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HEALTHCARE-ASSOCIATED INFECTIONS AND ANTIMICROBIAL RESISTANCE

SURVEILLANCE OF BLOODSTREAM INFECTIONS IN BELGIAN HOSPITALS

Report 2022
Data up to and including 2021

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Epidemiology and public health - Healthcare-associated infections and antimicrobial resistance

Surveillance of Bloodstream Infections in Belgian Hospitals

September 2022 • Brussels • Belgium
Internal reference number: D/2022.14.440/41

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With the financial support of

service public fédéral SANTE PUBLIQUE, SECURITE DE LA CHAINE ALIMENTAIRE ET ENVIRONNEMENT

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Wallonie

AViQ Agence pour une Vie de Qualité Familles Santé Handicap

Please cite as: Duysburgh E. Surveillance of Bloodstream Infections in Belgian Hospitals: Report 2022. Brussels, Belgium: Sciensano; 2022.
Depot Number: D/2022.14.440/41
ISSN: 2505-9640

Acknowledgments

The author wish to thank all the participating hospitals for their continuous efforts to provide data, the members of the Working Group ‘Bloodstream infections’ for their help in improving the surveillance report and protocol, the Healthdata team, especially Marijke Pauwels, for their contribution in the development of the data collection and reporting tool. And last but not least, I wish to thank my colleagues Laure Morgat and Boudewijn Catry for the review of this report and their useful comments and input.

Main findings and recommendations

In 2021, as in 2020, bloodstream infection surveillance data shows the effect of COVID-19 on hospital-associated bloodstream infections:

- **An increase in hospital-associated bloodstream infections (HABSI) and central line-associated bloodstream infection (CLABSI) incidence in Belgian hospitals and**
- **An increase in the proportion of HABSI secondary to pulmonary infection and among critical ill patients**

Between 2013 and 2019, we did not observe a trend or statistic significant change in HABSI and CLABSI incidence per 10,000 patient days. **From 2019 to 2021,** similar to what we found in 2020, the first COVID-19 year, we observed a statistical significant increase in the HABSI and CLABSI incidence and this at national and each of the regions level. **At Belgian level HABSI incidence increased by 19% and CLABSI incidence by 29%**.

In 2021, compared to the years prior to the COVID-19 crisis, we found proportionally more HABSI with as source a pulmonary infection and an endotracheal tube and more HABSI that occurred at the intensive care unit (ICU). These findings suggest that **compared with the years prior to the COVID-19 crisis** there were **among patients with HABSI more patients critically ill.**

In 2021, we did not observe a change in the trend of microorganism (MO) specific incidences of HABSI and in the antimicrobial resistance profile of selected causal MO. Also the 2021, findings on crude mortality for HABSI remained similar to the years before the COVID-19 crisis.

Recommendations

- Develop a robust and feasible crisis preparedness plan for the Belgian healthcare sector to guarantee the delivery of qualitative good care in all situations. Such a plan is needed on all levels, from the federal authority to the work floor level, and regular updates need to be foreseen.
- Continue the surveillance of bloodstream infections in Belgian hospitals to assess the HABSI and CLABSI incidence throughout and post COVID-19 crisis.
- Assess the impact of changing patient population due to the COVID-19 crisis on the increased HABSI and CLABSI incidence.
- To improve data quality (e.g. issues with not reporting all eligible HABSI and CLABSI), consider making participation on the surveillance voluntary. Publishing a list of hospitals that yearly participate may enhance transparency regarding participation at this surveillance. Publication of quarterly available public reports with data on national and regional level might be an incentive to continue participating in the surveillance.

Belangrijkste bevindingen en aanbevelingen

In 2021, net als in 2020, tonen de gegevens verzameld via de surveillance van bloedstroom infecties het effect van COVID-19 op de ziekenhuis-geassocieerde bloedstroominfecties:

- **Een stijging van de incidentie van ziekenhuis-geassocieerde bloedstroominfecties (HABSI) en centraal veneuze katheter-geassocieerde bloedstroominfecties (CLABSI) in Belgische ziekenhuizen en**
- **Een stijging van het aandeel HABSI met een longinfectie als oorsprong en bij patiënten in kritieke toestand**

Van 2013 tot 2019 observeerden we geen trend of statistisch significante verandering in de HABSI en CLABSI incidentie per 10.000 ligdagen. **Tussen 2019 en 2021,** net zoals we in 2020, het eerste COVID-19 jaar zagen, was er een statistisch significante toename van de HABSI en CLABSI incidentie en dit zowel op Belgisch niveau als op niveau van elk van de gewesten. **Op Belgisch niveau steeg de HABSI incidentie met 19% en de CLABSI incidentie met 29%.**

In 2021 vonden we, in vergelijking met jaren vóór de COVID-19 crisis, proportioneel meer HABSI met een longinfectie en een endotracheale tube als oorsprong. Proportioneel waren er ook meer HABSI die op de intensieve zorgen afdeling ontstonden. Deze bevindingen suggereren dat er in **vergelijking met voorgaande jaren verhoudingsgewijs bij patiënten met HABSI er meer zwaar zieke patiënten waren**.

In 2021 vonden we noch een verandering in de trend van HABSI incidenties voor specifieke micro-organismen, noch in het antimicrobiële resistentieprofiel voor de betrokken micro-organismen. Ook de gegevens betreffende mortaliteit zijn vergelijkbaar met jaren vóór de COVID-19 crisis.

Aanbevelingen

- Ontwikkeling van een robuust en haalbaar crisisplan voor de Belgische gezondheidszorgsector, dit om in alle situaties kwalitatieve goede zorg te kunnen blijven garanderen. Een dergelijk plan is nodig op alle niveaus, van het federale niveau tot op de werkvloer, en moet regelmatig geactualiseerd worden.
- De surveillance van bloedstroominfecties in Belgische ziekenhuizen verderzetten om de HABSI en CLABSI incidentie tijdens en na de COVID-19-crisis op te volgen en te evalueren.
- De impact van de veranderende patiëntenpopulatie als gevolg van de COVID-19-crisis op de toegenomen HABSI en CLABSI incidentie onderzoeken.
- Om de kwaliteit van de gegevens te verbeteren (bijvoorbeeld het niet rapporteren van alle in aanmerking komende HABSI en CLABSI), moet overwogen worden om deelname aan de surveillance vrijwillig te maken. Publicatie van een lijst van deelnemende ziekenhuizen die jaarlijks deelnemen kan de transparantie over de deelname aan deze surveillance vergroten. Publicatie van driemaandelijkse publiek beschikbaar rapport met gegevens op nationaal en regionaal niveau kan een stimulans zijn om aan de surveillance te blijven deelnemen.

Résultats principaux et recommandations

En 2021, comme en 2020, les données de la surveillance des septicémies montrent l'effet de la COVID-19 sur les septicémies associées à l'hôpital :

- **Une augmentation de l'incidence des septicémies associées à l'hôpital et des septicémies associées à un cathéter veineux central dans les hôpitaux belges et**
- **Une augmentation de la proportion de septicémies associées à l'hôpital provenant d'infections pulmonaires et chez les patients en état critique.**

De 2013 à 2019, nous n'avons observé aucune tendance particulière ni aucun changement statistiquement significatif dans l'incidence des septicémies associées à l'hôpital et de celles associées à un cathéter veineux central pour 10 000 journées d'hospitalisation. **Entre 2019 et 2021**, comme nous l'avons constaté en 2020, la première année COVID-19, nous observons une augmentation statistiquement significative de l'incidence des septicémies associées à l'hôpital et des septicémies associées à un cathéter veineux central, tant au niveau de la Belgique dans son ensemble qu'au niveau des régions. **Au niveau de la Belgique, l'incidence des septicémies associées à l'hôpital a augmenté de 19% et celle des septicémies associées à un cathéter veineux central de 29%.**

En 2021, par rapport aux années précédant la crise COVID-19, nous avons trouvé proportionnellement plus de septicémies associées à l'hôpital ayant pour origine une infection pulmonaire avec intubation endotrachéale. Il y a également eu proportionnellement plus de septicémies associées à l'hôpital qui sont apparues dans l'unité de soins intensifs. Ces résultats suggèrent qu'il y avait **chez des patients avec une septicémie associée à l'hôpital ils y avaient plus des patients gravement malades par rapport aux années précédentes**.

En 2021, nous n'avons constaté aucun changement dans la tendance des incidences des septicémies associées à l'hôpital causées par des micro-organismes spécifiques, ni dans le profil de résistance aux antimicrobiens pour les micro-organismes impliqués. Les données sur la mortalité sont également similaires à celles des années précédant la crise COVID-19.

Recommandations

- Développer un plan de crise robuste et réalisable pour le secteur des soins de santé en Belgique, afin de pouvoir continuer à garantir des soins de haute qualité dans toutes les situations. Un tel plan est nécessaire à tous les niveaux, du niveau fédéral au niveau hospitalier, et doit être régulièrement actualisé.
- Poursuivre la surveillance des septicémies dans les hôpitaux belges afin de suivre et d'évaluer l'incidence des septicémies associées à l'hôpital et de celles associées à un cathéter veineux central pendant et après la crise COVID-19.
- Investiguer l'effet de l'évolution de la population de patients, consécutive à la crise COVID-19, sur l'augmentation de l'incidence des septicémies associées à l'hôpital et de celles associées à un cathéter veineux central.
- Pour garantir une bonne qualité des données (par exemple, problème avec ne pas déclarer toutes les septicémies associées à l'hôpital et des septicémies associées à un cathéter veineux central admissibles), envisager de rendre la participation à la surveillance volontaire. La publication d'une liste des hôpitaux qui participent annuellement peut améliorer la transparence concernant la participation à la surveillance. La publication de rapports publics disponibles trimestriellement au niveau national et régional pourrait être une motivation à continuer à participer à la surveillance.

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Abbreviations

A. baumannii	*Acinetobacter baumannii*
BSI	Bloodstream infection
CDC	Centre for Disease Control and Prevention
CI	Confidence interval
CL	Central line
CLABSI	Central line-associated bloodstream infection
COVID-19	Coronavirus disease 2019
CRBSI	Central line-related bloodstream Infection
EARS-Net	European Antimicrobial Resistance Surveillance Network
ECDC	European centre for disease prevention and control
E. coli	*Escherichia coli*
E. faecalis	*Enterococcus faecalis*
E. faecium	*Enterococcus faecium*
Gly	Glycopeptide
HABSI	Hospital-associated bloodstream infection
HOST	Hospital outbreak support teams
ICD-9-CM	International classification of diseases, 9th revision, clinical modification
ICD-10-CM	International classification of diseases, 10th revision, clinical modification
ICU	Intensive care unit
INAMI	Institut national d'assurance maladie-invalidité
IQR	interquartile range
K. aerogenes	*Klebsiella aerogenes*
K. oxytoca	*Klebsiella oxytoca*
K. pneumoniae	*Klebsiella pneumoniae*
LCBI	Laboratory-confirmed bloodstream infection
MBI	Mucosal barrier injury
MO	Microorganism
MRSA	Methicillin resistant *Staphylococcus aureus*
MZG/RHM	Minimale ziekenhuisgegevens/Résumé hospitalier minimum
NA	Not available
NSIH	National Surveillance of Infections in Hospitals (www.nsih.be), Belgium
NIHDI	National Institute for Health and Disability Insurance (INAMI-RIZIV)
pd	Patient-days
P. aeruginosa	*Pseudomonas aeruginosa*
P. mirabilis	*Proteus mirabilis*
R	Resistant
RIZIV	Rijksinstituut voor ziekte- en invaliditeitsverzekering
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
S. aureus	*Staphylococcus aureus*
S. epidermidis	*Staphylococcus epidermidis*
SD	Standard deviation
spp.	Species
VIKZ	Vlaams instituut voor kwaliteit van zorg

Glossary

Acute care hospital
An acute care hospital is a hospital defined as an acute hospital by the National Institute for Health and Disability Insurance (NIHDI) (INAMI-RIZIV) in April 2017[1].

Central line-associated bloodstream infection (CLABSI)
To be considered as CLABSI in the Belgian bloodstream infection surveillance, a CLABSI must first meet the surveillance definition for hospital-associated bloodstream infection (HABSI). Depending on surveillance information we then define three CLABSI classifications:
Confirmed CLABSI: Laboratory-confirmed bloodstream infection (LCBI) with clinical suspicion that a central line (CL) is the cause of the LCBI and the association between the LCBI and the CL is microbiologically confirmed (same microorganism found in blood culture and on CL).
Probable CLABSI: LCBI with clinical suspicion that a CL is the cause of the LCBI but no microbiological confirmation.
Possible CLABSI: LCBI not secondary to an infection at another body site – origin recorded in the surveillance form as 'unknown' - but CL present within the two days prior to the LCBI.

Device-associated hospital-associated bloodstream infection (device-associated HABSI)
A device-associated HABSI is a HABSI in a patient with a (relevant) device that was used within the 48-hour period before onset of infection (even if it was used only intermittently). 'Relevant device' refers to intubation (endotracheal tube), a vascular catheter (central or peripheral) or an indwelling urinary catheter.

Hospital-associated bloodstream infection (HABSI)
A laboratory-confirmed bloodstream infection (LCBI) with date of bloodstream infection (BSI) diagnosis (that is sample date of first positive blood culture) two days or more after admission at the hospital (infection date – admission date ≥ 2 days).

Intensive care unit-associated bloodstream infection (ICU-associated BSI)
LCBI with date of BSI diagnosis (that is sample date of first positive blood culture) two days or more after admission at the intensive care unit (ICU).

Laboratory-confirmed bloodstream infection (LCBI)
A BSI where an eligible BSI organism is identified by the laboratory. As part of the surveillance programme only LCBI are registered. This implies that when mentioning BSI or HABSI in the frame of this surveillance programme this is always considered a LCBI.

Long-term care facility
A long-term care facility is a hospital defined as a chronic hospital by NIHDI in April 2017[2].

Non hospital-associated bloodstream infection (Non-HABSI)
BSI diagnosed prior to the second day of hospitalisation.

Non-tertiary hospital

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[1] NIHDI - liste hôpitaux - april 2017: acute / chronic / psychiatric hospitals.
[2] NIHDI - liste hôpitaux - april 2017: acute / chronic / psychiatric hospitals.

Non-tertiary hospitals include hospitals defined in the list of the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg)[3] under 'type hospital' (soort ziekenhuis – type hôpital) as general hospital (Algemeen ziekenhuis - Hôpital general).

Patient-days
Patient-days (or hospitalisation days) are defined as the invoiced days of a patient admitted at the hospital as defined by the *résumé hospitalier minimal/minimale ziekenhuisgegevens* (RHM/MZG). This means that ambulatory patients, patients at day hospitalisation and at the emergency department (without staying overnight) are not included in the count of patient-days. See also chapter 1.3.1.2 at
http://www.nsih.be/download/Protocol_Noemermodule%20en%20gemeenschappelijk%20gebruikte%20referentielijsten%20en%20variabelen%20(PDF)_2018.pdf (Dutch version) and
http://www.nsih.be/download/Protocole_Module%20du%20dénominateur%20et%20listes%20de%20références%20et%20variables%20communes%20(PDF)_2018.pdf (French version).

Primary bloodstream infection
A primary BSI is a catheter-associated BSI or a BSI with unknown source.

Secondary bloodstream infection
A secondary BSI is a BSI secondary to an infection at another body site.

Tertiary hospital
Tertiary hospitals include hospitals defined in the list of the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg)[4] under 'type hospital' (soort ziekenhuis – type hôpital) as:
University hospital (Universitair ziekenhuis - Hôpital universitaire) and
General hospital with university characteristics (Algemeen ziekenhuis met universitair karakter - Hôpital général à caractère universitaire).

[3] List of hospitals provided by the Belgian ministry of health (*Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg*); List dated February 2022: *Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022*.
[4] List of hospitals provided by the Belgian ministry of health (*Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg*); List dated February 2022: *Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022*.

Executive summary

1. BACKGROUND

Hospital-associated bloodstream infections (HABSI) are an important cause of morbidity and mortality. Many HABSI, especially those associated with an invasive device, are preventable. The surveillance programme on bloodstream infections (BSI) in Belgian hospitals exists since 1992. In 2013, there was a major surveillance protocol review. Since 2014, participation in the surveillance for a minimum of 3 months per year is mandatory for acute care hospitals and since 2017, data collection and reporting is via the Healthdata platform.

The objective of the surveillance programme on HABSI in Belgian hospitals is to enhance the quality of care provided at the hospital by:

- monitoring HABSI trends at hospital and national level with the objective to enhance and evaluate preventive measures,
- monitoring causal microorganisms and their resistance profile.

This report provides a summary of the Belgian surveillance data up to and including 2021. An additional objective of this report is to assess the impact of COVID-19 on HABSI and CLABSI (central line-associated bloodstream infection) bloodstream infections.

2. RESULTS

In 2021, 100 out of 104 eligible hospitals participated in the BSI-surveillance. Forty-four percent of these hospitals participated throughout the whole year. Participation throughout the year serves best the objective of surveillance.

2.1. TRENDS OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

2.1.1. HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

Between 2013 and 2019, no trend in the incidence of HABSI in Belgian hospitals – hospital-wide and at intensive care unit (ICU) level – was observed. In 2021, as in 2020, we observed, comparing 2019 with 2021, a statistically significant increase in HABSI per 10,000 patient-days (pd) (Table 1). At hospital level, HABSI incidences per 10,000 pd increased by 19% from 8.3 in 2019 to 10.0 in 2021. At ICU level, the incidence of ICU-associated BSI per 10,000 pd increased by 35% from 32.4 in 2019 to 46.9 in 2021. The impact of the COVID-19 on the incidence of HABSI is the most plausible hypothesis to explain this increase.

Table 1: Incidence of hospital-associated bloodstream infections, hospital-wide and at ICU-level, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cumulative incidence per 1,000 admissions									
mean – hospital-wide*	5.6	5.8	5.6	5.2	5.5	5.8	5.5	6.8	6.3
mean – ICU-level**	14.3	14.1	13.6	14.8	13.9	15.5	16.4	28.5	27.0
Incidence density per 10,000 patient-days									
mean – hospital-wide*	7.8	8.1	8.1	7.7	8.3	8.7	8.3	10.4	10.0
mean – ICU-level**	32.2	31.8	29.9	31.9	29.5	31.1	32.4	50.5	46.9

ICU, intensive care unit
Notes:
* Total hospital-associated BSI/total admissions or patient-days at hospital-level
** Total ICU-associated BSI/total admissions or patient-days at ICU-level

2.1.2. CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

Central line-associated bloodstream infections (CLABSI) are classified as 'confirmed' (clinical suspicion that central line (CL) is the cause of the BSI, with microbiological confirmation), 'probable' (clinical suspicion, no microbiological confirmation), and 'possible' (BSI not secondary to an infection at another body site but CL present within the two days prior to the BSI).

CLABSI incidence (three classifications together) per 10,000 pd did not change substantially between 2013 and 2019, but similar to HABSI incidences, from 2019 to 2021 increased statistically significant by 29% from 2.0 CLABSI per 10,000 pd in 2019 to 2.6 in 2021 (Figure 1). In 2021, 36% were confirmed CLABSI, 31% probable CLABSI and 33% possible CLABSI.

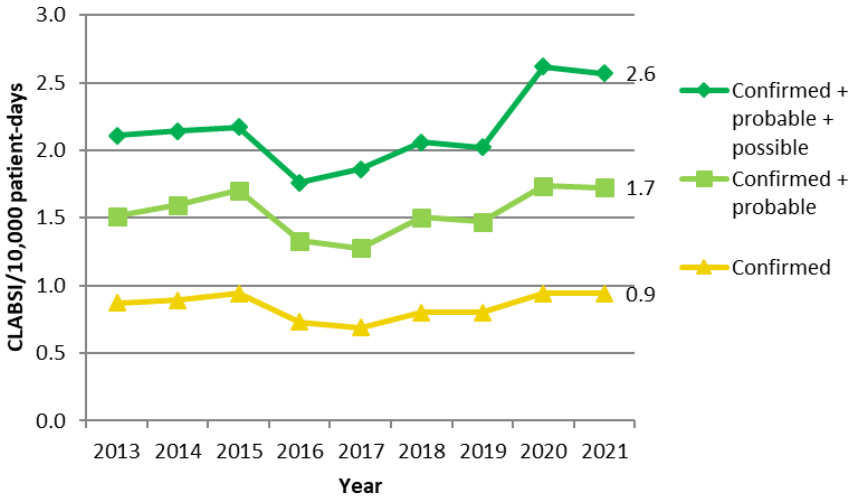


Figure 1: Mean incidence of central line-associated bloodstream infection hospital-wide, Belgium 2013-2021 (CLABSI, central line-associated bloodstream infections)

2.1.3. HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS PER MICROORGANISM, 2000-2021

Microorganism (MO) specific incidences of HABSI since 2000 for the most common MO are given in Figure 2. The incidence of HABSI with *S. aureus* did not change substantially over time. We observe a long-term trend of an increase in the incidence of HABSI with *E. coli*, *K. pneumoniae* and *E. faecium* as causal MO and a recent increase in the incidence of HABSI with *E. faecalis* as causal MO.

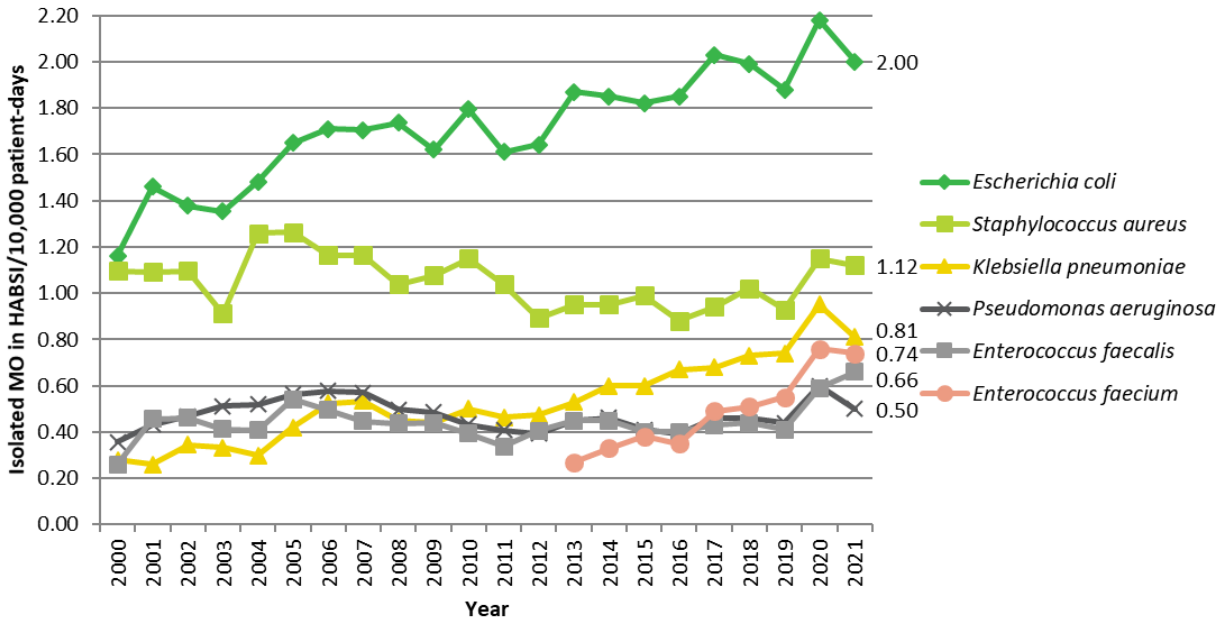


Figure 2: Mean incidence of hospital-associated bloodstream infections per microorganism, Belgium 2000-2021 (HABSI, hospital-associated bloodstream infections; MO, microorganism)

2.1.4. INCIDENCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS AT HOSPITAL LEVEL, 2021

In 2021, similar to previous years, there was a large variability in the reported incidence of HABSI between hospitals as shown in the boxplot[5] below where we notice several outliers (Figure 3).

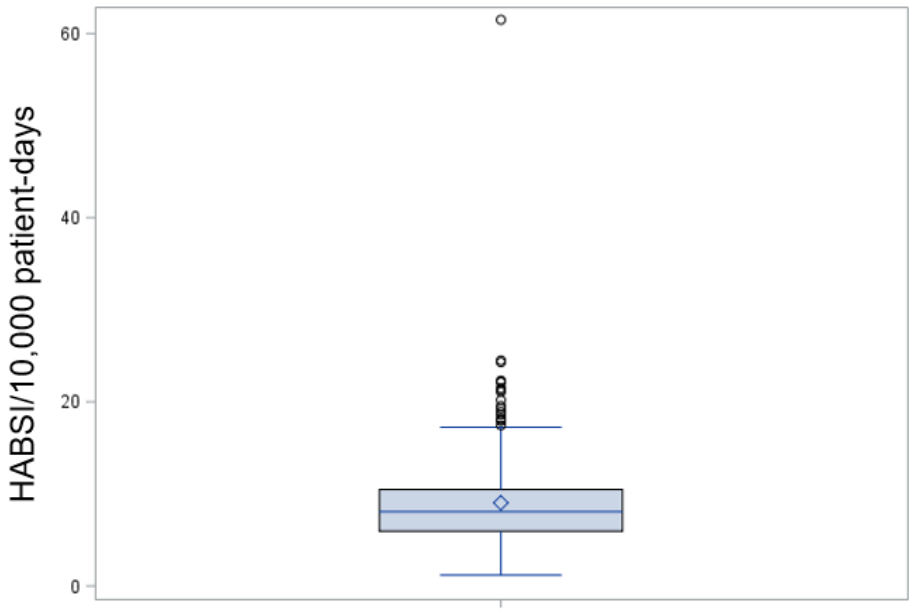


Figure 3: Hospital-associated bloodstream infections: incidence distribution across hospitals, Belgium, 2021 (HABSI, hospital-associated bloodstream infections)

[5] The boxplot displays the median incidence (blue line in the box) of the HABSI per 10,000 patient-days per hospital per participating quarter. The box limits represent the P25 and P75 values, the whiskers mark the lower and upper adjusted values (respectively P25 - 1.5 IQR and P75 + 1.5 IQR) and the dots represent the outliers (outside values). The diamond shape indicates the mean incidence density.

2.2. CHARACTERISTICS OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION, 2021

In 2021, 100 hospitals registered together 7,593 HABSI. Of all HABSI 28% occurred two days or later after admission at ICU (definition of ICU-associated BSI). Before 2020 the proportion of ICU-associated BSI was always around 20%. This proportion increased in 2020 (first COVID-19 year) to 27% and remains high in 2021 (28%).

Median number of days between admission in hospital and onset of HABSI was 12 days. Median age group of the patients was the 70-74 years of age group. Twenty percent of patients with HABSI died. However, there was a substantial amount of missing data for status at end-of-follow-up (26% missing data) and our data do not allow determining a causal link between death and infection.

The most common source of HABSI, hospital-wide, was a CL (26%)[6], followed by urinary tract infection (18%) (Figure 4). At ICU the most common source was a CL (38%) followed by pulmonary infection (30%). For 46% of the HABSI (hospital-wide) the infection source was confirmed (same MO isolated from blood cultures and the site considered to be the source of infection). An invasive device was directly (CL and other catheters or invasive manipulation) or indirectly (urinary catheter, endotracheal tube) associated in 45% of the hospital-wide HABSI and in 70% of the ICU-associated BSI.

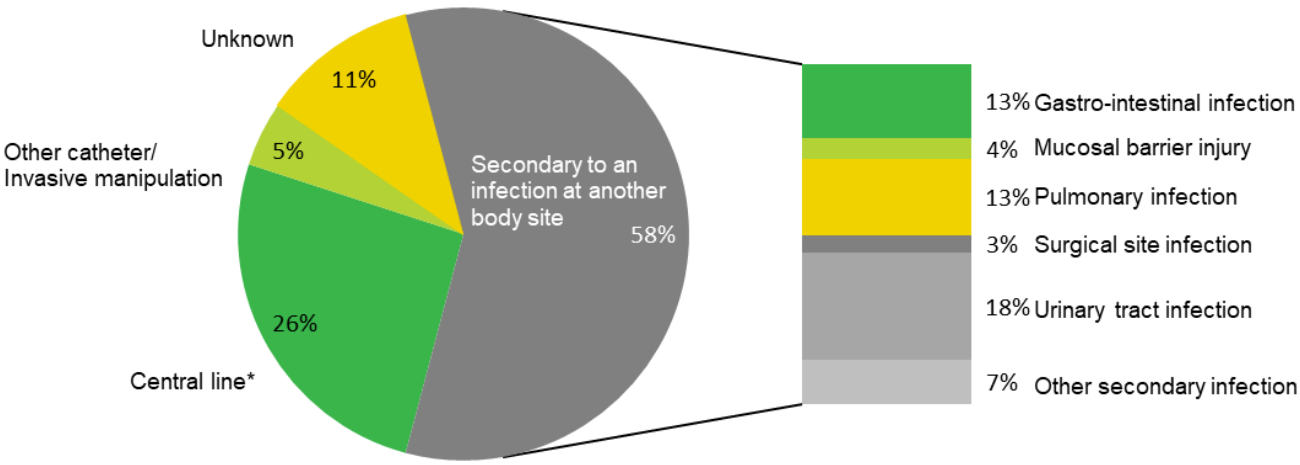


Figure 4: Source of hospital-associated bloodstream infections, Belgium 2021 (* Includes 'confirmed', 'probable' and 'possible' central line associated bloodstream infection)

[6] Including 'confirmed', 'probable' and 'possible' CLABSI

2.3. IDENTIFIED CAUSAL MICROORGANISMS AND THEIR ANTIMICROBIAL RESISTANCE PROFILE

The most common MO isolated from HABSI in 2021 were *E. coli* (19%), *S. aureus* (10%), and *S. epidermidis* (10%). Less than half of the hospitals reported a case of HABSI caused by a methicillin resistant *S. aureus* (MRSA) (Table 2).

Phenotypic antimicrobial resistance for selected markers is shown in Table 2. Between 2013 and 2021, the decrease in the proportion of MRSA (from 20.9% to 9.2%) was statistically significant. Other changes (if any) in proportion of resistant MO were not statistically significant.

Table 2: Resistance in microorganisms isolated from hospital-associated bloodstream infections, Belgium 2021

		Microorganisms 2021			% hospitals with >= one resistant case*
	Antibiotics	N	n	%	(N=100)
Staphylococcus aureus	Meti	859	79	9.2	41
	Gly	859	2	0.2	2
Enterococcus faecalis	Gly	496	4	0.8	2
Enterococcus faecium	Gly	570	14	2.5	11
Escherichia coli	C3G	1,527	199	13.0	63
	CAR	1,527	8	0.5	8
Klebsiella pneumoniae	C3G	611	174	28.5	57
	CAR	611	21	3.4	15
Enterobacter cloacae	C3G	271	103	38.0	43
	CAR	271	7	2.6	5
Proteus mirabilis	C3G	138	0	0.0	0
	CAR	138	0	0.0	0
Klebsiella oxytoca	C3G	202	31	15.3	20
	CAR	202	3	1.5	2
Klebsiella aerogenes	C3G	96	50	52.1	30
	CAR	96	2	2.1	2
Pseudomonas aeruginosa	CAR	380	92	24.2	35
Acinetobacter baumannii	CAR	26	1	3.8	1

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, methicillin; n, number resistant MO; N, total number MO; %, percent resistant MO
* hospitals participated 1, 2, 3 or 4 quarters

3. DETAILED RECOMMENDATIONS

Recommendations for policy makers

- Continue to support and enable infection prevention and control teams at hospitals in their responsibilities and tasks to decrease HABSI, among others through the 'Hospital Outbreak Support Teams (HOST)[7] projects. More focus on infection prevention and control in pre-service training (medical and nursing schools) would be useful.
- As part of broader quality of care improvement initiatives, enhance the creation of a general culture of good quality of care practice at hospital level. This includes the creation of a supportive, safe, secure and not judging hospital environment in which internal quality audits conducted by the hospital infection prevention and control teams can be implemented. If needed, this can be enhanced though the HOST projects.
- Continue to support a national organised surveillance of HABSI to assess changes in HABSI incidence at national and hospital level. Especially in the frame of the COVID-19 crisis it is very important to continue this surveillance, this to assess the impact of the COVID-19 crisis on the occurrence of HABSI and to be able to formulate, if needed, measures, guidelines and actions to strengthen quality of care and infection prevention and control management in times of a health crisis (lessons learned).
- The COVID-19 crisis stressed the importance to enhance a sound infection prevention and control policy at national and hospital level.
- To improve data quality (e.g. issues with not reporting all eligible HABSI and CLABSI), consider making participation on the surveillance voluntary. Publishing a list of hospitals that yearly participate may enhance transparency regarding participation at this surveillance. Publication of quarterly available public reports with data on national and regional level might be an incentive to continue participating in the surveillance.

Recommendations for hospitals

- Assess if there is still room for decrease of HABSI and, if needed, implement actions and activities to establish HABSI decrease. The organisation of internal HABSI audits conducted by the local infection prevention and control team is suggested.
- Continue recording and reporting HABSI data in the national BSI surveillance to be able to evaluate the HABSI situation at hospital level over time and evaluate the impact of locally implemented activities to decrease HABSI incidences and of locally occurred events on this HABSI incidence. Especially in the frame of the COVID-19 crisis it is very important to continue this reporting and recording, this to assess the impact of the COVID-19 crisis on the occurrence of HABSI and to be able to formulate, if needed, measures, guidelines and actions to strengthen quality of care and infection prevention and control management in times of a health crisis (lessons learned).

Recommendations for the scientists in charge of the surveillance (Sciensano)

- Assess why there was between 2013 and 2019, no decline in HABSI incidence in Belgian hospitals at national level. This can be done by assessing if same hospitals have consistently better or worse HABSI incidences and if so, assess through an additional study why this is the case. Or, by comparing hospitals with a low HABSI incidence with similar hospitals with a high incidence and assess reasons for this difference.

[7] See: https://organesdeconcertation.sante.belgique.be/fr/host-faqs

- Assess if the in the BSI surveillance asked antibiotic resistance data should be updated to be streamlined with international recommendations.
- Streamline between the other Sciensano surveillances the collection of antibiotic resistance data to avoid same data are asked several times.
- Continue implementing the surveillance of BSI in Belgian hospitals which includes a yearly update of protocol and data collection tool. Consider making participation on this surveillance voluntary.
- Further improve the Healthdata data collection and reporting tool (Healthstat).

Nederlandstalige samenvatting

1. ACHTERGROND

Ziekenhuis-geassocieerde bloedstroominfecties zijn een belangrijke oorzaak van morbiditeit en mortaliteit. Vele van deze bloedstroominfecties zijn te voorkomen, vooral deze geassocieerd met invasieve hulpmiddelen ('*invasive devices*'). De surveillance van bloedstroominfecties in het ziekenhuis bestaat in België sinds 1992. In 2013 vond een belangrijke aanpassing van het protocol plaats. Sinds 2014 is deelname aan de surveillance gedurende minimaal 1 kwartaal per jaar wettelijk verplicht voor acute ziekenhuizen en sinds 2017 gebeurt de gegevensverzameling en rapportage via het Healthdata platform.

De doelstelling van de bloedstroominfectie surveillance in Belgische ziekenhuizen is de kwaliteit van de zorg in Belgische ziekenhuizen te versterken door:

- het opvolgen van de trends van bloedstroominfecties, zowel op ziekenhuis als nationaal niveau, met als doel preventieve maatregelen te evalueren en te sturen,
- het opvolgen van de oorzakelijke micro-organismen en hun resistentieprofiel.

Dit rapport is een samenvatting van de Belgische surveillancegegevens tot en met 2021. Een bijkomende doelstelling is het beoordelen van de impact van COVID-19 op HABSI en CLABSI.

2. RESULTATEN

In 2021 namen 100 van de 104 ziekenhuizen die in aanmerking komen deel aan de bloedstroominfectie surveillance. Vierenveertig percent van de ziekenhuizen registreerden gegevens voor het hele jaar. Deelname gedurende het hele jaar beantwoordt best aan de doelstelling van surveillance.

2.1. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIE TRENDS

2.1.1. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIES, 2013-2021

Tussen 2013 en 2019 bleef de incidentie van ziekenhuis-geassocieerde bloedstroominfectie voor het hele ziekenhuis en voor de intensieve zorgen afdeling ongeveer hetzelfde (Tabel 1). In 2021, net zoals in 2020, was er tussen 2019 en 2021 een statistisch significante stijging van ziekenhuis-geassocieerde bloedstroominfectie per 10.000 ligdagen (Tabel 1). De gemiddelde ziekenhuis-geassocieerde bloedstroominfectie incidentie per 10.000 ligdagen steeg voor het hele ziekenhuis met 19% van 8,3 in 2019 tot 10,0 in 2021. Voor de bloedstroominfecties die 2 dagen of later na opname op intensieve zorgen optraden steeg de incidentie per 10.000 ligdagen met 35% van 32,4 in 2019 tot 46,9 in 2021. De impact van het COVID-19 op de HABSI incidentie is de meest plausibele hypothese om deze stijging te verklaren.

Tabel 1: Ziekenhuis-geassocieerde bloedstroominfectie incidentie, ziekenhuis-breed en op intensieve zorgen afdeling, België 2013-2021

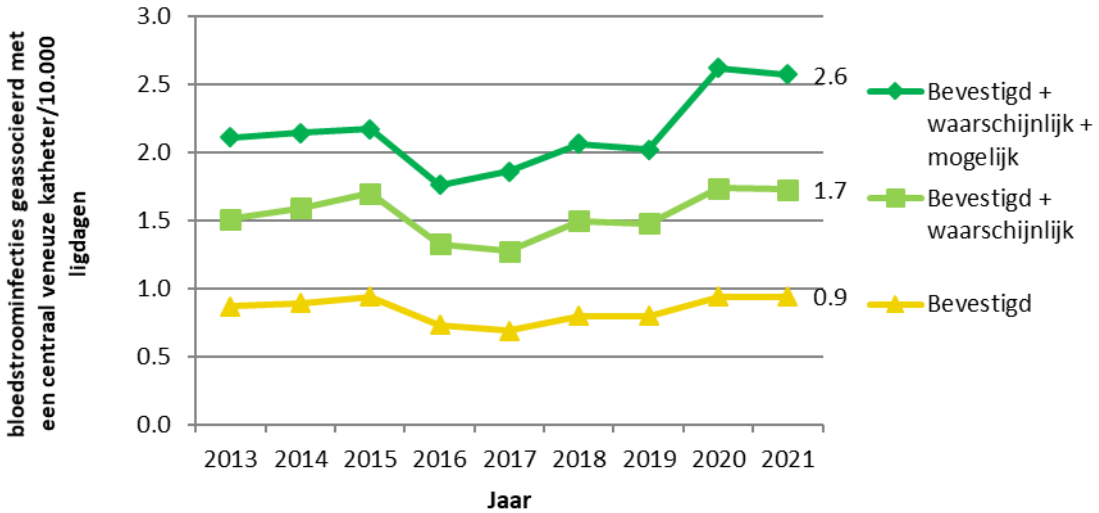
Jaar	2013	2014	2015	2016	2017	2018	2019	2020	2021
Cumulatieve incidentie per 1.000 opnames									
gemiddelde – ziekenhuis-breed*	5,6	5,8	5,6	5,2	5,5	5,8	5,6	6,8	6,3
gemiddelde – op intensieve zorgen afdeling**	14,3	14,1	13,6	14,8	13,9	15,5	16,4	28,5	27,0
Incidentie dichtheid per 10.000 ligdagen									
gemiddelde – ziekenhuis-breed *	7,8	8,1	8,1	7,7	8,3	8,7	8,3	10,4	10,0
gemiddelde – op intensieve zorgen afdeling **	32,2	31,8	29,9	31,9	29,5	31,1	32,4	50,5	46,9

* Totaal aantal ziekenhuis-geassocieerde bloedstroominfecties/totaal aantal opnames of ligdagen op ziekenhuis niveau
** Totaal aantal intensieve zorgen afdeling-geassocieerde bloedstroominfecties/totaal aantal opnames of ligdagen op de intensieve zorgen afdeling

2.1.2. BLOEDSTROOMINFECTIES GEASSOCIEERD MET EEN CENTRAAL VENEUZE KATHETER, 2013-2021

Bloedstroominfecties geassocieerd met een centraal veneuze katheter worden ingedeeld als 'bevestigd' (klinisch vermoeden dat de centraal veneuze katheter de oorzaak is van de bloedstroominfectie en microbiologische bevestiging), 'waarschijnlijk' (klinisch vermoeden maar geen microbiologische bevestiging) en 'mogelijk' (bloedstroominfectie niet secundair aan een infectie op een andere lichaamsplaats maar centraal veneuze katheter aanwezig gedurende de twee dagen voorafgaand aan de bloedstroominfectie).

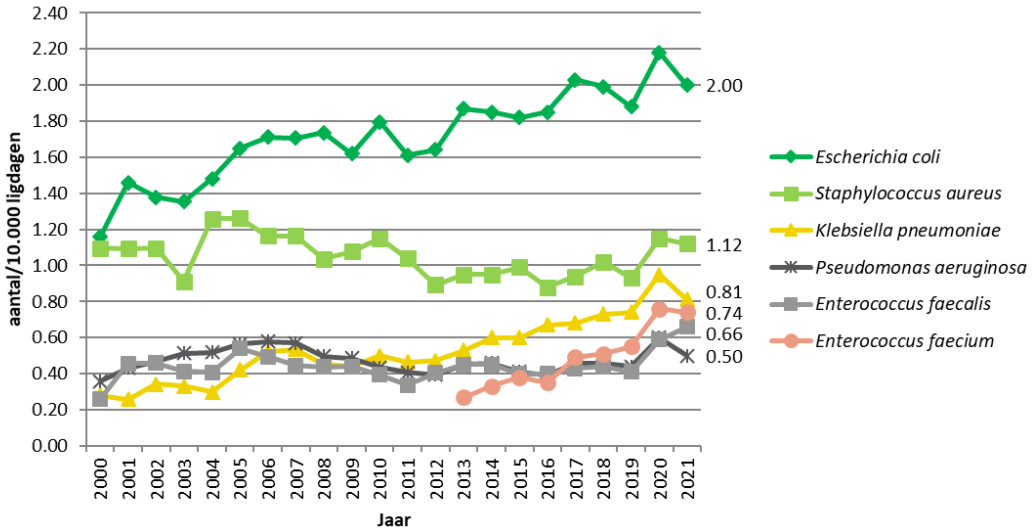
De incidentie van bloedstroominfecties geassocieerd met een centraal veneuze katheter (drie classificaties samen) per 10.000 ligdagen bleef tussen 2013 en 2019 ongeveer hetzelfde. Echter, zoals ook bij de incidentie van ziekenhuis-geassocieerde bloedstroominfectie, steeg deze incidentie tussen 2019 en 2021 statistisch significant met 29% van 2,0 bloedstroominfecties geassocieerd met een centraal veneuze katheter per 10.000 ligdagen in 2019 tot 2,6 in 2021 (Figuur 1). In 2021 was van alle bloedstroominfecties geassocieerd met een centraal veneuze katheter 36% 'bevestigd', 31% 'waarschijnlijk' en 33% 'mogelijk'.



Figuur 1: Gemiddelde incidentie van bloedstroominfecties geassocieerd met een centraal veneuze katheter, ziekenhuis-breed, België 2013-2021

2.1.3. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIES PER MICRO-ORGANISME, 2000-2021

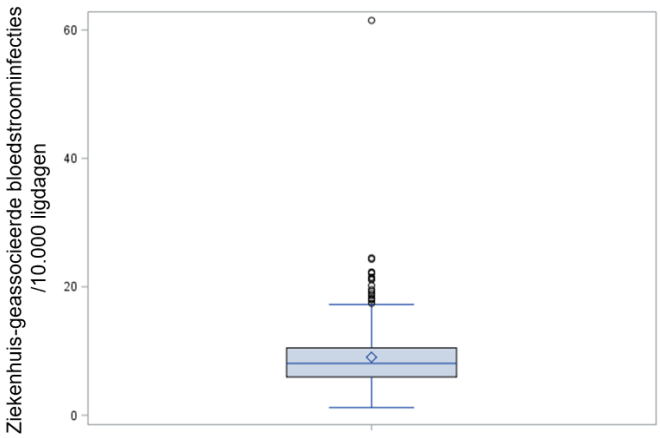
Figuur 2 geeft voor de meest voorkomende micro-organismen de micro-organismen-specifieke ziekenhuis-geassocieerde bloedstroominfectie incidentie vanaf 2000. De incidentie van bloedstroominfecties veroorzaakt door *S. aureus* bleef ongeveer gelijk. We zien een trend op lange termijn in toename van de incidentie van ziekenhuis-geassocieerde bloedstroominfecties veroorzaakt door *E. coli*, *K. pneumoniae* en *E. faecium.* en een recente toename van de incidentie van ziekenhuis-geassocieerde bloedstroominfecties veroorzaakt door *E. faecalis*.



Figuur 2: Gemiddelde incidentie van ziekenhuis-geassocieerde bloedstroominfecties per micro-organisme, België 2000-2021

2.1.4. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIE INCIDENTIE OP ZIEKENHUIS NIVEAU, 2021

Zoals de vorige jaren, was er ook in 2020 een grote variabiliteit tussen de ziekenhuizen in ziekenhuis-geassocieerde bloedstroominfectie incidentie. Dit is duidelijk in de boxplot[8] (Figuur 3) waar we verschillende uitschieters waarnemen.



Figuur 3: Ziekenhuis-geassocieerde bloedstroominfectie incidentie: incidentie verdeling per ziekenhuis, België 2021

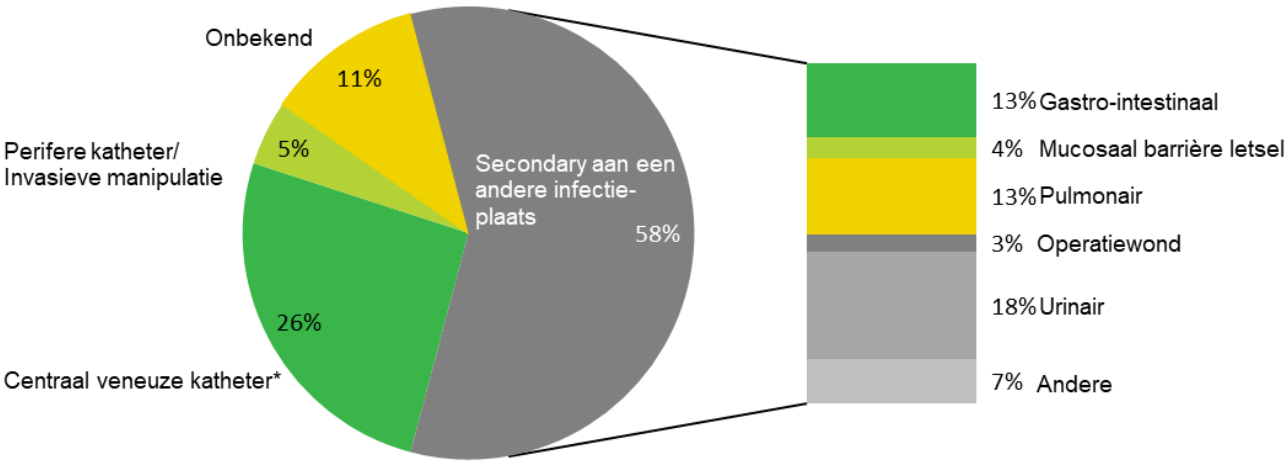
[8] De boxplot toont de ziekenhuis-geassocieerde bloedstroominfectie incidentie mediaan (blauwe lijn in de rechthoek) per 10.000 ligdagen per ziekenhuis per kwartaal dat het ziekenhuis deelnam aan de surveillance. De bovenste en onderste lijn van de rechthoek geven respectievelijk het 3de en 1ste kwartiel weer. De verticale lijnen strekken zich uit van de onder- en bovengrens van de rechthoek tot maximaal 1,5 keer de breedte van de rechthoek (de 1,5 interkwartielafstand) en de punten onder en boven deze lijnen geven de uitschieters weer. De diamantvorm geeft de gemiddelde incidentiedichtheid per 10.000 ligdagen.

2.2. KENMERKEN ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIES, 2021

In 2021 registreerden 100 ziekenhuizen 7,593 ziekenhuis-geassocieerde bloedstroominfecties. Van alle ziekenhuis-geassocieerde bloedstroominfecties ontstond 28% twee of meer dagen na opname op intensieve zorgen (definitie van intensieve zorgen-geassocieerde bloedstroominfectie). Vóór 2020 lag de proportie van intensieve zorgen-geassocieerde bloedstroominfectie altijd rond 20%. Deze proportie steeg in 2020 (eerste COVID-19 jaar) tot 27% en blijft hoog in 2021 (28%).

In de helft van de ziekenhuis-geassocieerde bloedstroominfecties werd de diagnose 12 dagen of meer na ziekenhuisopname gesteld. De helft van de patiënten behoorde tot de leeftijdsgroep 70-74 jarige of ouder en 20% van de patiënten overleed. Er was echter een aanzienlijke hoeveelheid ontbrekende follow-up gegevens (26% ontbrekende gegevens) en onze gegevens laten evenmin toe om een oorzakelijk verband tussen overlijden en bloedstroominfectie te bepalen.

De meest voorkomende vermoedelijke oorsprong van ziekenhuis-geassocieerde bloedstroominfecties, ziekenhuis-breed, was een centraal veneuze katheter (26%)[9], gevolgd door een urineweginfectie (18%) (Figuur 4). Op intensieve zorgen was de meest voorkomende vermoedelijke oorsprong een centraal veneuze katheter (38%) gevolgd door longinfectie (30%). De oorsprong van ziekenhuis-geassocieerde bloedstroominfecties (ziekenhuis-breed) werd in 46% van de gevallen bevestigd (zelfde micro-organisme geïsoleerd in bloedkwe(e)k(en) en vermoedelijke infectiebron). Een invasief hulpmiddel was rechtstreeks (centraal veneuze of andere katheter of invasieve manipulatie) of onrechtstreeks (urineweg sonde of endotracheale tube) geassocieerd met de infectie in 45% van de ziekenhuis-brede ziekenhuis-geassocieerde bloedstroominfecties en in 70% van de intensieve zorgen-geassocieerde bloedstroominfecties.



Figuur 4: Vermoedelijke oorsprong van ziekenhuis-geassocieerde bloedstroominfecties, België 2021 (* Omvat 'bevestigde', 'waarschijnlijke' en 'mogelijke' bloedstroominfecties geassocieerd met een centraal veneuze katheter)

[9] Omvat 'bevestigde', 'waarschijnlijke' en 'mogelijke' bloedstroominfecties geassocieerd met een centraal veneuze katheter

2.3. GEIDENTIFICEERDE OORZAKELIJKE MICRO-ORGANISMEN EN HUN RESISTENTIE PROFIEL

E. coli (19%), *S. aureus* (10%) en *S. epidermidis* (10%) waren in 2021 de meest voorkomende micro-organismen in ziekenhuis-geassocieerde bloedstroominfecties. Minder dan de helft van de ziekenhuizen rapporteerde een ziekenhuis-geassocieerde bloedstroominfectie veroorzaakt door een methicilline resistente *S. aureus* (Tabel 2).

Tabel 2 geeft antimicrobiële resistentie voor geselecteerde markers. Van 2013 tot 2021 was de daling in de proportie van methicilline-resistentie *S. aureus* (van 20,9% naar 9,2%) statistisch significant. Andere veranderingen (indien aanwezig) waren niet statistisch significant.

Tabel 2: Resistentie in micro-organismen geïsoleerd uit ziekenhuis-geassocieerde bloedstroominfecties, België 2021

		Micro-organismen 2021			% ziekenhuizen met minstens 1 resistent geval* (N=100)
	Antibiotica	N	n	%	
Staphylococcus aureus	Meti	859	79	9,2	41
	Gly	859	2	0,2	2
Enterococcus faecalis	Gly	496	4	0,8	2
Enterococcus faecium	Gly	570	14	2,5	11
Escherichia coli	C3G	1,527	199	13,0	63
	CAR	1,527	8	0,5	8
Klebsiella pneumoniae	C3G	611	174	28,5	57
	CAR	611	21	3,4	15
Enterobacter cloacae	C3G	271	103	38,0	43
	CAR	271	7	2,6	5
Proteus mirabilis	C3G	138	0	0,0	0
	CAR	138	0	0,0	0
Klebsiella oxytoca	C3G	202	31	15,3	20
	CAR	202	3	1,5	2
Klebsiella aerogenes	C3G	96	50	52,1	30
	CAR	96	2	2,1	2
Pseudomonas aeruginosa	CAR	380	92	24,2	35
Acinetobacter baumannii	CAR	26	1	3,8	1

C3G, derde generatie cefalosporines (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem); Gly, glycopeptides (vancomycine, teicoplanine); Meti, methicilline; N, aantal; %, percent resistente micro-organismen

* Ziekenhuizen namen deel gedurende 1, 2, 3 of 4 kwartalen.

3. AANBEVELINGEN

Aanbevelingen voor beleidsmakers

- Blijf infectie controle teams in ziekenhuizen ondersteunen en de mogelijkheid bieden, onder andere via de '*hospital outbreak support teams'* HOST[10] projecten, om hun taken en verantwoordelijkheden uit te oefenen, dit met als doel het aantal ziekenhuis-geassocieerde bloedstroominfecties te doen dalen. Meer aandacht voor infectiepreventie en -controle training in de medische opleidingen (geneeskunde- en verpleegkunde-opleidingen) zou nuttig zijn.
- Ondersteun in zorginstellingen, als deel van een algemeen beleid om de kwaliteit van ziekenhuiszorg te verbeteren, het creëren van een algemene cultuur voor kwaliteitsvolle zorg. Dit omvat het creëren van een ondersteunende, veilige en niet-beschuldigende ziekenhuisomgeving waarin interne zorgkwaliteit-audits kunnen plaatsvinden. Indien nodig kan dit via de HOST-projecten gedaan worden.
- Doorgaan met de ondersteuning van een nationale ziekenhuis-geassocieerde bloedstroominfectie surveillance om veranderingen in ziekenhuis-geassocieerde bloedstroominfectie incidentie op nationaal en ziekenhuis-niveau op te volgen. Vooral in het kader van de COVID-19-crisis is het van groot belang om deze surveillance verder te zetten, dit om de impact van de COVID-19-crisis op het ontstaan van ziekenhuis-geassocieerde bloedstroominfecties te evalueren en om, indien nodig, maatregelen, richtlijnen en acties te formuleren om de kwaliteit van de zorg en het infectiepreventie en -controlebeleid en management in tijden van een gezondheidscrisis bij te sturen en te optimaliseren.
- De huidige COVID-19-crisis benadrukt het belang van het versterken en ondersteunen van een goed werkend infectiepreventie en -controlebeleid en management op nationaal en ziekenhuisniveau.
- Om de kwaliteit van de gegevens te verbeteren (bijvoorbeeld het niet rapporteren van alle in aanmerking komende HABSI en CLABSI), moet overwogen worden om deelname aan de surveillance vrijwillig te maken. Publicatie van een lijst van deelnemende ziekenhuizen die jaarlijks deelnemen kan de transparantie over de deelname aan deze surveillance vergroten. Publicatie van driemaandelijkse publiek beschikbaar rapport met gegevens op nationaal en regionaal niveau kan een stimulans zijn om aan de surveillance te blijven deelnemen.

Aanbevelingen voor ziekenhuizen

- Onderzoek of een vermindering van het aantal ziekenhuis-geassocieerde bloedstroominfectie nog mogelijk is en, indien nodig, implementeer maatregelen en activiteiten om het aantal ziekenhuis-geassocieerde bloedstroominfectie te doen dalen. Hiervoor wordt de organisatie van interne audits uitgevoerd door lokale infectiepreventie en controle teams voorgesteld.
- Ga door met het registreren en rapporteren van ziekenhuis-geassocieerde bloedstroominfectie gegevens in de nationale bloedstroominfectie surveillance dit om de ziekenhuis-geassocieerde bloedstroominfectie situatie in de tijd en de impact van lokaal geïmplementeerde activiteiten en van lokaal optredende gebeurtenissen op de ziekenhuis-geassocieerde bloedstroominfectie incidentie te kunnen evalueren. Vooral in het kader van de COVID-19-crisis is het zeer belangrijk om deze rapportage en registratie verder te zetten, dit om de impact van de COVID-19-crisis op het ontstaan van ziekenhuis-geassocieerde bloedstroominfecties te evalueren en om, indien nodig, maatregelen, richtlijnen en acties te formuleren om de kwaliteit van de zorg en het infectiepreventie en -controlebeleid en management in tijden van een gezondheidscrisis bij te sturen en te optimaliseren.

[10] HOST zie: https://overlegorganen.gezondheid.belgie.be/nl/host-faqs

Aanbevelingen voor de wetenschappers verantwoordelijk voor de surveillance (Sciensano)

- Onderzoek waarom tussen 2013 en 2019 de ziekenhuis-geassocieerde bloedstroominfectie incidentie in Belgische ziekenhuizen op nationaal niveau niet is gedaald. Dit kan worden gedaan door te onderzoeken of dezelfde ziekenhuizen consistent een betere of slechtere bloedstroominfectie incidentie hadden en indien dit het geval is, met een bijkomende studie nagaan waarom dit zo is. Of, door ziekenhuizen met een lage ziekenhuis-geassocieerde bloedstroominfectie incidentie te vergelijken met vergelijkbare ziekenhuizen met een hogere incidentie en de oorzaak van dit verschil in incidentie te onderzoeken.
- Nagaan of de antibiotica-resistentiegegevens die momenteel in de bloedstroominfecties surveillance verzameld worden moeten worden aangepast om ze in overeenstemming te brengen met de internationale aanbevelingen.
- De verzameling van antibioticaresistentie gegevens tussen de Sciensano surveillances stroomlijnen om te voorkomen dat dezelfde gegevens verschillende keren worden gevraagd.
- Verder gaan met de bloedstroominfectie surveillance in Belgische ziekenhuizen. Dit omvat een jaarlijkse update van het protocol en de gegevensverzamelingstool.
- Verdere verbetering van het Healthdata gegevensverzamelingstool en rapportageplatform (Healthstat).

Résumé en français

1. CONTEXTE

Les septicémies associées à l'hôpital sont une source importante de morbidité et de mortalité. Nombre d'entre elles sont évitables, en particulier celles qui sont associées à des dispositifs invasifs (« *invasive devices* »). En Belgique, ces infections font l'objet d'une surveillance depuis 1992. Le protocole a été revu en 2013, pour mettre l'accent sur l'utilité de la récolte de données en vue d'orienter et d'évaluer les mesures de prévention. Depuis 2014, la participation à la surveillance est une obligation légale pour les hôpitaux aigus à raison d'au moins un trimestre par an et depuis 2017, la collecte et la visualisation des données se font via la plateforme Healthdata

L'objectif de la surveillance des septicémies dans les hôpitaux belges est d'améliorer la qualité des soins dans les hôpitaux belges par:

- le suivi des tendances des septicémies, tant au niveau local qu'au niveau national, dans le but de guider et d'évaluer les efforts de prévention,
- le suivi des micro-organismes impliqués et de leur profil de résistance.

Le présent rapport résume les données de surveillance belges jusqu'en 2021 inclus. Un objectif supplémentaire de ce rapport est d'évaluer l'impact de la COVID-19 sur les septicémies associées à l'hôpital et les septicémies associées au cathéter veineux central.

2. RÉSULTATS

En 2021, 100 des 104 hôpitaux éligibles ont participé à la surveillance des septicémies. Parmi eux, 44% ont enregistré des données sur l'ensemble de l'année. L'enregistrement en continu sert mieux l'objectif de la surveillance.

2.1. TENDANCES DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL

2.1.1. SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, 2013-2021

Entre 2013 et 2019, l'incidence des septicémies associées à l'hôpital est resté stable tant au niveau de tout l'hôpital, qu'au niveau des unités de soins intensifs. Par rapport à 2019, nous avons observé, en 2021 comme en 2020, une augmentation statistiquement significative des septicémies associées à l'hôpital pour 10 000 journées d'hospitalisation (Tableau 1).

Au niveau de tout l'hôpital, l'incidence moyenne des septicémies associées à l'hôpital pour 10 000 journées d'hospitalisation a augmenté de 19%, passant 8,3 en 2019 à 10,0 en 2021. Au niveau des unités de soins intensifs, l'incidence des septicémies survenant deux jours ou plus après l'admission dans une unité de soins intensifs par 10 000 journées d'hospitalisation a augmenté de 35%, passant de 32,4 en 2019 à 46,9 en 2021. L'impact du COVID-19 sur l'incidence des septicémies associées à l'hôpital est l'hypothèse la plus plausible pour expliquer cette augmentation.

Tableau 1 : Incidence des septicémies associées à l'hôpital, au niveau de tout l'hôpital et de l'unité de soins intensifs, Belgique 2013-2021

Année	2013	2014	2015	2016	2017	2018	2019	2020	2021
Incidence cumulative pour 1000 admissions									
moyenne – au niveau de tout l'hôpital*	5,6	5,8	5,6	5,2	5,5	5,8	5,6	6,8	6,3
moyenne – unité de soins intensifs**	14,3	14,1	13,6	14,8	13,9	15,5	16,4	28,5	27,0
Incidence pour 10 000 journées d'hospitalisation									
moyenne – au niveau de tout l'hôpital*	7,8	8,1	8,1	7,7	8,3	8,7	8,3	10,4	10,0
moyenne – unité de soins intensifs**	32,2	31,8	29,9	31,9	29,5	31,1	32,4	50,5	46,9

* nombre total de septicémies associées à l'hôpital / nombre total d'admissions ou de journées d'hospitalisation au niveau de tout l'hôpital
** nombre total de septicémies associées aux unités de soins intensifs / nombre total d'admissions ou de journées d'hospitalisation aux soins intensifs

2.1.2. SEPTICÉMIES ASSOCIÉES AU CATHÉTER VEINEUX CENTRAL, 2013-2021

Les septicémies associées au cathéter veineux central sont classifiées comme : « confirmées » (suspicion clinique que le cathéter veineux central est à l'origine de l'infection et confirmation microbiologique), « probables » (suspicion clinique, mais pas de confirmation microbiologique) et « possibles » (septicémies non secondaires à une infection d'un autre site mais présence d'un cathéter veineux central dans les deux jours précédant l'infection).

L'incidence des septicémies associées au cathéter veineux central (trois classifications ensemble) par 10 000 journées d'hospitalisation n'a pas changé de manière significative entre 2013 et 2019. Cependant, comme pour les septicémies associées à l'hôpital, entre 2019 et 2021, elle a augmenté de manière statistiquement significative de 29%, passant de 2,0 septicémies associées au cathéter veineux central pour 10 000 journées d'hospitalisation en 2019 à 2,6 en 2021 (Figure 1). En 2021, parmi ces septicémies, 36% étaient « confirmées », 31% « probables » et 33% « possibles ».

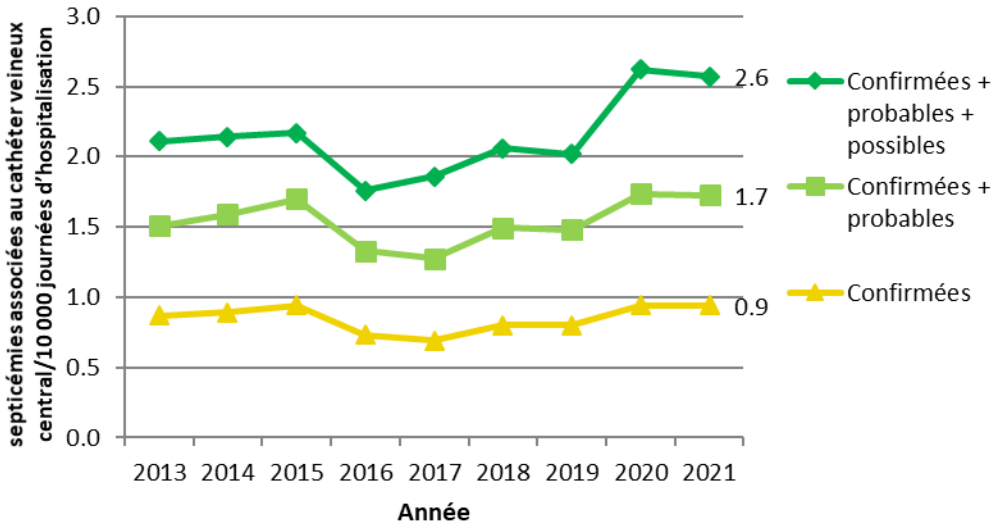


Figure 1 : Incidence moyenne des septicémies associées au cathéter veineux central au niveau de tout l'hôpital, Belgique, 2013-2021

2.1.3. SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, PAR MICRO-ORGANISME, 2000-2021

Les incidences des septicémies associées à l'hôpital par micro-organisme sont présentées dans la Figure 2, depuis l'année 2000 et pour les micro-organismes les plus communs. L'incidence des septicémies à *S. aureus* est restée plus ou moins stable. Nous observons une tendance à long terme à l'augmentation de l'incidence des septicémies associées à l'hôpital avec *E.coli, K. pneumoniae* et *E. faecium* comme micro-organisme causal et une augmentation récente de l'incidence des septicémies associées à l'hôpital avec *E. faecalis* comme micro-organisme causal.

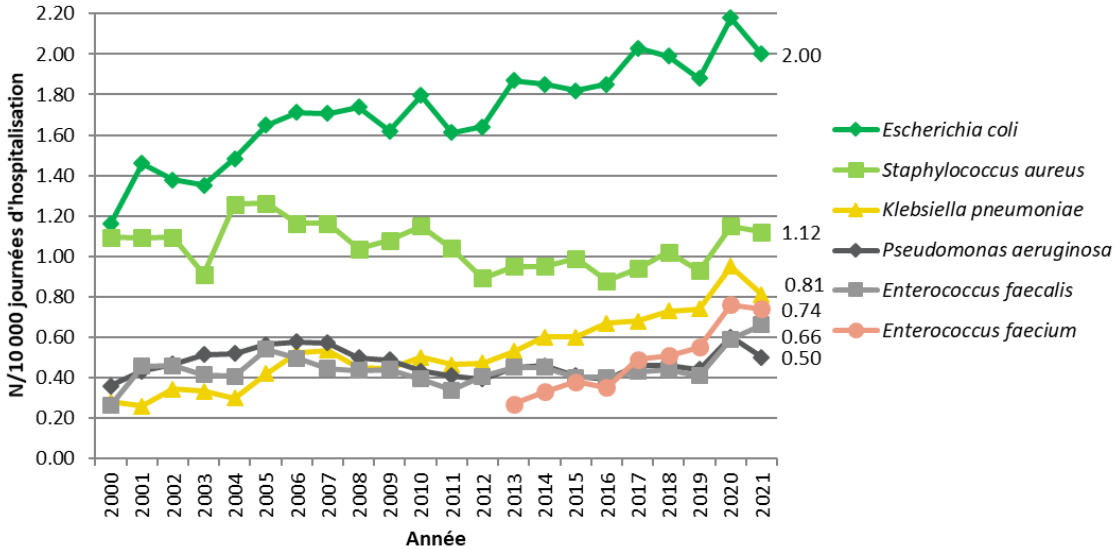


Figure 2 : Incidence moyenne des septicémies associées à l'hôpital par micro-organisme, Belgique, 2000-2021

2.1.4. INCIDENCE DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL AU NIVEAU DE L'HÔPITAL, 2021

Comme les années précédentes, on observe en 2021 une grande variabilité de l'incidence des septicémies associées à l'hôpital d'un hôpital à un autre. Cet aspect est clairement visible dans la boîte à moustaches[11] (Figure 3), qui fait apparaître plusieurs valeurs extrêmes.

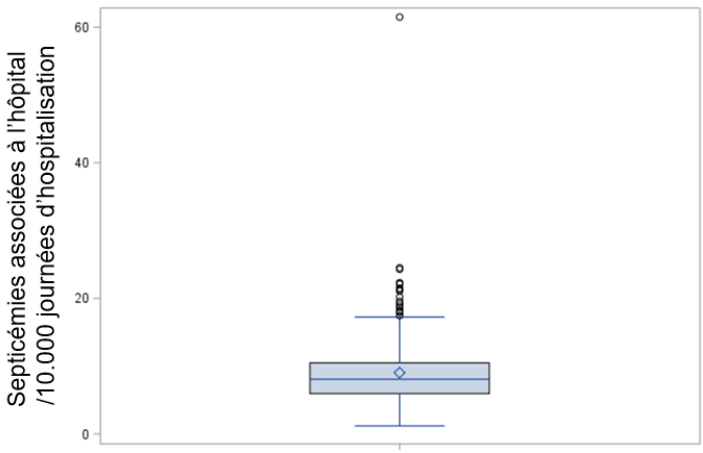


Figure 3 : Incidence des septicémies associées à l'hôpital, par hôpital, Belgique, 2021

[11] La boîte à moustaches montre l'incidence médiane des septicémies associées à l'hôpital (ligne bleue dans la boîte) pour 10 000 journées d'hospitalisation, par hôpital et par trimestre de participation. La ligne du haut et la ligne du bas de la boîte représentent respectivement le 3e et le 1er quartile. Les lignes verticales indiquent ces mêmes valeurs, ajustées d'1.5 X l'écart interquartile (Q3 + 1.5 écart interquartile et Q1 - 1.5 écart interquartile respectivement) et les points indiquent les valeurs extrêmes. Le losange représente l'incidence moyenne pour 10 000 journées d'hospitalisation.

2.2. CARACTÉRISTIQUES DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, 2021

En 2021, les 100 hôpitaux participants ont enregistré 7 593 septicémies associées à l'hôpital. De toutes les septicémies associées à l'hôpital, 28% sont apparues deux jours ou plus après une admission aux soins intensifs (définition des septicémies associées aux soins intensifs). Avant 2020, la proportion des septicémies associées aux soins intensifs était toujours d'environ 20%. Cette proportion a augmenté en 2020 (première année COVID-19) jusqu'à 27% et reste élevée en 2021 (28%).

La moitié des épisodes sont survenus 12 jours ou plus après l'admission à l'hôpital. La moitié des patients avaient au moins 70-74 ans et 20% des patients sont décédés. Cependant, une proportion importante des données relatives au « statut en fin de suivi » était manquante (26%) et nos données ne permettent pas d'établir un lien causal entre le décès et la septicémie.

Les origines les plus fréquentes, au niveau de tout l'hôpital, étaient le cathéter veineux central (26%)[12], suivi par les infections urinaires (18%) (Figure 4). Aux soins intensifs, les origines les plus fréquentes étaient le cathéter veineux central (38%), suivi par les pneumonies (30%). L'origine des septicémies associées à l'hôpital (au niveau de tout l'hôpital) était confirmée dans 46% des cas (même micro-organisme isolé dans les hémocultures qu'au niveau du site supposé être la source de l'infection). Un dispositif invasif était en cause directement (cathéter veineux central, autre cathéter ou manipulation invasive) ou indirectement (sonde urinaire ou tube endotrachéal) dans 45% des septicémies associées à l'hôpital au niveau de tout l'hôpital et dans 70% des septicémies associées aux soins intensifs.

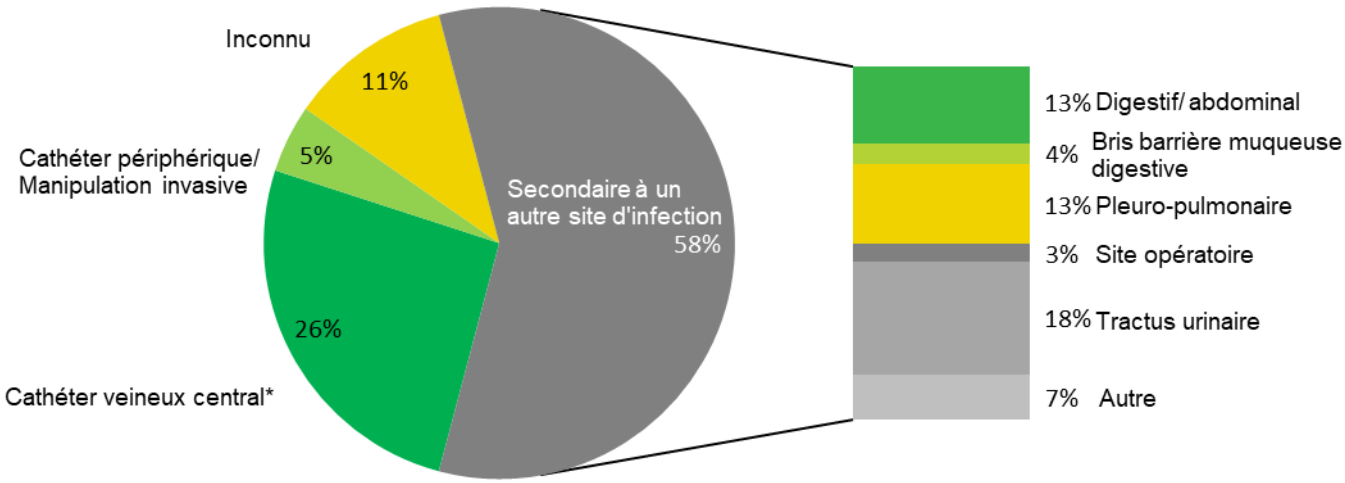


Figure 4 : Origine présumée des septicémies associées à l'hôpital, Belgique, 2021 (*Inclut origine « confirmées », « probables » et « possibles » pour les septicémies associées au cathéter veineux central)

[12] Ce chiffre inclut les septicémies liées à un cathéter veineux central « confirmées », « probables » et « possibles ».

2.3. MICRO-ORGANISMES CAUSAUX IDENTIFIÉS ET LEURS PROFIL DE RÉSISTANCE ANTIMICROBIENNE

Les micro-organismes les plus fréquemment isolés dans les septicémies associées à l'hôpital en 2021 étaient *E. coli* (19%), *S. aureus* (10%) et *S. epidermidis* (10%). Moins de la moitié des hôpitaux a rapporté un cas de septicémie associée à l'hôpital due à un *S. aureus* résistant à la méthicilline (MRSA) (Tableau 2).

Les profils de résistance phénotypique pour les micro-organismes objets de la surveillance sont présentés dans le Tableau 2. Entre 2013 et 2021, la diminution de la proportion de *S. aureus* résistant à la méthicilline (de 20,9% à 9,2%) était statistiquement significative. Les autres changements (s'il y en avait) n'étaient pas statistiquement significatifs.

Tableau 2 : Résistance aux antibiotiques pour les micro-organismes isolés dans les septicémies associées à l'hôpital, Belgique, 2021

		Micro-organismes 2021			% d'hôpitaux présentant au moins 1 cas de résistance* (N=100)
	Antibiotiques	N	n	%	
Staphylococcus aureus	Meti	859	79	9,2	41
	Gly	859	2	0,2	2
Enterococcus faecalis	Gly	496	4	0,8	2
Enterococcus faecium	Gly	570	14	2,5	11
Escherichia coli	C3G	1 527	199	13,0	63
	CAR	1 527	8	0,5	8
Klebsiella pneumoniae	C3G	611	174	28,5	57
	CAR	611	21	3,4	15
Enterobacter cloacae	C3G	271	103	38,0	43
	CAR	271	7	2,6	5
Proteus mirabilis	C3G	138	0	0,0	0
	CAR	138	0	0,0	0
Klebsiella oxytoca	C3G	202	31	15,3	20
	CAR	202	3	1,5	2
Klebsiella aerogenes	C3G	96	50	52,1	30
	CAR	96	2	2,1	2
Pseudomonas aeruginosa	CAR	380	92	24,2	35
Acinetobacter baumannii	CAR	26	1	3,8	1

C3G : céphalosporines de 3e génération (céfotaxime, ceftriaxone, ceftazidime) ; CAR : carbapénèmes (imipénème, méropénème) ; Gly : glycopeptides (vancomycine, teicoplanine) ; Meti : méthicilline ; N : nombre ; % : pourcentage de micro-organismes résistants.
* Les hôpitaux ont pris part à la surveillance pendant 1, 2, 3 ou 4 trimestres.

3. RECOMMANDATIONS

Recommandations à l'intention des décideurs politiques

- Renforcer le soutien fourni aux équipes d'hygiène hospitalière et faciliter l'exercice de leurs missions et responsabilités en termes de lutte contre les septicémies associées à l'hôpital, entre autres par les projets "*Hospital Outbreak Support Teams* (HOST)"[13]. Dans ce contexte, il serait utile de porter une attention accrue à la prévention et au contrôle des infections dans les formations médicales (médecine et soins infirmiers).
- Dans le cadre d'une politique générale d'amélioration de la qualité des soins, renforcer la création d'une culture de bonnes pratiques de qualité des soins au niveau de l'hôpital. Cela implique la mise en place d'un environnement positif, sécurisant, fiable et non-jugeant qui permette l'organisation d'audits internes de qualité des soins par l'équipe d'hygiène hospitalière. Si nécessaire, cela peut être renforcé par les projets HOST.
- Continuer à soutenir la surveillance nationale des septicémies associées à l'hôpital afin de suivre les modifications d'incidence aux niveaux national et hospitalier. En particulier dans le cadre de la crise COVID-19, il est très important de poursuivre cette surveillance, ceci afin d'évaluer l'impact de la crise COVID-19 sur l'apparition des septicémies associées à l'hôpital et de pouvoir formuler, si nécessaire, des mesures, des directives et des actions pour renforcer la qualité des soins et la gestion de la prévention et du contrôle des infections en temps de crise sanitaire.
- La crise COVID-19 actuelle souligne l'importance de renforcer une politique solide de prévention et de contrôle des infections au niveau national et hospitalier.
- Pour garantir une bonne qualité des données, envisager de rendre la participation à la surveillance volontaire.

Recommandations à l'intention des hôpitaux

- Évaluer s'il y a encore une place pour une diminution du nombre de septicémies associées à l'hôpital et, au besoin, implémenter les mesures et activités pour ce faire. L'organisation d'audits internes, menés par l'équipe locale d'hygiène hospitalière, est suggérée à cet effet.
- Poursuivre l'enregistrement et la communication des données sur les septicémies associées à l'hôpital dans le cadre de la surveillance nationale, afin de permettre l'évaluation de la situation dans le temps, de l'effet des activités mises en place localement afin de réduire leur incidence et de l'effet des événements survenus localement sur cette incidence. En particulier dans le cadre de la crise COVID-19, il est très important de poursuivre cette surveillance, afin d'évaluer l'impact de la crise COVID-19 sur l'apparition des septicémies associées à l'hôpital et de pouvoir formuler, si nécessaire, des mesures, des directives et des actions pour renforcer la qualité des soins et la gestion de la prévention et du contrôle des infections en période de crise sanitaire.

Recommandations à l'intention des scientifiques responsables de la surveillance (Sciensano)

- Investiguer les raisons pour lesquelles entre 2013 et 2019, l'incidence des septicémies associées à l'hôpital dans les hôpitaux belges n'a pas diminué au niveau national. Cela peut être fait en évaluant si ce sont systématiquement les mêmes hôpitaux qui présentent les meilleures ou les pires incidences et, dans ce cas, en investiguer les raisons par une étude

[13] Voire : https://organesdeconcertation.sante.belgique.be/fr/host-faqs

supplémentaire. Ou, en comparant les hôpitaux à faible incidence avec des hôpitaux similaires à incidence élevée et évaluer les raisons de cette différence.

- Évaluer si les données sur la résistance antibiotique actuellement demandées dans le cadre de la surveillance des septicémies devraient être mises à jour pour être harmonisées avec les recommandations internationales.
- Rationaliser entre les autres surveillances Sciensano le recueil des données de résistance aux antibiotiques pour éviter que les mêmes données soient demandées plusieurs fois.
- Poursuivre la surveillance des septicémies dans les hôpitaux belges. Cette mission implique la mise à jour annuelle du protocole et de l'outil de collecte des données.
- Continuer à améliorer l'outil de collecte de données et la plateforme de *reporting* Healthdata (Healthstat).

1 Introduction

Hospital-associated bloodstream infections (HABSI) cause considerable morbidity and mortality and have an important potential for prevention, especially for those HABSI associated with invasive devices (1-5). In Belgium, a national hospital-wide surveillance system for HABSI exists since 1992 (6).

The objective of the surveillance programme on HABSI in Belgian hospitals is to enhance the quality of care provided at the hospital by:

- monitoring HABSI trends, with a focus on BSI that can be prevented, at hospital and national level with the objective to enhance and evaluate preventive measures,
- monitoring causal microorganisms and their resistance profile.

The surveillance programme on HABSI in Belgian hospitals provides a standardized tool to (1) allow hospitals to follow-up their own HABSI and associated antimicrobial resistance trends at hospital and intensive care unit (ICU) level, and to (2) analyse data at national level.

Participation in the surveillance for a minimum of one quarter a year for acute care hospitals (Royal decree 08-01-2015) is legally required since 1 July 2014 (6). The surveillance protocol has been reviewed and considerably updated and changed in 2013. This updated protocol aimed to focus on the usefulness of the surveillance as a tool for prevention of HABSI at hospital level. Apart from this, a yearly review of the protocol takes place which includes minor updates and changes.

Data on bloodstream infection (BSI) occurring before 1 July 2017 were collected and hospital based results displayed though the online tool NSIHweb2. Data on BSI occurring since 1 July 2017 are collected through the Healthdata platform (see: https://healthdata.sciensano.be/en/home, https://www.healthdata.be/dcd/#/collection/NSIH-SEP/version/22 and https://www.healthdata.be/dcd/#/collection/NSIH-Denominators/version/19) and hospital based results reported through Healthstat (see: https://www.healthstat.be/).

As the number of days a patient is hospitalised reflects best the risk of becoming infected with a HABSI (the longer a patient is in the hospital the higher his/her chance to get a HABSI), we mainly focus on reporting HABSI data per 10,000 patient-days although, several times the number of HABSI per 1,000 admissions is also reported. This to put out findings in perspective.

This report describes trends in incidences of HABSI, causal microorganisms (MO), and their antimicrobial resistance profile until 2021 and provides a more detailed description of the 2021 BSI data.

2021 was the second year the COVID-19 pandemic hit the world. In Belgium, a third and fourth COVID-19 wave were observed in 2021 (see Sciensano dashboard https://datastudio.google.com/embed/reporting/c14a5cfc-cab7-4812-848c-0369173148ab/page/ZwmOB). An additional objective of this report is to assess the impact of COVID-19 on HABSI and CLABSI. A dedicated chapter on this issue (Chapter 5) is added.

2 Methods

2.1 PARTICIPATION AND DEFINITIONS

Participation criteria details and modalities for data collection can be found in the latest version of the protocol dated April 2019 (7, 8).

Hospitals are identified by their National Institute for Health and Disability Insurance (NIHDI)-number and hospital campuses by their campus-number.

Only laboratory confirmed bloodstream infections (LCBI) are recorded. For the surveillance the criteria 'BSI occurring two days or more after admission at the hospital' is used as proxy-indicator for a BSI acquired in a hospital. BSI defined as such are called 'hospital-associated bloodstream infections'. Similarly, an ICU-associated BSI is defined as a BSI occurring two days or more after admission at ICU. Registration of HABSI is mandatory. BSI occurring <2d after admission (for example community acquired or acquired in another hospital or long-term care facility) can optionally be registered.

The suspected source of origin of the BSI is based on clinical identification. If this suspected source is a central line (CL), we identify, based on the surveillance information[14], three central line-associated bloodstream infections (CLABSI) classifications:
Confirmed CLABSI: LCBI with clinical suspicion that a CL is the cause of the LCBI and the association between the LCBI and the CL is microbiologically confirmed (same MO found in blood culture and on CL).
Probable CLABSI: LCBI with clinical suspicion that a CL is the cause of the LCBI but no microbiological confirmation.
Possible CLABSI: LCBI not secondary to an infection at another body site – source recorded in the surveillance form as 'unknown' – but CL present within the two days prior to the LCBI.

To be able assessing in depth the impact of COVID-19 on HABSI and CLABSI we added in 2020 two additional SNOMED codes to identify the specialty of the ward where the BSI occurred, being: '*DS0001 - COVID-19 dedicated general ward*' and '*DS0002 - COVID-19 dedicated intensive care unit*'.

2.2 DATA ANALYSIS

This report presents the analysis results, mainly descriptive, of surveillance data up to 2021 (database data labelled as 'Approved' in Healthdata on 13 June 2021). Data collected before the protocol review in 2013 are not always comparable and because of this data from before 2013 are mostly not included in this report. They have been used only for trends in MO specific incidence data.

As defined in the Royal Decree, only data from acute care hospitals are included.

Information on the methods used to compute incidences is given in Annex 1. In brief, the mean incidence was computed as the sum of numerators (HABSI) divided by the sum of

[14] See BSI surveillance protocol chapter 4.5.2 (https://www.sciensano.be/nl/biblio/surveillance-des-septicemies-dans-les-hopitaux-belges-protocole-2019 (Dutch version), https://www.sciensano.be/fr/biblio/surveillance-des-septicemies-dans-les-hopitaux-belges-protocole-2019 (French version))

denominators (patient-days or admissions). To calculate medians the reporting quarter was used as unit of analysis[15].

To compare the HABSI incidences of the three Belgian regions we applied direct standardisation. For this we used the hospital population (number patient-days) distribution across tertiary and non-tertiary hospitals in Brussels as standard (reference) population.

We aimed to assess separately HABSI incidences in COVID-19 dedicated wards and compare these with the ones found in non-COVID-19 dedicated wards. Since only one hospitals reported denominator data (number of patient-days and/or admissions) for COVID-19 dedicated wards (SNOMED DS0001 or DS0002) we were not able to perform this assessment.

A Pearson chi-square test was used to check differences in antimicrobial resistance between regions.

Boxplots and funnel plots were used to assess variability of data. A boxplot consist of a box with whiskers and may have some dots below or above these whiskers. The line in the box displays the median value, the box limits represent the P25 and P75 values, the whiskers mark the lower and upper adjusted values (respectively P25 - 1.5 IQR and P75 + 1.5 IQR) and the dots represent the outliers (outside values). In a funnel plot an estimate of a parameter is plotted against a measure of its precision, here number of HABSI per 10,000 patient-days (pd) against size of the hospital (number of pd). Funnel plots give a visual identification of outliers – curved lines (above or below 2SD (95%) and 3 SD (99.7%)). To compile boxplots and funnel plots we used as unit of analysis at hospital level hospital-quarter (number of infections and pd per quarter for which the hospital participated in the surveillance) and at ICU-level ICU-quarter (number of infections and pd per quarter for which the ICU participated in the surveillance).

We fitted a negative binomial regression model with hospital as random effect and 2013 or the previous year as reference year to explore and assess statistically significant ($p<0.05$) changes in incidence of HABSI, CLABSI and antimicrobial resistant isolates. To assess whether trends observed in proportions of resistant MO among all MO isolated were statistically significant ($p<0.05$), we used chi-square for trends.

[15] Median: incidences of the HABSI per hospital per quarter per total hospital-quarters. Mean and median include only data for which the denominator (number admissions or patient-days) is available.

In 2019, EUCAST (European Committee on Antimicrobial Susceptibility Testing) changed the definitions of susceptibility testing categories S, I and R to 'S' being 'Susceptible, standard dosing regimen', 'I' being 'Susceptible, increased exposure' and 'R' being 'Resistant' (see https://www.eucast.org/newsiandr/). This change in approach implied that 'I' should be categorised as susceptible. Because in 2021 the majority of Belgian hospital laboratories did not switched to use the new EUCAST guidelines[16], for the 2021 data we still categorised 'I' (intermediary) as 'resistant'.

Data was analysed in SAS enterprise guide 7.1 except for the funnel plot that was designed using the tool developed by Public Health England[17] and for the statistical test for which STATA 14.1. (StataCorp LP, College Station, Texas, USA) was used.

[16] A survey conducted in April 2022 by the unit 'Quality of laboratories' of Sciensano found that only five (4%) of the 114 labs that completed the survey switched to the new EUCAST guidelines before 2022 (in April 2022 there were 198 accredited laboratories labs in Belgium according to the RIZIV/INAMI list https://www.riziv.fgov.be/nl/professionals/verzorgingsinstellingen/laboratoria/Paginas/historiek-erkende-labos-verstrekkingen.aspx)

[17] https://fingertips.phe.org.uk/profile/guidance/supporting-information/PH-methods - Analytical tools - Funnel plot for rates (updated July 2021)

3 Results surveillance of bloodstream infection in hospitals, 2013-2021

Participation

In 2021, 100 (96%) out of 104 eligible hospitals[18] participated in the BSI-surveillance. Forty-four percent of the eligible hospitals participated the whole year (Table 3)[19]. Divided by region this resulted in: 12 of the total of 14 hospitals participated in Brussels, 36% of the Brussel's hospitals participated throughout the whole year, 51 of 52 hospitals participated in Flanders, 52% throughout the whole year, and 37 of 38 hospital in Wallonia of which 37% participating throughout the whole year (Annex 2, Table 26).

Altogether, data for 258 quarters were submitted from which 256 (99%) quarters had denominator data available. This is the highest number of submitted matching denominators since 2013.

The number of hospitals participating since 2014, the year participation in the surveillance became mandatory, has always been higher than 90% (Table 3).

Table 3: Participation in the surveillance of bloodstream infections in Belgian hospitals, Belgium 2013-2021

N participating quarters	N hospitals participating (% of hospitals on total number of hospitals that should participate, until 2017 N=109 – 2018 N=107 – 2019-2021 N=104)*								
	2013	2014	2015	2016	2017	2018	2019	2020	2021
At least 1 quarter	**91 (83)**	**100 (92)**	**106 (97)**	**106 (97)**	**105 (96)**	**104 (97)**	**98 (94)**	**97 (93)**	**100 (96)**
1 quarter	35 (32)	34 (31)	34 (31)	31 (28)	29 (27)	27 (25)	31 (30)	39 (37)	39 (37)
2 quarters	11 (10)	11 (10)	7 (6)	6 (6)	12 (11)	9 (8)	10 (10)	8 (8)	10 (10)
3 quarters	5 (5)	3 (3)	1 (1)	2 (2)	4 (4)	6 (6)	5 (5)	7 (7)	5 (5)
4 quarters (whole year)	40 (36)	52 (48)	64 (59)	67 (61)	60 (55)	62 (58)	52 (50)	43 (41)	46 (44)

N, number

Note:

* Hospitals are identified by their RIZIV/INAMI number - total number of hospitals differs between years because of merges of hospitals.

[18] The total number of hospitals that should participate is based on the list of hospitals provided by the Belgian ministry of health (data management unit); List dated February 2022 (*Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022*). Hospitals are identified by their RIZIV/INAMI number.

[19] Total number of hospitals differs between years because of merges of hospitals.

3.1 TREND OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

3.1.1 HOSPITAL-WIDE

3.1.1.1 HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

In 2021, as in 2020, we observed, comparing 2019 with 2021, a statistically significant increase in HABSI per 10,000 patient-days (pd) and per 1,000 admissions (Table 4 and Figure 5). HABSI incidences per 10,000 pd increased from 8.3 in 2019 to 10.0 in 2021, incidence rate ratio 1.19 with 95% CI [1.13-1.26], meaning an increase of HABSI incidence by 19%. For HABSI incidence per 1,000 admissions we observed an increase from 5.5 in 2019 to 6.3 in 2021 (incidence rate ratio 1.13 with 95% CI [1.06-1.20]).

Comparing these incidences in 2021 with the one in 2020 (the two COVID-19 years), we did not observe a statistically significant change for the HABSI incidence per 10,000 pd but a statistically significant lower HABSI incidence per 1,000 admissions. This incidences decreased from 6.8 in 2020 to 6.3 in 2021, incidence rate ratio 0.92 with 95% CI [0.88-0.98], meaning an decrease of HABSI incidence by 8%.

The effect of the COVID-19 epidemic on the incidence of HABSI is the most plausible hypothesis to explain the increase still observed in 2021. This will be further discussed in chapter 5 of this report.

Table 4: Incidence of hospital-associated bloodstream infections (hospital-wide), Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N hospitals included in calculation of incidence*	86	96	102	103	93	100	98	97	99
N HABSI	5,584	6,926	7,875	7,791	6,755	7,909	7,239	7,256	7,511
Cumulative incidence per 1,000 admissions									
mean**	5.6	5.8	5.6	5.2	5.5	5.8	5.5	6.8	6.3
median***	5.2	4.8	4.8	4.7	4.7	4.6	4.5	5.6	5.2
Incidence density per 10,000 patient-days									
mean**	7.8	8.1	8.1	7.7	8.3	8.7	8.3	10.4	10.0
median***	6.9	6.9	6.8	6.8	7.0	7.2	7.0	8.6	8.1

HABSI, hospital-associated BSI; N, number
Notes:
* Hospitals included when denominator of the participating quarter was available[20]
** Total hospital-associated BSI/total denominator
*** Unit of analysis used to calculate median is quarter

[20] In 2021, for 99% of the reported HABSI matching denominator data was available.

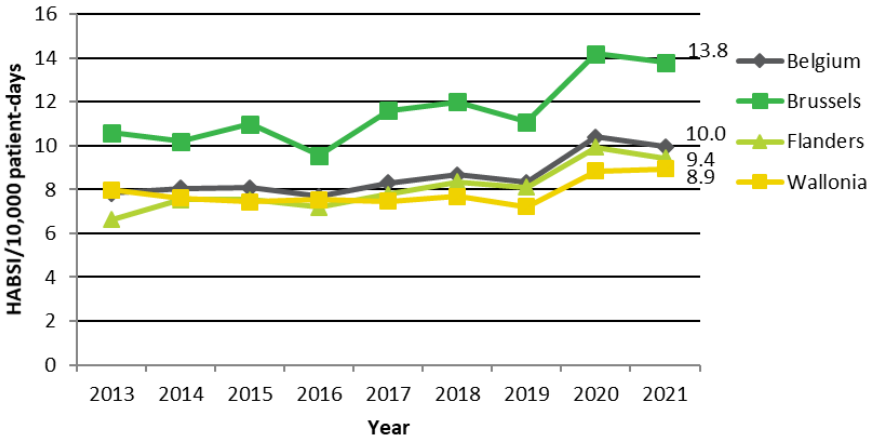


Figure 5: Mean incidence of hospital-associated bloodstream infections, hospital-wide, by region, Belgium 2013-2021 (HABSI, hospital-associated bloodstream infections)

Figure 5 and Annex 3, Table 27, show HABSI incidences by region. Similar to the finding for whole Belgium, we find in 2021 compared to 2019 for each of the three regions a statistically significant increase of HABSI incidences per 10,000 pd. In Brussels HABSI incidence per 10,000 pd increased from 11.1 in 2019 to 13.8 in 2021 (incidence rate ratio 1.23 with 95% CI [1.09-1.40]), for Flanders this was from 8.1 in 2019 to 9.4 in 2021 (incidence rate ratio 1.12 with 95% CI [1.05-1.20]) and for Wallonia from 7.2 in 2019 to 8.9 in 2021 (incidence rate ratio 1.33 with 95% CI [1.20-1.46]). Comparing these incidences found in 2021 with the one in 2020 (the two COVID-19 years), we did not observe a statistically significant change.

Compared to the two other regions, HABSI incidences are higher in Brussels. Since Brussels has more tertiary hospitals[21,22], observed differences in incidence of HABSI could be the result of confounding by type of hospital (tertiary versus other types) as we found that HABSI incidence in tertiary hospitals was persistently higher than in other hospitals (Annex 4, Table 28 and 29, Figure 28). We therefore applied on the 2021 data direct standardization to control for potential confounding. As standard population we used the 2021 hospital population of Brussels (patient-days per type of hospital), to which we applied rates observed in all three regions to obtain standardized rate ratios. After standardization, in line with the findings previous years, the 2021 HABSI incidence rate in Brussels remained higher than those of Flanders and Wallonia. Standardized rate ratios for the latter regions were 0.82 and 0.71 respectively when compared to Brussels. This means that with the same distribution of the population between tertiary and other hospitals we would find in Flanders 18% less HABSI than in Brussel and in Wallonia 29% less HABSI.

Apart from our observation that HABSI incidence in tertiary hospitals is persistently higher than in other hospitals the HABSI incidence in tertiary and in other hospitals per 10,000 pd remains fairly stable between 2013 and 2019 but is statistically significant higher in 2021 compared with 2019 (Annex 4, Table 28). In tertiary hospitals HABSI incidence per 10,000 pd increased from 11.6 in

[21] 'Tertiary hospitals' include the hospitals defined as 'university hospital' and 'general hospital with university characteristics' in the '*Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022*' published by FOD volksgezondheid – SPF santé publique.

[22] Proportion (absolute numbers and %) of tertiary hospitals participating by region in 2021;

- Brussels: 6/12 (50%)
- Flanders: 8/51 (16%)
- Wallonia: 9/36 (25%)

2019 to 13.9 in 2021 (incidence rate ratio 1.23 with 95% CI [1.15-1.32]) and in other non-tertiary hospitals from 6.6 in 2019 to 7.8 in 2021 (incidence rate ratio 1.16 with 95% CI [1.08-1.25]). Comparing 2021 findings with 2020 findings (the two COVID-19 years) no statistically significant change in these incidences is observed.

In 2021, the median number of HABSI episodes in Belgian hospitals was 19 (IQR 10-38) episodes per quarter.

3.1.1.2 CENTRAL-LINE ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

To be considered as CLABSI in the Belgian bloodstream infection surveillance, a CLABSI must first meet the surveillance definition for HABSI, being; a LCBI occurring two days or more after admission at the hospital. Depending on surveillance information we then define three CLABSI classifications: (1) confirmed CLABSI, (2) probable CLABSI and, (3) possible CLABSI.

In 2021, 36% were confirmed CLABSI, 31% probable CLABSI and 33% possible CLABSI. These proportions did not change substantially since 2013 (Annex 5, Table 30) and incidences varied accordingly (Table 5). CLABSI incidence (three classifications together) per 10,000 pd did not change substantially between 2013 and 2019, but similar to all previous reported incidences, from 2019 to 2021 increased statistically significant from 2.0 CLABSI per 10,000 pd in 2019 to 2.6 in 2021 (incidence rate ratio 1.29 with 95% CI [1.17-1.43]) (Figure 6). Comparing 2021 findings with 2020 findings (the two COVID-19 years) no statistically significant change in this incidence is observed.

Since 2013, the mean CLABSI incidence (three classifications together) per 10,000 pd remained more than two times as high in tertiary hospitals compared with other hospitals (Annex 6, Table 31).

Table 5: Mean incidence of central line-associated bloodstream infections, hospital-wide, according to classification, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Confirmed CLABSI									
N*	619	768	918	739	565	732	697	655	710
mean incidence per 10,000 pd	0.9	0.9	0.9	0.7	0.7	0.8	0.8	0.9	0.9
Probable CLABSI									
N*	459	601	742	610	475	637	582	560	591
mean incidence per 10,000 pd	0.6	0.7	0.8	0.6	0.6	0.7	0.7	0.8	0.8
Possible CLABSI									
N*	424	465	459	439	477	505	474	617	640
mean incidence per 10,000 pd	0.6	0.5	0.5	0.4	0.6	0.6	0.6	0.9	0.9
Total CLABSI									
N*	1,502	1,834	2,119	1,788	1,517	1,874	1,753	1,832	1,941
mean incidence per 10,000 pd	2.1	2.1	2.2	1.8	1.9	2.1	2.0	2.6	2.6

CLABSI, central line-associated bloodstream infection; N, number; pd, patient-days

Note:

* Includes only those episodes for which a denominator is available

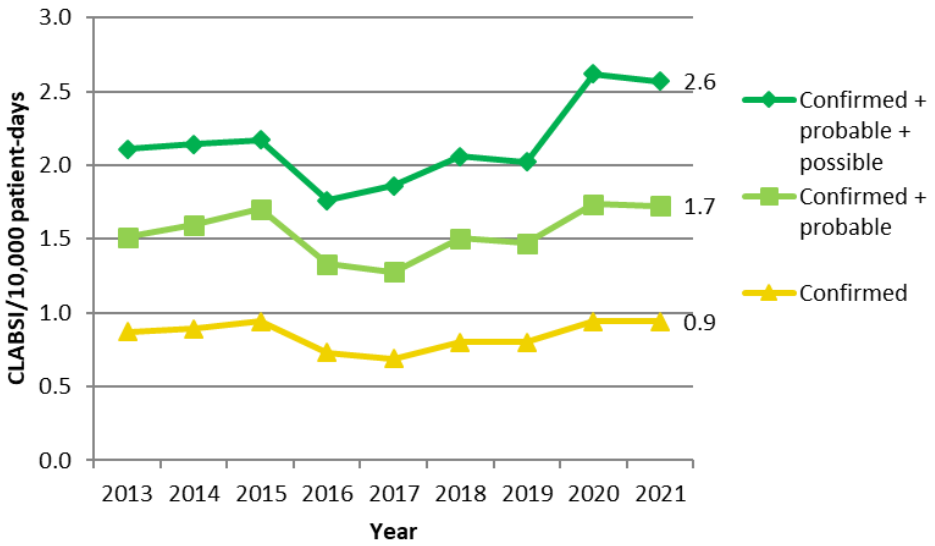


Figure 6: Mean incidence of central line-associated bloodstream infections (confirmed, probable, and possible), hospital-wide, Belgium 2013-2021 (CLABSI, central line-associated bloodstream infections)

In 2021, the median number of hospital-wide CLABSI (including confirmed, probable and possible cases) was 4 (IQR 1-11) episodes per quarter.

3.1.1.3 MICROORGANISM SPECIFIC HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS, 2000-2021

MO specific incidences of HABSI since 2000 for the most common MO are given in Figure 7. This graph illustrates long-term time trends of an increase in *E. coli*, *K. pneumoniae* and *E. faecium*[23] and a recent increase in the incidence of HABSI with *E. faecalis* as causal MO. The incidence of HABSI with *S. aureus* did not change substantially over time.

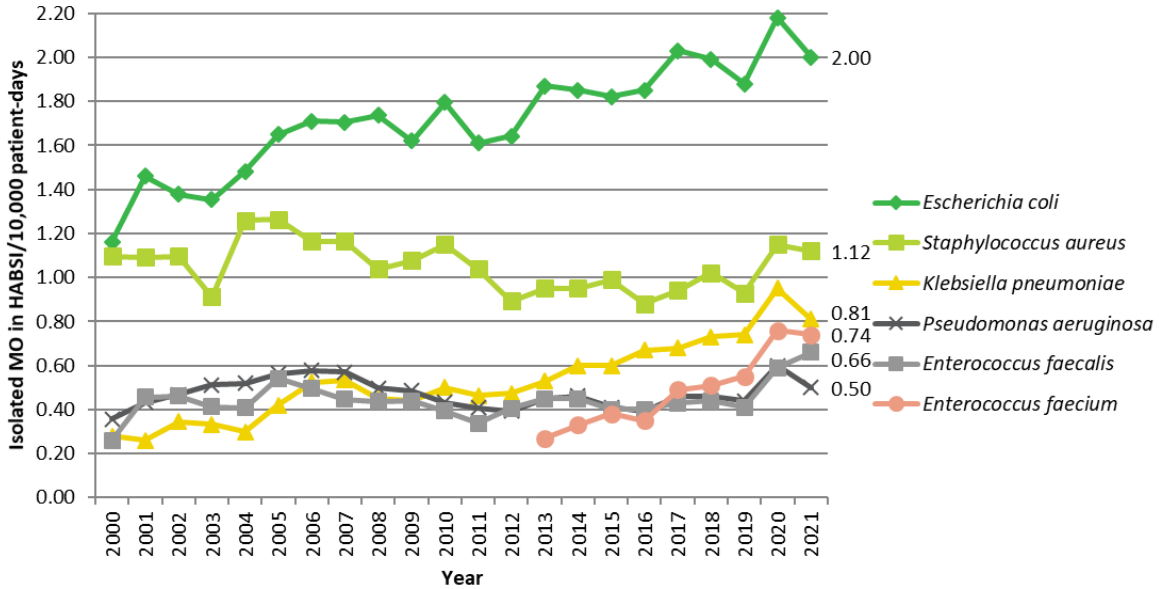


Figure 7: Mean incidence of hospital-associated bloodstream infections per microorganism, Belgium 2000-2021 (HABSI, hospital-associated bloodstream infection; MO, microorganism)

3.1.1.4 MICROORGANISM SPECIFIC CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

MO specific incidences of CLABSI since 2013 for the most common MO are given in Figure 8. Since 2013, the incidence of CLABSI caused by these most common MO did not change substantially over time.

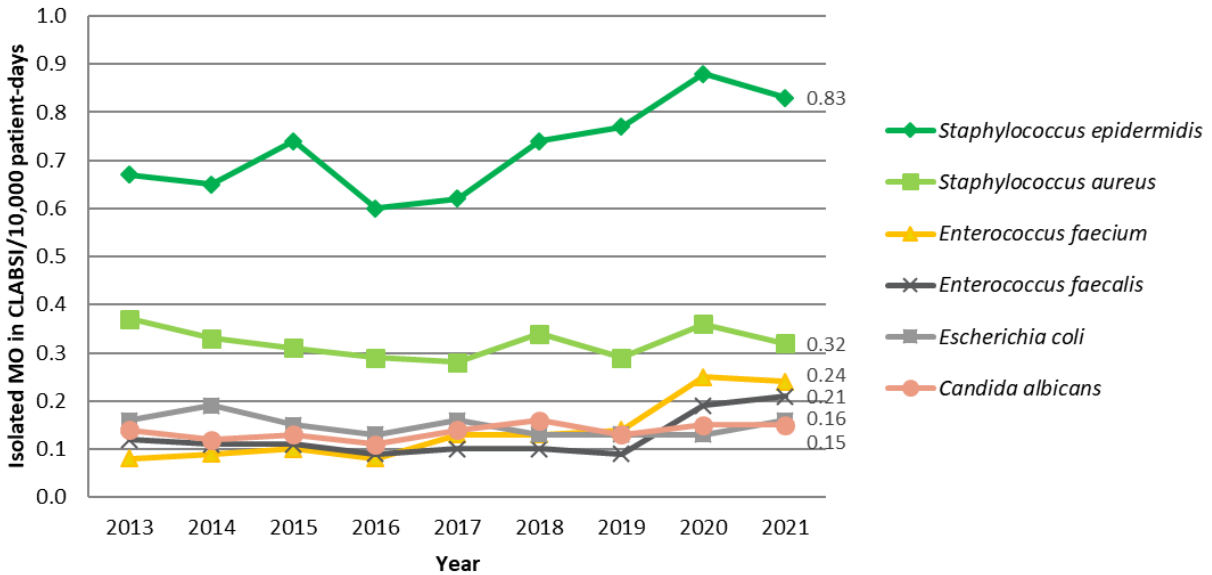


Figure 8: Mean incidence of central line-associated bloodstream infections per microorganism, Belgium 2013-2021 (CLABSI, central line-associated bloodstream infection; MO, microorganism)

[23] For *E. faecium* only data since 2013 available

3.1.1.5 INCIDENCES OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS AT HOSPITAL LEVEL, 2021

In 2021, similar to previous years, there was a large variability in the reported incidence of HABSI between hospitals as shown in the boxplot[24] and funnel plot[25] below (Figures 9 and 11). In both graphs several outliers are noticed. Incidence is compared with general hospitals without university characteristics higher in university hospitals and in general hospitals with university characteristics and compared with Flanders and Wallonia higher in Brussels (Figure 10), however within group-variability seems larger than between group-variability.

It would be useful to examine the outliers (extreme values) more in-depth to find and understand the reason of these values and their variability.

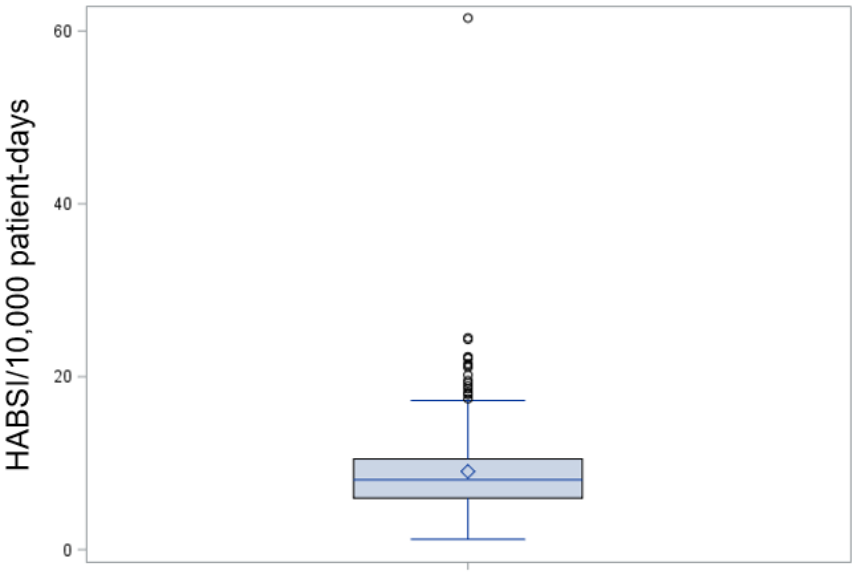


Figure 9: Hospital-associated bloodstream infections: incidence distribution across hospitals, Belgium 2021 (HABSI, hospital-associated bloodstream infection)

[24] The boxplot displays the median incidence (blue line in the box) of the HABSI per 10,000 patient-days per hospital per participating quarter. The box limits represent the P25 and P75 values, the whiskers mark the lower and upper adjusted values (respectively P25 - 1.5 IQR and P75 + 1.5 IQR) and the dots represent the outliers (outside values). The diamond shape indicates the mean incidence density.

[25] Funnel plots are a graphical aid for institutional comparisons. An estimate of the parameter is plotted against a measure of its precision, here number of HABSI per 10,000 patient-days against size of the hospital (number of patient-days). Funnel plots give a visual identification of outliers – curved lines (above or below 2SD (95%) and 3 SD (99.7%)) - and are used to assess outliers and validate data.

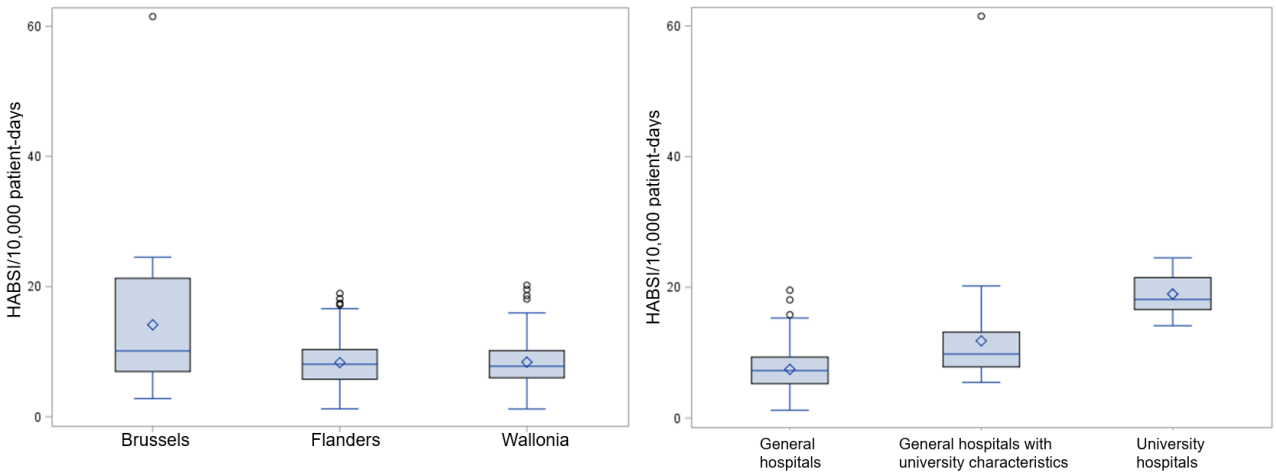


Figure 10: Hospital-associated bloodstream infections: incidence distribution across hospitals, by region and by hospital type[26], Belgium 2021 (HABSI, hospital-associated bloodstream infection)

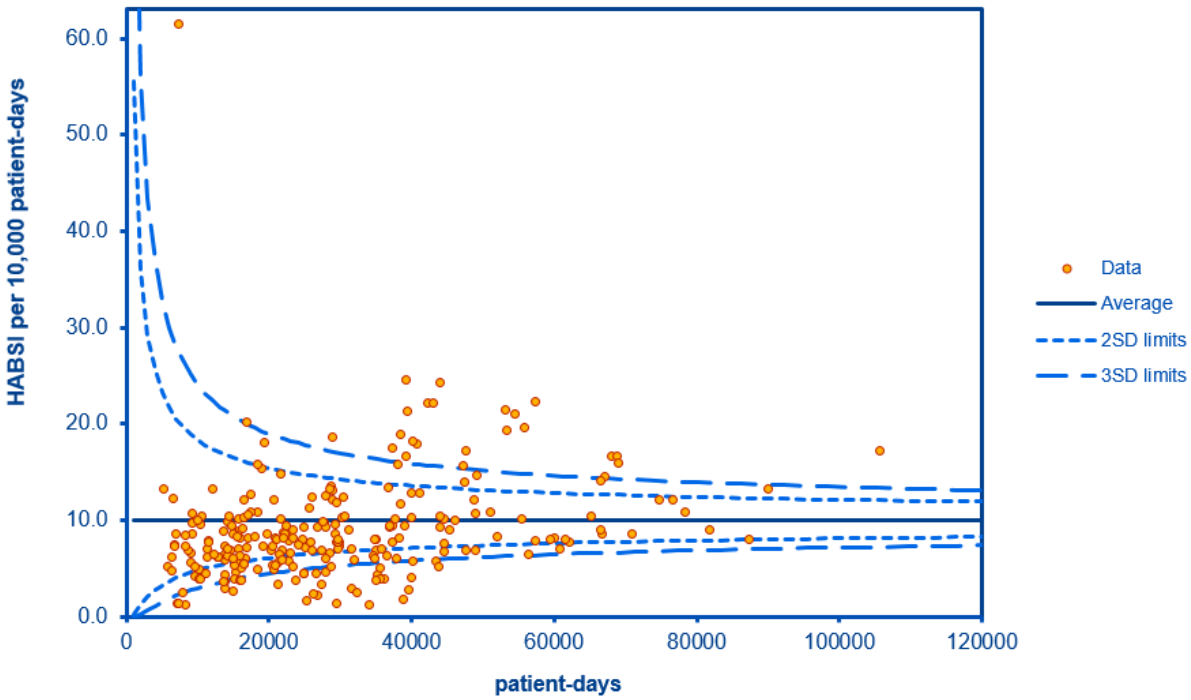


Figure 11: Variability in reported incidence of hospital-associated bloodstream infections between hospitals, Belgium 2021 (HABSI, hospital-associated bloodstream infection; SD, standard deviation)

The funnel plot gives a visual identification of outliers; above or below 2SD (95%) and 3SD (99.7%).

[26] Based on the classification given in the list of hospitals provided by the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg); List dated February 2022: Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022.

3.1.2 INTENSIVE CARE UNIT

Calculation and analysis of incidences per patient-days and per admissions include only the ICU-associated BSI with matching ICU-denominator data. In 2021, 2,120 ICU-associated BSI were registered in the surveillance of which 1,771 (84%) had matching ICU-denominator data. To calculate HABSI incidences at national level ICU-denominators of hospitals that participated in the surveillance but had no ICU-associated BSI registered for that quarter are also considered. In total we had ICU-associated BSI data with matching ICU-denominator data for 475 quarters.

3.1.2.1 INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

The incidence of ICU-associated BSI in Belgium at national level did not change much between 2013 and 2019 but increased clearly from 2019 to 2020 and remained high in 2021 (Table 6 and Figure 12). As previous years, regional data for 2021 shows the highest incidence in Brussels and the lowest in Flanders.

At national and regional level, there is no trend in the incidence of ICU-associated BSI per 10,000 patient-days between 2013 and 2019 and an increase from 2019 to 2021 (Figure 12). Comparing 2013 with 2019, none of the change in incidence per 10,000 patient-days at national or regional level was statistically significant. Comparing 2019 with 2021, apart from in Flanders, all other observed increases are statistically significant. In Belgium the incidence of ICU-associated BSI per 10,000 patient-days increased from 32.4 in 2019 to 46.9 in 2021 (incidence rate ratio 1.35 with 95% CI [1.18-1.55]). For Brussels we observed an increase from 39.8 in 2019 to 63.5 in 2021 (incidence rate ratio 1.52 with 95% CI [1.15-2.02), for Flanders this was 29.2 in 2019 and 39.4 in 2021 (incidence rate ratio 1.20 with 95% CI [0.97-1.45]) and for Wallonia 32.1 in 2019 and 53.8 in 2021 (incidence rate ratio 1.41 with 95% CI [1.16-1.71]) (Figure 12). Comparing these incidences in 2020 with those observed in 2021, none of these changes was statistically significant.

Table 6: Incidence of intensive care unit-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N hospitals included in calculation of incidence*	55	62	67	67	77	96	92	93	100
N ICU-associated BSI	692	776	792	850	799	1,262	1,248	1,764	1,771
Cumulative incidence per 1,000 admissions									
mean**	14.3	14.1	13.6	14.8	13.9	15.6	16.4	28.5	27.0
median***	13.6	11.5	10.8	12.2	11.7	12.4	15.1	23.1	24.1
Incidence density per 10,000 patient-days									
mean**	32.2	31.8	29.9	31.9	29.5	31.1	32.4	50.5	46.9
median***	24.3	23.5	23.1	25.1	25.1	25.3	27.4	40.0	37.5

BSI, bloodstream infection; ICU, intensive care unit; N, number
Notes:
* Hospitals included when ICU-denominator of the participating quarter was available
** Total ICU-associated BSI/total denominator
*** Unit of analysis used to calculate median is quarter

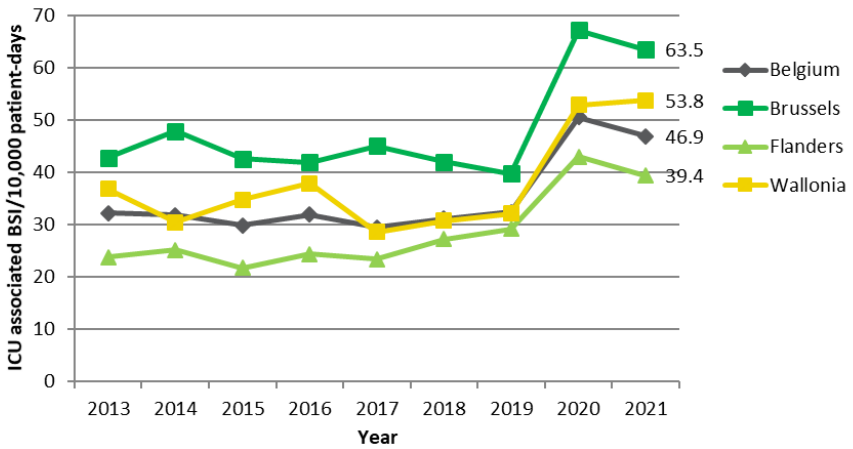


Figure 12: Mean incidence of intensive care unit-associated bloodstream infections, by region, Belgium 2013-2021 (BSI, bloodstream infections; ICU, intensive care unit)

In 2021, the median number (IQR) of ICU-associated BSI was 3 (IQR 1-5) episodes per quarter.[27]

3.1.2.2 INTENSIVE CARE UNIT-ASSOCIATED CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2021

Among the total of ICU-associated CLABSI the CLABSI classifications 'possible' in ICU has a proportion of more than 10% points higher than the other two classifications (Annex 7, Table 32). This is different than our findings of previous years, where each of the different CLABSI classifications was represented by a similar proportion of about 1/3 of the total ICU-associated CLABSI.

Between 2013 and 2019, the total CLABSI incidence at ICU per 10,000 pd (three classifications together) shows no trend (Table 7 and Figure 13). Comparing 2013 with 2019, there is no statistically significant difference in the number of ICU-associated CLABSI (three classifications together) per 10,000 pd. However, the observed increase of this incidence from 11.6 in 2019 to 17.6 in 2021 is statistically significant (incidence rate ratio 1.43 with 95% CI [1.20-1.70]).

In 2021, the mean CLABSI incidence at ICU per 10,000 patient-days for the three classifications together was 17.6; almost seven times higher than the hospital-wide incidence of 2.6 CLABSI per 10,000 patient-days.

[27] Includes only those episodes for which a denominator is available.

Table 7: Mean incidence of central line-associated bloodstream infections in intensive care units according to classification, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Confirmed CLABSI									
N*	101	105	97	94	88	149	150	224	195
mean incidence per 10,000 pd	4.7	4.3	3.7	3.5	3.3	3.7	3.9	6.4	5.2
Probable CLABSI									
N*	65	60	67	69	80	154	137	164	177
mean incidence per 10,000 pd	3.0	2.5	2.5	2.6	3.0	3.8	3.6	4.7	4.7
Possible CLABSI									
N*	111	96	90	98	86	157	159	249	292
mean incidence per 10,000 pd	5.2	3.9	3.4	3.7	3.2	3.9	4.1	7.1	7.7
Total CLABSI									
*N**	277	261	254	261	254	460	446	637	664
mean incidence per 10,000 pd	12.9	10.7	9.6	9.8	9.4	11.3	11.6	18.2	17.6

CLABSI, central line-associated bloodstream infection; N, number; pd, patient-days
Note: * Includes only those episodes for which a denominator is available

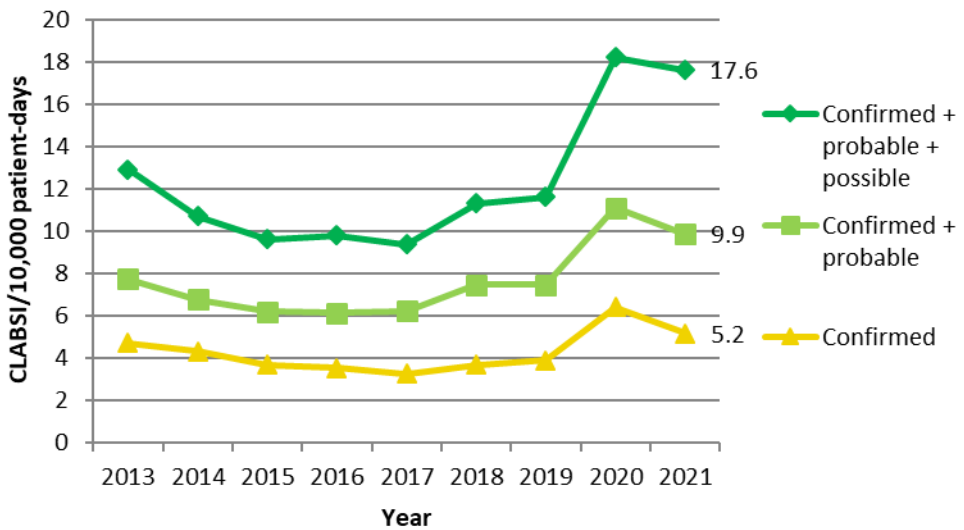


Figure 13: Mean incidence of central line-associated bloodstream infections (confirmed, probable, and possible) in intensive care units, Belgium 2013-2021 (CLABSI, central line-associated bloodstream infections)

In 2021, the median (IQR) number of ICU-associated CLABSI was 1 (0-2) episodes per quarter[28].

[28] Includes only those episodes for which a denominator is available.

3.1.2.3 INCIDENCES OF INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS AT INTENSIVE CARE UNIT LEVEL, 2020

Similar to our observation at hospital-level, boxplots show variability in the reported incidence of ICU-associated BSI between regions and type of hospitals but also large in-group-variability of the reported incidence of ICU-associated BSI (Figure 14 and 15). However, the funnel plot shows less outliers than what we found at hospital-level (Figure 16).

We found that in 2021, 89 (19%) of the 475 ICU quarters that participated in the surveillance and for which denominator data were available had no ICU-associated BSI registered, meaning no ICU-associated BSI occurred in that ICU during the reporting quarter.

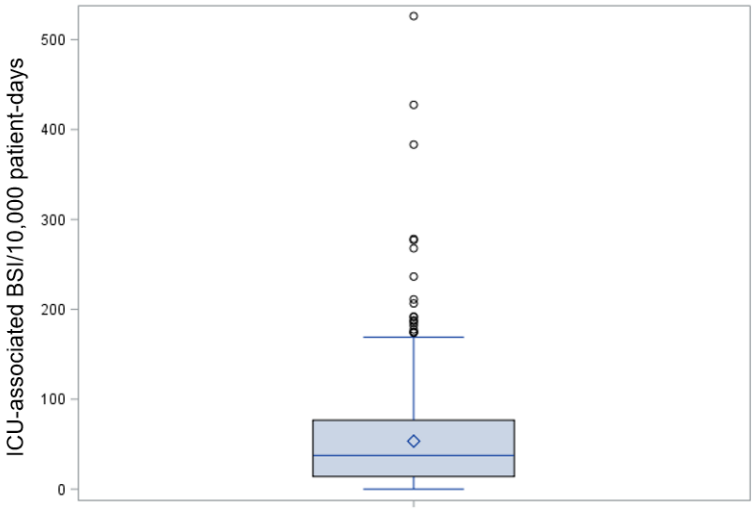


Figure 14: Intensive care unit-associated bloodstream infections: incidence distribution across intensive care units, Belgium 2021 (BSI, bloodstream infection; ICU, intensive care unit)

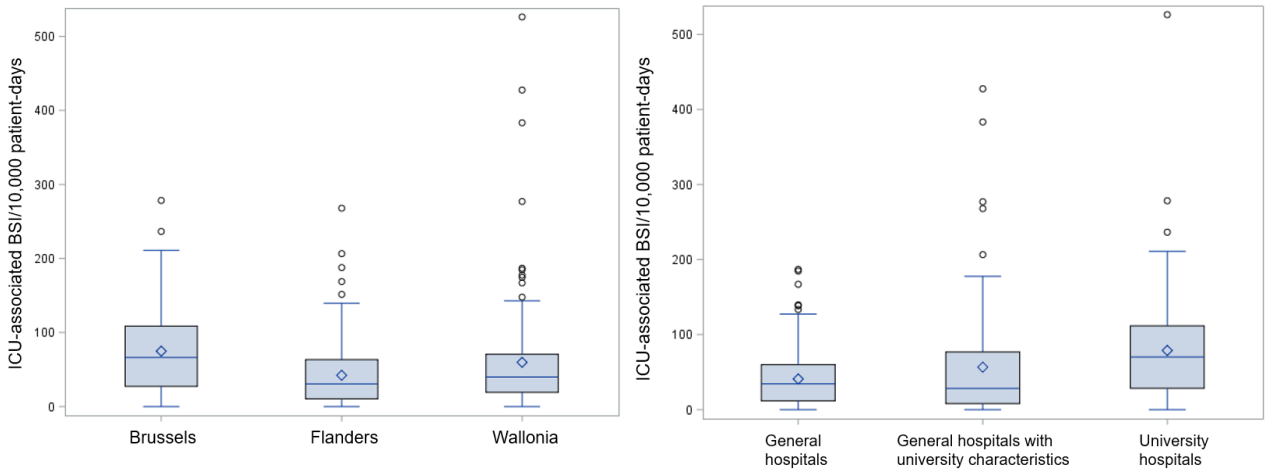


Figure 15: Intensive care unit-associated bloodstream infections: incidence distribution across hospitals, by region and by hospital type[29], Belgium 2021 (BSI, bloodstream infection; ICU, intensive care unit)

[29] Based on the classification given in the list of hospitals provided by the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg); List dated February 2022: Adressenlijst ziekenhuizen 02/2022 - Liste d'adresses des hôpitaux 02/2022.

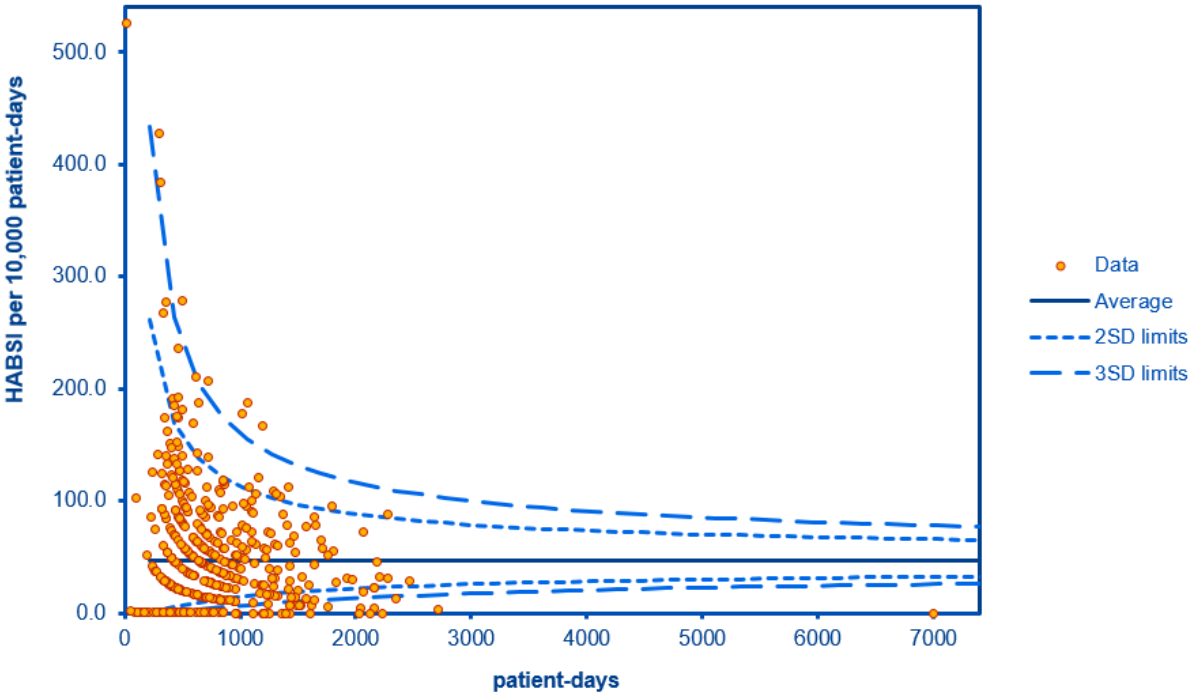


Figure 16: Variability in reported incidence of intensive care unit-associated bloodstream infections between hospitals, Belgium 2021 (BSI, bloodstream infection; ICU, intensive care unit; SD, standard deviation)

3.2 CHARACTERISTICS OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION, 2021

3.2.1 HOSPITAL-WIDE

In 2021, 100 hospitals registered together 9,164 BSI of which 7,593 were reported as HABSI. None of the 256 quarters with available denominator data had zero episode of HABSI reported.

3.2.1.1 DEPARTMENT WHERE THE HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION WAS DIAGNOSED

Thirty percent of all HABSI were diagnosed at ICU (Table 8). Of these ICU diagnosed BSI, 2,120 (92%) were ICU-associated BSI (see chapter 3.2.2 ICU findings).

In summer 2020, to assess the impact of the COVID-19 crisis, '*COVID-19 general department*' and '*COVID-19 ICU*' were introduced as possible departments where HABSI occurred. In 2021, according to our findings only few HABSI occurred at these COVID-19 dedicated wards (Table 8). This clearly seems a problem of underreporting. Only 15 of the 100 hospitals that reported HABSI use the COVID-19 department registration codes. Probably other hospitals were not aware of the availability of these codes and encoded HABSI that occurred at a COVID-19 department at another department.

Table 8: Department of hospital-associated bloodstream infection diagnosis, Belgium 2021

Department	N	%
Medical department	1,782	23
Gastro-enterology	*551*	*7*
Cardiology	*207*	*3*
Pneumology	*198*	*3*
COVID-19 general department	*22*	*0*
Other	*804*	*11*
ICU*	2,299	30
COVID-19 ICU	*69*	*1*
Surgery	778	10
Geriatrics	1,097	14
Hemato-oncology	991	13
Paediatrics	95	1
Obstetrics/gynaecology	42	1
Other	509	7
Total	**7,593**	**100**

ICU, intensive care unit; N, number
* 'Diagnosed in ICU' is different than 'ICU-associated'

3.2.1.2 SOURCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

Twenty six percent of HABSI were associated with a CL (Table 9, Figure 17). This was the main single suspected source of HABSI diagnosed at ICU, oncology and the medical and paediatric department. At the other departments, being geriatrics, obstetrics/gynaecology, and surgery, urinary tract infection was the main suspected source (Annex 8, Table 33). 57% of all CLABSI was ***not*** diagnosed in ICU.

Forty six percent of the clinically suspected sources were confirmed (same MO found in blood culture(s) and suspected source). The proportion of confirmation varies by source (Table 9).

Table 9: Confirmed and non-confirmed sources of hospital-associated bloodstream infections, Belgium 2021

	Hospital-associated bloodstream infections					
	Confirmed		Non-confirmed		Total	
Source	**N**	**%**	**N**	**%**	**N**	**%**
CLABSI*	715	21	1,248	30	1,963	26
Urinary tract infection	1,178	34	226	5	1,404	18
with catheter	*548*		*111*		*659*	
Gastro-intestinal infection	248	7	716	17	964	13
Pulmonary infection	699	20	298	7	997	13
with endotracheal tube/cannula	*468*		*82*		*550*	
Surgical site infection	138	4	85	2	223	3
Peripheral and other catheter	120	3	158	4	278	4
Mucosal barrier injury	30	1	237	6	267	4
Invasive manipulation	29	1	47	1	76	1
Other secondary infection**	308	9	261	6	569	7
Unknown	0	0	852	21	852	11
Total	**3,465**	**100**	**4,128**	**100**	**7,593**	**100**

CLABSI, central line-associated bloodstream infection; N, number
Notes:
***** Includes 'probable' and 'possible' CLABSI
** Skin/soft tissue and other

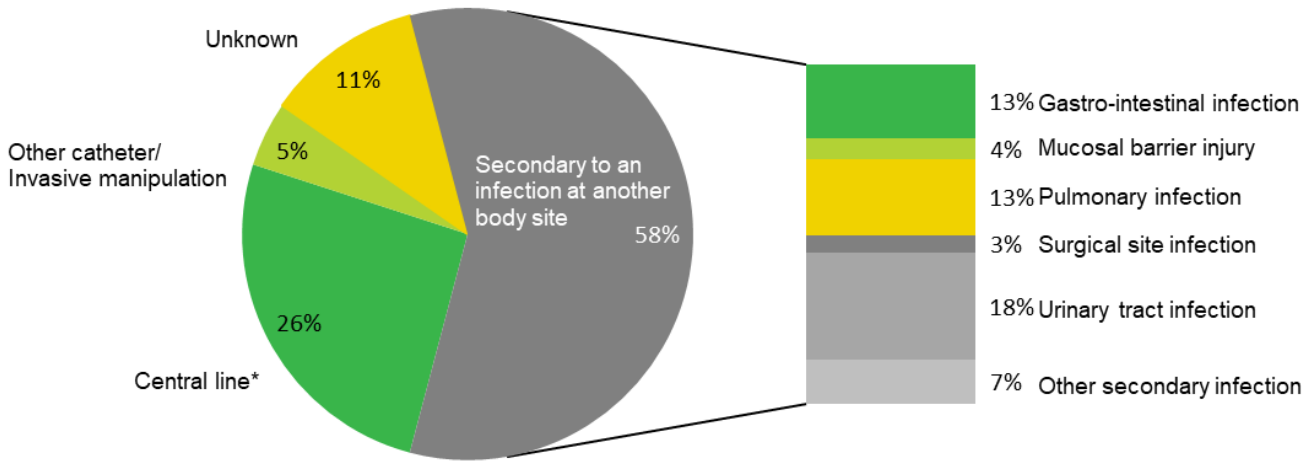


Figure 17: Sources of hospital-associated bloodstream infections, Belgium 2021 (* Includes 'confirmed', 'probable' and 'possible' central line-associated bloodstream infection)

Hospital-associated bloodstream infections associated with invasive devices

Forty five percent of all HABSI were infections associated directly or indirectly with an invasive devise among which 54% (1,851/3,450) were confirmed (Annex 9, Table 34).

Table 9 and 10 show that 659 (47%) of all HABSI with a urinary tract infection as source were catheter associated. Of these 659 cases, 548 cases (83%) were confirmed (same MO found in

blood culture(s) and on device). Regarding HABSI with a pulmonary infections as suspected origin, 55% of these BSI were endotracheal tube associated of which 85% were confirmed.

Before 2020, the proportion of endotracheal tube associated HABSI with a pulmonary infections as suspected origin was always around 30%, so about 20% points lower than what we found in 2021. This change might be due to COVID-19 causing the admission of patients with, compared to previous years, more severe pulmonary pathology.

Table 10: Hospital-associated bloodstream infections associated with invasive devices, Belgium 2021

	HABSI	
HABSI	**N**	**%**
CLABSI*	***1,963***	***100***
Confirmed (CRBSI)	715	36
Urinary tract infection	***1,404***	***100***
Urinary catheter present	659	47
Presence urinary catheter unknown	99	7
Urinary catheter as origin of HABSI is confirmed	548	39
Pulmonary infection	***997***	***100***
Endotracheal tube present	550	55
Presence endotracheal tube unknown	49	5
Endotracheal tube as origin of HABSI is confirmed	468	47
Peripheral and other catheter associated BSI	***278***	***100***
Confirmed	120	43

BSI, bloodstream infection; CLABSI, central line-associated bloodstream infection; CRBSI, central line-related bloodstream infection; HABSI, hospital-associated bloodstream infection; N, number

Note:

* Includes ‘confirmed’, ‘probable’ and ‘possible’ CLABSI

3.2.1.3 CLASSIFICATION OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS ACCORDING TO THE CASE DEFINITION

An overview of the BSI by case definition is given in Table 11.

Table 11: Bloodstream infections per case definition, Belgium 2021

Case definition	**HABSI N (%)**	**Non-HABSI N (%)**
At least one BC positive for a recognised pathogen	6,420 (84)	1,491 (95)
At least two different BC positive for the same pathogen belonging to the normal microbiota of the skin and clinical symptoms	1,117 (15)	79 (5)
Only one positive BC for a coagulase negative *Staphylococcus* (this applies only to neonatal cases)	56 (1)	1 (0.1)
Total BSI	**7,593 (100)**	**1,571 (100)**

BSI, bloodstream infection; BC, blood culture; HABSI, hospital-associated bloodstream infection; N, number

3.2.1.4 TIME TO INFECTION

Median time to onset of HABSI was 12 days (IQR 6-24) after admission at the hospital.

3.2.1.5 PATIENTS' CHARACTERISTICS AND END-OF-FOLLOW-UP STATUS

Thirty nine percent of the HABSI occurred in women. The median age-group was the 70-74 years of age group (IQR 55-59 age group – 80-84 age group). The majority of the HABSI were caused by one MO; 9% of the infection episodes involved more than one MO.

The crude mortality for HABSI was 20% however, there was a substantial amount of missing data for status at end-of-follow-up (26% missing data) (Annex 10, Table 35). Our data do not allow determining a causal link between death and infection. This mortality data are very similar to the ones found previous years.

3.2.2 INTENSIVE CARE UNIT

In 2021, 2,120 (28%) of the total HABSI were ICU-associated BSI. Before 2020 the proportion of ICU-associated BSI was always around 20%. This proportion increased in 2020 (first COVID-19 year) to 27% and remains high in 2021 (28%).

3.2.2.1 SOURCE OF INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS

In 2021, as in previous years, more than one third of the ICU-associated BSI were CL-associated infections. Compared to the years before 2020, the proportion of pulmonary infections as source for ICU-associated BSI is about 10% points higher (Figure 18).

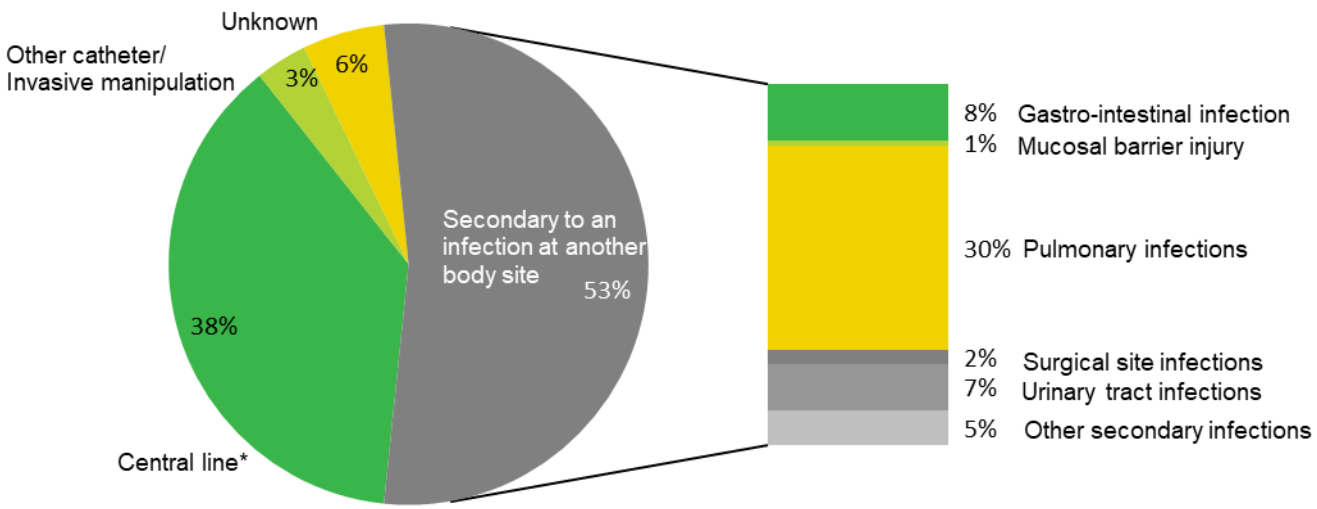


Figure 18: Sources of intensive care unit-associated bloodstream infections, Belgium 2021
(* Includes 'confirmed', 'probable' and 'possible' central line-associated bloodstream infections)

ICU-associated bloodstream infections associated with invasive devices

The proportion of ICU-associated BSI associated directly or indirectly with invasive devices is higher compared to the proportions of these kind of BSI found hospital-wide. In 2021, as mentioned above, 44% (3,450) of all hospital-wide HABSI were directly or indirectly associated with invasive devices compared to 70% (1,474) of all ICU-associated BSI (Table 12).

Table 12: Intensive care unit-associated bloodstream infections associated with invasive devices, Belgium 2021

ICU-associated BSI	ICU-associated BSI N	ICU-associated BSI %
CLABSI*	**797**	**100**
Confirmed (CRBSI)	245	31
Urinary tract infection	**144**	**100**
Urinary catheter present	114	79
Presence urinary catheter unknown	12	8
Urinary catheter as origin of HABSI is confirmed	101	70
Pulmonary infection	**639**	**100**
Endotracheal tube present	489	77
Presence endotracheal tube unknown	33	5
Endotracheal tube as origin of HABSI is confirmed	422	66
Peripheral and other catheter associated BSI	**74**	**100**
Confirmed	44	59

BSI, bloodstream infection; CLABSI, central line-associated bloodstream infection; CRBSI, central line-related bloodstream infection; ICU, intensive care unit; N, number

Note:

* Includes ‘confirmed’, ‘probable’ and ‘possible’ CLABSI

In 2021, 42% of CLABSI (all case definitions together) were diagnosed in ICU (Annex 8, Table 33).

3.2.2.2 TIME TO INFECTION

In 2021, ICU-associated BSI appeared with a median delay of 11 days (IQR 6-22 days) after admission at ICU.

3.2.2.3 PATIENTS’ CHARACTERISTICS AND END-OF-FOLLOW-UP STATUS

Thirty one percent of patients with ICU-associated BSI died. However, status at end-of-follow-up was missing for 24% of the infection episodes. This is comparable with our findings regarding this indicator for previous years. Our data do not allow determining a causal link between death and infection.

3.3 IDENTIFIED CAUSAL MICROORGANISMS AND THEIR ANTIMICROBIAL RESISTANCE PROFILE, 2013-2021

3.3.1 HOSPITAL-WIDE

3.3.1.1 IDENTIFIED MICROORGANISMS, 2021

In 2021, 8,215 MO were identified as etiological agent for 7,593 HABSI, 2,090 MO for 1,963 CLABSI and 1,685 MO for 1,571 non-HABSI (Table 13). Table 13 gives the data for the MO that caused at least 50 in the surveillance registered HABSI episodes in 2021 (for data on MO with less than 50 episodes see Annex 11, Table 36).

In summer 2020 the SNOMED code for SARS-CoV-2 '*840533007 - Severe acute respiratory syndrome coronavirus 2*' was added. In 2021, no SARS-CoV-2 related BSI were reported in the surveillance.

The most frequent found MO by source are given in Annex 12, Table 37 and were:

- *E. coli* in BSI secondary to urinary tract (46%), gastro-intestinal (27%) and MBI (23%) infection,
- *S. epidermidis* in CLABSI (26%) and BSI with as source a peripheral or catheter or invasive manipulation (20%), and
- *S. aureus* in BSI secondary to pulmonary (15%) and surgical site (17%) infections.

Table 13: Microorganisms isolated from bloodstream infections in hospitals, Belgium 2021

	HABSI		CLABSI		Non-HABSI	
Microorganisms	**N**	**%**	**N**	**%**	**N**	**%**
Enterobacteriaceae	**3,380**	**41**	**382**	**18**	**905**	**54**
Escherichia coli	1,527	19	105	5	652	39
Klebsiella pneumoniae	611	7	86	4	83	5
Enterobacter cloacae	271	3	49	2	27	2
Klebsiella oxytoca	202	2	34	2	24	1
Serratia marcescens	188	2	37	2	15	1
Proteus mirabilis	138	2	6	0	31	2
Klebsiella aerogenes	96	1	14	1	8	0
Morganella morganii	70	1	8	0	10	1
Genus Klebsiella (others or not specified)	51	1	5	0	11	1
Other/not identified*	226	3	38	2	44	3
Gram-positive cocci	**3,443**	**42**	**1,367**	**65**	**563**	**33**
Staphylococcus aureus	859	10	201	10	186	11
Staphylococcus epidermidis	797	10	553	26	38	2
Enterococcus faecium	570	7	174	8	30	2
Enterococcus faecalis	496	6	141	7	59	4
Staphylococcus hominis	134	2	91	4	9	1
Staphylococcus haemolyticus	86	1	62	3	2	0
Staphylococcus capitis	71		50		2	
Streptococcus mitis group	51	1	11	1	13	1
Other/not identified*	379	5	84	4	224	13
Non-fermenting Gram-negative bacilli	**629**	**8**	**106**	**5**	**83**	**5**
Pseudomonas aeruginosa	380	5	60	3	44	3
Genus Acinetobacter (others or not specified)	68	1	16	1	4	0
Stenotrophomonas maltophilia	52		10		1	
Other/not identified*	181	2	30	1	35	2
Fungi	**449**	**5**	**190**	**9**	**20**	**1**
Candida albicans	216	3	100	5	5	0
Candida glabrata	102	1	31	1	8	0
Other/not identified*	131	2	59	3	7	0
Anaerobic bacilli	**215**	**3**	**14**	**1**	**86**	**5**
Bacteroides fragilis	71	1	6	0	28	2
Other/not identified*	144	2	8	0	58	3
Gram-positive bacilli	**48**	**1**	**20**	**1**	**14**	**1**
Gram-negative cocci	**20**	**0**	**2**	**0**	**9**	**1**
Other and not identified	**31**	**0**	**9**	**0**	**5**	**0**
Total	**8,215**	**100**	**2,090**	**100**	**1,685**	**100**

BSI, bloodstream infection; HABSI, hospital-associated bloodstream infection; n, number

Note:

* Other includes microorganisms causing among the HABSI reported in the 2020 surveillance <50 episodes of HABSI/year

3.3.1.2 TRENDS IN ANTIMICROBIAL RESISTANCE FOR SELECTED MICROORGANISMS AND SELECTED ANTIBIOTICS, 2013-2021

In line with ECDC recommendations, for a set of selected MO and selected antibiotics(markers) resistance to these antibiotics(markers) was tested (9, 10).

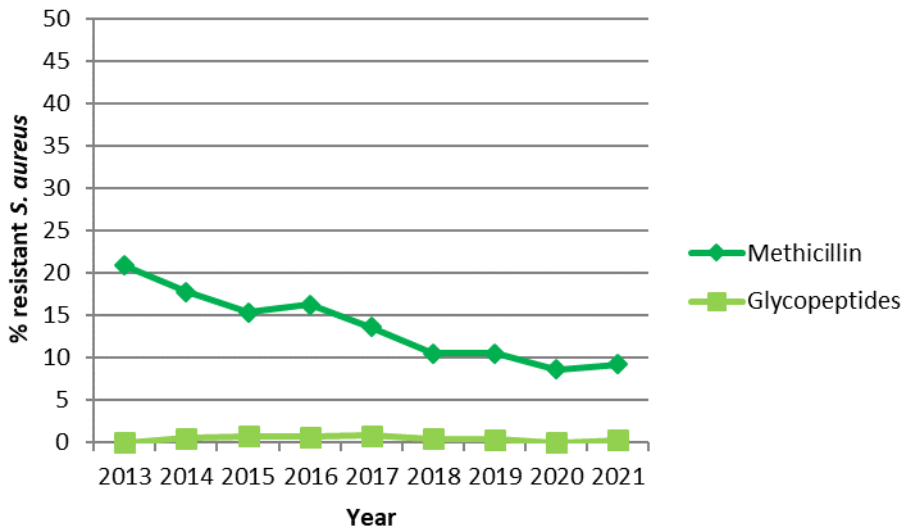
Tables 14 to 19 give for *S. aureus, E. coli, K. pneumoniae, E. cloacae, P. aeruginosa*, and *E. faecium*, the number and proportion of resistant MO isolated from HABSI, the mean incidence of HABSI with a resistant MO per 10,000 patient-days and the number and proportion of hospitals in which at least one HABSI with a resistant MO was identified, from 2013 till 2021.

More hospitals reported at least one HABSI with a third generation cephalosporin resistant *E. coli, K. pneumoniae* or *E. cloacae* strain than with a methicillin resistant *S. aureus.*

1. Staphylococcus aureus

Table 14: Antimicrobial resistance in* S. aureus *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	681	813	964	893	890	971	813	818	859
N hospitals**	87	96	103	103	102	101	98	98	100
Methicillin									
nR	142	144	148	145	121	102	85	70	79
%R	*20.9*	*17.7*	*15.4*	*16.2*	*13.6*	*10.5*	*10.5*	*8.6*	*9.2*
Mean incidence per 10,000 pd*	0.20	0.17	0.15	0.14	0.14	0.11	0.10	0.10	0.10
Hospitals with ≥ one R case	54	58	64	61	50	52	47	38	41
% hospitals with ≥ one R case	*62*	*60*	*62*	*59*	*49*	*51*	*48*	*39*	*41*
Glycopeptides (vancomycin, teicoplanin)									
nR	0	4	7	6	7	4	3	0	2
%R	*0.0*	*0.5*	*0.7*	*0.7*	*0.8*	*0.4*	*0.4*	*0.0*	*0.2*
Mean incidence per 10,000 pd*	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.00
Hospitals with ≥ one R case	0	3	7	6	6	3	2	0	2
% hospitals with ≥ one R case	*0*	*3*	*7*	*6*	*6*	*3*	*2*	*0*	*2*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

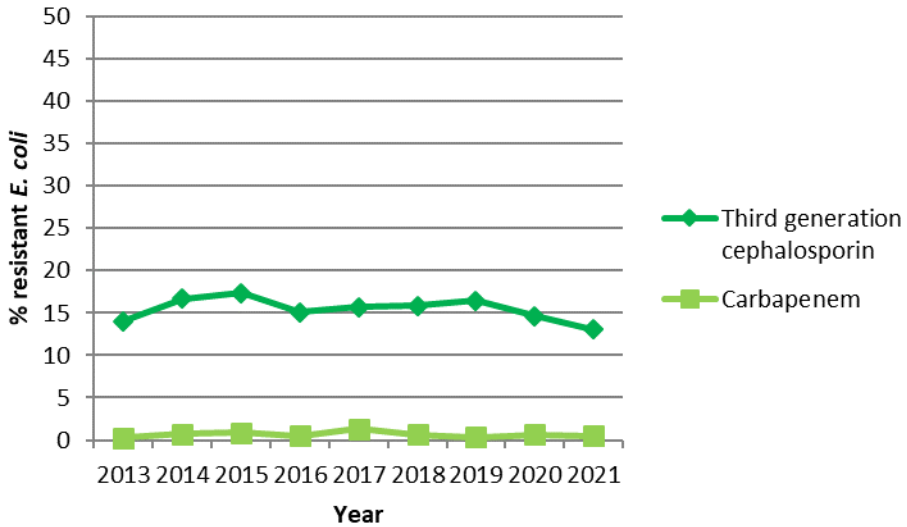
** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

The decrease in proportion of methicillin resistant *S. aureus* (MRSA) (p<0.0001) and in the incidence of HABSI with a MRSA per 10,000 pd (2021 compared to 2013, incidence rate ratio 0.53 with 95% CI [0.40-0.72]) are both statistically significant. Changes in the proportion (p=0.27) and incidence of HABSI with a *S. aureus* resistant to glycopeptides are not statistically significant.

2. *Escherichia coli*

Table 15: Antimicrobial resistance in* E. coli *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	1,339	1,593	1,776	1,873	1,926	1,893	1,637	1,557	1,527
N hospitals**	87	96	103	103	102	101	98	98	100
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)									
nR	188	266	308	282	303	300	269	228	199
%R	*14.0*	*16.7*	*17.3*	*15.1*	*15.7*	*15.8*	*16.4*	*14.6*	*13.0*
Mean incidence per 10,000 pd*	0.26	0.31	0.32	0.28	0.32	0.32	0.31	0.32	0.26
Hospitals with ≥ one R case	61	68	74	75	71	76	70	65	63
% hospitals with ≥ one R case	*70*	*71*	*72*	*73*	*70*	*75*	*71*	*66*	*63*
Carbapenems (imipenem, meropenem)									
nR	4	11	16	9	26	12	6	10	8
%R	*0.3*	*0.7*	*0.9*	*0.5*	*1.3*	*0.6*	*0.4*	*0.6*	*0.5*
Mean incidence per 10,000 pd*	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Hospitals with ≥ one R case	4	10	12	8	11	12	6	9	8
% hospitals with ≥ one R case	*5*	*10*	*12*	*8*	*11*	*12*	*6*	*9*	*8*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

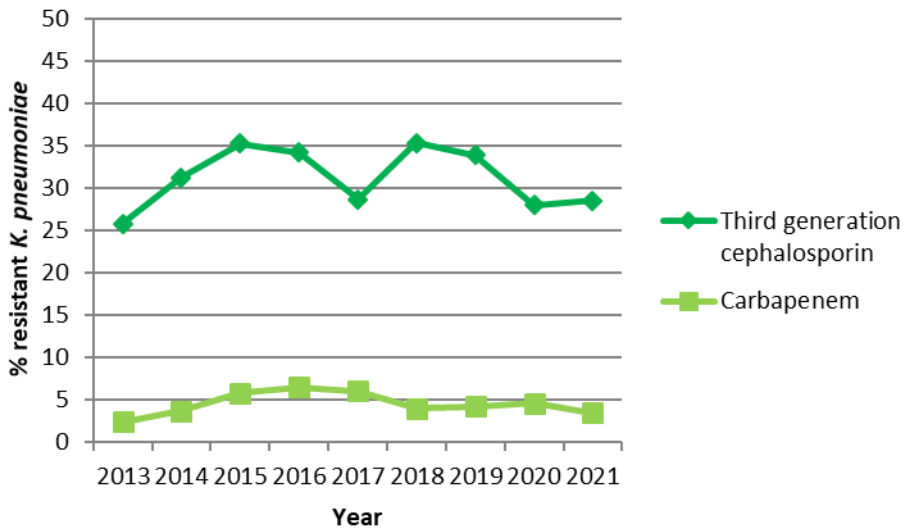
** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

Changes in proportion of *E. coli* resistant to third generation cephalosporins (p=0.08) and to carbapenems (p=0.81) are not statistically significant. Comparing 2021 with 2013, there is no statistically significant change in the incidence of HABSI with an *E. coli* resistant to third generation cephalosporins or carbapenems per 10,000 pd.

3. *Klebsiella pneumoniae*

Table 16: Antimicrobial resistance in* K. pneumoniae *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	380	513	585	682	667	737	644	680	611
N hospitals**	87	96	103	103	102	101	98	98	100
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)									
nR	98	160	206	233	191	260	218	190	174
%R	*25.8*	*31.2*	*35.2*	*34.2*	*28.6*	*35.3*	*33.9*	*27.9*	*28.5*
Mean incidence per 10,000 pd*	0.14	0.19	0.21	0.23	0.19	0.27	0.25	0.26	0.23
Hospitals with ≥ one R case	38	51	56	61	61	63	55	53	57
% hospitals with ≥ one R case	*44*	*53*	*54*	*59*	*60*	*62*	*56*	*54*	*57*
Carbapenems (imipenem, meropenem)									
nR	9	19	34	44	40	29	27	31	21
%R	*2.4*	*3.7*	*5.8*	*6.5*	*6.0*	*3.9*	*4.2*	*4.6*	*3.4*
Mean incidence per 10,000 pd*	0.01	0.02	0.03	0.04	0.04	0.03	0.03	0.04	0.03
Hospitals with ≥ one R case	9	11	18	22	24	17	17	17	15
% hospitals with ≥ one R case	*10*	*11*	*17*	*21*	*24*	*17*	*17*	*17*	*15*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

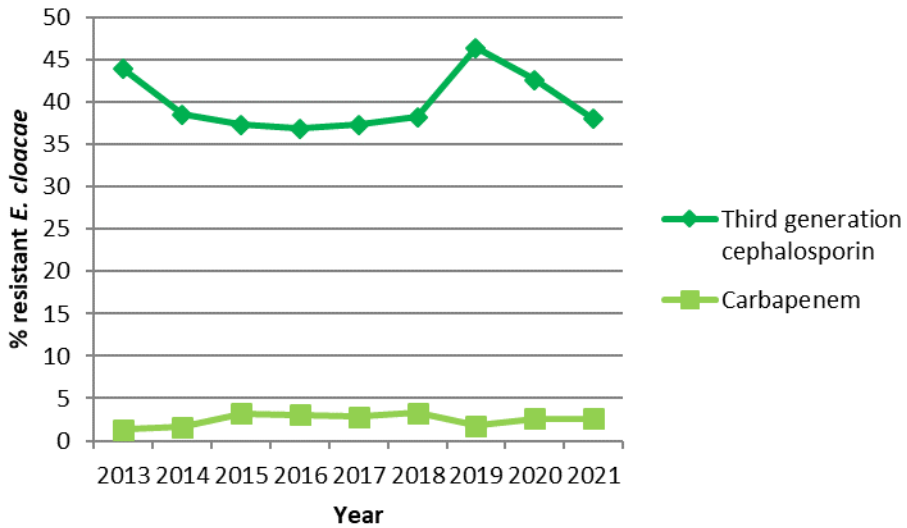
Changes in the incidence of HABSI with *K. pneumoniae* resistant to third generation cephalosporins per 10,000 pd (2021 compared to 2013, incidence rate ratio 1.79 with 95% CI [1.31-2.45]) are statistically significant.

Changes in proportion of *K. pneumoniae* resistant to third generation cephalosporins (p=0.52) and to carbapenems (p=0.64) and in incidence of HABSI with *K. pneumoniae* resistant to carbapenems per 10,000 pd (2013 compared to 2021) are not statistically significant.

4. *Enterobacter cloacae*

Table 17: Antimicrobial resistance in* E. cloacae *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	223	249	311	323	316	306	280	270	271
N hospitals**	87	96	103	103	102	101	98	98	100
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)									
nR	98	96	116	119	118	117	130	115	103
%R	*43.9*	*38.6*	*37.3*	*36.8*	*37.3*	*38.2*	*46.4*	*42.6*	*38.0*
Mean incidence per 10,000 pd*	0.14	0.11	0.12	0.12	0.12	0.12	0.15	0.15	0.14
Hospitals with ≥ one R case	41	40	52	54	53	48	46	40	43
% hospitals with ≥ one R case	*47*	*42*	*50*	*52*	*52*	*48*	*47*	*41*	*43*
Carbapenems (imipenem, meropenem)									
nR	3	4	10	10	9	10	5	7	7
%R	*1.3*	*1.6*	*3.2*	*3.1*	*2.8*	*3.3*	*1.8*	*2.6*	*2.6*
Mean incidence per 10,000 pd*	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Hospitals with ≥ one R case	3	4	9	8	7	10	3	5	5
% hospitals with ≥ one R case	*3*	*4*	*9*	*8*	*7*	*10*	*3*	*5*	*5*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

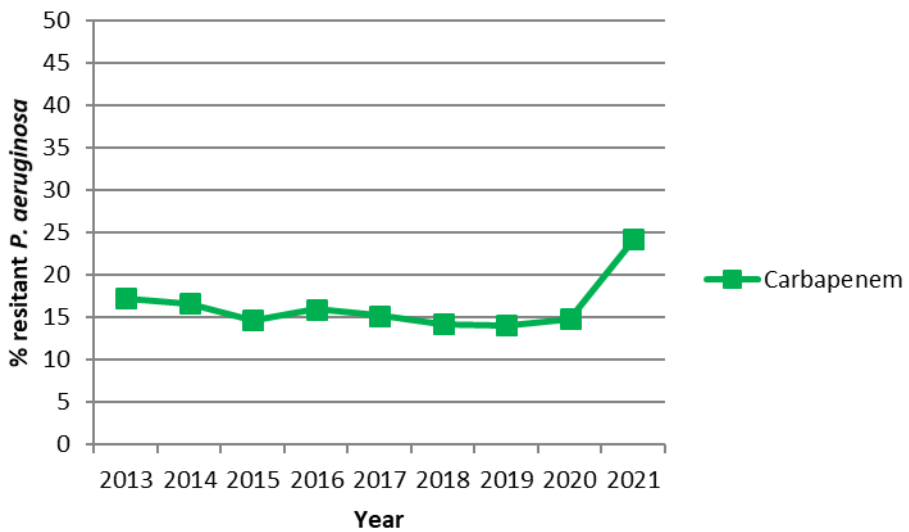
** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

None of the changes in the proportion of *E. cloacae* resistant to third generation cephalosporins (p=0.58) or to carbapenems (p=0.60) and in the incidence of HABSI with *E. cloacae* resistant to third generation cephalosporins or carbapenems per 10,000 pd (2021 compared to 2013) are found to be statistically significant.

5. *Pseudomonas aeruginosa*

Table 18: Antimicrobial resistance in* P. aeruginosa *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	319	396	401	395	421	443	384	425	380
N hospitals**	87	96	103	103	102	101	98	98	100
Carbapenems (imipenem, meropenem)									
nR	55	66	59	63	64	63	54	63	92
%R	*17.2*	*16.7*	*14.7*	*15.9*	*15.2*	*14.2*	*14.1*	*14.8*	*24.2*
Mean incidence per 10,000 pd*	0.08	0.08	0.06	0.06	0.06	0.07	0.06	0.09	0.12
Hospitals with ≥ one R case	27	39	36	33	30	32	21	30	35
% hospitals with ≥ one R case	*31*	*41*	*35*	*32*	*29*	*32*	*21*	*31*	*35*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

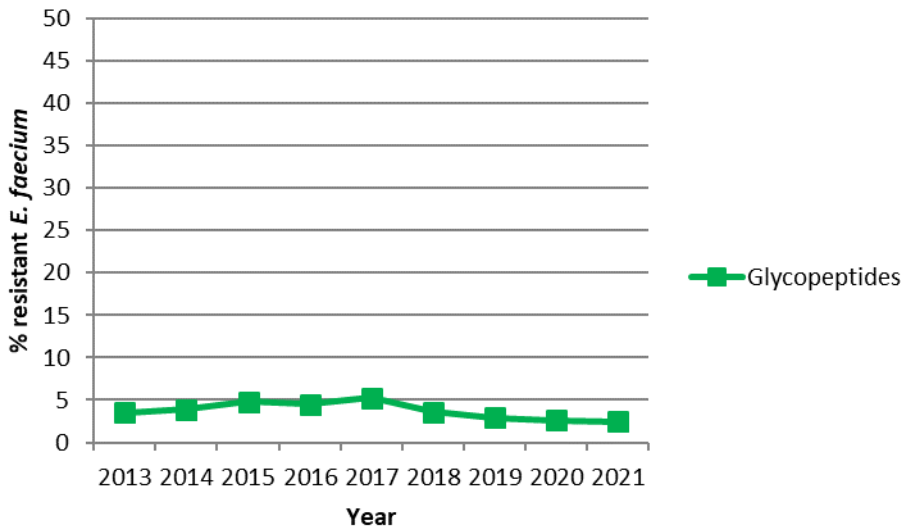
** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

Since 2013, changes in the proportion of *P. aeruginosa* resistant to carbapenems (p=0.19) are found to be not statistically significant. Changes in the incidence of HABSI with *P. aeruginosa* resistant to third generation carbapenems per 10,000 pd (2021 compared to 2013, incidence rate ratio 1.63 with 95% CI [1.14-2.34]) are statistically significant.

6. *Enterococcus faecium*

Table 19: Antimicrobial resistance in* E. faecium *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
N strains	197	285	377	357	454	496	480	538	570
N hospitals**	87	96	103	103	102	101	98	98	100
Glycopeptides (vancomycin, teicoplanin)									
nR	7	11	18	16	24	18	14	14	14
%R	*3.6*	*3.9*	*4.8*	*4.5*	*5.3*	*3.6*	*2.9*	*2.6*	*2.5*
Mean incidence per 10,000 pd*	0.01	0.01	0.02	0.02	0.03	0.02	0.02	0.02	0.02
Hospitals with ≥ one R case	5	10	14	10	14	13	8	12	11
% hospitals with ≥ one R case	*6*	*10*	*14*	*10*	*14*	*13*	*8*	*12*	*11*



N, total number; nR, number resistant MO; pd, patient-days; R, resistant

Notes:

* Total HABSI/total patient-days x 10,000 for all hospitals participating at least one quarter

** Hospitals participate 1, 2, 3 or 4 quarters. Specialised hospitals not included.

Changes in the proportion of *E. faecium* resistant to glycopeptides (p=0.02) are statistically significant. Comparing 2021 with 2013, there is no statistically significant change in the incidence of HABSI with *E. faecium* resistant to glycopeptides per 10,000 pd.

Additional data on MO isolated from the HABSI and their resistance profile are given in Annex 13 Table 38, 39 and 40. We found that compared to HABSI, and for most MO, resistance is lower in BSI when acquired outside the hospital (defined as non-HABSI) (Annex 13, Table 40). However, because of the low numbers for some of the MO for BSI acquired outside the hospital this finding has to be considered with care.

3.3.1.3 ANTIMICROBIAL RESISTANCE BY REGION, 2021

Table 20 gives for each region for the set of selected MO and selected antibiotics(markers), the number and proportion of resistant MO isolated from HABSI in 2021. Across the three regions, for most of the tested resistance patterns, more or less the same resistance proportions are found. Due to the small sample size, we should also be caution to interpret and formulate conclusions based on the identified differences in resistance patterns.

For *S. aureus, E. coli*, *K. pneumoniae*, *E. cloacae* and *P. aeruginosa* which have larger sample sizes, we further explored statistically significance in the regional differences identified. This gave following outcomes:

- There is no statistically significant difference for the proportion of MRSA in HABSI when comparing the three regions.
- There is no statistically significant difference in the proportion of *E. coli* resistance to third generation cephalosporins when comparing the three regions.
- The proportion of *K. pneumoniae* resistance to third generation cephalosporins is statistically significant higher in Flanders ($p<0.001$) compared with the proportion in Wallonia. There is no statistically significant difference for these proportions when comparing Brussels with Flanders ($p=0.07$) and Brussels with Wallonia ($p=0.10$).
- There is no statistically significant difference in the proportion of *E. cloacae* resistance to third generation cephalosporins when comparing the three regions.
- There is no statistically significant difference in the proportion of *P. aeruginosa* resistance to carbapenems when comparing the three regions.

The number and proportion per region for the set of selected MO resistant to selected antibiotics(markers) from non-HABSI and the number and proportion of hospitals with at least one case of a BSI with a resistant MO are given in Annex 14, Table 41 and 42.

Table 20: Resistance in microorganisms isolated from hospital-associated bloodstream infections by region, Belgium 2021

		Brussels			Flanders			Wallonia		
Microorganisms	**Antibiotics**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**
Gram-positive cocci										
S. aureus	Meti	154	12	7.8	450	37	8.2	255	30	11.8
	Gly	154	0	0.0	450	1	0.2	255	1	0.4
All Enterococcus spp.	Gly	233	5	2.1	539	6	1.1	311	9	2.9
E. faecalis	Gly	112	1	0.9	219	0	0.0	165	3	1.8
E. faecium	Gly	119	4	3.4	311	5	1.6	140	5	3.6
Enterobacteriaceae	C3G	744	151	20.3	1,758	339	19.3	878	176	20.0
	CAR	744	13	1.7	1,758	11	0.6	878	24	2.7
E. coli	C3G	317	48	15.1	815	102	12.5	395	49	12.4
	CAR	317	2	0.6	815	3	0.4	395	3	0.8
K. pneumoniae	C3G	154	46	29.9	290	65	22.4	167	63	37.7
	CAR	154	7	4.5	290	1	0.3	167	13	7.8
E. cloacae	C3G	89	26	29.2	111	53	47.7	71	24	33.8
	CAR	89	1	1.1	111	2	1.8	71	4	5.6
P. mirabilis	C3G	22	0	0.0	74	0	0.0	42	0	0.0
	CAR	22	0	0.0	74	0	0.0	42	0	0.0
K. oxytoca	C3G	40	9	22.5	129	19	14.7	33	3	9.1
	CAR	40	1	2.5	129	0	0.0	33	2	6.1
K. aerogenes	C3G	24	8	33.3	41	21	51.2	31	21	67.7
	CAR	24	0	0.0	41	1	2.4	31	1	3.2
Serratia spp.	C3G	47	8	17.0	104	37	35.6	46	7	15.2
	CAR	47	1	2.1	104	0	0.0	46	0	0.0
Non-fermenting Gram-negative bacilli										
P. aeruginosa	CAR	114	33	28.9	156	40	25.6	110	19	17.3
A. baumannii	CAR	3	1	33.3	18	0	0.0	5	0	0.0
Acinetobacter spp.	CAR	12	1	8.3	72	3	4.2	24	1	4.2

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, Methicillin; MO, microorganism; N, total number MO; n, number resistant MO; R, resistant; spp., species; %, percent resistant MO

The proportion MRSA and the proportion of third generation cephalosporins resistant *E. coli* and *K. pneumoniae* strains isolated from HABSI by province is given in the three maps below (Figure 19 to 21)[30].

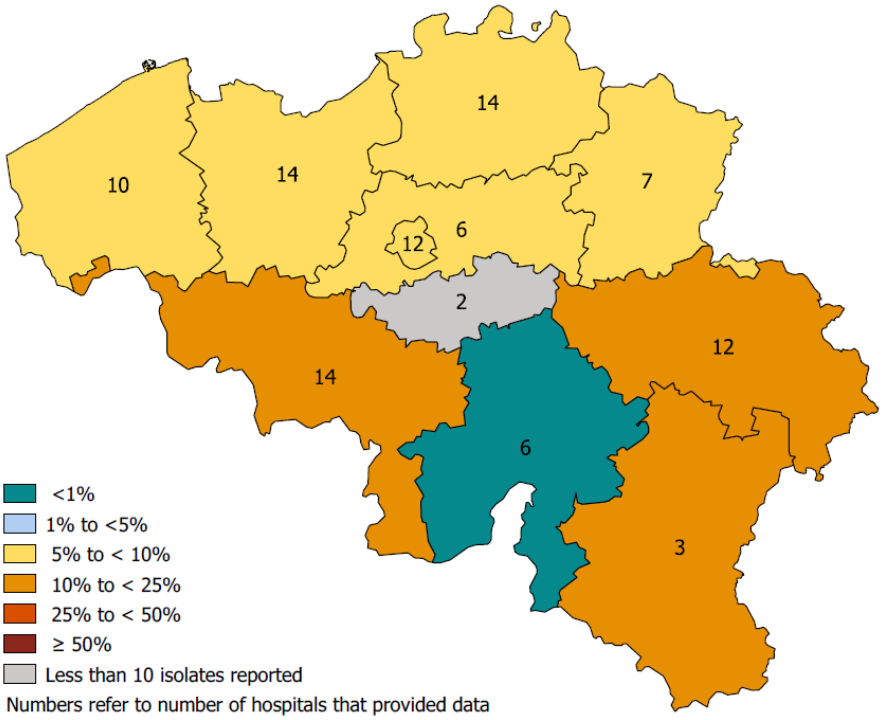


Figure 19: Percent of methicillin resistant* S. aureus *strains isolated from hospital-associated bloodstream infections, by province, Belgium 2021

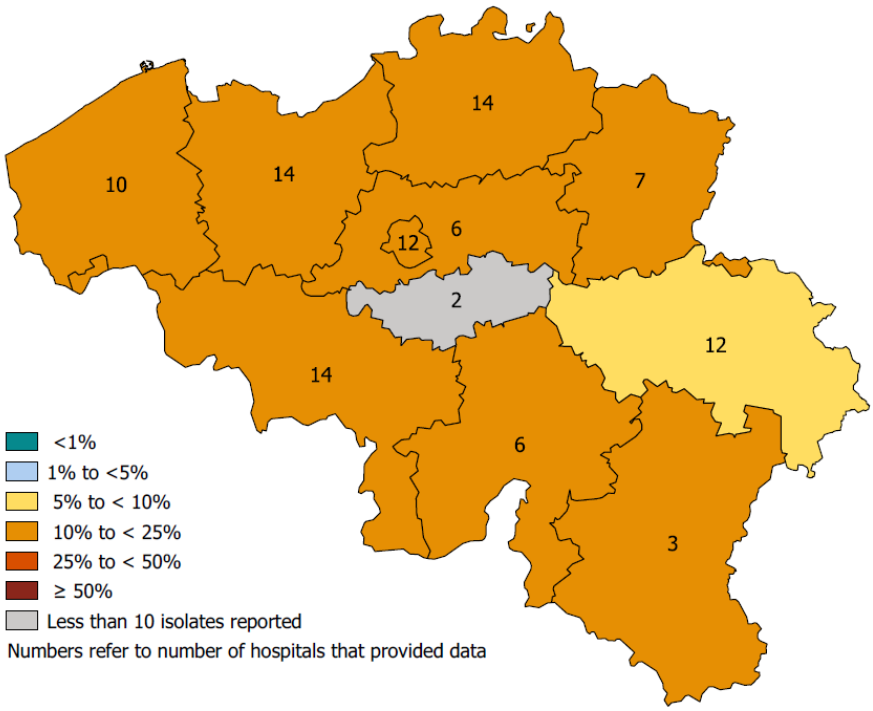


Figure 20: Percent of* E. coli *strains resistant to third generation cephalosporins isolated from hospital-associated bloodstream infections, by province, Belgium 2021

[30] The colour scale used in the maps is similar to those used by ECDC. See e.g. ECDC report: '*Surveillance of antimicrobial resistance in Europe. Annual report of the European Antimicrobial Resistance Surveillance Network (EARS-Net). 2019.*'

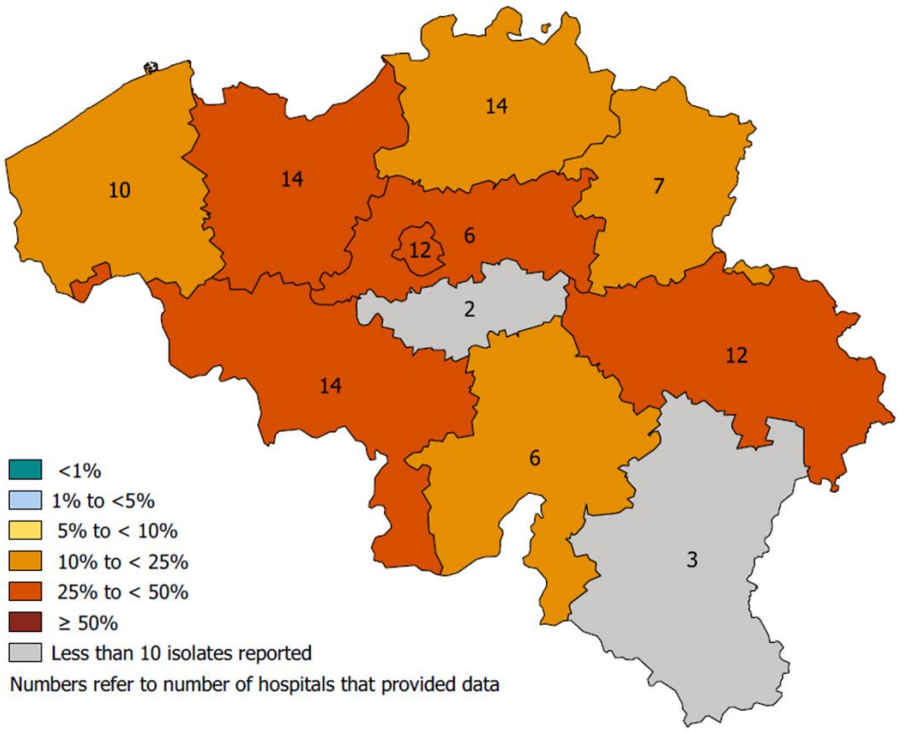


Figure 21: Percent of* K. pneumoniae *strains resistant to third generation cephalosporins isolated from hospital-associated bloodstream infections, by province, Belgium 2021

3.3.2 INTENSIVE CARE UNIT

3.3.2.1 IDENTIFIED MICROORGANISMS, 2021

A total of 2,323 MO were identified as etiological agent for 2,120 ICU-associated BSI (Table 21). *S. epidermidis, E. Faecium and S. aureus* were the most frequent identified MO.

Table 21: Microorganisms isolated from intensive care unit-associated bloodstream infections, Belgium 2021

	ICU-associated BSI	
Microorganisms	**n**	**%**
Enterobacteriaceae	793	34
Escherichia coli	204	9
Klebsiella pneumoniae	177	8
Serratia marescens	102	4
Enterobacter cloacae	87	4
Klebsiella oxytoca	66	3
Klebsiella aerogenes	44	2
Other/not identified*	113	5
Gram-positive cocci	1,090	47
Staphylococcus epidermidis	261	11
Enterococcus faecium	233	10
Staphylococcus aureus	216	9
Enterococcus faecalis	195	8
Staphylococcus hominis	38	2
Staphylococcus haemolyticus	35	2
Staphylococcus capitis	29	1
Other/not identified*	83	4
Non-fermenting Gram-negative bacilli	215	9
Pseudomonas aeruginosa	160	7
Other/not identified*	55	2
Fungi	140	6
Candida albicans	74	3
Candida glabrata	28	1
Other/not identified*	38	2
Anaerobic bacilli	52	2
Gram-positive bacilli	15	1
Gram-negative cocci	5	0
Other and not identified	13	1
Total	**2,323**	**100**

BSI, bloodstream infection; n, number

Note:

* Other includes microorganisms causing <25 episodes of ICU-associated BSI/year

3.3.2.2 ANTIMICROBIAL RESISTANCE DATA FOR SELECTED MICROORGANISMS AND SELECTED ANTIBIOTICS, 2021

For a set of selected MO and selected antibiotics(markers) (9, 10), number and proportion of resistant MO among the MO isolated from the ICU-associated BSI are given in Table 22. The proportions of resistant strains isolated from the ICU-associated BSI are similar to the proportions found hospital-wide.

Table 22: Resistance in microorganisms isolated from ICU-associated bloodstream infections, Belgium 2021

		Microorganisms			ICUs with >= one resistant case of ICU-associated BSI*- N=233	
	Antibiotics	N	n	%	n	%
Gram-positive cocci						
S. aureus	Meti	216	18	8	16	7
	Gly	216	1	0	1	0
All Enterococcus spp.	Gly	430	9	2	9	4
E. faecalis	Gly	195	1	1	1	0
E. faecium	Gly	233	8	3	8	3
Enterobacteriacea	C3G	793	213	27	91	39
	CAR	793	22	3	18	8
E. coli	C3G	204	22	11	16	7
	CAR	204	1	0	1	0
K. pneumoniae	C3G	177	71	40	49	21
	CAR	177	15	8	11	5
E. cloacae	C3G	87	34	39	30	13
	CAR	87	3	3	3	1
P. mirabilis	C3G	24	0	0	0	0
	CAR	24	0	0	0	0
K. oxytoca	C3G	66	17	26	16	7
	CAR	66	0	0	0	0
K. aerogenes	C3G	44	20	45	18	8
	CAR	44	0	0	0	0
Serratia spp.	C3G	105	31	30	19	8
	CAR	105	0	0	0	0
Non-fermenting Gram-negative bacilli						
P. aeruginosa	CAR	160	55	34	39	17
A. baumannii	CAR	7	1	14	1	0
Acinetobacter spp.	CAR	13	1	8	1	0

BSI, bloodstream infection; C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); ICU, intensive care unit; Meti, Methicillin; N, total number MO or total number of ICUs; n, number resistant MO or number of ICUs; spp., species; %, percent resistant MO

Notes:

* ICUs participate 1, 2, 3 or 4 quarters

4 Comparison between different sources of Belgian data

4.1 MINIMUM HOSPITAL DATA (MINIMALE ZIEKENHUISGEGEVENS/ RÉSUMÉ HOSPITALIER MINIMUM – MZG/RHM)

In Belgium, data of each hospital admission has to be reported at the Belgian federal public service for health, food chain safety and environment (MZG/RHM – 'minimale ziekenhuisgegevens'/'résumé hospitalier minimum'). Until 2014, for this reporting, diagnoses were coded using ICD-9-CM (International Classification of Diseases, 9th Revision, Clinical Modification), since 2016 ICD-10-CM (International Classification of Diseases, 10th Revision, Clinical Modification) is used (11). Due to transition from ICD-9-CM to ICD-10-CM coding, data on diagnosis is not available for 2015.

Data given in Figure 22 and Table 23 was provided by the Belgian federal public service for health, food chain safety and environment (Service public fédéral santé publique, securite de la chaine alimentaire et environnement/Federale overheidsdienst volksgezondheid, veiligheid van de voedselketen en leefmilieu) and includes all hospital admissions with the exception of day-care and ambulatory care at the emergency room (MZG/RHM field: A2/Veld 14 => A2_HOSPTYPE_FAC in H, F, M and L (12)).

The table and figure shows data on hospital admissions with septicaemia and bacteraemia as diagnosis (ICD-9-CM code 038:0-9 and 790.7 and ICD-10-CM code A40:0-9, A41:0-9 and R78.81) from 2008 to 2020 (most recent available data) (11)[31]. For both diagnoses the main[32] (MZG/RHM field: M1/Veld 6 => TYPE_DIAGNOSE = P) and secondary[33] (MZG/RHM field: M1/Veld 6 => TYPE_DIAGNOSE = S) diagnosis were included and for both diagnosis we looked at those labelled as 'not present on admission', a variable introduced in 2008 (MZG/RHM field: M1/Veld 9 => M1_PRESENT_ADM: code is N) (13). An infection 'not present on admission' is the exact definition of an healthcare associated or nosocomial infection[34]. This implies that the incidence of hospital admissions with ICD-9-CM and ICD-10-CM septicaemia and bacteraemia codes that are coded as 'not present on admission' should be comparable to the incidence of HABSI found using the Belgian BSI surveillance data.

MZG/RHM data is exhaustive and therefore, the number of episodes measures the burden of HABSI in Belgium. Disadvantage regarding MZG/RHM data is their delay in availability which is at least one year.

MZG/RHM data shows that since 2008, compared to the number of BSI as secondary diagnosis, the number of total BSI per 1,000 admissions and per 10,000 patient-days increased more (Table 23 and Figure 22). For the number of BSI not present on admission

[31] For findings from 2000 to 2007 see BSI report 2021: https://www.sciensano.be/en/biblio/surveillance-bloodstream-infections-belgian-hospitals-report-2021.

[32] The main diagnosis is defined as the condition that is identified after examination as the main cause for admission of the patient.

[33] Secondary diagnosis is defined as a condition that has an impact on the patientcare and that was present on admission or occurred after admission.

[34] Definition world health organisation of healthcare-associated infection, also referred to as 'nosocomial' or 'hospital' infection; an infection occurring in a patient during the process of care in a hospital or other health care facility which was not present or incubating at the time of admission.

per 1,000 admissions and per 10,000 patient-days we notice a remarkable (and unexplained) decrease for 2013 and 2014. However, since 2016 data are again higher. In 2020, the first COVID-19 year, we observe compared to previous years, a greater increase in the number of BSI not present on admission per 1,000 admissions and per 10,000 patient-days. In 2020, both indicators have also the highest incidence since the start of their reporting in 2008 (Table 23 and Figure 22).

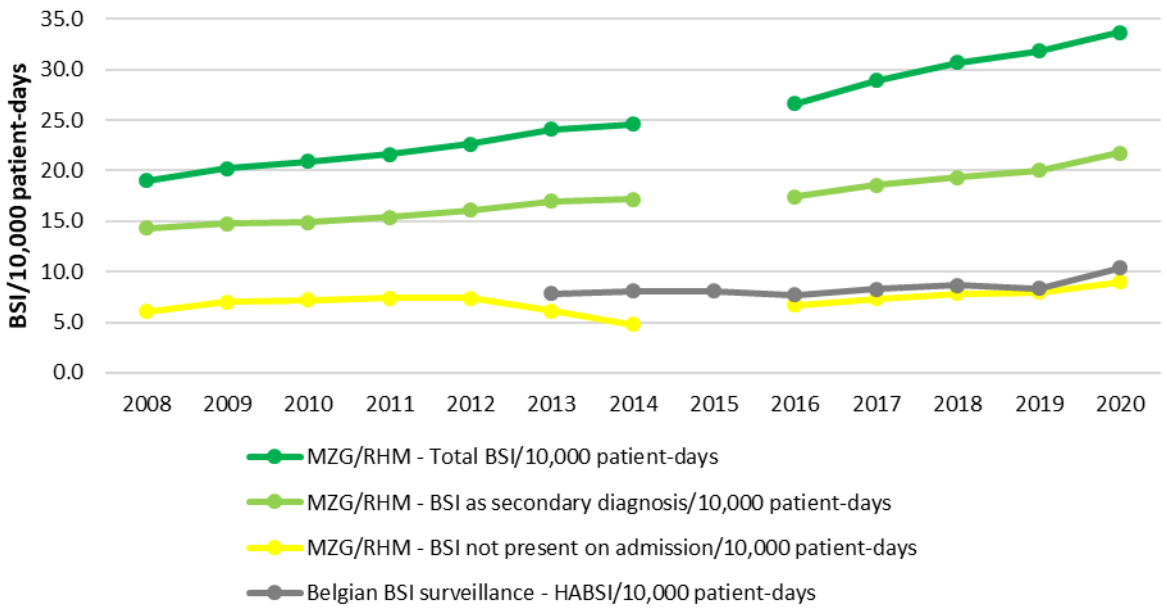


Figure 22: Incidence of bloodstream infections in Belgium, results from minimum hospital data (MZG/RHM) and Belgian bloodstream infection surveillance, 2008-2020 (BSI, bloodstream infection; HABSI, hospital-associated bloodstream infection)

Comparing the MZG/RHM incidences of BSI not present on admission per 1,000 admissions and per 10,000 patient-days with the incidences of HABSI per 1,000 admissions and per 10,000 patient-days found in the Belgium BSI surveillance, we found that incidences reported in the Belgium surveillance are higher than those reported in the MZG/RHM. However, this difference became quite small in 2019 but increases again in 2020 (Table 23 and Figure 22).

The lower reported incidence based on the MZG/RHM data is not exactly what we expect because, comparing the definition used in MZG/RHM (infection not present on admission) with the definition used in the Belgian BSI surveillance (infection occurring 2 days or more after admission) we would expect the opposite, meaning a higher incidence in the MZG/RHM reporting. In this context validation of data would be useful.

For 2020, the first COVID-19 year, we observed for the two data sources an increase in HABSI incidence. However, this increase was steeper using the Belgian BSI surveillance data compared to what we observed using the MZG/RHM data.

Table 23: Incidence of bloodstream infections in Belgium, results from minimum hospital data versus surveillance data, 2008-2020

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Minimum hospital data (minimale ziekenhuisgegevens/ résumé hospitalier minimum)													
Total BSI[1] (n)	29,229	30,653	31,620	32,691	33,877	35,400	35,362		38,262	40,517	42,810	42,660	39,004
Total BSI/1,000 admissions[2]	15.3	15.9	16.3	16.7	17.2	18.0	17.9		19.1	20.3	21.3	21.3	23.2
Total BSI/10,000 patient-days[3]	19.0	20.2	20.9	21.6	22.6	24.1	24.6		26.6	28.9	30.7	31.8	33.7
BSI as secondary diagnosis[4] (n)	21,948	22,321	22,517	23,301	24,038	24,969	24,731		24,987	26,004	26,943	26,835	25,165
BSI as secondary diagnosis/1,000 admissions[2]	11.5	11.6	11.6	11.9	12.2	12.7	12.5		12.5	13.0	13.4	13.4	15.0
BSI as secondary diagnosis/10,000 patient-days[3]	14.3	14.7	14.9	15.4	16.1	17.0	17.2		17.4	18.5	19.3	20.0	21.7
BSI not present on admission[5] (n)	9,269	10,603	10,873	11,164	11,059	9,005	6,857		9,613	10,276	10,938	10,688	10,401
BSI not present on admission/1,000 admissions[2]	4.9	5.5	5.6	5.7	5.6	4.6	3.5		4.8	5.2	5.5	5.3	6.2
BSI not present on admission/10,000 patient-days[3]	6.0	7.0	7.2	7.4	7.4	6.1	4.8		6.7	7.3	7.8	8.0	9.0
Surveillance of bloodstream infections in Belgian hospitals data													
HABSI/1,000 admissions						5.6	5.8	5.6	5.2	5.5	5.8	5.5	6.8
HABSI/10,000 patient-days						7.8	8.1	8.1	7.7	8.3	8.7	8.3	10.4

BSI, bloodstream infection; HABSI, hospital-associated bloodstream infection; NA, not available

Notes:

2015: Due to transition from ICD-9-CM to ICD-10-CM coding, data on diagnosis is not available for 2015

[1] 'Total BSI' includes admissions with septicaemia and bacteraemia as main and secondary diagnosis (13)

[2] 'admissions' include all admissions labelled as 'classic admissions (with overnight stay)' in MZG/RHM (see MZG/RHM: A2/Veld 14 => A2_HOSPTYPE_FAC for code H en L) (12)

[3] 'patient-days' include for each 'classic admission' total number of hospitalisation days that have to be billed (see MZG/RHM: A2/Veld 15 => A2_TOTAL_NUMBER_DAY_FAC voor alle types A2_HOSPTYPE_FAC in H, F, M, L) (12)

[4] 'BSI as secondary diagnosis' includes admissions with septicaemia and bacteraemia as secondary diagnosis (13)

[5] 'BSI not present on admission' includes admissions with septicaemia and bacteraemia as diagnosis and labelled as 'not present on admissions' (MZG/RHM: M1 / Veld 9 => M1_PRESENT_ADM: code is N) (13)

4.2 OTHER SOURCES OF BELGIAN ANTIMICROBIAL RESISTANCE DATA

See the 2021 report for the comparison of a set of selected antimicrobial resistance data from 2020 from the Belgian BSI surveillance with two other sources; *European Antimicrobial Resistance Surveillance Network* (EARS-Net) and *Surveillance of antimicrobial resistant bacteria in Belgian hospitals.* This comparison, based on 2021 data, will be published in the 2023 BSI report.

5 Effect of COVID-19 crisis on hospital-associated bloodstream infections

Regarding the 2020 and 2021 BSI data, we cannot ignore the presence of the COVID-19 crisis and its possible effect on the HABSI and CLABSI incidence, on the source of these infections and on its causal microorganism.

As a reminder, between March 2020 and the end of 2021, we observed four COVID-19 waves. Two waves in 2020 and two waves in 2021. The first wave in 2021 (third COVID-19 wave in Belgium) mainly situated in the second quarter with its peak in COVID-19 patients hospital occupation at the beginning of April, and a second wave in 2021 (fourth COVID-19 wave in Belgium) mainly situated in the fourth quarter with its peak in COVID-19 patients hospital occupation end of November (Figure 23).

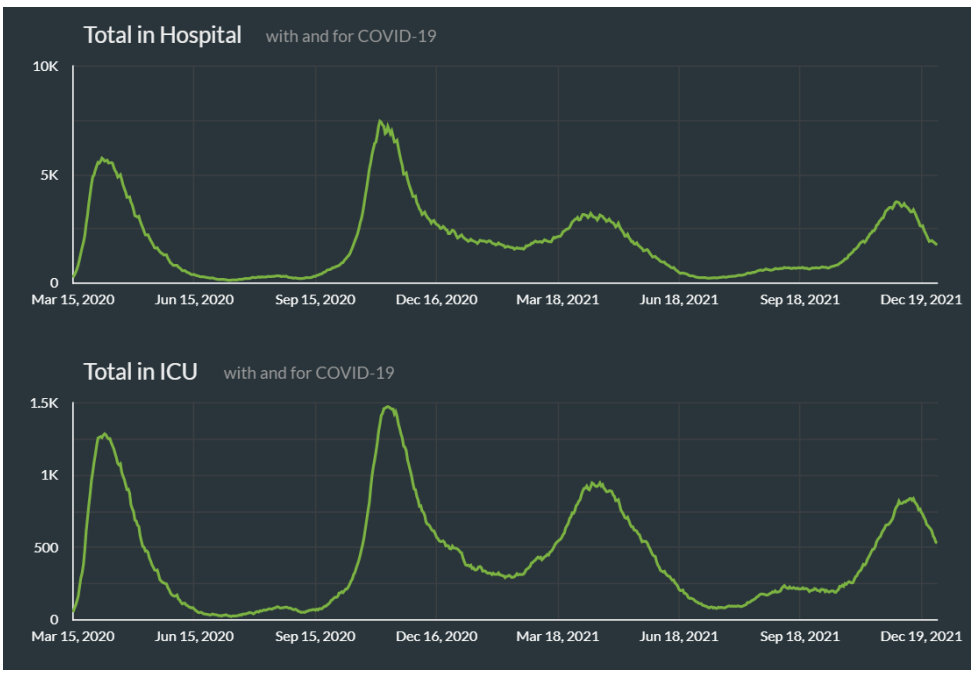


Figure 23: Total number of COVID-19 patients at hospitals and intensive care units, Belgium, 15 March 2020 – 31 December 2021[35] (ICU, intensive care unit)

[35] Data see Sciensano COVID-19 dashboard: https://datastudio.google.com/embed/reporting/c14a5cfc-cab7-4812-848c-0369173148ab/page/ZwmOB (accessed June 2022)

5.1 COVID-19 EFFECT ON THE INCIDENCE OF HOSPITAL- AND CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS

Between 2013 and 2019, as already mentioned above, we did not observe a trend or statistically significant change in HABSI and CLABSI incidence per 10,000 pd hospital wide. From 2019 to 2020, we observed a statistically significant increase in the HABSI and CLABSI incidence at Belgium and at each of the regions which remained observed in 2021, the second COVID-19 year (Figure 24). Comparing 2019 with 2021, at Belgian level the HABSI incidence increase by 19% and CLABSI incidence by 29%.

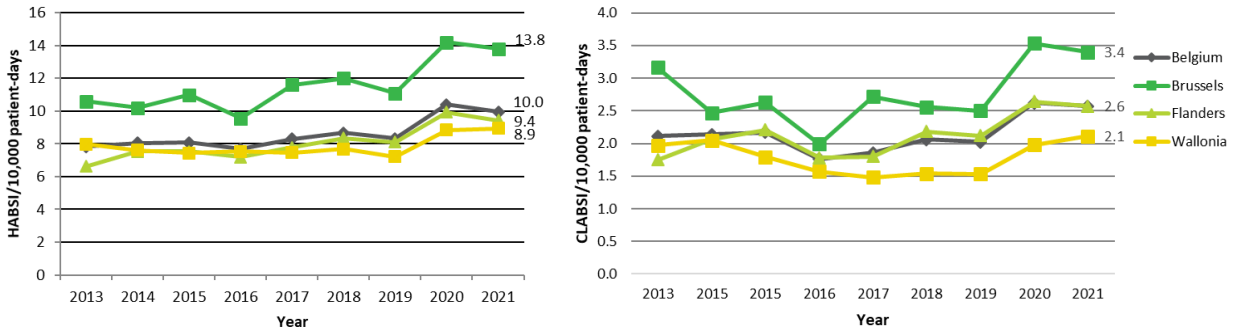


Figure 24: Mean incidence of hospital- and central line-associated bloodstream infection, hospital-wide, Belgium and by region, 2013-2021 (CLABSI, central line-associated bloodstream infection; HABSI, hospital-associated bloodstream infection)

The same is observed at ICU-level and if assessing HABSI incidence by hospital type. At ICU-level, from 2019 to 2021, the HABSI incidence in Belgium increase by 35% and CLABSI incidence by 43% (Figure 25). In both, tertiary and other type hospitals, no trend in HABSI incidence was observed between 2013 and 2019. From 2019 to 2021, the HABSI incidence increased statistically significant (Figure 26), at Belgium level at tertiary hospitals by 23% and in other hospital by 16%.

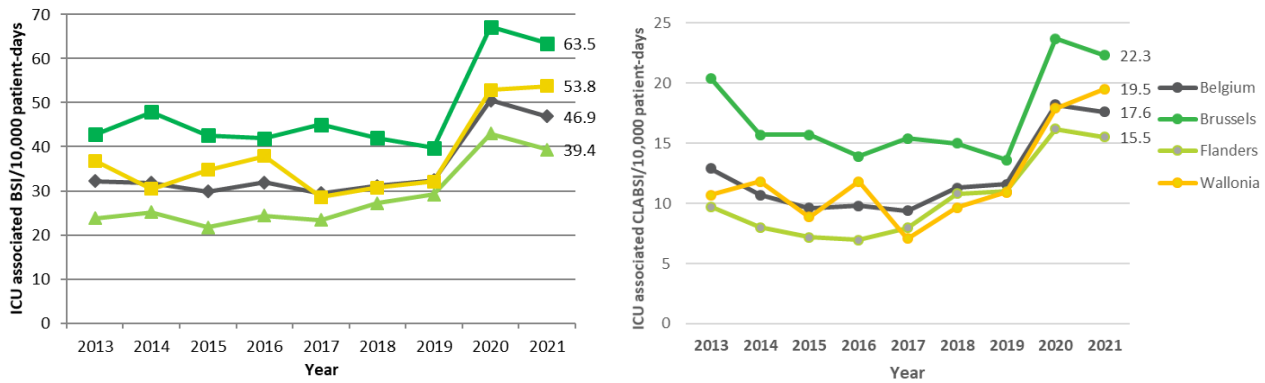


Figure 25: Mean incidence of hospital- and central line-associated bloodstream infection, intensive care units, Belgium and by region, 2013-2021 (CLABSI, central line-associated bloodstream infection; HABSI, hospital-associated bloodstream infection; ICU, intensive care unit)

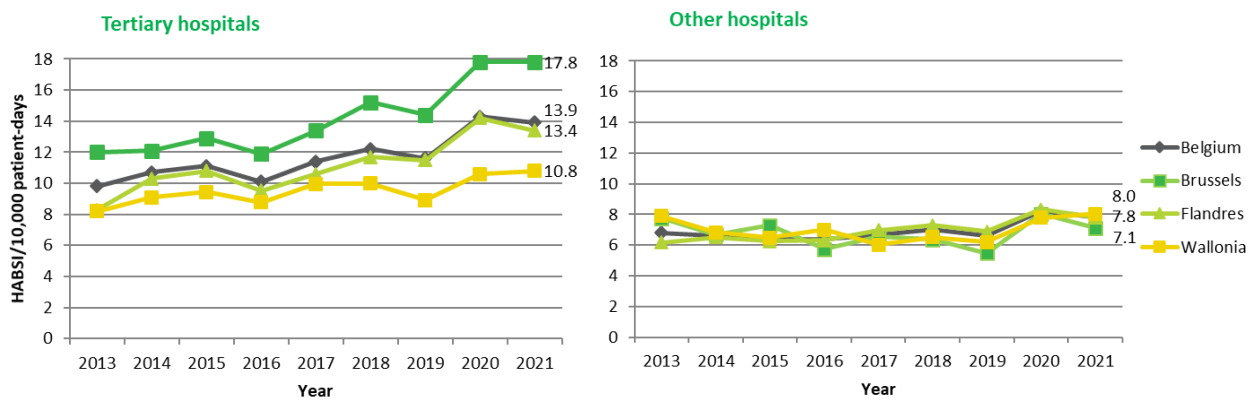


Figure 26: Mean incidence of hospital-associated bloodstream infection in tertiary and other hospitals, Belgium and by region, 2013-2021 (HABSI, hospital-associated bloodstream infection)

Figures 27 and 28 give the HABSI and CLABSI incidence between 2013 and 2021 by quarter, hospital wide and at ICU. Different than what we observed in 2020 where the increase in HABSI and CLABSI incidence between 2019 and 2020 was mainly due to the increase in infections observed during the second and fourth quarter of 2020, being the quarters of the first and second COVID-19 wave, we observed in 2021 compared with 2019 an increase in infections in all quarters and not only in the quarters of the third and fourth COVID-19 waves. So in 2021, the increased incidence in HABSI and CLABSI wasn't linked to the COVID-19 waves occurrence as we observed in 2020.

Figure 27: Mean incidence of hospital- and central line-associated bloodstream infection by quarter, hospital-wide, Belgium, 2013-2021 (CLABSI, central line-associated bloodstream infection; HABSI, hospital-associated bloodstream infection)

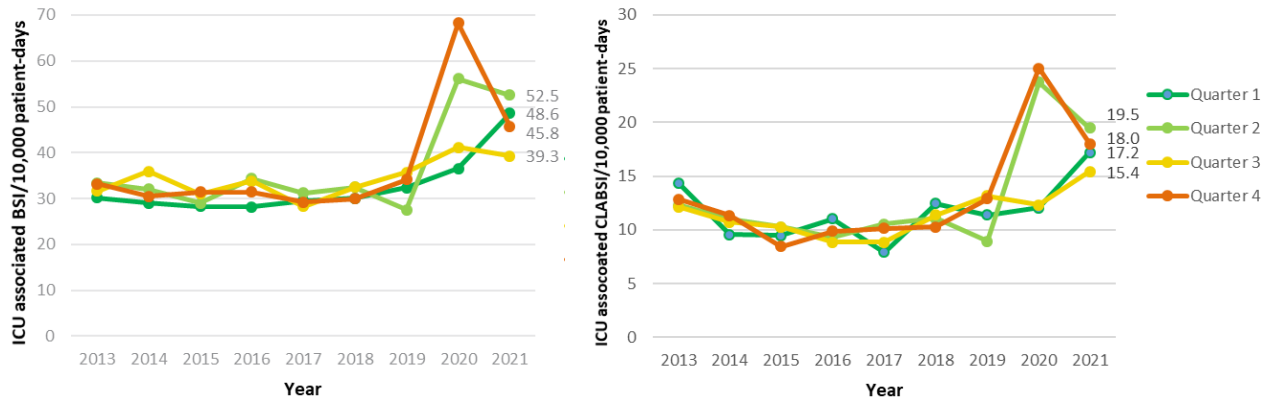


Figure 28: Mean incidence of hospital- and central line-associated bloodstream infection by quarter, intensive care units, Belgium, 2013-2021 (CLABSI, central line-associated bloodstream infection; HABSI, hospital-associated bloodstream infection; ICU, intensive care unit)

5.2 COVID-19 EFFECT ON SOURCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION AND CAUSAL MICROORGANISM

Similar to 2020, in 2021, compared to previous years, we found proportional more HABSI with source pulmonary infection (at hospital level: 2019, 11% - 2021, 13% and at ICU level: 2019, 23% - 2020, 30%) and more with endotracheal tube present (2019, 34% - 2020, 55%). Also in 2021 compared with the years before 2020, proportional more HABSI occurred at ICU (2019, 20% - 2021, 28%). These findings suggest that compared with the years before the COVID-19 pandemic, there were among patients with HABSI proportionally more patients critical ill.

In 2021, we did not observe a change in trend of MO specific HABSI incidences and antimicrobial resistance profile of selected causal MO. Also the 2021 crude mortality for HABSI (20%) remained similar to previous years.

5.3 CONCLUSION COVID-19 EFFECT ON HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

Several publications observed similar findings regarding the impact of COVID-19 on HABSI and CLABSI incidence during 2020 and 2021 (14-20).

Lastinger *et al*. analysed data reported to the National Healthcare Safety Network. They report that the effect of COVID-19 on healthcare-associated infections observed in 2020 remained present in 2021. During the last three quarters of 2020 and the first and third quarter on 2021, they observed a significant increase in the CLABSI standardized infection ratios. From 2015 to 2019, they found consistent significant reductions in this ratio for CLABSI (19, 20).

Possible hypotheses for this increase in incidence are, as also stated in the studies above, that during the COVID-19 crisis the heavy working conditions and the fact that many COVID-19 patients are critical ill on admission, might be a reason why infection prevention and control measure (including CLABSI bundle requirements) were not or could not be implemented as they should, leading to an increase in CLABSI and HABSI incidence.

Another hypothesis is that during the COVID-19 crisis, due to the periodically setting on-hold of routine care and planned admission at the hospitals and due to the fact that people for whatever reason waited longer to consult a medical doctor or go to the hospital, the hospital patient population profile changed considerable, having proportionally more severely ill and weaker patients in the hospital than normally, meaning patients with a weaker immune system, making them more susceptible to develop HABSI and as such leading to an increased HABSI incidence.

Why during 2021 the increase in HABSI and CLABSI incidence is not linked with the occurrence of the COVID-19 waves as was the case in 2020 but is due to an more or less similar increase in incidence throughout the year might be explained by the fact that due to the long duration of the crisis hospital services become more and more in a situation of continue pressure and stress with among others challenging human resources situations.

6 General comments

2020 data given in the 2022 report may differ slightly from those in the 2021 report. This due to the fact that some hospitals still entered data after closing the data submission deadline. These data are included in the analyses done for the 2022 report.

Although data entry for the bloodstream infection surveillance can be done throughout the year, some hospitals prefer to enter data and fulfil their obligation just before the data submission deadline which is the 31st of March of the year following the reporting year. For 2021, the extension of the deadline for submitting data was individually discussed with hospitals for whom data was missing. We implemented this approach due to the COVID-19 crisis to provide infection prevention and control teams additional time to submit their data.

As extensive described in the main findings and the dedicated section on the impact of COVID-19 on HABSI and CLABSI incidence, the effect of the pandemic on HABSI and CLABSI occurrence in Belgian hospital remains present for the reporting year 2021, being the second COVID-19 year.

To enhance data quality an extensive and detailed data cleaning was conducted. This included among others contacting hospitals with ‘strange’ results. However, not all hospitals reacted or acted as required or needed to address these ‘strange’ results. This can be considered as a negative side effect of mandatory registration impacting the quality of data. Making the participation voluntary will avoid the participation of non-motivated hospitals for whom data quality for this surveillance isn’t a priority. In case of voluntary participation, to ensure high participation rates, it is needed to ensure that hospitals considers this surveillance as added value and useful for the hospital and IPC management.

In 2022, to assess and enhance data quality, we initiated, in cooperation with *‘Vlaams Instituut voor Kwaliteit van Zorg’* (VIKZ), a study on validation of surveillance data in which we compare data from the surveillance with data received through the MZG/RHM. Part of this study is also to assess if data collected through MZG/RHM could serve to timely answer the objectives of the surveillance of BSI in Belgian hospitals

7 Detailed recommendations

7.1 RECOMMENDATIONS FOR POLICY MAKERS

- Continue to support and enable infection prevention and control teams at hospitals in their responsibilities and tasks to decrease HABSI, among others through the 'Hospital Outbreak Support Teams (HOST) projects. More focus on infection prevention and control in pre-service training (medical and nursing schools) would be useful.
- As part of broader quality of care improvement initiatives, enhance the creation of a general culture of good quality of care practice at hospital level. This includes the creation of a supportive, safe, secure and not judging hospital environment in which internal quality audits conducted by the hospital infection prevention and control teams can be implemented. If needed, this can be enhanced though the HOST projects.
- Continue to support a national organised surveillance of HABSI to assess changes in HABSI incidence at national and hospital level. Especially in the frame of the COVID-19 crisis it is very important to continue this surveillance, this to assess the impact of the COVID-19 crisis on the occurrence of HABSI and to be able to formulate, if needed, measures, guidelines and actions to strengthen quality of care and infection prevention and control management in times of a health crisis (lessons learned).
- The COVID-19 crisis stressed the importance to enhance a sound infection prevention and control policy at national and hospital level.
- To improve data quality (e.g. issues with not reporting all eligible HABSI and CLABSI), consider making participation on the surveillance voluntary. Publishing a list of hospitals that yearly participate may enhance transparency regarding participation at this surveillance. Publication of quarterly available public reports with data on national and regional level might be an incentive to continue participating in the surveillance.

7.2 RECOMMENDATIONS FOR HOSPITALS

- Assess if there is still room for decrease of HABSI and, if needed, implement actions and activities to establish HABSI decrease. The organisation of internal HABSI audits conducted by the local infection prevention and control team is suggested.
- Continue recording and reporting HABSI data in the national BSI surveillance to be able to evaluate the HABSI situation at hospital level over time and evaluate the impact of locally implemented activities to decrease HABSI incidences and of locally occurred events on this HABSI incidence. Especially in the frame of the COVID-19 crisis it is very important to continue this reporting and recording, this to assess the impact of the COVID-19 crisis on the occurrence of HABSI and to be able to formulate, if needed, measures, guidelines and actions to strengthen quality of care and infection prevention and control management in times of a health crisis (lessons learned).

7.3 RECOMMENDATIONS FOR THE SCIENTISTS IN CHARGE OF THE SURVEILLANCE (SCIENSANO)

- Assess why there was between 2013 and 2019, no decline in HABSI incidence in Belgian hospitals at national level. This can be done by assessing if same hospitals have consistently better or worse HABSI incidences and if so, assess through an additional study why this is the case. Or, by comparing hospitals with a low HABSI incidence with similar hospitals with a high incidence and assess reasons for this difference.

RECOMMENDATION

- Assess if the in the BSI surveillance asked antibiotic resistance data should be updated to be streamlined with international recommendations.
- Streamline between the other Sciensano surveillances the collection of antibiotic resistance data to avoid same data are asked several times.
- Continue implementing the surveillance of BSI in Belgian hospitals which includes a yearly update of protocol and data collection tool. Consider making participation on this surveillance voluntary.
- Further improve the Healthdata data collection and reporting tool (Healthstat).

8 References

1. Blot SI, Depuydt P, Annemans L, Benoit D, Hoste E, De Waele JJ *et al*.: **Clinical and economic outcomes in critically ill patients with nosocomial catheter-related bloodstream infections.** *Clin Infect Dis* 2005, **41:** 1591-1598.

2. Ista E, van der Hoven B, Kornelisse RF, van der Starre C, Vos MC, Boersma E *et al*.: **Effectiveness of insertion and maintenance bundles to prevent central-line-associated bloodstream infections in critically ill patients of all ages: a systematic review and meta-analysis.** *Lancet Infect Dis* 2016, **16:** 724-734.

3. Schreiber PW, Sax H, Wolfensberger A, Clack L, Kuster SP: **The preventable proportion of healthcare-associated infections 2005-2016: Systematic review and meta-analysis.** *Infect Control Hosp Epidemiol* 2018, **39:** 1277-1295.

4. Umscheid CA, Mitchell MD, Doshi JA, Agarwal R, Williams K, Brennan PJ: **Estimating the proportion of healthcare-associated infections that are reasonably preventable and the related mortality and costs.** *Infect Control Hosp Epidemiol* 2011, **32:** 101-114.

5. Vrijens F, Hulstaert F, Devriese S, van de Sande S: **Hospital-acquired infections in Belgian acute-care hospitals: an estimation of their global impact on mortality, length of stay and healthcare costs.** *Epidemiol Infect* 2012, **140:** 126-136.

6. NSIH. National surveillance of hospital associated bloodstream infections (hospital-wide). https://www.sciensano.be/en/projects/national-surveillance-bloodstream-infections-belgian-hospitals, https://www.sciensano.be/nl/projecten/nationale-surveillance-van-bloedstroominfecties-belgische-ziekenhuizen, https://www.sciensano.be/fr/projets/surveillance-nationale-des-septicemies-dans-les-hopitaux-belges. [assessed June 2022]

7. Duysburgh E. *Surveillance des Septicémies dans les Hôpitaux Belges, Protocole 2019, avril 2019*. https://www.sciensano.be/fr/biblio/surveillance-des-septicemies-dans-les-hopitaux-belges-protocole-2019. 2019. Brussels, Belgium, NSIH - Sciensano.

8. Duysburgh E. *Surveillance Bloedstroominfecties in Belgische Ziekenhuizen, Protocol 2019, mei 2019.* https://www.sciensano.be/nl/biblio/surveillance-des-septicemies-dans-les-hopitaux-belges-protocole-2019. 2019. Brussels, Belgium, NSIH-Sciensano.

9. European Centre for Disease Prevention and Control (ECDC). *Point prevalence survey of healthcareassociated infections and antimicrobial use in European acute care hospitals - protocol version 5.3*. 2016. Stockholm, Sweden, ECDC.

10. European Centre for Disease Prevention and Control (ECDC*). Surveillance of healthcare-associated infections and prevention indicators in European intensive care units. HAI-Net ICU protocol, version 2.2.* 2017. Stockholm, Sweden, ECDC.

11. WHO. ICD10 classification. http://apps.who.int/classifications/icd10/browse/2010/en [assessed September 2018]

12. Belgian federal public service for health, food chain safety and environment. *MZG: Domein 3 - Administratieve gegevens / RHM: Domaine 3 - Données administratives*. 2019. https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/richtlijnen_domein_3_administratieve_gegevens_a_2019_12_0.pdf,

https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/directives_domaine_3_donnees_administratives_a_2019_0.pdf. Brussels, Belgium, Federal Public Service Health, Food Chain Safety and Environment.

13. Belgian federal public service for health, food chain safety and environment. *MZG: Domein 5 - Medische gegevens / RHM: Domaine 5 - Données médicales.* 2019. https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/richtlijnen_domein_5_medische_gegevens_m_2020_05.pdf, https://www.health.belgium.be/sites/default/files/uploads/fields/fpshealth_theme_file/directives_domaine_5_donnees_medicales_m_2020_05.pdf. Brussels, Belgium, Federal Public Service Health, Food Chain Safety and Environment.

14. Baccolini V, Migliara G, Isonne C, Dorelli B, Barone LC, Giannini D, et al. **The impact of the COVID-19 pandemic on healthcare-associated infections in intensive care unit patients: a retrospective cohort study**. Antimicrob Resist Infect Control. 2021 Dec;10(1):87.

15. Fakih MG, Bufalino A, Sturm L, Huang R-H, Ottenbacher A, Saake K, et al. **Coronavirus disease 2019 (COVID-19) pandemic, central-line–associated bloodstream infection (CLABSI), and catheter-associated urinary tract infection (CAUTI): The urgent need to refocus on hardwiring prevention efforts**. Infect Control Hosp Epidemiol. 2021 Feb 19;1–6.

16. LeRose J, Sandhu A, Polistico J, Ellsworth J, Cranis M, Jabbo L, et al. **The impact of coronavirus disease 2019 (COVID-19) response on central-line–associated bloodstream infections and blood culture contamination rates at a tertiary-care center in the Greater Detroit area**. Infect Control Hosp Epidemiol. 2021 Aug;42(8):997–1000.

17. McMullen KM, Smith BA, Rebmann T. **Impact of SARS-CoV-2 on hospital acquired infection rates in the United States: Predictions and early results**. Am J Infect Control. 2020 Nov;48(11):1409–11.

18. Patel PR, Weiner-Lastinger LM, Dudeck MA, Fike LV, Kuhar DT, Edwards JR, et al. **Impact of COVID-19 pandemic on central-line–associated bloodstream infections during the early months of 2020, National Healthcare Safety Network**. Infect Control Hosp Epidemiol. 2021 Mar 15;1–4.

19. Weiner-Lastinger LM, Pattabiraman V, Konnor RY, Patel PR, Wong E, Xu SY, et al. **The impact of coronavirus disease 2019 (COVID-19) on healthcare-associated infections in 2020: A summary of data reported to the National Healthcare Safety Network.** Infect Control Hosp Epidemiol. 2021 Sep 3;1–14.

20. Lastinger LM, Alvarez CR, Kofman A, Konnor RY, Kuhar DT, Nkwata A, et al. **Continued increases in the incidence of healthcare-associated infection (HAI) during the second year of the coronavirus disease 2019 (COVID-19) pandemic**. Infect Control Hosp Epidemiol. 2022 Apr; 1–5.

9 Annexes

1. CALCULATION OF INCIDENCES

Table 24: Calculation of mean incidences, surveillance of bloodstream infections in Belgian hospitals

Incidences	NUMERATOR	DENOMINATOR
	Hospital-wide	
Mean cumulative incidence HABSI/1,000 admissions	∑ N BSI ≥2 days in hospital	∑ Total admissions
Mean incidence density HABSI/10,000 patient-days		∑ Total patient-days
	ICU	
Mean cumulative incidence ICU-associated BSI/1,000 admissions ICU	∑ N BSI ≥2 days in ICU	∑ Total admissions ICU
Mean incidence density ICU-associated BSI/10,000 patient-days ICU		∑ Total patient-days ICU

HABSI, hospital-associated bloodstream infection; ICU, intensive care unit; N, number; ∑, sum

The mean incidence numerator at ICU includes the number of ICU-associated BSI (≥2 days in ICU) and the denominator includes the TOTAL number of admissions or patient-days at ICU (including patients staying < 2 days in ICU). This means that the denominator includes patients who are not at risk for acquiring an ICU-associated BSI.

For the incidence calculation only those hospitals and ICU units with available and matching denominator data for the reporting quarter and year were included in the analysis. We noticed that this denominator data was often missing for the ICU units.

2. PARTICIPATION BY REGION

In 2021, in Flanders half and in Brussels and Wallonia about one third of the hospitals participated in the BSI-surveillance the whole year.

Table 25: Participation in the surveillance of bloodstream infections in Belgian hospitals by region, 2021

N participating quarters	N hospitals participating (% of hospitals on total number of hospitals that should participate: Brussels N=14, Flanders N=52, Wallonia N=38)*		
	Brussels	Flanders	Wallonia
At least 1 quarter	**12 (86)**	**51 (99)**	**37 (97)**
1 quarter	4 (29)	19 (37)	16 (42)
2 quarters	2 (14)	3 (6)	5 (13)
3 quarters	1 (7)	2 (4)	2 (5)
4 quarters (whole year)	5 (36)	27 (52)	14 (37)

N, number

Note: *Hospitals as identified by their RIZIV/INAMI number

3. INCIDENCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS BY REGION

Table 26: Incidence of hospital-associated bloodstream infections by region, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Brussels									
N hospitals included in calculation of incidence*	11	11	12	12	10	12	12	12	12
N HABSI	1,586	1,686	1,741	1,635	1,485	1,591	1,540	1,672	1,579
Cumulative incidence per 1,000 admissions									
mean**	7.8	7.4	7.8	7.0	8.2	8.3	7.5	9.9	8.2
median***	8.1	6.8	8.1	7.2	7.6	8.1	5.5	9.3	7.9
Incidence density per 10,000 patient-days									
mean**	10.6	10.2	11.0	9.6	11.6	12.0	11.1	14.2	13.8
median***	9.4	9.3	11.3	9.2	8.8	11.2	7.8	10.8	10.1
Flanders									
N hospitals included in calculation of incidence*	44	51	53	53	49	51	50	51	51
N HABSI	2,450	3,634	4,273	4,242	3,676	4,353	3,974	3,980	4,131
Cumulative incidence per 1,000 admissions									
mean**	4.6	5.3	5.1	4.7	5.0	5.5	5.1	6.2	5.8
median***	4.3	4.2	4.3	4.3	4.5	4.5	4.5	5.3	4.8
Incidence density per 10,000 patient-days									
mean**	6.6	7.6	7.5	7.2	7.8	8.3	8.1	9.9	9.4
median***	6.2	6.5	6.4	6.5	6.8	7.2	7.2	8.3	8.1
Wallonia									
N hospitals included in calculation of incidence*	31	34	37	38	34	37	36	34	36
N HABSI	1,548	1,606	1,861	1,914	1,594	1,965	1,725	1,604	1,801
Cumulative incidence per 1,000 admissions									
mean**	6.0	5.8	5.3	5.4	5.3	5.1	5.2	6.4	6.2
median***	5.8	5.1	5.4	5.2	4.5	4.6	4.6	5.4	5.3
Incidence density per 10,000 patient-days									
mean**	8.0	7.6	7.5	7.5	7.5	7.7	7.2	8.8	8.9
median***	8.0	7.0	7.0	6.7	6.7	6.9	6.3	7.2	7.8

HABSI, hospital-associated BSI; N, number
Notes:
* Hospitals included when denominator of the participating quarter was available
** Total hospital-associated BSI/total denominator
*** Unit of analysis used to calculate median is quarter

4. INCIDENCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS IN TERTIARY AND NON-TERTIARY HOSPITALS

Table 27: Incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-tertiary hospital									
N hospitals included in calculation of incidence*	67	74	78	79	73	77	75	74	76
N HABSI	3,207	3,663	4,035	4,307	3,609	4,318	3,704	3,667	3,826
mean incidence 1,000 admissions**	4.9	4.7	4.4	4.4	4.5	4.6	4.3	5.3	5.0
mean incidence 10,000 patient-days**	6.8	6.6	6.4	6.4	6.7	7.0	6.6	8.2	7.8
Tertiary hospital									
N hospitals included in calculation of incidence*	19	22	24	24	20	23	23	23	23
N HABSI	2,377	3,263	3,840	3,484	3,146	3,591	3,535	3,589	3,685
mean incidence 1,000 admissions**	7.0	7.9	7.9	6.7	7.4	8.3	7.9	9.5	8.6
mean incidence 10,000 patient-days**	9.8	10.7	11.1	10.1	11.4	12.2	11.6	14.3	13.9

HABSI, hospital-associated BSI; N, number
Notes:
* Hospitals included when denominator of the participating quarter was available
** Total HABSI/total denominator

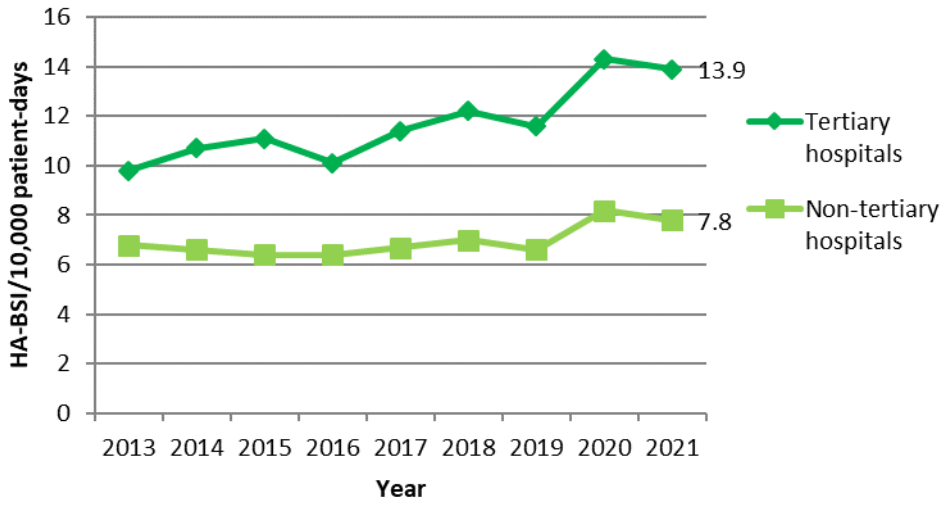


Table 28: Incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals by region, Belgium 2017-2021[36]

	Brussels					Flanders					Wallonia				
Year	**2017**	**2018**	**2019**	**2020**	**2021**	**2017**	**2018**	**2019**	**2020**	**2021**	**2017**	**2018**	**2019**	**2020**	**2021**
Non-tertiary hospital															
N hospitals included in calculation of incidence*	5	6	6	6	6	44	44	43	43	43	24	27	26	25	27
N HABSI	224	312	284	353	305	2,564	2,894	2,492	2,428	2,429	821	1,112	928	886	1,092
*mean incidence 1,000 admissions***	4.2	4.3	3.5	5.4	4.4	4.6	4.8	4.3	5.2	4.8	4.3	4.3	4.5	5.6	5.7
*mean incidence 10,000 patient-days***	6.6	6.4	5.5	8.1	7.1	7.0	7.3	6.9	8.3	7.8	6.0	6.5	6.2	7.8	8.0
Tertiary hospital															
N hospitals included in calculation of incidence*	5	6	6	6	6	5	7	7	8	8	10	10	10	9	9
N HABSI	1,261	1,279	1,256	1,319	1,274	1,112	1,459	1,482	1,552	1,702	773	853	797	718	709
*mean incidence 1,000 admissions***	9.8	10.7	10.0	12.8	10.2	6.0	8.0	7.5	8.7	8.4	7.0	6.6	6.4	7.7	7.1
*mean incidence 10,000 patient-days***	13.4	15.2	14.4	17.8	17.8	10.6	11.7	11.5	14.2	13.4	10.0	10.0	8.9	10.6	10.8

HABSI, hospital-associated BSI; N, number
Notes:
* Hospitals included when denominator of the participating quarter was available
** Total HABSI/total denominator

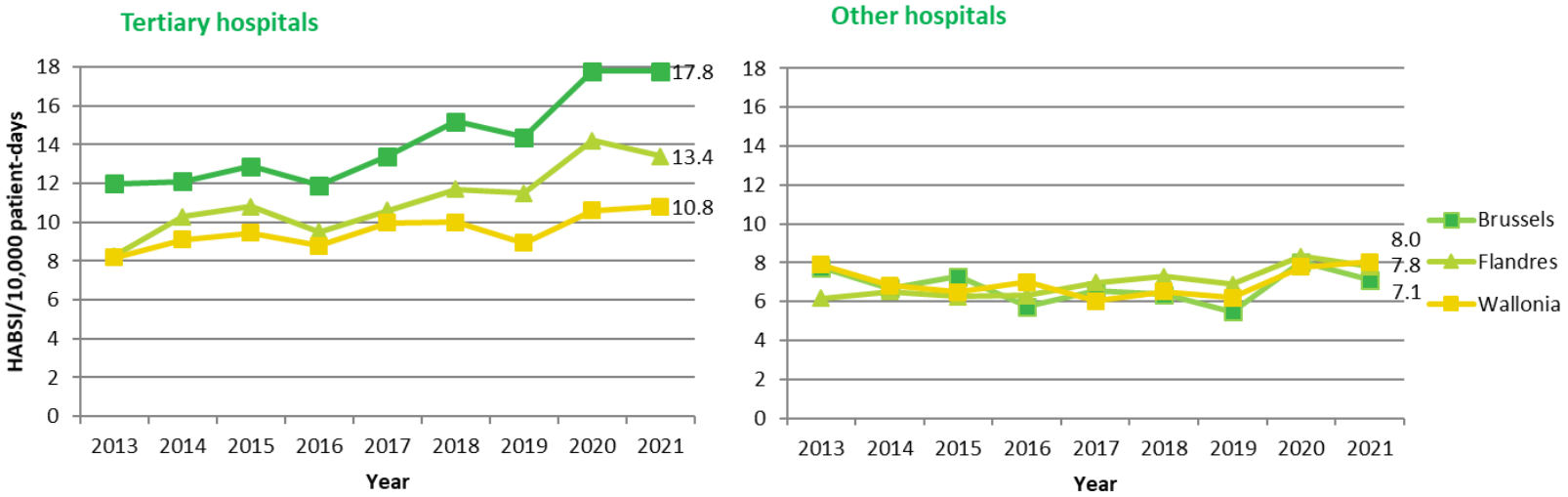


Figure 29: Mean incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals by region, Belgium 2013-2021 (HABSI, hospital-associated bloodstream infection)

[36] Because of readability of the table, data from only five last years are given. See 2020 report for 2013-2016 data: https://www.sciensano.be/en/biblio/surveillance-bloodstream-infections-belgian-hospitals-report-2020.

5. HOSPITAL-WIDE CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS BY CLASSIFICATION

Table 29: Central line-associated bloodstream infections, hospital-wide, according to classification (proportions)*, Belgium 2013-2021

Year	2013		2014		2015		2016		2017		2018		2019		2020		2021	
CLABSI	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Confirmed	623	41	768	42	920	43	739	41	666	37	774	39	699	40	666	36	715	36
Probable	459	30	601	33	742	35	610	34	613	34	652	33	582	33	569	31	597	31
Possible	425	28	465	25	463	22	439	25	537	30	557	28	476	27	624	33	651	33
Total	**1,507**	**100**	**1,834**	**100**	**2,125**	**100**	**1,788**	**100**	**1,816**	**100**	**1,983**	**100**	**1,757**	**100**	**1,859**	**100**	**1,963**	**100**

CLABSI, central line associated bloodstream infection; N, number

Note:

* Includes all CLABSI episodes (also those without denominator)

6. INCIDENCE OF CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS IN TERTIARY AND NON-TERTIARY HOSPITALS

Table 30: Incidence of central line-associated bloodstream infections* in tertiary and non-tertiary hospitals, Belgium 2013-2021

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021
Non-tertiary hospital									
N hospitals included in calculation of incidence**	67	74	78	79	73	77	75	74	76
N CLABSI	714	806	919	793	700	886	801	826	891
mean incidence 10,000 patient-days***	1.5	1.5	1.5	1.2	1.3	1.4	1.4	1.8	1.8
Tertiary hospital									
N hospitals included in calculation of incidence**	19	22	24	24	20	23	23	23	23
N CLABSI	788	1,028	1,200	995	817	988	952	1,006	1,050
mean incidence 10,000 patient-days***	3.3	3.4	3.5	2.9	3.0	3.4	3.1	4.0	4.0

CLABSI, central line-associated bloodstream infection; N, number

Notes:

* Includes ‘confirmed’, ‘probable’ and ‘possible’ CLABSI

** Hospitals included when denominator of the participating quarter was available

*** Total CLABSI/total denominator

7. INTENSIVE CARE UNIT-ASSOCIATED CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS BY CLASSIFICATION

Table 31: Intensive care unit-associated central line-associated bloodstream infections according to case definition (proportions)*, Belgium 2013-2021

Year	2013		2014		2015		2016		2017		2018		2019		2020		2021	
CLABSI	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Confirmed	177	37	202	40	222	39	185	35	173	34	218	35	204	36	256	34	245	31
Probable	128	27	133	26	189	33	173	33	159	31	188	30	168	30	202	27	206	26
Possible	170	36	170	34	158	28	173	33	174	34	217	35	192	34	290	39	346	43
Total	**475**	**100**	**505**	**100**	**569**	**100**	**531**	**100**	**506**	**100**	**623**	**100**	**564**	**100**	**748**	**100**	**797**	**100**

CLABSI, central line-associated bloodstream infection; ICU, intensive care unit; N, number

Note:

* Includes all CLABSI episodes (also those without denominator)

8. HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS BY SOURCE AND SPECIALITY

Table 32: Hospital-associated bloodstream infections by source and speciality, Belgium 2021

Speciality	Geriatrics		Intensive care unit****		Medical department*		Obstetrics/ gynaecology		Oncology		Paediatrics		Surgery		Other		Total	
source	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
CL**	121	11	833	36	384	22	0	0	335	34	46	48	162	21	82	16	1,963	26
Urinary tract infection	400	36	173	8	349	20	11	26	102	10	5	5	192	25	172	34	1,404	18
Gastro-intestinal infection	98	9	216	9	296	17	4	10	126	13	7	7	147	19	70	14	964	13
Pulmonary infection	63	6	679	30	151	8	1	2	41	4	5	5	30	4	27	5	997	13
Surgical site infection	21	2	51	2	37	2	7	17	5	1	0	0	78	10	24	5	223	3
Peripheral and other catheter	35	3	79	3	104	6	2	5	20	2	3	3	23	3	12	2	278	4
MBI	8	1	14	1	19	1	0	0	206	21	13	14	6	1	1	0	267	4
Invasive manipulation	7	1	5	0	29	2	0	0	8	1	0	0	11	1	16	3	76	1
Other secondary infections***	114	10	117	5	155	9	6	14	59	6	9	9	60	8	49	10	569	7
Unknown	230	21	132	6	258	14	11	26	89	9	7	7	69	9	56	11	852	11
Total	**1,097**	**100**	**2,299**	**100**	**1,782**	**100**	**42**	**100**	**991**	**100**	**95**	**100**	**778**	**100**	**509**	**100**	**7,593**	**100**

CL, central line; MBI, mucosal barrier injury

Notes:

* Medical department includes; cardiology, gastro-enterology, nephrology, neurology, pneumology, urology, COVID-19 general department and other internal medicine

** Includes confirmed, probable and possible CLABSI

*** Skin/soft tissue and other infections

**** Intensive care unit includes COVID-19 intensive care unit

9. INVASIVE DEVICE-ASSOCIATED HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

Table 33: Hospital-associated bloodstream infections associated with invasive devices, Belgium 2021

Invasive device	Confirmed		Non-confirmed		Total HABSI	
	N	% total HABSI	N	% total HABSI	N	% total HABSI
CLABSI	715	21	1,248	30	1,963	26
Urinary tract infection with catheter	548	16	111	3	659	9
Pulmonary infection with ET/cannula	468	14	82	2	550	7
Peripheral/other catheter	120	3	158	4	278	4
Total invasive device associated HABSI	**1,851**	**53**	**1,599**	**39**	**3,450**	**45**
Total HABSI	**3,465**	**100**	**4,128**	**100**	**7,593**	**100**

CLABSI, central line-associated bloodstream infection; d, days; ET, endotracheal tube; HABSI, hospital-associated bloodstream infection; N, number

Note:

* Includes ‘probable’ and ‘possible’ CLABSI

10. END-OF-FOLLOW-UP STATUS

Table 34: End-of-follow-up status of patients with diagnosed hospital-associated bloodstream infections, Belgium 2021

End-of-follow-up status	N	%
Died*	1,544	20
Still admitted	810	11
Discharged	3,267	43
Unknown	1,972	26

N, number

Note:

* Causality between death and HABSI cannot be implied

11. EXHAUSTIVE LIST OF MICROORGANISMS ISOLATED FROM BLOODSTREAM INFECTIONS, BELGIAN ACUTE CARE HOSPITALS

Table 35: Microorganisms isolated as etiological agents for bloodstream infections, exhaustive list, Belgium 2021

	HABSI		CLABSI		Non-HABSI	
Microorganism	**N**	**%**	**N**	**%**	**N**	**%**
Escherichia coli	1,527	19	105	5	652	39
Staphylococcus aureus	859	10	201	10	186	11
Staphylococcus epidermidis	797	10	553	26	38	2
Klebsiella pneumoniae	611	7	86	4	83	5
Enterococcus faecium	570	7	174	8	30	2
Enterococcus faecalis	496	6	141	7	59	4
Pseudomonas aeruginosa	380	5	60	3	44	3
Enterobacter cloacae	271	3	49	2	27	2
Candida albicans	216	3	100	5	5	0
Klebsiella oxytoca	202	2	34	2	24	1
Serratia marcescens	188	2	37	2	15	1
Proteus mirabilis	138	2	6	0	31	2
Staphylococcus hominis	134	2	91	4	9	1
Candida glabrata	102	1	31	1	8	0
Klebsiella aerogenes	96	1	14	1	8	0
Staphylococcus haemolyticus	86	1	62	3	2	0
Bacteroides fragilis	71	1	6	0	28	2
Staphylococcus capitis	71	1	50	2	2	0
Morganella morganii	70	1	8	0	10	1
Genus Acinetobacter (others or not specified)	68	1	16	1	4	0
Candida parapsilosis	56	1	29	1	2	0
Stenotrophomonas maltophilia	52	1	10	0	1	0
Genus Klebsiella (others or not specified)	51	1	5	0	11	1
Streptococcus mitis group	51	1	11	1	13	1
Citrobacter koseri	47	1	7	0	3	0
Streptococcus pneumoniae	44	1	1	0	52	3
Citrobacter freundii	43	1	11	1	7	0
Streptococcus anginosus	37	0	9	0	17	1
Staphylococcus, coagulase negative (others or not specified)	36	0	20	1	2	0
Genus Streptococcus (others or not specified)	35	0	9	0	14	1
Candida tropicalis	32	0	12	1	2	0
Genus Candida (others or not specified)	32	0	12	1	2	0
Acinetobacter baumannii	26	0	3	0	0	0
Streptococcus agalactiae	26	0	5	0	38	2
Streptococcus viridans group	25	0	0	0	1	0
Genus Bacteroides (others or not specified)	24	0	1	0	7	0
Genus Enterobacter (others or not specified)	24	0	2	0	2	0
Genus Pseudomonas	24	0	4	0	3	0
Gram-negative bacillus (not specified)	23	0	9	0	6	0
Streptococcus gallolyticus	23	0	2	0	8	0
Genus Bacillus	21	0	14	1	0	0
Genus Clostridioides (others or not specified)	21	0	3	0	6	0
Bacteroides thetaiotaomicron	19	0	0	0	7	0
Enterobacter cloacae complex	18	0	4	0	0	0
Streptococcus oralis	18	0	4	0	5	0

Microorganism	HABSI N	HABSI %	CLABSI N	CLABSI %	Non-HABSI N	Non-HABSI %
Genus Enterococcus (others or not specified)	17	0	2	0	5	0
Genus Staphylococcus (not specified)	16	0	7	0	3	0
Fusobacterium nucleatum	14	0	1	0	3	0
Hafnia alvei	13	0	2	0	0	0
Streptococcus bovis group	13	0	0	0	9	1
Streptococcus dysgalactiae	13	0	1	0	31	2
Haemophilus influenzae	12	0	0	0	3	0
Raoultella ornithinolytica	12	0	2	0	4	0
Acinetobacter lwoffii	10	0	1	0	2	0
Clostridioides perfringens	10	0	0	0	9	1
Genus Morganella	10	0	1	0	5	0
Eggerthella lenta	9	0	1	0	2	0
Enterococcus avium	9	0	3	0	0	0
Genus Lactobacillus	9	0	3	0	4	0
Gram-positive coccus (others or not specified)	9	0	4	0	1	0
Pantoea agglomerans	9	0	1	0	1	0
Anaerobic bacteria (others or not specified)	8	0	0	0	1	0
Genus Actinomyces	8	0	0	0	2	0
Genus Citrobacter (others or not specified)	8	0	2	0	0	0
Genus Corynebacterium	8	0	2	0	1	0
Genus Prevotella	8	0	0	0	2	0
Enterococcus gallinarum	7	0	2	0	0	0
Family Enterobacteriaceae (others or not specified)	7	0	1	0	1	0
Genus Aeromonas	7	0	0	0	5	0
Genus Serratia (others or not specified)	7	0	2	0	1	0
Clostridioides ramosum	6	0	0	0	1	0
Genus Providencia	6	0	0	0	3	0
Proteus vulgaris	6	0	1	0	2	0
Streptococcus pyogenes	6	0	1	0	8	0
Streptococcus salivarius group	6	0	2	0	2	0
Aerococcus urinae	5	0	0	0	2	0
Anaerobic Gram-positive coccus	5	0	1	0	0	0
Genus Achromobacter	5	0	0	0	0	0
Staphylococcus pettenkoferi	5	0	2	0	1	0
Staphylococcus warneri	5	0	5	0	0	0
Bacteroides vulgatus	4	0	0	0	6	0
Candida krusei	4	0	2	0	1	0
Genus Campylobacter	4	0	0	0	8	0
Genus Flavobacterium	4	0	0	0	1	0
Genus Fusobacterium	4	0	1	0	5	0
Gram-negative coccus (others or not specified)	4	0	2	0	0	0
Gram-positive bacillus (others or not specified)	4	0	1	0	0	0
Parabacteroides distasonis	4	0	0	0	1	0
Parvimonas micra	4	0	1	0	3	0
Streptococcus constellatus	4	0	1	0	3	0
Streptococcus sanguis group	4	0	0	0	1	0
Yeast	4	0	3	0	0	0
Bacteroides fragilis group	3	0	0	0	0	0
Staphylococcus schleiferi	3	0	2	0	0	0

Microorganism	HABSI N	HABSI %	CLABSI N	CLABSI %	Non-HABSI N	Non-HABSI %
Veillonella parvula	3	0	0	0	0	0
Abiotrophia adjacens	2	0	0	0	1	0
Acinetobacter calcoaceticus	2	0	1	0	0	0
Acinetobacter haemolyticus	2	0	2	0	0	0
Burkholderia cepacia	2	0	0	0	0	0
Campylobacter jejuni	2	0	0	0	3	0
Citrobacter braakii	2	0	0	0	0	0
Enterobacter asburiae	2	0	0	0	1	0
Finegoldia magna	2	0	1	0	0	0
Fungus (others or not specified)	2	0	1	0	0	0
Gemella morbillorum	2	0	0	0	2	0
Genus Moraxella (others or not specified)	2	0	0	0	0	0
Genus Mycoplasma	2	0	0	0	1	0
Genus Nocardia	2	0	1	0	0	0
Genus Pasteurella	2	0	0	0	1	0
Genus Proteus (others or not specified)	2	0	1	0	1	0
Genus Veillonella	2	0	0	0	0	0
Listeria monocytogenes	2	0	0	0	7	0
Pasteurella multocida	2	0	0	0	1	0
Peptoniphilus harei	2	0	0	0	0	0
Prevotella oris	2	0	1	0	0	0
Ruminococcus gnavus	2	0	0	0	1	0
Salmonella Typhimurium	2	0	0	0	1	0
Serratia liquefaciens	2	0	0	0	0	0
Alistipes finegoldii	1	0	0	0	0	0
Aspergillus niger	1	0	0	0	0	0
Bacterium (others or not specified)	1	0	1	0	0	0
Bacteroides caccae	1	0	0	0	1	0
Bacteroides faecis	1	0	0	0	0	0
Clostridioides clostridiiforme	1	0	0	0	2	0
Clostridioides difficile	1	0	0	0	0	0
Enterococcus casseliflavus	1	0	0	0	1	0
Fusobacterium necrophorum	1	0	0	0	3	0
Genus Agrobacterium	1	0	0	0	0	0
Genus Anaerococcus	1	0	0	0	1	0
Genus Atopobium	1	0	0	0	0	0
Genus Eubacterium	1	0	0	0	0	0
Genus Haemophilus (others or not specified)	1	0	0	0	0	0
Genus Hafnia	1	0	0	0	0	0
Genus Neisseria (others or not specified)	1	0	0	0	0	0
Genus Salmonella (others or not specified)	1	0	0	0	6	0
Genus Shigella	1	0	0	0	0	0
Haemophilus parainfluenzae	1	0	0	0	0	0
Kingella kingae	1	0	0	0	5	0
Neisseria meningitidis	1	0	0	0	2	0
Non-Enterobacteriaceae (others or not specified)	1	0	0	0	0	0
Prevotella bivia	1	0	0	0	0	0
Propionibacterium acnes	1	0	0	0	2	0
Providencia rettgeri	1	0	0	0	4	0

Microorganism	HABSI		CLABSI		Non-HABSI	
	N	%	N	%	N	%
Aerococcus sanguinicola	0	0	0	0	1	0
Family Pseudomonadaceae (others or not specified)	0	0	0	0	2	0
Genus Dialister	0	0	0	0	1	0
Genus Paenibacillus	0	0	0	0	1	0
Salmonella Typhi (not specified)	0	0	0	0	2	0
Streptococcus intermedius	0	0	0	0	2	0
Streptococcus, group C	0	0	0	0	10	1
Streptococcus, group G	0	0	0	0	1	0
Unidentified	18	0	7	0	1	0
TOTAL	**8,215**	**100**	**2,090**	**100**	**1,685**	**100**

CLABSI, central line-associated bloodstream infection; HABSI, hospital-associated bloodstream infection; N, number

12.MICROORGANISMS BY SUSPECTED SOURCE OF THE BLOODSTREAM INFECTION

Table 36: Microorganisms isolated from hospital-associated bloodstream infection by source, Belgian acute care hospitals, 2021

		CL		Urinary tract infection		Gastro-intestinal infection		Pulmonary infection		Surgical site infection		Peripheral and other catheter and invasive manipulation		MBI		Other*		Unknown		Total	
Family MO	**MO**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Enterobacteriaceae		382	18	1,090	73	582	54	553	50	118	48	101	26	126	41	132	22	296	33	3,380	41
	Escherichia coli	105	5	681	46	297	27	117	11	40	16	28	7	69	23	53	9	137	15	1,527	19
	Klebsiella pneumoniae	86	4	163	11	93	9	156	14	17	7	11	3	26	9	10	2	49	5	611	7
	Enterobacter cloacae	49	2	39	3	53	5	52	5	16	7	18	5	9	3	19	3	16	2	271	3
	Klebsiella oxytoca	34	2	31	2	31	3	39	4	10	4	11	3	7	2	13	2	26	3	202	2
	Proteus mirabilis	6	0	83	6	8	1	19	2	2	1	4	1	2	1	6	1	8	1	138	2
	Serratia marcescens	37	2	14	1	15	1	78	7	14	6	6	2	2	1	6	1	16	2	188	2
	Klebsiella aerogenes	14	1	9	1	17	2	39	4	4	2	4	1	2	1	4	1	3	0	96	1
	Other/not identified	51	2	70	5	68	6	53	5	15	6	19	5	9	3	21	3	41	5	347	4
Gram-positive cocci		1,367	65	246	17	270	25	319	29	87	36	243	62	119	39	351	57	441	49	3,443	42
	Staphylococcus aureus	201	10	48	3	14	1	163	15	41	17	68	17	6	2	186	30	132	15	859	10
	Staphylococcus epidermidis	553	26	9	1	6	1	10	1	12	5	79	20	1	0	39	6	88	10	797	10
	Enterococcus faecium	174	8	57	4	133	12	51	5	12	5	29	7	43	14	28	5	43	5	570	7
	Enterococcus faecalis	141	7	111	7	55	5	37	3	10	4	24	6	14	5	40	7	64	7	496	6
	Other/not identified	298	14	21	1	62	6	58	5	12	5	43	11	55	18	58	9	114	13	721	9
Non-fermenting Gram-negative bacilli		106	5	95	6	57	5	171	16	16	7	18	5	29	10	51	8	86	10	629	8
	Pseudomonas aeruginosa	60	3	82	6	27	2	118	11	10	4	9	2	18	6	29	5	27	3	380	5
	Other/not identified	46	2	13	1	30	3	53	5	6	2	9	2	11	4	22	4	59	7	249	3
Fungi		190	9	47	3	69	6	33	3	4	2	22	6	8	3	37	6	39	4	449	5
	Candida albicans	100	5	23	2	30	3	13	1	2	1	9	2	3	1	19	3	17	2	216	3
	Candida glabrata	31	1	19	1	20	2	6	1	2	1	5	1	3	1	7	1	9	1	102	1
	Other/not identified	59	3	5	0	19	2	14	1	0	0	8	2	2	1	11	2	13	1	131	2
Anaerobic bacilli		14	1	6	0	92	8	12	1	17	7	5	1	15	5	26	4	28	3	215	3
Gram-positive bacilli		20	1	0	0	8	1	4	0	2	1	1	0	1	0	4	1	8	1	48	1
Gram-negative cocci		2	0	0	0	5	0	4	0	1	0	1	0	2	1	2	0	3	0	20	0
Other and not identified		9	0	2	0	1	0	6	1	0	0	0	0	4	1	8	1	1	0	31	0
Total		**2,090**	**100**	**1,486**	**100**	**1,084**	**100**	**1,102**	**100**	**245**	**100**	**391**	**100**	**304**	**100**	**611**	**100**	**902**	**100**	**8,215**	**100**

CL, central line; MBI, mucosal barrier injury; MO, microorganism; n, number
Note: * Skin/soft tissue and other

13.MICROORGANISMS RESISTANCE PROFILE, ADDITIONAL DATA

Table 37: Antimicrobial resistance among hospital-associated bloodstream infections, Belgium 2017-2021[37]

		Microorganisms														
		2017			2018			2019			2020			2021		
	Antibiotics	N	n	%	N	n	%	N	n	%	N	n	%	N	n	%
Gram-positive cocci																
S. aureus	Meti	890	121	13.6	971	103	10.6	813	85	10.5	818	70	8.6	859	79	9.2
	Gly	890	7	0.8	971	4	0.4	813	3	0.4	818	0	0.0	859	2	0.2
All Enterococcus spp.	Gly	906	37	4.1	965	34	3.5	855	25	2.9	976	22	2.3	1,083	20	1.8
E. faecalis	Gly	410	2	0.5	422	3	0.7	358	2	0.6	423	5	1.2	496	4	0.8
E. faecium	Gly	454	24	5.3	496	18	3.6	480	14	2.9	538	14	2.6	570	14	2.5
Enterobacteriaceae	C3G	3,755	767	20.4	3,846	883	23.0	3,375	798	23.6	3,434	721	21.0	3,380	666	19.7
	CAR	3,755	93	2.5	3,846	70	1.8	3,375	59	1.7	3,434	70	2.0	3,380	48	1.4
E. coli	C3G	1,926	303	15.7	1,893	301	15.9	1,637	269	16.4	1,557	228	14.6	1,527	199	13.0
	CAR	1,926	26	1.3	1,893	12	0.6	1,637	6	0.4	1,557	10	0.6	1,527	8	0.5
K. pneumoniae	C3G	667	191	28.6	737	260	35.3	644	218	33.9	680	190	27.9	611	174	28.5
	CAR	667	40	6.0	737	29	3.9	644	27	4.2	680	31	4.6	611	21	3.4
E. cloacae	C3G	316	118	37.3	306	117	38.2	280	130	46.4	270	115	42.6	271	103	38.0
	CAR	316	9	2.8	306	10	3.3	280	5	1.8	270	7	2.6	271	7	2.6
P. mirabilis	C3G	150	5	3.3	176	7	4.0	133	4	3.0	138	1	0.7	138	0	0.0
	CAR	150	1	0.7	176	1	0.6	133	1	0.8	138	0	0.0	138	0	0.0
K. oxytoca	C3G	187	21	11.2	181	27	14.9	175	35	20.0	168	31	18.5	202	31	15.3
	CAR	187	3	1.6	181	1	0.6	175	2	1.1	168	2	1.2	202	3	1.5
K. aerogenes	C3G	95	50	52.6	103	68	66.0	59	29	49.2	101	41	40.6	96	50	52.1
	CAR	95	3	3.2	103	3	2.9	59	2	3.4	101	2	2.0	96	2	2.1
Serratia spp.	C3G	151	28	18.5	134	30	22.4	170	45	26.5	149	43	28.9	197	52	26.4
	CAR	151	5	3.3	134	3	2.2	170	2	1.2	149	7	4.7	197	1	0.5
Non-fermenting Gram-negative bacilli																
P. aeruginosa	CAR	421	64	15.2	443	63	14.2	384	54	14.1	425	63	14.8	380	92	24.2
A. baumannii	CAR	57	5	8.8	55	4	7.3	41	1	2.4	28	0	0.0	26	1	3.8
Acinetobacter spp.	CAR	144	8	5.6	163	7	4.3	131	2	1.5	99	0	0.0	108	5	4.6

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, methicillin; n, number resistant MO; N, total number MO; spp., species; %, percent resistant MO

[37] See 2020 report for 2013-2016 data: https://www.sciensano.be/en/biblio/surveillance-bloodstream-infections-belgian-hospitals-report-2020.

Table 38: Hospitals with at least one resistant microorganism isolated from hospital-associated bloodstream infections, Belgium 2017-2021[38]

		Hospitals with >= one resistant case*									
		2017 (N=102)		2018 (N=101)		2019 (N=98)		2020 (N=98)		2021 (N=100)	
Microorganisms	**Antibiotics**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Gram-positive cocci											
S. aureus	Meti	50	49	53	52	46	47	38	39	41	41
	Gly	6	6	3	3	2	2	0	0	2	2
All Enterococcus spp.	Gly	22	22	22	22	14	14	18	18	14	14
E. faecalis	Gly	2	2	3	3	2	2	5	5	2	2
E. faecium	Gly	14	14	13	13	8	8	12	12	11	11
Enterobacteriaceae	C3G	91	89	93	92	89	91	83	85	90	90
	CAR	36	35	40	40	29	30	29	30	31	31
E. coli	C3G	71	70	76	75	70	71	65	66	63	63
	CAR	11	11	12	12	6	6	9	9	8	8
K. pneumoniae	C3G	61	60	63	62	55	56	53	54	57	57
	CAR	24	24	17	17	17	17	17	17	15	15
E. cloacae	C3G	53	52	48	48	46	47	40	41	43	43
	CAR	7	7	10	10	3	3	5	5	5	5
P. mirabilis	C3G	5	5	6	6	4	4	1	1	0	0
	CAR	1	1	1	1	1	1	0	0	0	0
K. oxytoca	C3G	18	18	19	19	20	20	17	17	20	20
	CAR	3	3	1	1	2	2	2	2	2	2
K. aerogenes	C3G	31	30	33	33	20	20	23	23	30	30
	CAR	3	3	3	3	2	2	2	2	2	2
Serratia spp.	C3G	23	23	20	20	24	24	19	19	15	15
	CAR	5	5	3	3	2	2	4	4	1	1
Non-fermenting Gram-negative bacilli											
P. aeruginosa	CAR	30	29	32	32	21	21	30	31	35	35
A. baumannii	CAR	5	5	3	3	1	1	0	0	1	1
Acinetobacter spp.	CAR	7	7	6	6	2	2	0	0	5	5

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, Methicillin; N, number participating hospitals; n, number of hospitals reporting at least one resistant MO; spp., species
Note: * Hospitals participate 1, 2, 3 or 4 quarters

[38] See 2020 report for 2013-2016 data: https://www.sciensano.be/en/biblio/surveillance-bloodstream-infections-belgian-hospitals-report-2020.

Table 39: Antimicrobial resistance in microorganisms isolated from hospital-associated and non-hospital-associated bloodstream infections, Belgium 2021

Microorganisms	Antibiotics	HABSI N	HABSI n	HABSI %	Non-HABSI N	Non-HABSI n	Non-HABSI %	Hospitals with >= one resistant case* - N=100 n	Hospitals with >= one resistant case* - N=100 %
Gram-positive cocci									
S. aureus	Meti	859	79	9.2	186	16	8.6	46	46
	Gly	859	2	0.2	186	0	0.0	2	2
All Enterococcus spp.	Gly	1,083	20	1.8	94	2	2.1	16	16
E. faecalis	Gly	496	4	0.8	59	0	0.0	2	2
E. faecium	Gly	570	14	2.5	30	1	3.3	12	12
Enterobacteriacea	C3G	3,380	666	19.7	905	90	9.9	91	91
	CAR	3,380	48	1.4	905	3	0.3	31	31
E. coli	C3G	1,527	199	13.0	652	59	9.0	67	67
	CAR	1,527	8	0.5	652	2	0.3	9	9
K. pneumoniae	C3G	611	174	28.5	83	13	15.7	59	59
	CAR	611	21	3.4	83	0	0.0	15	15
E. cloacae	C3G	271	103	38.0	27	3	11.1	43	43
	CAR	271	7	2.6	27	0	0.0	5	5
P. mirabilis	C3G	138	0	0.0	31	0	0.0	0	0
	CAR	138	0	0.0	31	0	0.0	0	0
K. oxytoca	C3G	202	31	15.3	24	0	0.0	20	20
	CAR	202	3	1.5	24	0	0.0	2	2
K. aerogenes	C3G	96	50	52.1	8	6	75.0	32	32
	CAR	96	2	2.1	8	0	0.0	2	2
Serratia spp.	C3G	197	52	26.4	16	3	18.8	15	15
	CAR	197	1	0.5	16	0	0.0	1	1
Non-fermenting Gram-negative bacilli									
P. aeruginosa	CAR	380	92	24.2	44	3	6.8	35	35
A. baumannii	CAR	26	1	3.8	0	0	0.0	1	1
Acinetobacter spp.	CAR	108	5	4.6	6	0	0.0	5	5

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); HABSI, hospital-associated bloodstream infection; Meti, Methicillin; N, total number MO; n, number resistant MO or number of hospitals; spp., species; %, percent resistant MO

Notes:

* Hospitals participate 1, 2, 3 or 4 quarters - includes all BSI (HABSI and non-HABSI)

14. ANTIMICROBIAL RESISTANCE BY REGION, ADDITIONAL DATA

Table 40: Resistance in microorganisms isolated from non-hospital-associated bloodstream infections by region, Belgium 2021

		Brussels			Flanders			Wallonia		
Microorganisms	**Antibiotics**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**
Gram-positive cocci										
S. aureus	Meti	73	10	14	78	4	5	35	2	6
	Gly	73	0	0	78	0	0	35	0	0
All Enterococcus spp.	Gly	35	0	0	33	0	0	26	2	8
E. faecalis	Gly	22	0	0	24	0	0	13	0	0
E. faecium	Gly	11	0	0	8	0	0	11	1	9
Enterobacteriaceae	C3G	300	26	9	381	35	9	224	29	13
	CAR	300	2	1	381	0	0	224	1	0
E. coli	C3G	210	17	8	294	24	8	148	18	12
	CAR	210	2	1	294	0	0	148	0	0
K. pneumoniae	C3G	32	3	9	29	5	17	22	5	23
	CAR	32	0	0	29	0	0	22	0	0
E. cloacae	C3G	11	1	9	7	1	14	9	1	11
	CAR	11	0	0	7	0	0	9	0	0
P. mirabilis	C3G	8	0	0	11	0	0	12	0	0
	CAR	8	0	0	11	0	0	12	0	0
K. oxytoca	C3G	9	0	0	9	0	0	6	0	0
	CAR	9	0	0	9	0	0	6	0	0
K. aerogenes	C3G	2	2	100	4	3	75	2	1	50
	CAR	2	0	0	4	0	0	2	0	0
Serratia spp.	C3G	7	0	0	3	1	33	6	2	33
	CAR	7	0	0	3	0	0	6	0	0
Non-fermenting Gram-negative bacilli										
P. aeruginosa	CAR	19	3	16	19	0	0	6	0	0
A. baumannii	CAR	0	0	0	0	0	0	0	0	0
Acinetobacter spp.	CAR	2	0	0	2	0	0	2	0	0

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, Methicillin; N, total number MO; n, number resistant MO; neg., negative; pos., positive; spp., species; %, percent resistant MO

Table 41: Hospitals with at least one resistant microorganism isolated from hospital-associated bloodstream infection by region, Belgium 2021

		Hospitals with >= one resistant case*					
		Brussels (N=12)		Flanders (N=51)		Wallonia (N=37)	
Microorganisms	**Antibiotics**	**n**	**%**	**n**	**%**	**n**	**%**
Gram-positive cocci							
S. aureus	Meti	6	50	19	38	16	46
	Gly	0	0	1	2	1	3
All Enterococcus spp.	Gly	3	25	5	10	6	17
E. faecalis	Gly	1	8	0	0	1	3
E. faecium	Gly	2	17	4	8	5	14
Enterobacteriaceae	C3G	12	100	44	88	34	97
	CAR	7	58	11	22	13	37
E. coli	C3G	10	83	29	58	24	69
	CAR	2	17	3	6	3	9
K. pneumoniae	C3G	10	83	24	48	23	66
	CAR	5	42	1	2	9	26
E. cloacae	C3G	8	67	19	38	16	46
	CAR	1	8	2	4	2	6
P. mirabilis	C3G	0	0	0	0	0	0
	CAR	0	0	0	0	0	0
K. oxytoca	C3G	5	42	13	26	2	6
	CAR	1	8	0	0	1	3
K. aerogenes	C3G	4	33	13	26	13	37
	CAR	0	0	1	2	1	3
Serratia spp.	C3G	3	25	6	12	6	17
	CAR	1	8	0	0	0	0
Non-fermenting Gram-negative bacilli							
P. aeruginosa	CAR	8	67	18	36	9	26
A. baumannii	CAR	1	8	0	0	0	0
Acinetobacter spp.	CAR	1	8	3	6	1	3

C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem, doripenem); Gly, glycopeptides (vancomycin, teicoplanin); Meti, Methicillin; N, number participating hospitals; n, number of hospitals reporting at least one resistant MO; R, resistant; spp., species

Note:

* Hospitals participate 1, 2, 3 or 4 quarters - includes all BSI (HABSI and non-HABSI)

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MORE INFORMATION

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