Section: Miscellaneous

Original Research Article

CULTURE-POSITIVE NEONATAL SEPSIS: CLINICAL PROFILE, RISK FACTORS, AND ANTIMICROBIAL SUSCEPTIBILITY PATTERNS IN A SPECIAL CARE NEONATAL UNIT OF CENTRAL ASSAM

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ABSTRAC

Background: Neonatal sepsis remains a major cause of morbidity and mortality in the first month of life. Its clinical features are often nonspecific, and pathogen distribution varies across regions. Understanding local microbial profiles and antibiotic susceptibility is essential for guiding empirical therapy and preventing antimicrobial resistance.

Aim: To assess risk factors, clinical presentation, causative organisms, and antibiotic susceptibility patterns in culture-proven neonatal sepsis.

Materials and Methods: This prospective observational cross-sectional study was conducted from 1st October2021 to 31st March 2022 in the Departments of Paediatrics and Microbiology, Tezpur Medical College and Hospital. Neonates aged 0–28 days with clinical features or risk factors for sepsis and a positive blood culture were included. Those with congenital anomalies or prior antibiotic use were excluded. Relevant demographic, clinical, microbiological, and antibiotic sensitivity data were recorded and analysed.

Results: Of 106 neonates with suspected sepsis, 46 (43.3%) were culture-positive. Early-onset sepsis accounted for 60.9%, and males comprised 56.5%. Term neonates formed 56.5%, and low-birth-weight neonates 52.1%. Frequent risk factors included premature rupture of membranes (39.1%), perinatal asphyxia (36.9%), and prolonged labour (28.2%). Common presentations were respiratory distress (52.1%), jaundice (45.6%), refusal to feed (41.3%), and convulsions (32.6%). Gram-positive organisms accounted for 50% of isolates, Gram-negative for 41.3%, and fungi for 8.6%. Staphylococcus aureus (43.4%) and Klebsiella spp. (30.4%) were predominant. S. aureus showed highest sensitivity to Vancomycin (100%) and Linezolid (85%). Gram-negative isolates were fully sensitive to Meropenem and Imipenem but resistant to Cephalosporins and commonly used antibiotics.

Conclusion: Nearly half of clinically suspected cases were culture-positive. High resistance to commonly used antibiotics and better sensitivity to Carbapenems and Vancomycin highlight the need for local antibiogram-based empirical therapy and strong antibiotic stewardship.

Keywords: Neonatal Sepsis, SCNU, Risk factors, Blood culture.

INTRODUCTION

Neonatal sepsis is a major cause of morbidity and mortality in the first month of life, contributing to about 9% of under-five deaths worldwide, with India accounting for a large proportion.[2] Many affected neonates develop long-term complications such as developmental delay, learning difficulties, cerebral palsy, and sensory impairment.[2]

Clinical features are often nonspecific and include temperature instability, respiratory distress, feeding difficulty, lethargy, abdominal distension, apnoea, and shock.[1] Risk factors for early-onset sepsis

(EOS) include low birth weight, prolonged rupture of membranes, foul-smelling liquor, multiple vaginal examinations and maternal fever, while late-onset sepsis (LOS) is often associated with prematurity, very low birth weight, prolonged hospitalization, and the use of invasive devices.[1]

In developing countries, common pathogens include Klebsiella pneumoniae, Acinetobacter spp., Staphylococcus aureus, and E. coli.[2]

Antimicrobial resistance is a growing global concern. In India alone, an estimated 50,000 neonatal deaths are attributed to resistance to first-line antibiotics.[2] While early initiation of antibiotics is often lifesaving, unnecessary or inappropriate use contributes substantially to antimicrobial resistance. As blood culture results typically require 48–72 hours, understanding local microbial patterns and antibiotic susceptibility is essential for guiding timely empirical therapy and preventing antimicrobial resistance.

MATERIALS AND METHODS

This prospective observational cross-sectional study was conducted between 1st October2021 and 31st March 2022 in the Departments of Paediatrics and Microbiology, Tezpur Medical College and Hospital. Neonates aged 0–28 days who presented with clinical features and/or risk factors for sepsis and had positive blood culture results were included. Neonates with congenital anomalies or those who had received antibiotics before sampling were excluded.

Clinical and demographic detail such as age, sex, gestational age, birth weight, mode and place of delivery, relevant maternal and neonatal risk factors, presenting clinical features, isolated organisms, and their antibiotic susceptibility profile were documented using a predesigned proforma.

Under strict aseptic precautions, 1–2 mL of blood sample was collected before initiation of antibiotics, inoculated into blood culture bottles and immediately loaded into the BacT/ALERT automated blood culture system. Once a positive signal was detected through carbon dioxide production, subcultures were performed on blood agar and MacConkey agar plates and aerobically incubated at 35–37°C. Organisms were identified based on colony morphology, Gram staining, and biochemical reactions using standard methods (Mackie & McCartney).

Antibiotic sensitivity testing was carried out by the Kirby–Bauer disk diffusion method. Zone diameters were measured and interpreted according to Clinical and Laboratory Standards Institute (CLSI) guidelines. Antimicrobial discs were obtained from HiMedia Laboratories Pvt. Ltd. Strains used for quality control were Staphylococcus aureus ATCC 23235 and Escherichia coli ATCC 25922. Commonly used antibiotics were tested for sensitivity.

RESULTS

During the study period, 106 babies with signs and symptoms of probable sepsis were admitted to the SCNU, and their blood samples were sent for culture. Out of these, 46 samples were culture-positive (43.3%), and these 46 cases were included in the study for analysis. Among them, 28 babies (60.86%) showed symptoms within the first 72 hours and were classified as early-onset sepsis (EOS), while 18 babies (39.13%) developed symptoms after 72 hours and were classified as late-onset sepsis (LOS).

Table 1: Risk Factors of Neonatal Sepsis

Sl no	Risk factors		Total (n=46)	EOS	LOS
1	Gender	MALE	27(56.5%)	16 (34.7%)	11(23.9%)
		FEMALE	19(41.3%)	12(26.06%)	7(15.2%)
2	Gestation	<28 weeks	2(4.3%)	2 (4.3%)	0 (0%)
		28-34 weeks	7 (15.2%)	4 (8.6%)	3 (6.5%)
		34-37 weeks	11(23.9%)	7 (15.2%)	4 (8.6%)
		>37 weeks	26(56.5%)	15(32.6%)	11(23.9%)
3	Birth weight	<1000 gm	2 (4.3%)	2 (4.3%)	0 (0%)
		1000-1500 gm	4 (8.6%)	2 (4.3%)	2 (4.3%)
		1500-2500 gm	18 (39.1%)	12(26.08)	6 (13.04%)
		2500 gm or more	22(47.8%)	12(26.08%)	10(21.7%)
4	Place of delivery	In born	33 (71.7%)	22(47.8%)	11(23.9%)
		Out born	13 (28.2%)	6(13.04%)	7(15.2%)
5	Mode of delivery	LSCS	21 (45.6%)	11(23.9%)	10(21.7%)
		SVD	25 (54.3%)	17 (36.9%)	8(17.3%)
7	Perinatal asphyxia		17 (36.9%)	10 (21.7%)	7 (15.2%)
8	Mechanical ventilation & CPAP		8 (17.3%)	3 (6.5%)	5 (10.8%)
9	Premature rupture of membrane (PROM)		18(39.1%)	11(23.9%)	7 (15.2%)
10	Meconium stained amniotic fluid (MSAF)		14(30.4%)	9 (19.5%)	5(10.8%)
11	Prolonged labour		13(28.2%)	7 (15.2%)	6 (13.04%)
12	Urinary tract infection		5 (10.8%)	4 (8.6%)	1 (2.1%)
13	Febrile illness		3 (6.5%)	2 (4.3%)	1 (2.1%)
14	Foul smelling liquor		3 (6.5%)	3 (6.5%)	0 (0%)

Risk factors associated with neonatal sepsis are summarized in Table I. Several neonates had multiple risk factors.

Gender distribution showed a male predominance, with 56.5% males (EOS 34.7%, LOS 23.9%) and 41.3% females (EOS 26.0%, LOS 15. 2%).Regarding gestational age, most neonates were term (56.5%), while 43.4% were preterm. Among the preterm group, 4.3% were <28 weeks, 15.2% were between 28–34 weeks, and 23.9% were 34–37 weeks. Birth weight distribution revealed that 52.1% were low-birth-weight (LBW) neonates, including 4.3% <1000 gm, 8.6% between 1000–1499 gm, and 39.1% between 1500–2499 gm. Normal-birth-weight neonates (≥2500 g) constituted 47.8%. A majority of the neonates were inborn (71.7%), with 47.8% belonging to the EOS group and 23.9% to the LOS group. The remaining 28.2% were outborn, comprising 13.04% EOS and 15.2% LOS cases. Most neonates were delivered by spontaneous vaginal delivery (54.3%), including 36.9% EOS and 17.3% LOS. The remaining 45.6% were delivered by LSCS, of which 23.9% were EOS and 21.7% were LOS.

Among perinatal risk factors, perinatal asphyxia was present in 36.9% of cases (EOS 21.7%, LOS 15.2%). Requirement of mechanical ventilation or CPAP was noted in 17.3% (EOS 6.5%, LOS 10. 8%).PROM was associated with 39.1% of cases (EOS 23.9%, LOS 15.2%). Prolonged labour was reported in 28.2% (EOS 15.2%, LOS 13.04%).

Maternal UTI was present in 10.8% (EOS 8.6%, LOS 2.1%), while maternal febrile illness was found 6.5% (EOS 4.3%, LOS 2.1%). Foul-smelling liquor was observed in 6.5% of cases, all belonging to the EOS group.

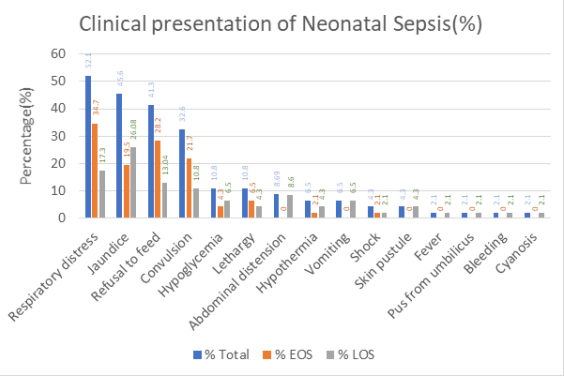

Figure 1: Clinical presentation of neonatal sepsis

Figure 1 is describing the clinical presentation. Multiple symptoms were presented in same patient. Respiratory distress (52.1%), Jaundice (45.6%), Refusal to feed 41.3% and Convulsion 32.6% were commonest presentation. Other were hypoglycemia (10.8%), lethargy (10.8%), abdominal distension 8.6%, hypothermia 6.5%, vomiting 6.5%, shock 4.3% seen in both EOS& LOS while skin pustule 4.3%, fever (2.1%), pus from umbilicus (2.1%), bleeding (2.1%) and cyanosis (2.1%) was found only in LOS.

Table 2: Distribution of isolated organism

Organism isolated	EOS (no &%)	LOS (no &%)	Total (no &%)
Gram positive	15 (53.5%)	8(44.4%)	23 (50%)
Staphylococcus aureus	14(50.0%)	6 (33.3%)	20 (43.4%)
Enterococcus species	1(3.5%)	1(5.5%)	2 (4.3%)
CONS	O(0%)	1(5.5%)	1(2.1%)
Gram negative	10 (35.7%)	9 (50%)	19 (41.3%)
Klebsiella pneumonia	8 (28.5%%)	6(33.3%)	14(30.4%)
Acinatobacter species	2 (7.14%)	2(11.1%)	4(8.6%)
Escherichia coli	0 (0%)	1(5.5%)	1(2.1%)
Fungus	3(10.7%)	1(5.5%)	4 (8.6%)
Total	28 (60.8%)	18(39.1%)	46(100%)

The distribution of the organism has been shown in Table II. Isolated organisms were gram positive (50%), gram negative (41.3%) and fungus (8.6%). Among gram positive organism Staphylococcus Aureus 43.4%, Enterococcus 4.3%, CONS 2.1%, and among gram negative organism Klebsiella (30.4%), Acinatobacter species (8.6%), E coli (2.1%).

Table 3: Sensitivity of gram positive organisms

Sl no	Name of antibiotics	STAPH. AUREUS	ENTERO-COCCUS SPECIES	CONS
1	Amikacin	12/20 (60%)	0/2 (0%)	1/1 (100%)
2	Clindamycin	15/20 (75%)	0/2 (0%)	0/1 (0%)
3	Ampicillin	4/20 (20%)	0/2 (0%)	0/1(0%)
4	CoTrimoxazole	8/20 40%)	0/2 (0%)	0/1(0%)
5	Doxicyclin	6/20 (30%)	0/2 (0%)	O/1(0%)
6	Linezolid	17/20 (85%)	2/2 (100%)	1/1(100%)
7	Vancomycin	20/20 (100%)	2/2 (100%)	1/1(100%)
8	Gentamycin	13/20 65%)	0/2 (0%)	1/1(100%)

The sensitivity pattern of gram positive bacteria against antibiotics were presented in Table III. They have wider variation of sensitivity Staphylococcus Aureus is highly sensitive to Vancomycin (100%) and Linezolid (85%), moderately to Clindamycin 75%) Gentamycin (65%). Others are less sensitive-Amikacin (60%), Co-trimoxazole (40%), Doxycycline (30%) and Ampicillin (20%).

Enterococcus is sensitive to both Vancomycin (100%) and Linezolid (100%) but others are not sensitive. CONS was detected in only in one sample. Vancomycin, Linezolid, Amikacin and Gentamycin is sensitive (100%), others are not sensitive.

Enterococcus was isolated in 2cases (4.3%) only, Sensitive to and Vancomycin (100%) linezolid others were resistant.

CONS was isolated only in one cases which is 100% sensitive to Gentamycin, Amikacin, Gentamycin, Vancomycin and Linezolid , other were resistant.

Table 4: Sensitivity pattern of gram negative organism

Sl no	Name of the antibiotics	Klebsiella pneumonia	ACINETOBACTER SPECIES	ESCHERICHIA COLI
1	Amikacin	11/14 (78.5%)	1/4(25%)	1/1 (100%)
2	Cotrimoxazole	3/14 (21.4)	0 (0%)	1/1 (100%)
3	Gentamycin	10/14 (71.4%)	1/4 (25%)	1/1 (100%)
4	Piperacillin-tazobactum	6/14 (42.8%)	0/4 (0%)	0/1 (0%)
5	Ceftrioxone	4/14 (28.5%)	0/4 (0%)	0/1 (0%)
6	Cefuroxime	0/14 (0%)	0/4 (0%)	0/1 (0%)
7	Amoxycav	8/14 (57.1%)	0/4 (0%)	0/1 (0%)
8	Imipenem	14/14 (100%)	4/4 (100%)	1/1 (100%)
9	Meropenem	14/14 (100%)	4/4 (100%)	1/1 (100%)
10	Levofloxacin	3/14 (21.4%)	3/4 (75%)	0 (0%)
11	ceftazidimie	4/14 (28.5%)	0/4 (0%)	0 (0%)

The sensitivity pattern of gram-negative isolates to 11 commonly used antibiotics is presented in Table IV. The organisms demonstrated wide variability in antibiotic susceptibility.

Klebsiella pneumoniae was the most frequently isolated gram-negative organism. It showed 100% sensitivity to Meropenem and Imipenem. Moderate sensitivity was observed to Amikacin (78.5%), Gentamicin (71.4%), Amoxiclav (57.1%) and Piperacillin–Tazobactam (42.8%). The organism showed low sensitivity to Ceftazidime and Ceftriaxone (28.5% each), Levofloxacin and Cotrimoxazole (21.4% each), and was completely resistant to Cefuroxime (0%).

Acinetobacter species, detected in four cases, were fully sensitive (100%) to Meropenem and Imipenem. Sensitivity to Levofloxacin was 75%, whereas Amikacin and Gentamicin showed only 25% sensitivity. The isolates were resistant to all remaining antibiotics, including Cotrimoxazole, Piperacillin–Tazobactam, Ceftriaxone, Cefuroxime and Ceftazidime.

Escherichia coli, isolated in one case (2.1%), demonstrated complete sensitivity (100%) to Amikacin, Cotrimoxazole, Gentamicin, Imipenem and Meropenem. It showed no sensitivity to Piperacillin–Tazobactam, Ceftriaxone, Cefuroxime, Amoxiclav, Levofloxacin and Ceftazidime.

DISCUSSION

Among 106 neonates with suspected sepsis, 46 had positive blood cultures (43.3%). Reported culture-positivity varies widely across studies: Singhvi M,[3] (7%), Das M,[4] (24.1%), Devi D,[5] (46.66%), Saha N[6] (57.98%), and Garg A,[7] (66.6%).

Of the 46 culture-positive cases, 28 had EOS and 18 had LOS (EOS 60.86%, LOS 39.1%). Similar findings were reported by Das M,[4] (61%), Kuruvilla KA,[8] (77.1%), Verma T,[9] (61.3%), and Singhvi M,[3] (61.6%). In contrast, Mahakud NK,[10] reported more LOS (72.2%) than EOS (27.8%).

Among affected neonates, 43.7% were preterm and 56.5% term. Although some studies report higher preterm involvement (Mahakud NK,[10] Singhvi M,[3] Pandit BR,[11]), others show patterns similar to ours (Saha N,[6] Eswaran L,[12] Devi D,[5]). Differences may relate to population and referral variations.

Male predominance (56%) matched trends in several studies: Devi D,[5] (66.6%), Eswaran L,[12] (57.3%), Singhvi M[3] (50.6%), Das M,[5] (68.8%), Saha N,[6] (62.18%), Kuruvilla KA,[8] (68.3%), and Verma T,[9] (75%).

Low-birth-weight infants accounted for 52.1% of cases, consistent with findings from Pandit BR[11] (78.2%), Eswaran L,[12] (75.3%), Saha N,[6] (60.5%), and Devi D,[5] (53.3%).

Normal vaginal delivery contributed to 54.3% of cases, similar to Saha N,[6] (52.9%). EOS was more common after spontaneous vaginal delivery. Other studies report variable associations: Pandit BR,[11] (76.8%) and Eswaran L,[12] (41%).

Inborn babies comprised 71.7% of cases, comparable to Jatsho J,[15] (88.2%), Singhvi,[3] (67%), and Mohakud NK,[10] (53.9%).

Perinatal asphyxia was present in 36.9%, higher than Eswaran[12] (20.8%). Ventilation/CPAP was required in 17.3% (lower than Eswaran's 29.5%). PROM occurred in 39.1%, higher than Munot DC,[13] (31.2%), Jatsho J,[15] (27.1%), and Eswaran,[12] (7.6%). Prolonged labour (28.2%) was lower than Salama B,[14] (70.6%).

Maternal UTI was noted in 10.8% (Jatsho J,[15] 1.9%; Munot DC,[13] 15.2%). Maternal fever occurred in 6.5% (similar to Jatsho J,[15]: 7.2%; lower than Munot DC,[13]: 22.4%). Foul-smelling liquor (6.5%) matched Shivaprasad B,[18] (6%) and was higher than Jatsho J,[15] (2.8%).

In our study, the most common presenting symptom in neonates with sepsis was respiratory distress (52.1%), followed by jaundice (45.6%), refusal to feed (41.3%), and convulsions (32.6%). Other features included hypoglycemia (10.8%), lethargy (10.8%), abdominal distension (8.6%), and

hypothermia (6.5%). These findings suggest respiratory and neurological manifestations are key indicators of neonatal sepsis, consistent with previous studies. Pandit BR et al. reported respiratory distress (20.4%), fever (17.5%), and poor cry (14.75%) as common features.[11] Tiwari MK et al. noted respiratory distress (66.5%), poor feeding (62.96%), and fever (51.8%)16, while Munot DC et al. documented temperature instability (75.6%), jaundice (79.2%), feeding intolerance (66.8%), respiratory distress (57.2%), and apnea (35.6%).[13] These differences reflect variability in demographics, presentation timing, and causative pathogens.

In our study, Gram-positive organisms constituted 50% of isolates, and Gram-negative 41.3%, similar to findings by Singhvi M,[3] (57.3% and 45.2%), Das M,[4] (51.2% and 46.3%), and Pandit BR,[11] (74.39% and 25.6%). However, some studies report Gram-negative predominance, such as Devi D,[5] (53.3%) and Garg A,[7] (57.5%), highlighting the importance of local surveillance.

The three most common pathogens in our study were Staphylococcus aureus (43.4%), Klebsiella spp. (30.4%), and Acinetobacter spp. (8.6%). Pandit BR,[11] also reported S. aureus predominance (63.08%) followed by Klebsiella (13.2%) and Streptococcus spp. (7.71%), while Singhvi M,[3] found S. aureus (28.7%) followed by Acinetobacter (24.6%). Das M,[4] documented S. aureus (43.9%), Klebsiella (22%), and Acinetobacter (12.2%), whereas Garg A,[7] observed E. coli (27.5%) as the most common isolate. The high prevalence of S. aureus may reflect its presence in normal skin and nasal flora and potential transmission via inadequate hand hygiene.

In early-onset sepsis (EOS), S. aureus (50%) predominated, followed by Klebsiella spp. (28.5%), Acinetobacter spp. (7.14%), and Enterococcus spp. (3.5%). No EOS cases were caused by Coagulase-negative Staphylococci (CONS) or E. coli. These results align with Pandit BR,[11] (S. aureus 62.7%, Klebsiella 14.3%, Pseudomonas 5.51%) and Singhvi M[3] (S. aureus, Enterococcus, Acinetobacter), though Kuruvilla KA,[8] reported E. coli (23.3%) and Das M,[4] found Klebsiella (36%) as predominant EOS pathogens. Fungal infections occurred in 8.6% of cases, similar to Singhvi M,[3] (9.8%).

In late-onset sepsis (LOS), S. aureus (33.3%) and Klebsiella spp. (33.3%) were most common, followed by Acinetobacter spp. (11.1%), and Enterococcus spp., CONS, and E. coli (5.2% each). Kuruvilla KA,[8] reported Klebsiella as the primary LOS pathogen, followed by Enterococcus, Enterobacter, and S. aureus, while Pandit BR[11] found high S. aureus prevalence (64.39%). Singhvi M,[3] observed Acinetobacter predominance. These findings highlight regional variations in LOS etiology.

Antibiotic sensitivity patterns revealed S. aureus had low sensitivity to Co-trimoxazole (40%), Doxycycline (30%), and Ampicillin (20%), moderate sensitivity to Clindamycin (75%), Gentamicin (65%), and Amikacin (60%), and high sensitivity to Vancomycin (100%) and Linezolid (85%).[3,7] Kuruvilla KA,[8] reported high resistance to Vancomycin (58.8%) and Linezolid (52.9%). Klebsiella showed high sensitivity to Meropenem and Imipenem (100%), moderate to Amikacin (78.5%), Gentamicin (71.4%), Amoxiclav (57.1%), and Piperacillin-Tazobactam (42.8%), and poor sensitivity to Ceftazidime, Ceftriaxone (28.5%), Levofloxacin (21.4%), and Co-trimoxazole (21.4%). Saha N,[6] reported moderate sensitivity to Ceftriaxone (83.3%), Meropenem (77.78%), Imipenem (77.78%), and Piperacillin-Tazobactam (66.67%), while Garg A,[7] noted high resistance to several antibiotics including Meropenem and Imipenem. Acinetobacter isolates were fully sensitive to Meropenem and Imipenem, moderately sensitive to Levofloxacin (75%), and poorly sensitive to Amikacin and Gentamicin (25%).

Only one E. coli isolate was identified, showing 100% sensitivity to Amikacin, Cotrimoxazole, Gentamicin, Imipenem, and Meropenem but complete resistance to Piperacillin-Tazobactam, Ceftriaxone, Cefuroxime, Amoxiclav, Levofloxacin, and Ceftazidime. Enterococcus (4.3%) was fully sensitive to Linezolid and Vancomycin but resistant to other antibiotics, consistent with Das M.[4] CONS (2.1%) were fully sensitive to Amikacin, Gentamicin, Linezolid, and Vancomycin, matching Pandit BR,[11] findings, though Das M,[4] reported lower sensitivity to Gentamicin and Amikacin.

These results underline the broad clinical spectrum of neonatal sepsis, with respiratory and neurological symptoms being most frequent. They also highlight regional differences in pathogen distribution and antibiotic susceptibility, emphasizing the importance of continuous local surveillance to guide empirical therapy.

CONCLUSION

Nearly half of clinically suspected neonatal sepsis cases were culture-positive, with S. aureus and Klebsiella spp. being the leading pathogens. Resistance to commonly used antibiotics was high, while Carbapenems and Vancomycin remained effective. These findings highlight the need for local antibiogram-based empirical therapy and robust antibiotic stewardship to limit the emergence of multidrug-resistant organisms.

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