Supplementary data

Table 1. International classification of diseases, 10th revision (ICD-10) codes used to identify hospital-treated infection

Hospital-diagnosed infectious diseases	ICD-10 codes
Miscellaneous bacterial infections	A20–A38, A42–A44, A48–A49, A65A79
Miscellaneous viral infections	A90–A99, B03–B09, B25–B34
Candidiasis and other fungal infections	B35–B49
Parasitic infections	B50–B89
Herpes simplex or zoster	B00–B02, G05.1I, G05.1M, H03.1F, H13.1M, H19.0D, H19.2D, H19.2J, H22.0C, H62.1B, G53.0, G63.0F
HIV	B20–B24
Tuberculosis	A15–A19
Atypical mycobacteria	A31
Bacteremia	A49.9, A39.4
Sepsis	A40–A41, B37.7, A32.7, A54.8G, A02.1, A22.7, A26.7, A42.7, A28.2B
Abscess	A06.5, A54.1, B43, D73.3, E06.0A, E23.6A, E32.1, G06, G07, H00.0A, H05.0A, H44.0A, H60.0, J34.0A, J36, J38.3D, J38.7G, J39.0, J39.1, J39.8A, J85.1, J85.2, J85.3, K04.6, K04.7, K11.3, K12.2, K13.0A, K14.0A, K20.9A, K35.3A, K35.3B, K57.0, K57.2, K57.4, K57.8, K61, K63.0, K65.0, K75.0, K81.0A, K85.8A, L02, L05.0, L05.9, M60.8A, M86.8A, M86.9A, N15.1, N34.0, N41.2, N45.0, N48.2, N49.2A, N61.9A, N61.9B, N70.0A, N70.0B, N71.0A, N73.0A, N73.0B, N73.2A, N73.2B, N73.3A, N73.5A, N73.8A, N73.8C, N75.1, N76.4, N76.8A (Except: A54.1B, B43.0, B43.8, B43.9, K57.0B, K57.0C, K57.2B, K57.2C, K57.4A, K65.0M, K65.0N, K65.0O, K65.0P)
Skin infections	A46, H01.0, H03, H60.0, H60.1, H60.2, H60.3, H62, K12.2, K13.0, K61, M72.6, L01, L08
Cellulitis	L03
Other skin infections (including carbuncle, furuncle, lymphadenitis, cutaneous abscess, cyst, and dermatitis)	J34.0, L00, L02, L04, L05, L06, L07, L30.3, L73.8
Eye infections	H00, H01.0, H03.0, H03.1, H04.3, H05.0, H06.1, H10, H13.0, H13.1, H15.0, H19.1, H19.2, H22.0, H32.0, H44.0, H44.1
Ear infections	H60, H61.0, H62.0, H62.1, H62.2, H62.3, H65, H66, H67.0, H67.1, H68, H70, H73.0, H75.0, H83.0, H94.0 (Except: H60.4, H60.4A, H605, H60.5B, H60.8, H608.A, H65.2, H65.3, H65.4, H65.4C, H66.1, H66.2, H66.3, H68.1, H70.1, H70.8)
Central nervous system infections (except meningococcal disease)	G00–G07, A80–A89
Meningitis	G00, G01, G02, G03, A32.1, A39.0, A17.0, A20.3, A87, A54.8D, A02.2C, B37.5, B00.3, B01.0, B02.1, B05.1, B26.1, B38.4
Gastrointestinal infections	A00–A09
Intra-abdominal infection	K35, K37, K57.0, K57.2, K57.4, K57.8, K61, K63.0, K65.0, K65.9, K67, K75.0, K75.1, K80.0, K80.3, K80.4, K81.0, K81.9, K83.0, K85.9
Viral hepatitis	B15–B19
Heart infections (acute rheumatic fever, infectious pericarditis or myocarditis, endocarditis)	I30.1, I32.0, I33, I38, I40.0, I39.8, B37.6
Upper respiratory tract infection	J00–J06, J36, J39.0, J39.1
Influenza	J10–J11
Pneumonia	J12–J18
Other lower respiratory tract infections	J20–J22, J44.0, J85.1, J86, J20–J22, J34.0, J35.0, J38.3C, J38.3D, J38.7B, J38.7F, J38.7G (Except: J34.0E, J34.0F, J34.0G, J34.0H)
Sexually transmitted diseases	A50–A64
Male genital infections (prostatitis, orchitis, epididymitis)	N41, N45, N48.1, N48.2, N49, N51.1, N51.2
Female pelvic infections (salpingo-oophoritis, uterine infections, vulvovaginitis)	N70–N77
Septic arthritis, osteomyelitis, myositis	M00, M01, M86, M63.0, M63.2
Infectious complications of procedures, catheters etc.	T80.2, T81.4, T82.6, T82.7, T83.5, T83.6, T84.5, T84.6, T84.7, T85.7, T88.0, T89.9
Other infections or sequelae	B90–B99, K04.0, K05.2

Table 2. International classification of diseases, 10th revision (ICD-10) codes used to identify hospital-treated infection. Values are number of events   (% of population)

Hospital-diagnosed infectious diseases	n (%)
Miscellaneous bacterial infections	260 (0.88)
Miscellaneous viral infections	9 (0.03)
Candidiasis and other fungal infections	140 (0.47)
Parasitic infections	≤ 5 (−)
Herpes simplex or zoster	14 (0.05)
HIV	≤ 5 (−)
Tuberculosis	≤ 5 (−)
Atypical mycobacteria	≤ 5 (−)
Bacteremia	214 (0.72)
Sepsis	522 (1.76)
Abscess	64 (0.22)
Skin infections	148 (0.50)
Cellulitis	6 (0.02)
Other skin infections (including carbuncle, furuncle, lymphadenitis, cutaneous abscess, cyst, and dermatitis)	35 (0.12)
Eye infections	12 (0.04)
Ear infections	≤ 5 (−)
Central nervous system infections (except meningococcal disease	≤ 5 (−)
Meningitis	≤ 5 (−)
Gastrointestinal infections	253 (0.85)
Intra-abdominal infection	71 (0.24)
Viral hepatitis	10 (0.03)
Heart infections (acute rheumatic fever, infectious pericarditis or myocarditis, endocarditis)	10 (0.03)
Upper respiratory tract infection	12 (0.04)
Influenza	≤ 5 (−)
Pneumonia	3,005 (10.15)
Other lower-respiratory tract infections	228 (0.77)
Sexually transmitted diseases	≤ 5 (−)
Male genital infections (prostatitis, orchitis, epididymitis)	6 (0.02)
Female pelvic infections (salpingo-oophoritis, uterine infections, vulvovaginitis)	≤ 5 (−)
Septic arthritis, osteomyelitis, myositis	8 (0.03)
Infectious complications of procedures, catheters etc.	430 (1.45)
Other infections or sequelae	54 (0.18)

Table 3. Anatomical Therapeutical Chemical Classification system (ATC) codes to identify community-acquired infections.

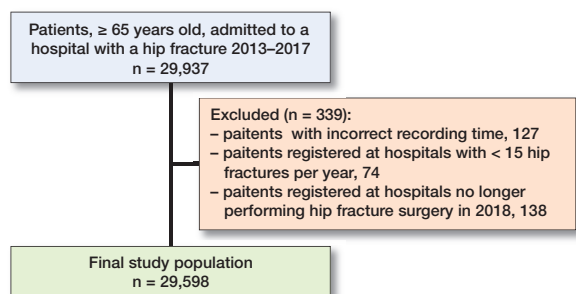| Type of antibiotic	ATC codes
Beta-lactamase sensitive penicillins	J01CE
Beta-lactamase resistant penicillins	J01CF
Cephalosporins (first generation)	J01DB
Cephalosporins (second generation)	J01DC
Cephalosporins (third generation)	J01DD
Cephalosporins (fourth generation)	J01DE
Carbapenems	J01DH
Other cephalosporins and penems	J01DI
Combinations of penicillins, including beta-lactamase inhibitors	J01CR
Penicillins with extended spectrum	J01CA
Macrolides, lincosamides, and streptogramins	J01F
Trimethoprim and derivatives	J01E
Fluroquinolones	J01MA
Tetracyclines	J01A

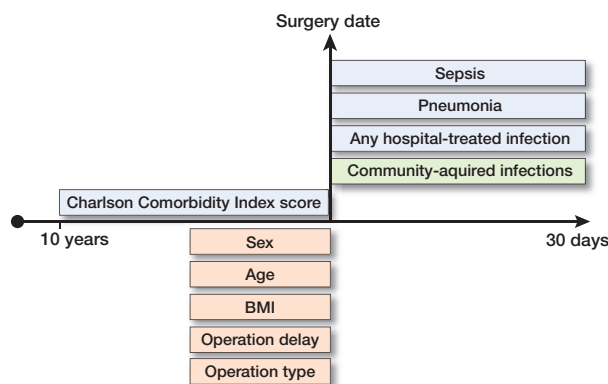Figure 1. Flow chart describing selection of study population.

Figure 2. Chart of study design. Orange indicates data obtained from the Danish Multidisciplinary Hip Fracture Database. Blue indicates data from the Danish National Patient Register. Green indicates data from the Danish Health Service Prescription Database.

Table 4. International classification of diseases, 10th revision (ICD-10) codes used to Charlson comorbidity index

Disease	ICD-10	Score
Myocardial infarction	I21, I22, I23	1
Congestive heart failure	I50, I11.0, I13.0, I13.2	1
Peripheral vascular disease	I70, I71, I72, I73, I74, I77	1
Cerebrovascular disease	I60–I69, G45, G46	1
Dementia	F00–F03, F05.1, G30	1
Chronic pulmonary disease	J40–J47, J60–J67, J68.4, J70.1, J70.3, J84.1, J92.0, J96.1, J98.2, J98.3	1
Connective tissue disease	M05, M06, M08, M09, M30, M31, M32, M33, M34, M35, M36, D86	1
Ulcer disease	K22.1, K25–K28	1
Mild liver disease	B18, K70.0–K70.3, K70.9, K71, K73, K74, K76.0	1
Diabetes type 1	E10.0, E10.1, E10.9 1	
Diabetes type 2	E11.0, E11.1, E11.9	
Hemiplegia	G81, G82	2
Moderate to severe renal disease	I12, I13, N00–N05, N07, N11, N14, N17–N19, Q61	2
Diabetes with end organ damage		2
type 1	E10.2–E10.8	
type 2	E11.2–E11.8	
Any tumor	C00–C75	2
Leukemia	C91–C95	2
Lymphoma	C81–C85, C88, C90, C96	2
Moderate to severe liver disease	B15.0, B16.0, B16.2, B19.0, K70.4, K72, K76.6, I85	3
Metastatic solid tumor	C76–C80	6
AIDS	B21–B24	6

Table 8. Multilevel Poisson regression, for combined outcome of death and hospital-treated infection within 30 days. Values are relative risk (95% confidence interval)

Individual variables	Death or infection
Sex (ref. Female)	
Male	1.60 (1.53–1.69)
Age (ref. 65–79).	
80–89	1.57 (1.48–1.67)
> 89	2.18 (2.04–2.33)
Charlson Comorbidity Index (ref. 0 points)	
Low (1–2 points)	1.44 (1.36–1.53)
High (> 3 points)	1.78 (1.67–1.90)
BMI (ref. 18.5–24.9)	
Underweight (< 18.5)	1.27 (1.19–1.35)
Overweight (25–29.9)	0.89 (0.84–0.95)
Obese (≥ 30)	1.00 (0.91–1.10)
Surgery delay (ref. < 24 h)	
24–48	1.07 (1.01–1.13)
> 48 h	1.07 (0.97–1.18)
Operation type (ref. Osteosynthesis)	
Total/hemiarthroplasty	1.09 (1.04–1.15)
Hospital contextual effects	
ICC [a] hospital (%)	8.4 (3.8–12.4)
MRR [b]	1.46 (1.29–1.60)

[a] ICC = intra-class coefficient.
[b] MRR = median risk ratio.

Table 9. Multilevel Poisson regression, for any hospital-treated infection, when excluding patients having received antibiotics <14 days before surgery. Values are relative risk (95% confidence interval)

Individual variables	Hospital-treated infection
Sex (ref. Female)	
Male	1.63 (1.53–1.74)
Age (ref. 65–79)	
80–89	1.40 (1.30–1.50)
> 89	1.58 (1.46–1.72)
Charlson Comorbidity Index (ref. 0 points).	
Low comorbidity (1–2 points)	1.36 (1.26–1.46)
High comorbidity (> 3 points)	1.55 (1.43–1.68)
BMI (ref. 18.5–24.9)	
Underweight (< 18.5)	1.19 (1.10–1.30)
Overweight (25–29.9)	1.02 (0.95–1.10)
Obese (≥ 30)	1.13 (1.01–1.27)
Surgery delay (ref. < 24 h)	
24–48	1.08 (1.01–1.16)
> 48 hours	1.03 (0.91–1.17)
Operation type (ref. Osteosynthesis)	
Total/hemiarthroplasty	1.16 (1.09–1.23)
General contextual effects	
ICC [a] hospital (%)	18.4 (10.0–22.7)
MRR [b]	1.96 (2.38–1.64)

[a, b] See Table 8.

Table 10. Multilevel Poisson regression, for any hospital-treated infection and community-acquired infections as a combined outcome. Values are relative risk (95% confidence interval)

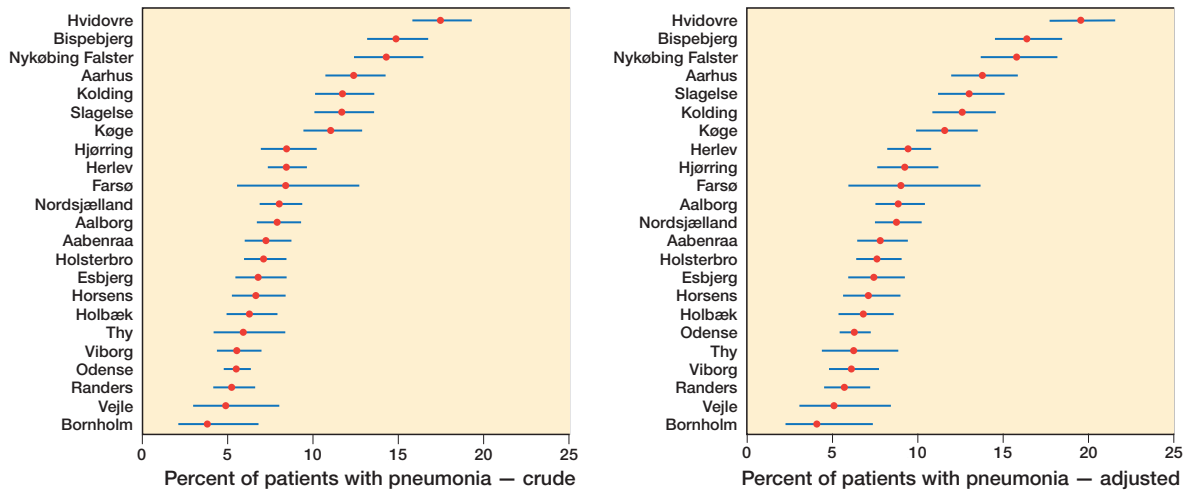| Individual variables	Infection
Sex (ref. Female)	
Male	1.14 (1.09–1.20)
Age (ref. 65–79)	
80–89	1.31 (1.25–1.37)
> 89	1.47 (1.39–1.55)
Charlson Comorbidity Index (ref. 0 points)	
Low (1–2 points)	1.21 (1.15–1.26)
High (> 3 points)	1.35 (1.29–1.43)
BMI (ref. 18.5–24.9)	
Underweight (< 18.5)	1.04 (0.98–1.10)
Overweight (25–29.9)	1.02 (0.97–1.07)
Obese (≥ 30)	1.13 (1.05–1.21)
Surgery delay (ref. < 24 h)	
24–48 h	1.04 (0.99–1.09)
> 48 h	1.07 (0.99–1.16)
Operation type (ref. Osteosynthesis)	
Total/hemiarthroplasty	1.02 (0.98–1.06)
General contextual effects	
ICC [a] hospital (%)	10.9 (4.1–16.2)
MRR [b]	1.32 (1.41–1.19)

[a, b] See Table 8.

Figure 5. League tables ranking hospitals for pneumonia. Right panel adjusted for sex, age, comorbidity, body mass index, surgery delay, and operation type.
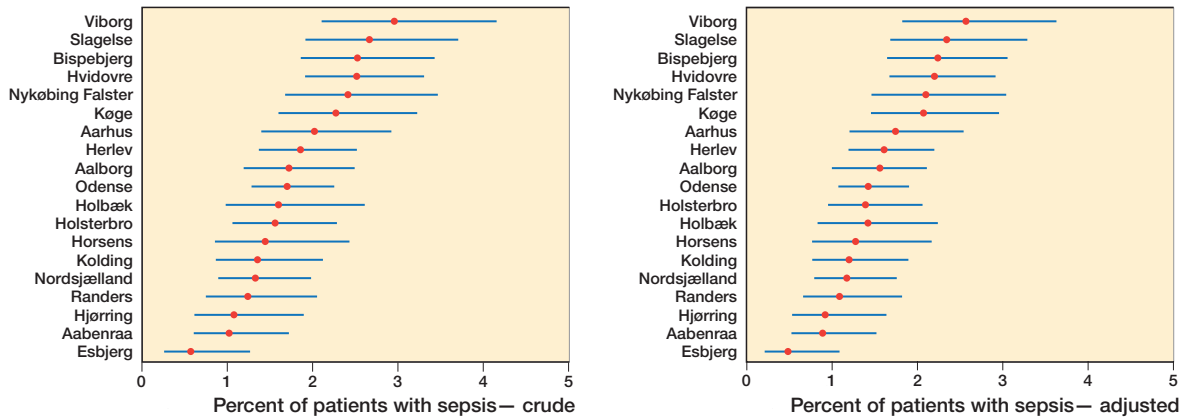

Figure 6. League tables ranking hospitals for sepsis, excluding hospitals < 5 infections. Right panel adjusted for sex, age, comorbidity, body mass index, surgery delay, and operation type.
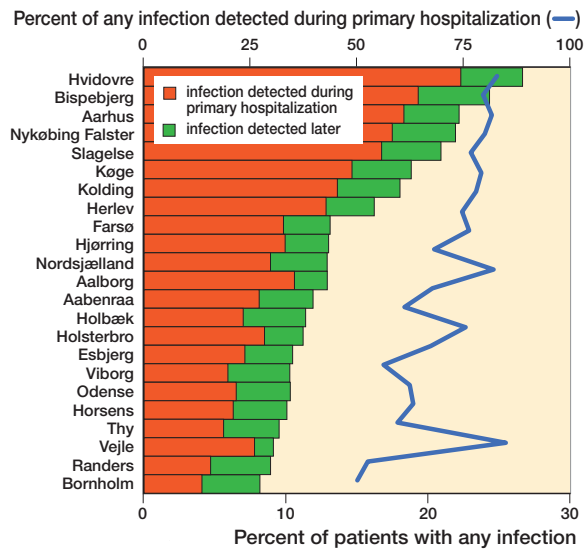

Figure 7. Risk of infection detected during primary hospitalization (red). Risk of all infections (red + green). Percentage of infections detected during primary hospitalization (blue line).
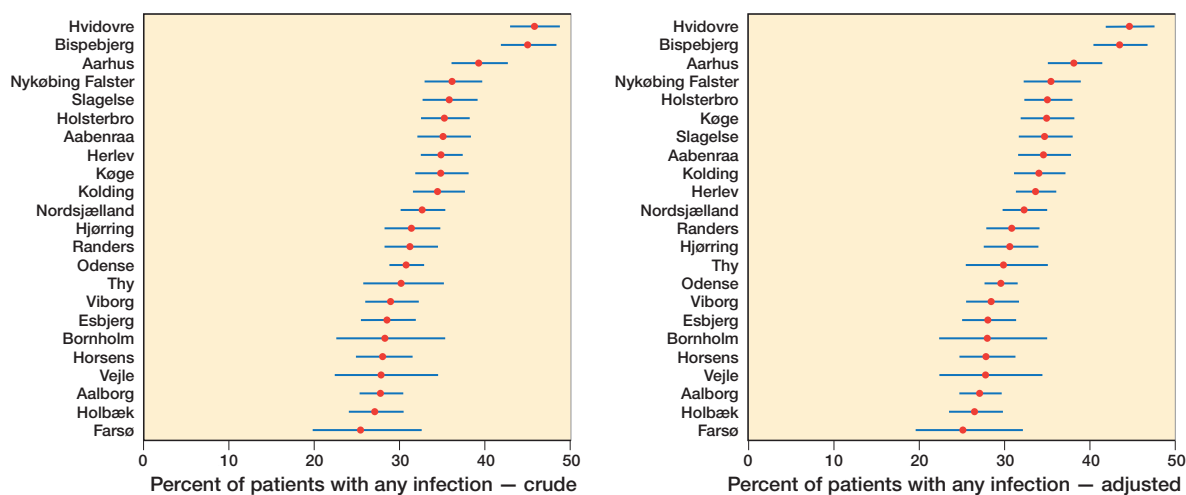
Figure 8. League tables ranking hospitals for hospital-treated and community-acquired infection as combined outcome. Right panel adjusted for sex, age, comorbidity, body mass index, surgery delay, and operation type.
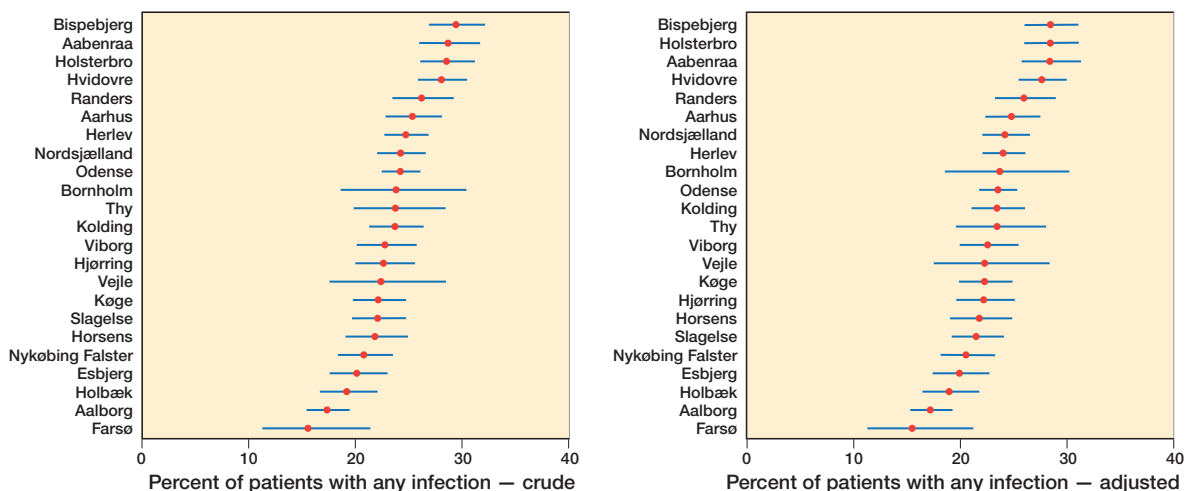

Figure 9. League tables ranking hospitals for community-acquired infection with follow-up from discharge. Right panel adjusted for sex, age, comorbidity, body mass index, surgery delay, and operation type.
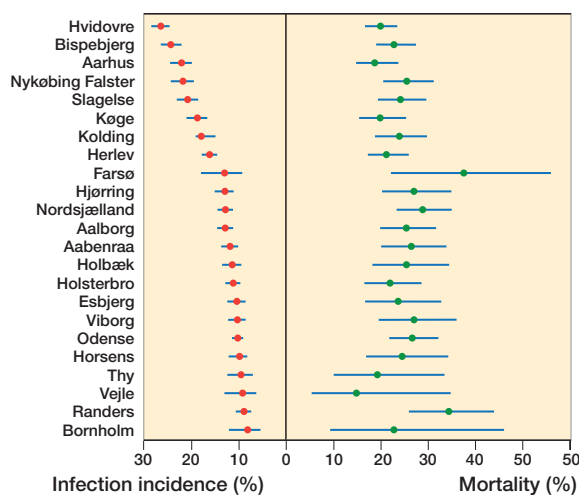

Figure 10. Infection incidence (red) and mortality (green) across hospitals. Adjusted for sex, age, comorbidity, body mass index, operation delay, and operation type.