Second report of Swissnoso on the epidemiology of healthcare-associated infections in Switzerland

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1. Executive summary

In a year that continued to be marked by the COVID-19 pandemic, Swissnoso further advanced the development of the national monitoring system for healthcare-associated infections (HAIs). Point prevalence studies (PPS) and surgical site infection (SSI) surveillance continued to provide high-quality outcome data on HAIs. National HAI monitoring systems have been under development for catheter-associated urinary tract infections (CAUTI), central line-associated bloodstream infections (CLABSI), ventilator-associated pneumonia (VAP) and non-ventilator-associated hospital-acquired pneumonia (nvHAP). In addition, process indicators have been collected in several fields. For the first time, data on nosocomial COVID-19, provided by the COVID-19 Hospital-Based Surveillance system (CH-SUR) from a major hospital network, has been included in this report. In the medium term, information on HAIs supplied by hospitals participating in Swissnoso activities will be supplemented by systematic screening of Swiss health registries for HAI outcome data.

After a pandemic-related break in 2020, Swissnoso resumed the PPS in a reduced form in spring 2021. Among the participating hospitals, the observed HAI prevalence (6.1%) remained similar to findings in previous PPS. While university(-affiliated) hospitals had the highest HAI prevalence among the various healthcare facilities, intensive care units were the departments most affected within hospitals. Antimicrobial use among all patients did not differ significantly among the subset of hospitals participating in all surveys (31.5% in 2021 vs 29.5% in 2019, 28.7% in 2018 and 29.9% in 2017).

One hundred and sixty-five hospitals participated in the Swissnoso SSI surveillance module. As regards the SSI rate across all observation periods since October 2011 (Cochran-Armitage test for trend), a significant reduction (for all infection depths) was observed for appendectomy (2.5%; P<0.001), gastric bypass (2.8%; P<0.001), hernia surgery (0.6%; P<0.001), colon surgery (12.8%; P=0.002), cardiac surgery (all procedures, 3.1%; P<0.001), coronary artery bypass (3.5%; P<0.001), elective hip replacement (0.9%; P<0.001) and laminectomy with implant (since 2013; 1.3%; P=0.009). Conversely, a continuous increase in SSIs was observed for rectal surgery and Caesarean section (C-section) between 2011 and September 2020. However, the SSI rate for C-section decreased in the current surveillance period compared to the previous one (1.8% vs 2.4%, P=0.018). Infection rates were stable for all other types of surgery.

Other relevant surveillance programmes, including CAUTI, CLABSI, VAP and nvHAP, have made substantial progress, with the aim being to provide process and outcome indicators in the near future. Following a pilot study, the CAUTI surveillance module was established in 2021. By January 2022, data collection will start in some hospitals.

For CLABSI, a feasibility study has been launched in the intensive care unit of the lead institution (HUG) and is currently ongoing. Following single-centre experiences in Bern, Geneva, and Zurich, concrete planning and implementation of feasibility studies for VAP and nvHAP surveillance are also underway.

In rapid response to the pandemic, CH-SUR adapted a pilot surveillance system for influenza to monitor COVID-19-related hospitalisations and nosocomial transmission. Among the 21 participating hospitals, CH-SUR recorded 18,901 COVID-19 cases between October 2020 and September 2021, of which nearly 14% were hospital-acquired. Two-thirds of these cases were discharged either home, to long-term care facilities, or for rehabilitation. Among nosocomial cases, mortality in hospital or within 30 days post-discharge was almost 24% compared to 11% among community-acquired cases. An estimated 70% of these deaths were directly associated with COVID-19.

Swissnoso assumed a crucial role during the pandemic: guidelines on comprehensive COVID-19 management were published by Swissnoso for acute care hospitals and regularly updated. Weekly video calls with all members, the FOPH and other invited guests provided a framework enabling acute care hospitals to harmonise their guidelines across Switzerland. In addition, Swissnoso experts served as consultants for institutions concerned with long-term healthcare, such as CURAVIVA.

Last but not least, progress was made towards the implementation of structural minimum requirements. A first national symposium was held online in August 2021, with a large number of stakeholders participating.

2. Introduction

The COVID-19 health crisis has put enormous pressure on the acute care system, requiring both agility and adaptability to the epidemiological situation and the resulting measures, as well as the maintenance of established functions, operations and hygiene measures. From the acute care hospital perspective, infection prevention and control (IPC) remains a significant pillar in limiting the effects of the pandemic on hospitalised patients.

While the objectives remained unchanged, the scope of the framework agreement between the Federal Office of Public Health (FOPH) and Swissnoso had to be expanded to meet the need for recommendations and guidance arising from the COVID-19 pandemic.

This second epidemiological report, coming one-and-a-half years after the publication of the first report, summarises the current status of the epidemiology and control of HAIs in Switzerland. It presents the ongoing modules and activities, methodology, and results obtained between October 2020 and October 2021.

In addition to the existing activities listed in the previous report, new activities are focusing on surveillance of the most critical HAIs in terms of incidence and impact on human health. These activities include a market analysis on the current structure and need for and priority of HAI surveillance and the development of surveillance modules for the most important HAIs –central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI) and ventilator-associated pneumonia (VAP). Progress has been made in designing the new surveillance systems, and they are to be implemented in the near future.

While Swissnoso activities have resumed after an unplanned interruption – primarily due to the management of the first and second COVID-19 waves – the results need to be considered in light of the challenging conditions of the last two years.

3. Epidemiology of HAIs in Switzerland

3.1 Point prevalence survey

As an integral part of the NOSO Strategy[1] which results from the federal Health2020 policy agenda, the point prevalence survey (PPS) is a vital tool for measuring the extent of HAIs in Switzerland. It also forms part of the Strategy on Antibiotic Resistance (StAR)[2].

Therefore it has been proposed as a tool for surveillance under the structural minimum requirements for the prevention and control of HAIs in acute care hospitals[3].

After five nationwide HAI prevalence surveys (Swiss Nosocomial Infection Prevalence = SNIP) conducted between 1996 and 2004, with over 100 participating hospitals, followed by a 13-year gap, PPS were resumed for HAIs and conducted for the first time on antimicrobial use (AU) between April and June 2017. Data collected on approximately 13,000 patients from 96 acute care hospitals throughout Switzerland suggested satisfactory participation. Data analysis revealed an overall HAI prevalence of 5.9%, placing Switzerland at the European average level. Subsequently, in 2018, 2019 and 2021, interested hospitals could use the CH-PPS platform to continue conducting annual surveys. Due to the COVID-19 pandemic, Swiss acute care hospitals did not conduct a PPS on HAIs or AU in spring 2020.

In 2021, due to ongoing exceptional circumstances with limited hospital resources, PPS data collection focused exclusively on HAIs. Hospital indicators were not collected. Information on antimicrobials was only collected on a voluntary basis, focusing on antimicrobial use, including the indication with no further details. The protocol and forms remained largely the same as in previous years, except for minor updates to better address the diagnosis of a nosocomial COVID-19.

Between April and June 2021, 29 acute care hospitals agreed to participate in the PPS, providing data on 5,551 patients. Of these hospitals, 18 were small (<200 beds), 6 were medium-sized (200–650 beds) and 5 were large (>650 beds). Four of the latter were also university-affiliated.

HAI prevalence in 2021 was 6.1%, the prevalence of HAI attributable to the current hospital was 5.5%, and the prevalence of HAI attributable to the current hospital stay was 4.6%. Large hospitals, tertiary care hospitals and university-affiliated hospitals had a higher HAI prevalence than their category comparators. This difference was statistically significant between large and small hospitals, tertiary and primary care hospitals, and university-affiliated and non-university-affiliated hospitals. HAI prevalence among intensive care unit (ICU) infections was 22%, accounting for a total of 57 infections in ICUs. Overall, the most common HAIs were lower

[1] https://www.bag.admin.ch/bag/en/home/strategie-und-politik/nationale-gesundheitsstrategien/strategie-noso--spital--und-pflegeheiminfektionen.html
[2] https://www.star.admin.ch/star/en/home.html
[3] https://www.swissnoso.ch/forschung-entwicklung/strukturelle-mindestanfoderungen-hai

respiratory tract infections (LRTI; n=89, 24.1%), followed by surgical site infections (SSI; n=85, 23%), bloodstream infections (BSI; n=56, 15.2%) and urinary tract infections (UTI; n=45, 12.2%).

Differences in HAI prevalence between 2017, 2018, 2019 and 2021 were not statistically significant in the overall PPS population or among hospitals participating in all surveys (Figure 1).

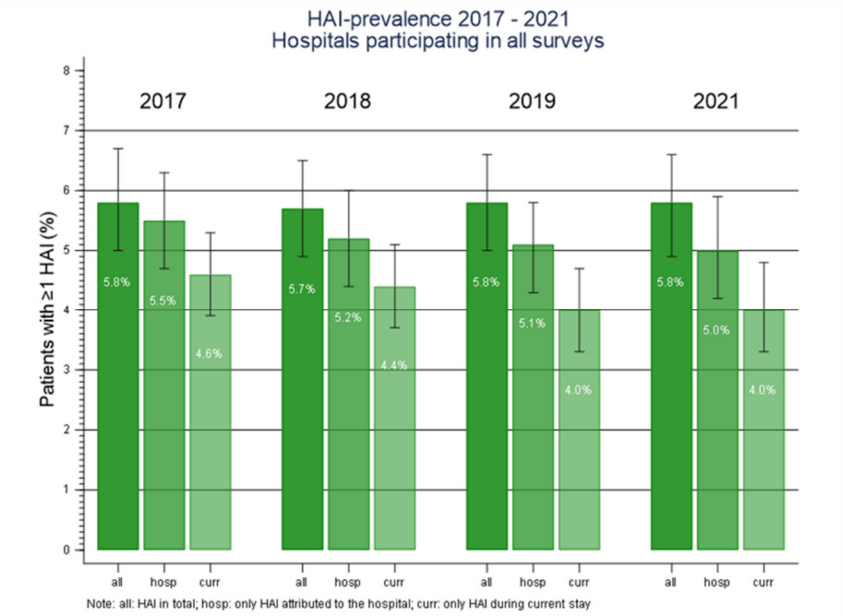


Figure 1: Differences in HAI prevalence in all surveys: all (HAI in total), hosp (HAI attributable to the current hospital), curr (HAI attributable to the current stay).

Similarly, AU did not differ significantly in the subset of hospitals participating in all surveys (n=29): 31.5% (CI 29.8–33.3) in 2021 vs 29.5% (CI 27.9–31.1) in 2019, 28.7% (CI 26.9–30.6) in 2018 and 29.9% (CI 28.3–31.5) in 2017.

On the day of the survey, 29.8% of all patients received one or more antimicrobials (Figure 2 & 3); amoxicillin and clavulanic acid, piperacillin-tazobactam and ceftriaxone were the most frequently used antimicrobial agents (Figure 4).

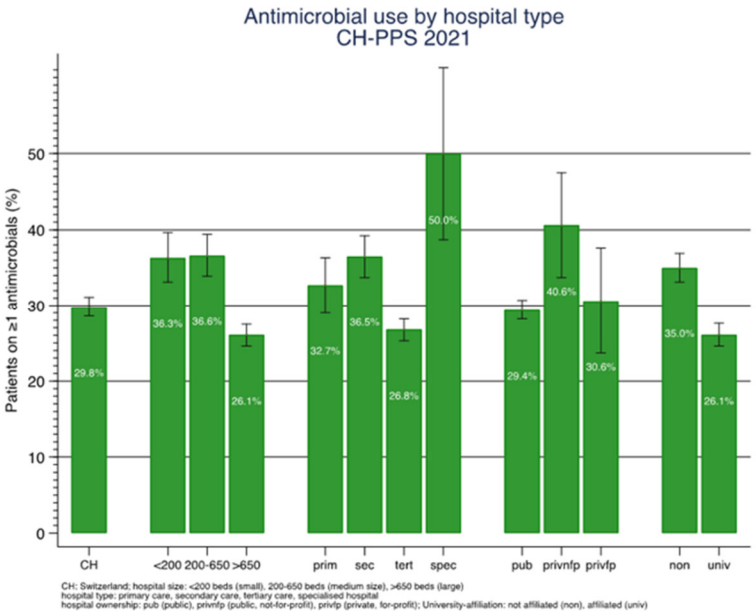


Figure 2: Antimicrobial use by hospital type. CH: Switzerland. Hospital size: <200 beds (small), 200–650 beds (medium-sized), >650 beds (large). Hospital type: prim (primary care), sec (secondary care), tert (tertiary care), spec (specialised hospital). Hospital ownership: pub (public), privnfp (private not-for-profit), privfp (private for-profit). University affiliation: non (non-affiliated), univ (affiliated).

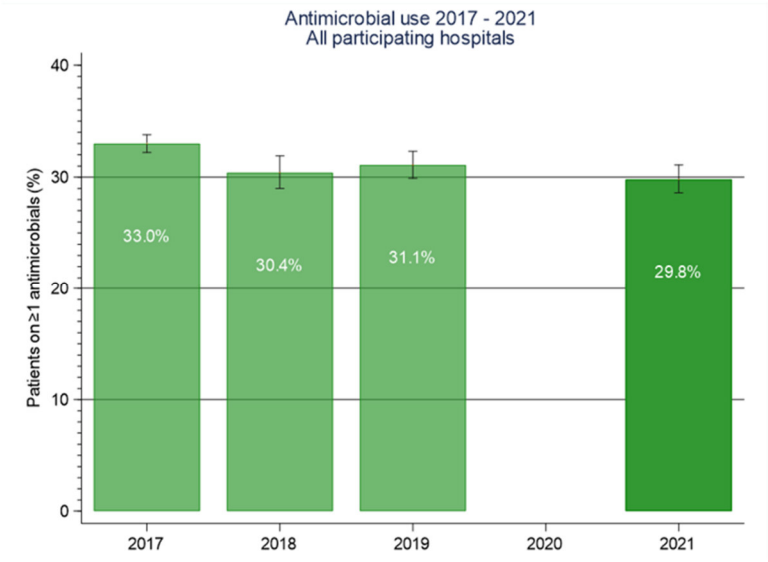


Figure 3: Patients receiving at least one antimicrobial agent in all participating hospitals (not only those which participated in all PPS)

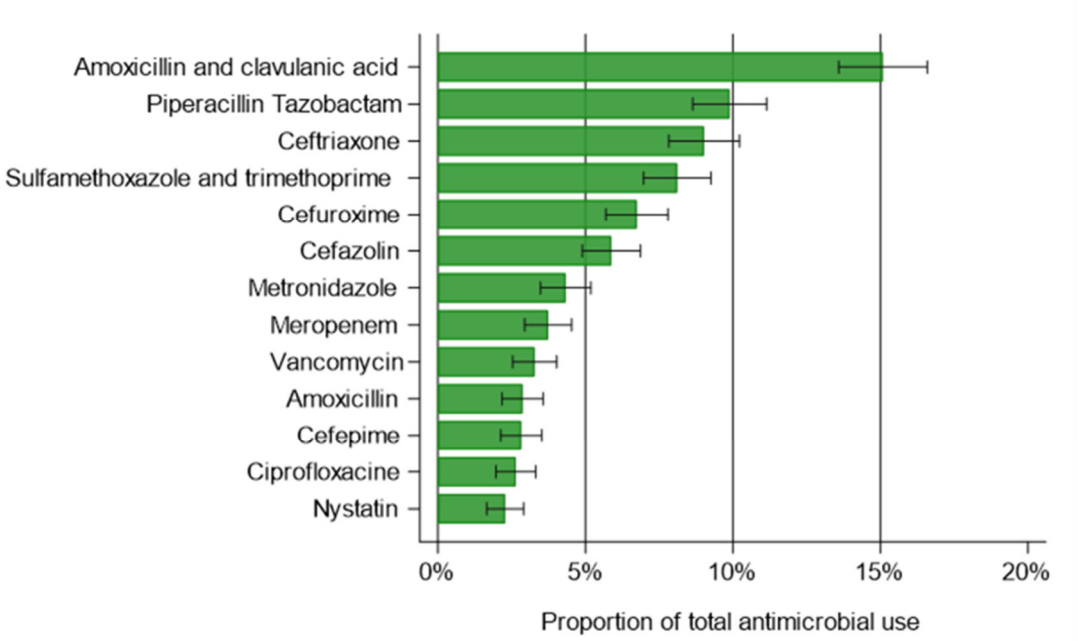


Figure 4: Frequency of use of the antimicrobials reported in the PPS 2021, representing 75% of all antimicrobials used.

The next national PPS will be conducted in spring 2022, 26 years after the first SNIP prevalence study in 1996 and 5 years after the first PPS (2017). It will coincide with the next PPS conducted by the European Centre for Disease Prevention and Control (ECDC), allowing a direct international comparison with hospitals in European countries and the European Economic Area. A hundred and ten Swiss acute care hospitals have expressed an interest in participating in the national PPS in 2022. Despite the complex context caused by the COVID-19 pandemic, we noted an increase in participation compared to PPS 2017 (96 in 2017).

The participating hospitals will also complete the IPCAF questionnaire (a tool for assessing the implementation of the WHO Guidelines on core components of infection prevention and control programmes) as part of the PPS 2022. This information will make it possible to see where Swiss hospitals stand in terms of minimum infection control standards and where they stand compared to other Swiss and European hospitals, as the same questionnaire will also be completed as part of the ECDC PPS.

3.2 Surgical site infection surveillance

Swissnoso continued its SSI surveillance programme in collaboration with the Swiss National Association for Quality Development in Hospitals and Clinics (ANQ) from October 2019 to September 2020, with 165 hospitals participating. This module is used for active, prospective monitoring of SSIs, providing healthcare professionals and service providers with an instrument

for measuring a critical indicator of surgical treatment quality. Participation in this module is mandatory for all Swiss acute care hospitals.

An internationally recognised method is used, based on the principles of the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN). The observation period is 30 days for procedures without and 12 months for operations with implantation of foreign material. However, for the latter, the observation period has been reduced to 90 days as of 1 October 2021. In case of a suspected infection identified during a telephone interview, the attending physician is contacted at the rehabilitation facility or other institution. The diagnosis of infection is made according to the international CDC criteria, which also allows distinction between superficial or deep incisional infections and organ/space infections.

The data is entered via the protected Swissnoso platform (hosted by Swiss RDL – medical Registries and Data Linkage at the Institute of Social and Preventive Medicine, University of Bern).

The SSI module monitors several types of procedures, covering different fields such as abdominal surgery, gynaecology, orthopaedics, cardiac and spinal surgery. The procedures included are defined according to the Swiss Classification of Surgical Interventions (CHOP version 2019). Participating hospitals and clinics are obliged to monitor at least three types of procedures selected from the surgical catalogue. At the beginning of a 12-month observation period, the institution may decide to change the types of surgery monitored. Recording starts in October and lasts until September of the following year. Surveillance of colon surgery and paediatric appendectomy (<16 years) is mandatory in hospitals where this type of surgery is performed.

Procedure type	Hospitals *n*	Procedures *n*	Infections *n*	Infection rate % (95% CI)	Depth/distribution of infection		
					Superficial *n* (%)	Deep *n* (%)	Organ/space *n* (%)
Period: 1 October 2019 – 30 September 2020*							
Appendectomy	86	3746	92	2.5 (2.0–3.0)	22 (23.9)	7 (7.6)	63 (68.5)
Cholecystectomy	34	3077	65	2.1 (1.6–2.7)	30 (46.2)	1 (1.5)	34 (52.3)
Hernia operation	44	2643	16	0.6 (0.3–1.0)	7 (43.8)	6 (37.5)	3 (18.8)
Colon surgery	104	5137	659	12.8 (11.9–13.8)	206 (31.3)	71 (10.8)	382 (58.0)
Rectal surgery	15	271	56	20.7 (16.0–26.0)	13 (23.2)	5 (8.9)	38 (67.9)
Gastric bypass	14	1115	31	2.8 (1.9–3.9)	1 (3.2)	1 (3.2)	29 (93.5)
Caesarean section	33	4766	84	1.8 (1.4–2.2)	61 (72.6)	7 (8.3)	16 (19.0)
Hysterectomy	16	1311	28	2.1 (1.4–3.1)	7 (25.0)	0 (0.0)	21 (75.0)
Laminectomy without implant	21	2418	32	1.3 (0.9–1.9)	9 (28.1)	10 (31.3)	13 (40.6)
Period: 1 October 2018 – 30 September 2019*							
Cardiac surgery							
All procedures	11	3797	118	3.1 (2.6–3.7)	51 (43.2)	39 (33.1)	28 (23.7)
CAB	11	1822	63	3.5 (2.7–4.4)	28 (44.4)	28 (44.4)	7 (11.1)
Valve replacement	9	965	29	3.0 (2.0–4.3)	11 (37.9)	3 (10.3)	15 (51.7)
Elective total hip replacement	102	13087	119	0.9 (0.8–1.1)	32 (26.9)	12 (10.1)	75 (63.0)
Elective knee replacement	66	9518	69	0.7 (0.6–0.9)	18 (26.1)	3 (4.3)	48 (69.6)
Laminectomy with implant	15	218	1	0.5 (0.01–2.5)	0 (0.0)	1 (100.0)	0 (0.0)

Table 1: Infection rates by type of procedure and depth of infection for surgery without implant (1 October 2019 – 30 September 2020) and for surgery with implant (1 October 2018 – 30 September 2019).
Abbreviations: CI, confidence interval; CAB, coronary artery bypass.
*Patients who had surgery without implant are followed up for 30 days after the procedure, those with surgery with implant for one year after the procedure.

The national comparative report with SSI surveillance results for October 2019 – September 2020[4] was published in October 2021.

Analyses and reporting activities for the most recent period (1 October 2019 to 30 September 2020): 52,968 cases were analysed, and 165 specific reports (in German or French) were provided to participating hospitals. The number of cases included for the most recent surveillance period decreased compared to the previous periods (61,171 in 2018 and 60,950 in 2019), which can be explained by the interruption of the surveillance between March and May 2020 due to the COVID-19 pandemic. In addition, the pandemic had an impact on elective surgical activity, which

4 https://www.swissnoso.ch/fileadmin/module/ssi_surveillance/Dokumente_D/9_Resultate/20210826_ANQakut_SSI_Nationaler_Vergleichsbericht_2019_2020.pdf

was temporarily postponed in some institutions. In total, 538,976 cases have been included and analysed since 1 June 2009.

Communication to encourage institutions to lock their cases on time in the database continued to be strengthened towards the end of the reporting period. Support was actively provided to all hospitals and clinics during data cleaning.

Comparing all transparently published monitoring periods (1 October 2011 – 30 September 2020), a significant reduction in infection rates (all infection depths) was observed for appendectomy (P<0.001, Cochran-Armitage test for trend), gastric bypass (P<0.001), hernia surgery (P<0.001), colon surgery (P=0.002), heart surgery (all procedures, P<0.001), CAB (P<0.001), elective hip replacement (P<0.001) and laminectomy with implant (since 2013) (P=0.009).

Conversely, a significant increase in infection rates was once again seen in rectal surgery (P<0.001) and Caesarean section (P=0.002). Infection rates remained stable for cholecystectomy, hysterectomy, elective knee replacement and laminectomy without an implant.

Considering only the last two years for rectal surgery, there was an increase in the crude infection rate (20.7%) compared to the previous period (14.6%), not reaching statistical significance (P=0.07). However, surgical cases during the surveillance period of this report are at greater risk, as the proportion of cases with an NHSN/NNIS risk index ≥2 is significantly higher than in the previous period (P=0.034).

For Caesarean sections, a significant decrease in the crude infection rate was observed, compared to the previous monitoring period (1.8% vs 2.4%; P=0.02) despite an overall upward trend since 2011. This could be an early sign of stabilisation.

In summary, when stratifying by type of surgery, a significant decrease was observed for:

- Elective hip replacement (organ/space SSI) 0.6% vs 0.8% (P=0.03)
- Caesarean section (combined deep and organ/space SSI) 0.5% vs 0.9% (P=0.02)

In contrast, a significant increase was observed for:

- Laminectomy without implant (deep and organ/space SSI combined) 1.0% vs 0.4% (P=0.04)

No significant changes in SSI rates occurred for the other surgical procedures. The proportion of patients undergoing laparoscopic procedures increased for colon surgery (P=0.007), as did the proportion of minimally invasive techniques used for elective hip replacement (P<0.001).

Finally, the proportion of patients receiving antibiotic prophylaxis within one hour before incision increased significantly for colon surgery (contamination class II, 79.9%, P=0.01) and elective knee replacement (contamination class I, 86.5%, P=0.001). For Caesarean sections, the proportion of patients receiving antibiotic prophylaxis before skin incision (as currently recommended) was

significantly lower (71.5%, P<0.001), while the proportion receiving it during surgery after umbilical cord clamping was significantly higher (15.8%, P<0.001).

Compared with previous international data, Swiss infection rates for the procedures recorded seem higher at first glance. However, such comparisons are only possible to a limited extent on account of differences in methodology, including definitions, case inclusion criteria and post-discharge follow-up, as well as uncertainties regarding the validity of internationally collected data. In no other country is post-discharge monitoring as thorough as in Switzerland. In addition, the quality of data recording is regularly reviewed for hospitals and clinics in this country. This validation process (not performed in all systems) promotes good case detection and contributes to the quality of the data produced. In this regard, a recently published study based on Swissnoso data shows a correlation between the quality of surveillance and infection rates: institutions with the lowest infection rates have the lowest quality of surveillance (1). This suggests that the quality of surveillance, as assessed by the Swissnoso audits, should be considered a factor to be included in the adjusted analyses to enable comparisons between hospitals and clinics.

3.3 Surveillance of acute COVID-19 nosocomial cases

The COVID-19 Hospital-Based Surveillance system (CH-SUR) was established on the basis of the pilot surveillance system for influenza in Swiss hospitals launched in 2018. By 1 March 2020, four days after the first confirmed COVID-19 case was reported in Switzerland, the system was modified for COVID-19 and ready to register hospitalisations related to laboratory-confirmed SARS-CoV-2 infection. Twenty-one hospitals actively participated, including most cantonal and university hospitals, covering a large proportion of hospitalised paediatric and adult patients throughout Switzerland.

CH-SUR collects data on patients hospitalised with a SARS-CoV-2 infection for more than 24 hours, including nosocomial SARS-CoV-2 infections. A case is classified as nosocomial when the patient tests positive for SARS-CoV-2 five or more days after being admitted to hospital for non-COVID-related reasons. Confirmation of infection is a positive PCR (polymerase chain reaction) test or a positive rapid antigen test, or clinical and radiological (CT-scan) evidence of COVID-19. CH-SUR also registers whether the patient dies as a result of COVID-19 during hospitalisation.

From 1 October 2020 to 30 September 2021, CH-SUR recorded 18,901 COVID-19 cases (German-speaking Switzerland: 10,258, 54.3%; Latin-speaking Switzerland: 8,643, 45.7%), of which 2,593 (13.7%) were nosocomial (German-speaking Switzerland: 991; Latin-speaking Switzerland: 1,602) (Figure 5).

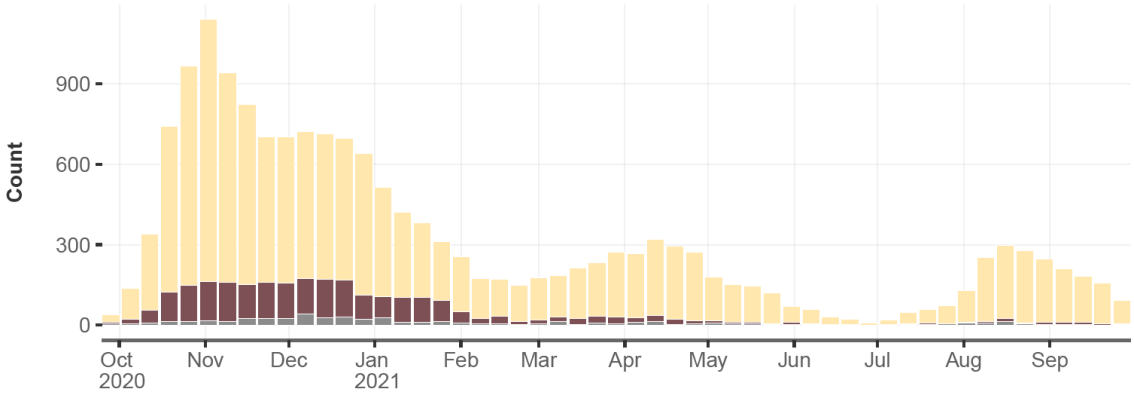


Figure 5: Absolute number of COVID-19 cases recorded by CH-SUR from 1 October 2020 to 30 September 2021, by week of the first hospitalisation. Case classification (infection source): community-acquired cases: yellow; nosocomial cases: brown.

Of these 2,593 cases, 1,238 (47.7%) were female; 20 (0.8%) were under 20 years of age, 320 (12.3%) were between 20 and 59, and 2,253 (86.9%) were 60 or older.

The diagnosis of COVID-19 was confirmed by RT-PCR in 2,481 patients (95.7%), mainly from nasopharyngeal specimens (n=2,430, 93.7%). These patients were hospitalised primarily in a medical (Switzerland: n=1,208, 46.6%; German-speaking Switzerland: n=665, 55%; Latin-speaking Switzerland: n=543, 45%), geriatric (Switzerland: n=461, 17.8%; German-speaking Switzerland: n=44, 10%; Latin-speaking Switzerland: n=417, 90%) or surgical ward (Switzerland: n=310, 12.0%; German-speaking Switzerland: n=125, 40%; Latin-speaking Switzerland: n=185, 60%).

Most of these patients (n=2,413, 93.1%) had at least one co-morbidity, with the following conditions predominating: hypertension (n=1,535, 59.2%), cardiovascular disease (n=1,263, 48.7%), renal disease (n=729, 28.1%), diabetes (n=681, 26.3%), neurological disease (n=655, 25.3%), dementia (n=620, 23.9%), cancer (n=554, 21.4%), respiratory disease (n=516, 19.9%) and obesity (n=446, 17.2%).

Between 23 December 2020 – the date of introduction of COVID-19 vaccines in Switzerland – and 30 September 2021, 1,078 nosocomial cases were recorded in CH-SUR. Of these patients, 57 (5.3%) had received two doses and 49 (4.5%) one dose of vaccine, while 784 (72.7%) were unvaccinated, and 188 (17.4%) had an unknown vaccination status.

Treatment of nosocomial cases included corticosteroids for COVID-19 (661, 25.5%) or COVID-related complications (430, 16.6%) and antiviral therapy (311, 12.0%). Antibiotic or antifungal treatment was prescribed in 35.3% and 2.4% of cases, respectively.

The most common post-acute symptoms of nosocomial COVID-19 were classified as pulmonary (1,277, 49.2%) – with 880 cases of viral pneumonia (33.9%) – renal (377, 14.5%) or cardiovascular (364, 14.0%). A fatigue syndrome was observed in 509 cases (19.6%).

Nosocomial COVID-19 required an intermediate care unit (IMC) stay in 222 cases (8.6%) and/or an ICU stay in 313 cases (12.1%). Of these, 313 received non-invasive ventilation, 141 intubation and 7 extracorporeal membrane oxygenation (ECMO).

The destination after discharge was known for 2,488 nosocomial COVID-19 patients (95.9%): 1,730 (66.7%) were discharged either home (859, 33.1%), to a long-term care facility (572, 22.1%) or to a rehabilitation centre (228, 8.8%); 146 patients (5.6%) were transferred to another hospital; 612 (23.6%) died either in hospital (n=562, 21.7%) or after leaving the hospital (n=50, 1.9%); of these deaths, 428 (69.9%) were related to COVID-19. This mortality rate was higher than among the 15,807 community-acquired COVID-19 cases, of which 1,760 (11.1%) died either in hospital (n=1684) or after discharge (n=76).

	CH-SUR 2593	
Outcome	**n**	**%**
Discharged	1730	66.7
Home	859	33.1
LTC facility	572	22.1
Rehabilitation	228	8.8
Incomplete data	71	2.7
Transferred to another hospital	146	5.6
Transfer outside CH-SUR	123	4.7
Transfer within CH-SUR	19	0.7
Incomplete data	4	0.2
Death	612	23.6
Died in hospital	562	21.7
Died after discharge	50	1.9
Incomplete data	105	4.0
Death due to COVID	428	16.5

Table 2: Outcome of nosocomial COVID-19 cases.

4. Update on the progress of planned surveillance modules

4.1 CAUTI surveillance

From 2015 to 2018, Patient Safety Switzerland and Swissnoso conducted a pilot programme, commissioned by the FOPH, entitled "progress! Urinary catheter safety". This involved surveillance of infectious and non-infectious complications of urinary catheterisation. The results of the pilot programme were summarised in the previous Swissnoso report on the epidemiology of HAIs. In 2021, based on the experience with this programme, Swissnoso established the CAUTI surveillance module[5], which will be available to all Swiss acute care hospitals from January 2022. An invitation to participate in the module was sent to all 156 Swiss acute care hospitals at the end of June 2021.

The module is used to monitor symptomatic catheter-associated urinary tract infections and catheter use as an indicator of the frequency of CAUTI and non-infectious complications of urinary catheterisation. Optionally, hospitals may also record the indication for urinary catheterisation. The first hospital-specific results will be made available to participating hospitals at the end of April 2022, in the first quarterly feedback. The general annual report based on the anonymised data from all participating hospitals is planned for spring 2023.

4.2 CLABSI surveillance

Around 10% of all nosocomial infections are bloodstream infections. Compared to SSI, nosocomial bloodstream infections are less frequent, but mortality is comparatively high (10 – 40%). In 2019, Swissnoso decided to prioritise this surveillance module, which offers the greatest potential to avoid infections (most commonly associated with central venous catheters). However, due to the pandemic, module development had to be delayed. In September 2020, a first informal meeting was held between the coordinating centre (Geneva) and the IPC representatives of the four other Swiss university hospitals (Basel, Bern, Lausanne, and Zurich). All participants agreed on the main elements of the development and organisation of the national surveillance system.

Currently, less than one-third (28%) of hospitals use surveillance systems for central line-associated bloodstream infections (CLABSI) in Switzerland (2). Fully automated surveillance systems in Switzerland are based only on initiatives by individual hospitals. Following meetings between the university hospitals (June and September 2021), Swissnoso and the FOPH, as well as European initiatives (PRAISE group) (3), a pilot study has been launched, aiming to develop a fully automated system for monitoring intravascular catheter infections.

This *feasibility study* will focus on an intensive care unit (ICU) setting and central-line venous catheters (CVC). At the time of writing, the first phase is ongoing: this involves the

[5] https://www.swissnoso.ch/module/cauti-surveillance/ueber-cauti-surveillance/das-modul

implementation of a development module by the lead institution in Geneva (HUG). An automated CLABSI (possibly intravascular catheter-related bloodstream infection [CRBSI]) detection algorithm is to be established (scoping review and meta-analysis) and validated (preliminary automated algorithm already implemented at the Geneva University Hospital), which can then be used in other Swiss hospitals. Preliminary results of a systematic literature review showed that, to date, only a few centres have implemented automated systems for CRBSI/CLABSI surveillance (Table 3).

Authors, year	Country	Study setting	Sensitivity	Specificity
Trick *et al.*, 2004	US	Two centres, inpatients	100%	56%
Woeltje *et al.*, 2008	US	Single centre, 6 ICUs	97%	44%
Blacky *et al.*, 2011	Austria	Single centre, 2 ICUs	90%	100%
Woeltje *et al.*, 2011	US	Single centre, 4 non-ICU wards	95%	97%
De Bruin *et al.*, 2012	Austria	Single centre, 2 ICUs	N/A	N/A
Venable *et al.*, 2013	US	Single centre, burn unit, ICUs	100%	95%
Kaiser *et al.*, 2014	Netherlands	Single centre, 1 ICU	91%	100%
Tseng *et al.*, 2015	Taiwan	Single centre: inpatients	98%	99%
Ridgway *et al.*, 2016	US	Four centres, inpatients	89%	99%
Beeler *et al.*, 2018	US	Single centre, inpatients	N/A	N/A

Table 3: Preliminary results of a systematic review of studies investigating automated CLABSI monitoring. [Confidential/courtesy of N. Buetti & N. Lotfinejad, Geneva].

Most of these studies were single-centre and conducted in high-income countries. Interestingly, the algorithms developed mostly focused on CLABSI (i.e. a less accurate definition, considering a positive blood culture in a patient with a central-line catheter in place and no other source of bacteraemia except the catheter) and disregarded CRBSI, which is usually considered the gold standard for diagnosing intravascular catheter infections.

The pilot study, which will be implemented in 2022, will have the following objectives/milestones:

- Systematic review (scoping review and meta-analysis) on automatic surveillance approaches.
- Development of an algorithm for automated detection of hospital-acquired bloodstream infection (HABSI) with a strong focus on CLABSI.
- Internal validation of the algorithm using data from manual prospective surveillance.

- Development of a minimum dataset for the participating pilot hospitals.
- Initiation of data collection in the participating pilot hospitals.

Several challenges must be considered in the development of this pilot study: i) establishment of the definition of true infection versus potential contamination; ii) assessment of multiple infections in a single patient; iii) automated differentiation between catheter-associated and non-catheter-associated bloodstream infections (i.e. other sources of infection); iv) automated differentiation between catheter-related and catheter-associated bloodstream infections; v) heterogeneity in data collection across multiple hospitals with different electronic medical record systems and different electronic resources; vi) internal and external validation of automated surveillance.

In a further step, a surveillance module will be developed for the non-ICU setting and for non-CVC. As a second phase, a national rollout is planned, based on the knowledge acquired during the pilot study.

4.3 VAP surveillance

Currently, no national VAP surveillance programme exists in Switzerland. The diagnostic criteria are ill-defined, making this surveillance module a diagnostic challenge. A survey evaluating existing and desired measures for monitoring, prevention and control of HAIs in Swiss hospitals revealed that only 15 of 94 participating hospitals (16%) currently perform VAP surveillance (2).

While seven of these hospitals followed the Robert Koch Institute Krankenhaus-Infektions-Surveillance-System (RKI-KISS) guidelines, three followed CDC guidelines, and one followed ECDC guidelines. Four hospitals reported following their own VAP definitions for in-house surveillance. Thus, no standard definition of VAP is used in the few hospitals that conduct surveillance (Figure 6).

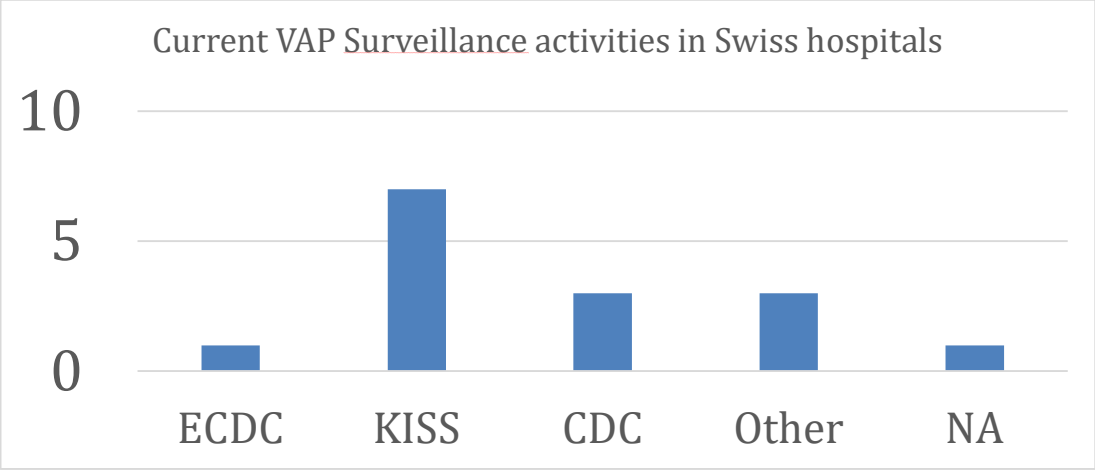


Figure 6: Current VAP surveillance activities in Swiss hospitals (15/94), adapted from (2)

The first single-centre outcome data are available from Bern University Hospital, which developed a CDC-adapted protocol for automated detection of ventilator-associated events (VAEs) (4). This tool allowed retrospective determination of yearly VAE incidence in a single large hospital over eight years. The results showed a significant decrease in the yearly incidence at a rate ratio of 0.96 (95% CI, 0.93–1.00, p = 0.03, Figure 7).

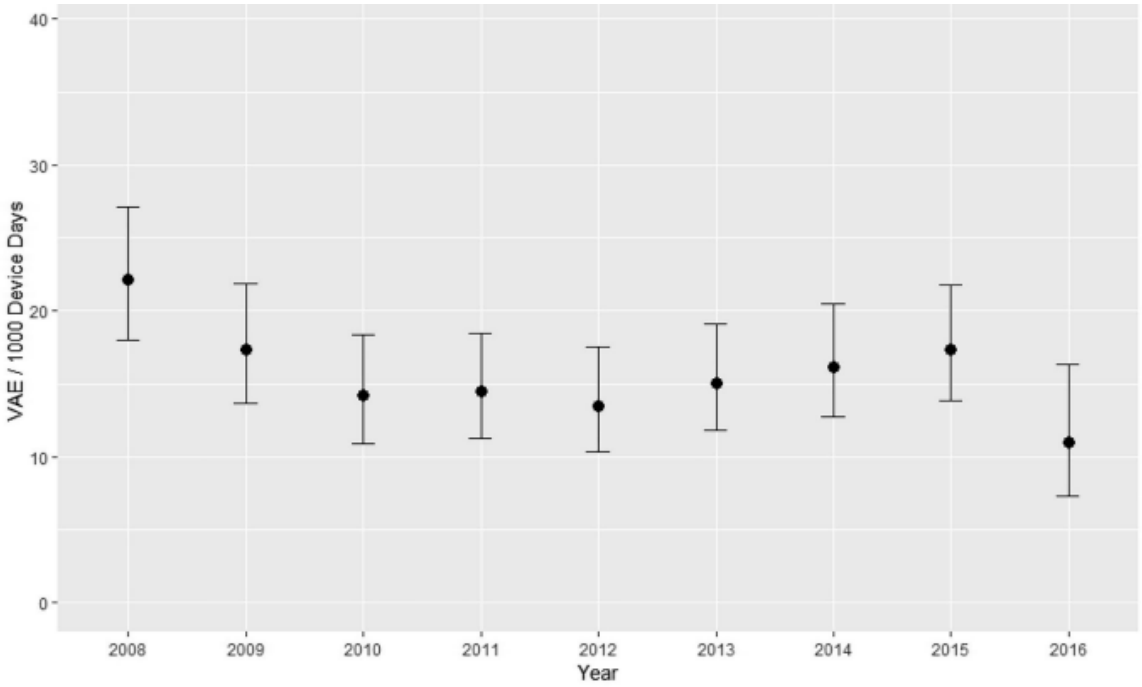


Figure 7: Incidence of ventilator-associated events at Bern University Hospital between 2008 and 2016 (4).

The next steps include establishing a project group involving Swissnoso and the Society for Intensive Care Medicine (SGI-SSMI). Potential milestones towards a national VAP surveillance system are:

- Examine possibilities to build on the "minimum dataset", based on the one already delivered to the SGI-SSMI by all ICUs in Switzerland.
- Establish and approve a VAP definition.
- Develop candidate classification algorithms.
- Set up a proposal for the pilot/feasibility study.

4.4 nvHAP surveillance

Currently, no national surveillance programme for non-ventilator-associated hospital-acquired pneumonia (nvHAP) exists in Switzerland. Traditionally, infection prevention and control efforts focus on device- and procedure-related infections. However, nvHAP is one of the most common HAIs, with mortality rates and costs similar to VAP (5-8).

NvHAP can affect virtually any hospitalised patient (except those currently on invasive respiratory devices), making continuous manual incidence surveillance impossible. Since 2017, the University Hospital Zurich (USZ) has been conducting semi-automated nvHAP surveillance. A computerised algorithm selects patients with potential nvHAP, followed by manual surveillance on this subset of patients. The USZ semi-automated surveillance was validated against full manual surveillance in (among others) a cohort of patients with a diagnostic code of nosocomial pneumonia at discharge. In this cohort, the semi-automated surveillance had a sensitivity of 97.5% (CI: 93.7–99.3%) (9).

The establishment of a national nvHAP surveillance system would be the cornerstone of a future initiative to prevent nvHAP, one of the most common and relevant HAIs in both larger and smaller hospitals. A pilot study is currently in the planning stage. The objectives of this pilot study are expected:

- To further specify the ECDC nvHAP surveillance definition and align and design training material for nvHAP surveillance.
- To develop classification algorithms and evaluate their sensitivity and positive predictive value.
- To implement semi-automated surveillance in pilot hospitals and to generate/evaluate:
  - data on nvHAP incidence and incidence rate
  - time investment for implementation of the algorithm and manual surveillance
  - barriers and facilitators of implementation of the algorithm
  - inter-observer agreement in nvHAP surveillance.

5. Process monitoring data

5.1 Clean Care Monitor

To monitor infection prevention processes, Swissnoso provides *Clean Care Monitor (CCM)*, an electronic application that allows data collection on adherence to infection prevention processes. The application allows direct feedback to healthcare workers and monitoring with benchmarking. The *CleanHands* module monitors hand hygiene processes. In contrast, the *CCM-SSI* module monitors adherence to preoperative procedures to prevent surgical site infections.

5.2 CleanHands programme[6]

The application *CleanHands* allows simple electronic recording and automated analysis of hand hygiene adherence and immediate feedback on the results. The *CleanHands* concept is based on the "My 5 Moments for Hand Hygiene" approach (developed by the WHO), but it also allows data collection according to a "four-moment" model and in a context where gloves are used. Further details on the application and its possible use in healthcare facilities are published on the Swissnoso website.

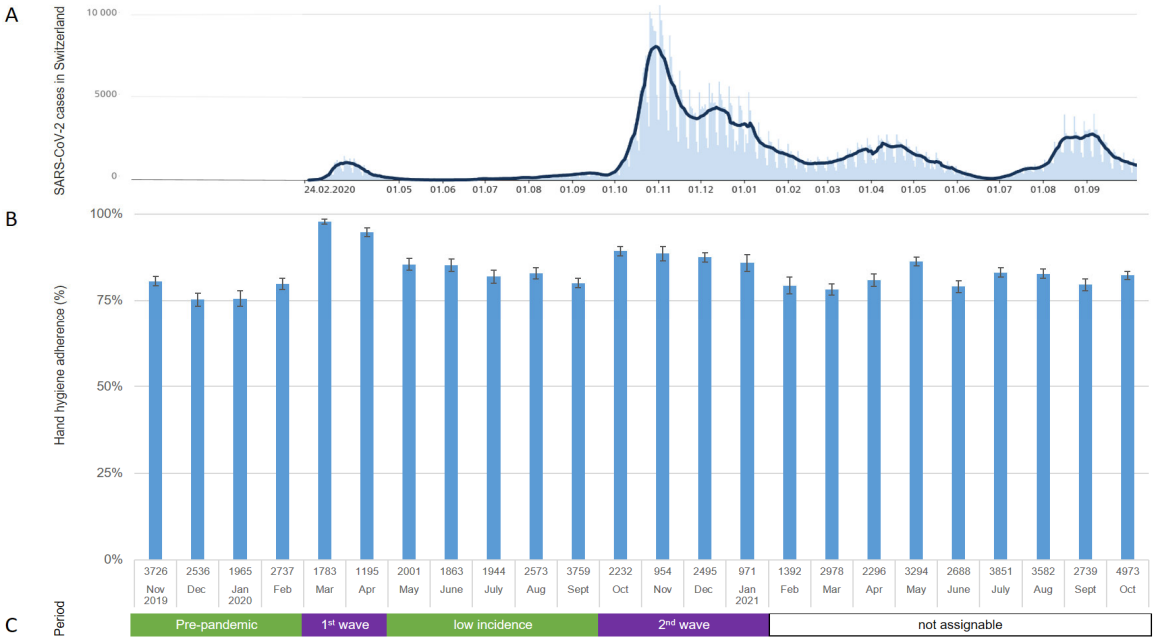
In 2021, *CleanHands* was used in many hospitals, and more widely than in the previous year. Overall adherence did not change over the past two years and did not differ between smaller and larger hospitals:

	2020		2021	
	n	Adherence	n	Adherence
Four moments				
Hospitals <200 beds	868	76%	3,184	77%
Hospitals 200–500 beds	2,443	79%	4,642	79%
Hospitals >500 beds	381	80%	1,759	80%
Overall	**3,692**	**78%**	**9,585**	**78%**
Five moments				
Hospitals <200 beds	10,404	82%	23,074	81%
Hospitals 200–500 beds	9,536	82%	15,532	80%
Hospitals >500 beds	13,658	87%	12,921	79%
Overall	**33,598**	**84%**	**51,527**	**80%**

Table 4: Adherence to four vs five moments of hand hygiene. Number of observations (n) and adherence to the four vs five moments of hand hygiene during the last two years, stratified by hospital size.

During the SARS-CoV-2 waves in Switzerland, adherence increased under stressful circumstances and with reduced staff capacities, and between the waves it declined to the pre-pandemic mean level (Figure 8).

[6] https://www.swissnoso.ch/module/ccm-cleanhands/ccm-cleanhands/das-modul



S. Rüfenacht, P. Kohler, R. Kuhn, D. Flury, A. Widmer, M. Schlegel and Swissnoso, Increased hand hygiene adherence in hospitals during high SARS-CoV-2 activity – data from a Swiss national surveillance system, Abstract accepted at the European Congress of Clinical Microbiology & Infectious Diseases, 2022.

Figure 8: A) Absolute numbers of laboratory-confirmed SARS-CoV-2 cases in Switzerland (as of 18 November 2021). **B)** Hand hygiene adherence according to the WHO 5 moments approach from November 2019 to October 2021. The numbers of opportunities observed are indicated below the bars. **C)** Definitions of the various periods: pre-pandemic and low incidence period in green, first and second SARS-CoV-2 pandemic waves in purple. The white bar shows the "not assignable" period from February 2021 to October 2021.

6. Multidrug-resistant organisms in HAIs

6.1 Introduction

The burden of antimicrobial resistance (AMR) in HAIs in Switzerland is unclear. Surveillance of infections with multidrug-resistant organisms (MDROs) is one of the key measures policymakers can implement to combat AMR (10). Yet Switzerland (unlike Germany, for example) does not continuously and systematically collect relevant data on AMR and HAIs. The epidemiology of HAIs associated with MDROs is therefore largely unknown. Moreover, Switzerland does not yet have a uniformly accepted definition of Gram-negative multidrug-resistant pathogens for surveillance purposes. Barnsteiner et al. (11) recently evaluated temporal trends of AMR infections in patients hospitalised in Swiss intensive care units over the past decade. Among 34,887 bacterial isolates sent to the Swiss Centre for Antibiotic Resistance (ANRESIS), they found a decline in the proportion of MRSA infections, whereas the proportion of infections due to extended-spectrum cephalosporin-resistant and carbapenem-resistant pathogens had increased. However, not all pathogens represented actual infections, nor were all of these infections truly healthcare-associated. ANRESIS was not set up to strictly stratify healthcare-associated vs community-acquired AMR.

6.2 Swissnoso survey on VRE epidemiology and guideline adherence in Swiss acute care hospitals

Strengthening the implementation of infection prevention and control (IPC) measures is also crucial for preventing AMR and HAIs related to AMR. Our pilot study evaluated adherence to national vancomycin-resistant enterococci (VRE) control guidelines and the potential impact on VRE epidemiology in Swiss acute care hospitals (12). In March 2020, Swissnoso distributed a survey to all Swiss acute care hospitals. It was designed to investigate the level of adherence, as well as changes in IPC strategies in the years following the publication of the national guidelines (2018 and 2019), and to assess VRE surveillance and outbreaks. Ninety-seven of 146 health professionals responded (66%), representing 81.6% of all acute care beds in Switzerland in 2019. Of the 81 IPC professional respondents, 72 (88%) indicated that they had fully or largely adopted the Swissnoso guidelines in their institutions, with no significant difference related to hospital size.

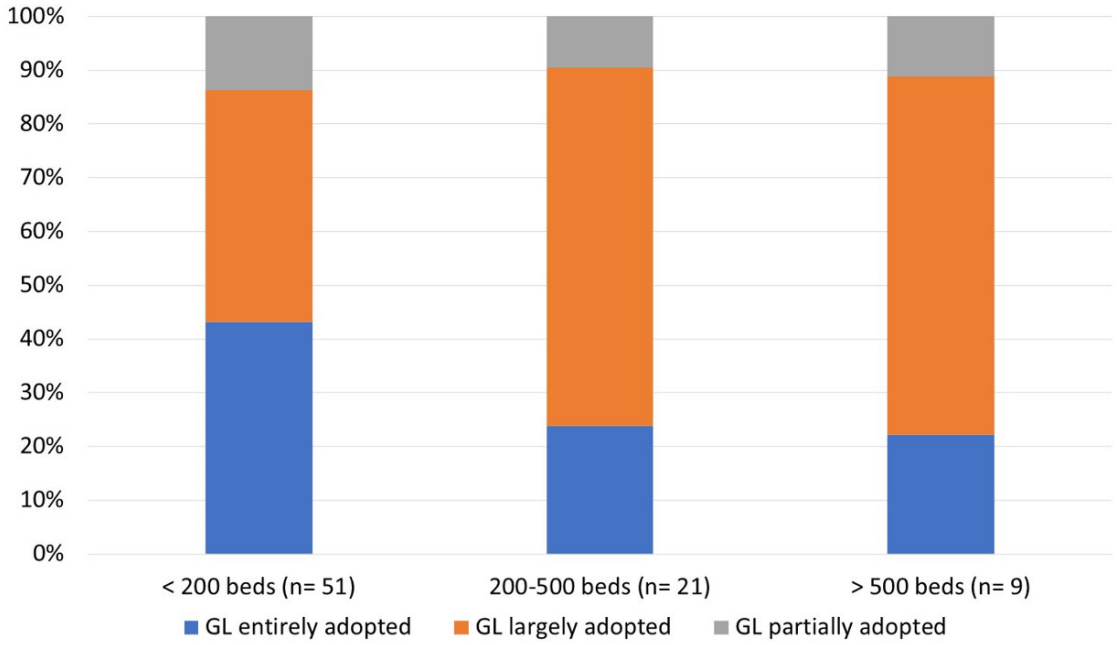


Figure 9: Self-reported compliance with Swissnoso guidelines (GL) by hospital size.

Medium-sized hospitals and hospitals that had already encountered VRE cases were found to be significantly more likely to have recently changed their VRE management.

	VRE control measures intensified	***p*-value**
Small hospitals (<200 beds) (n=57)	33 (57.9%)	0.225
Medium-sized hospitals (200–500 beds) (n=23)	18 (78.3%)	
Large hospitals (>500 beds) (n=9)	6 (66.7%)	
Have never detected any VRE cases (n=38)	19 (50%)	**0.017**
Have already detected VRE cases (n=51)	38 (74.5%)	

Table 5: Enhancement of VRE infection control measures since 2018 according to hospital size and experience with VRE cases. A p-value of <0.05 was considered statistically relevant (12).

Fifty-two hospitals (54%) reported 569 new VRE cases, including 14 bacteraemias, in 2018 and 472 new cases, with 10 bacteraemias, in 2019. The proportion of VRE bacteraemia thus remained low in both years, with 14 (2.5%) in 2018 and 10 (2.1%) in 2019. We saw a significant decrease in VRE cases in large hospitals responsible for the main VRE burden. On the other hand, we observed an increase in VRE cases detected in smaller hospitals.

Wide adoption of the VRE control guidelines, which were developed following the VRE outbreak in Bern, seemed to have positive effects on VRE containment in Swiss acute care hospitals over two years, even if their long-term impact on VRE epidemiology remains to be evaluated. Likewise, the future monitoring of adherence to IPC guidelines remains to be determined. This work could serve as an example of a rational approach to assessing IPC compliance that may also be applied to other MDROs.

6.3 Outbreaks with MDROs in Swiss hospitals

While there is no formal outbreak registry in Switzerland, between September and December 2020 a sizeable cantonal hospital in the east of Switzerland reported an outbreak consisting of two almost simultaneous clusters of carbapenem-resistant *Acinetobacter baumannii* complex (CRABC) infection in a medical and surgical ICU setting. Seven of the ten patients affected were COVID-19 positive. The index patients had been repatriated from the Balkans. A literature review showed other outbreaks, mainly with CRAB and *Candida auris,* across the globe during the COVID-19 pandemic (13). Risk factors associated with the outbreaks were reduced compliance with IPC measures and general hand hygiene, increased antibiotic use in COVID-19 patients, and "overcrowding" of patients, particularly in high-risk settings with a lack of specialised staff. Global reports also showed reduced MDRO screening, which has not been explicitly reported in Switzerland. However, the reported outbreak shows the strain put on the hospitals, their ICU settings, and the importance of maintaining high standards with IPC measures.

Screening of patients at risk for carriage of AMR bacteria remains at the discretion of the hospitals, but Swissnoso guidelines were followed by most acute care hospitals.

7. Further Swissnoso activities to reduce HAIs

7.1 Minimum standards for the prevention of HAIs in acute care hospitals in Switzerland

The "Structural minimum requirements for the prevention and control of healthcare-associated infections in Swiss acute hospitals"[7] were developed by a working group under the leadership of Swissnoso, with the involvement of the professional societies concerned (SGSH, SSI, SIPI and fibs). They are based on scientific evidence and on ECDC and WHO recommendations. The first version of this document was published in January 2021.

The FOPH, the GDK and H+ recognise the importance of these national minimum requirements and recommend that they be implemented by the cantons and hospitals. The 1st National Symposium on "Structural minimum requirements for successful prevention and control of healthcare-associated infections" took place in August 2021. Participating in this online event were more than 180 interested persons responsible for the topic from the cantonal health directorates as well as hospitals and clinics. The aim of the event was to discuss unresolved questions regarding the structural minimum requirements and to promote their implementation.

In the coming months, all the actors involved (the FOPH, cantons, hospitals and professional societies) will continue discussions with the three key target groups – cantonal authorities, hospital managements and hospital hygiene teams – to clarify the following questions:

- How binding will these requirements be?
- How can these minimum requirements be embedded institutionally in a hospital?
- What tools are desired and will be made available to hospitals for implementation?
- How will implementation be evaluated, and who will be responsible?

7.2 COVID-19 pandemic

In January 2020, Swissnoso published its first management guidelines for COVID-19 patients in acute care hospitals. By the time the present report was finalised, in February 2022, 39 different recommendations had been published, mostly on infection prevention and control measures for patients and healthcare workers, with more specific advice concerning children, pregnant healthcare workers, visitor management and diagnostic aids. Decision aids on dealing with elective surgery in COVID-19 patients were published in collaboration with the Swiss Society for Anaesthesiology. During the influenza season, standard guidelines addressing both viral diseases were produced. With the arrival of new variants, Swissnoso responded promptly with updated position papers providing appropriate guidance for acute care hospitals. Online conferences

[7] https://www.swissnoso.ch/forschung-entwicklung/strukturelle-mindestanfoderungen-hai

were held with the FOPH on an almost weekly basis. Overall, the excellent collaboration between Swissnoso and the FOPH, as well as many other partners such as FMH, helped to minimise the impact of the pandemic on the healthcare system in Switzerland.

7.3 Market survey[8]

Under the FOPH mandate for developing and operating a national HAI surveillance system, Swissnoso developed a survey to explore the feasibility of expanding the existing Swiss HAI surveillance system to Swiss acute care hospitals (2).

An online survey was sent to all Swiss acute care hospitals at the end of June 2020. Local IPC professionals were asked to respond on behalf of their institution to several questions regarding the structure and organisation of IPC programs, current prevention measures, electronic medical record (EMR) capabilities, and the ability and willingness to establish and participate in proposed new surveillance modules. Responses were collected up to the end of August 2020.

Ninety-four of 156 hospitals/networks responded to the survey; of the 84 hospitals reporting the number of acute care beds, 61 (73%) were small (<200 beds), 15 (19%) were medium-sized (200–650 beds), and 7 (8%) were large (>650 beds). Seventeen hospitals out of 94 (18%) did not have an EMR system but were planning to introduce one in the near future, while eight small hospitals (9%) did not have an EMR and were not planning to use one (Figure 10).

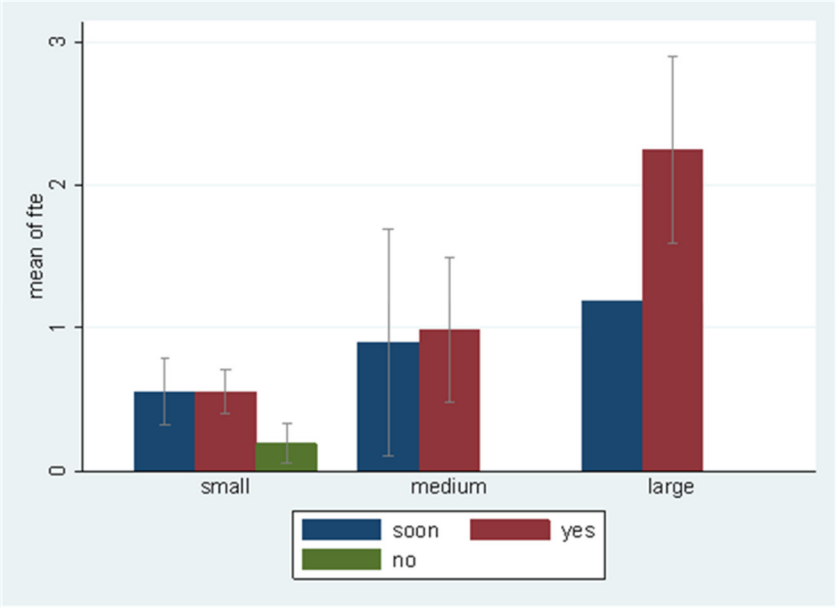


Figure 10: Mean full-time equivalents (FTE) dedicated to HAI surveillance, by hospital size and electronic medical record (EMR) availability (2). Hospital size: small (<200 beds), medium-sized (200–650 beds), large (>650 beds). EMR availability: soon: not yet but soon to be available; yes: EMR in use in the hospital; no: EMR not available in the hospital.

[8] https://smw.ch/article/doi/smw.2021.20516

Thirty different EMR systems were in use in the various participating hospitals. Surveillance for central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), and ventilator-associated pneumonia (VAP) had already been implemented in 26 (16.6%), 15 (9.6%), and 15 (9.6%) of the participating hospitals, respectively. Thirty hospitals (36%) agreed to participate in the pilot phase of the surveillance system; of these, 15 indicated that they wished to be part of the pilot hospital network, 6 provided hospital-level surveillance denominators (such as catheter-days and patient-days) to calculate the incidence rate, and 8 did both (Figure 11).

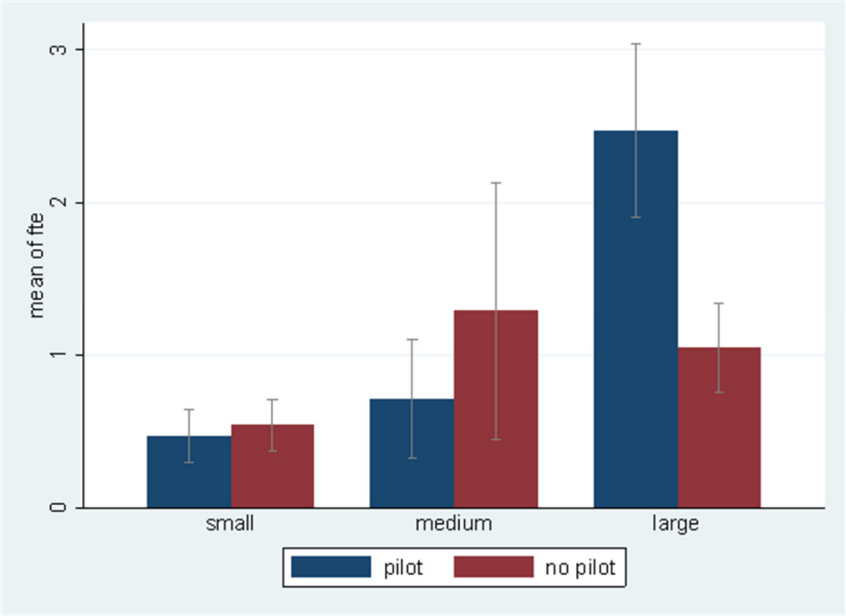


Figure 11: Mean full-time equivalents (FTE) dedicated to HAI surveillance, by hospital size and willingness to participate as a pilot hospital in a national surveillance network (2). Hospital size: small (<200 beds), medium-sized (200–650 beds), large (>650 beds).

This survey provided essential baseline information on the hospitals' IPC structure and process indicators, as well as their surveillance capabilities. Electronic health records and human resources dedicated to surveillance are critical elements of a successful surveillance system. The survey sought to summarise important information on the key IPC strategies of acute care hospitals in Switzerland, with a view to expanding existing surveillance activities.

7.4 Review of registries

To increase the spectrum of HAI surveillance options, Swissnoso screened a total of 116 – primarily national but also international – registries on different types of diseases. Besides known Swissnoso surveillance programmes (e.g. concerning SSI and national COVID-19 nosocomial cases), 18 registries are likely to deliver outcome data on HAI (including several transplant and surgical registries), while another 10 registries may or may not provide HAI outcome data. To further develop national HAI surveillance, Swissnoso aims to contact the various registry operators to potentially improve HAI outcome data and explore collaborations in cases of overlapping interests.

8. Experience from university/large cantonal hospitals

8.1 Experience from hospitals

Large university hospitals, cantonal hospitals, and middle-sized and smaller hospitals faced challenges, having to continuously adapt their SARS-CoV-2 guidelines according to local epidemiological conditions and national and local regulations, given the emergence of new variants, vaccinations and therapeutic options. Furthermore, hospitals had to provide training on PPE for healthcare workers in cohort wards. In view of the intermittently high workload in ICU settings and COVID-19 cohort wards, the challenges for hospitals included seeking to maintain high standards of general IPC measures and surveillance of HAIs.

Notably, almost no cases of influenza were recorded in Swiss hospitals during the period of ongoing SARS-CoV-2 control measures. This highlights the importance of protective measures such as universal mask-wearing and visitor restrictions in preventing nosocomial transmission of respiratory viruses.

8.2 HAIs during the COVID-19 pandemic

A nationwide surveillance study on blood culture results in ICU patients in 52 Swiss hospitals – covering the period from the start of the first wave of the COVID-19 pandemic in March 2020 until after the second wave in May 2021 – showed an increase in blood culture contaminations as well as actual bloodstream infections compared to the period between the two waves (14). These findings were attributed to multiple factors, including increased ICU occupancy and emergency staffing of ICUs by less experienced personnel.

9. Conclusions and outlook

Outcome data from the long-running SSI surveillance module and the PPS showed no overall change in HAI rates compared to previous years, which is in line with reports from the CDC (15).

What needs to be highlighted is the high proportion of nosocomial infection among hospitalised patients with COVID-19 (up to 15%), especially in Q4 2020 before effective vaccination became available. This clearly showed the limits imposed by a pandemic on an otherwise very well developed and functioning IPC landscape in Swiss hospitals. Swissnoso is participating in the ongoing revision of the Epidemics Act to better manage this type of crisis.

More recent surveillance programmes, though not yet fully implemented, saw further progress. CAUTI will provide its first outcome data to participating hospitals in spring 2022. For CLABSI, VAP and nvHAP, feasibility studies have either been started or are at the planning stage.

Data from a market survey analysis provided insights into the heterogeneity of surveillance measures in Swiss acute care hospitals. Despite the current lack of national surveillance systems, between 10% and 17% of hospitals reported already performing surveillance for CAUTI, CLABSI, VAP and nvHAP. Large hospitals welcomed the idea of participating in pilot studies. However, a remarkable degree of diversity and, in some cases, the absence of electronic patient records showed how difficult nationwide data collection might be.

Collaboration with other existing national registries may provide a valuable additional tool for HAI screening and monitoring in the future.

As regards adherence to national guidelines on IPC measures, a national survey on compliance with new VRE guidelines revealed a change in practice primarily in hospitals already affected by VRE outbreaks. New VRE cases mainly occurred in smaller hospitals. Overall, the adoption of VRE guidelines also seemed to show positive effects on IPC. Therefore, continued surveillance remains crucial and should be applied to all MDROs.

Swissnoso also provided rapid response by delivering guidance on the management of patients and healthcare workers with regard to COVID-19.

Importantly, the implementation of structural minimum requirements for acute care hospitals nationwide showed substantial progress.

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