

Supplement S1

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Search strategy in PubMed for the literature review of healthcare-associated foodborne outbreaks

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(((((nosocomial[Title/Abstract] OR "healthcare-associated"[Title/Abstract] OR "healthcare associated"[Title/Abstract] OR "health care associated"[Title/Abstract] OR "health care acquired"[Title/Abstract] OR "healthcare acquired infection"[Title/Abstract] OR HAI[Title/Abstract] OR HCAI[Title/Abstract] OR "hospital"[Title/Abstract] OR clinic[Title/Abstract] OR "health care facility"[Title/Abstract] OR "healthcare facility"[Title/Abstract] OR "health care facilities"[Title/Abstract] OR "health care facilities"[Title/Abstract] OR hospitals[Title/Abstract] OR "rehabilitation center"[Title/Abstract] OR "rehabilitation centers"[Title/Abstract] OR "rehabilitation centre"[Title/Abstract] OR "rehabilitation centres"[Title/Abstract] OR "medical center"[Title/Abstract] OR "medical centers"[Title/Abstract] OR "medical centre"[Title/Abstract] OR "medical centres" [Title/Abstract] OR "medical institution"[Title/Abstract] OR "medical institutions"[Title/Abstract] OR "nursing home"[Title/Abstract] OR "nursing homes"[Title/Abstract] OR "nursery home"[Title/Abstract] OR "nursery homes"[Title/Abstract]))) AND (outbreak*[Title/Abstract])) AND (food[Title/Abstract] OR foodborne[Title/Abstract] OR food-borne[Title/Abstract] OR Salmonella[Title/Abstract] OR Campylobacter[Title/Abstract] OR "Bacillus cereus"[Title/Abstract] OR Escherichia[Title/Abstract] OR Listeria[Title/Abstract] OR Norovirus[Title/Abstract])) AND ("2001"[Date - Publication] : "3000"[Date - Publication])
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Supplementary Table S1. Overview of published articles on hospital associated foodborne outbreaks (2001-2018, n=57) in OECD countries and HA-FBOs from the German surveillance system (SurvNet, 2012-2018, n=28)

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
<i>Salmonella</i> spp.													
<i>S. Brandenburg</i> + <i>S. Corvallis</i>	Japan	Unknown	2001	Hospital	Epi descriptive; Mibi ^b : detection in food vehicle or its component	8	0	no	Elderly	(66-88)	NA ^c	NA	[1]
<i>S. Enteritidis</i>	Netherlands	Bavarian cream-dessert	2001	Hospital and nursing home	Epi analytical: cohort study	82	5	yes	Elderly	NA	NA	NA	[2]
<i>S. Typhimurium</i>	Australia	Rice pudding, meat based, potato pie	2001	Aged care facility	Epi descriptive; detection in food vehicle or its component; product-tracing	18	0	yes	Adults, Elderly	NA	NA	NA	[3]
<i>S. Enteritidis</i>	UK	Imported eggs	2002	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component	29	1	no	NA	NA	NA	NA	[4]
<i>S. Infantis</i>	Germany	Pasta, vegetables, rice	2002-2009	Rehabilitation oncology clinic	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	90	0	yes	NA	NA	NA	NA	[5]
<i>S. Javiana</i>	USA	Salad, fresh vegetable	2003	Tertiary hospital. Children's Hospital	Epi analytical: case-control study	101	0	yes	Adults, Children	NA	NA	NA	[6]
<i>S. Enteritidis</i>	Germany	Contaminated pudding/curd dumpling	2004	Hospitals, Elderly homes	Epi analytical: case-control study; Product-tracing	47	0	yes	Adults, Elderly	83 (57-102) ^d	27/37 ^d	73	[7]
<i>S. Enteritidis</i>	Greece	Unknown	2005	Hospital	Epi analytical: case-control study	102	2	yes	Adults, Elderly, Children	60 ^e	NA	67	[8]
<i>S. Enteritidis</i>	Germany	Bakery products (cake)	2006	Nursing home	Epi analytical: cohort study; Mibi: detection in	111	1	yes	Adults, Elderly	NA	NA	NA	[9]

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
					food vehicle or its component								
<i>S. Oranienburg</i>	USA + Canada	Fruit salad	2006	Health care facilities	Epi analytical: case-control study	29	0	yes	Adults, Elderly, Infant ^f	59 (8 months-96) ^g	28/41	68 ^g	[10]
<i>S. Enteritidis</i>	Germany	Unknown	2007	Hospital	Epi analytical: case-control study	33	0	yes	Adults, Elderly, Children	66 (1-87)	17	61	[11]
<i>S. Enteritidis</i>	Germany	Cheesecake	2010	Tertiary care hospital/children's hospital (3 hospitals)	Epi descriptive	4	0	no	Adults, Children	NA	NA	NA	[12]
<i>S. Newport</i>	Germany + Netherlands	Mung bean sprouts	2011	Rehabilitation clinic in Germany, Hospital in the Netherlands	Epi analytical: case-control study; Mibi: detection in food vehicle or its component; Product-tracing	≥ 2 (2 in NL; NA for HCF in DE)	0	NA	NA	NA	NA	NA	[13]
<i>S. Enteritidis</i>	USA	Raw unpasteurized shell egg	2012	Long-term care facility	Epi analytical: cohort study	21	0	yes	Adults, Elderly	83 (21-94)	15	71	[14]
<i>S. Bovismorbificans</i>	Germany	Unknown	2013	Rehabilitation centre	No details/unknown/weak	37	0	NA	Adults, Children Infants	12 (0-44)	20	46	SN1
<i>S. Derby</i>	Germany	Spreadable raw sausages (Teewurst)	2013-2014	Hospitals and residential institutions	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	130 ^h	1	yes ⁱ	Adults, Elderly, Children Infants	76 (0-100) ^j	76 ^j /150	51 ^j	SN2*
<i>S. Enteritidis</i>	Germany	Unknown	2013	Nursing home	No details/unknown/weak	11	0	NA	Adults, Elderly, Children	79 (16-96)	11	100	SN3
<i>S. Enteritidis</i>	UK (part of multinational outbreak)	Eggs from a German producer	2014	Hospital	Epi descriptive; detection in food vehicle or its component; product-tracing	32	1	yes	NA	NA	NA	NA	[15]

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
<i>S. Enteritidis</i>	Germany	Unknown	2014	Nursing home	No details/unknown/weak	4	0	no	Elderly	88 (85-94)	4	100	SN4
<i>S. Gruppe B</i>	Germany	Unknown	2014	Hospital	No details/unknown/weak	3	0	NA	Adults	31 (24-37)	0	0	SN5
<i>S. Muenchen</i>	Germany	Raw pork products	2014	3 Nursing homes	Epi analytical; Mibi: detection in food vehicle or its component; detection in food chain or its environment	NA	NA	yes ≥ 6	NA	NA	NA	NA	[16]
<i>S. Gruppe B</i>	Germany	Unknown	2015	Nursing home	No details/unknown/weak	9	0	NA	Adults, Elderly, Children	84 (16-98)	8	67	SN6
<i>S. Enteritidis</i>	Germany	Sauce for cabbage roulade	2017	Nursing home	Epi descriptive; Mibi: detection in food vehicle or its component	10	0	no	Elderly	83 (75-93)	10	67	SN7*
<i>S. Enteritidis</i>	Germany	Unknown	2018	Nursing home	No details/unknown/weak	3	0	NA	Adults, Elderly	56 (55-68)	NA	NA	SN8
Norovirus													
Norovirus	Spain	Whipped cream mousse	2001	Elderly home	Epi analytical: case-control study	56	0	yes	Adults, Elderly	mean 83 (56-101)	32	78	[17]
Norovirus ^k	Spain	Dried fruit, strawberry jam	2002	Health Centre	Epi analytical: cohort study	50	0	yes	Adults	NA	NA	NA	[18]
Norovirus	Denmark	Frozen raspberry pieces	2005	Hospital, Nursing homes	Epi analytical: case-control study; cohort study	570	0	NA	Adults, Elderly	NA	NA	NA	[19]
Norovirus	Italy	Thin soup	2006	Elderly home	Epi analytical: cohort study	29	0	yes	Adults, Elderly	74 (19-97) ^l	NA	NA	[20]
Norovirus	Japan	Unknown	2007	Hospital, Long-Term Care facility, Daycare users	Epi analytical: cohort study	102	0	yes	Adults, Elderly	56 (IQR 45-66)	18	33	[21]
Norovirus	Austria	Cold sliced sausage, meat dish with salad, hand-	2009	Healthcare facility (Hospital+rehabilitation)	Epi analytical: cohort study, others	148	0	yes	Adults, Elderly?	52 ^m	NA	Sex ratio (male)	[22]

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
		rolled spinach pancake		centre, convalescent home)								:female): 0.77 ^m	
Norovirus	Germany	Unknown	2011	University hospital	Epi descriptive	144	0	yes	NA	NA	NA	NA	[23]
Norovirus	Germany	Frozen strawberry	2012	Disability care (3), elderly homes (2) rehabilitation clinic (1)	Epi analytical: case-control study; Product-tracing	NA	0	NA	NA	NA	NA	NA	[24]
Norovirus	France	Oysters	2012	Nursing home	Epi analytical: cohort study; Mibi: detection in food vehicle or its component	55	1	yes	Adults, Elderly	NA	NA	NA	[25]
Norovirus	Germany	Unknown	2013	Hospital	No details/unknown/weak	5	0	NA	Adults	35 (29-45)	3	60	SN9
Norovirus	Germany	Unknown dishes prepared in the hospital kitchen	2013	Hospital/medical care facility	Epi descriptive	14	0	NA ^l	Adults, Elderly	72 (23-80)	4	29	SN10*
Norovirus	Germany	Unknown	2016	Rehabilitation centre	No details/unknown/weak	35	0	NA	Adults, Children	7 (1-51)	25	71	SN11
Norovirus	Germany	Raspberry fruit quark, with frozen raspberries ⁿ	2016	Hospital/medical care facility	Epi descriptive; Mibi: detection in food vehicle or its component; Product-tracing	103	0	NA	Adults, Elderly	34 (19-68)	7	7	SN12*
Norovirus	Germany	Frozen raspberries ^o	2016	Hospital/medical care facility	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	25	0	NA	Elderly, Adults, Infants	65 (0-79)	6/18 ^p	33	SN13*
Norovirus	Germany	Unknown	2016	Hospital	No details/unknown/weak	6	0	NA	Adults, Elderly	76 (40-82)	6	100	SN14

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
Norovirus	Germany	Unknown	2016	Nursing home	No details/unknown/weak	54	0	NA	Elderly, Adults, Infants	64 (0-93)	4/6 ^q	67	SN15
Norovirus	Germany	Unknown	2017	Hospital	No details/unknown/weak	35	0	NA	Adults (80% missing)	NA	25	71	SN16
Norovirus	Germany	Unknown	2017	Hospital	No details/unknown/weak	21	0	NA	Adults, Elderly	48 (18-84)	15	71	SN17
Norovirus	Germany	Unknown	2017	Hospital	No details/unknown/weak	13	0	NA	Adults, Elderly	72 (50-81)	4	31	SN18
Norovirus	Germany	Bread, bread rolls	2017	Nursing home	Epi descriptive	126	0	NA ⁱ	Elderly, Adults, Infants	69 (0-95)	94	75	SN19*
Norovirus	Germany	Unknown	2018	Rehabilitation centre	No details/unknown/weak	7	0	NA	Adults, Children	24 (1-59)	9	75	SN20
Norovirus	Germany	Unknown	2018	Nursing home	No details/unknown/weak	2	0	no	Elderly	(83-89)	NA	NA	SN21
<i>Listeria monocytogenes</i>													
<i>L. monocytogenes</i>	UK	Sandwiches	2003	Hospital - oncology unit	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	2	2	no	Adults	(46-63)	2	100	[26]
<i>L. monocytogenes</i>	UK	Prepacked sandwiches	2003	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component	4	0	no	Adults (pregnant)	NA	4	100	[27]
<i>L. monocytogenes</i>	UK	Sandwiches: various fillings	2004	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	2	1	no	Elderly	NA	0	0	[28]

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<i>L. monocytogenes</i>	Germany	Ready to eat scalded sausage	2006-2007	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	11	5	no	Adults, Elderly	72 (50-83)	4	36	[29]
<i>L. monocytogenes</i>	Norway	Camembert cheese made from pasteurised milk	2007	Tertiary care hospital	Epi descriptive; Mibi: detection in food vehicle or its component	17	3	yes	Adults, Elderly	64 (27-84)	11	65	[30]
<i>L. monocytogenes</i>	Canada	Delicatessen meat	2008	Long-term care facility, hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment; Product-tracing	48	24 ^r	no	Adults, Elderly	78 (29-98)	NA	NA	[31]
<i>L. monocytogenes</i>	UK	Sandwiches: various fillings	2008	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component	3	1	no	Elderly	NA	NA	NA	[28]
<i>L. monocytogenes</i>	UK	Sandwiches: various fillings	2008	2 hospitals	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	7	3	no	> 60 years	67	2	29	[32]
<i>L. monocytogenes</i>	USA	Tuna salad	2008	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	5	3	no	Adults, Elderly	62 (52-92)	1	20	[33]
<i>L. monocytogenes</i>	UK	Sandwiches: various fillings	2010	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	5	1	no	NA	NA	NA	NA	[34]

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
<i>L. monocytogenes</i>	USA	Diced celery	2010	5 Acute care hospitals	Epi descriptive; Mibi: detection in food chain or its environment	10	5	no	Adults, Elderly	80 (56-93)	5	50	[35]
<i>L. monocytogenes</i>	USA	Milkshake	2010-2015	Hospitals in 2 states	Epi descriptive; Mibi: detection in food vehicle or its component	10	3	no	NA	NA	NA	NA	[36]
<i>L. monocytogenes</i>	UK	Sandwiches: various fillings	2011	Hospital	Epi descriptive	3	0	no	Adults, Elderly	50~59	1	33	[37]
<i>L. monocytogenes</i>	Finland	Ready-sliced meat jelly	2012	Municipal hospital, institutional care	Epi analytical: cohort study; Mibi: detection in food chain or its environment	18 (10 hospital, 8 other HCF)	3	no	Elderly	82 in hospital; 73 in other HCF	4/10 in hospital	40 in hospital	[38]
<i>L. monocytogenes</i>	Australia	Dessert	2013	3 Tertiary hospitals	Epi descriptive; Mibi: detection in food chain or its environment	3	1	no	Adults, Elderly	79 (34-82)	NA	NA	[39]
<i>L. monocytogenes</i>	Germany	Mixed salad ^s	2013	Hospital/medical care facility	Mibi: detection in food vehicle or its component; detection in food chain or its environment	3	1	no	Elderly	NA	NA	NA	SN22*
<i>L. monocytogenes</i>	Denmark	Spiced meat roll	2013-2014	Hospitals, long-term care facilities	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment; Product-tracing	20 ^t (5+15)	9 ^u (1+8)	no	Adults, Elderly	71 (43-90) ^v	23/41 ^q	56 ^q	[40]
<i>L. monocytogenes</i>	USA	Ice cream mix, milkshake	2014-2015	Hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	3	0	no	Adults	2 patients 50ies, 1 patient 40ies	1	33	[41-43]
<i>L. monocytogenes</i>	Germany	Iceberg lettuce with yoghurt dressing, Gouda cheese	2014	Hospital/medical care facility	Epi descriptive	2	0	no	Elderly	83 (79-87)	1	50	SN23*

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
<i>Bacillus cereus</i>	France	Pooled breast milk	2010	Tertiary care teaching hospital	Epi descriptive	2	0	no	Newborn	(29-30 weeks)	NA	NA	[44]
<i>B. cereus</i>	Austria	Fruit salad and deer ragout	2013	Rehabilitation clinic	Epi analytical: cohort study; Mibi: detection in food vehicle or its component	106	0	no	Adults, Elderly?	59	NA	Sex ratio (male :female ratio) 0.74:1	[45]
<i>B. cereus</i>	Germany	Unknown	2017	Nursing home	No details/unknown/weak	33	0	no	Adults, Elderly	86 (63-97)	26	79	SN24
<i>B. cereus</i>	Germany	Canapes with turkey, canapes with ham, salmon canapes, vital wraps with vegetables	2017	Nursing home	Epi descriptive; Mibi: detection in food vehicle or its component; Product-tracing	26	0	yes	Adults, Elderly	70 (54-87)	3	75	SN25*
<i>Clostridium perfringens</i>	Japan	Boiled beans	2001	Nursing home	Epi descriptive	90	0	no	Elderly	NA	NA	NA	[46]
<i>C. perfringens</i>	USA	Meal with turkey	2001	Residential care facility for mentally ill	Epi descriptive	7	0	no	Adults	48 (30-59)	4	57	[47]
<i>C. perfringens</i>	USA	Chicken	2010	Psychiatric hospital	Epi descriptive; Mibi: detection in food vehicle or its component	54	3	yes	Adults, Elderly?	NA	NA	NA	[48]
<i>C. perfringens</i>	Germany	Unknown	2015	Nursing home	No details/unknown/weak	10	0	NA	Adults, Elderly	86 (46-100)	6	60	SN26
<i>Escherichia coli</i> O157:H7	Canada	Salads and sandwiches	2002	Psychiatric hospital, health care facilities	Epi analytical: case-control study	109	2	yes	Adults	NA	NA	NA	[49]
<i>E. coli</i> O157:H7	USA	Raw spinach	2003	Nursing home	Epi analytical: case-control study	46	1	yes	Elderly	NA	NA	NA	[50]

Agent causing outbreak	Country	Likely source or vehicle	Year of outbreak	Healthcare Setting	Evidence: link cases and food vehicle	No of cases	No of deaths	Personnel in cases	Age groups	Median (range) years	No of female cases/N	% females	Ref ^a
<i>E. coli</i> (ESBL)	Japan	Donor breast milk	2012	Neonatal intensive care unit	Epi analytical: case-control study; Mibi: detection in food vehicle or its component; detection in food chain or its environment	4	0	no	Newborn	(26-37 weeks)	3	50	[51]
<i>E. coli</i> O157	Japan	Pickled cabbage	2012	Nursing homes	Epi descriptive; detection in food vehicle or its component	107	5	no	Elderly	87 (72-102)	94	88	[52]
<i>Campylobacter jejuni</i>	Austria	Poultry dishes	2006	Tertiary care hospital	Epi descriptive	21	0	yes	Adults, Elderly?	NA	NA	NA	[53]
<i>C. jejuni</i>	Germany	Unknown	2015	Rehabilitation centre	No details/unknown/weak	15	0	NA	Adults, Elderly	62 (47-87)	10	67	SN27
<i>C. jejuni</i>	Germany	Unknown	2017	Rehabilitation centre	No details/unknown/weak	18	0	NA	Adults, Elderly	52 (23-65)	12	67	SN28
Group A β -hemolytic streptococci (GAS)	Turkey	Milky dessert	2008	Hospital	Epi analytical: case-control study; Mibi: detection in food vehicle or its component	251	0	yes	Adults	NA	NA	NA	[54]
<i>Klebsiella pneumoniae</i>	Spain	Handmade fruit puree, soup	2008	Acute care Hospital	Epi analytical: case-control study	35	0	no ^w	Elderly	mean 69 ^x	NA	43 ^x	[55]
<i>Citrobacter freundii</i> (VIM Carbapenemase-Expressing)	Germany	Presliced vegetables	2016	University hospital	Epi descriptive; Mibi: detection in food vehicle or its component; detection in food chain or its environment	76 ^y	0	no	Adults, Elderly	mean 69 (54-84)	43	45	[56]
<i>Cyclospora cayentanensis</i>	USA	Snow peas	2004	Residential facility	Epi analytical: cohort study; Product-tracing	96	0	NA	Adults	NA	NA	NA	[57, 58]
<i>Blastoschizomyces capitatus</i>	Spain	Milk	2002	Tertiary care hospital: haematology unit	Epi descriptive; Mibi: detection in food chain or its environment	4	2	no	Adults, Elderly	NA	NA	NA	[59]

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- ^a SN: SurvNet; Outbreak retrieved from the German electronic surveillance system (SurvNet@RKI) (search date: 11 September 2019)
SN*: Outbreaks categorised as "strong-evidence"-FBOs according to EFSA criteria [60]
- ^b Mibi: microbiological evidence
- ^c NA: not available
- ^d Only for the 37 patients in HCFs (i.e. age and gender of 10 members of personnel not included)
- ^e Based on 133 outbreak cases (i.e. including 31 visitors)
- ^f Not clear if infant healthcare-associated
- ^g Based on 41 outbreak cases (of which 29 cases were healthcare-associated)
- ^h Case number reported to EFSA
- ⁱ Infected food handler
- ^j Based on 150 outbreak cases due to late reporting
- ^k Norovirus: suspected aetiological agent, Kaplan criteria met
- ^l Based on a total of 35 outbreak cases (i.e. 21 residents, eight staff members and six guests)
- ^m Based on 204 outbreak cases (i.e. 114 patients and resident cases, 34 staff and 56 secondary cases)
- ⁿ Risk factor: unprocessed contaminated ingredient, inadequate heat treatment
- ^o Risk factor: unprocessed contaminated ingredient
- ^p Information available for 18 outbreak cases
- ^q Information available for 6 outbreak cases
- ^r In total there were 57 outbreak cases (48 healthcare-associated, nine from community);
of 24 fatalities, not clear if all deaths were healthcare-associated
- ^s Risk factor: Unprocessed contaminated ingredient
- ^t For 15/20 case patients, the place of exposure was possibly in hospitals/long-term care
- ^u For 8/9 deaths the place of exposure was possibly in hospitals/long-term care
- ^v Based on 41 outbreaks cases (of which 29 considered healthcare-associated)
- ^w 1 food handler and 5 cleaning staff were faecal carriers (not included in outbreak case number)
- ^x Based on 156 colonized and/or infected patients
- ^y Colonisations (i.e. not infections)

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