
Secondary bacterial infections	1	32	76	10
Skin/soft-tissue/abscess	0	6	10	1
Necrotizing fasciitis	0	1	0	0
Purpura fulminans	0	1	0	0
Lymphadenitis	1	9	8	1
Bacterial pneumonia	0	1	5	0
Osteoarticular infection	0	2	14	0
Sepsis	0	18	43	4
CNS related VZV complication				
Encephalitis	0	2	2	0
Cerebellitis	0	6	10	1
Meningitis	0	2	3	2
Stroke (post infectious complication)	0	1	2	0
No complication	8	0	5	18

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4.6 Acute paediatric hepatitis of unknown origin – final report

Background

Most cases of acute hepatitis in children are mild and transient, and those of clinical significance are usually due to hepatitis viruses A-to-E. Since early 2022, an unusually high number of acute hepatitis of unknown origin have been reported, mainly in the United Kingdom [1], but also in the USA, France, Belgium, Spain, Italy, Norway, Romania, the Netherlands, New Zealand and Denmark [2]. As of 6 May 2022, several cases in Switzerland met the WHO case definition [3]. This syndrome mostly affects previously healthy children aged 2 – 5 years but cases up to 16 years have been described [1,2]. The most frequently reported symptoms are jaundice, vomiting, abdominal pain, pale stool, diarrhea, lethargy, and malaise [1,2,4,5]. The reported frequency of fever varies between 0% to 55% [1,2,4,6]. Between 7% to 10% of documented cases have required liver transplantation [2,7]. Despite an extensive infectious, immunological and toxicological workup, the etiology of this entity remains unclear. There is no clear association with travel or recent vaccination. Adenovirus has been identified in about 60 – 70% of cases, either in blood, upper respiratory tract or stools. The most frequently identified adenovirus is adenovirus type 41 [2,4,7]. However, it is not clear whether this simply reflects sustained circulation of adenoviruses in the paediatric community. Moreover, low viral load in blood [2,4] and negative PCR on explant biopsies children having undergone liver transplant do not support the hypothesis of a primary adenovirus hepatitis. Similarly, SARS-CoV-2 was also identified in some cases, but it could simply reflect community circulation. For example, out of the 114 cases reported in the UK, 60 (53%) were positive for adenovirus and 18 (16%) for SARS-CoV-2 [2]. Other working hypotheses include a new viral variant of adenovirus or SARS-CoV-2, a coinfection, an immune-mediated hepatitis triggered by a viral infection in a relatively naïve paediatric population or a toxic agent.

Aims of the Study

We aimed to rapidly implement a nationwide surveillance system for acute non-A-to-E hepatitis in children aged <16 years with the following aims:

Primary aim

- Identify the epidemiology of acute non-A-to-E hepatitis

Secondary aims

- Identify the etiology of acute non-A-to-E hepatitis
- Characterize the clinical presentation of acute non-A-to-E hepatitis
- Identify risk factors for occurrence of acute non-A-to-E hepatitis
- Analyze risk factors for a severe course (liver failure and liver transplantation)
- Analyze management of acute non-A-to-E hepatitis with a view to streamline and rationalize management

Duration of the study:
1 July 2023 – 28 February 2025

Case definition

In order to allow for international comparisons, this study followed the World Health Organisation (WHO) accepted case definition [3]:

- Confirmed: N/A
- Probable: A person presenting with acute hepatitis (non-hepatitis viruses A, B, C, D and E) with aspartate transaminase (AST) or alanine transaminase (ALT) over 500 IU/L, who is 16 years old or younger, since 1 October 2021.

Results

Four out of ten (4/10) reported cases that occurred between 1 July 2022 and 28 February 2025, met the case definition. All 10 cases presented with acute non-A-to-E hepatitis. Of these, 5 were male and 5 were female. The median age was 10 years (age range: 0 to 15 years). The diagnoses are distributed as follows: viral n = 3, parainfectious n = 1, degranulation defect n = 1, autoimmune n = 1, unknown etiology n = 4. No liver transplants were necessary. Treatment was supportive in all cases. Risk factors could not be determined in this small sample size.

Conclusion

Primary aim:

Ten cases of acute hepatitis were diagnosed in the SPSU over the entire study period. In summary, acute non-A-to-E hepatitis does not represent an unusual clinical problem or a threat to public health in Switzerland, as was originally feared.

Secondary aims:

Given the low number of cases and the lack of reporting, no conclusions can be drawn regarding the secondary objectives.

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4.7 Neonatal enterovirus infections

Background

Enterovirus infections, caused by a family of RNA viruses belonging to the Picornaviridae family, affect newborns differently and often more severely than older children. They usually present fever, poor feeding, lethargy, irritability, sometimes a rash, and may occasionally progress to sepsis, myocarditis, hepatitis with coagulopathy, and meningoencephalitis. Factors influencing severity and outcome include viral serotype, mode of transmission, and the presence or absence of passively acquired maternal antibodies. The serotypes most commonly associated with severe neonatal infections are group B coxsackieviruses and echoviruses, particularly Echovirus-11.

Enteroviruses are transmitted primarily via the fecal-oral and respiratory routes. In newborns, infection can be transmitted vertically (before, during, or after delivery), horizontally (from family members), or through nosocomial transmission in neonatal units. The predominant mode of transmission (63%) is intrapartum, at the time of delivery, through contact with maternal blood, feces, amniotic fluid, or vaginal or cervical secretions [1].

In 2022–2023, the World Health Organization (WHO) and the European Centre for Disease Prevention and Control (ECDC) reported an increase in severe and fatal neonatal infections with Echovirus-11 enteroviruses, leading to the rapid establishment of a national surveillance system for enteroviruses, particularly Echovirus-11, in newborns [2 – 4].

Aims of the study

This study aims to describe the epidemiology of enterovirus infections, including Echovirus-11, in Swiss newborns.

Case definition

Newborn (<28 days) hospitalised with a laboratory-confirmed diagnosis of non-polio enterovirus.

Inclusion criteria:

- age <28 days
- laboratory-confirmed non-polio enterovirus infection

Results

Neonatal enterovirus infections since 1 September 2023 status as of 31 December 2024:

Since surveillance began on 1 September 2023, 94 cases of newborns hospitalised with laboratory-confirmed non-polio enterovirus infection have been reported. The epidemic curve shows a seasonal peak in the summer (Figure 7).

The age distribution (Figure 8) shows a peak in infants younger than 5 days. Fifty-seven percent of cases occurred in boys (Table 11). In only 6% of cases, the mother was reported to have had diarrhea and/or fever in the week before giving birth (Table 11).

Most of the kids had birth weights between 2,500 and 4,000 grams (80%) and were born at full term (91%).

The most common symptom was fever, reported in 87% of cases. Difficulty feeding, irritability, and lethargy were reported in approximately 20% to 25% of cases, while other symptoms were less common. Meningitis was the most common diagnosis, reported in 80% of cases, while sepsis syndromes, upper respiratory tract infections, encephalitis, hepatitis, and gastroenteritis were reported less frequently (Table 12).

Complications were observed in 5 cases (5%), details of which are provided in Table 2. In 96% of cases, infants survived without sequelae. Two children (2%) died, both from hepatitis, one of whom also had myocarditis. Both newborns were premature.

84 samples were sent to the National Reference Center for genotyping. This allowed the serotype to be determined for 41 samples. Echovirus-11 was identified in seven samples (7%). It was not detected in the two cases of death. The most frequently detected pathogen was Coxsackievirus B5, found in 11 cases (11%) (Figure 9).

Conclusion

This national surveillance study of enterovirus infections in newborns in Switzerland since September 2023 provides important epidemiological data on this disease. With 94 cases reported, we observed a seasonal peak in the summer, which is consistent with known epidemiological data for these infections. Most cases involved full-term infants with normal birth weight.

Meningitis was the most common diagnosis. Two deaths related to hepatitis were reported in premature infants.

Genotypic analysis of samples identified Coxsackievirus B5 as the most common pathogen, while Echovirus-11, which is being closely monitored following alerts from the WHO and ECDC, was detected in 7% of cases but was not involved in any deaths.

This surveillance should be maintained to monitor the epidemiological evolution of these infections, particularly the distribution of the different serotypes.

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Figure 7 – Incidence of neonatal enterovirus infections over time, 09/2023 – 12/2024

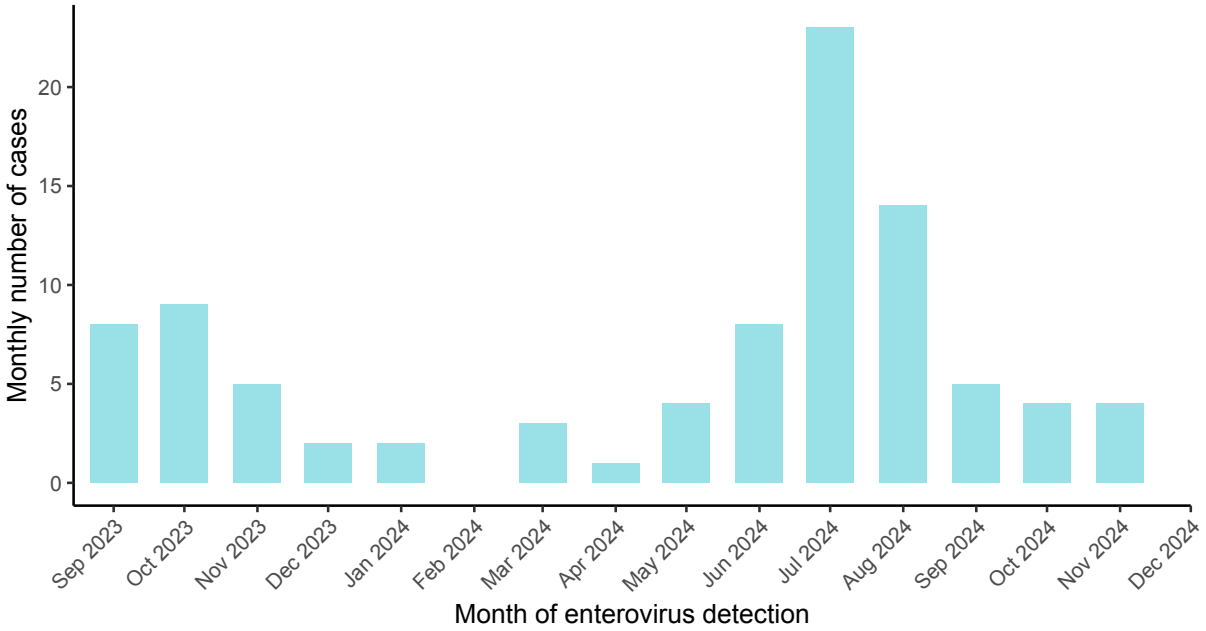


Figure 8 – Distribution of age in days

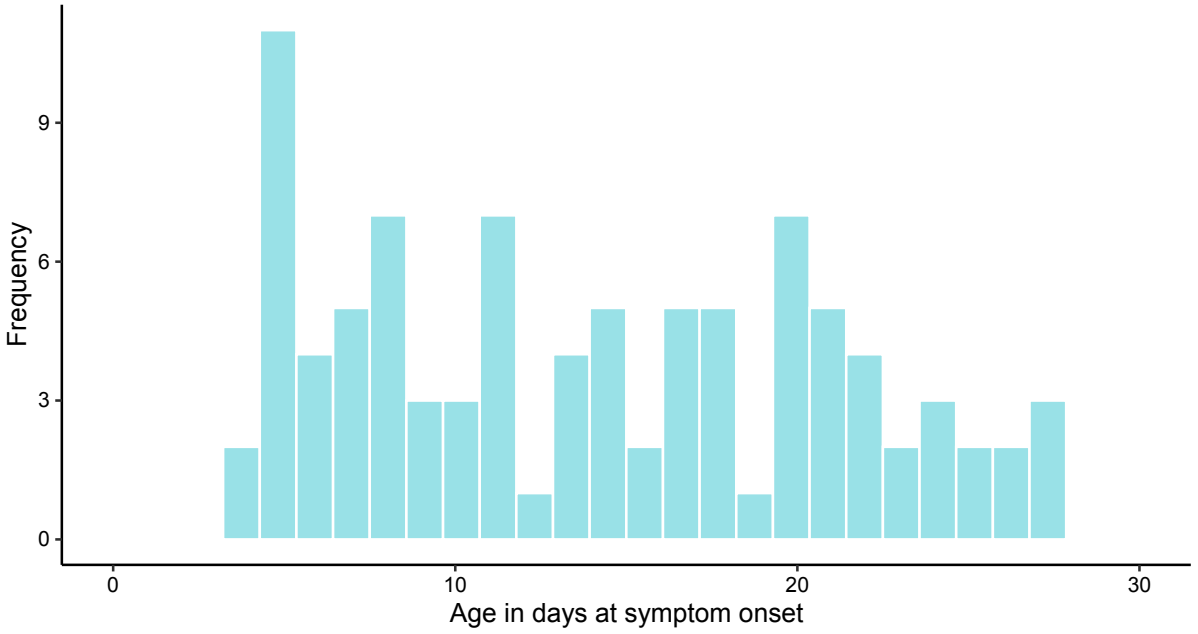


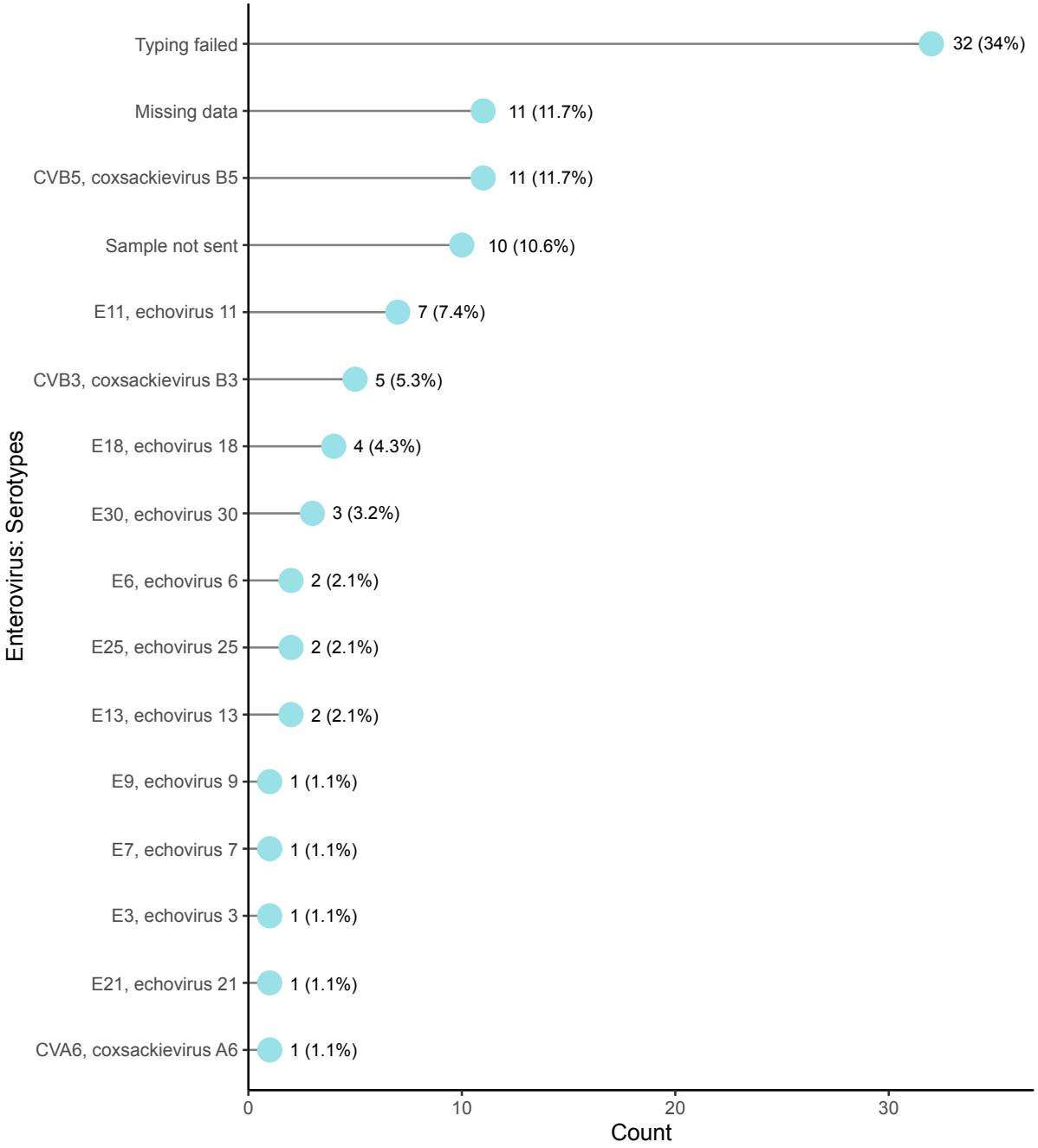
Table 11 – Demographic characteristics

	n	%
Total	94	100
Age at onset of symptoms		
<8 days	22	23.4
8 to 14 days	27	28.7
15 to 27 days	44	46.8
Unknown	1	1.1
Gender		
Male	54	57 .4
Female	39	41 .5
Unknown	1	1.1
Birth weigth		
<1,500 g	2	2.1
1,500–2,499 g	3	3.2
2,500–3,999 g	75	79.8
≥4,000 g	9	9.6
Unknown	5	5.3
Gestational age		
24 – 28 weeks	2	2.1
29 – 34 weeks	2	2.1
35 – 36 weeks	2	2.1
≥37 weeks	85	90.5
Unknown	3	3.2
Maternal symptoms (fever, diarrhea) within 7 days before or after birth		
Yes	6	6.4
No	67	71.3
Unknown	21	22.3

Table 12 – Clinical progression

	n	%
Symptoms at the onset of the disease		
Irritability	24	25.5
Lethargy	17	18.1
Fever	82	87.2
Decreased appetite	24	25.5
Diarrhea	6	6.4
Upper respiratory tract infection	10	10.6
Rash	4	4.3
Respiratory distress	4	4.3
Syndromic diagnosis		
Meningitis	75	79.8
Encephalitis	2	2.1
Sepsis	8	8.5
Gastroenteritis	1	1.1
Upper respiratory tract infection	7	7.4
Pneumonia	0	0
Complications		
Circulatory shock	1	1.1
Respiratory failure	3	3.2
Acute liver failure	1	1.1
Necrotizing enterocolitis	1	1.1
Encephalopathy	1	1.1
Hemorrhagic diathesis	1	1
Thrombocytopenia	2	2.1
Disseminated intravascular coagulation	1	1.1
Organ support		
ECMO (ExtraCorporeal Membrane Oxygenation)	1	1.1
Invasive ventilation	1	1.1
Non-invasive ventilation	2	2.1
Outcome		
Recovery	90	95.8
Death	2	2.1
Unknown	2	2.1

Figure 9 – Distribution of enterovirus serotypes



5. Publications and contributions to conferences 2015 – 2024

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- Abu Raya B, Jost M, Bettinger J, Bortolussi R, Grabowski J, Lacaze-Masmonteil T, Robinson J L, Posfay-Barbe K M, Galanis E, Schutt E, Mäusezahl M, Kollmann T R. Listeriosis in infants: Prospective surveillance studies in Canada and Switzerland, *Paediatr Child Health.* 2021 Jun 19;26(7):e277-e282. doi:10.1093/pch/pxab035
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- Fritschi N, Wind A, Hammer J, Ritz N and Swiss Pediatric Surveillance Unit (SPSU). Subclinical tuberculosis in children: diagnostic strategies for identification reported in a 6-year national prospective surveillance study. Annual Meeting of the European Society for Paediatric Infectious Diseases (ESPID 2021), virtual and hosted from Geneva, Switzerland, 24 – 29 May 2021
- Uka A, Buettcher M, Bernhard-Stirnemann S, Fougère Y, Moussaoui D, Kottanattu L, Wagner N, Zimmermann P, Ritz N and Swiss Pediatric Surveillance Unit (SPSU). Factors Associated With Hospital and Intensive Care Admission in Paediatric SARS-CoV-2 Infection: A Prospective Nationwide Observational Cohort Study. Oral presentation at the 9th Research Day in Medicine UniFR, online| 14th April 2021
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- Maeusezahl M, Lynn R, Zurynski Y, Moore Hepburn C, Duncan M, Rudin C. The power of surveillance data to change Public Health Policy and practice in rare paediatric conditions. 36th Annual Meeting of the European Society for Paediatric Infectious Diseases (ESPID 2018), to be held in Malmö, Sweden | May 28 – June 2, 2018
- Maeusezahl M, Rudi n C, Beeli D on behalf of the SPSU-Steering committee. The Swiss Paediatric Surveillance Unit SPSU contributes to change in Public Health Policy and Practice. Oral presentation at the fPmH conference. Mai 24, 2018, Lausanne, Switzerland. Suppl 228 ad *Swiss MedWkly*, 2018; 148: 5
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6. International activites

Through its participation in International Network of Paediatric Surveillance Units (INOPSU), the SPSU enables studies involving international collaboration. The INOPSU provides researchers and interested parties with simple, low-threshold access to study protocols from other countries operating national surveillance systems comparable to the SPSU (www.inopsu.com). This offers a unique opportunity to compare demographic, diagnostic, clinical and therapeutic data on rare paediatric diseases on a global level.

Every few years, representatives from the 10 current member states meet to share the latest findings at a scientific conference. Since the start of the pandemic, these exchanges have become more frequent, in the form of regular online meetings.

The activities of INOPSU are illustrated by the following publications (listed in reverse chronological order):

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