

Health-care-associated infections in neonates, children, and adolescents: an analysis of paediatric data from the European Centre for Disease Prevention and Control point-prevalence survey

ECDC PPS study group

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Supplementary table 1: Definitions of healthcare-associated infections for neonates, bloodstream infections and clinical sepsis – Paediatric data, standard protocol, ECDC point prevalence survey 2011-2012

BSI: BLOODSTREAM INFECTION

BSI: Laboratory-confirmed bloodstream infection

One positive blood culture for a recognised pathogen
or
patient has at least one of the following signs or symptoms: fever (> 38 °C), chills, or hypotension
and
two positive blood cultures for a common skin contaminant (from two separate blood samples, usually within 48 hours)

Skin contaminants: coagulase-negative staphylococci (including *S. epidermidis*), *Micrococcus* spp., *Propionibacterium acnes*, *Bacillus* spp., *Corynebacterium* spp.

- Primary bloodstream infections include catheter-related BSI and BSI of unknown origin.
- A CVC-associated bloodstream infection according to CDC/NHSN definitions (different from CVC-related BSI) is a primary BSI with central vascular catheter use (even intermittent) in the 48 hours preceding the onset of the infection: therefore the presence of 'the relevant device' (central/peripheral vascular catheter) in the 48 hours before onset of infection is collected even in the absence of microbiological confirmation

CRI: CATHETER-RELATED INFECTION

CRI1-CVC: local CVC-related infection (no positive blood culture)

Quantitative CVC culture $\geq 10^3$ CFU/ml (1) or semi-quantitative CVC culture > 15 CFU
and
pus/inflammation at the insertion site or tunnel

CRI1-PVC: local PVC-related infection (no positive blood culture)

Quantitative PVC culture $\geq 10^3$ CFU/ml or semi-quantitative PVC culture > 15 CFU
and
pus/inflammation at the insertion site or tunnel

CRI2-CVC: General CVC-related infection (no positive blood culture)

Quantitative CVC culture $\geq 10^3$ CFU/ml or semi-quantitative CVC culture > 15 CFU
and
clinical signs improve within 48 hours after catheter removal

CRI2-PVC: General PVC-related infection (no positive blood culture)

Quantitative PVC culture $\geq 10^3$ CFU/ml or semi-quantitative PVC culture > 15 CFU
and
clinical signs improve within 48 hours after catheter removal

CRI3-CVC: microbiologically confirmed CVC-related bloodstream infection

BSI occurring 48 hours before or after catheter removal
and
positive culture with the same microorganism of either:
- quantitative CVC culture $\geq 10^3$ CFU/ml or semi-quantitative CVC culture > 15 CFU
- quantitative blood culture ratio CVC blood sample/peripheral blood sample > 5 (3)

- differential delay of positivity of blood cultures (4): CVC blood sample culture positive two hours or more before peripheral blood culture (blood samples drawn at the same time)
- positive culture with the same microorganism from pus from insertion site

CRI3-PVC: microbiologically confirmed PVC-related bloodstream infection

BSI occurring 48 hours before or after catheter removal

and

positive culture with the same microorganism of either:

- quantitative PVC culture $\geq 10^3$ CFU/ml or semi-quantitative PVC culture > 15 CFU
- positive culture with the same microorganism from pus from insertion site

- Central vascular catheter colonisation should not be reported
- A CRI3 (-CVC or -PVC) is also a bloodstream infection with source C-CVC or C-PVC respectively; however: when a CRI3 is reported, the BSI should not be reported in the point prevalence survey; microbiologically confirmed catheter-related BSI should be reported as CRI3

SYS: SYSTEMIC INFECTIONS

SYS-CSEP: clinical sepsis in adults and children

Patient has at least one of the following criteria:

- clinical signs or symptoms with no other recognised cause
- fever (38 °C)
- hypotension (systolic pressure < 90 mm)
- or oliguria (20 cm³ (ml)/hour)

and

- blood culture not done or no organisms or antigen detected in blood

and

- no apparent infection at another site

and

- physician institutes treatment for sepsis

- Do not use this code unless absolutely needed (last-resort definition)
- For CSEP in neonates, use NEO-CSEP case definition (see below)

NEO: SPECIFIC NEONATAL CASE DEFINITIONS

NEO-CSEP: clinical sepsis in neonates

All of the three following criteria:

- supervising physician started appropriate antimicrobial therapy for sepsis for at least five days
- no detection of pathogens in blood culture or not tested
- no obvious infection at another site

and

two of the following criteria (without other apparent cause):

- fever (> 38 °C) or temperature instability (frequent post-set of the incubator) or hypothermia (< 36.5 °C)
- tachycardia (> 200 /min) or new /increased bradycardia (< 80 /min)
- capillary refilling time (CRT) > 2 s
- new or increased apnoea(s) (> 20 s)
- unexplained metabolic acidosis
- new-onset hyperglycemia (> 140 mg/dl)
- another sign of sepsis (skin colour (only if the CRT is not used), laboratory signs (CRP, interleukin), increased oxygen requirement (intubation), unstable general condition of the patient, apathy)

A one-time detection of coagulase-negative staphylococci (CNS) in blood cultures should not exclude the diagnosis of clinical sepsis. A clinical sepsis can also be diagnosed with a single positive blood culture with CNS, which is considered as a blood culture contamination, while other criteria of CNS bloodstream infection are not met and criteria of clinical sepsis have been met.

NEO-LCBI: laboratory-confirmed BSI

At least two of:

- temperature > 38 °C or < 36.5 °C or temperature instability
- tachycardia or bradycardia,
- apnoea

- In order to be consistent with BSI reporting in adults (including secondary BSI), the criterion 'the organism is not related to an infection at another site' was removed from the Neo-KISS definition for the purposes of the ECDC PPS
- Report the origin of the neonatal BSI in the field BSI origin

- extended capillary refilling time (CRT)
- metabolic acidosis
- hyperglycaemia
- other sign of BSI such as apathy;

and

- a recognised pathogen other than coagulase-negative staphylococci (CNS) cultured from blood or cerebrospinal fluid (CSF; this is included because meningitis in this age group is usually haematogenous, so positive CSF can be regarded as evidence of BSI even if blood cultures are negative or were not taken)

NEO-CNSB: laboratory-confirmed BSI with coagulase-negative staphylococci (CNS)

At least two of:

- temperature > 38 °C or < 36.5 °C or temperature instability
- tachycardia or bradycardia,
- apnoea
- extended capillary refilling time (CRT)
- metabolic acidosis
- hyperglycaemia
- other sign of BSI such as apathy;

and

- CNS is cultured from blood or catheter tip;

and

patient has one of:

- C-reactive protein > 2.0 mg/dL
- immature/total neutrophil ratio (I/T ratio) > 0.2
- leukocytes < 5/nL
- platelets <100/nL

NEO-PNEU: pneumonia

Respiratory compromise

and

new infiltrate, consolidation or pleural effusion on chest x-ray;

and

at least four of:

- temperature > 38 °C or < 36.5 °C or temperature instability
- tachycardia or bradycardia
- tachypnoea or apnoea
- dyspnoea
- increased respiratory secretions
- new onset of purulent sputum
- isolation of a pathogen from respiratory secretions
- C-reactive protein > 2.0 mg/dL
- I/T ratio >0.2

- If both the case definitions for NEO-LCBI and NEO-CNSB are matched, report NEO-LCBI

- Report the origin of the neonatal BSI in the field BSI origin

- If both the case definitions for NEO-LCBI and NEO-CNSB are matched, report NEO-LCBI

NEO-NEC: necrotising enterocolitis

Histopathological evidence of necrotising enterocolitis

or

at least one characteristic radiographic abnormality (pneumoperitoneum, pneumatosis intestinalis, unchanging 'rigid' loops of small bowel)

and

at least two of the following without other explanation:

- vomiting
- abdominal distention
- prefeeding residuals
- persistent microscopic or gross blood in stools

BSI = bloodstream infection; CFU = colony forming unit; CNSB = coagulase negative staphylococcus bacteraemia; CDC = US Center for Disease Control and Prevention; CNS = coagulase negative staphylococci; CRI = catheter-related infection; CRT = capillary refilling time; CSEP = clinical sepsis; CVC = central venous catheter; ECDC = European Centre for Disease Prevention and Control; LCBI = laboratory-confirmed bloodstream infection; NEC = necrotizing enterocolitis; NEO = neonatology; NHSN = National Healthcare Safety Network; PNEU = pneumonia; PPS = point prevalence survey; PVC = peripheral venous catheter; SYS = systemic infection

Supplementary table 2: Prevalence of children with one or more healthcare-associated infections – Paediatric data, ECDC point prevalence survey 2011-2012

Country	Healthcare-associated infections (N)	Children (N)	HAI prevalence *(95 % confidence interval)
Poland	97	934	10.4 % (7.6-14.1)
Finland	33	413	8.0 % (5.4-11.8)
Cyprus	9	116	7.8 % (6.2-9.7)
Iceland	3	39	7.7 % (3.7-15.3)
Croatia	28	432	6.5 % (4.1-10.1)
Netherlands	33	529	6.2 % (3.7-10.3)
Estonia	6	100	6.0 % (1.6-19.7)
Greece	44	744	5.9 % (3.2-10.6)
Spain	47	882	5.3 % (3.0-9.3)
Luxemburg	3	63	4.8 % (1.7-12.6)
Portugal	31	670	4.6 % (3.0-7.0)
Belgium	42	936	4.5 % (2.5-7.9)
United Kingdom	121	2857	4.2 % (3.2-5.6)
Malta	3	71	4.2 % (4.1-4.4)
Hungary	35	878	4.0 % (2.9-5.6)
Norway	4	115	3.5 % (1.4-8.6)
Denmark	1	30	3.3 % (1.0-10.7)
Austria	7	210	3.3 % (1.1-10.0)
Latvia	11	336	3.3 % (1.6-6.6)
Bulgaria	37	1193	3.1 % (1.8-5.4)
Slovenia	17	617	2.8 % (1.7-4.5)
France	10	367	2.7 % (1.2-6.1)
Ireland	21	801	2.6 % (1.7-4.1)
Slovakia	28	1073	2.6 % (0.9-7.7)
Lithuania	14	619	2.3 % (1.2-4.3)
Italy	25	1166	2.1 % (1.5-3.2)
Romania	8	471	1.7 % (0.6-5.1)
Germany	4	280	1.4 % (0.2-8.6)
Czech Republic	4	331	1.2 % (0.6-2.4)

*95% confidence interval using two nested levels of clustering at the hospital level and country level; ECDC = European Centre for Disease Prevention and Control

Supplementary table 3: Predicted HAI prevalence among clinical settings and according to the number of children a hospital included in the survey – Paediatric data, standard protocol, ECDC point prevalence survey 2011-2012

	Prevalence (%)	95%CI
Clinical setting		
Paediatric intensive care	18.6	13.0-25.9
Neonatal intensive care	12.6	10.6-14.9
Neonatology	3.8	3.7-5.3
Paediatric surgery	3.8	2.3-6.1
General paediatrics	2.2	1.4-3.4

95%CI: 95% confidence interval; ECDC: European Centre for Disease Prevention and Control; HAI: healthcare-associated infection

Supplementary table 4: Distribution of case-mix indicators compared to the number of children enrolled by the hospitals – Paediatric data, standard protocol, ECDC point prevalence survey 2011-2012

	Number of children enrolled in the survey				P-value
	≤25	26-40	41-70	>70	
McCabe classification					
Nonfatal	3846 (90.2%)	3287 (87.5%)	3586 (83.6%)	3159 (80.4%)	<0.001
Ultimately fatal	13 (0.3%)	22 (0.6%)	54 (1.3%)	24 (0.6%)	
Rapidly fatal	59 (1.4%)	70 (1.9%)	100 (2.3%)	158 (4.0%)	
Clinical setting					
Neonatal intensive care	258 (6.1%)	518 (13.8%)	704 (16.4%)	658 (16.8%)	<0.001
Paediatric intensive care	102 (2.5%)	148 (4.0%)	246 (5.7%)	268 (6.9%)	
General paediatrics	2760 (64.8%)	1915 (51.0%)	1632 (38.0%)	1549 (39.4%)	
Neonatology	1040 (24.4%)	1011 (26.9%)	1277 (29.8%)	853 (21.7%)	
Paediatric surgery	102 (2.4%)	166 (4.4%)	431 (10.1%)	599 (15.3%)	
Presence of an invasive medical device					
None	2548 (59.8%)	2247 (59.8%)	2323 (54.1%)	1976 (50.3%)	<0.001
1 device	1664 (39.0%)	1362 (36.2%)	1653 (38.5%)	1654 (42.1%)	
2 devices	39 (0.9%)	101 (2.7%)	215 (5.0%)	190 (4.8%)	
≥devices	11 (0.3%)	48 (1.3%)	99 (2.3%)	107 (2.7%)	
Length of stay (days)*					
<4	2135 (49.5%)	1703 (45.3%)	1869 (43.6%)	1430 (36.4%)	<0.001
4-7	1247 (28.9%)	1033 (27.5%)	1069 (24.9%)	1061 (27.0%)	
8-14	467 (10.8%)	471 (12.5%)	575 (13.4%)	604 (15.4%)	
>14	465 (10.8%)	551 (14.7%)	777 (18.1%)	832 (21.2%)	

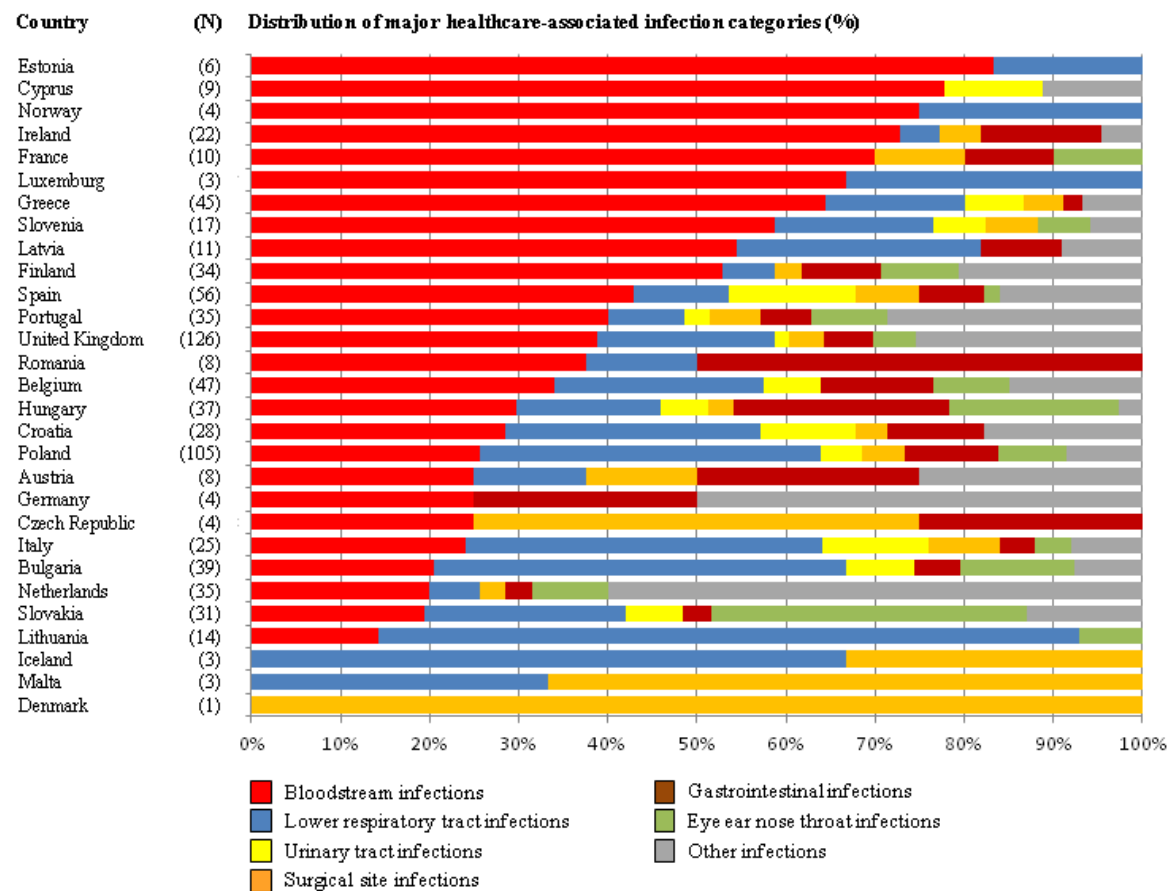
*Before and including the day of the point prevalence survey

Supplementary table 5: Distribution of the major types of healthcare-associated infection, by country – Paediatric data, ECDC point prevalence survey 2011-2012

Country	HAI N	BSI N (%)	LCBI N (%)	UTI N (%)	SSI N (%)	GI N (%)	EENT N (%)	OTH N (%)
Austria	8	3 (37.5)	1 (12.5)	0 (0.0)	1 (12.5)	2 (25.0)	0 (0.0)	1 (12.5)
Belgium	47	20 (42.6)	11 (23.4)	3 (6.4)	0 (0.0)	6 (12.8)	4 (8.5)	3 (6.4)
Bulgaria	39	8 (20.5)	18 (46.2)	3 (7.7)	0 (0.0)	2 (5.1)	5 (12.8)	3 (7.7)
Croatia	28	13 (46.4)	8 (28.6)	3 (10.7)	1 (3.6)	3 (10.7)	0 (0.0)	0 (0.0)
Cyprus	9	8 (88.9)	0 (0.0)	1 (11.1)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Czech Republic	4	1 (25.0)	0 (0.0)	0 (0.0)	2 (50.0)	1 (25.0)	0 (0.0)	0 (0.0)
Denmark	1	0 (0.0)	0 (0.0)	0 (0.0)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)
Estonia	6	5 (83.3)	1 (16.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Finland	34	20 (58.8)	2 (5.9)	0 (0.0)	1 (2.9)	3 (8.8)	3 (8.8)	5 (14.7)
France	10	7 (70.0)	0 (0.0)	0 (0.0)	1 (10.0)	1 (10.0)	1 (10.0)	0 (0.0)
Germany	4	2 (50.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (25.0)	0 (0.0)	1 (25.0)
Greece	45	30 (66.7)	7 (15.6)	3 (6.7)	2 (4.4)	1 (2.2)	0 (0.0)	2 (4.4)
Hungary	37	12 (32.4)	6 (16.2)	2 (5.4)	1 (2.7)	9 (24.3)	7 (18.9)	0 (0.0)
Iceland	3	0 (0.0)	2 (66.7)	0 (0.0)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)
Ireland	22	16 (72.7)	1 (4.5)	0 (0.0)	1 (4.5)	3 (13.6)	0 (0.0)	1 (4.5)
Italy	25	6 (24.0)	10 (40.0)	3 (12.0)	2 (8.0)	1 (4.0)	1 (4.0)	2 (8.0)
Latvia	11	6 (54.5)	3 (27.3)	0 (0.0)	0 (0.0)	1 (9.1)	0 (0.0)	1 (9.1)
Lithuania	14	2 (14.3)	11 (78.6)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.1)	0 (0.0)
Luxembourg	3	2 (66.7)	1 (33.3)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Malta	3	0 (0.0)	1 (33.3)	0 (0.0)	2 (66.7)	0 (0.0)	0 (0.0)	0 (0.0)
Netherlands	35	11 (31.4)	2 (5.7)	0 (0.0)	1 (2.9)	1 (2.9)	3 (8.6)	17 (48.6)
Norway	4	3 (75.0)	1 (25.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Poland	105	29 (27.6)	40 (38.1)	5 (4.8)	5 (4.8)	11 (10.5)	8 (7.6)	7 (6.7)
Portugal	35	16 (45.7)	3 (8.6)	1 (2.9)	2 (5.7)	2 (5.7)	3 (8.6)	8 (22.9)
Romania	8	3 (37.5)	1 (12.5)	0 (0.0)	0 (0.0)	4 (50.0)	0 (0.0)	0 (0.0)
Slovakia	31	9 (29.0)	7 (22.6)	2 (6.5)	0 (0.0)	1 (3.2)	11 (35.5)	1 (3.2)
Slovenia	17	11 (64.7)	3 (17.6)	1 (5.9)	1 (5.9)	0 (0.0)	1 (5.9)	0 (0.0)
Spain	56	31 (55.4)	6 (10.7)	8 (14.3)	4 (7.1)	4 (7.1)	1 (1.8)	2 (3.6)
United Kingdom	126	69 (54.8)	25 (19.8)	2 (1.6)	5 (4.0)	7 (5.6)	6 (4.8)	12 (9.5)
Total	770	343 (44.6)	171 (22.2)	37 (4.8)	34 (4.4)	64 (8.3)	55 (7.1)	121 (15.7)

BSI: Bloodstream infection; EENT: Eye, ear, nose, throat infection; HAI: Healthcare-associated infection; GI: Gastrointestinal infection; LCBI: Lower respiratory tract infection; OTH: Other infection; SSI: Surgical site infection; UTI: Urinary tract infection

Supplementary figure 1: Distribution of the major types of healthcare-associated infection, by country – Paediatric data, ECDC point prevalence survey 2011-2012



Supplementary figure 2: Proportion of antimicrobial-resistant isolates for the major microorganisms documented in the survey (n=136) – Paediatric data, ECDC point prevalence survey 2011-2012

