

Supplementary Table S1 Summary of neonatology fellows' responses: clinical infectious diseases topics for a neonatal intensive care unit Antibiotic Stewardship Program

1. Discontinuation of antibiotics to decrease exposure
2. NEC: Should we use piperacillin/tazobactam, metronidazole + clindamycin, or gentamicin? How long should we treat NEC?
3. Indications for cefotaxime during shortage
4. Antifungal prophylaxis and treatment indications
5. Guidelines for initiating antibiotics for newborns admitted for respiratory distress in absence of risk factors
6. Management of clinically well-appearing babies with positive cord culture and negative baby culture
7. Utility of cord cultures vs. infant cultures vs. both
8. Management of "congenital pneumonia"
9. Management of coagulase negative Staphylococci with single positive blood culture
10. Duration of therapy for culture negative sepsis
11. Treatment of feeding intolerance which is not consistent with NEC
12. Management of premature infants with prematurity for maternal indications
13. Guidance for negative cultures in infants with antibiotic treated mothers
14. Treat or not to treat endotracheal tube cultures
15. Indications for probiotics
16. Most useful would be in establishing strict guidelines for initiation on empiric antibiotics at birth
17. Management of critically ill patients with bacteremia and only one central line for IV access a
18. Initiation of antibiotic therapy in infants born to mothers with chorioamnionitis
19. Discontinuation of antibiotics after 48 hours of negative cultures
20. Surgery prophylaxis
21. Management of early and late onset sepsis
22. Standardization of empirical antibiotic use

Abbreviation: NEC, necrotizing enterocolitis.

Supplementary Table S2 Summary of neonatology fellows' survey responses: knowledge, attitudes, and perceptions about antibiotic stewardship programs according to geographical regions in the United States					
Survey questions	Overall n (%)	Midwest n	Northeast n	South n	West n
Fellow year	139 ^a	23	43	59	14
First-year fellows	48 (35.0)	9	10	24	5
Second-year fellows	40 (29.2)	3	16	18	3
≥Third-year fellows	51 (37.2)	11	17	17	6
Neonatal intensive care unit size (patient beds)					
10–20	3 (2.2)	0	0	3	0
21–30	8 (5.8)	1	3	4	0
31–40	14 (10.1)	3	2	8	1
41–50	26 (19)	5	8	10	3
Greater than 50	88 (63.3)	14	30	34	10
External ASP collaborative participation					
Vermont Oxford Network iNICQ (2016 or 2017): choosing antibiotics wisely	67 (48.2)	11	23	30	3
State-level collaborative	6 (4.3)	0	1	2	3
Healthcare system-based collaborative, e.g., Kaiser Permanente	1 (0.7)	0	0	1	0
Regional collaborative	7 (5)	1	0	3	3
Sharing antimicrobial reports for pediatric stewardship collaborative	1 (0.7)	1	0	0	0
Knowledge questions (correct responses)					
Identified components of ASP	120 (86.3)	19	42	48	11
Identified appropriate time to discontinue antibiotics	139 (100)	23	43	59	14
Identified appropriate empirical antibiotic for neonatal meningitis	69 (49.6)	11	19	30	9
Identified optimal MSSA treatment	124 (89.2)	21	40	52	11
Attitude questions					
Presence of NICU ASP (yes)	102 (73.4)	20	37	34	11
If present, is NICU ASP useful?	59 (42.4)	14	18	21	6
If not present, would NICU ASP be helpful? ^b	37 (26.6)	2	5	25	3
Formal ASP teaching (yes)	56 (40.3)	10	18	21	7
Most useful format of ASP teaching (among 56 fellows with ASP teaching)					
Online learning modules	22 (15.8)	2	9	10	1
Small group case based conferences focusing on clinical scenarios	30 (21.6)	5	12	9	4
Audit and feedback of individual antibiotic ordering behavior (directly to prescriber)	31 (22.3)	6	8	13	4
Didactic lectures	25 (18)	7	4	9	5
Other/additional	1 (0.7)	0	0	0	1

Abbreviation: MSSA, methicillin susceptible *Staphylococcus aureus*; NICU ASP, Neonatal Intensive Care Unit Antibiotic Stewardship Program.

^aOne respondent had incomplete data for some sections. All responses provided were included in analysis.

^bAll respondents without dedicated NICU ASPs reported that it would be helpful.

Supplementary Material 1 Neonatology fellow survey form assessing knowledge, attitudes and perceptions about Antibiotic Stewardship Programs

1. What is your current level of neonatology training?
2. Do you have rotations in more than one NICU in your hospital system? (If yes, for the purposes of this survey, please refer to practices in your main NICU for answers)"
3. Where is your primary NICU located? (Responses will be kept confidential) Geographical area, Region, and State.
4. How many beds are in the primary NICU where you rotate?
5. How many pediatric beds (including NICU) are in the primary hospital where you rotate?
6. In your opinion, rate the importance of the following roles for ASPs in the NICU (1 = not important; 2 = somewhat important; 3 = no difference; 4 = very important; 5 = critically important)

Reduce prevalence of resistant organisms in the NICU environment	1	2	3	4	5
Reduce risk of <i>Clostridium difficile</i> infection	1	2	3	4	5
Prevent antibiotic associated adverse effects such as renal injury	1	2	3	4	5
Limit disruption of neonatal microbiome	1	2	3	4	5
Reduce health care costs	1	2	3	4	5

7. Which of the following is/are important components of antibiotic stewardship? Select all that apply.
 - (a) Using an antibiotic only when it is truly indicated
 - (b) Using the right drug at the right dose
 - (c) Using the correct route
 - (d) Using antibiotics for the proper duration based on the infectious process
 - (e) All of the above*
8. You are evaluating a premature infant, born at 27 weeks of gestation for maternal complications, who was started on gentamicin and ampicillin at birth. Blood cultures are negative at 48 hours and the infant is receiving age appropriate care in the NICU. What is the best course of action?
 - (a) Switch to cefotaxime and continue antibiotics for 7 days
 - (b) Discontinue antibiotics*
 - (c) Repeat blood cultures to determine duration of antibiotics
 - (d) Add fluconazole
9. A 5-day-old full-term infant is admitted from the emergency department with hypothermia, and decreased feeding and emesis. Maternal history is notable for inadequate penicillin prophylaxis for Group B Streptococcus colonization. You are concerned for meningitis. What do you do next?
 - (a) Start vancomycin and third generation cephalosporin
 - (b) Start piperacillin/tazobactam and metronidazole
 - (c) Obtain blood, urine, and cerebrospinal fluid (CSF) cultures and then start ampicillin and third generation cephalosporin*
 - (d) Obtain blood, urine, and CSF cultures and then start ampicillin and gentamicin
 - (e) Start vancomycin and piperacillin/tazobactam
10. A 42-day old ex 25 WGA infant developed labile blood pressures, and increased apneic events and respiratory distress 2 days ago. He has a central catheter and was started on vancomycin and cefotaxime for empiric antimicrobial coverage. His blood cultures are growing methicillin susceptible *Staphylococcus aureus*? What do you do about his antimicrobial coverage?
 - (a) Change to oxacillin and discuss catheter removal*
 - (b) Continue current coverage with vancomycin and cefotaxime
 - (c) Continue vancomycin, discontinue cefotaxime, and discuss line removal
 - (d) Change to ampicillin and gentamicin
11. Does your hospital have an antibiotic stewardship program (ASP) that includes the NICU?

Note: A dedicated program involving physicians and/or pharmacists to review antibiotic use, bacteria resistance patterns, appropriate drug dosing, clinician education, etc.

 - (a) Yes
 - (b) No
 - (c) Unsure

12. If yes, do you think your ASP is
- Useful
 - Delaying appropriate care
 - A method of improving clinical outcomes
13. If no, do you think an ASP dedicated to neonates in a NICU setting would be helpful?
- Yes
 - No
 - Unsure
14. If you answered “no” to the previous question, what is the top reason why you do not think an antibiotic stewardship program for the NICU would be helpful?
15. Have you had formal teaching or training on antibiotic stewardship practices during your fellowship?
- Yes
 - No
 - Unsure
16. Which format of antibiotic stewardship education would be most useful to you?^{2,6}
- Online learning modules
 - Small group case based conferences focusing on clinical scenarios
 - Audit and feedback of individual antibiotic ordering behavior (directly to prescriber)
 - Didactic lectures
 - Other/additional
17. Do you think a trainee-led ASP program (such as antibiotic time-out during rounds or sepsis checklists) would help improve antibiotic use in the NICU?
- Note: An antibiotic timeout is a verbal or electronic prompt to assess the continuing need for and choice of antibiotics when a patient’s clinical picture is clearer or more diagnostic information is available usually occurs 48 hours after starting antibiotics?⁷
- Probably yes
 - Definitely yes
 - Might or might not
 - Probably no
 - Definitely no
18. Do you think a nursing-led ASP program (such as antibiotic time-out during rounds) would help to improve antibiotic use in the NICU?
- Probably yes
 - Definitely yes
 - Might or might not
 - Probably no
 - Definitely no
19. Does your NICU participate in any external NICU antibiotic stewardship collaborative?
- Please check all that apply
- Vermont Oxford Network iNICQ (2016 or 2017): choosing antibiotics wisely
 - State-level collaborative
 - Health care system-based collaborative, e.g., Kaiser Permanente
 - Regional collaborative
 - Sharing Antimicrobial Reports for Pediatric Stewardship collaborative
 - Other: _____
20. If you selected “other” external NICU antibiotic stewardship collaborative, please list below.
21. Can specific areas of clinical infectious diseases in the NICU be standardized with an antibiotic stewardship program? Some examples may include management of patients with a single blood culture growing coagulase negative Staphylococcus, duration of therapy for culture-negative sepsis, or indications for fluconazole prophylaxis or probiotics in the NICU. Please share below any areas where an ASP might help to standardize management.