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HEALTHCARE-ASSOCIATED INFECTIONS AND ANTIMICROBIAL RESISTANCE

SURVEILLANCE OF BLOODSTREAM INFECTIONS IN BELGIAN HOSPITALS

Report 2019
Data up to and including 2018

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Sciensano

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

Surveillance of Bloodstream Infections in Belgian Hospitals

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DUYSBURGH ELS

Els Duysburgh • T+32 2 647 57 44 • els.duysburgh@siensano.be

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Abbreviations

A. baumannii	*Acinetobacter baumannii*
BSI	Bloodstream infection
CDC	Centres for Disease Control and Prevention
CI	Confidence interval
CL	Central line
CLABSI	Central line-associated bloodstream infection
CRBSI	Central line-related bloodstream Infection
E. aerogenes	*Enterobacter aerogenes*
EARS-Net	European Antimicrobial Resistance Surveillance Network
ECDC	European centre for disease prevention and control
E. cloacae	*Enterobacter cloacae*
E. coli	*Escherichia coli*
E. faecalis	*Enterococcus faecalis*
E. faecium	*Enterococcus faecium*
Gly	Glycopeptide
HABSI	Hospital-associated bloodstream infection
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. 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
S. aureus	*Staphylococcus aureus*
S. epidermidis	*Staphylococcus epidermidis*
SD	Standard deviation
spp.	Species

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.

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

Non-tertiary hospital
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),
General hospital with university characteristics (Algemeen ziekenhuis met universitair karakter - Hôpital général à caractère universitaire), and
Specialised hospital (Gespecialiseerd ziekenhuis - Hôpital spécialisé).

[3] List of hospitals provided by the Belgian ministry of health (*Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg*); List dated April 2019: *Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019*.
[4] List of hospitals provided by the Belgian ministry of health (*Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg*); List dated April 2019: *Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019*.

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. The surveillance protocol has been reviewed in 2013, with a focus on the usefulness of data collection for guidance and evaluation of preventive actions. Since 2014, participation in the surveillance for a minimum of 3 months per year is mandatory for all acute care hospitals and long-term care facilities with >150 beds. This implies the registration of standardized data for each HABSI episode (by definition a BSI occurring two days or more after admission).

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.

This report provides a summary of the Belgian surveillance data up to and including 2018.

2. RESULTS

In 2018, 104 (101 acute care hospitals and 3 long-term care facilities with > 150 beds) out of 107 eligible hospitals (101 acute care hospitals and 6 long term-care facilities with > 150 beds) participated in the BSI-surveillance. Fifty-eight percent of these hospitals participated throughout the whole year. Participation throughout the year serves best the objective of surveillance as a tool for prevention at hospital level.

2.1. TRENDS OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

2.1.1. HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2018

The incidence of HABSI in Belgian hospitals – hospital-wide and at ICU-level – did not change substantially since 2013 (see Table 1). In 2018, the mean incidence of HABSI was 8.6/10,000 patient-days (pd) hospital-wide, and 29.2/10,000 pd for the BSI occurring two days or more after admission at the intensive care unit (ICU).

Table 1: Incidence of hospital-associated bloodstream infections, hospital-wide and at ICU-level, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Cumulative incidence per 1,000 admissions						
mean – hospital-wide*	5.4	5.6	5.7	5.2	5.4	5.8
mean – ICU-level**	14.1	13.9	13.5	14.8	13.8	14.3
Incidence density per 10,000 patient-days						
mean – hospital-wide*	7.5	7.8	8.0	7.6	8.1	8.6
mean – ICU-level**	32.0	31.6	29.8	31.9	29.6	29.2

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, 2013-2018

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 – origin recorded in surveillance form as 'unknown' - but CL present within the two days prior to the BSI).

CLABSI incidence (three classifications together) per 10,000 pd did not change substantially since 2013 with no statistically significant changes observed since 2013 (Figure 1). In 2018, 39% of all CLABSI were 'confirmed', 33% 'probable', and 29% 'possible'.

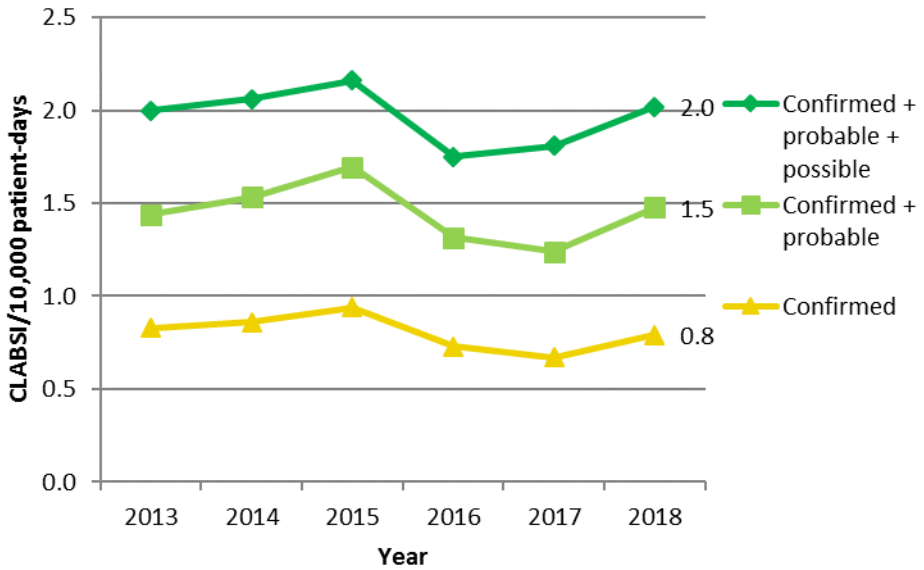


Figure 1: Mean incidence of central line-associated bloodstream infection hospital-wide, Belgium 2013-2018 (CLABSI, central line-associated bloodstream infections)

2.1.3. HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS PER MICROORGANISM, 2000-2018

Microorganism (MO) specific incidences of HABSI since 2000 for the most common MO are given in Figure 2. This graph illustrates long-term time trends of an increase in *E. coli*,

K. pneumoniae and *E. faecium*[5]. The incidence of HABSI with *S. aureus* did not change substantially over time. Since 2000, the incidence of HABSI with *E.coli* and *K. pneumoniae* as causal MO doubled. We notice the same regarding the incidence of HABSI with *E. faecium* since 2013.

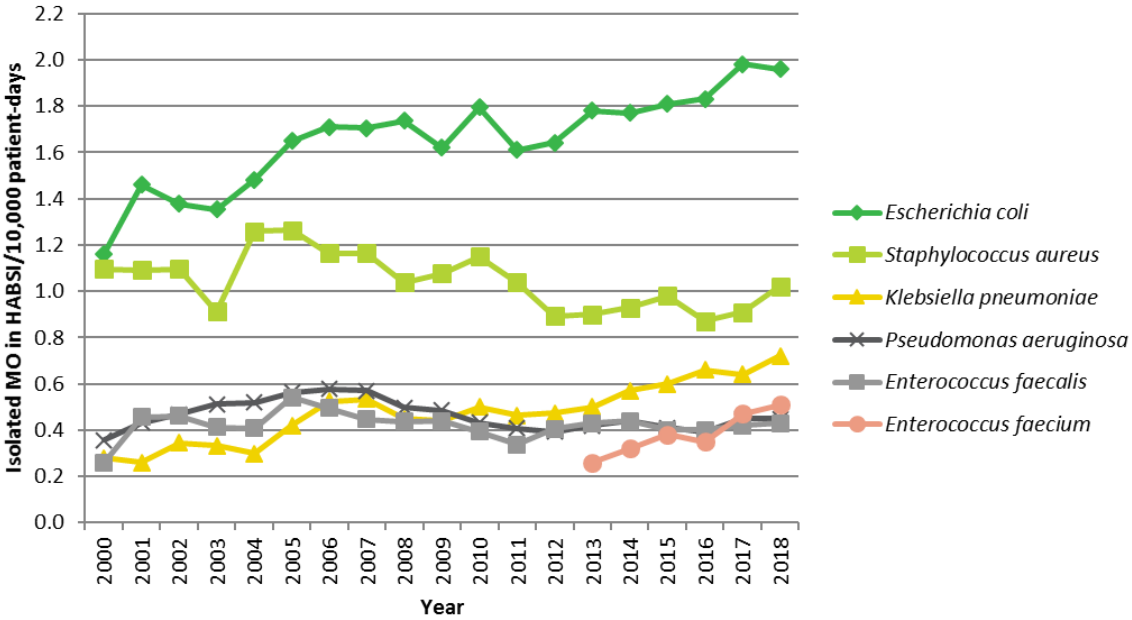


Figure 2: Mean incidence of hospital-associated bloodstream infections per microorganism, Belgium 2000-2018 (HABSI, hospital-associated bloodstream infections; MO, microorganism)

2.1.4. INCIDENCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS AT HOSPITAL LEVEL, 2018

In 2018, similar to previous years, there was a large variability in the reported incidence of HABSI between hospitals as shown in the boxplot[6] below where we notice several outliers (Figure 3).

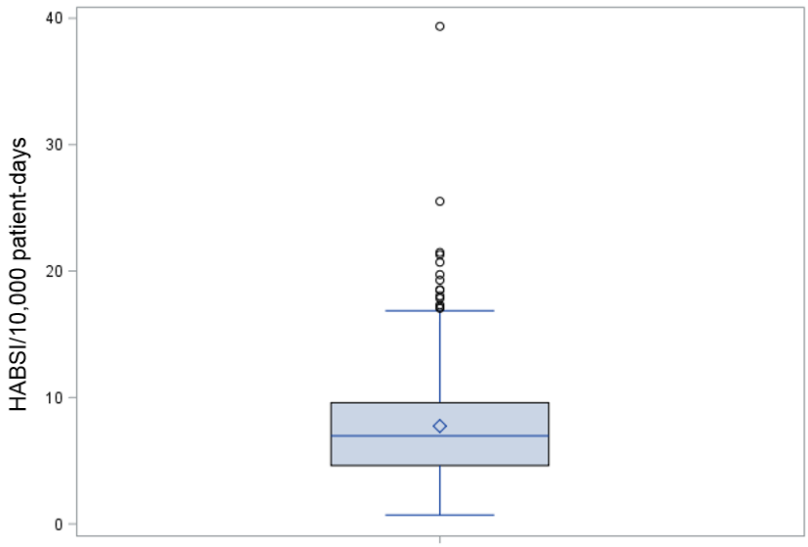


Figure 3: Hospital-associated bloodstream infections: incidence distribution across hospitals, Belgium, 2018 (HABSI, hospital-associated bloodstream infections)

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

[6] 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, 2018

In 2018, 104 hospitals registered together 8.296 HABSI; 82% of these met the definition 'at least one blood culture positive for a recognised pathogen' and 17% the definition ‘at least two different blood cultures positive for the same pathogen belonging to the normal microbiota of the skin and clinical symptoms'. One HABSI out of five occurred two days or later after admission at ICU (definition of ICU-associated bloodstream infection).

Median number of days between admission in hospital and onset of HABSI was 12 days. Median age of the patients was 71 years of age. Twenty-one percent of patients with HABSI died. However, there was a substantial amount of missing data for status at end-of-follow-up (19% 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 (24%)[7], followed by urinary tract infection (21%) (Figure 4). At ICU the most common source was a CL (37%) followed by pulmonary infection (21%). For 43% 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 39% of the hospital-wide HABSI and in 61% of the ICU-associated BSI.

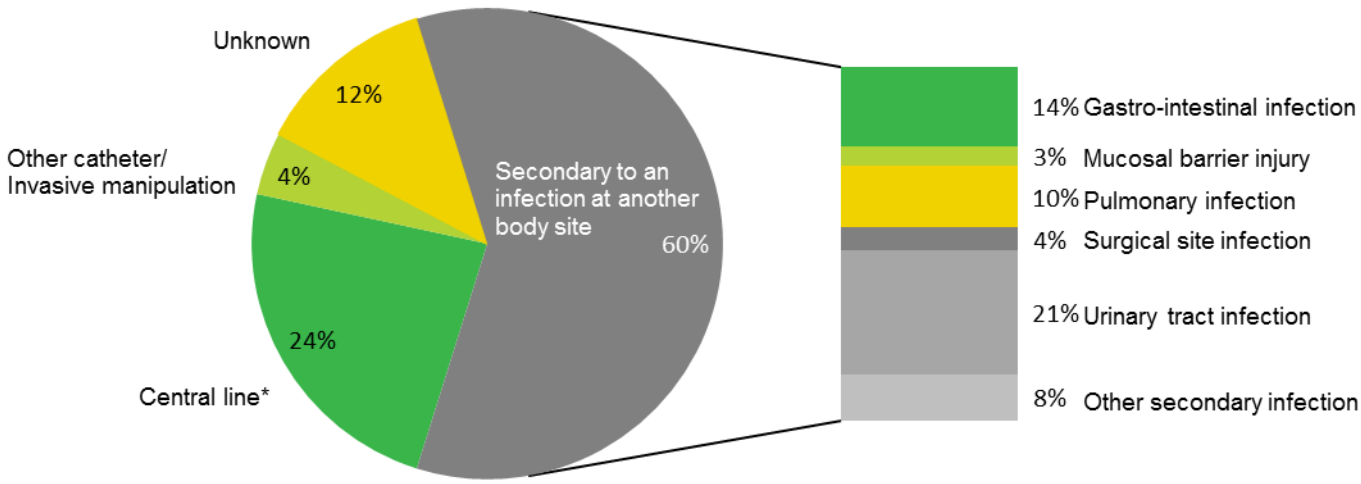


Figure 4: Source of hospital-associated bloodstream infections, Belgium 2018 (* Includes ‘confirmed’, ‘probable’ and ‘possible’ central line associated bloodstream infection)

[7] Including ‘confirmed’, ‘probable’ and ‘possible’ CLABSI

2.3. IDENTIFIED CAUSAL MICROORGANISMS AND THEIR ANTIMICROBIAL RESISTANCE PROFILE

The most common MO isolated from HABSI in 2018 were *E. coli* (21%), *S. aureus* (11%), and *S. epidermidis* (9%). Only 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 2018, only the decrease in the proportion of MRSA (from 21.0% to 10.5%) 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 2018

		Microorganisms 2018			% hospitals with >= one resistant case* (N=104)
	Antibiotics	N	n	%	
Staphylococcus aureus	Meti	968	102	10.5	52
	Gly	968	4	0.4	3
Enterococcus faecalis	Gly	430	3	0.7	3
Enterococcus faecium	Gly	489	18	3.7	13
Escherichia coli	C3G	1,885	299	15.9	72
	CAR	1,885	12	0.6	12
Klebsiella pneumoniae	C3G	728	257	35.3	61
	CAR	728	28	3.8	15
Enterobacter cloacae	C3G	302	117	38.7	46
	CAR	302	10	3.3	10
Proteus mirabilis	C3G	176	7	4.0	6
	CAR	176	1	0.6	1
Klebsiella oxytoca	C3G	178	27	15.2	18
	CAR	178	1	0.6	1
Enterobacter aerogenes	C3G	101	67	66.3	32
	CAR	101	3	3.0	3
Pseudomonas aeruginosa	CAR	437	63	14.4	31
Acinetobacter baumannii	CAR	55	4	7.3	3

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. CONCLUSIONS AND RECOMMENDATIONS

3.1. CONCLUSIONS

In 2018, HABSI findings in Belgian hospitals were very similar to the findings of the previous five years.

- Participation in the surveillance of HABSI is mandatory (minimum 3 months) since 2014. In 2018, 58% of the hospitals contributing data for the entire year.
- The incidence of HABSI, at 8.6/10,000 patient-days, has changed little during the past six years, and findings are fairly consistent:
    - Higher incidence in tertiary hospitals
    - Higher incidence in ICU (2018 incidence of ICU-associated BSI was 29.2/10,000 patient-days)
- There is a large variability in the reported incidence of HABSI between hospitals. This suggests a potential for prevention and/or a need for data validation.
- CLABSI incidence per 10,000 patient-days did not change substantially since 2013. Among HABSI in 2018, 39% HABSI were associated with an invasive device (CL: 24%, peripheral and other catheter: 4%, urinary catheter: 9% and endotracheal tube: 3%). These infections associated with invasive devices are a priority target for prevention.
- The most common MO isolated from HABSI were *E. coli* and *S. aureus*. Since 2000, the incidence of HABSI with *E. coli* and *K. pneumoniae* doubled.
- Since 2013, methicillin resistance in *S. aureus* has decreased.

3.2. RECOMMENDATIONS

Because findings are quite similar to those of the previous BSI surveillance report published end 2018 recommendations remained the same. These recommendations are briefly repeated below.

Recommendations for policy makers

- Continue to support and enable infection prevention and control teams at hospitals in their responsibilities and tasks to decrease HABSI. More focus on infection prevention and control in pre-service training (medical and nursing schools) and having infection control physicians as an recognised speciality in Belgium would be helpful in this context.
- 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.
- Support the organisation of BSI surveillance data validation and the assessment on why the HABSI incidence did not changed during the past six years. This validation and assessment can be conducted by Sciensano.
- Continue to support a national organised surveillance of HABSI to assess changes in HABSI incidence at national and hospital level.

Recommendations for hospitals

- Assess if there is still room for decrease of HABSI and, if needed, implement actions and activities to establish HABSI decrease. For this, 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.

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

- Validation of surveillance data. Comparing, at hospital and ICU level, data from the surveillance with data received through the MZG/RHM could be a first step in this validation.
- Assess reasons why there was no decline in HABSI incidence in Belgian hospitals at national level during the past six years. 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.
- The at present in the BSI surveillance asked antibiotic resistance data is not useful and relevant for the Belgian context and should be streamlined with the recommendation on antibiotic resistance testing given by the Superior Health Council. Because of this and because resistance data is already asked in other surveillances coordinated by Sciensano this data should not be asked again as part of the BSI surveillance and should be removed from the BSI surveillance.
- Continue implementing the continuous surveillance of BSI in Belgian hospitals which includes a yearly update of protocol and data collection tool.
- Further improve the Healthdata data collection and reporting tool (Healthstat).
- Assess if data recording and reporting cannot be further simplified and streamlined in the future. In this frame it would be useful to assess if data collected through other channels (e.g. MZG/RHM) could serve to answer the objectives of the surveillance of BSI in Belgian hospitals.

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. Het protocol werd herwerkt in 2013. In dit herwerkte protocol ligt de nadruk op het nut van het inzamelen van gegevens voor het sturen en evalueren van preventieve maatregelen. Deelname aan de surveillance gedurende minimaal 1 kwartaal per jaar is sinds 2014 wettelijk verplicht voor alle acute ziekenhuizen en voor chronische zorginstellingen indien >150 bedden. Deze deelname omvat een gestandaardiseerde gegevensregistratie voor elke ziekenhuis-geassocieerde bloedstroominfectie (bloedstroominfectie die 2 dagen of later na ziekenhuisopname optreedt).

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 die kunnen vermeden worden, 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 2018.

2. RESULTATEN

In 2018 namen 104 (101 acute ziekenhuizen en 3 chronische zorginstellingen met >150 bedden) van de 107 ziekenhuizen die in aanmerking komen (101 acute ziekenhuizen en 6 chronische zorginstellingen met >150 bedden) deel aan de bloedstroominfectie surveillance. Achtenvijftig percent van de ziekenhuizen registreerden gegevens voor het hele jaar. Deelname gedurende het hele jaar beantwoordt best aan de doelstelling van surveillance als een middel voor preventie van ziekenhuis-geassocieerde bloedstroominfectie.

2.1. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIE TRENDS

2.1.1. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIES, 2013-2018

De incidentie van ziekenhuis-geassocieerde bloedstroominfectie bleef sinds 2013 voor het hele ziekenhuis en voor de intensieve zorgen afdeling ongeveer hetzelfde (Tabel 1). In 2018 was de gemiddelde ziekenhuis-geassocieerde bloedstroominfectie incidentie voor het hele ziekenhuis 8,6/10.000 ligdagen en voor de bloedstroominfecties die 2 dagen of later na opname op intensieve zorgen optraden 29,2/10.000 ligdagen.

Tabel 1: Ziekenhuis-geassocieerde bloedstroominfectie incidentie, ziekenhuis-breed en op de intensieve zorgen afdeling, België 2013-2018

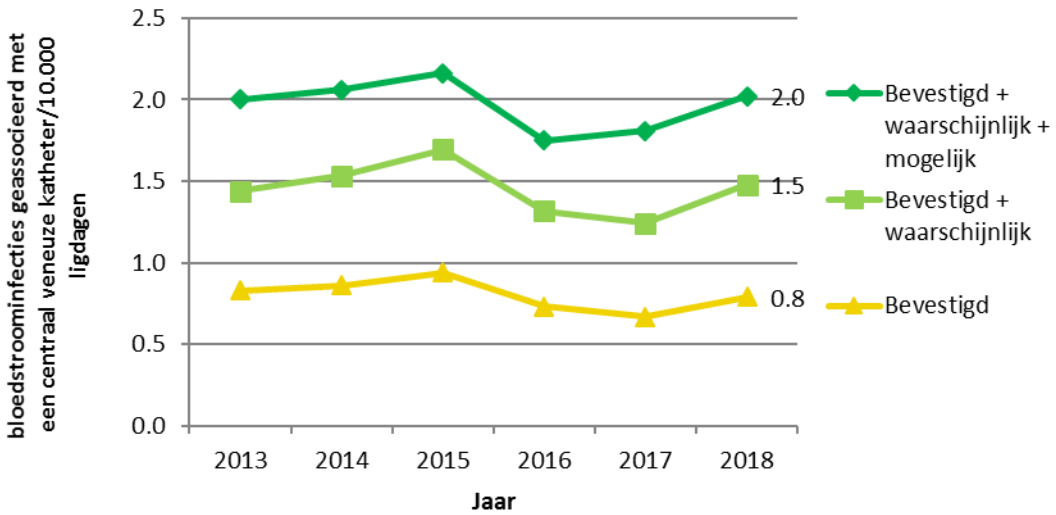
Jaar	2013	2014	2015	2016	2017	2018
Cumulatieve incidentie per 1.000 opnames						
gemiddelde – ziekenhuis-breed*	5,4	5,6	5,7	5,2	5,4	5,8
gemiddelde – op intensieve zorgen afdeling**	14,1	13,9	13,5	14,8	13,8	14,3
Incidentie dichtheid per 10.000 ligdagen						
gemiddelde – ziekenhuis-breed *	7,5	7,8	8,0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

* 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, 2013-2018

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 – in de surveillance 'oorsprong' geregistreerd als 'onbekend' - maar centraal veneuze katheter aanwezig in de twee dagen voorafgaand aan de bloedstroominfectie).

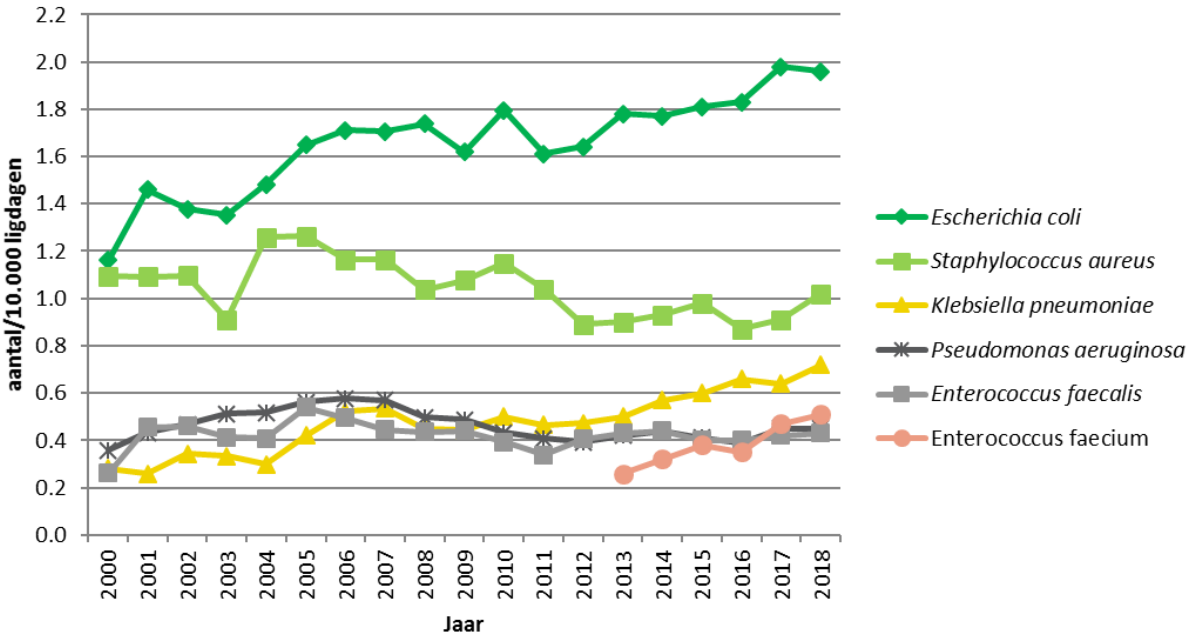
De incidentie van bloedstroominfecties geassocieerd met een centraal veneuze katheter (drie classificaties samen) per 10.000 ligdagen bleef sinds 2013 ongeveer hetzelfde zonder statistisch significante veranderingen (Figuur 1). In 2017 was van alle bloedstroominfecties geassocieerd met een centraal veneuze katheter 39% 'bevestigd', 33% 'waarschijnlijk' en 29% 'mogelijk'.



Figuur 1: Gemiddelde incidentie van bloedstroominfecties geassocieerd met een centraal veneuze katheter, ziekenhuis-breed, België 2013-2018

2.1.3. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIES PER MICRO-ORGANISME, 2000-2018

Figuur 2 geeft voor de meest voorkomende micro-organismen de micro-organismen-specifieke ziekenhuis-geassocieerde bloedstroominfectie incidentie vanaf 2000. Deze figuur toont een stijging van met *E. coli*, *K. pneumoniae* en *E. faecium*[8] geassocieerde bloedstroominfecties op lange termijn. De incidentie van bloedstroominfecties veroorzaakt door *S. aureus* bleef ongeveer gelijk. De incidentie van ziekenhuis-geassocieerde bloedstroominfecties met *E. coli* en *K. pneumoniae* is sinds 2000 verdubbeld. Hetzelfde zien we sinds 2013 voor de incidentie van ziekenhuis-geassocieerde bloedstroominfecties met *E. faecium.*

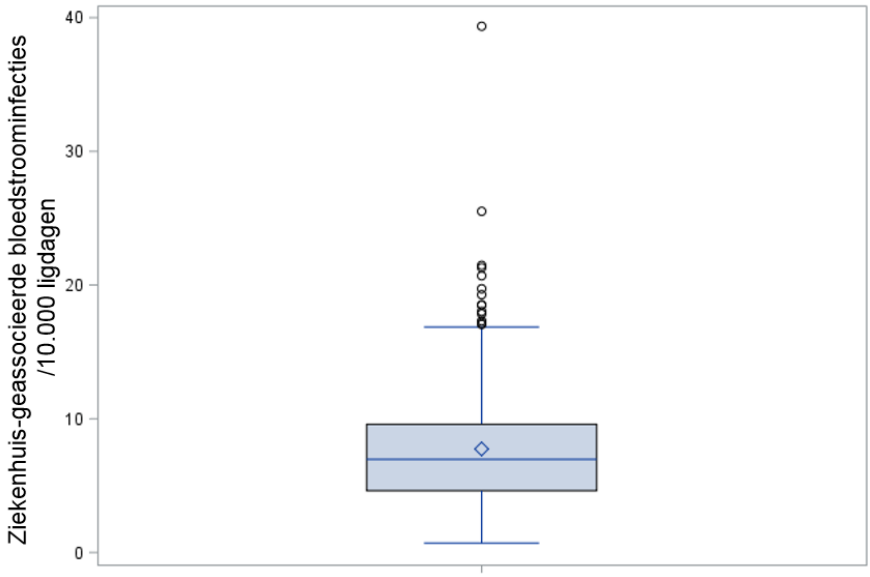


Figuur 2: Gemiddelde incidentie van ziekenhuis-geassocieerde bloedstroominfecties per micro-organisme, België 2000-2018

[8] Voor *E. faecium* zijn enkel gegevens beschikbaar sinds 2013

2.1.4. ZIEKENHUIS-GEASSOCIEERDE BLOEDSTROOMINFECTIE INCIDENTIE OP ZIEKENHUIS NIVEAU, 2018

Zoals de vorige jaren, was er ook in 2018 een grote variabiliteit tussen de ziekenhuizen in ziekenhuis-geassocieerde bloedstroominfectie incidentie. Dit is duidelijk in de boxplot[9] (Figuur 3) waar we verschillende uitschieters waarnemen.



Figuur 3: Ziekenhuis-geassocieerde bloedstroominfectie incidentie: incidentie verdeling per ziekenhuis, België 2018

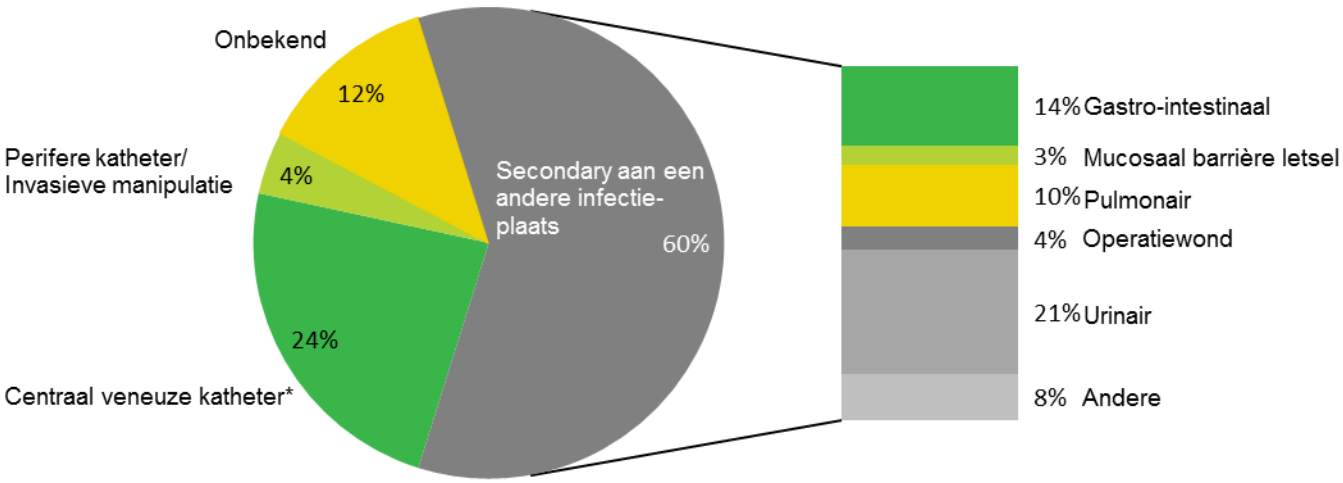
2.2. KENMERKEN ZIEKENHUIS-GEASSOCIEERDE BLOODSTROOMINFECTIES, 2018

In 2018 registreerden 104 ziekenhuizen 8,296 ziekenhuis-geassocieerde bloedstroominfecties; 82% hiervan beantwoordde aan de definitie '*minstens 1 positieve hemocultuur voor een erkend pathogeen micro-organisme*' en 17% aan de definitie '*minstens twee verschillende positieve hemoculturen voor hetzelfde micro-organisme behorend tot de normale huidflora en klinische symptomen*'. Eén of vijf ziekenhuis-geassocieerde bloedstroominfecties ontstond 2 of meer dagen na opname op intensieve zorgen (definitie van intensieve zorgen-geassocieerde bloedstroominfectie).

In de helft van de ziekenhuis-geassocieerde bloedstroominfecties werd de diagnose 12 dagen of meer na ziekenhuisopname gesteld. De helft van de patiënten was 71 jaar of ouder en 21% van de patiënt overleed. Er was echter een aanzienlijke hoeveelheid ontbrekende follow-up gegevens (19% ontbrekende gegevens) en onze gegevens laten evenmin toe om een oorzakelijk verband tussen overlijden en bloedstroominfectie te bepalen.

[9] 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.

De meest voorkomende vermoedelijke oorsprong van ziekenhuis-geassocieerde bloedstroominfecties, ziekenhuis-breed, was een centraal veneuze katheter (24%)[10], gevolgd door een urineweginfectie (21%) (Figuur 4). Op intensieve zorgen was de meest voorkomende vermoedelijke oorsprong een centraal veneuze katheter (37%) gevolgd door longinfectie (21%). De oorsprong van ziekenhuis-geassocieerde bloedstroominfecties (ziekenhuis-breed) werd in 43% 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 39% van de ziekenhuis-brede ziekenhuis-geassocieerde bloedstroominfecties en in 61% van de intensieve zorgen-geassocieerde bloedstroominfecties.



Figuur 4: Vermoedelijke oorsprong van ziekenhuis-geassocieerde bloedstroominfecties, België 2018 (* Omvat 'bevestigde', 'waarschijnlijke' en 'mogelijke' bloedstroominfecties geassocieerd met een centraal veneuze katheter)

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

2.3. GEIDENTIFICEERDE OORZAKELIJKE MICRO-ORGANISMEN EN HUN RESISTENTIE PROFIEL

E. coli (21%), *S. aureus* (11%) en *S. epidermidis* (9%) waren in 2018 de meest voorkomende micro-organismen in ziekenhuis-geassocieerde bloedstroominfecties. Enkel 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 2018 was enkel de daling in de proportie van methicilline-resistentie *S. aureus* (van 21,0% naar 10,5%) statistisch significant. Andere veranderingen (indien aanwezig) waren niet statistisch significant.

Tabel 2: Resistentie in micro-organismen geïsoleerd uit ziekenhuis-geassocieerde bloedstroominfecties, België 2018

		Micro-organismen 2018			% ziekenhuizen met minstens 1 resistent geval* (N=104)
	Antibiotica	N	n	%	
Staphylococcus aureus	Meti	968	102	10,5	52
	Gly	968	4	0,4	3
Enterococcus faecalis	Gly	430	3	0,7	3
Enterococcus faecium	Gly	489	18	3,7	13
Escherichia coli	C3G	1,885	299	15,9	72
	CAR	1,885	12	0,6	12
Klebsiella pneumoniae	C3G	728	257	35,3	61
	CAR	728	28	3,8	15
Enterobacter cloacae	C3G	302	117	38,7	46
	CAR	302	10	3,3	10
Proteus mirabilis	C3G	176	7	4,0	6
	CAR	176	1	0,6	1
Klebsiella oxytoca	C3G	178	27	15,2	18
	CAR	178	1	0,6	1
Enterobacter aerogenes	C3G	101	67	66,3	32
	CAR	101	3	3,0	3
Pseudomonas aeruginosa	CAR	437	63	14,4	31
Acinetobacter baumannii	CAR	55	4	7,3	3

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. CONCLUSIE EN AANBEVELINGEN

3.1. CONCLUSIE

Ziekenhuis-geassocieerde bloedstroominfectie surveillance resultaten voor 2018 waren vergelijkbaar met de resultaten gevonden in de vorige vijf jaar:

- Sinds 2014 is het verplicht om deel te nemen aan de bloedstroominfectie surveillance. In 2018, registreerde 58% van de ziekenhuizen surveillance gegevens voor het hele jaar.
- De ziekenhuis-geassocieerde bloedstroominfectie incidentie, 8,6/10.000 ligdagen, is weinig veranderd in de afgelopen zes jaar en de bevindingen zijn vrij consistent:
    - Een hogere incidentie in universitaire ziekenhuizen en ziekenhuizen met een universitair karakter
    - Een hogere incidentie op intensieve zorgen afdeling (de incidentie van intensieve zorgen-geassocieerde bloedstroominfecties was in 2018 29,2/10.000 ligdagen)
- Tussen de ziekenhuizen onderling is er een grote variabiliteit in ziekenhuis-geassocieerde bloedstroominfectie incidentie. Dit suggereert mogelijkheden voor preventie en/of de noodzaak voor gegevensvalidatie.
- De incidentie van bloedstroominfecties geassocieerd met een centraal veneuze katheter per 10.000 ligdagen bleef sinds 2013 ongeveer hetzelfde. Van alle ziekenhuis-geassocieerde bloedstroominfecties in 2018 was 39% geassocieerd met een invasief hulpmiddel (centraal veneuze katheter: 24%, perifere katheter: 4%, urineweg sonde: 9% en endotracheale tube: 3%). Deze infecties geassocieerd met een invasief hulpmiddel vormen een prioriteit voor preventieve maatregelen.
- *E. coli* en *S. aureus* waren de meest voorkomende micro-organismen gevonden in ziekenhuis-geassocieerde bloedstroominfecties. De incidentie van ziekenhuis-geassocieerde bloedstroominfecties met *E. coli* en met *K. pneumoniae* is sinds 2000 verdubbeld.
- Sinds 2013 daalde meticilline-resistentie in *S. aureus*.

3.2. AANBEVELINGEN

Omdat de bevindingen vrij gelijkaardig zijn aan die van het vorige bloedstroominfectie surveillance rapport dat eind 2018 werd gepubliceerd, zijn de aanbevelingen ongewijzigd. Deze aanbevelingen worden hieronder kort herhaald.

Aanbevelingen voor beleidsmakers

- Blijf infectie controle teams in ziekenhuizen ondersteunen en de mogelijkheid bieden 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) en de formele erkenning van infectie controle als geneeskundig specialisme zouden in dit verband 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.
- Ondersteun het opzetten en uitvoeren van een validatie van de bloedstroominfectie-surveillance gegevens en een studie naar waarom de ziekenhuis-geassocieerde

bloedstroominfectie incidentie niet veranderde gedurende de laatste zes jaar. Beide studies kunnen door Sciensano uitgevoerd worden.
- Doorgaan met de ondersteuning van een nationale ziekenhuis-geassocieerde bloedstoominfectie surveillance om veranderingen in ziekenhuis-geassocieerde bloedstoominfectie incidentie op nationaal en ziekenhuis-niveau op te volgen.

Aanbevelingen voor ziekenhuizen
- Onderzoek of een vermindering van het aantal ziekenhuis-geassocieerde bloedstoominfectie nog mogelijk is en, indien nodig, implementeer maatregelen en activiteiten om het aantal ziekenhuis-geassocieerde bloedstoominfectie 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 bloedstoominfectie gegevens in de nationale bloedstroominfectie surveillance dit om de ziekenhuis-geassocieerde bloedstoominfectie situatie in de tijd en de impact van lokaal geïmplementeerde activiteiten op de ziekenhuis-geassocieerde bloedstoominfectie incidentie te kunnen evalueren.

Aanbevelingen voor de wetenschappers verantwoordelijk voor de surveillance (Sciensano)
- Validatie van de surveillance gegevens. Het vergelijken, op ziekenhuis- en intensieve zorgen afdeling niveau, van surveillance gegevens met de gegevens van de ‘minimale ziekenhuisgegevens’ gegevensverzameling zou een eerste stap kunnen zijn in deze validatie.
- Onderzoek waarom de afgelopen zes jaar de ziekenhuis-geassocieerde bloedstoominfectie 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 bloedstoominfectie 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 bloedstoominfectie incidentie te vergelijken met vergelijkbare ziekenhuizen met een hogere incidentie en de oorzaak van dit verschil in incidentie te onderzoeken.
- De antibiotica-resistentiegegevens die momenteel in de bloedstroominfecties surveillance verzameld worden zijn niet nuttig en relevant voor de Belgische context. Deze moeten gestroomlijnd worden met de aanbevelingen hierover gegeven door de Hoge Gezondheidsraad. Hierom en omdat antibiotica-resistentiegegevens reeds verzameld worden in andere door Sciensano gecoördineerde surveillances, moeten deze gegevens niet opnieuw gevraagd worden als deel van de bloedstroominfectie surveillance.
- 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).
- Onderzoek of in de toekomst de gegevensregistratie en rapportage niet verder kan worden vereenvoudigd en gestroomlijnd. In deze context zou het nuttig zijn te onderzoeken of gegevens verzameld via andere kanalen (bijvoorbeeld de ‘minimale ziekenhuisgegevens’) gebruikt zouden kunnen worden om de doelstellingen van de bloedstroominfectie surveillance in Belgische ziekenhuizen te beantwoorden.

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 tous les hôpitaux aigus et les institutions de soins chroniques de plus de 150 lits à raison d'au moins un trimestre par an. Cela implique l'enregistrement de données standardisées pour chaque épisode de septicémie survenant 2 jours ou plus après l'admission du patient à l'hôpital (« septicémies associées à l'hôpital »).

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, avec un focus sur les septicémies évitables, tant au niveau local qu'au niveau national, dans le but de guider et d'évaluer les efforts de prévention,
- le suivi des microorganismes impliqués et de leur profil de résistance.

Le présent rapport résume les données de surveillance belges jusqu'en 2018 inclus.

2. RÉSULTATS

En 2018, 104 (101 hôpitaux aigus et 3 institutions de soins chroniques de plus de 150 lits) des 107 hôpitaux éligibles (101 hôpitaux aigus et 6 institutions de soins chroniques de plus de 150 lits) ont participé à la surveillance des septicémies. Parmi eux, 58% ont enregistré des données sur l'ensemble de l'année. L'enregistrement en continu sert mieux l'objectif de la surveillance en tant qu'outil de prévention des septicémies associées à l'hôpital.

2.1. TENDANCES DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL

2.1.1. SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, 2013-2018

L'incidence des septicémies associées à l'hôpital reste stable depuis 2013 tant au niveau de tout l'hôpital, qu'au niveau des unités de soins intensifs (Tableau 1). En 2018, l'incidence moyenne des septicémies associées à l'hôpital était de 8,6/10 000 journées d'hospitalisation au niveau de tout l'hôpital et de 29,2/10 000 journées d'hospitalisation pour les septicémies survenant deux jours ou plus après l'admission dans une unité de soins intensifs.

Tableau 1 : Incidence des septicémies associées à l'hôpital, au niveau de tout l'hôpital et de l'unité de soins intensifs, Belgique 2013-2018

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

* 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, 2013-2018

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 corporel – « origine inconnue » encodée dans le formulaire de surveillance –, 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 est restée stable depuis 2013, sans changement statistiquement significatif (Figure 1). En 2017, parmi ces septicémies, 39% étaient « confirmées », 33% « probables » et 29% « possibles ».

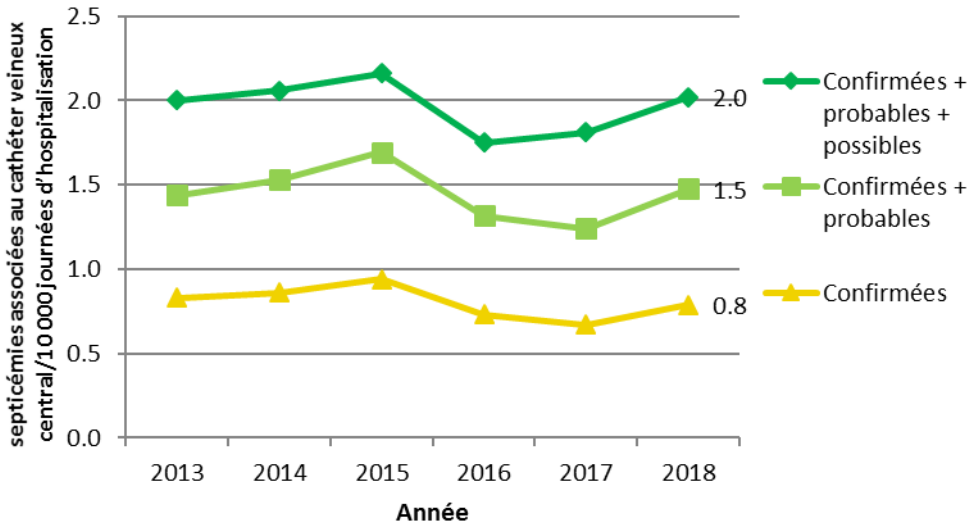


Figure 1 : Incidence moyenne des septicémies associées au cathéter veineux central au niveau de tout l'hôpital, Belgique, 2013-2018

2.1.3. SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, PAR MICRO-ORGANISME, 2000-2018

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. Cette Figure met en évidence une hausse des septicémies à *E. coli*, *K. pneumoniae* et *E. faecium*[11] sur le long terme. L'incidence des septicémies à *S. aureus* est restée plus ou moins stable. Pour *E. coli* et *K. pneumoniae*, l'incidence des septicémies associées à l'hôpital a doublé depuis 2000 et elle a fait de même pour E. *faecium* depuis 2013.

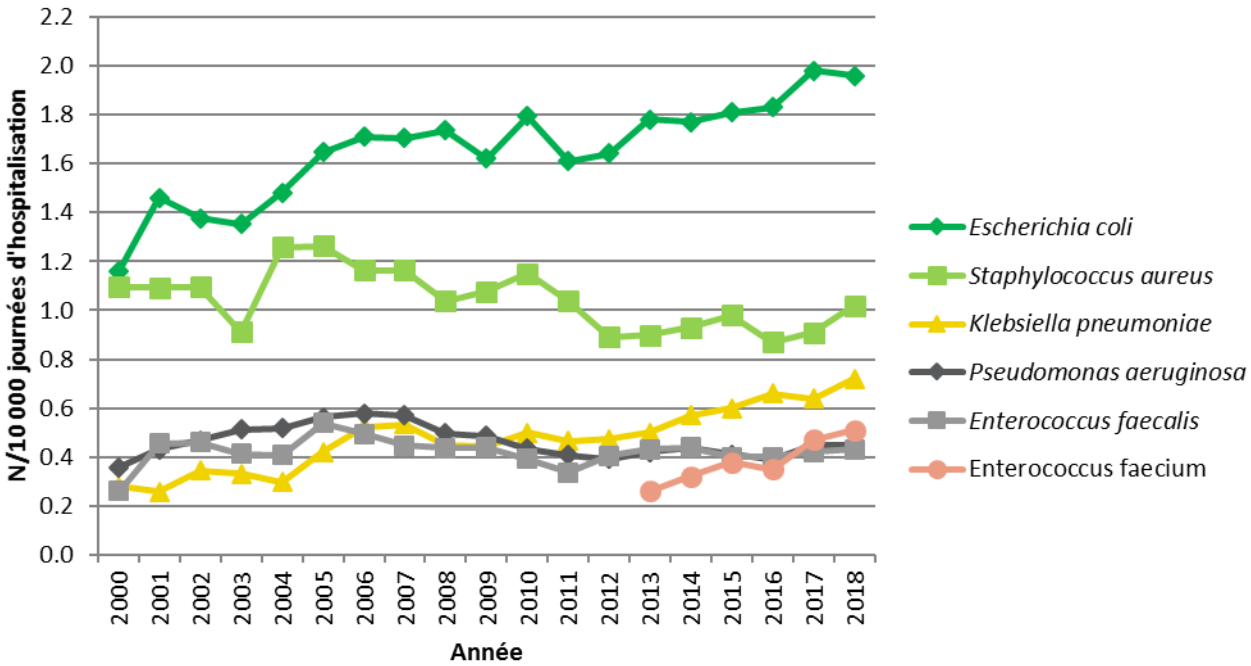


Figure 2 : Incidence moyenne des septicémies associées à l'hôpital par micro-organisme, Belgique, 2000-2018

[11] Les données concernant *E. faecium* sont seulement disponibles depuis 2013.

2.1.4. INCIDENCE DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL AU NIVEAU DE L'HÔPITAL, 2018

Comme les années précédentes, on observe en 2018 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[12] (Figure 3), qui fait apparaître plusieurs valeurs extrêmes.

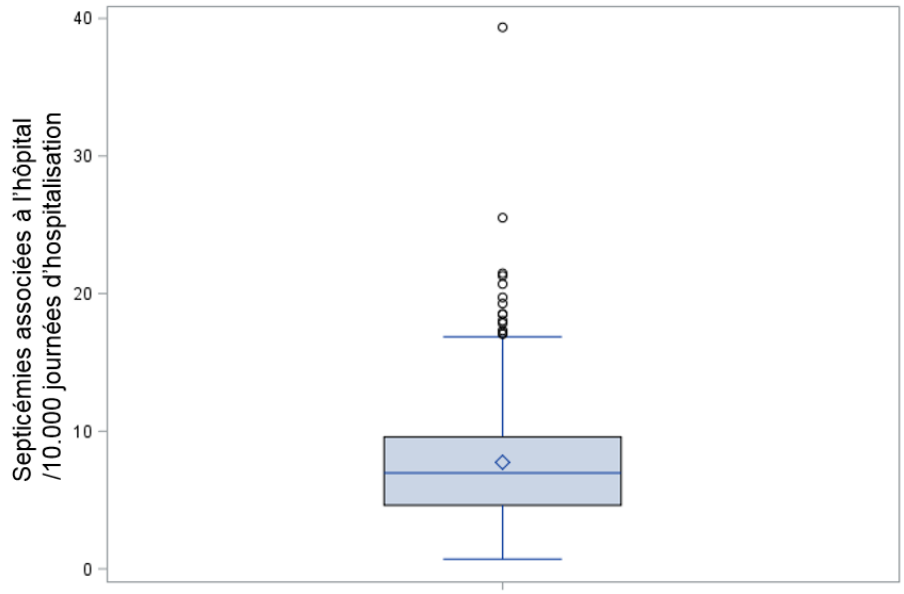


Figure 3 : Incidence des septicémies associées à l'hôpital, par hôpital, Belgique, 2018

2.2. CARACTÉRISTIQUES DES SEPTICÉMIES ASSOCIÉES À L'HÔPITAL, 2018

En 2018, les 104 hôpitaux participants ont enregistré 8 296 septicémies associées à l'hôpital, 82% répondant à la définition « *au moins une hémoculture positive pour un micro-organisme pathogène* » et 17% à la définition « *au moins deux hémocultures différentes positives pour le même micro-organisme appartenant à la flore cutanée classique et présence de symptômes cliniques* ». Une septicémie associée à l'hôpital sur cinq est apparue deux jours ou plus après une admission aux soins intensifs (définition des septicémies associées aux soins intensifs).

La moitié des épisodes sont survenus 12 jours ou plus après l'admission à l'hôpital. La moitié des patients avaient au moins 71 ans et 21% des patients sont décédés. Cependant, une proportion importante des données relatives au « status en fin de suivi » était manquante (19%) et nos données ne permettent pas d'établir un lien causal entre le décès et la septicémie.

[12] La boîte à moustaches montre l'incidence médiane des septicémies associées à l'hôpital (ligne bleue dans la boîte) par 10 000 journées d'hospitalisation par hôpital 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 par 10 000 journées d'hospitalisation.

Les origines les plus fréquentes, au niveau de tout l'hôpital, étaient le cathéter veineux central (24%)[13], suivi par les infections urinaires (21%) (Figure 4). Aux soins intensifs, les origines les plus fréquentes étaient le cathéter veineux central (37%), suivi par les pneumonies (21%). L'origine des septicémies associées à l'hôpital (au niveau de tout l'hôpital) était confirmée dans 43% 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 39% des septicémies associées à l'hôpital au niveau de tout l'hôpital et dans 61% des septicémies associées aux soins intensifs.

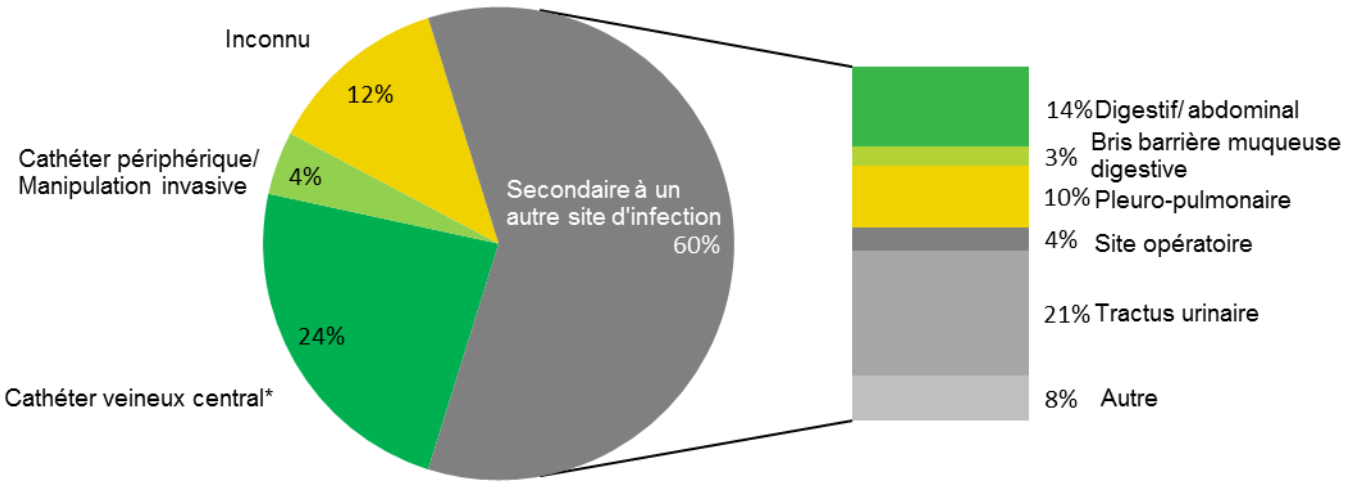


Figure 4 : Origine présumée des septicémies associées à l'hôpital, Belgique, 2018 (*Inclut origine « confirmées », « probables » et « possibles » pour les septicémies associées au cathéter veineux central)

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

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

Les micro-organismes les plus fréquemment isolés dans les septicémies associées à l'hôpital en 2018 étaient *E. coli* (21%), *S. aureus* (11%) et *S. epidermidis* (9%). Seulement 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 2018, seule la diminution de la proportion de *S. aureus* résistance à la méthicilline (de 21,0% à 10.5%) 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, 2018

		Micro-organismes 2018			% d'hôpitaux présentant au moins 1 cas de résistance* (N=104)
	Antibiotiques	N	n	%	
Staphylococcus aureus	Meti	968	102	10,5	52
	Gly	968	4	0,4	3
Enterococcus faecalis	Gly	430	3	0,7	3
Enterococcus faecium	Gly	489	18	3,7	13
Escherichia coli	C3G	1,885	299	15,9	72
	CAR	1,885	12	0,6	12
Klebsiella pneumoniae	C3G	728	257	35,3	61
	CAR	728	28	3,8	15
Enterobacter cloacae	C3G	302	117	38,7	46
	CAR	302	10	3,3	10
Proteus mirabilis	C3G	176	7	4,0	6
	CAR	176	1	0,6	1
Klebsiella oxytoca	C3G	178	27	15,2	18
	CAR	178	1	0,6	1
Enterobacter aerogenes	C3G	101	67	66,3	32
	CAR	101	3	3,0	3
Pseudomonas aeruginosa	CAR	437	63	14,4	31
Acinetobacter baumannii	CAR	55	4	7,3	3

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. CONCLUSIONS ET RECOMMANDATIONS

3.1. CONCLUSIONS

Les résultats de la surveillance des septicémies associées à l'hôpital pour 2018 sont similaires à ceux observés ces cinq dernières années :

- En 2014, la participation à la surveillance des septicémies est devenue obligatoire. En 2018, 58% des hôpitaux ont enregistré des données de surveillance tout au long de l'année.
- L'incidence des septicémies associées à l'hôpital, 8,6/10 000 journées d'hospitalisation en 2018, a peu changé au cours des six dernières années et les observations sont plutôt uniformes :
    - Incidence plus élevée dans les hôpitaux universitaires ou à caractère universitaire ;
    - Incidence plus élevée dans les unités de soins intensifs (en 2017, l'incidence des septicémies associées aux soins intensifs était de 29,2/10 000 journées d'hospitalisation).
- Il existe une grande variabilité dans l'incidence des septicémies associées à l'hôpital entre les hôpitaux, ce qui laisse à penser qu'un important potentiel de prévention existe, et/ou que les données doivent faire l'objet d'une validation.
- L'incidence des septicémies associées au cathéter veineux central par 10 000 journées d'hospitalisation est restée quasi stable depuis 2013. Au total, 39% des septicémies associées à l'hôpital enregistrées en 2018 étaient associées à un dispositif invasif (cathéter veineux central : 24% ; cathéter périphérique : 4% ; sonde urinaire : 9% et tube endotrachéal : 3%). Il s'agit là d'une cible prioritaire pour la prévention.
- Les micro-organismes les plus fréquemment associés aux septicémies associées à l'hôpital étaient *E. coli* et *S. aureus*. L'incidence des septicémies associées à l'hôpital à *E. coli* ou *K. pneumoniae* a doublé depuis 2010.
- Depuis 2013, la résistance à la méthicilline a diminué pour *S. aureus*.

3.2. RECOMMANDATIONS

Parce que les conclusions sont assez similaires à celles du rapport de surveillance des septicémies précédent publié fin 2018, les recommandations sont restées les mêmes. Ces recommandations sont brièvement répétées ci-dessous.

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. 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) et de reconnaître de manière formelle l'infectiologie comme une spécialité médicale pour laquelle des tâches et des responsabilités spécifiques sont définies.
- 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.

- Soutenir la mise en œuvre d'une validation des données de surveillance des septicémies et d'une étude visant à examiner pourquoi l'incidence des septicémies associées à l'hôpital n'a pas changé ces six dernières années. Sciensano peut se charger de la réalisation de ces deux études.
- Continuer à soutenir la surveillance nationale des septicémies associées à l'hôpital afin de suivre les modifications d'incidence aux niveaux national et hospitalier.

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 et de l'effet des activités mises en place localement afin de réduire leur incidence.

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

- Procéder à une validation des données de surveillance. Un premier pas serait de comparer, au niveau de l'hôpital et du service, les données de surveillance avec celles du résumé hospitalier minimum.
- Investiguer les raisons pour lesquelles l'incidence des septicémies associées à l'hôpital dans les hôpitaux belges n'a pas diminué au niveau national ces cinq dernières années. 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 supplémentaire. Ou, en comparant les hôpitaux à faible incidence avec des hôpitaux similaires à incidence élevée et évaluer les raisons de cette différence.
- Les données sur la résistance antibiotique actuellement demandées dans le cadre de la surveillance des septicémies ne sont ni utiles ni pertinentes dans le contexte belge et devraient être rationalisées sur base des recommandations concernant les tests de résistance aux antibiotiques du Conseil Supérieur de la Santé. Pour cette raison et parce que les données de résistance sont déjà demandées dans d'autres surveillances coordonnées par Sciensano, ces données ne devraient plus être demandées dans le cadre de la surveillance des septicémies.
- 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).
- Examiner si l'enregistrement et le *reporting* des données ne peuvent pas être simplifiés et rationalisés à l'avenir. Dans ce contexte, il serait utile d'étudier si des données recueillies par d'autres canaux (par exemple, le résumé hospitalier minimum) pourraient être utilisées pour satisfaire aux objectifs de la surveillance des septicémies dans les hôpitaux belges.

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 [1-7]. In Belgium, a national hospital-wide surveillance system for HABSI exists since 1992 [8].

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 all acute care hospitals and for long-term care facilities with >150 beds (Royal decree 08-01-2015) is legally required since July 2014 [8]. 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 (http://nsihweb.wiv-isp.be/). 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/7 and https://www.healthdata.be/dcd/#/collection/NSIH-Denominators/version/19) and hospital based results reported through Healthstat (see: https://www.healthstat.be/).

This report describes trends in incidences of HABSI, causal microorganisms (MO), and their antimicrobial resistance profile until 2018 and provides a more detailed description of the 2018 BSI data.

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 [9,10].

Since the migration to Healthdata, hospitals are identified by their National Institute for Health and Disability Insurance (NIHDI)-number and hospital campuses by their campus-number. Before this migration, hospitals were identified by a specific 'NSIH-code', which was specifically created for the NSIH-coordinated surveillances.

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.

2.2 DATA ANALYSIS

This report presents the analysis results, mainly descriptive, of surveillance data up to 2018 (database data labelled as 'Approved' in Healthdata on 12 July 2019). Data collected before the protocol review in 2012 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. For data on HABSI before 2013, see previous reports [8].

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 divided by the sum of denominators. To calculate medians the reporting quarter was used as unit of analysis[15].

[14] See BSI surveillance protocol chapter 4.5.2 (http://www.nsih.be/download/BSI%20surv%20protocol_NL_April2019.pdf (Dutch version), http://www.nsih.be/download/BSI%20surv%20protocol_FR_April2019.pdf (French version))
[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.

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 between tertiary and non-tertiary hospitals in Brussels as standard (reference) population.

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 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.

Regarding resistance; ‘intermediary’ resistance was categorized in the analysis 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[16] and for the statistical test for which STATA 14.1. (StataCorp LP, College Station, Texas, USA) was used.

[16] https://fingertips.phe.org.uk/profile/guidance - Analytical tools - Funnel plot for rates (updated July 2018)

3 Results surveillance of bloodstream infection in hospitals, 2013-2018

Participation

In 2018, 104 (101 acute care hospitals and 3 long-term care facilities with > 150 beds) out of 107 eligible hospitals (101 acute care hospitals and 6 long term-care facilities with > 150 beds)[17] participated in the BSI-surveillance. Fifty-eight percent of these hospitals participated the whole year (Table 3)[18]. Divided by region this resulted in: 12 of the total of 14 hospitals participated in Brussels, of which 36% throughout the whole year, 55 of 56 hospitals participated in Flanders, 68% throughout the whole year, and in Wallonia all hospitals participated with 51% participating throughout the whole year (Annex 2, Table 26). So, the percentage of hospitals that participated throughout the whole year in Flanders is almost double compared with this percentage in Brussels.

Altogether, data for 311 quarters were submitted from which 296 (95%) quarters had denominator data available.

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 2013-2018

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

N, number

Note:

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

[17] 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 April 2019 (*Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019*). Hospitals are identified by their RIZIV/INAMI number.

[18] 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, 2013-2018

The incidence of HABSI in Belgian hospitals increased slightly since 2013. This increase in HABSI per 10,000 patient-days (pd) from 7.5 in 2013 to 8.6 in 2018 is statistically significant (incidence rate ratio 1.16 with 95% CI [1.07-1.27]). However, for HABSI per 1,000 admissions no statistically significant changes were observed throughout the years (Table 4 and Figure 5).

Table 4: Incidence of hospital-associated bloodstream infections (hospital-wide), Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
N hospitals included in calculation of incidence*	89	99	104	106	95	103
N HABSI	5,594	6,976	7,889	7,849	6,511	7,756
Cumulative incidence per 1,000 admissions						
mean**	5.4	5.6	5.7	5.2	5.4	5.8
median***	5.2	4.8	4.8	4.7	4.7	4.6
Incidence density per 10,000 patient-days						
mean**	7.5	7.8	8.0	7.6	8.1	8.6
median***	6.8	6.8	6.7	6.6	6.9	7.0

HABSI, hospital-associated BSI; N, number
Notes:
* Hospitals included when denominator of the participating quarter was available[19]
** Total hospital-associated BSI/total denominator
*** Unit of analysis used to calculate median is quarter

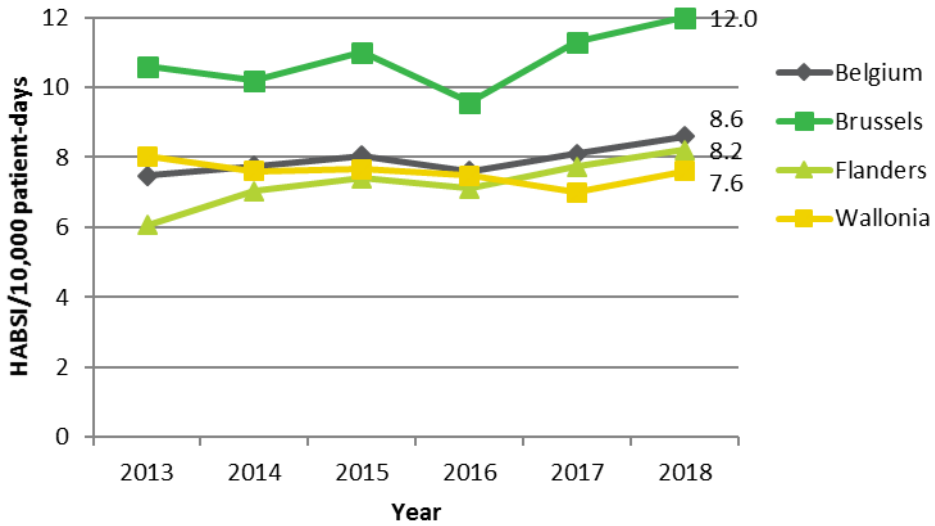


Figure 5: Mean incidence of hospital-associated bloodstream infections, hospital-wide, by region, Belgium 2013-2018 (HABSI, hospital-associated bloodstream infections)

Figure 5 and Annex 3, Table 27, show HABSI incidences by region. Compared to 2013 the incidences per 10,000 pd decreased in Wallonia and increased in Brussels and Flanders. These findings are statistically significant for Flanders but not for Brussels and Wallonia. In Flanders, the incidence of HABSI per 10,000 pd increased statistically significantly from 6.1 in 2013 to 8.2 in 2018 (incidence rate ratio 1.36 with 95% CI [1.20-1.55]).

[19] In 2018, for 93% of the reported HABSI matching denominator data were available.

HABSI incidences are higher in Brussels compared to the two other regions. Since Brussels has more tertiary hospitals[20,21], 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 23). We therefore applied on the 2018 data direct standardization to control for potential confounding. As standard population we used the 2018 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, the 2018 HABSI incidence rate in Brussels remained higher than those of Flanders and Wallonia. Standardized rate ratios for the latter regions were 0.81 and 0.72 respectively when compared to Brussels.

Comparing 2013 with 2018, the incidence of HABSI in tertiary hospitals per 10,000 pd increased statistically significantly from 8.4 in 2013 to 11.7 in 2018 (incidence rate ratio 1.51 with 95% CI [1.21-1.89]). In non-tertiary hospitals the HABSI incidence per 10,000 pd remains fairly stable since 2013 (Annex 4, Table 28).

In 2018, the median number of HABSI episodes in Belgian hospitals was 16 (IQR 8-34) episodes per quarter.

3.1.1.2 CENTRAL-LINE ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2018

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 2018, 39% were confirmed CLABSI, 33% probable CLABSI and 29% possible CLABSI. These proportions did not change substantially since 2013 (Annex 5, Table 30) and incidences varied accordingly (Table 5). Also CLABSI incidence (three classifications together) per 10,000 pd did not change substantially since 2013 with no statistically significant changes observed since 2013 (Figure 6).

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

[20] 'Tertiary hospitals' include the hospitals defined as 'university hospital', 'general hospital with university characteristics', and 'specialised hospitals' in the '*Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019*' published by FOD volksgezondheid – SPF santé publique.

[21] Proportion (absolute numbers and %) of tertiary hospitals participating by region in 2017;

- Brussels: 7/12 (58%)
- Flanders: 9/54 (17%)
- Wallonia: 10/37 (27%)

Table 5: Mean incidence of central line-associated bloodstream infections, hospital-wide, according to classification, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Confirmed CLABSI						
N*	619	776	919	749	541	717
mean incidence per 10,000 pd	0.8	0.9	0.9	0.7	0.7	0.8
Probable CLABSI						
N*	459	603	743	610	460	619
mean incidence per 10,000 pd	0.6	0.7	0.8	0.6	0.6	0.7
Possible CLABSI						
N*	423	473	460	442	459	495
mean incidence per 10,000 pd	0.6	0.5	0.5	0.4	0.6	0.6
Total CLABSI						
N*	1,501	1,852	2,122	1,801	1,460	1,831
mean incidence per 10,000 pd	2.0	2.1	2.2	1.8	1.8	2.0

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

Note:

* Includes only those episodes for which a denominator is available

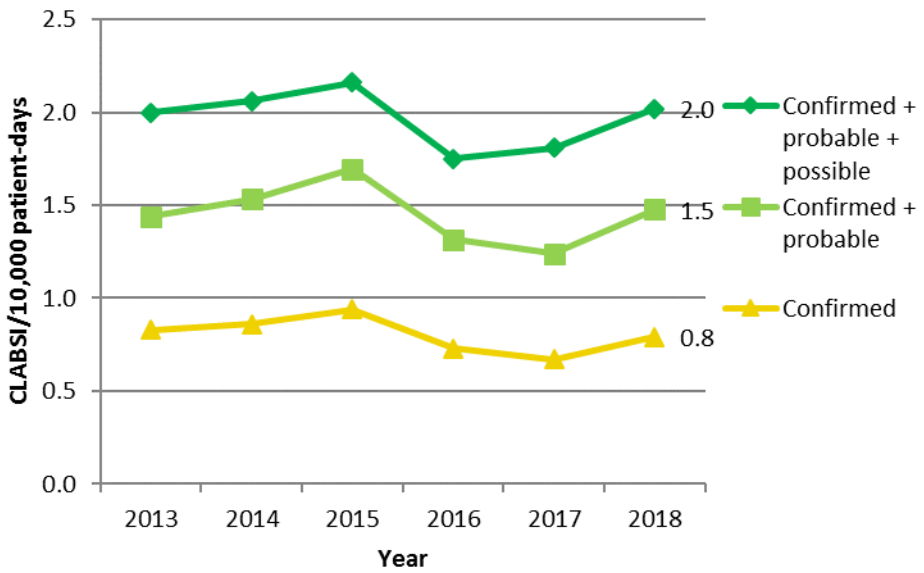


Figure 6: Mean incidence of central line-associated bloodstream infections (confirmed, probable, and possible), hospital-wide, Belgium 2013-2018 (CLABSI, central line-associated bloodstream infections)

In 2018, the median number of hospital-wide CLABSI (including confirmed, probable and possible cases) was 3 (IQR 1-8) episodes per quarter.

3.1.1.3 MICROORGANISM SPECIFIC HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS, 2000-2018

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*[22]. The incidence of HABSI with *S. aureus* did not change substantially over time. Since 2000, the incidence of HABSI with *E. coli* and *K. pneumoniae* as causal MO doubled. Since 2013, we notice the same regarding the incidence of HABSI with *E. faecium*.

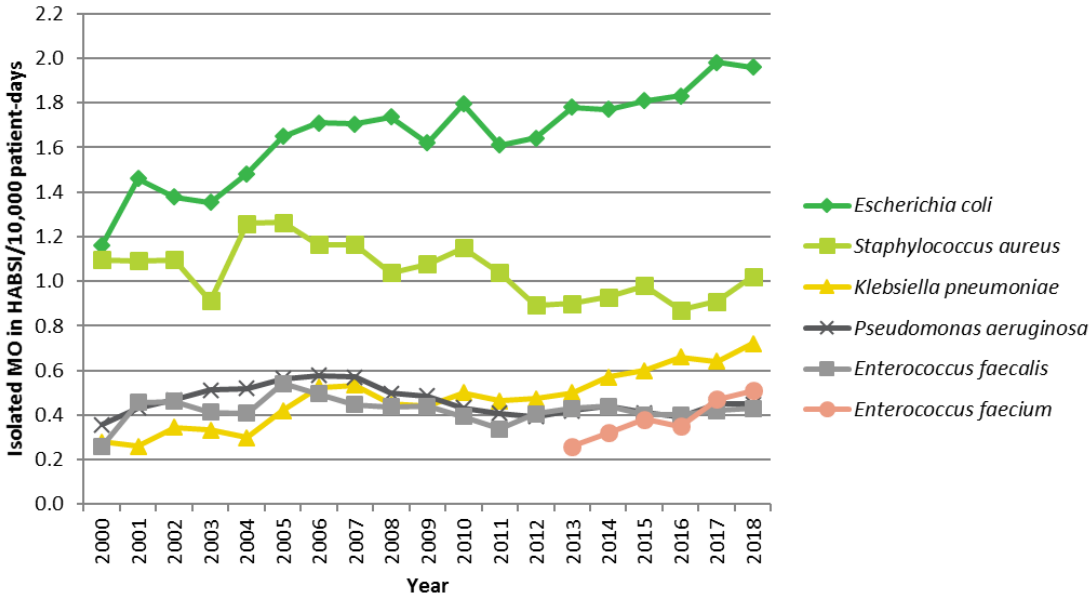


Figure 7: Mean incidence of hospital-associated bloodstream infections per microorganism, Belgium 2000-2018 (HABSI, hospital-associated bloodstream infection; MO, microorganism)

3.1.1.4 MICROORGANISM SPECIFIC CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2018

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.

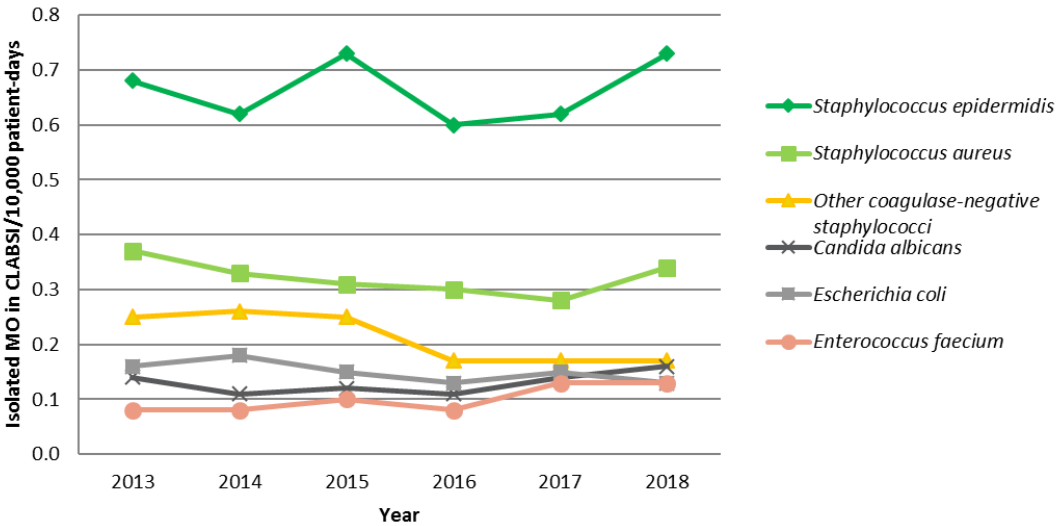


Figure 8: Mean incidence of central line-associated bloodstream infections per microorganism, Belgium 2013-2018 (CLABSI, central line-associated bloodstream infection; MO, microorganism)

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

3.1.1.5 INCIDENCES OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS AT HOSPITAL LEVEL, 2018

In 2018, as in previous years, there was a large variability in the reported incidence of HABSI between hospitals as shown in the boxplot[23] and funnel plot[24] below (Figures 9 and 11). In both graphs several outliers are noticed. Incidence is higher in university hospitals and in general hospitals with university characteristics and 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.

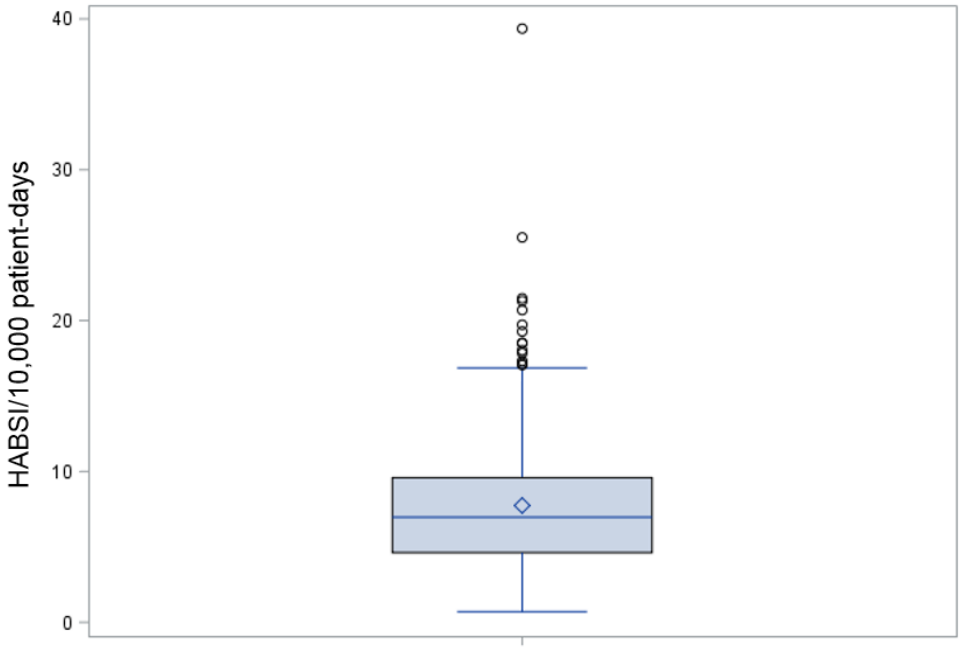


Figure 9: Hospital-associated bloodstream infections: incidence distribution across hospitals, Belgium 2018 (HABSI, hospital-associated bloodstream infection)

[23] 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.

[24] 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.

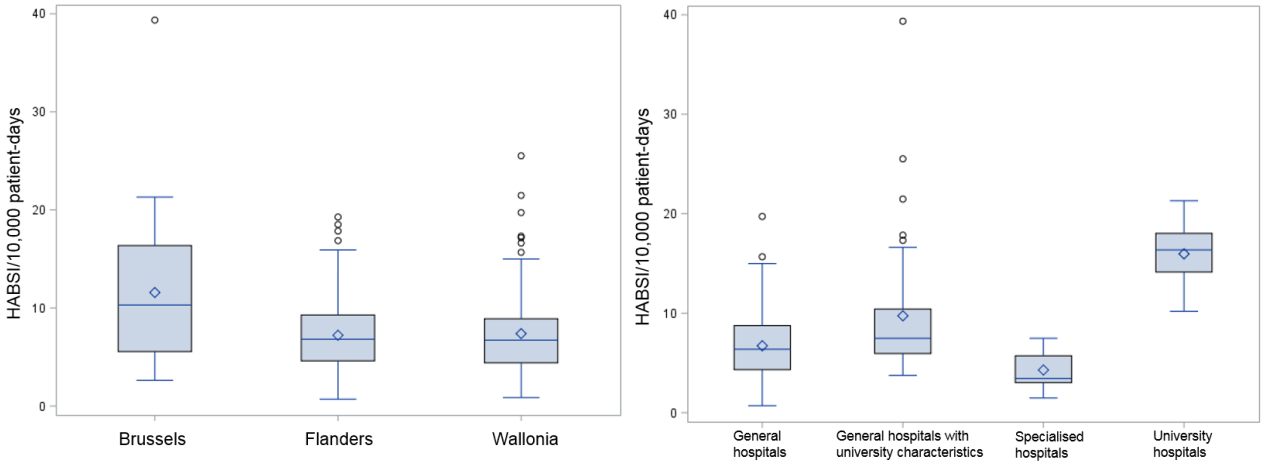


Figure 10: Hospital-associated bloodstream infections: incidence distribution across hospitals, by region and by hospital type[25], Belgium 2018 (HABSI, hospital-associated bloodstream infection)

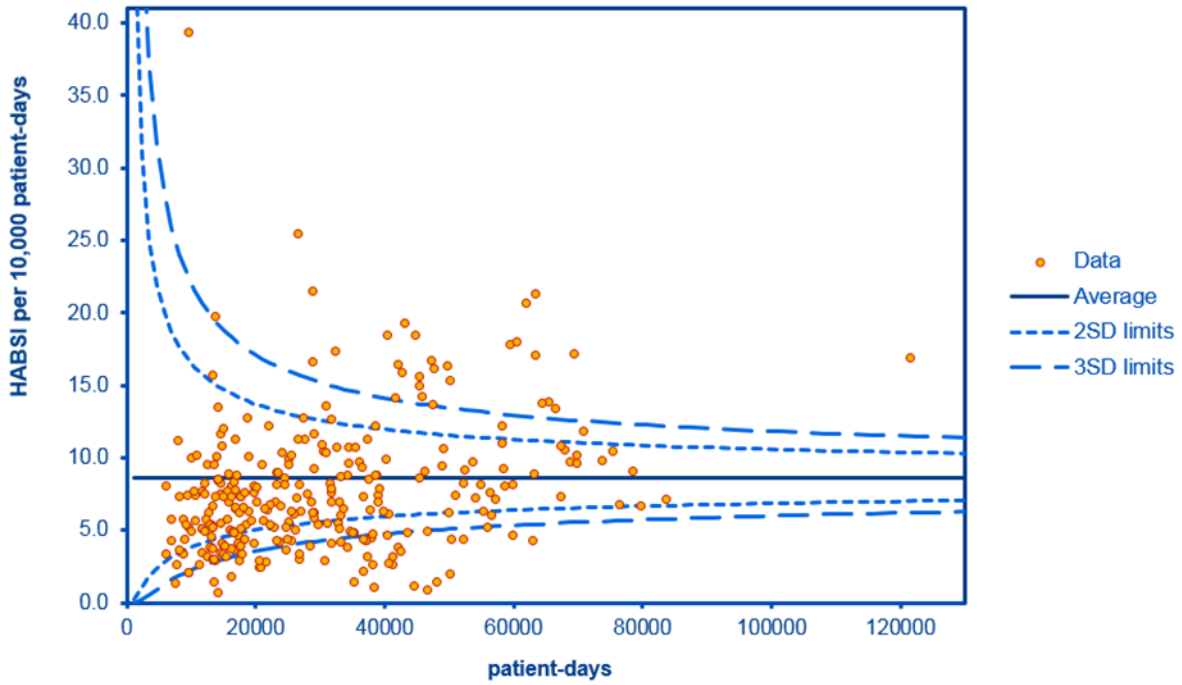


Figure 11: Variability in reported incidence of hospital-associated bloodstream infections between hospitals, Belgium 2018 (HABSI, hospital-associated bloodstream infection; SD, standard deviation)

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

[25] Based on the classification given in the list of hospitals provided by the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg); List dated April 2019: Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019.

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 2018, 1,646 ICU-associated BSI were registered in the surveillance of which 1,157 (70%) 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 471 quarters.

3.1.2.1 INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2018

The incidence of ICU-associated BSI in Belgium at national level did not change much during the past six years (Table 6 and Figure 12). Regional data for 2018 shows the highest incidences in Brussels and the lowest in Flanders.

At national as well as at regional level, there is no real trend in the incidence of ICU-associated BSI per 10,000 patient-days between 2013 and 2018 (Figure 12). Comparing 2013 with 2018, none of the change in incidence per 10,000 patient-days at national or regional level was statistically significant.

Table 6: Incidence of intensive care unit-associated bloodstream infections, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
N hospitals included in calculation of incidence*	56	64	68	68	75	97
N ICU-associated BSI	693	798	794	856	761	1,157
Cumulative incidence per 1,000 admissions						
mean**	14.1	13.9	13.5	14.8	13.8	14.3
median***	13.2	11.2	10.6	12.2	11.5	10.8
Incidence density per 10,000 patient-days						
mean**	32.0	31.6	29.8	31.9	29.6	29.2
median***	24.1	24.2	22.8	25.0	25.1	23.9

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

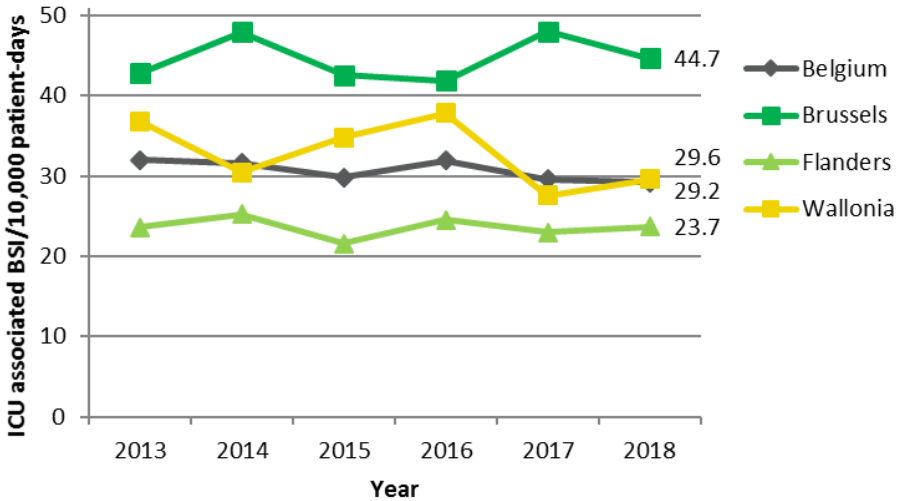


Figure 12: Mean incidence of intensive care unit-associated bloodstream infections, by region, Belgium 2013-2018 (BSI, bloodstream infections; ICU, intensive care unit)

3.1.2.2 INTENSIVE CARE UNIT-ASSOCIATED CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS, 2013-2018

Each of the different CLABSI classifications in ICU is represented by a similar proportion of about 1/3 of the total ICU-associated CLABSI (Annex 7, Table 32).

Compared with 2013, the total CLABSI incidence at ICU per 10,000 pd (three classifications together) decreased (Table 7 and Figure 13). However, this is only due to the decrease identified between 2013 and 2015. This decrease in CLABSI (three classifications together) per 10,000 pd, comparing 2013 with 2018, is not statistically significant.

In 2018, the mean CLABSI incidence in ICU per 10,000 patient-days for the three classifications together was 10.6; more than five times higher than the hospital-wide incidence.

Table 7: Mean incidence of central line-associated bloodstream infections in intensive care units according to classification, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Confirmed CLABSI						
N*	101	108	98	94	84	141
mean incidence per 10,000 pd	4.7	4.3	3.7	3.5	3.3	3.6
Probable CLABSI						
N*	65	61	67	69	78	130
mean incidence per 10,000 pd	3.0	2.4	2.5	2.6	3.0	3.3
Possible CLABSI						
N*	111	97	90	98	85	148
mean incidence per 10,000 pd	5.1	3.8	3.4	3.7	3.3	3.7
Total CLABSI						
*N**	277	266	255	261	247	419
mean incidence per 10,000 pd	12.8	10.5	9.6	9.7	9.6	10.6

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

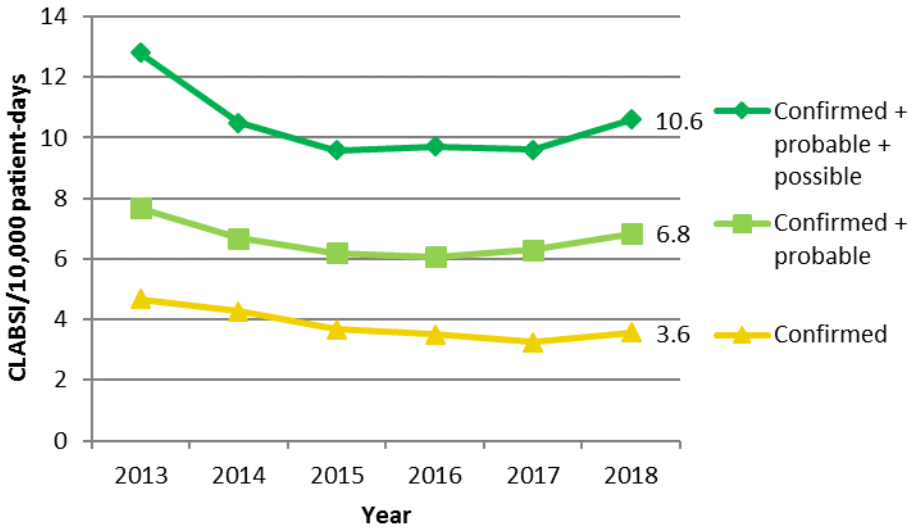


Figure 13: Mean incidence of central line-associated bloodstream infections (confirmed, probable, and possible) in intensive care units, Belgium 2013-2018 (CLABSI, central line-associated bloodstream infections)

In 2018, the median (IQR) number of ICU-associated CLABSI was null (0-1) episodes per quarter[26].

3.1.2.3 INCIDENCES OF INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS AT INTENSIVE CARE UNIT LEVEL, 2018

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 2018, 114 of the 471 (is 24%) 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.

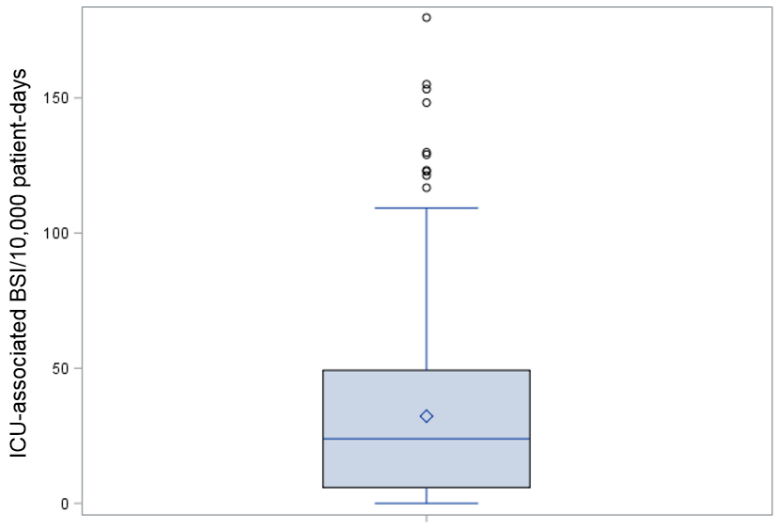


Figure 14: Intensive care unit-associated bloodstream infections: incidence distribution across intensive care units, Belgium 2018 (BSI, bloodstream infection; ICU, intensive care unit)

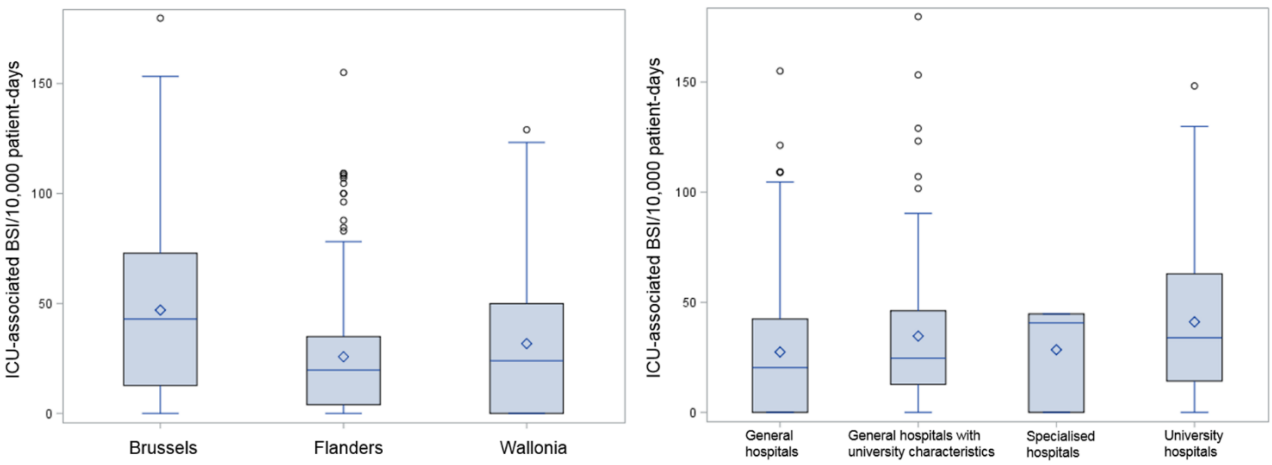


Figure 15: Intensive care unit-associated bloodstream infections: incidence distribution across hospitals, by region and by hospital type[27], Belgium 2018 (BSI, bloodstream infection; ICU, intensive care unit)

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

[27] Based on the classification given in the list of hospitals provided by the Belgian ministry of health (Dienst Datamanagement - Directoraat-Generaal Gezondheidszorg); List dated April 2019: Adressenlijst ziekenhuizen 04/2019 - Liste d'adresses des hôpitaux 04/2019.

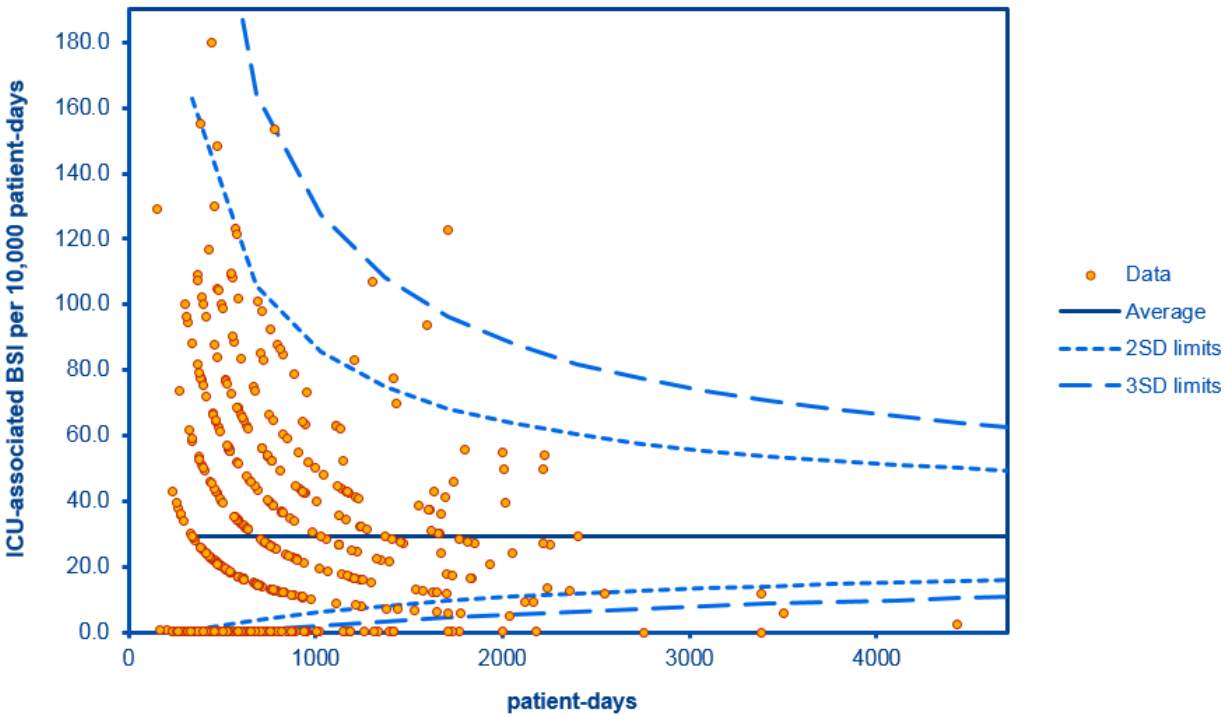


Figure 16: Variability in reported incidence of intensive care unit-associated bloodstream infections between hospitals, Belgium 2018 (BSI, bloodstream infection; ICU, intensive care unit; SD, standard deviation)

3.2 CHARACTERISTICS OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION, 2018

3.2.1 HOSPITAL-WIDE

In 2018, 104 hospitals registered together 10,528 BSI of which 8,296 were reported as HABSI. None of the 296 quarters with available denominator data had zero episode of HABSI reported.

3.2.1.1 DEPARTMENT WHERE THE HOSPITAL-ASSOCIATED BLOODSTREAM INFECTION WAS DIAGNOSED

Almost a quarter of all HABSI were diagnosed at ICU (Table 8). Of these ICU diagnosed BSI, 1,646 (90%) were ICU-associated BSI (see chapter 3.2.2 ICU findings).

Table 8: Department of hospital-associated bloodstream infection diagnosis, Belgium 2018

Department	N	%
Medical department	2,123	26
Gastro-enterology	*593*	*7*
Cardiology	*253*	*3*
Pneumology	*209*	*3*
Other	1,068	13
ICU*	1,839	22
Surgery	1,143	14
Geriatrics	1,227	15
Hemato-oncology	1,125	14
Paediatrics	104	1
Obstetrics/gynaecology	67	1
Other	668	8
Total	**8,296**	**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 four 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 paediatric department. At the other departments, being geriatrics, the medical department, obstetrics/gynaecology, and surgery, urinary tract infection was the main suspected source (Annex 8, Table 33). 67% of all CLABSI was ***not*** diagnosed in ICU.

The definition of mucosal barrier injuries (MBI) as a possible source of HABSI was introduced in 2015. In 2015, only 20 cases from 6 different hospitals were reported. This increased to 274 cases reported by 27 different hospitals in 2018 (Table 9).

Forty-three 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 2018

	Hospital-associated bloodstream infections					
	Confirmed		Non-confirmed		Total	
Source	**N**	**%**	**N**	**%**	**N**	**%**
CLABSI*	761	21	1,193	25	1,954	24
Urinary tract infection	1,426	40	309	7	1,735	21
with catheter	*624*		*133*		*757*	
Gastro-intestinal infection	273	8	843	18	1,116	13
Pulmonary infection	455	13	404	9	859	10
with endotracheal tube/cannula	*206*		*75*		*281*	
Surgical site infection	205	6	120	3	325	4
Peripheral and other catheter	86	2	178	4	264	3
Mucosal barrier injury	29	1	245	5	274	3
Invasive manipulation	31	1	64	1	95	1
Other secondary infection**	308	9	336	7	644	8
Unknown	0	0	1,030	22	1,030	12
Total	**3,574**	**100**	**4,722**	**100**	**8,296**	**100**

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

Notes:

***** Includes 'probable' and 'possible' CLABSI

** Skin/soft tissue and other

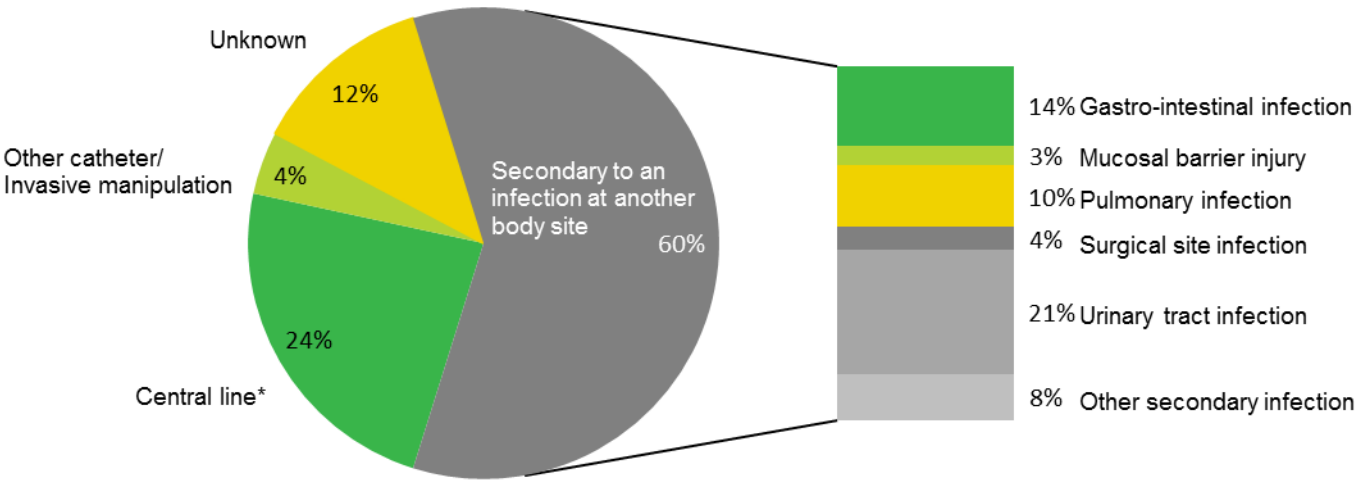


Figure 17: Sources of hospital-associated bloodstream infections, Belgium 2018 (* Includes 'confirmed', 'probable' and 'possible' central line-associated bloodstream infection)

Hospital-associated bloodstream infections associated with invasive devices

Thirty-nine percent of all HABSI were infections associated directly or indirectly with an invasive devise among which 52% (1,677/3,256) were confirmed (Annex 9, Table 34).

Table 9 and 10 show that 757 (44%) of all HABSI with a urinary tract infection as source were catheter associated. Of these 757 cases, 624 cases (82%) were confirmed (same MO found in blood culture(s) and on device). Regarding HABSI with a pulmonary infections as suspected origin, 33% of these BSI were endotracheal tube associated of which 73% were confirmed.

Table 10: Hospital-associated bloodstream infections associated with invasive devices, Belgium 2018

HABSI	HABSI N	HABSI %
CLABSI*	**1,954**	**100**
Confirmed (CRBSI)	761	39
Urinary tract infection	**1,735**	**100**
Urinary catheter present	757	44
Presence urinary catheter unknown	247	14
Urinary catheter as origin of HABSI is confirmed	624	36
Pulmonary infection	**859**	**100**
Endotracheal tube present	281	33
Presence endotracheal tube unknown	94	11
Endotracheal tube as origin of HABSI is confirmed	206	24
Peripheral and other catheter associated BSI	**264**	**100**
Confirmed	86	33

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 2018

Case definition	HABSI N (%)	Non-HABSI N (%)
At least one BC positive for a recognised pathogen	6,791 (82)	2,015 (90)
At least two different BC positive for the same pathogen belonging to the normal microbiota of the skin and clinical symptoms	1,447 (17)	211 (9)
Only one positive BC for a coagulase negative *Staphylococcus* (this applies only to neonatal cases)	58 (1)	6 (0.3)
Total BSI	**8,296 (100)**	**2,232 (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 6-23) after admission at the hospital.

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

Forty-one percent of the HABSI occurred in women. The median age was 71 years of age (IQR 60-81). 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 21% however, there was a substantial amount of missing data for status at end-of-follow-up (19% missing data) (Annex 10, Table 35). Our data do not allow determining a causal link between death and infection.

3.2.2 INTENSIVE CARE UNIT

In 2018, 1,646 (20%) of the total HABSI were ICU-associated BSI.

3.2.2.1 SOURCE OF INTENSIVE CARE UNIT-ASSOCIATED BLOODSTREAM INFECTIONS

In 2018, more than one third of the ICU-associated BSI were CL-associated infections (Figure 18).

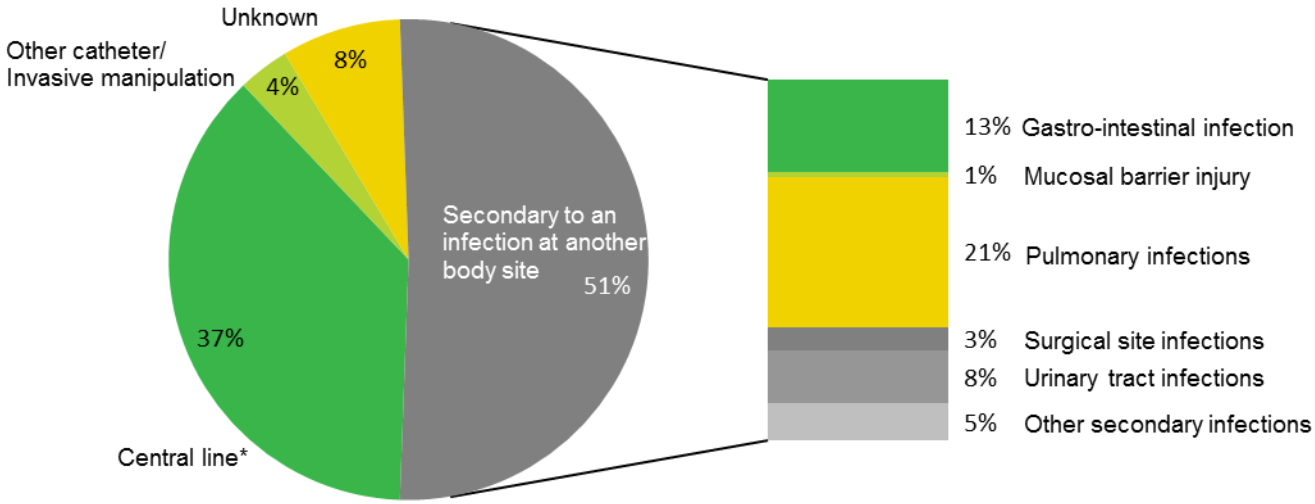


Figure 18: Sources of intensive care unit-associated bloodstream infections, Belgium 2018 (* Includes 'confirmed', 'probable' and 'possible' central line-associated bloodstream infections)

ICU-associated bloodstream infections associated with invasive devices

The proportion of ICU-associated BSI associated directly or indirectly with invasive devices was higher compared to the proportions of these kind of BSI found hospital-wide. In 2018, as mentioned above, 39% (3,256) of all hospital-wide HABSI were directly or indirectly associated with invasive devices compared to 61% (1,005) of all ICU-associated BSI (Table 12).

Table 12: Intensive care unit-associated bloodstream infections associated with invasive devices, Belgium 2018

ICU-associated BSI	ICU-associated BSI N	ICU-associated BSI %
CLABSI*	**614**	**100**
Confirmed (CRBSI)	214	35
Urinary tract infection	**126**	**100**
Urinary catheter present	98	78
Presence urinary catheter unknown	19	15
Urinary catheter as origin of HABSI is confirmed	85	67
Pulmonary infection	**350**	**100**
Endotracheal tube present	241	69
Presence endotracheal tube unknown	43	12
Endotracheal tube as origin of HABSI is confirmed	182	52
Peripheral and other catheter associated BSI	**52**	**100**
Confirmed	25	48

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 2018, 33% of CLABSI (all case definitions together) were diagnosed in ICU (Annex 8, Table 33).

3.2.2.2 TIME TO INFECTION

In 2018, ICU-associated BSI appeared with a median delay of 10 days (IQR 5-18 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 19% of the infection episodes. Our data do not allow determining a causal link between death and infection.

3.3 IDENTIFIED CAUSAL MICROORGANISMS AND THEIR ANTIMICROBIAL RESISTANCE PROFILE, 2013-2018

3.3.1 HOSPITAL-WIDE

3.3.1.1 IDENTIFIED MICROORGANISMS, 2018

In 2018, 9,049 MO were identified as etiological agent for 8,296 HABSI, 2,120 MO for 1,954 CLABSI and 2,354 MO for 2,232 non-HABSI (Table 13). Table 13 gives the data for the MO that caused at least 50 episodes of HABSI in 2018 (for data on MO with less than 50 episodes see Annex 11, Table 36). *Enterobacteriaceae* and Gram-positive cocci were the most frequently isolated MO-families.

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

- *E. coli* in BSI secondary to urinary tract (49%), gastro-intestinal (29%) infection and MBI (26%).
- *S. epidermidis* in CLABSI (28%), and
- *S. aureus* in BSI secondary to pulmonary (14%) and surgical site (18%) infection and with as source a peripheral or other catheter or invasive manipulation (23%).

Table 13: Microorganisms isolated from bloodstream infections, Belgium 2018

	HABSI		CLABSI		Non-HABSI	
Microorganisms	**N**	**%**	**N**	**%**	**N**	**%**
Enterobacteriaceae	**3,812**	**42**	**362**	**17**	**1,259**	**53**
Escherichia coli	1,885	21	99	5	912	39
Klebsiella pneumoniae	728	8	99	5	121	5
Enterobacter cloacae	302	3	43	2	28	1
Klebsiella oxytoca	178	2	26	1	31	1
Proteus mirabilis	176	2	17	1	73	3
Serratia marcescens	118	1	21	1	9	0
Enterobacter aerogenes	101	1	20	1	7	0
Genus *Morganella*	83	1	6	0	18	1
Genus *Klebsiella* (others or not specified)	58	1	4	0	3	0
Other/not identified*	183	2	27	1	57	2
Gram-positive cocci	**3,513**	**39**	**1,309**	**62**	**839**	**36**
Staphylococcus aureus	968	11	241	11	260	11
Staphylococcus epidermidis	858	9	590	28	63	3
Enterococcus faecium	489	5	113	5	23	1
Enterococcus faecalis	420	5	82	4	83	4
Staphylococcus, coagulase negative (others or not specified)	232	3	153	7	13	1
Genus *Streptococcus* (others or not specified)	209	2	32	2	111	5
Streptococcus pneumoniae	82	1	3	0	154	7
Staphylococcus haemolyticus	76	1	51	2	4	0
Genus *Staphylococcus* (not specified)	55	1	28	1	14	1
Other/not identified*	124	1	16	1	114	5
Non-fermenting Gram-negative bacilli	**750**	**8**	**152**	**7**	**109**	**5**
Pseudomonas aeruginosa	437	5	74	3	48	2
Genus *Acinetobacter* (others or not specified)	87	1	22	1	3	0
Acinetobacter baumannii	55	1	14	1	3	0
Stenotrophomonas maltophilia	54	1	13	1	6	0
Other/not identified*	117	1	29	1	49	2
Fungi	**552**	**6**	**230**	**11**	**23**	**1**
Candida albicans	287	3	131	6	14	1
Candida glabrata	142	2	41	2	6	0
Other/not identified*	123	1	58	3	3	0
Anaerobic bacilli	**272**	**3**	**22**	**1**	**79**	**3**
Bacteroides fragilis	116	1	6	0	26	1
Genus *Bacteroides* (others or not specified)	58	1	4	0	11	0
Genus *Clostridium* (others or not specified)	50	1	6	0	14	1
Other/not identified*	48	1	6	0	28	1
Gram-positive bacilli	**83**	**1**	**28**	**1**	**27**	**1**
Gram-negative cocci	**17**	**0**	**5**	**0**	**8**	**0**
Other and not identified	**50**	**1**	**12**	**1**	**10**	**0**
Total	**9,049**	**100**	**2,120**	**100**	**2,354**	**100**

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

Note:

* Other includes microorganisms causing <50 episodes of HABSI/year

3.3.1.2 TRENDS IN ANTIMICROBIAL RESISTANCE FOR SELECTED MICROORGANISMS AND SELECTED ANTIBIOTICS, 2013-2018

In line with ECDC recommendations, for a set of selected MO and selected antibiotics(markers) resistance to these antibiotics(markers) was tested [11,12].

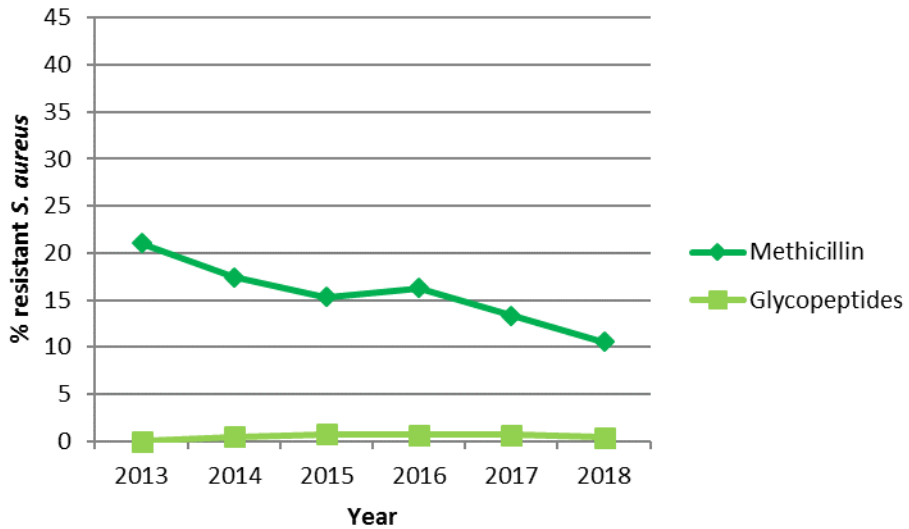
Tables 14 to 19 give for *S. aureus, E. coli, K. pneumoniae, E. cloacae, P. aeruginosa*, and *E. faecium*, the number and proportion of resistant MO isolated from HABSI, the mean incidence of HABSI with a resistant MO per 10,000 patient-days and the number and proportion of hospitals in which at least one HABSI with a resistant MO was identified, from 2013 till 2018.

More hospitals reported at least one HABSI with a third generation cephalosporin resistant *E. coli* or *K. pneumoniae* 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 2013-2018

Year	2013	2014	2015	2016	2017	2018
N strains	685	844	967	899	886	968
N hospitals**	91	100	106	106	105	104
Methicillin						
nR	144	147	148	146	118	102
%R	*21.0*	*17.4*	*15.3*	*16.2*	*13.3*	*10.5*
Mean incidence per 10,000 pd*	0.19	0.16	0.15	0.14	0.13	0.11
Hospitals with ≥ one R case	55	59	64	62	50	54
% hospitals with ≥ one R case	*60*	*59*	*60*	*58*	*48*	*52*
Glycopeptides (vancomycin, teicoplanin)						
nR	0	4	7	6	6	4
%R	*0.0*	*0.5*	*0.7*	*0.7*	*0.7*	*0.4*
Mean incidence per 10,000 pd*	0.00	0.00	0.01	0.01	0.01	0.00
Hospitals with ≥ one R case	0	3	7	6	5	3
% hospitals with ≥ one R case	*0*	*3*	*7*	*6*	*5*	*3*



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

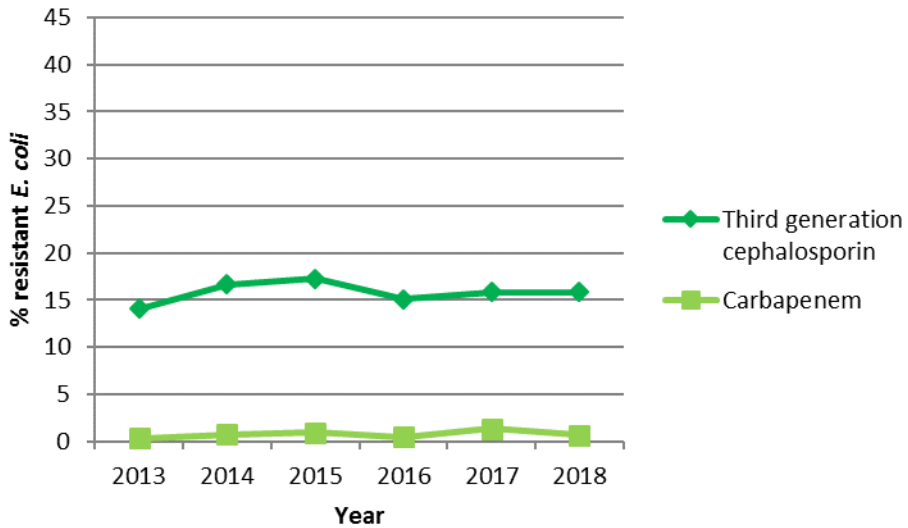
** Hospitals participate 1, 2, 3 or 4 quarters

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 (2018 compared to 2013, incidence rate ratio 0.57 with 95% CI [0.44-0.76]) are both statistically significant. Changes in the proportion (p=0.31) 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 2013-2018

Year	2013	2014	2015	2016	2017	2018
N strains	1,349	1,599	1,784	1,893	1,915	1,885
N hospitals**	91	100	106	106	105	104
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)						
nR	190	266	308	286	303	299
%R	*14.1*	*16.6*	*17.3*	*15.1*	*15.8*	*15.9*
Mean incidence per 10,000 pd*	0.25	0.30	0.31	0.28	0.31	0.31
Hospitals with ≥ one R case	62	68	75	77	72	75
% hospitals with ≥ one R case	*68*	*68*	*71*	*73*	*69*	*72*
Carbapenems (imipenem, meropenem)						
nR	4	11	16	9	26	12
%R	0.3	0.7	0.9	0.5	1.4	0.6
Mean incidence per 10,000 pd*	0.00	0.01	0.02	0.01	0.01	0.01
Hospitals with ≥ one R case	4	10	10	8	11	12
% hospitals with ≥ one R case	*4*	*10*	*9*	*8*	*10*	*12*



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

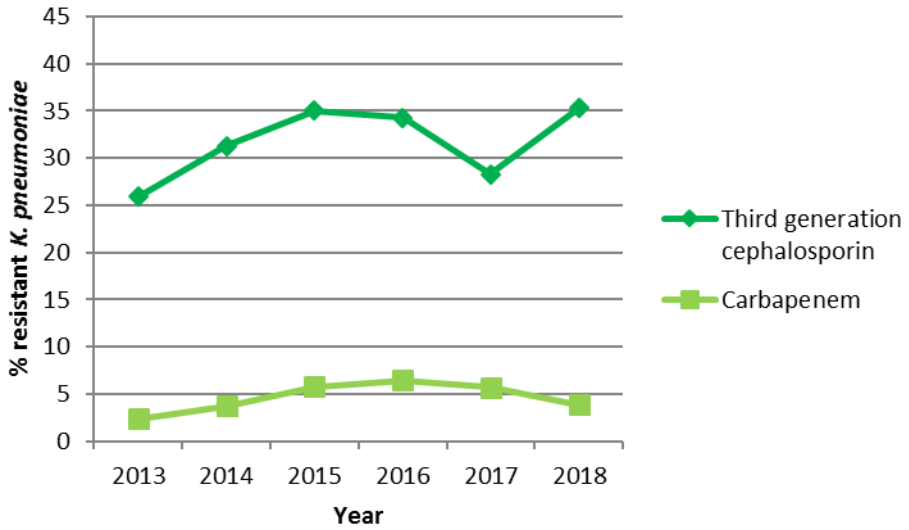
** Hospitals participate 1, 2, 3 or 4 quarters

Changes in proportion of *E. coli* resistant to third generation cephalosporins (p=0.74) and to carbapenems (p=0.09) are not statistically significant. Comparing 2018 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 2013-2018

Year	2013	2014	2015	2016	2017	2018
N strains	382	515	588	685	651	728
N hospitals**	91	100	106	106	105	104
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)						
nR	99	161	206	235	184	257
%R	*25.9*	*31.3*	*35.0*	*34.3*	*28.3*	*35.3*
Mean incidence per 10,000 pd*	0.13	0.18	0.21	0.23	0.18	0.26
Hospitals with ≥ one R case	39	53	56	62	60	63
% hospitals with ≥ one R case	*43*	*53*	*53*	*58*	*57*	*61*
Carbapenems (imipenem, meropenem)						
nR	9	19	34	44	37	28
%R	*2.4*	*3.7*	*5.8*	*6.4*	*5.7*	*3.8*
Mean incidence per 10,000 pd*	0.01	0.02	0.03	0.04	0.04	0.03
Hospitals with ≥ one R case	9	11	18	22	24	16
% hospitals with ≥ one R case	*10*	*11*	*17*	*21*	*23*	*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

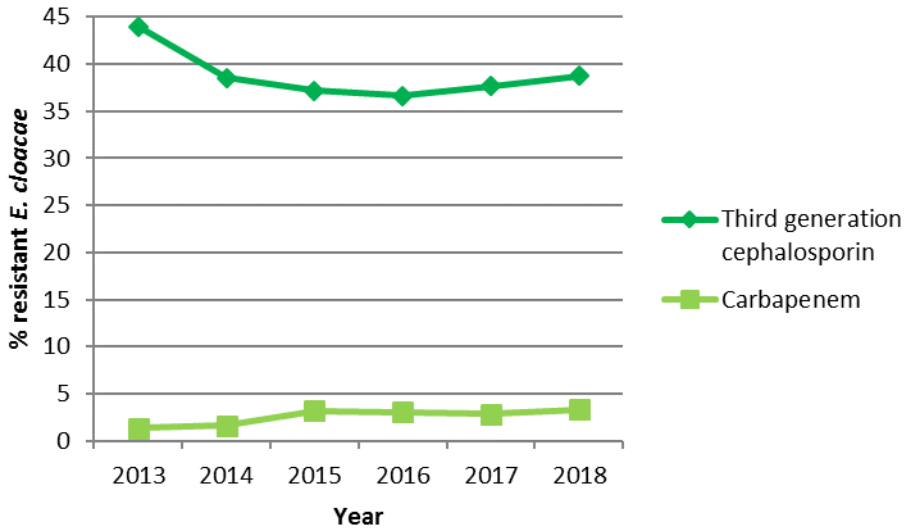
Changes in proportion of *K. pneumoniae* resistant to third generation cephalosporins (p=0.06) and to carbapenems (p=0.22) are not statistically significant.

Change in the incidence of HABSI with *K. pneumoniae* resistant to third generation cephalosporins per 10,000 pd (2018 compared to 2013, incidence rate ratio 2.18 with 95% CI [1.62-2.94]) is statistically significant. Change in incidence of HABSI with *K. pneumoniae* resistant to carbapenems per 10,000 pd (2018 compared to 2013) is not statistically significant.

4. *Enterobacter cloacae*

Table 17: Antimicrobial resistance in* E. cloacae *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
N strains	223	249	312	325	311	302
N hospitals**	91	100	106	106	105	104
Third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime)						
nR	98	96	116	119	117	117
%R	*43.9*	*38.6*	*37.2*	*36.6*	*37.6*	*38.7*
Mean incidence per 10,000 pd*	0.13	0.11	0.12	0.12	0.11	0.12
Hospitals with ≥ one R case	41	40	52	54	53	48
% hospitals with ≥ one R case	*45*	*40*	*49*	*51*	*50*	*46*
Carbapenems (imipenem, meropenem)						
nR	3	4	10	10	9	10
%R	*1.3*	*1.6*	*3.2*	*3.1*	*2.9*	*3.3*
Mean incidence per 10,000 pd*	0.00	0.00	0.01	0.01	0.01	0.01
Hospitals with ≥ one R case	3	4	9	8	7	10
% hospitals with ≥ one R case	*3*	*4*	*8*	*8*	*7*	*10*



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

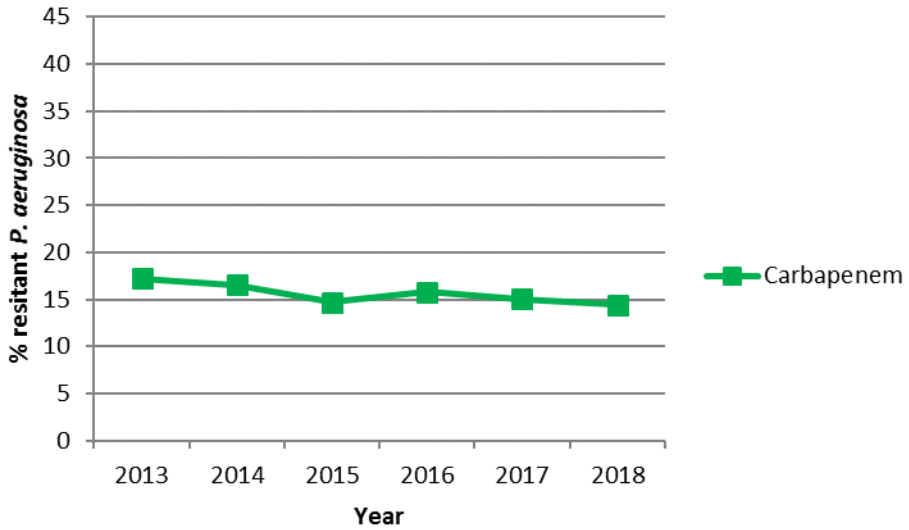
** Hospitals participate 1, 2, 3 or 4 quarters

None of the changes in the proportion of *E. cloacae* resistant to third generation cephalosporins (p=0.30) or to carbapenems (p=0.12) and in the incidence of HABSI with *E. cloacae* resistant to third generation cephalosporins or carbapenems per 10,000 pd (2018 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 2013-2018

Year	2013	2014	2015	2016	2017	2018
N strains	319	399	402	399	419	437
N hospitals**	91	100	106	106	105	104
Carbapenems (imipenem, meropenem)						
nR	55	66	59	63	63	63
%R	*17.2*	*16.5*	*14.7*	*15.8*	*15.0*	*14.4*
Mean incidence per 10,000 pd*	0.07	0.07	0.06	0.06	0.06	0.07
Hospitals with ≥ one R case	27	39	36	33	30	32
% hospitals with ≥ one R case	*30*	*39*	*34*	*31*	*29*	*31*



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

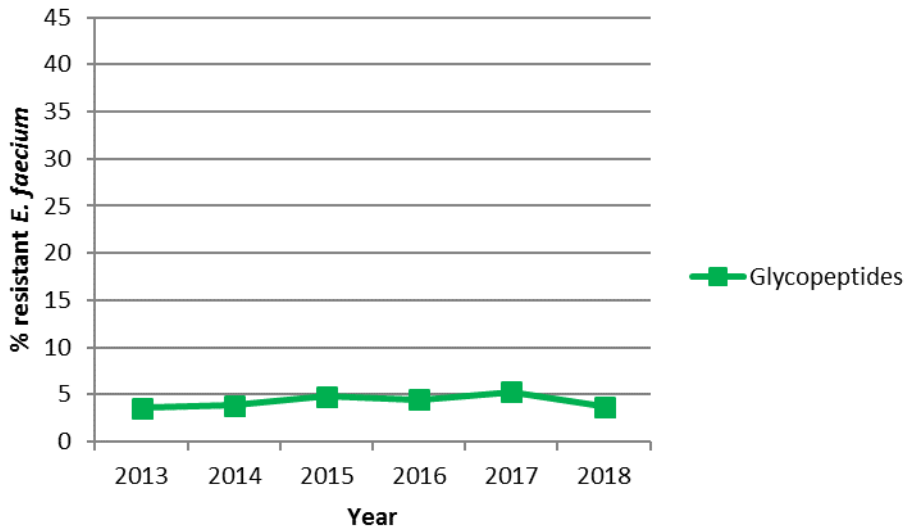
** Hospitals participate 1, 2, 3 or 4 quarters

Since 2013, neither changes in the proportion of *P. aeruginosa* resistant to carbapenems (p=0.54) nor in the incidence of HABSI with *P. aeruginosa* resistant to carbapenems per 10,000 pd are found to be statistically significant.

6. *Enterococcus faecium*

Table 19: Antimicrobial resistance in* E. faecium *strains isolated from hospital-associated bloodstream infections, Belgium 2013-2018

Year	2013	2014	2015	2016	2018	2019
N strains	197	285	377	359	453	489
N hospitals**	91	100	106	106	105	104
Glycopeptides (vancomycin, teicoplanin)						
nR	7	11	18	16	24	18
%R	*3.6*	*3.9*	*4.8*	*4.5*	*5.3*	*3.7*
Mean incidence per 10,000 pd*	0.01	0.01	0.02	0.01	0.03	0.02
Hospitals with ≥ one R case	5	10	14	10	14	13
% hospitals with ≥ one R case	*5*	*10*	*13*	*9*	*13*	*13*



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

Changes in the proportion of *E. faecium* resistant to glycopeptides (p=0.81) and in the incidence of HABSI with *E. faecium* resistant to glycopeptides per 10,000 pd (2018 compared to 2013) are not statistically significant.

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 almost all MOs, resistance is lower in BSI when acquired outside the hospital (defined as non-HABSI) (Annex 13, Table 40).

3.3.1.3 ANTIMICROBIAL RESISTANCE BY REGION, 2018

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 2018. 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, E. aerogenes* and *P. aeruginosa* which have larger sample sizes, we further explored statistically significance in the regional differences identified with following outcomes:

- Similar to the two previous years, MRSA in HABSI has a statistically significant higher proportion in Wallonia compared with the proportions found in Flanders ($p<0.001$) and Brussels ($p=0.03$) but there is no statistically significant difference for this proportion when comparing Flanders with Brussels ($p=0.33$).
- The proportion of *K. pneumoniae* resistance to third generation cephalosporins is statistically significant higher in Wallonia compared with the proportion in Flanders ($p=0.002$) and Brussels ($p<0.001$) but there is no statistically significant difference for this proportion when comparing Brussels with Flanders ($p=0.26$).
- There is no statistically significant difference in the proportion of *E. coli* nor of *E. cloacae* and of *E. aerogenes* 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 2018

		Brussels			Flanders			Wallonia		
Microorganisms	**Antibiotics**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**
Gram-positive cocci										
S. aureus	Meti	172	17	9.9	532	39	7.3	264	46	17.4
	Gly	172	2	1.2	532	2	0.4	264	0	0.0
All Enterococcus spp.	Gly	203	6	3.0	516	17	3.3	237	11	4.6
E. faecalis	Gly	72	0	0.0	230	1	0.4	118	2	1.7
E. faecium	Gly	125	5	4.0	259	7	2.7	105	6	5.7
Enterobacteriaceae	C3G	776	180	23.2	2,043	436	21.3	993	259	26.1
	CAR	776	21	2.7	2,043	27	1.3	993	21	2.1
E. coli	C3G	370	63	17.0	1,041	160	15.4	474	76	16.0
	CAR	370	2	0.5	1,041	4	0.4	474	6	1.3
K. pneumoniae	C3G	144	57	39.6	372	103	27.7	212	97	45.8
	CAR	144	12	8.3	372	8	2.2	212	8	3.8
E. cloacae	C3G	71	25	35.2	155	66	42.6	76	26	34.2
	CAR	71	2	2.8	155	6	3.9	76	2	2.6
P. mirabilis	C3G	40	0	0.0	84	4	4.8	52	3	5.8
	CAR	40	0	0.0	84	1	1.2	52	0	0.0
K. oxytoca	C3G	36	9	25.0	103	14	13.6	39	4	10.3
	CAR	36	1	2.8	103	0	0.0	39	0	0.0
E. aerogenes	C3G	27	14	51.9	48	35	72.9	26	18	69.2
	CAR	27	1	3.7	48	2	4.2	26	0	0.0
Serratia spp.	C3G	24	0	0.0	65	12	18.5	41	16	39.0
	CAR	24	0	0.0	65	1	1.5	41	2	4.9
Non-fermenting Gram-negative bacilli										
P. aeruginosa	CAR	108	22	20.4	210	25	11.9	119	16	13.4
A. baumannii	CAR	10	3	30.0	38	1	2.6	7	0	0.0
Acinetobacter spp.	CAR	21	3	14.3	109	2	1.8	31	2	6.5

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)[28].

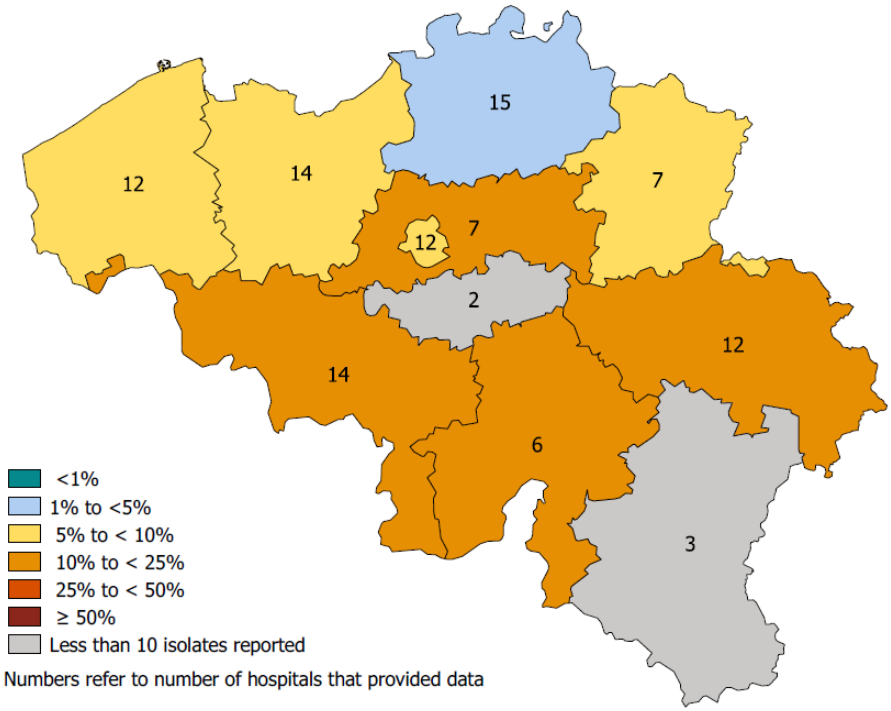


Figure 19: Percent of methicillin resistant* S. aureus *strains isolated from hospital-associated bloodstream infections, by province, Belgium 2018

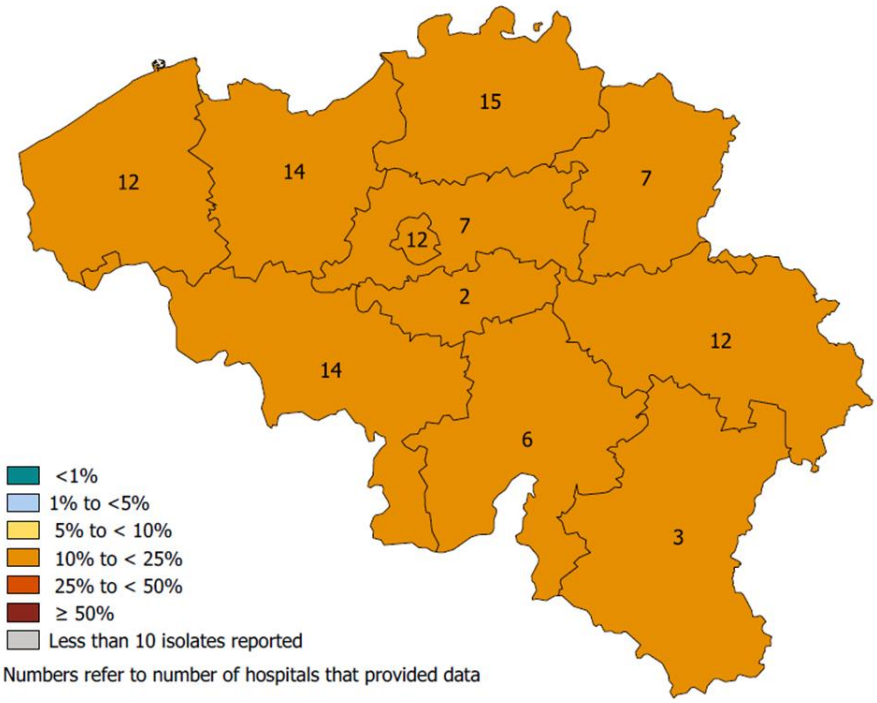


Figure 20: Percent of* E. coli *strains resistant to third generation cephalosporins isolated from hospital-associated bloodstream infections, by province, Belgium 2018

[28] 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). 2017*.'

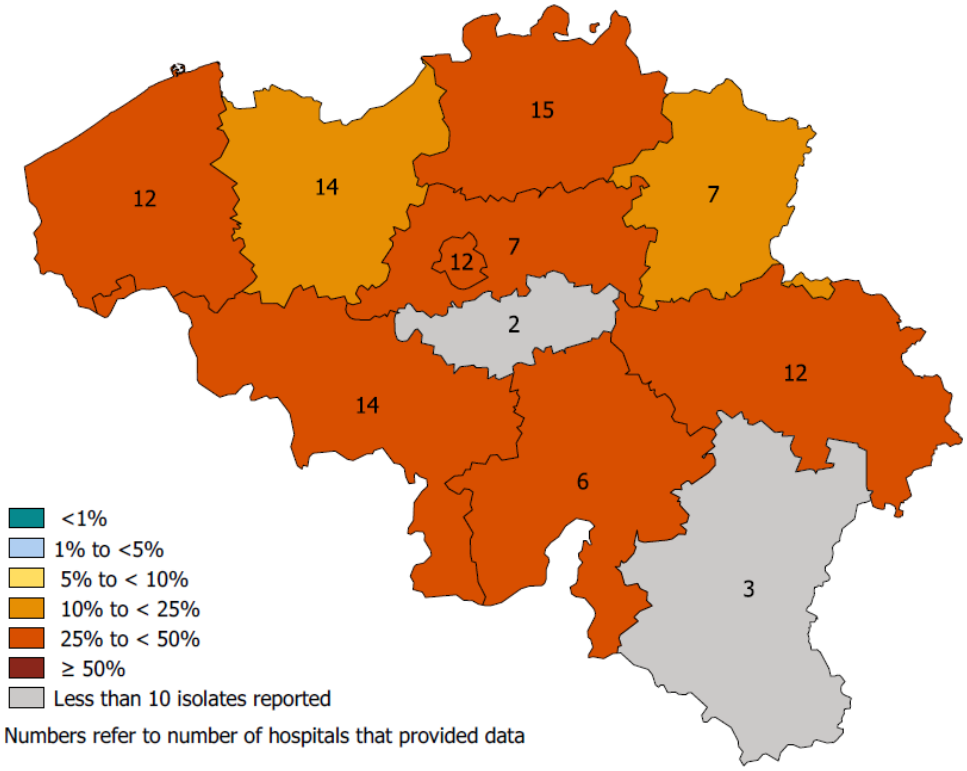


Figure 21: Percent of* K. pneumoniae *strains resistant to third generation cephalosporins isolated from hospital-associated bloodstream infections, by province, Belgium 2018

3.3.2 INTENSIVE CARE UNIT

3.3.2.1 IDENTIFIED MICROORGANISMS, 2018

A total of 1,808 MO were identified as etiological agent for 1,646 ICU-associated BSI (Table 21). Similar to the hospital-wide HABSI, *E. coli, S. aureus* and *S. epidermidis* were the most frequent identified MO.

Table 21: Microorganisms isolated from intensive care unit-associated bloodstream infections, Belgium 2018

	ICU-associated BSI	
Microorganisms	**n**	**%**
Enterobacteriaceae	**615**	**34**
Escherichia coli	200	11
Klebsiella pneumoniae	145	8
Enterobacter cloacae	72	4
Serratia marcescens	44	2
Klebsiella oxytoca	37	2
Enterobacter aerogenes	32	2
Genus *Morganella*	25	1
Proteus mirabilis	25	1
Other/not identified*	35	2
Gram-positive cocci	**776**	**43**
Staphylococcus epidermidis	217	12
Staphylococcus aureus	185	10
Enterococcus faecium	137	8
Enterococcus faecalis	96	5
Staphylococcus, coagulase negative (others or not specified)	60	3
Other/not identified*	81	4
Non-fermenting Gram-negative bacilli	**154**	**9**
Pseudomonas aeruginosa	116	6
Other/not identified*	38	2
Fungi	**171**	**9**
Candida albicans	96	5
Candida glabrata	40	2
Other/not identified*	35	2
Anaerobic bacilli	56	3
Gram-positive bacilli	23	1
Gram-negative cocci	1	0
Other and not identified	12	1
Total	**1,808**	**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, 2018

For the set of selected MO and selected antibiotics(markers) [11,12], 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 2018

		Microorganisms			ICUs with >= one resistant case of ICU-associated BSI*- N=246	
	Antibiotics	N	n	%	n	%
Gram-positive cocci						
S. aureus	Meti	185	17	9	16	7
	Gly	185	1	1	1	0
All Enterococcus spp.	Gly	248	9	4	8	3
E. faecalis	Gly	96	1	1	1	0
E. faecium	Gly	137	7	5	6	2
Enterobacteriacea	C3G	615	184	30	101	41
	CAR	615	21	3	20	8
E. coli	C3G	200	42	21	37	15
	CAR	200	3	2	3	1
K. pneumoniae	C3G	145	60	41	43	17
	CAR	145	10	7	10	4
E. cloacae	C3G	72	30	42	30	12
	CAR	72	3	4	3	1
P. mirabilis	C3G	25	1	4	1	0
	CAR	25	0	0	0	0
K. oxytoca	C3G	37	9	24	9	4
	CAR	37	0	0	0	0
E. aerogenes	C3G	32	18	56	16	7
	CAR	32	0	0	0	0
Serratia spp.	C3G	46	10	22	9	4
	CAR	46	1	2	1	0
Non-fermenting Gram-negative bacilli						
P. aeruginosa	CAR	116	21	18	18	7
A. baumannii	CAR	5	2	40	1	0
Acinetobacter spp.	CAR	12	2	17	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 for diagnostic coding [13]. 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 [14]).

We analysed hospital admission data with septicaemia and bacteremia 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 2000 to 2016 (most recent available data) [13]. For both diagnoses the main[29] (MZG/RHM field: M1/Veld 6 => TYPE_DIAGNOSE = P) and secondary[30] (MZG/RHM field: M1/Veld 6 => TYPE_DIAGNOSE = S) diagnosis were included and for both diagnosis we also 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) [15]. An infection 'not present on admission' is the exact definition of an healthcare associated or nosocomial infection[31]. This implies that the incidence of hospital admissions with ICD-9-CM and ICD-10-CM septicaemia and bacteremia 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.

MZG/RHM data shows that since 2000 the number of total BSI per 1,000 admissions and per 10,000 patient-days increased more compared to the number of BSI as secondary diagnosis (Table 23 and Figure 22). For the number of BSI not present on admission per 1,000 admissions and per 10,000 patient-days (data only available since 2008) we notice a

[29] The main diagnosis is defined as the condition that is identified after examination as the main cause for admission of the patient.
[30] Secondary diagnosis is defined as a condition that has an impact on the patientcare and that was present on admission or occurred after admission.
[31] 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.

remarkable (and unexplained) decrease for 2013 and 2014. However, since 2016 data are again higher and more in line with data found before 2013 (Table 23 and Figure 22).

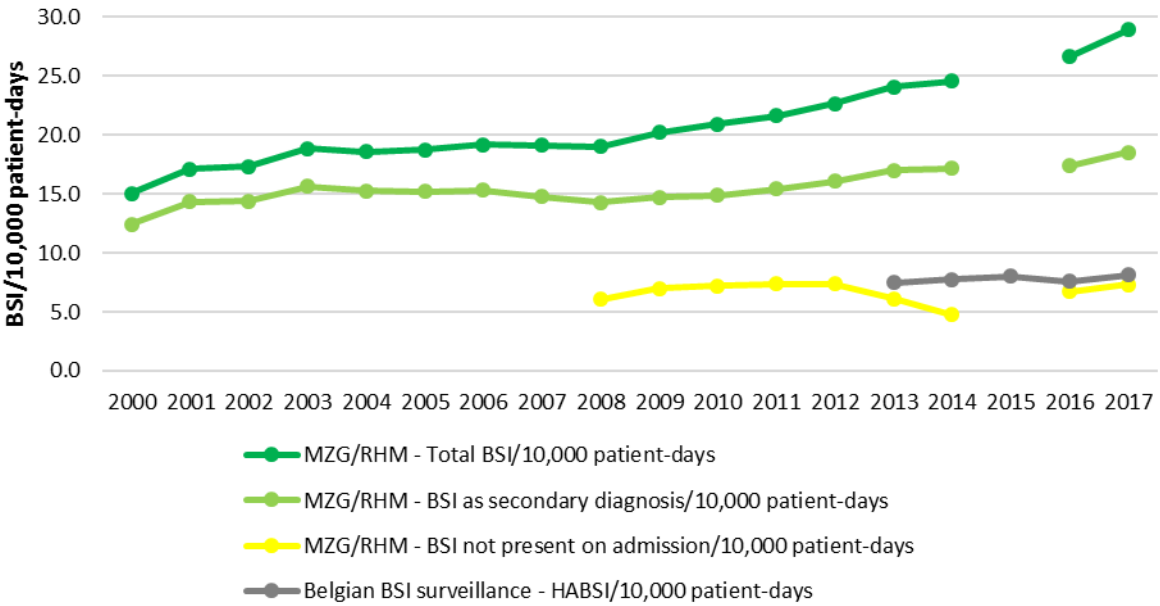


Figure 22: Incidence of bloodstream infections in Belgium, results from minimum hospital data (MZG/RHM) and Belgian bloodstream infection surveillance, 2000-2017 (BSI, bloodstream infection; HABSI, hospital-associated bloodstream infection)

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 (Table 23 and Figure 22). This 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. However, for the two most recent years, 2016 and 2017, for which we have data from both sources this difference in incidences is smaller than what we found in the previous years. Based on this finding it might be considered to further investigate if the objectives of the surveillance of bloodstream infections in Belgian hospitals cannot be answered by the data collected through MZG/RHM.

Table 23: Incidence of bloodstream infections in Belgium, results from minimum hospital data versus surveillance data, 2000-2017

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Minimum hospital data (minimale ziekenhuisgegevens/ résumé hospitalier minimum)																		
Total BSI[1] (n)	24,985	28,595	28,516	29,814	28,921	29,062	29,484	29,008	29,229	30,653	31,620	32,691	33,877	35,400	35,362	NA	38,262	40,517
Total BSI/1,000 admissions[2]	13.4	15.3	15.4	16.1	15.6	15.6	15.7	15.4	15.3	15.9	16.3	16.7	17.2	18.0	17.9	NA	19.1	20.3
Total BSI/10,000 patient-days[3]	15.0	17.1	17.3	18.8	18.6	18.8	19.2	19.1	19.0	20.2	20.9	21.6	22.6	24.1	24.6	NA	26.6	28.9
BSI as secondary diagnosis[4] (n)	20,613	23,995	23,697	24,723	23,793	23,588	23,554	22,425	21,948	22,321	22,517	23,301	24,038	24,969	24,731	NA	24,987	26,004
BSI as secondary diagnosis/1,000 admissions[2]	11.0	12.9	12.8	13.4	12.8	12.6	12.6	11.9	11.5	11.6	11.6	11.9	12.2	12.7	12.5	NA	12.5	13.0
BSI as secondary diagnosis/10,000 patient-days[3]	12.4	14.4	14.4	15.6	15.3	15.2	15.3	14.8	14.3	14.7	14.9	15.4	16.1	17.0	17.2	NA	17.4	18.5
BSI not present on admission[5] (n)									9,269	10,603	10,873	11,164	11,059	9,005	6,857	NA	9,613	10,276
BSI not present on admission/1,000 admissions[2]									4.9	5.5	5.6	5.7	5.6	4.6	3.5	NA	4.8	5.2
BSI not present on admission/10,000 patient-days[3]									6.0	7.0	7.2	7.4	7.4	6.1	4.8	NA	6.7	7.3
Surveillance of bloodstream infections in Belgian hospitals data																		
HABSI/1,000 admissions														5.4	5.6	5.7	5.2	5.4
HABSI/10,000 patient-days														7.5	7.8	8.0	7.6	8.1

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 bacteremia as main and secondary diagnosis [15]

[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) [14]

[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) [14]

[4] 'BSI as secondary diagnosis' includes admissions with septicaemia and bacteremia as secondary diagnosis [15]

[5] 'BSI not present on admission' includes admissions with septicaemia and bacteremia as diagnosis and labelled as 'not present on admissions' (MZG/RHM: M1 / Veld 9 => M1_PRESENT_ADM: code is N) [15]

4.2 OTHER SOURCES OF BELGIAN ANTIMICROBIAL RESISTANCE DATA

We compared antimicrobial resistance results 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* (Table 24) [16,17]. EARS-Net surveillance includes data on antimicrobial resistance from blood, cerebrospinal fluid and urine samples (community and hospital-acquired) from a sample of laboratories that voluntary participate. The surveillance of antimicrobial resistant bacteria in Belgian hospitals includes resistance data from a wide variety of clinical samples[32] (e.g. urine-, sputum-, stool-, blood-, and wound-sample) from community and hospital-acquired infections. For this comparison we use the 2017 data, being the most recent year for which data are available for all three data-sources.

The resistance proportions found are higher when only including hospital-associated infections. However, overall, the resistance data found by the three different surveillances are comparable and validate each other (Table 24).

[32] A clinical sample is a sample collected for diagnostic reasons in the presence of clinical signs

Table 24: Comparison of antimicrobial resistance data from three different surveillances, Belgium 2017

Microorganisms	Surveillance of BSI in Belgian hospitals (N hospitals = 105)[1]						Surveillance of resistant MO in Belgian hospitals (N hospitals = 102[3])			EARS-Net Belgium (N laboratories = 31)			EARS-Net Belgium (N laboratories = 24)		
	Blood samples - HABSI			Blood samples – non-HABSI[2]			Clinical samples – all sites - from hospital-associated and other infections[4]			Blood and cerebrospinal fluid samples from hospital-associated and other infections			Urine samples from hospital-associated and other infections		
Antibiotic markers	**N**	**nR**	**%R**	**N**	**nR**	**%R**	**N**	**nR**	**%R**	**N**	**nR**	**%R**	**N**	**nR**	**%R**
S. aureus															
Meti	886	116	13.3	298	24	8.1	33,477	4,831[5]	14.4	1,510	129	8.5	1,582	310	19.6
Gly R	886	6	0.7	298	2	0.7	NA	NA	NA	1,225	1[8]	0.1	1,422	1	0.1
E. coli															
C3G	1,915	303	15.8	1,082	102	9.4	62,900	5,053[5,6]	8.0	4,670	755	9.7	82,636	4,839	5.8
CAR	1,915	26	1.4	1,082	23	2.1	86,923	113[5,7]	0.13	4,670	1	0.0	82,460	17	0.0
K. pneumoniae															
C3G	651	184	28.3	155	24	15.6	12,470	2,253[5,6]	18.1	802	155	19.3	9,597	1,295	13.5
CAR	651	37	5.7	155	8	5.2	NA	NA	2.04[5,7]	790	9	1.1	9,531	36	0.4
P. aeruginosa															
CAR	419	63	15.0	62	7	11.3	NA	NA	NA	475	39	8.2	3,816	175	4.6
E. faecium															
Gly R	454	24	5.3	41	1	2.4	7,011	119[8]	1.69	417	23[8]	5.5	1,073	16[8]	1.5

BSI, bloodstream infection; C3G, third generation cephalosporins (cefotaxime, ceftriaxone, ceftazidime); CAR, carbapenems (imipenem, meropenem); Gly, glycopeptides (vancomycin, teicoplanin); EARS, European Antimicrobial Resistance Surveillance; HABSI, hospital-associated bloodstream infections; Meti, Methicillin; N, total number MO; nR, number resistant MO; NA, not available; R, resistant: %R, percent resistant MO

Notes:

[1] This surveillance includes the results of blood samples (blood cultures) of HABSI and non-HABSI. Hospitals identified by RIZIV/INAMI code.

[2] Non-HABSI are optionally reported in this surveillance.

[3] Hospitals identified by RIZIV/INAMI code

[4] This surveillance includes the results of all clinical samples (e.g. urine-, sputum-, stool-, blood-, and wound-sample) collected for diagnostic reasons in the presence of clinical signs and covers acute hospitals and long-term care facilities [16].

[5] Includes only cases from acute hospitals.

[6] Includes MO resistant to third and fourth generation cephalosporins

[7] Includes only resistance to meropenem

[8] Vancomycin resistant

5 Main findings

In 2018, 104 out of 107 (97%) eligible Belgians hospitals participated for at least one quarter in the BSI surveillance of which 58% participated throughout the year.

Our 2018 findings on HABSI in Belgian hospitals are very similar to the findings of the previous five years.

In 2018, for data covering the whole hospital, we found an incidence of 8.6 HABSI and of 2.0 CLABSI per 10,000 patient-days. There is no clear trend in these incidences since 2013. However, when comparing the 2018 HABSI incidence per 10,000 patient-days with this incidence found in 2013 there is a statistically significant increase in HABSI incidence. Comparing these two years (2013 and 2018) regarding HABSI incidence per 1,000 admissions and CLABSI incidences per 10,000 patient-days and per 1,000 admissions, no statistically significant changes were found. HABSI incidence was higher in tertiary hospitals and at ICU.

Although these incidences did not change much during the past five years we notice a large variability in the reported incidence of HABSI between hospitals. This variability remained substantial when we adjusted for hospital type. This suggests a potential for prevention although there is also a need for data validation.

Also the proportion of invasive device-associated BSI remains quite the same since 2013. In 2018 at hospital level, 39% of the HABSI were associated directly or indirectly with an invasive device (CL: 24%, peripheral and other catheter: 4%, urinary catheter: 9% and endotracheal tube: 3%). The most frequently isolated MO in HABSI was *E. coli* (21%) followed by *S. aureus* (11%) and *S. epidermidis* (9%). The incidence of HABSI with *S. aureus* as causal MO did not chance substantially since 2000 but doubled for HABSI with *K. pneumoniae* as causal MO. Also the incidence of HABSI with *E. faecium* doubled since 2013. Eleven percent of the *S. aureus* isolates were methicillin-resistant (MRSA). Resistance to third-generation cephalosporins was reported in 16% of *E. coli* isolates, 35% of *K. pneumoniae* and 39% *E. cloacae* isolates. Carbapenem resistance was reported in 4% of *K. pneumoniae*, 14% of *P. aeruginosa* and 7% of *A. baumannii* isolates. Since 2013, methicillin-resistance in *S. aureus* decreased. For none of the studied MO resistance to carbapenems increased.

In 2018, the incidence of ICU-associated BSI was 29.2 per 10,000 patient-days and the incidence of ICU-associated CLABSI was 10.6 per 10,000 patient-days. Sixty-one % of the ICU-associated BSI were associated directly or indirectly with an invasive device (CL: 37%, peripheral and other catheter: 3%, urinary catheter: 6% and endotracheal tube: 15%). Similar to what we found hospital-wide, the three most frequently isolated MO in ICU-associated BSI were *E. coli* (11%), *S. aureus* (10%) and *S. epidermidis* (12%). For most MO, the proportion of resistant strains isolated from the ICU-associated BSI are similar to the proportion found hospital-wide. Nine percent of the *S. aureus* isolates were methicillin-resistant (MRSA). Resistance to third-generation cephalosporins was reported in 21% of *E. coli* isolates, 41% of *K. pneumoniae* and 42% *E. cloacae* isolates. Of notice, carbapenem resistance in ICU was reported in 7% of *K. pneumoniae* and 18% of *P. aeruginosa* isolates.

Findings on the incidence of HABSI and on antimicrobial resistance found using MZG/RHM data and reported by other Belgian surveillances on antimicrobial resistance are comparable to our findings.

6 General comments

2018 was the first year in which the BSI surveillance data collection for the whole year was only possible through Healthdata. Very positive is to notice that all hospitals managed to submit data using this new data registration tool. In 2018, reports based on the approved submitted data became available on the Healthdata reporting platform called Healthstat (https://www.healthstat.be/) where individual hospital reports (hospitals have only access to the reports reporting on findings of their own hospital) are available. At present for the BSI surveillance three reports at individual hospital level are consultable, being; (1) '*Absolute number and incidence of hospital-associated bloodstream infections: tables and graphs*', (2) '*Incidence of hospital-associated bloodstream infections: funnel plot*', and (3) '*Description of hospital-associated bloodstream infection episodes: tables and graph*'. Reports on incidence of hospital-associated bloodstream infection per MO and on MO resistance profile and reports with box-plots on incidence of hospital-associated bloodstream infections will follow as well as reports with data at national level. The latter will be, in contrast with the confidential feedback reports at individual hospital level, publically available on Healthstat.

Overall the 2019 report findings are very similar to those of the 2018 report which was published at the end of last year [18]. Because of the short time period between the publication of these 2018 and 2019 reports and these similar surveillance findings, reflections and comments made in the discussion of the 2018 report are still valid and no full discussion is added to this 2019 report. Only some general comments and reflections were added that can be find below in this chapter [18].

HABSI and CLABSI incidence at national level seems not to change really during the last six years. This finding underlines a really pressing need for additional research and action to gain additional knowledge on why this incidence is not decreasing and what could/should be done to decrease this incidence. Because of this our unit plans following two initiatives to be executed in autumn and winter this year:

- Study if same hospitals and same ICU have high or low HABSI and/or CLABSI incidences throughout the previous 6 years (since 2013) and study the reason why this is the case in order to be able to advise more focussed on actions for improvement.
- Conduct additional validation of the BSI surveillance data by comparing this data with the MZG/RHM data and assess possibilities to use MZG/RHM data to answer the BSI surveillance objectives.

7 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. More focus on infection prevention and control in pre-service training (medical and nursing schools) and having infection control physicians as an recognised speciality in Belgium would be helpful in this context.
- 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.
- Support the organisation of BSI surveillance data validation and the assessment on why the HABSI incidence did not changed during the past five years. This validation and assessment can be conducted by Sciensano.
- Continue to support a national organised surveillance of HABSI to assess changes in HABSI incidence at national and hospital level.

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. For this, 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.

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

- Validation of surveillance data. Comparing, at hospital and ICU level, data from the surveillance with data received through the MZG/RHM could be a first step in this validation.
- Assess reasons why there was no decline in HABSI incidence in Belgian hospitals at national level during the past six years. 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 the reason for this difference.
- The at present in the BSI surveillance asked antibiotic resistance data is not useful and relevant for the Belgian context and should be streamlined with the recommendation on antibiotic resistance testing given by the Superior Health Council. Because of this and because resistance data is already asked in other surveillances coordinated by Sciensano this data should not be asked again as part of the BSI surveillance and considered to be removed from the BSI surveillance.
- Continue implementing the continuous surveillance of BSI in Belgian hospitals which includes a yearly update of protocol and data collection tool.
- Further improve the Healthdata data collection and reporting tool (Healthstat).

RECOMMENDATION

- Assess if data recording and reporting cannot be further simplified and streamlined in the future. In this frame it would be useful to assess if data collected through other channels (e.g. MZG/RHM) could serve to answer the objectives of the surveillance of BSI in Belgian hospitals.

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10 Annexes

1. CALCULATION OF INCIDENCES

Table 25: 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 2018, in Brussels about one third, in Wallonia half and in Flanders two third of the hospitals participated in the BSI-surveillance the whole year.

Table 26: Participation in the surveillance of bloodstream infections in Belgian hospitals by region, 2018

	N hospitals participating (% of hospitals on total number of hospitals that should participate: Brussels N=14, Flanders N=56, Wallonia N=37)*		
N participating quarters	Brussels	Flanders	Wallonia
At least 1 quarter	**12 (86)**	**55 (98)**	**37 (100)**
1 quarter	3 (21)	12 (21)	12 (32)
2 quarters	3 (21)	2 (4)	4 (11)
3 quarters	1 (7)	3 (5)	2 (5)
4 quarters (whole year)	5 (36)	38 (68)	19 (51)

N, number

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

3. INCIDENCE OF HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS BY REGION

Table 27: Incidence of hospital-associated bloodstream infections by region, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Brussels						
N hospitals included in calculation of incidence*	11	11	12	12	10	12
N HABSI	1,586	1,686	1,741	1,635	1,461	1,580
Cumulative incidence per 1,000 admissions						
mean**	7.8	7.4	7.8	7.0	8.1	8.3
median***	8.1	6.8	8.1	7.2	7.6	8.1
Incidence density per 10,000 patient-days						
mean**	10.6	10.2	11.0	9.6	11.3	12.0
median***	9.4	9.3	11.3	9.2	8.9	10.3
Flanders						
N hospitals included in calculation of incidence*	48	55	56	56	51	54
N HABSI	2,477	3,702	4,300	4,300	3,553	4,293
Cumulative incidence per 1,000 admissions						
mean**	4.3	5.0	5.1	4.7	4.9	5.5
median***	4.3	4.2	4.4	4.4	4.5	4.5
Incidence density per 10,000 patient-days						
mean**	6.1	7.0	7.4	7.1	7.7	8.2
median***	6.0	6.1	6.1	6.4	6.7	6.8
Wallonia						
N hospitals included in calculation of incidence*	30	33	36	38	34	37
N HABSI	1,531	1,588	1,848	1,914	1,497	1,883
Cumulative incidence per 1,000 admissions						
mean**	6.0	5.8	5.7	5.4	5.0	5.1
median***	5.8	5.0	5.4	5.1	4.5	4.6
Incidence density per 10,000 patient-days						
mean**	8.0	7.6	7.7	7.5	7.0	7.6
median***	8.0	7.0	7.0	6.7	6.7	6.7

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 28: Incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Non-tertiary hospital						
N hospitals included in calculation of incidence*	66	73	77	79	72	77
N HABSI	3,185	3,639	4,017	4,288	3,420	4,195
mean incidence 1,000 admissions**	4.9	4.7	4.4	4.4	4.4	4.6
mean incidence 10,000 patient-days**	6.9	6.6	6.4	6.4	6.5	7.0
Tertiary hospital						
N hospitals included in calculation of incidence*	23	26	27	27	23	26
N HABSI	2,409	3,337	3,872	3,561	3,091	3,561
mean incidence 1,000 admissions**	6.1	7.2	7.9	6.6	7.3	8.1
mean incidence 10,000 patient-days**	8.4	9.6	11.0	9.7	11.0	11.7

HABSI, hospital-associated BSI; N, number

Notes:

* Hospitals included when denominator of the participating quarter was available

** Total HABSI/total denominator

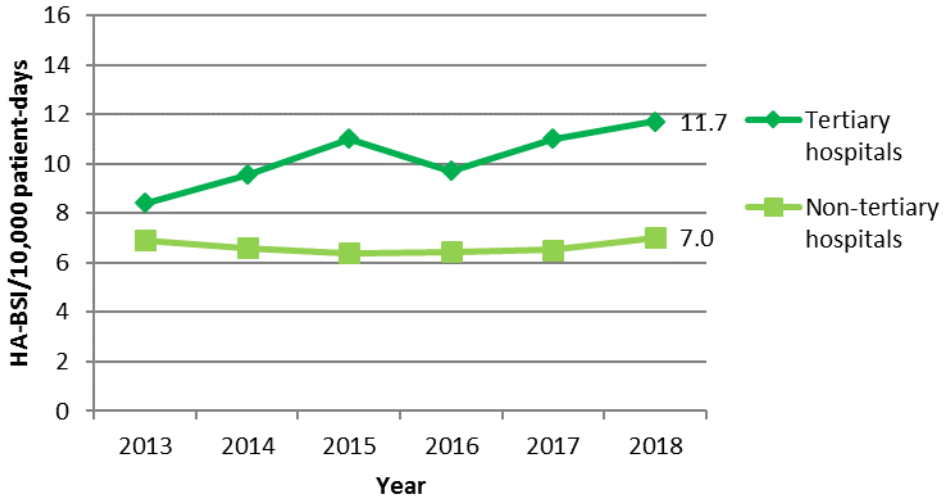

Table 29: Incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals by region, Belgium 2013-2018

	Brussels						Flanders						Wallonia					
Year	2013	2014	2015	2016	2017	2018	2013	2014	2015	2016	2017	2018	2013	2014	2015	2016	2017	2018
Non-tertiary hospital																		
N hospitals included in calculation of incidence*	4	4	5	5	4	5	39	45	46	46	43	45	23	24	26	28	24	27
N HABSI	376	395	373	359	182	282	1,766	2,299	2,565	2,698	2,423	2,858	1,033	945	1,077	1,231	812	1,055
*mean incidence 1,000 admissions***	5.3	4.5	4.6	3.8	3.9	4.3	4.4	4.4	4.1	4.3	4.5	4.7	6.1	5.4	5.2	5.1	4.1	4.4
*mean incidence 10,000 patient-days***	7.8	6.7	7.2	5.7	5.6	6.4	6.3	6.5	6.2	6.3	6.9	7.3	8.0	6.8	6.7	7.0	5.8	6.5
Tertiary hospital																		
N hospitals included in calculation of incidence*	7	7	7	7	6	7	9	10	10	10	7	9	7	9	10	10	10	10
N HABSI	1,210	1,291	1,368	1,276	1,279	1,298	701	1,403	1,733	1,602	1,127	1,435	498	643	771	683	685	828
*mean incidence 1,000 admissions***	9.1	9.2	9.6	9.1	9.7	10.4	4.0	6.2	7.5	5.6	6.1	7.8	5.8	6.6	6.7	6.0	6.6	6.4
*mean incidence 10,000 patient-days***	11.9	12.1	12.9	11.9	13.3	14.8	5.6	8.2	10.5	9.0	10.1	10.9	8.2	9.1	9.5	8.4	9.3	9.7

HABSI, hospital-associated BSI; N, number

Notes:

* Hospitals included when denominator of the participating quarter was available

** Total HABSI/total denominator

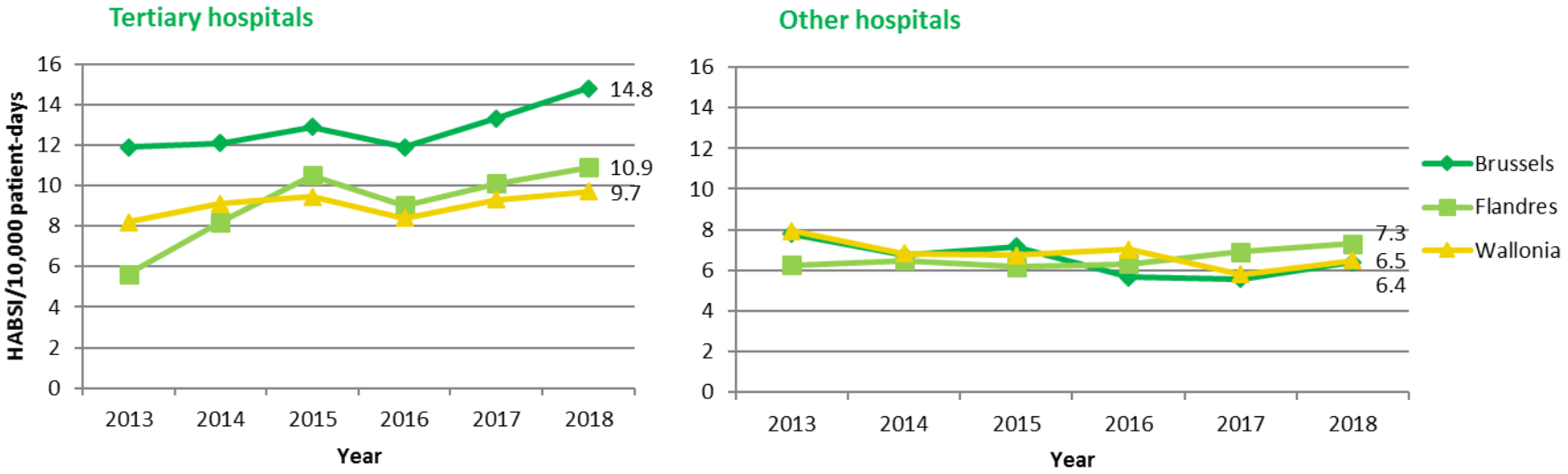

Figure 23: Mean incidence of hospital-associated bloodstream infections in tertiary and non-tertiary hospitals by region, Belgium 2013-2018 (HABSI, hospital-associated bloodstream infection)

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

Table 30: Central line-associated bloodstream infections, hospital-wide, according to classification (proportions)*, Belgium 2013-2018

Year	2013		2014		2015		2016		2017		2018	
CLABSI	N	%	N	%	N	%	N	%	N	%	N	%
Confirmed	623	41	776	42	921	43	749	42	660	37	761	39
Probable	459	30	604	33	743	35	611	34	608	34	637	33
Possible	425	28	473	26	465	22	442	25	533	30	556	28
Total	**1,507**	**100**	**1,853**	**100**	**2,129**	**100**	**1,802**	**100**	**1,801**	**100**	**1,954**	**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 31: Incidence of central line-associated bloodstream infections* in tertiary and non-tertiary hospitals, Belgium 2013-2018

Year	2013	2014	2015	2016	2017	2018
Non-tertiary hospital						
N hospitals included in calculation of incidence**	66	73	77	79	72	77
N CLABSI	709	801	912	782	652	852
mean incidence 10,000 patient-days***	1.5	1.5	1.5	1.2	1.2	1.4
Tertiary hospital						
N hospitals included in calculation of incidence**	23	26	27	27	23	26
N CLABSI	792	1,051	1,210	1,019	808	979
mean incidence 10,000 patient-days***	2.8	3.0	3.4	2.8	2.9	3.2

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 32: Intensive care unit-associated central line-associated bloodstream infections according to case definition (proportions)*, Belgium 2013-2018

Year	2013		2014		2015		2016		2017		2018	
CLABSI	N	%	N	%	N	%	N	%	N	%	N	%
Confirmed	177	37	205	40	222	39	188	35	171	34	214	35
Probable	128	27	134	26	189	33	173	32	159	32	184	30
Possible	170	36	174	34	159	28	174	33	174	35	216	35
Total	**475**	**100**	**513**	**100**	**570**	**100**	**535**	**100**	**504**	**100**	**614**	**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 33: Hospital-associated bloodstream infections by source and speciality, Belgium 2018

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**	128	10	644	35	406	19	8	12	389	35	53	51	244	21	82	12	1,954	24
Urinary tract infection	460	37	156	8	441	21	15	22	120	11	9	9	309	27	225	34	1,735	21
Gastro-intestinal infection	108	9	257	14	356	17	7	10	145	13	9	9	158	14	76	11	1,114	13
Pulmonary infection	111	9	384	21	203	10	1	1	56	5	4	4	50	4	50	7	859	10
Surgical site infection	18	1	68	4	42	2	3	4	5	0	1	1	143	13	45	7	325	4
Peripheral and other catheter	32	3	55	3	114	5	2	3	21	2	2	2	25	2	13	2	264	3
MBI	1	0	13	1	9	0	0	0	243	22	6	6	1	0	1	0	274	3
Invasive manipulation	6	0	7	0	30	1	0	0	8	1	0	0	24	2	20	3	95	1
Other secondary infections***	107	9	103	6	192	9	15	22	69	6	9	9	83	7	66	10	642	8
Unknown	256	21	152	8	330	16	16	24	69	6	11	11	106	9	90	13	1,030	12
Total	**1,227**	**100**	**1,839**	**100**	**2,123**	**100**	**67**	**100**	**1,125**	**100**	**104**	**100**	**1,143**	**100**	**668**	**100**	**8,296**	**100**

CL, central line; MBI, mucosal barrier injury

Notes:

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

** Includes confirmed, probable and possible CLABSI

*** Skin/soft tissue and other infections

9. INVASIVE DEVICE-ASSOCIATED HOSPITAL-ASSOCIATED BLOODSTREAM INFECTIONS

Table 34: Hospital-associated bloodstream infections associated with invasive devices, Belgium 2018

Invasive device	Confirmed N	Confirmed % total HABSI	Non-confirmed N	Non-confirmed % total HABSI	Total HABSI N	Total HABSI % total HABSI
CLABSI	761	21	1,193	25	1,954	24
Urinary tract infection with catheter	624	17	133	3	757	9
Pulmonary infection with ET/cannula	206	6	75	2	281	3
Peripheral/other catheter	86	2	178	4	264	3
Total invasive device associated HABSI	**1,677**	**47**	**1,579**	**33**	**3,256**	**39**
Total HABSI	**3,574**	**100**	**4,722**	**100**	**8,296**	**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 35: End-of-follow-up status of patients with diagnosed hospital-associated bloodstream infections, Belgium 2018

End-of-follow-up status	N	%
Died*	1,709	21
Still admitted	971	12
Discharged	4,000	48
Unknown	1,616	19

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 36: Microorganisms isolated as etiological agents for bloodstream infections, exhaustive list, Belgium 2018

	HABSI		CLABSI		Non-HABSI	
Microorganisms	**N**	**%**	**N**	**%**	**N**	**%**
Escherichia coli	1,885	21	99	5	912	39
Staphylococcus aureus	968	11	241	11	260	11
Staphylococcus epidermidis	858	9	590	28	63	3
Klebsiella pneumoniae	728	8	99	5	121	5
Enterococcus faecium	489	5	113	5	23	1
Pseudomonas aeruginosa	437	5	74	3	48	2
Enterococcus faecalis	420	5	82	4	83	4
Enterobacter cloacae	302	3	43	2	28	1
Candida albicans	287	3	131	6	14	1
Staphylococcus, coagulase negative (others or not specified)	232	3	153	7	13	1
Genus *Streptococcus* (others or not specified)	209	2	32	2	111	5
Klebsiella oxytoca	178	2	26	1	31	1
Proteus mirabilis	176	2	17	1	73	3
Candida glabrata	142	2	41	2	6	0
Serratia marcescens	118	1	21	1	9	0
Bacteroides fragilis	116	1	6	0	26	1
Enterobacter aerogenes	101	1	20	1	7	0
Genus *Acinetobacter* (others or not specified)	87	1	22	1	3	0
Genus *Morganella*	83	1	6	0	18	1
Streptococcus pneumoniae	82	1	3	0	154	7
Staphylococcus haemolyticus	76	1	51	2	4	0
Genus *Bacteroides* (others or not specified)	58	1	4	0	11	0
Genus *Klebsiella* (others or not specified)	58	1	4	0	3	0
Acinetobacter baumannii	55	1	14	1	3	0
Genus *Staphylococcus* (not specified)	55	1	28	1	14	1
Stenotrophomonas maltophilia	54	1	13	1	6	0
Genus *Clostridium* (others or not specified)	50	1	6	0	14	1
Genus *Enterococcus* (others or not specified)	47	1	7	0	12	1
Citrobacter freundii	43	0	6	0	9	0
Candida parapsilosis	38	0	22	1	1	0
Citrobacter koseri	34	0	5	0	6	0
Genus *Candida* (others or not specified)	33	0	16	1	0	0
Anaerobic bacteria (others or not specified)	32	0	4	0	24	1
Streptococcus agalactiae	30	0	5	0	33	1
Candida tropicalis	28	0	12	1	1	0
Genus *Bacillus*	22	0	10	0	4	0
Gram-positive coccus (others or not specified)	22	0	4	0	11	0
Genus *Lactobacillus*	21	0	8	0	3	0
Genus *Corynebacterium*	20	0	7	0	4	0
Genus *Enterobacter* (others or not specified)	18	0	1	0	4	0
Family Pseudomonadaceae (others or not specified)	17	0	3	0	1	0
Gram-negative bacillus (not specified)	17	0	5	0	16	1
Family Enterobacteriaceae (others or not specified)	16	0	1	0	3	0
Streptococcus pyogenes	16	0	0	0	29	1
Genus *Actinomyces*	15	0	3	0	4	0

Microorganisms	HABSI N	HABSI %	CLABSI N	CLABSI %	Non-HABSI N	Non-HABSI %
Bacterium (others or not specified)	14	0	1	0	3	0
Genus *Achromobacter*	12	0	5	0	1	0
Genus *Aeromonas*	12	0	2	0	2	0
Genus *Hafnia*	12	0	1	0	3	0
Genus *Prevotella*	12	0	1	0	2	0
Haemophilus influenzae	12	0	0	0	13	1
Gram-positive bacillus (others or not specified)	12	0	3	0	10	0
Acinetobacter Iwoffii	10	0	3	0	2	0
Candida krusei	10	0	2	0	0	0
Genus *Providencia*	10	0	1	0	7	0
Genus *Salmonella* (others or not specified)	10	0	0	0	8	0
Pantoea agglomerans	10	0	3	0	1	0
Yeast	10	0	6	0	1	0
Haemophilus parainfluenzae	8	0	1	0	0	0
Listeria monocytogenes	8	0	0	0	6	0
Genus Campylobacter	7	0	0	0	6	0
Serratia liquefaciens	7	0	4	0	0	0
Acinetobacter calcoaceticus	6	0	3	0	0	0
Genus *Citrobacter* (others or not specified)	6	0	1	0	6	0
Genus *Moraxella* (others or not specified)	6	0	2	0	0	0
Non-Enterobacteriaceae (others or not specified)	6	0	3	0	1	0
Proteus vulgaris	6	0	0	0	4	0
Genus *Proteus* (others or not specified)	5	0	0	0	0	0
Genus *Serratia* (others or not specified)	5	0	3	0	0	0
Moraxella catarrhalis	5	0	2	0	3	0
Streptococcus, group C	5	0	0	0	24	1
Genus *Nocardia*	4	0	0	0	0	0
Streptococcus, group G	4	0	0	0	5	0
Acinetobacter haemolyticus	3	0	1	0	0	0
Fungus (others or not specified)	3	0	0	0	0	0
Genus *Propionibacterium*	3	0	1	0	2	0
Neisseria meningitidis	3	0	0	0	5	0
Burkholderia cepacia	2	0	2	0	1	0
Genus *Flavobacterium*	2	0	0	0	0	0
Genus *Neisseria* (others or not specified)	2	0	1	0	0	0
Genus *Pasteurella*	2	0	0	0	3	0
Aspergillus fumigatus	1	0	0	0	0	0
Clostridium difficile	1	0	0	0	0	0
Cronobacter sakazakii	1	0	1	0	0	0
Genus *Alcaligenes*	1	0	1	0	1	0
Gram-negative coccus (others or not specified)	1	0	0	0	0	0
Genus *Haemophilus* (others or not specified)	0	0	0	0	2	0
Genus *Shigella*	0	0	0	0	1	0
Mycobacterium, non-tuberculosis	0	0	0	0	1	0
Salmonella Enteritidis	0	0	0	0	1	0
Salmonella Typhi (not specified)	0	0	0	0	3	0
Salmonella Typhimurium	0	0	0	0	1	0
Unidentified	17	0	8	0	2	0
Total	**9,049**	**100**	**2,120**	**100**	**2,354**	**100**

HABSI, hospital-associated bloodstream infection; N, number

12.MICROORGANISMS BY SUSPECTED SOURCE OF THE BLOODSTREAM INFECTION

Table 37: Microorganisms isolated from hospital-associated bloodstream infection by source, Belgian acute care hospitals, 2018

		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		**362**	**17**	**1,407**	**77**	**718**	**56**	**408**	**43**	**138**	**38**	**95**	**24**	**130**	**41**	**161**	**23**	**393**	**35**	**3,812**	**42**
	Escherichia coli	99	5	888	49	363	29	114	12	51	14	36	9	84	26	76	11	174	16	1,885	21
	Klebsiella pneumoniae	99	5	234	13	121	10	122	13	22	6	16	4	15	5	20	3	79	7	728	8
	Enterobacter cloacae	43	2	41	2	69	5	45	5	20	6	10	3	15	5	16	2	43	4	302	3
	Klebsiella oxytoca	26	1	40	2	34	3	30	3	6	2	8	2	7	2	4	1	23	2	178	2
	Proteus mirabilis	17	1	100	5	13	1	8	1	8	2	4	1	0	0	14	2	12	1	176	2
	Serratia marcescens	21	1	16	1	12	1	34	4	10	3	3	1	1	0	5	1	16	1	118	1
	Enterobacter aerogenes	20	1	19	1	20	2	19	2	9	2	5	1	1	0	5	1	3	0	101	1
	Other/not identified	37	2	69	4	86	7	36	4	12	3	13	3	7	2	21	3	43	4	324	4
Gram-positive cocci		**1,309**	**62**	**251**	**14**	**266**	**21**	**285**	**30**	**153**	**42**	**238**	**61**	**130**	**41**	**400**	**57**	**481**	**43**	**3,513**	**39**
	Staphylococcus aureus	241	11	50	3	16	1	131	14	66	18	91	23	17	5	200	28	156	14	968	11
	Staphylococcus epidermidis	590	28	17	1	10	1	5	1	17	5	81	21	6	2	46	7	86	8	858	9
	Enterococcus faecium	113	5	52	3	136	11	27	3	22	6	15	4	47	15	32	5	45	4	489	5
	Enterococcus faecalis	82	4	105	6	52	4	33	3	26	7	12	3	12	4	35	5	63	6	420	5
	Other/not identified	283	13	27	1	52	4	89	9	22	6	39	10	48	15	87	12	131	12	778	9
Non-fermenting Gram-negative bacilli		**152**	**7**	**97**	**5**	**74**	**6**	**181**	**19**	**26**	**7**	**28**	**7**	**23**	**7**	**54**	**8**	**115**	**10**	**750**	**8**
	Pseudomonas aeruginosa	74	4	85	5	42	3	114	12	21	6	15	4	13	4	35	5	38	3	437	5
	Other/not identified	78	4	12	1	32	3	67	7	5	1	13	3	10	3	19	3	77	7	313	3
Fungi		**230**	**11**	**53**	**3**	**81**	**6**	**52**	**6**	**12**	**3**	**22**	**6**	**13**	**4**	**34**	**5**	**55**	**5**	**552**	**6**
	Candida albicans	131	6	29	2	42	3	25	3	6	2	8	2	6	2	12	2	28	3	287	3
	Candida glabrata	41	2	13	1	29	2	17	2	5	1	9	2	3	1	10	1	15	1	142	2
	Other/not identified	58	3	11	1	10	1	10	1	1	0	5	1	4	1	12	2	12	1	123	1
Anaerobic bacilli		**22**	**1**	**8**	**0**	**120**	**9**	**7**	**1**	**27**	**7**	**3**	**1**	**15**	**5**	**36**	**5**	**34**	**3**	**272**	**3**
Gram-positive bacilli		**28**	**1**	**7**	**0**	**8**	**1**	**5**	**1**	**2**	**1**	**4**	**1**	**4**	**1**	**12**	**2**	**13**	**1**	**83**	**1**
Gram-negative cocci		**5**	**0**	**0**	**0**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**2**	**1**	**1**	**0**	**5**	**0**	**17**	**0**
Other and not identified		**4**	**0**	**0**	**0**	**6**	**0**	**3**	**0**	**3**	**1**	**3**	**1**	**2**	**1**	**6**	**1**	**23**	**2**	**50**	**1**
Total		**2,112**	**100**	**1,823**	**100**	**1,273**	**100**	**945**	**100**	**361**	**100**	**393**	**100**	**319**	**100**	**704**	**100**	**1,119**	**100**	**9,049**	**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 38: Antimicrobial resistance among hospital-associated bloodstream infections, Belgium 2013-2018

		Microorganisms																	
		2013			2014			2015			2016			2017			2018		
Antibiotics		**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**
Gram-positive cocci																			
S. aureus	Meti	685	144	21.0	844	147	17.4	967	148	15.3	899	146	16.2	886	118	13.3	968	102	10.5
	Gly	685	0	0.0	844	4	0.5	967	7	0.7	899	6	0.7	886	6	0.7	968	4	0.4
All Enterococcus spp.	Gly	555	15	2.7	712	19	2.7	804	23	2.9	813	28	3.4	903	37	4.1	956	34	3.6
E. faecalis	Gly	330	3	0.9	392	1	0.3	394	2	0.5	412	1	0.2	407	2	0.5	420	3	0.7
E. faecium	Gly	197	7	3.6	285	11	3.9	377	18	4.8	359	16	4.5	454	24	5.3	489	18	3.7
Enterobacteriaceae	C3G	2,616	547	20.9	3,197	722	22.6	3,526	813	23.1	3,805	833	21.9	3,720	759	20.4	3,812	875	23.0
	CAR	2,616	26	1.0	3,197	40	1.3	3,526	73	2.1	3,805	79	2.1	3,720	90	2.4	3,812	69	1.8
E. coli	C3G	1,349	190	14.1	1,599	266	16.6	1,784	308	17.3	1,893	286	15.1	1,915	303	15.8	1,885	299	15.9
	CAR	1,349	4	0.3	1,599	11	0.7	1,784	16	0.9	1,893	9	0.5	1,915	26	1.4	1,885	12	0.6
K. pneumoniae	C3G	382	99	25.9	515	161	31.3	588	206	35.0	685	235	34.3	651	184	28.3	728	257	35.3
	CAR	382	9	2.4	515	19	3.7	588	34	5.8	685	44	6.4	651	37	5.7	728	28	3.8
E. cloacae	C3G	223	98	43.9	249	96	38.6	312	116	37.2	325	119	36.6	311	117	37.6	302	117	38.7
	CAR	223	3	1.3	249	4	1.6	312	10	3.2	325	10	3.1	311	9	2.9	302	10	3.3
P. mirabilis	C3G	138	4	2.9	155	2	1.3	155	2	1.3	164	6	3.7	150	5	3.3	176	7	4.0
	CAR	138	0	0.0	155	1	0.6	155	1	0.6	164	2	1.2	150	1	0.7	176	1	0.6
K. oxytoca	C3G	124	25	20.2	167	32	19.2	210	43	20.5	183	37	20.2	187	21	11.2	178	27	15.2
	CAR	124	3	2.4	167	1	0.6	210	4	1.9	183	3	1.6	187	3	1.6	178	1	0.6
E. aerogenes	C3G	102	62	60.8	123	69	56.1	103	54	52.4	111	58	52.3	94	50	53.2	101	67	66.3
	CAR	102	4	3.9	123	2	1.6	103	1	1.0	111	4	3.6	94	3	3.2	101	3	3.0
Serratia spp.	C3G	104	23	22.1	149	38	25.5	112	21	18.8	136	24	17.6	150	28	18.7	130	28	21.5
	CAR	104	2	1.9	149	0	0.0	112	2	1.8	136	1	0.7	150	5	3.3	130	3	2.3
Non-fermenting Gram-negative bacilli																			
P. aeruginosa	CAR	319	55	17.2	399	66	16.5	402	59	14.7	399	63	15.8	419	63	15.0	437	63	14.4
A. baumannii	CAR	38	5	13.2	50	6	12.0	56	3	5.4	53	2	3.8	54	5	9.3	55	4	7.3
Acinetobacter spp.	CAR	105	5	4.8	140	11	7.9	152	6	3.9	122	3	2.5	138	8	5.8	161	7	4.3

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

Table 39: Hospitals with at least one resistant microorganism isolated from hospital-associated bloodstream infections, Belgium 2013-2018

		Hospitals with >= one resistant case*											
		2013 (N=91)		2014 (N=100)		2015 (N=106)		2016 (N=106)		2017 (N=105)		2018 (N=104)	
Microorganisms	**Antibiotics**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Gram-positive cocci													
S. aureus	Meti	55	60	59	59	64	60	62	58	50	48	54	52
	Gly	0	0	3	3	7	7	6	6	5	5	3	3
All Enterococcus spp.	Gly	12	13	15	15	17	16	17	16	22	21	22	21
E. faecalis	Gly	2	2	1	1	2	2	1	1	2	2	3	3
E. faecium	Gly	5	5	10	10	14	13	10	9	14	13	13	13
Enterobacteriaceae	C3G	79	87	89	89	99	93	96	91	93	89	96	92
	CAR	19	21	22	22	36	34	35	33	36	34	39	38
E. coli	C3G	62	68	68	68	75	71	77	73	72	69	75	72
	CAR	4	4	10	10	10	9	8	8	11	10	12	12
K. pneumoniae	C3G	39	43	53	53	56	53	62	58	60	57	63	61
	CAR	9	10	11	11	18	17	22	21	24	23	16	15
E. cloacae	C3G	41	45	40	40	52	49	54	51	53	50	48	46
	CAR	3	3	4	4	9	8	8	8	7	7	10	10
P. mirabilis	C3G	4	4	2	2	2	2	5	5	5	5	6	6
	CAR	0	0	1	1	1	1	2	2	1	1	1	1
K. oxytoca	C3G	21	23	21	21	25	24	29	27	18	17	19	18
	CAR	3	3	1	1	3	3	3	3	3	3	1	1
E. aerogenes	C3G	36	40	36	36	31	29	35	33	31	30	33	32
	CAR	3	3	2	2	1	1	4	4	3	3	3	3
Serratia spp.	C3G	16	18	22	22	16	15	19	18	23	22	20	19
	CAR	2	2	0	0	2	2	1	1	5	5	3	3
Non-fermenting Gram-negative bacilli													
P. aeruginosa	CAR	27	30	39	39	36	34	33	31	30	29	32	31
A. baumannii	CAR	5	5	3	3	3	3	2	2	5	5	3	3
Acinetobacter spp.	CAR	5	5	8	8	6	6	3	3	7	7	6	6

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

Table 40: Antimicrobial resistance in microorganisms isolated from hospital-associated and non-hospital-associated bloodstream infections, Belgium 2018

Microorganisms	Antibiotics	HABSI N	HABSI n	HABSI %	Non-HABSI N	Non-HABSI n	Non-HABSI %	Hospitals with >= one resistant case* - N=104 n	Hospitals with >= one resistant case* - N=104 %
Gram-positive cocci									
S. aureus	Meti	968	102	10.5	260	23	8.8	60	58
	Gly	968	4	0.4	260	2	0.8	3	3
All Enterococcus spp.	Gly	956	34	3.6	118	6	5.1	4	4
E. faecalis	Gly	420	3	0.7	83	1	1.2	25	24
E. faecium	Gly	489	18	3.7	23	0	0.0	13	13
Enterobacteriacea	C3G	3,812	875	23.0	1,259	129	10.2	99	95
	CAR	3,812	69	1.8	1,259	5	0.4	41	39
E. coli	C3G	1,885	299	15.9	912	84	9.2	81	78
	CAR	1,885	12	0.6	912	3	0.3	14	13
K. pneumoniae	C3G	728	257	35.3	121	12	9.9	64	62
	CAR	728	28	3.8	121	2	1.7	18	17
E. cloacae	C3G	302	117	38.7	28	9	32.1	49	47
	CAR	302	10	3.3	28	0	0.0	10	10
P. mirabilis	C3G	176	7	4.0	73	0	0.0	6	6
	CAR	176	1	0.6	73	0	0.0	1	1
K. oxytoca	C3G	178	27	15.2	31	4	12.9	22	21
	CAR	178	1	0.6	31	0	0.0	1	1
E. aerogenes	C3G	101	67	66.3	7	5	71.4	34	33
	CAR	101	3	3.0	7	0	0.0	3	3
Serratia spp.	C3G	130	28	21.5	9	3	33.3	22	21
	CAR	130	3	2.3	9	0	0.0	3	3
Non-fermenting Gram-negative bacilli									
P. aeruginosa	CAR	437	63	14.4	48	5	10.4	33	32
A. baumannii	CAR	55	4	7.3	3	0	0.0	3	3
Acinetobacter spp.	CAR	161	7	4.3	8	0	0.0	6	6

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 41: Resistance in microorganisms isolated from non-hospital-associated bloodstream infections by region, Belgium 2018

		Brussels			Flanders			Wallonia		
Microorganisms	**Antibiotics**	**N**	**n**	**%**	**N**	**n**	**%**	**N**	**n**	**%**
Gram-positive cocci										
S. aureus	Meti	75	5	7	105	9	9	80	9	11
	Gly	75	2	3	105	0	0	80	0	0
All Enterococcus spp.	Gly	36	0	0	49	4	8	33	2	6
E. faecalis	Gly	24	0	0	35	0	0	24	1	4
E. faecium	Gly	8	0	0	10	0	0	5	0	0
Enterobacteriaceae	C3G	366	38	10	535	57	11	358	34	9
	CAR	366	1	0	535	1	0	358	3	1
E. coli	C3G	254	26	10	395	35	9	263	23	9
	CAR	254	0	0	395	1	0	263	2	1
K. pneumoniae	C3G	43	6	14	48	4	8	30	2	7
	CAR	43	1	2	48	0	0	30	1	3
E. cloacae	C3G	7	3	43	16	5	31	5	1	20
	CAR	7	0	0	16	0	0	5	0	0
P. mirabilis	C3G	23	0	0	30	0	0	20	0	0
	CAR	23	0	0	30	0	0	20	0	0
K. oxytoca	C3G	9	0	0	13	3	23	9	1	11
	CAR	9	0	0	13	0	0	9	0	0
E. aerogenes	C3G	1	0	0	4	3	75	2	2	100
	CAR	1	0	0	4	0	0	2	0	0
Serratia spp.	C3G	4	1	25	2	1	50	3	1	33
	CAR	4	0	0	2	0	0	3	0	0
Non-fermenting Gram-negative bacilli										
P. aeruginosa	CAR	11	1	9	28	3	11	9	1	11
A. baumannii	CAR	0	0	0	2	0	0	1	0	0
Acinetobacter spp.	CAR	2	0	0	4	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 42: Hospitals with at least one resistant microorganism isolated from hospital-associated bloodstream infection by region, Belgium 2018

		Hospitals with >= one resistant case*					
		Brussels (N=12)		Flanders (N=55)		Wallonia (N=37)	
Microorganisms	**Antibiotics**	**n**	**%**	**n**	**%**	**n**	**%**
Gram-positive cocci							
S. aureus	Meti	9	75	24	44	21	57
	Gly	1	8	2	4	0	0
All Enterococcus spp.	Gly	2	17	13	24	7	19
E. faecalis	Gly	0	0	1	2	2	5
E. faecium	Gly	2	17	6	11	5	14
Enterobacteriaceae	C3G	12	100	49	89	35	95
	CAR	7	58	15	27	17	46
E. coli	C3G	8	67	40	73	27	73
	CAR	2	17	4	7	6	16
K. pneumoniae	C3G	10	83	28	51	25	68
	CAR	5	42	5	9	6	16
E. cloacae	C3G	7	58	25	45	16	43
	CAR	2	17	6	11	2	5
P. mirabilis	C3G	0	0	3	5	3	8
	CAR	0	0	1	2	0	0
K. oxytoca	C3G	5	42	10	18	4	11
	CAR	1	8	0	0	0	0
E. aerogenes	C3G	5	42	17	31	11	30
	CAR	1	8	2	4	0	0
Serratia spp.	C3G	0	0	7	13	13	35
	CAR	0	0	1	2	2	5
Non-fermenting Gram-negative bacilli							
P. aeruginosa	CAR	6	50	15	27	11	30
A. baumannii	CAR	2	17	1	2	0	0
Acinetobacter spp.	CAR	2	17	2	4	2	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; R, resistant; spp., species

Note:

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

CONTACT
Els Duysburgh • els.duysburgh@sciensano.be • T +32 2 642 57 44

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