

## Supplemental Online Content

Johnson J, Malwade S, Agarkhedkar S, et al. Risk factors for health care–associated bloodstream infections in NICUs. *JAMA Netw Open*. 2025;8(3):e251821. doi:10.1001/jamanetworkopen.2025.1821

**eTable 1.** Pathogen Distribution for Healthcare-Associated Bloodstream Infections Among Neonates Admitted to Three Tertiary Care Neonatal Intensive Care Units in Pune, India, May 1, 2017-July 31, 2019

**eTable 2.** Demographic, Birth, and Clinical Characteristics of Neonates Admitted to Three Tertiary Care Neonatal Intensive Care Units  $\geq 7$  Days by Healthcare-Associated Bloodstream Infection (HA-BSI) Status, Pune, India, May 1, 2017-July 31, 2019

**eTable 3.** Hazard of Healthcare-Associated Bloodstream Infection (HA-BSI) Among Neonates Admitted to Three Tertiary Care Neonatal Intensive Care Units  $\geq 7$  Days, Pune, India, May 1, 2017-July 31, 2019

**eTable 4.** Duration of Antibiotic Courses Initiated During the First Seven Days of Admission Among Neonates Admitted to Three Tertiary Care Neonatal Intensive Care Units  $\geq 7$  Days, Pune, India, May 1, 2017-July 31, 2019

This supplemental material has been provided by the authors to give readers additional information about their work.

**eTable 1. Pathogen distribution for healthcare-associated bloodstream infections among neonates admitted to three tertiary care neonatal intensive care units in Pune, India, May 1, 2017-July 31, 2019**

	Total n = 412 n (%)
Gram-negative organisms	273 (66.3)
<i>Klebsiella</i> spp.	124 (30.1)
<i>Acinetobacter</i> spp.	47 (11.4)
<i>Citrobacter</i> spp.	41 (10.0)
<i>Escherichia</i> spp.	20 (4.9)
<i>Enterobacter</i> spp.	16 (3.9)
<i>Pseudomonas</i> spp.	8 (1.9)
<i>Elizabethkingia</i> spp.	5 (1.2)
<i>Serratia</i> spp.	2 (0.5)
<i>Burkholderia</i> spp.	1 (0.2)
Gram-negative, unspciated	9 (2.2)
Gram-positive organisms	105 (25.5)
<i>Bacillus</i> spp.	11 (2.7)
<i>Enterococcus</i> spp.	12 (2.9)
<i>Staphylococcus</i> spp.	77 (18.7)
<i>Streptococcus</i> spp.	5 (1.2)
Yeast	34 (8.3)
<i>Candida</i> spp.	31 (7.5)
Yeast, unspciated	3 (0.7)

Table notes. 412 organisms were detected from 409 HA-BSI events among 373 neonates. Three neonates had two organisms detected from the same culture: (*Klebsiella* and *Enterococcus* (n=1); *Escherichia* and *Enterobacter* (n=1); *Klebsiella* and *Citrobacter* (n=1). Percentages were calculated by using 412 isolates as the denominator, rather than 409 HA-BSI events. Abbreviations: HA-BSI – healthcare-associated bloodstream infection; *spp.* – species.

**eTable 2. Demographic, birth, and clinical characteristics of neonates admitted to three tertiary care neonatal intensive care units  $\geq 7$  days by healthcare-associated bloodstream infection (HA-BSI) status, Pune, India, May 1, 2017-July 31, 2019**

	No HA-BSI n=3109	HA-BSI n=190	Total n=3299
<b>Demographic and Birth Characteristics</b>			
Male sex, n (%)	1763 (56.7)	102 (53.7)	1865 (56.5)
Multiple gestation, n (%)	531 (17.1)	47 (24.7)	578 (17.5)
<i>Gestational age</i>			
Gestational age in weeks, median (IQR)	33 (31-36)	31 (29-33)	33 (31-35)
Preterm (< 37 weeks), n (%)	2291 (79.4)	161 (91.0)	2452 (80.1)
Extremely preterm (< 28 weeks)	122 (4.2)	28 (15.8)	150 (4.9)
Very preterm (28-31weeks)	834 (28.9)	73 (41.2)	907 (29.6)
Moderate to late preterm (32-36 weeks)	1335 (46.3)	60 (33.9)	1395 (45.6)
Term ( $\geq 37$ weeks), n (%)	594 (20.6)	16 (9.0)	610 (19.9)
<i>Birth weight</i>			
Birth weight in grams, median (IQR)	1563 (1250-2020)	1300 (1010-1600)	1550 (1250-2000)
All LBW (< 2500g), n (%)	2592 (84.8)	175 (92.1)	2767 (85.2)
ELBW (< 1000g)	222 (7.3)	33 (17.4)	255 (7.9)
VLBW (1000-1499g)	1066 (34.9)	94 (49.5)	1160 (35.7)
LBW (1500-2499g)	1304 (42.6)	48 (25.3)	1352 (41.6)
Non-LBW ( $\geq 2500$ g), n (%)	466 (15.2)	15 (7.9)	481 (14.8)
Inborn, n (%)	2759 (88.7)	171 (90.0)	2930 (88.8)
Cesarean delivery, n (%)	1566 (51.6)	79 (42.2)	1645 (51.0)
<b>Clinical Characteristics</b>			
<i>Respiratory support</i>			
Any respiratory support, n (%)	2356 (75.8)	184 (96.8)	2540 (77.0)
Respiratory support days, median (IQR)	6 (2-11)	16.5 (8-26)	6 (3-12)
Mechanical ventilation, n (%)	927 (29.8)	121 (63.7)	1048 (31.8)
Ventilator days, median (IQR)	4 (2-7)	6 (3-11)	4 (2-7)
Surfactant administration, n (%)	479 (15.4)	57 (30.0)	536 (16.2)
<i>Nutrition</i>			
Any breast milk, n (%)	2999 (96.5)	186 (97.9)	3185 (96.5)
<i>Indwelling devices</i>			
CVC, n (%)	955 (30.7)	115 (60.5)	1070 (32.4)
CVC days, median (IQR)	7 (5-10)	11 (7-18)	7 (6-11)
PAL, n (%)	44 (1.4)	7 (3.7)	51 (1.5)
PAL days, median (IQR)	2 (1-4)	1 (1-2)	2 (1-4)
PIV, n (%)	2463 (79.2)	121 (63.7)	2584 (78.3)
PIV days, median (IQR)	6 (3-11)	6 (2-15)	6 (3-11)
Chest tube, n (%)	105 (3.4)	12 (6.3)	117 (3.5)

	No HA-BSI n=3109	HA-BSI n=190	Total n=3299
Chest tube presence in days, median (IQR)	4 (2-6)	2.5 (1-4.5)	4 (2-6)
Urinary catheter, n (%)	261 (8.4)	33 (17.4)	294 (8.9)
Urinary catheter days, median (IQR)	2 (1-5)	2 (1-6)	2 (1-5)
Naso- or orogastric feeding tube, n (%)	2,959 (95.2)	188 (98.9)	3,147 (95.4)
Feeding tube days, median (IQR)	9 (5-18)	23.5 (14.5-38.5)	10 (6-19)
<i>Antibiotic exposure</i>			
Any antibiotic exposure, n (%)	2,536 (81.6)	189 (99.5)	2,725 (82.6)
Antibiotic days, median (IQR)	7 (4-11)	21 (12-28)	7 (4-12)
Antibiotic exposure, days 1-2, n	2,117 (68.1)	165 (86.8)	2,282 (69.2)
Antibiotic exposure, days 1-7, n (%)	2,495 (80.3)	183 (96.3)	2,678 (81.2)
<i>Surgery</i>			
Surgery during admission, n (%)	151 (4.9)	14 (7.4)	165 (5.0)
<i>Disposition</i>			
Length of stay in days, median (IQR)	13 (9-22)	30 (20-46)	14 (9-23)
Died, n (%)	248 (8.0)	46 (24.2)	294 (8.9)

eTable 1 notes. Abbreviations: CVC – central venous catheter; ELBW – extremely low birth weight; HA-BSI – healthcare-associated bloodstream infection; IQR – interquartile range; LBW – low birth weight; PAL – peripheral arterial line; PIV – peripheral intravenous catheter; VLBW – very low birth weight

**eTable 3. Hazard of healthcare-associated bloodstream infection (HA-BSI) among neonates admitted to three tertiary care neonatal intensive care units  $\geq 7$  days, Pune, India, May 1, 2017-July 31, 2019**

	HA-BSI	Patient-days	Unadjusted Hazard Ratios		Hazard Ratios Adjusted for Birth Weight	
			HR	95% CI	aHR	95% CI
<b>Demographic and Birth Characteristics</b>						
<i>Sex</i>						
Male	102	22269				
Female	88	16893	1.14	1.00-1.30	1.11	0.86-6.16
<i>Gestational Age</i>						
Extremely preterm (< 28 weeks)	28	4484	1.64	0.60-4.46	2.30	0.86-6.16
Very preterm (28-31 weeks)	73	16796	1.14	0.63-2.05	1.32	0.78-2.23
Moderate to late preterm (32-36 weeks)	60	11406	1.38	1.14-1.67	1.51	1.33-1.71
Term ( $\geq 37$ weeks)	16	4195				
<i>Birth weight</i>						
ELBW (< 1000g)	33	7878	0.87	0.33-2.27		
VLBW (1000-1499g)	94	17985	1.09	0.52-2.29		
LBW (1500-2499g)	48	9802	1.02	0.65-1.59		
Non-LBW ( $\geq 2500$ g)	15	3117				
<b>Clinical Characteristics</b>						
<i>Respiratory Support</i>						
Any respiratory support, past 3 days						
Yes	140	18232	3.30	2.66-4.12 $\ddagger$	3.00	2.61-3.44 $\ddagger$
No	50	20970				
Mechanical ventilation, past 3 days						
Yes	40	4202	2.00	1.35-2.95 $\ddagger$	1.96	1.40-2.76 $\ddagger$
No	150	35000				
<i>Nutrition</i>						
Breast milk, any prior day	175	37656	0.59	0.31-1.13	0.52	0.34-0.80 $\ddagger$
No breast milk	15	1546				
<i>Indwelling devices</i>						
CVC presence, past 3 days						
Yes	76	6680	2.74	2.23-3.37 $\ddagger$	3.04	2.50-3.69 $\ddagger$
No	114	32522				
Urinary catheter presence, past 3 days						
Yes	8	949	1.51	0.37-6.06	1.52	0.44-5.23
No	182	38253				
Naso- or orogastric feeding tube, past 3 days						

	HA-BSI	Patient-days	Unadjusted Hazard Ratios		Hazard Ratios Adjusted for Birth Weight	
			HR	95% CI	aHR	95% CI
Yes	176	33457	2.04	0.53-7.86	2.07	0.68-6.29
No	14	5745				
<i>Antibiotic Exposure</i>						
Antibiotic exposure, any prior day						
Yes	184	36250	3.10	0.76-12.70	3.01	0.79-11.54
No	6	2952				
Antibiotic exposure, past 3 days						
Yes	135	18019	2.48	1.98-3.11‡	2.62	1.95-3.52‡
No	55	21183				
Early antibiotic exposure (admission days 1-2)						
Yes	165	7446	1.86	0.86-4.03	1.81	0.90-3.65
No	25	31756				
Early antibiotic exposure (admission days 1-7)						
Yes	183	35764	3.06	1.17-7.95*	2.96	1.22-7.17*
No	7	3438				

eTable 2 notes. Hazard ratios were calculated using complementary log-log regression adjusting for day of admission as a smoothed function and using cluster robust standard errors to account for clustering of neonates within NICU sites. Abbreviations: aHR – adjusted hazard ratio; CI – confidence interval; CVC – central venous catheter; ELBW – extremely low birth weight; HA-BSI – healthcare-associated bloodstream infection; HR – hazard ratio; LBW – low birth weight; VLBW – very low birth weight.

\* p < 0.05, † p < 0.01, ‡ p < 0.001

**eTable 4. Duration of antibiotic courses initiated during the first seven days of admission among neonates admitted to three tertiary care neonatal intensive care units  $\geq 7$  days, Pune, India, May 1, 2017-July 31, 2019**

	<b>Duration <math>\geq 3</math> days n=2082</b>	<b>Duration <math>\geq 5</math> days n=1571</b>	<b>Duration <math>\geq 7</math> days n=1135</b>	<b>Duration <math>\geq 14</math> days n=273</b>	<b>All n=2678</b>
Any antibiotic initiation during first 7 days, n (%)	2082 (77.7)	1571 (58.7)	1135 (42.4)	273 (10.2)	2678 (100)
Antibiotic initiation within 1 day of negative blood culture, n (%)	1190 (73.1)	880 (54.1)	636 (39.1)	144 (8.9)	1628 (100)
Antibiotic initiation $>1$ day before or after a negative blood culture, n (%)	252 (86.9)	203 (70.0)	152 (52.4)	39 (13.6)	290 (100)
Antibiotic initiation without a blood culture, n (%)	640 (84.2)	488 (64.2)	347 (45.7)	90 (11.8)	760 (100)

eTable 3 notes. Duration of antibiotic courses among neonates admitted for at least seven days and started on an antibiotic course during the first week of admission. Neonates with a positive blood, urine, or CSF culture during the first week of admission were excluded from the subcohort. Duration of antibiotic course represents consecutive antibiotic days and could extend beyond the first week of admission; first dose was administered during the first week. Abbreviations: CSF – cerebrospinal fluid