swissnoso

Nationales Zentrum für Infektionsprävention
Centre national de prévention des infections
Centro nazionale per la prevenzione delle infezioni
National Center for Infection Control

# First report of Swissnoso on the epidemiology of healthcare-associated infections in Switzerland since 2017

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## Executive summary

Since the start of NOSO Strategy activities in 2017, Swissnoso has been conducting and expanding a comprehensive programme focusing on the surveillance and prevention of healthcare-associated infections (HAIs).

According to repeated national point prevalence surveys, HAI prevalence lies between 5.4% and 5.9%, which places Switzerland to European average. These surveys also showed that, compared to neighbouring countries, the proportion of HAIs in Switzerland caused by multi-drug resistant organisms (MDROs) remains low. Of a total of 257 HAI-causative Enterobacterales recorded in 2017, 59 (23.0%; 95% CI 17.8–28.1%) had reduced susceptibility to third-generation cephalosporins, and 5 (1.9%; 95% CI 0.2–3.6%) were resistant to carbapenems; of the 44 *Pseudomonas aeruginosa* isolates, 5 (11.4%; 95% CI 1.6–21.1%) were resistant to carbapenems. Of the 100 *Staphylococcus aureus* isolates, 11 (11.0%; 95% CI 4.8–17.2%) were resistant to methicillin; 2 (2.2%; 95% CI 0.0–5.3%) of the 90 enterococci isolates (*E. faecium* and *E. faecalis*) were resistant to vancomycin.

Continuous surveillance of surgical site infections (SSI) for selected operative procedures in 178 hospitals shows a significant long-term reduction of infection rates (for all infection depths) in appendectomy (P<0.001, Cochran-Armitage test for trend), hernia surgery (P=0.009), gastric bypass surgery (P<0.001), colon surgery (P=0.029), laminectomy with implant (since 2013; P=0.006), elective hip joint replacement (P=0.006), heart surgery (all procedures; P=0.03) and coronary artery bypass surgery (P=0.03). Conversely, there was a significantly increasing trend of SSI rates in rectal surgery (P<0.001).

Compared with other countries, Swiss infection rates for the surgical procedures listed above 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.

Initial pilot studies show that process parameters may serve as a good surrogate marker for the potential future reduction of HAIs. In the “progress! Urinary catheter safety” study, designed to reduce urinary catheter use in hospitals, utilisation in the observed patient population decreased from 23.7% to 21.0% (p=0.001). As a result, non-infectious complications dropped significantly, from 0.79 to 0.56 events per 100 patient-days (p<0.001). Infectious complications of urinary catheterisation were from the beginning at a very low level (in 7 pilot hospitals) and could not be reduced further.

In a pilot intervention study in 8 hospitals aiming at implementing a national-wide SSI intervention module to improve local structure and process quality, compliance with three important preoperative procedures for SSI prevention (correct hair removal, skin disinfection and antimicrobial prophylaxis) increased significantly over a period of almost two years from 55% (CI 45–67%) to 78% (CI 65–92%). The impact of the intervention on SSI outcomes will be evaluated in 2020.

Recommendations for structural minimal standards for the prevention and control of HAI in acute care hospitals in Switzerland have been developed with the participation and consultation of further expert organisations. The recommendations include 7 key components

(guidelines/directives; material, equipment and ergonomics; organisation of infection control and staffing; training; audits/monitoring; surveillance/outbreaks; interventions). They have been sent for consultation to H+ and to the Conference of Cantonal Ministers of Public Health (GDK).

Based on a survey of inventory and HAI surveillance capacity in Swiss hospitals, requirements for the development of new modules for a national HAI surveillance system are currently being investigated.

Even though a reasonable overview of HAIs in Switzerland is already available, further comprehensive and continuous monitoring of the most important HAIs will be developed by Swissnoso over the next few years.

## Introduction

### *Aim of the report*

This first annual report summarises the current state of knowledge on the epidemiology of healthcare-associated infections (HAI) in Switzerland. It presents the HAI outcome data generated by Swissnoso since 2017 and provides an overview of the process parameters currently being recorded as surrogate markers for HAIs. It also summarises other Swissnoso activities offering insights into the epidemiology of HAIs in Switzerland.

### *Mandate for provision of external expertise*

On 29 August 2019, a framework agreement was signed between Swissnoso and the Federal Office of Public Health (FOPH) concerning the provision of support for tasks relating to HAI prevention and control.

Three key activities were defined:

i. providing expertise in the prevention and control of HAIs;
ii. establishing and operating a national surveillance system for HAIs in hospitals, in accordance with the legal framework and the objectives of the NOSO Strategy; and
iii. operating a centre of excellence for epidemiological investigations of regional and national outbreaks related to HAIs, multidrug-resistant organisms, and other emerging and potentially dangerous pathogens of public health concern, in accordance with the Epidemics Act (SR 818.101).

To address the challenge of optimising infection prevention and control in Switzerland, additional expert knowledge is required. This will make it possible to identify and prioritise current problems, and place them in a socioeconomic and healthcare-related context, thus driving actionable solutions in the evolving and dynamic field of HAI prevention and control.

Among European countries, Switzerland is in the upper third for HAI prevalence. In contrast, the prevalence of infections due to multidrug-resistant organisms (MDROs) is much lower than in most European countries, particularly compared to southern European countries. High prevalence of MDROs is observed as we cross the Swiss southern border to Italy and even higher in Greece, countries less than 3 hours by air from Switzerland. In addition, the use of antibiotics in agriculture and animal husbandry can rapidly have significant consequences for human medicine, via direct contact or food contaminated with resistant pathogens. Emerging diseases, such as Ebola virus disease or Lassa fever, are a constant threat requiring rapid responses – again less than 6 hours by air from Switzerland. Considering the Switzerland's ageing population and its high prevalence of comorbidities, senior citizens are more prone for HAI. Medical devices are becoming increasingly sophisticated and technical support permits more complicated treatments. As a consequence, new fields for HAIs are arising – as seen, for example, in the transmission of *Mycobacterium chimaera* from heater-cooler units or *Burkholderia stabilis* via contaminated washing gloves. Further challenges include rapid developments in the area of data and social sciences, as well as the implementation of knowledge/guidelines in clinical practice.

Tackling these challenges requires the continuous provision of expert knowledge and advice. The diversity of healthcare facilities in Switzerland calls for evidence-based recommendations, while taking into account individual factors affecting implementation.

For this reason, an additional agreement on expertise came into force on 21 November 2019. One of the key objectives defined was the preparation of a consolidated annual report, informing the FOPH about the current epidemiology of HAIs in Swiss hospitals, based on data collected by existing monitoring systems and publicly available, as well as on hospital experience.

# Epidemiology of HAIs in Switzerland

## Part 1: Outcome data

### *Methods*

Swissnoso currently uses two modules to measure HAI– prospective surveillance of the incidence of surgical site infections (SSIs) and annual point prevalence surveys on HAIs and antimicrobial use (AU).

### i) Point prevalence surveys

The objectives of this module are to estimate the burden of HAIs and AU in Swiss acute care hospitals (participation is not mandatory). Participating hospitals collect data on a single day between April and June each year. The first national PPS allowed direct comparison to countries within the European Union and European Economic Area. Then, PPS repeated in 2018 and 2019 allowed hospitals to monitor their HAI prevalence, and to benchmark their findings to hospitals of the same category and size. The next national PPS will be performed in 2022 with the objectives to provide national representative data on HAI and AU and benchmark them with the concurrently performed European Centre for Disease Prevention and Control (ECDC) PPS.

### ii) SSI surveillance module

On behalf of and in collaboration with the ANQ, the Swiss National Association for Quality Development in Hospitals and Clinics Swissnoso has been recording and monitoring the development of surgical site infections in Swiss acute hospitals since 2009. This module is used for active, prospective monitoring of SSIs. It provides healthcare professionals and service providers with an instrument that measures an important indicator of surgical treatment quality. The 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 operations without, and 12 months for operations with, implantation of foreign material. The attending physician is contacted in case where SSI is suspected based on a telephone interview, and is reported during rehabilitation in another institution. The diagnosis of infection is made according to the international CDC criteria which also allow distinction between superficial or deep incisional infections and organ/space infections.

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

The module monitors several types of procedure from the fields of visceral surgery, gynaecology, orthopaedics, heart and spinal surgery. The procedures included are defined according to the Swiss Classification of Surgical Interventions (CHOP version 2017). Participating hospitals and clinics are obliged to monitor at least three types of surgery. At the beginning of a 12-month registration period, the institution may decide to change the types of surgery monitored. Recording starts in October and lasts until September of the following year.

Three types of procedure can be freely selected from the surgical catalogue. Surveillance of colon surgery is mandatory in hospitals where such operations are performed.

## *Outcomes (results and discussion)*

### *Point Prevalence Survey of HAIs and AU in Swiss acute care hospitals – 2017 (CH-PPS 2017)*

Between April and May 2017, 96 acute care hospitals in Switzerland performed a joint point prevalence survey on HAIs and AU. The average HAI prevalence was 5.9% in 12,931 patients; 33% of all patients received one or more antimicrobials on the day of the survey. The most common HAIs were SSIs (29%), lower respiratory tract infections (18%), urinary tract infections (15%), and bloodstream infections (13%). The highest proportions were identified in intensive care units (20.6%), in large hospitals (7.8%), in elderly patients (7.4%), in male patients (7.2%), and in patients with ultimately (9.3%) or rapidly (10.6%) fatal outcomes.

The 2017 PPS reflected the priority given to HAI prevention in the "Health 2020" strategy. It was organised by Swissnoso, with financial support from the FOPH. The survey protocol followed the ECDC (www.ecdc.eu) methodology, which was jointly developed by different stakeholders and was used concurrently in surveys on HAI and AU in other European countries. The HAI prevalence of 5.9% placed Switzerland to the European average. In comparison, the prevalence recorded in Austria and Germany was statistically significantly lower with 4.0% (95% CI 3.4–4.7%) and 3.6% (95% CI 2.8–4.7%), respectively while the prevalence in Italy – 8.0% (95% CI 6.8–9.5%) – was significantly higher (Zingg *et al*. Eurosurveillance 2019).

Before the CH-PPS 2017, the last survey on HAI in Switzerland was performed in 2004. Direct comparison with previous national prevalence surveys is not possible because past surveys were performed with the period prevalence rather than the point prevalence methodology.

Assuming that period prevalence surveys inflate point prevalence by a third, the period prevalence of 7.2% measured in 2004 would translate into a point prevalence of 5.5%. This suggests that HAI prevalence did not change in Swiss acute care hospitals over the past decade. After all, reductions may only be expected after successful implementation of interventions. The only previous HAI prevention initiative was the national hand hygiene campaign conducted in 2005/2006.

### *Point prevalence surveys of HAIs and AU in Swiss acute care hospitals – 2018 and 2019 (CH-PPS 2018, CH-PPS 2019)*

Thanks to the financial support from the FOPH, the Swissnoso PPS platform remained open and free of charge to all acute care hospitals in Switzerland interested in measuring their HAI prevalence and benchmarking to other hospitals in 2018 and 2019.

The aim of the PPS 2019 was to provide hospital administrations and Infection Prevention and Control (IPC) teams with the opportunity to estimate the burden of HAIs and antimicrobial use at a hospital level, using the same protocol and database as the national PPS studies conducted in 2017 and 2018. A total of 34 acute care hospitals agreed to participate in the PPS 2019, providing data on 5,706 patients. Of these hospitals, 20 were small-size (<200 beds), 11 medium-size (200-650 beds) and 3 large-size (>650 beds).

Pooled HAI prevalence was 5.4%; considering only those hospitals which have participated in all the surveys since 2017, HAI prevalence was also 5.4%, compared to a prevalence of 5.8% in 2017 and 5.5% in 2018. Large and university-affiliated hospitals had a significantly higher prevalence (7.4% in both cases) compared to other hospital types. With 18.8%, HAI prevalence was highest in intensive care units (ICUs). The two most common HAI types were SSIs and lower respiratory tract infections (LRTIs), accounting for half of all HAIs.

Approximately a third of all patients (31.4%) received one or more antimicrobials on the day of the survey; the prevalence of antimicrobial use remained unchanged from previous years (33% in 2017 and 30.4% in 2018); cephalosporins and penicillin combinations were the most frequently used antimicrobial groups. Due to the current COVID-19 crisis, the PPS originally planned for 2020 has been postponed.

### *SSI surveillance*

During 2018, Swissnoso continued its SSI surveillance programme in collaboration with the Swiss National Association for Quality Development in Hospitals and Clinics (ANQ). The number of participating hospitals in 2018 changed slightly compared to 2017: two private clinics from the cantons of Geneva and Neuchâtel announced their future participation, while one private clinic in St. Gallen and one in Liechtenstein terminated their contract in the summer.

By the end of 2018, 176 hospitals, private clinics and hospital sites were participating in the SSI surveillance programme. Based on a decision of ANQ, most multi-site hospitals registered their cases by sites with specific codes in 2018. The national comparative report with SSI surveillance results for 2017–2018 was published in June 2019. Link: https://www.anq.ch/de/fachbereiche/akutsomatik/messergebnisse-akutsomatik/step3/measure/11/year/2019/.

*Analysis and reporting activities for the recent period (1 October 2017 to 30 September 2018)*
61,171 cases were analysed and 172 specific reports (in German or French) were provided to participating hospitals. The number of cases included for the recent surveillance period increased slightly compared to the previous period (57,638). In total, 425,038 cases have been included and analysed since 1 June 2009.

During this surveillance period, some additional tools were implemented to encourage institutions to complete and lock their cases on time in the database. In addition, communication towards the end of the surveillance period was strengthened, as was the support provided during data cleaning. As a positive result, no significant problems were encountered, and only 69 incomplete cases (0.11%) were flagged and excluded from the analysis.

Table 1: Infection rates by type of procedure and depth of infection for surgery without implant (1 October 2017 – 30 September 2018) and for surgery with implant (1 October 2016 – 30 September 2017)

| 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 2017 – 30 September 2018[1]** | | | | | | | |
| Appendectomy | 93 | 5795 | 178 | 3.1 (2.6–3.5) | 48 (27.0) | 15 (8.4) | 115 (64.6) |
| Cholecystectomy | 36 | 4073 | 89 | 2.2 (1.8–2.7) | 39 (43.8) | 2 (2.2) | 48 (53.9) |
| Hernia operation | 47 | 4055 | 35 | 0.9 (0.6–1.2) | 21 (60.0) | 10 (28.6) | 4 (11.4) |
| Colon surgery | 121 | 7034 | 948 | 13.5 (12.7–14.3) | 305 (32.2) | 77 (8.1) | 566 (59.7) |
| Rectal surgery | 17 | 334 | 59 | 17.7 (13.7–22.2) | 16 (27.1) | 6 (10.2) | 37 (62.7) |
| Gastric bypass | 11 | 1481 | 46 | 3.1 (2.3–4.1) | 15 (32.6) | 2 (4.3) | 29 (63.0) |
| Caesarean section | 36 | 6818 | 125 | 1.8 (1.5–2.2) | 76 (60.8) | 18 (14.4) | 31 (24.8) |
| Hysterectomy | 19 | 1792 | 42 | 2.3 (1.7–3.2) | 14 (33.3) | 9 (21.4) | 19 (45.2) |
| Laminectomy without implant | 23 | 2559 | 30 | 1.2 (0.8–1.7) | 12 (40.0) | 8 (26.7) | 10 (33.3) |
| **Period: 1 October 2016 – 30 September 2017[1]** | | | | | | | |
| Cardiac surgery | | | | | | | |
| All procedures | 12 | 4214 | 180 | 4.3 (3.7–4.9) | 67 (37.2) | 56 (31.1) | 57 (31.7) |
| CAB | 12 | 1993 | 81 | 4.1 (3.2–5.0) | 33 (40.7) | 33 (40.7) | 15 (18.5) |
| Valve replacement | 10 | 1132 | 49 | 4.3 (3.2–5.7) | 18 (36.7) | 5 (10.2) | 26 (53.1) |
| Elective hip replacement | 106 | 12451 | 137 | 1.1 (0.9–1.3) | 26 (19.0) | 15 (10.9) | 96 (70.1) |
| Elective knee replacement | 70 | 9017 | 72 | 0.8 (0.6–1.0) | 22 (30.6) | 11 (15.3) | 39 (54.2) |
| Laminectomy with implant | 15 | 321 | 6 | 1.9 (0.7–4.0) | 3 (50.0) | 1 (16.7) | 2 (33.3) |

Abbreviations: CI, confidence interval; CAB, coronary artery bypass.

[1]Patients who had surgery without implant are followed up for 30 days after the procedure, those with surgery with implant up to one year after the procedure.

Comparing all transparently published monitoring periods (1 October 2011 – 30 September 2018), a significant reduction in infection rates (all infection depths) was observed for appendectomy (P<0.001, Cochran-Armitage test for trend), hernia surgery (P=0.009), gastric bypass surgery (P<0.001), colon surgery (P=0.029), laminectomy with implant (since 2013; P=0.006), elective hip replacement (P =0.006), heart surgery (all procedures; P=0.03) and CAB surgery (P=0.03). Conversely, a significant increase was seen in the trend of SSI rates in rectal surgery (P<0.001). Compared to the previous monitoring period, no statistically significant increase or decrease in crude infection rates (all infection depths) was observed for the procedures performed. When comparing infection rates by depth of infection (superficial, deep and organ/space) from one period to another, a significant decrease was observed for CAB (deep infection) – 1.7% vs 2.6% (P=0.047). Also compared to the previous monitoring period, higher deep infection rates were observed for Caesarean section (0.3% vs 0.1%; P=0.048) and for laminectomy without implant (0.3% vs 0.05%; P=0.045).

No significant changes were observed for the other surgical procedures compared to the previous year. The same applies when deep and organ/space infections are combined for all procedures, or superficial and deep infections are combined for laminectomy and for cardiac surgery. The proportion of patients undergoing laparoscopic procedures increased in colon surgery and hernia operations. Finally, the proportion of patients receiving correct antibiotic prophylaxis within 60 minutes before skin incision increased significantly for cholecystectomy (contamination level II), rectal surgery (contamination level II), hysterectomy (contamination level II), laminectomy without implant (contamination level I), cardiac surgery (all procedures, contamination level I), CAB (contamination level I) and elective hip replacement (contamination level I), while this proportion decreased significantly for appendectomy (all contamination levels).

### *Comparison with international data*

Compared with other countries, 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, data recording quality is regularly reviewed for hospitals and clinics in this country. Validation is based on audits conducted by experts on-site. This increases the quality of coverage and thus the reliability of the data collected. Because of such differences, comparisons of results with those obtained from other monitoring systems should be treated with caution.

## Part 2: Process parameters

### *Methods*

Swissnoso currently uses two modules to monitor HAI process data. The following paragraphs describe how process parameters are monitored in Switzerland and what sources of data are used. This information will be updated in subsequent annual reports, when further modules are added.

### *i) Clean Care Monitor*

To monitor infection prevention processes, Swissnoso provides the *Clean Care Monitor*, an electronic application which allows data to be collected on compliance with infection prevention procedures and standards. The application provides direct feedback for healthcare-workers and enables monitoring with benchmarking. The *CleanHands* module is used to monitor hand hygiene processes (the basis of hospital hygiene), while the *CleanCareSSI* module monitors compliance with preoperative procedures for the prevention of surgical site infections.

### *ii) Monitoring of urinary catheter use*

A pilot programme on catheter-associated urinary tract infections (CAUTIs) and non-infectious complications due to urinary catheters ran in Switzerland between 2015 and 2018. Commissioned by the FOPH, this was Patient Safety Switzerland's third "progress!" programme and was carried out in collaboration with Swissnoso.

The "progress! Urinary catheter safety" study involved surveillance in 7 pilot hospitals and was accompanied by a nationwide awareness campaign and an employee survey in the pilot hospitals. The intervention period involved three elements: distribution of an evidence-based indication list for catheterisation, daily evaluation of whether a catheter is still needed, and an educational module on the placing and handling of urinary catheters. The impact of the intervention bundle was subsequently assessed.

## *Monitoring of compliance with process parameters (Results and discussion)*

### *Hand hygiene (CleanHands programme)*

Since the beginning of 2015, Swissnoso has been making the *CleanHands* instrument available to all interested hospitals. *CleanHands* is a web-based application for mobile monitoring of compliance with the "My 5 Moments for Hand Hygiene" approach recommended by the World Health Organization (WHO). It was widely used during 2018: over 95 acute care hospitals and chronic care facilities throughout Switzerland participated in the programme.

The easy-to-use analysis tool can also be used for benchmarking, involving anonymous comparisons with all other participating hospitals. Thanks to a filter-and-split function, the results can be analysed in detail individually. Since April 2015, opportunities for hand disinfection have been recorded throughout Switzerland via 170,000 observations (*CleanHands* database query, 24 October 2018), with 145,000 observations made in acute care hospitals and just under 25,000 in long-term care facilities.

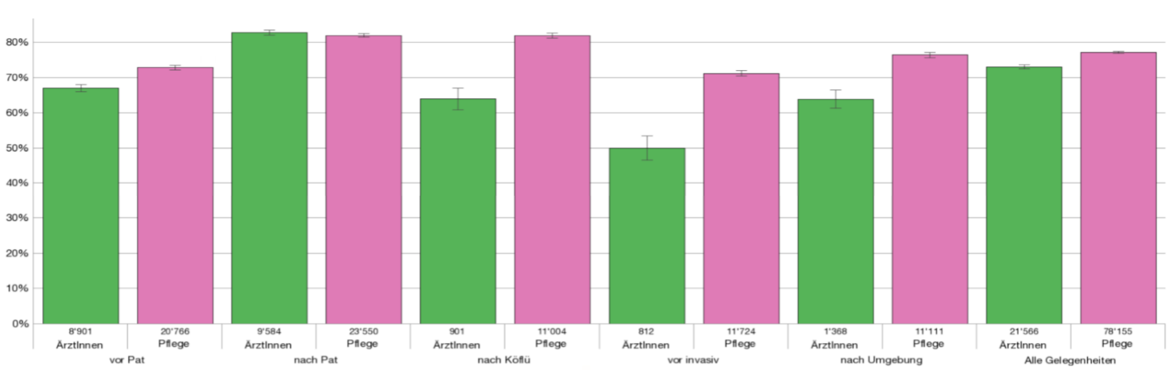



Figure 1: Compliance with the five WHO indications for hand disinfection in the inpatient area of all acute care hospitals, by professional group (green: physicians, pink: nursing staff). The 95% confidence interval is also shown.

After an update in 2019, the application now also permits recording of the correct use of gloves, which is known to have an influence on compliance with hand hygiene.

For the time being, no conclusions can be drawn on the extent to which use of this tool and the resulting data (including the potential benefits of benchmarking) will have an impact on the epidemiology of HAIs in Switzerland. A broader HAI surveillance system needs to be established to evaluate possible effects directly.

### *CleanCare SSI programme*

The *CleanCare SSI* application was developed during 2018 and rolled out during spring 2019. Its goal is to help hospitals increase compliance with selected preoperative procedures. As potential surrogate markers for SSIs, process parameters allow rapid feedback and complement SSI surveillance.

The *CleanCare SSI* monitoring variables were largely chosen on the basis of those used in the SSI intervention pilot programme.

In autumn 2018, Swissnoso completed the SSI pilot phase and subsequently launched the SSI intervention module as one of the three modules in the national *Swiss Clean Care* programme. Eight of ten participating pilot hospitals continued to apply the module, and a new hospital began using the module in January 2019. Altogether, the nine participating hospitals account for approximately 900 surgical beds.

In the pilot programme, the participating hospitals focused on the practical implementation of changes in structural and, in particular, procedural quality in the operating room, with the ultimate goal of lowering the SSI rate. The local project managers organised internal hospital training courses for physicians and nursing staff. As a further effect of the intervention, the presence of the local project manager in the operating room was perceived as a general quality improvement, and the direct feedback provided during the observations was considered particularly valuable. The greatest difficulty in implementation reported by local project managers concerned the desired case number of 10 observations per quarter, owing to a lack of human resources.

In nearly a year, bundle compliance increased from 67% to 80%. However, the goal of overall bundle compliance of >90% was not achieved. The lowest compliance rate was observed in surgical antimicrobial prophylaxis. This was due in particular to non-compliance with the administration time before incision and incorrect redosing practice. As regards disinfection, most errors were due to the use of disinfectants without remanence and a lack of compliance with the recommended overall contact time. Nevertheless, an increase in the compliance rate to over 90% was achieved for the disinfection and hair removal elements. As regards surgical antimicrobial prophylaxis, overall compliance was not yet sufficient, with a rate of 86%.

Table 2: Overall hospital compliance rates for the bundle and for each intervention

| | Q4 2017<br>% | Q1 2018<br>% | Q2 2018<br>% | Q3 2018<br>% |
|---|---|---|---|---|
| Bundle | 66.7 (52.5–78.4)* | 64 (50.1–75.9) | 76.3 (65.6–84.5) | 80.4 (68.0–88.8) |
| Hair removal | 97.9 (88.1–99.9) | 98 (88.5–99.9) | 96.1 (88.6–99.1) | 100 (92.3–100) |
| Disinfection | 85.4 (72.5–93.1) | 84 (71.2–91.9) | 89.5 (80.3–94.8) | 94.6 (84.8–98.7) |
| Antimicrobial prophylaxis | 75.0 (61.1–85.8) | 76 (62.5–85.8) | 86.8 (77.3–92.9) | 85.7 (74.0–92.8) |

*95% confidence intervals by the modified Wald method

Evidently, the processes known to be linked to HAI prevention are not yet perfectly executed. Further developments remain to be seen, and it would also be interesting to obtain data from the hospitals which have not yet participated in this module.

An evaluation of how the SSI rate is affected by the introduction of the intervention module is currently ongoing. Recruitment of hospitals will continue.

### *Monitoring of urinary catheter utilisation*

25,880 patients were included in the study [13,171 before the intervention (August–October 2016) and 12,709 after the intervention (August–October 2017)]. Catheter utilisation – the primary endpoint – decreased from 23.7% to 21.0% (p=0.001), and catheter-days per 100 patient-days from 17.4 to 13.5 (p=0.167). CAUTI incidence remained stable at a low level, with 0.02 infections per 100 patient-days (before) and 0.02 infections (after) (p=0.98). This corresponded to an absolute risk reduction (aRR) of 1.01 (95% CI 0.51–2.00). With infections measured per 1,000 catheter-days, the rate was 1.02 (before) and 1.33 (after) (p=0.60); here, the aRR was 1.20 (95% CI 0.60–2.39). Non-infectious complications dropped significantly, from 0.79 to 0.56 events per 100 patient-days (p<0.001), and from 39.4 to 35.4 events per 1,000 catheter-days (p=0.23).

Two process variables included in the evaluation both pointed to improvements in the clinical process: the percentage of clinically indicated catheters increased from 74.5% to 90.0% (p<0.001), and re-evaluations of the need for catheterisation increased from 168 to 624 per 1,000 catheter-days (p<0.001).

Placed in an international context, catheter utilisation was initially very similar to that of the United States (US) surveillance system (NHSN data from 2013 reported 17 catheter-days per 100 patient-days) while the CAUTI rate was somewhat lower (NHSN reported 1.3 CAUTI events per 1000 catheter-days in 2013).

The goal of the pilot study – reducing urinary catheter utilisation, which is known to be closely linked to the CAUTI outcome – was achieved. Likewise, clinically indicated catheters and daily evaluations increased over the study period. The low baseline CAUTI rate could not be further reduced; however, non-infectious complications decreased as a result of the intervention. All in all, this pilot programme demonstrated the feasibility of establishing CAUTI surveillance in

Swiss pilot hospitals and implementing a straightforward intervention bundle, which led to the desired outcome – reducing unnecessary urinary catheterisation.

It should be noted that the 7 pilot hospitals participating may not be representative of Switzerland, in that they are “over-achievers” in terms of infection rates. This hypothesis is supported by the fact that urinary tract infections were the third most common HAI in the 2017 national point prevalence study (Zingg *et al*, Eurosurveill 2019). Given that on average 54% are avoidable, according to a recent meta-analysis (Schreiber *et al*, Infect Control Hosp Epidemiol 2018), we would expect to see a significant reduction in CAUTI events once the intervention module is rolled out nationally and these device-associated infections are systematically recorded for the first time across the country.

## Part 3: Multi-drug resistant organisms (MDROs) in HAIs

### *MDRO HAI outcome data*

In the 2017 Swiss National Point Prevalence survey, with 96 participating hospitals, 576 (69%; 95% CI 65.7 72.1%) of 835 HAIs were examined microbiologically; of these, 536 (93.1; 95% CI: 90.7–95.0%) showed a positive culture, with a total of 746 microorganisms. The types of bacteria most commonly isolated were Gram-positive cocci and Enterobacterales (approximately 40.2% and 34.5%, respectively). Overall, Gram-negative bacilli and Gram-positive cocci represented more than 80% of the microorganisms isolated. Of 257 Enterobacterales, 59 (23%; 95% CI 17.8–28.1%) had reduced susceptibility to third-generation cephalosporins and 5 (1.9%; 95% CI 0.2–3.6%) had reduced susceptibility to carbapenems; of the 44 *Pseudomonas aeruginosa* isolates, 5 (11.4%; 95% CI 1.6–21.1%) had reduced susceptibility to carbapenems. Of the 100 *Staphylococcus aureus* isolates, 11 (11.0%; 95% CI: 4.8–17.2%) had reduced susceptibility to methicillin; 2 (2.2%; 95% CI 0.0–5.3%) of the 90 enterococci (*E. faecium* and *E. faecalis*) were resistant to vancomycin. In 2019, 12 (13.8%; 95% CI 6.4–21.2%) of a total of 87 Enterobacterales had reduced susceptibility to third-generation cephalosporins, and 2 (2.3%; 95% CI 0–5.5%) had reduced susceptibility to carbapenems. Of the 34 *S. aureus* isolates, 5 (14.7%; 95% CI 2.2–27.2%) were resistant to methicillin; 3 (8.1%; 95% CI 0–17.3%) of the 37 enterococci were resistant to vancomycin.

### *MDRO surveillance: vancomycin-resistant enterococci*

The epidemiology of vancomycin-resistant enterococci (VRE) is constantly evolving. In recent years, large VRE outbreaks have occurred in Switzerland, mainly in the canton of Vaud and most recently in the canton of Bern, with intra- and intercantonal spread to other hospitals. The Bern outbreak gained international attention due to its extent and the emergent clone, with the potential for rapid and efficient spread despite extensive infection control measures. This clone (VRE VanB ST 796, identified in Europe for the first time, was probably imported from Australia (Wassilew *et al*., Eurosurveillance 2019).

At the same time, a national epidemiological survey revealed that, from January 2015 to March 2018, 46 of 142 hospitals (32%) had observed VRE cases, with a total of 652 VRE patients; of these patients, 67 (10%) had invasive infections. During this period, the mean number of VRE outbreaks (defined as ≥2 confirmed VRE cases in the same time period in an individual hospital) per year was 7. The total number of VRE cases detected increased markedly from 2015 to 2018, and an increased number of outbreaks were observed in German-speaking Switzerland during the first three months of 2018. This trend is also in line with the rise in VRE prevalence and outbreaks observed in some neighbouring European countries (e.g. Italy and Germany), as reported by the ECDC (Buetti et al. 2019).

In the absence of a systematic surveillance programme, Swissnoso has set up a collaboration with the Swiss Centre for Antibiotic Resistance (www.anresis.ch) for quarterly publication of new VRE cases per canton, with information gathered from centres participating in the national antibiotic resistance surveillance programme. The latest numbers from April 2019 to March 2020 are shown in Figure 2. In the canton of Bern, the number of new VRE cases detected in clinical isolates or from blood cultures during recent months has remained stable, but cases have increased in the canton of Zurich. The VRE outbreak in the hospitals of the *Inselgruppe* has been declared to be contained. Other cantons also reported smaller outbreaks in acute care hospitals in 2019, which were successfully contained. It should be noted, however, that the validity of the data shown in Figure 2 is limited, since screening activities in hospitals and hospital regions are heterogeneous and in some cases unknown, leading to potential underestimation of and bias in the distribution of cases. The Swiss Centre for Antibiotic resistance (www.anresis.ch) was developed to monitor trends in antibiotic resistance of invasive isolates and not to detect nosocomial outbreaks. An increasing number of VRE cases in individual hospitals may therefore be due simply to increased entry screening of high-risk patients or an increase in sporadic cases (e.g. canton of Thurgau) and does not necessarily indicate an outbreak.

### *Discussion of VRE outbreak*

As a result of the national VRE outbreak in 2018, which affected several hospitals, and following an investigation conducted on behalf of the FOPH, Swissnoso has elaborated guidelines on VRE prevention and control in acute care hospitals. Updated recommendations were published in December 2019. Link:
https://www.swissnoso.ch/fileadmin/swissnoso/Dokumente/5_Forschung_und_Entwicklung/6_Aktuelle_Erreignisse/191220_Aktualisierte_VRE_Management_Guideline_final_rev.pdf.

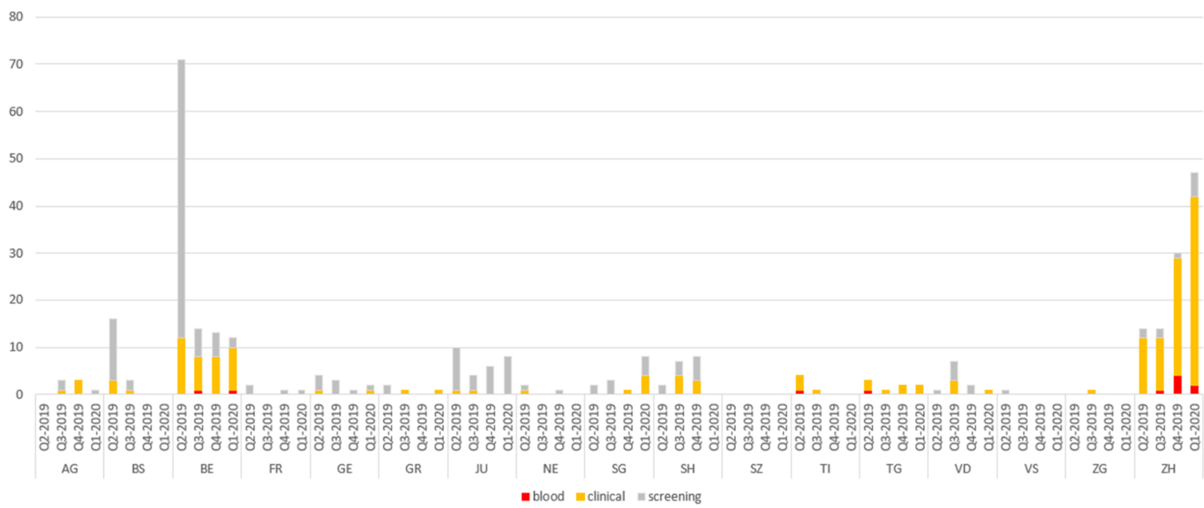
In the light of the findings of the outbreak investigation, the FOPH has introduced mandatory reporting of VRE outbreaks in hospitals from 1 January 2020. The goals are to understand the epidemiological situation in hospitals, evaluating transmission routes between facilities and facilitating communication between hospitals and health authorities. Although Swissnoso acknowledges these efforts, the current reporting format has some inherent limitations. One major shortcoming is that the reporting of an evolving outbreak lacks the flexibility required to better estimate its dynamics and extent.

As an example, we would mention the rising numbers of new VRE cases in the canton of Zurich, which seem to be quite worrisome. Despite the current instruments – Swissnoso quarterly reporting and the mandatory reporting recently introduced by the FOPH – it remains unclear whether, for example, other healthcare facilities receiving patients from such institutions should be alarmed or whether the actions taken by the hospitals are beginning to have an effect.

In order to better understand the dynamics of the VRE situation in acute care hospitals and to evaluate whether and how VRE management has changed since the last national survey was conducted in early 2018, Swissnoso designed a structured online questionnaire addressed to all acute care hospitals.

In view of the Covid-19 outbreak, Swissnoso decided to extend the deadline for completing the survey to the beginning of June 2020. Therefore, no results are available yet.

Figure 2. New VRE cases per quarter and canton from April 2019 to March 2020 (last updated 30 March 2020, source: [www.anresis.ch](http://www.anresis.ch))




## *Preventive measures: Candida auris*

*Candida auris*, a globally emerging pathogen, has been repeatedly introduced into European healthcare settings, leading to large, prolonged nosocomial outbreaks. Most *C. auris* isolates are resistant to fluconazole and voriconazole and exhibit variable rates of non-susceptibility to other antifungal classes, such as amphotericin and echinocandins. Most worrying, however, is the fact that there are already reports of pan-resistant isolates. This is of major concern since treatment options in cases of invasive infection will be extremely limited. *C. auris* is more likely to cause invasive infections, including candidemia, than other *Candida* spp. Serious infections are observed especially in patients with severe underlying diseases or immunosuppression and in neonates. Case fatality rates for *C. auris* bloodstream infections may exceed 30%. However, attributable mortality is difficult to determine since invasive infections usually occur in severely ill patients with multiple comorbidities.

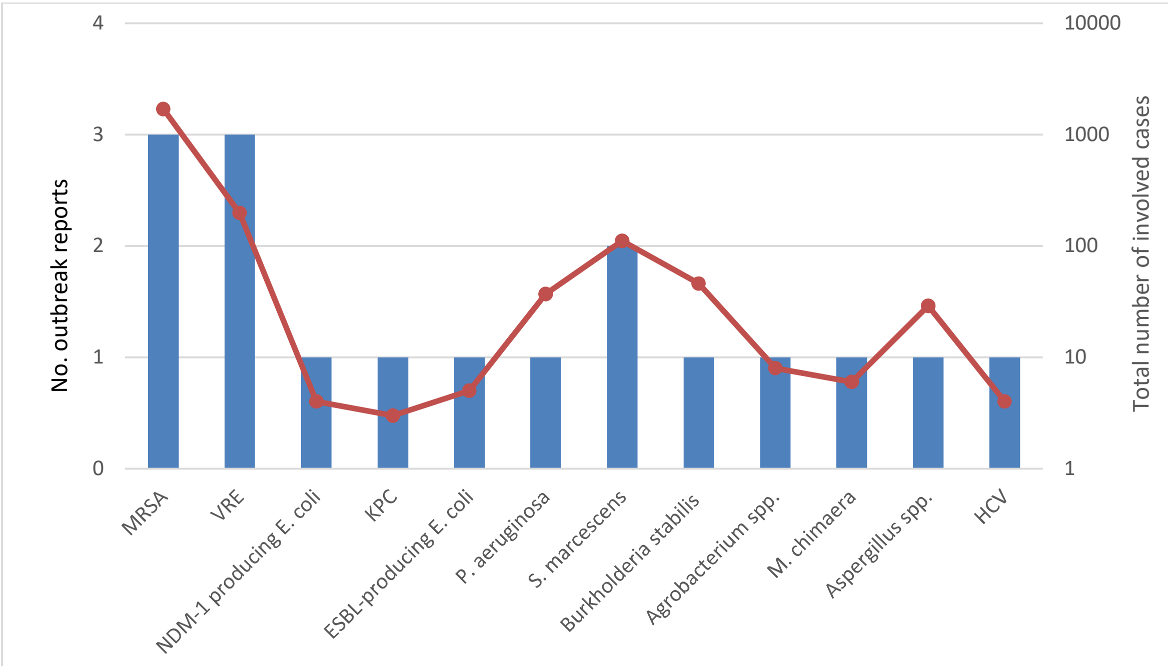
Since the detection of the first case of *C. auris* in Switzerland in 2018, Swissnoso has become aware (through personal communication) of two other cases in Switzerland, indicating that this emerging fungus has definitively arrived in Switzerland. Lack of awareness could quickly result in an outbreak if *C. auris* remains unnoticed or is only detected once a patient has developed invasive infection. Clinicians, hospital epidemiologists and microbiologists thus need to be prepared for their first case. Swissnoso has therefore developed the first national recommendations aiming to provide guidance for *C. auris* infection prevention and control in Swiss healthcare settings. These recommendations are currently under consideration for publication in *Swiss Medical Weekly*, a journal with a broad readership in Switzerland and a certain international reputation.

Due to the lack of mandatory reporting to the FOPH, the current epidemiology of *C. auris* in Switzerland is unknown. However, the fact that hospitals or local IPC teams have not consulted Swissnoso regarding preventive measures for *C. auris* cases suggests that the incidence is limited to a few sporadic cases.

### *Review of the epidemiology of HAI outbreaks and outbreaks with epidemiologically relevant pathogens in Swiss healthcare settings*

HAI outbreaks occurring in Switzerland over the last decade (2010–2020) have been reviewed. Outbreak reports were identified by querying the international Outbreak Database (www.outbreak-database.com/about.aspx), conducting a title/abstract search of the PubMed database, and screening published abstracts from the last two international conferences on infection prevention and control (ICPIC 2017 and 2019). Only original outbreak reports were included. Community-based outbreaks, as well as influenza and norovirus outbreaks, were excluded based on title screening. A total of 18 reports of HAI outbreaks in Switzerland were identified (Supplementary Table). One outbreak report which included 21 *M. chimaera* cases from different countries, including Switzerland, was not further considered because of potential duplication of cases reported in a previous article. Of the remaining 17 reports, 9 (53%) concerned Gram-positive and Gram-negative MDROs. Outbreaks with MRSA involved the largest total number of cases (>1700 cases), followed by outbreaks with VRE (198 cases), whereas all three published outbreaks concerning multi-drug resistant Enterobacterales involved less than 10 cases (Figure 3). The most frequently reported intervention was reinforcement of compliance with hand hygiene and standard precautions (Supplementary Table), which is in line with the most common mode of MDRO transmission (via the hands of healthcare workers).

Figure 3. Number of HAI outbreaks reported in Switzerland between 2010 and 2020 (blue bars) and number of cases involved per pathogen (red line).




## *Discussion (nosocomial outbreaks)*

Swissnoso would like to emphasise that the surveillance instruments currently available in Switzerland are not yet adequate to ensure timely detection of nosocomial outbreaks with multidrug-resistant organisms and other epidemiologically relevant pathogens.

Healthcare facilities and public health authorities would therefore benefit from systematic and robust surveillance, considering not only antibiotic resistance data but also meta-data from hospitals and individual patients. An intelligently developed surveillance programme could even serve as an early warning system for nosocomial outbreaks and help to mitigate further spread of such pathogens, thus preventing major harm – especially in terms of worse patient outcomes and exploding healthcare costs.

## Part 4: Swissnoso activities

### *Minimal Standards for the prevention of HAIs in acute care hospitals in Switzerland*

As part of the national NOSO strategy and in close collaboration with the FOPH, Swissnoso has prepared recommendations for structural minimal standards for the prevention and control of HAIs in acute care hospitals in Switzerland ─ with the participation and consultation of further expert organisations. The recommendations include 7 key components (guidelines/directives; material, equipment and ergonomics; organisation of infection control and staffing; training; audits/monitoring; surveillance/outbreaks; interventions), with a total of 22 subcomponents. They are based on expert consensus, scientific evidence and well-established international recommendations from the WHO and other associations. As a next step, the FOPH will hold a consultation and discuss the potential strategy for implementation of the minimal standards together with the cantons. These minimal standards are an important building block of the NOSO strategy. They are currently being sent for consultation by the FOPH to members of H+ and the Conference of Cantonal Ministers of Public Health (GDK).

It is not yet possible to assess the extent to which the introduction of these minimum standards will influence the epidemiological situation in Switzerland over the next few years. However, it can be assumed that the introduction of minimal standards throughout Switzerland, including increased screening activities, will have a positive effect on HAI surveillance and ultimately on HAI rates.

### *Events affecting Swissnoso activities: Covid-19 pandemic*

The effects of the Covid-19 pandemic have led to Swissnoso activities concerning the epidemiology of HAIs in Switzerland having to be scaled down. During the main lockdown period (16 March – end of May 2020), SSI surveillance was suspended – not least because elective operations were suspended and reallocation of surveillance staff was necessary. The monitoring of process parameters (Clean Hands, SSI intervention) was declared a voluntary process during the lockdown. In addition, activities under the FOPH mandate have also been delayed. For example, Swissnoso decided not to send out any surveys during the lockdown, which would have further limited the capacity of the healthcare system. The preparation of this annual report was also delayed. The planned nationwide PPS 2020 has been cancelled and the next national PPS is planned in 2022. It is important to mention this interruption, as it could have an impact on the number of HAIs and the evaluation of HAI outcomes in the coming period(s).

## Part 5: Experience from university/large cantonal hospitals

### *Experience from hospitals*

It is difficult to summarise the situation in hospitals for the past year, given the heterogeneous landscape and their varying requirements.

However, high on the agenda was certainly the VRE outbreak, which was challenging for many hospitals in terms of both financial and human resources. Through increased screening activities and attention, many VRE cases were found which might not have been previously detected because they were not clinically apparent. However, in many hospitals, the VRE outbreak has led to improvements in standard hygiene measures: some hospitals have acquired UV equipment for terminal room disinfection and have improved IT structures. This has also highlighted the need for requirements at the national level, in the sense of minimum standards for hospital hygiene equipment.

While droplet isolation at the bedside for respiratory infections has been implemented in a number of smaller hospitals for some time, this now seems to be gaining a foothold in clinical routine in some larger hospitals. In contrast to the empirical approach adopted in smaller hospitals, this is also accompanied by surveillance activities to monitor the number of nosocomial influenza or other respiratory virus cases. So far, the available data has not shown a corresponding signal of patient risk, so this could become an increasingly serious strategy in the prevention of nosocomial respiratory virus transmission in the coming years.

What is striking is that last year another two patients were diagnosed with healthcare-associated *Mycobacterium chimaera.* These patients underwent heart surgery at a time when the problem was not yet sufficiently known, and the appropriate preventive measures had not yet been implemented. Nevertheless, the long latency period of over 5 years is worrying, and it is not clear for how long potential cases can be expected to arise. On the other hand, Swissnoso is not aware of any cases occurring at a time when the prevention measures were already active, which is certainly encouraging.

## Part 6: Conclusions and outlook

In addition to the well-established SSI surveillance module, Swissnoso can now draw clear conclusions on the epidemiological situation/trends of confirmed HAIs in Switzerland from the PPS data. These modules will be continued in the future, to provide reliable data and trends. This development is currently supported by further modules, which do not provide hard outcome data but also examine process parameters known to be associated with the occurrence of HAIs. This type of data can be very helpful, as compliance with key processes can make an important contribution to HAI prevention.

Nevertheless, to obtain a complete picture of HAI development in Switzerland, monitoring is either not yet broad enough (continuous surveillance for SSIs only) or provides only a cross-sectional view (PPS).

For this reason, expansion of the surveillance network to other HAIs such as central line-associated bloodstream infection (CLABSI), CAUTI and ventilator-associated pneumonia (VAP) is urgently needed. In 2020, a market analysis of the current structure and the necessity and priority of HAI surveillance beyond SSIs is being carried out at all Swiss acute care hospitals.

The still-evolving structure of the outbreak investigation centre has already proved useful during the investigation of a large intercantonal outbreak of VRE. During the present Covid-19 pandemic, Swissnoso has again shown its capability to quickly assemble an expert group and efficiently produce practical guidance for the prevention and control of emerging pathogens such as SARS-CoV-2 in hospitals. In the future, the expertise on investigation of nosocomial outbreaks should be supplemented by a surveillance tool allowing early detection of such outbreaks and instruments to monitor compliance with existing guidelines.

Based on the results of the market survey and the needs defined by the FOPH, the establishment of an extended HAI surveillance programme is one of the primary goals of Swissnoso for the coming years, supported by a mandate from the FOPH. In addition, the linking of data between modules is an important point which needs to be improved in the near future in order to obtain a more accurate picture of the epidemiology of HAIs in Switzerland.

**Supplementary Table: Nosocomial outbreaks in Switzerland (or involving cases from Switzerland) in the last decades (1996 – 2018).** The outbreak reports were identified by a query of the international outbreak database (www.outbreak-database.com/about.aspx) using the term "Switzerland" and by a [Title/abstract] search of the PubMed database using the terms "Swiss" OR "Switzerland" AND "outbreak*" filtered by "human". The additional query of the PubMed database yielded 212 hits. Only original outbreak reports were included, and community-based outbreaks were excluded based on title screening. One Swissnoso expert provided an additional report that was not identified by the literature search.

| | **Year** | **Title (Reference)** | **Pathogen/ disease** | **No. affected patients and institutions** | **Duration of outbreak** | **Study type** | **Microbiological diagnostics to assess relatedness of strains** | **Intervention** |
|---|---|---|---|---|---|---|---|---|
| 1 | 2018 | Outbreak of vancomycin-resistant *Enterococcus faecium* clone ST796 (1) | Vancomycin-resistant *Enterococcus faecium* (VRE) | **77 related cases** > 1000 patients screened negative<br><br>**6 institutions** | 8 months (investigation ongoing as per December 2018) | Retrospective molecular epidemiological study | Whole Genome Sequencing (WGS) | Multifaceted: increased targeted screening, cohorting, reinforcing standard precautions |
| 2 | 2017 | *Burkholderia stabilis* outbreak associated with contaminated commercially-available washing gloves (2) | *Burkholderia stabilis* | **46 cases** (14 blood stream infections)<br>**9 institutions** | 16 months | Retrospective case finding | WGS | Information of the Swiss Agency for Therapeutic Products (Swissmedic) and the<br>Swiss distributor of the washing gloves GD Medical with subsequent sales stop of this product |
| 3 | 2017 | Global outbreak of severe *Mycobacterium chimaera* disease after cardiac surgery (3) | *Mycobacterium chimaera* | **21 cardiac surgery-related patients** from **4 countries** (CH, D, NL, and UK) | Several years | Retrospective case analysis, phylogenetic analyses, including environmental samples | WGS | Controlling the contamination at the LivaNova (heater-cooler unit factory) production line |
| 4 | 2016 | A Hospital-wide Outbreak of *Serratia marcescens* in cardiac surgery patients (4) | *Serratia marcescens* (2 clusters) | **91 cases**<br><br>**1 institution** | 12 months | Case-control and additional "Ishikawa's fishbone" analysis | pulsed-field gel electrophoresis (PFGE) | Active surveillance of all cardiac surgery patients during one month, environmental cultures, exchange of a brittle transoesophageal echocardiography (TOE) probe and complete re-engineering of the disinfectant procurement and logistics |
| 5 | 2015 | Prolonged Outbreak of *Mycobacterium chimaera* Infection After Open-Chest Heart Surgery. | *Mycobacterium chimaera* | **6 cases**<br><br>**1 institution** | Several years | Retrospective and Prospective Case Detection | Randomly amplified polymorphic DNA Polymerase Chain Reaction (PCR) | Notification to the national regulatory bodies and the manufacturer of the heater-cooler units, daily water changes over 0.2-µm bacteria filters, regular water and air surveillance cultures |
| 6 | 2015 | Outbreak of invasive filamentous fungal infection (IFFI) among hospitalized hemato-oncological patients (6) | Various filamentous fungi:<br>*Aspergillus* spp.<br>*Acremonium* spp.<br>*Alternaria* spp. | **29 cases** (6 proven, 8 probable, and 15 possible) of IFFI<br><br>**1 institution** | 2 years and 4 months | retrospective, matched, case-control study | Standard cultures and antifungal susceptibility testing | Ensure use of a high-efficiency mask during transport outside the protected environment of the dedicated ward and avoidance of unnecessary transfers for severely immunocompromised patients with hematological malignancies |
| 7 | 2014 | First documented outbreak of KPC-2-producing *Klebsiella pneumoniae* in Switzerland (7) | KPC | **3 cases** 36 contacts (21 screened negative, 15 with no or | 2 months | Case report | KPC-specific conventional PCR<br>PFGE | Contact precautions<br>Enhanced surface disinfection<br>Cohorting of patients<br>Cohorting of staff (not strictly maintained)<br>Observation of hand hygiene adherence and behaviour |

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|---|---|---|---|---|---|---|---|---|
| | | | | incomplete screening)<br>**1 institution** | | | | |
| 8 | 2013 | Control of an outbreak of vancomycin-resistant enterococci in several hospitals of western Switzerland (8) | VRE | **104 cases**<br><br>**2 institutions** | 10 months | Case report | PFGE<br>MLST | Multifaceted intervention including screening of contact patients, (preventive) contact isolation, cohorting, systematic screening of affected units, limit of patient transfers, reinforced hand hygiene and environmental decontamination |
| 9 | 2012 | A multiple-strain outbreak with vancomycin-resistant E*nterococcus faecium* at a Swiss tertiary care hospital (9) | VRE | **17 cases**<br>(4 infections, 4 deaths)<br>a total of 361 rectal screenings<br><br>**1 institution** | 8 weeks | Prevalence surveys by weekly rectal screening, environmental screening | Pulse Field Gel Electrophoresis (PFGE) for clonal typing and PCR for resistance determinants and virulence factors detection | Contact isolation in single rooms, enhanced surface-disinfection, designation of link nurses, regular teaching of hand hygiene practice, implementation of systematic screening |
| 10 | 2011 | Methicillin-resistant *Staphylococcus aureus* outbreak at a university department of dermatology (10) | MRSA | **65 cases**<br>(2 MRSA related deaths)<br><br>**1 institution** | | Case report<br>Retrospective case finding | Genotyping by PFGE | Strict hand hygiene, increase in the number of fixed installed alcohol dispensers, avoidance of sharing ointments among patients, individual MRSA decolonization attempts |
| 11 | 2010 | Eradication of an epidemic methicillin-resistant Staphylococcus aureus (MRSA) from a geriatric university Hospital (11) | MRSA | **37 cases**<br>(32 patients and 3 HCW, 2 housekeepers)<br><br>**1 institution** | 2 years | Case report | PFGE and Spa-typing | Contact isolation, optimization of infection control, screening and decolonization of all MRSA carriers |
| 12 | 2010 | Pseudomonas aeruginosa Outbreak in a Pediatric Intensive Care Unit Linked to a Humanitarian Organization Residential Center (12) | Pseudomonas aeruginosa | **37 cases**<br>(incl. 3 fatal blood stream infections) | > 2 years | Retrospective case finding<br>Case-control study | PFGE | Surveillance cultures of patients and the environment<br>Reinforcement of standard precautions, observation of surgical procedures, exchange of the PICU's contaminated sink and drain pipes, review of the ECMO and HF records and observation of procedures; modification of empirical coverage of cardiac surgery patients presenting signs of sepsis to ensure coverage of P. aeruginosa<br>At the NGO centre: ban of common use of containers of lotions at the NGO centre; removal of pipe deposits and disinfection of the sewage system |
| 13 | 2007 | An outbreak of scabies: a forgotten parasitic disease still present in Switzerland (13) | *Sarcoptes scabiei*<br><br>Crusted scabies | **24 cases**<br>116 contacts screened negative<br>**3 institutions** | 9 months | Case report<br>Retro- and prospective case finding | detection of mites from scrapings or skin biopsy | Creation of a task force<br>Contact tracing, systemic and topical (preventive) treatment of affected patients and close contacts, notification of suspected cases to public health authorities, information of general practitioners and local dermatologists |

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|---|---|---|---|---|---|---|---|---|
| 14 | 2006 | Outbreak of endophthalmitis after cataract surgery related to damaged surgical blades (14) | *S. epidermidis* and *Streptococcus* spp. | **8 cases**<br><br>**1 institution** | 8 months | Case control | The organism was identified by PCR | Switch to disposable blades, systematic suturing of the wound and use of pre-emptive topical antibiotics in the early postoperative phase |
| 15 | 2006 | Control of a cluster of community-associated, methicillin-resistant Staphylococcus aureus in neonatology (15) | MRSA | **5 cases**<br>(fatality 0)<br><br>**1 institution**<br>(ICU only) | 1 month | Case report | Genotyping by multiplex PCR<br>PFGE<br>MLST | Contact isolation and cohorting<br>Spacial separation of new admissions<br>Universal daily CHX body washes for infants aged > 32 gestational weeks<br>Reinforced standard precautions and decontamination practices<br>Targeted screening<br>Decolonization of all carriers |
| 16 | 2002 | Three consecutive outbreaks of Serratia marcescens in a neonatal intensive care unit (18) | *Serratia marcescens* | **11 cases**<br><br>**1 institutions** | 1. 16 months<br>2. 4 months<br>3. 3 months | Case report<br>Prevalence survey | PFGE | Replacement of theophylline bottles<br>Reorganization of procedures in the milk kitchen including cange of bottle reprocessing to thermal disinfection |
| 17 | 2000 | Effect of delayed infection control measures on a hospital outbreak of methicillin-resistant Staphylococcus aureus (19) | MRSA | **1771** new cases<br><br>**1 Institution** | 1989 to 1997 | Cohort study | Standard cultures and antimicrobial susceptibility testing | In 1993: Implementation of a multifaceted intervention, including active surveillance cultures, introduction of a hospital-wide education programme to improve compliance with hand hygiene, additional precaution measures |
| 18 | 1999 | Outbreak of *Enterobacter cloacae* related to understaffing, overcrowding, and poor hygiene practices in a Neonatal ICU (20) | *Enterobacter cloacae* | **8 cases**<br>(1 fatality)<br><br>**1 institution** | 2 months | Cohort study | Genotyping by CHEF electrophoresis (=modified PFGE) | Isolation/cohorting of affected patients<br>Use of single-dose medication |
| 19 | 1996 | Outbreak of invasive mycoses caused by Paecilomyces lilacinus from a contaminated skin lotion on a hemato-/oncology unit (21) | *Paecilomyces lilacinus* | **16 cases**<br>(13 infected, 3 colonized)<br>(2 fatalities)<br>**1 institution** | 2 months | Case-control study | Standard cultures and antifungal susceptibility testing | Temporal unit closure for new admissions, high-level disinfection, surveillance cultures from HCW's hands. Outbreak ended after skin lotion was recalled |

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