CENTRAL VENOUS CATHETER ASSOCIATED BLOOD STREAM INFECTION IN NEONATAL INTENSIVE CARE UNIT - PREDICTION AND PREVENTION
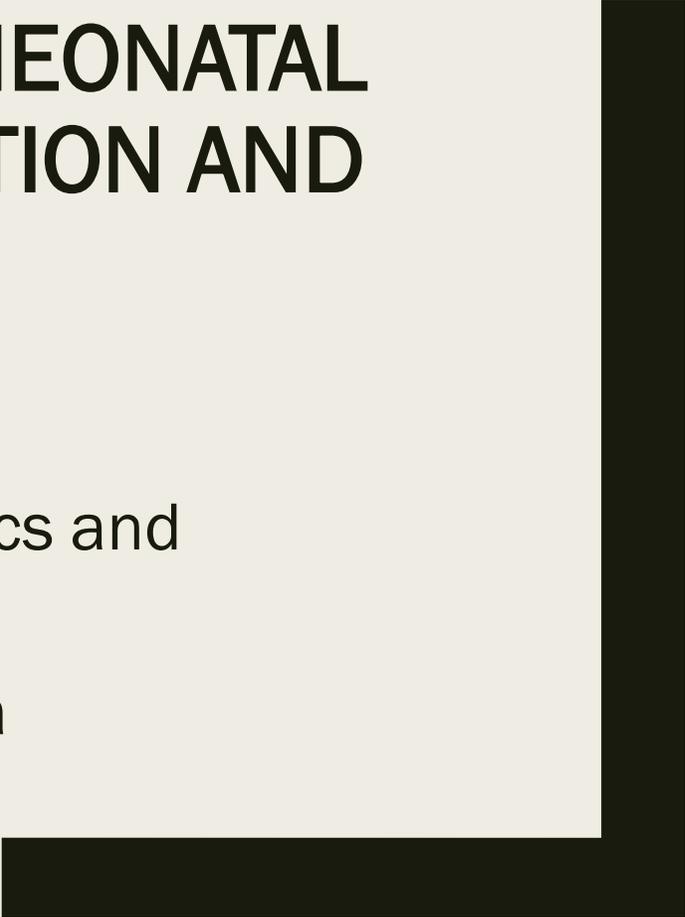
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Introduction

- **Central venous catheters (CVCs)**
  - Common form of vascular access in the NICU - Parenteral nutrition, complex care

- Major source of **late onset sepsis** and the most common cause of hospital acquired infection

Introduction

Implications of neonatal CVC-BSI

- Mortality (4% to 20%) *
- Morbidity (increased ventilation and respiratory supports)
- Prolonged hospital stay (average 7 days)
- Poor growth and adverse neurodevelopmental outcome at 2 years of age

Importance in identifying modifiable risk factors to reduce infection rate

Saint S, Veenstra DL, Lipsky BA. The clinical and economic consequences of nosocomial central venous catheter- related infection: are antimicrobial catheters useful? Infect Control Hosp Epidemiol. 2000 ; 21(6):375-380

AIM

1. Determine the incidence of CVC-BSI in our NICU.
2. Identify potential factors contributing to CVC-BSI.

Review the effectiveness of implementing a CVC-BSI prevention bundle.

Definitions

CVC - Catheters inserted into a central vein - terminated at or close to the heart or in one of the great vessels (inferior vena cava, superior vena cava, brachiocephalic, internal jugular vein or subclavian vein)

- **Laboratory confirmed CVC- associated blood stream infection (LC CVC-BSI)** - Positive blood cultures while the CVC was insitu and the cultured organism was not related to infection from an alternative source.

- **Clinical CVC- BSI** - development of temperature instability, tachypnoea, apnoea, lethargy, abdominal distension, an increase in C reactive protein (CRP) level, or subtle nonspecific signs in keeping with probable sepsis, but in the absence of a positive blood culture and clinical signs attributable to any particular organ system.

Design

■ Retrospective analysis of prospectively collected data over 9 years (2006–2014)

■ Pooled data - Analysed for LC CVC BSI and clinical CVC BSI pooled together

Inclusion criteria:

All CVCs inserted

First hospitalisation to NICU, Royal Hobart Hospital

Exclusion

Umbilical line

CVC-BSI rate per 1000 catheter days - number of CVC-BSI divided by the number of catheter days and multiplying the result by 1000.

Variables studied

- Birth weight
- Intrauterine growth restriction
- Gestational age

- Type of catheter (PICC, 3F to 5F)
- Number of lumens
- Site of insertion
- Operator seniority
- Line adjustment after insertion to locate the tip in appropriate position
- Breaches in catheter to deliver medications
- Nature of Infusate
- Presence of previous catheters
- Presence of multiple CVC's concurrently
- Underlying disease

Methodology

- Baseline data extracted from NICU data base

- Study Parameters from DMR and charts review

- Microsoft excel and NCSS software for analysis

- Continuous data – Median, interquartile ranges - Mann Whitney test

- Categorical data- Chi square test

- Associations – Logistic regression

　　　　Univariate analysis done- Association of parameters with catheter infection

　　　　Multivariate analysis model- for factors found predictive on univariate analysis

P value <0.05 taken significant

CVC BSI rates

- Pooled – 19.2/1000 catheter days
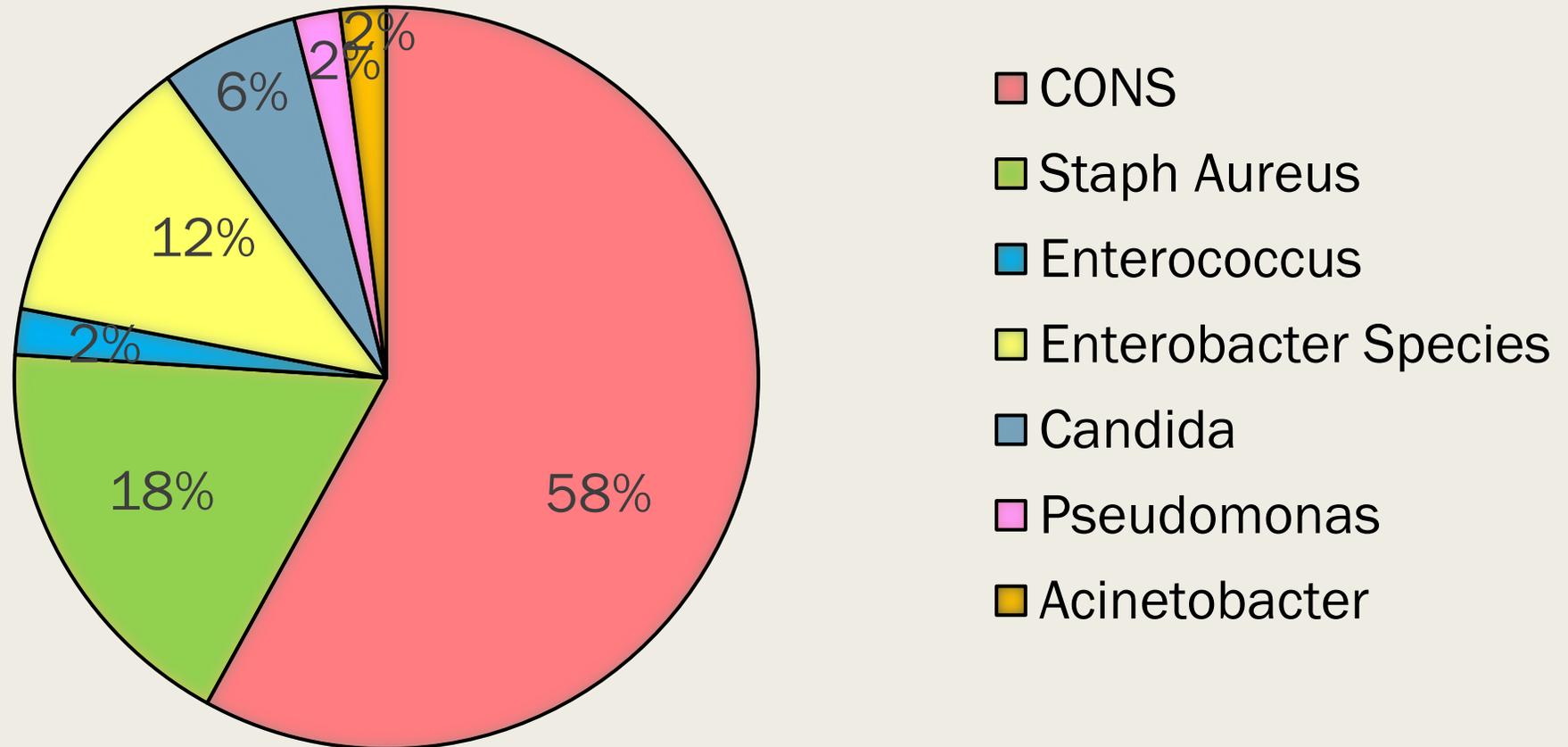- LC CVC-BSI – 8.2/ 1000 catheter days

Table 1: Patient demographics

	CVC-BSI	No CVC-BSI	P value
Number of patients (n)	119	534	
Birth weight (g)	930* (860-1085)	1200* (901-1880)	<0.01
Gestation (weeks)	27* (26-28)	29* (27-34)	<0.01
Males (n)	68 (57%)	295 (55%)	0.7
Females(n)	51 (42%)	239 (45%)	
Male: Female	1.3:1	1.2:1	

Table 1: Demographics of neonates admitted to the NICU who had CVC inserted. Data presented as median (IQR) or n (%). CVC-BSI: Central venous catheter associated blood stream infection. P value considered statistically significant if P <0.01.

Figure 1: Organisms cultured on LC CVC-BSI

- CONS — 58%
- Staph Aureus — 18%
- Enterococcus — 2%
- Enterobacter Species — 12%
- Candida — 6%
- Pseudomonas — 2%
- Acinetobacter — 2%

Table 2: Predictive factors for CVC-BSI

	OR (95% CI)	P value
Gestation < 28 weeks	2.9 (1.8-4.7)	<0.01
Saphenous vein insertion	1.99 (1.3-3.09)	<0.01
Parenteral nutrition	2.3 (1.5-3.8)	<0.01
Multi-lumen CVCs	5.6 (2.8-11.4)	<0.01
Underlying GIT disease	2.1 (1.3-3.5)	0.05

Table 2: Factors examined and found predictive of neonatal CVC-BSI. Results presented as odds ration (95% confidence interval). GIT: Gastrointestinal tract. P value considered statistically significant if P <0.01

Table 3: Factors not predictive of CVC-BSI

			P value
Duration of CVC *in situ*	≤10 days	84/442 (19%)	0.4
	>10 days	32/179 (17.9%)	
CVC adjustment		26/141 (18.4%)	0.6
CVC breaches		20/117 (17%)	0.7
CVC size	24 G	8/46 (17.4%)	0.7
	28 G	104/486 (21.4%)	0.3
	Others	7/52 (13.5%)	
Multiple CVCs		11/60 (18.3%)	0.9
Personnel inserting CVC	SMO	64/397 (16.1%)	
	JMO	55/256 (21.5%)	0.08

Table 3: Factors examined and demonstrated to be not predictive of neonatal CVC-BSI. G: gauge. Multiple CVCs reflects the presence of multiple CVC inserted in a neonate at any given time. SMO: Senior Medical Officer. JMO: Junior Medical Officer. P values are considered statistically significant if P <0.01.

Operator related factors

Veins used

- Saphenous vein

- **Below diaphragm veins** (femoral and saphenous) more likely to be infected compared to above diaphragm venous lines

Operator seniority

- No difference in infection risk

- Senior registrar, consultants and registrars

Catheter related

- Multilumen CVC's

- Infusate – Parenteral nutrition (?Lipids in the TPN predisposes to infection)

Patient related factors- Underlying GIT

GIT disease predisposed to infection

- *Definite NEC, Gastroschisis, Omphalocele, intestinal obstruction*

CVC prevention bundle

CVC prevention bundle

Data for the subsequent 12-months was prospectively collected following the introduction of a CVC-BSI prevention bundle and the infection rates were compared over the two epochs.

CVC insertion by designated team of trained physicians who have successfully completed

- CVC training package
- Aseptic non-touch technique (ANTT)
- Hand hygiene modules, and
- Accreditation by a neonatal consultant after supervision of two satisfactory CVC insertions

CVC prevention bundle

- CVC insertion checklist

- A dedicated nurse observing CVC insertion to ensure asepsis

- Appropriate structural barriers around the patient (e.g. screens)

- Dedicated CVC insertion trolley and

- Standardized dressing, redressing and CVC access procedures

CVC BSI rates

- Pooled – 19.2/1000 catheter days
- LC CLABSI – 8.2/ 1000 catheter days

After CVC bundle – 1.2 per 1000 catheter days

CVC BSI rates across countries

- CVC - BSI rate – 1.7 to 2.3 cases /1000 catheter days*

- Spain – 6.7/1000

- Brazilian and Latin American hospitals (1.6 to 44.6/1000 catheter days)

- Brazilian study (15/1000 in 2010 to 13/1000 in 2011)**

* Safdar N, maki DG.Risk of catheter-related blood stream infection with peripherally inserted central venous catheters used in hospitalized patients. Chest.2005;128(2):489-495

**Rosado V, Camargos P, Clemente W, Romanelli R. Incidence of infectious complications associated with central venous catheters in pediatric population. Am J Infect Control 2013;41:e81-e84

Conclusions

1. Below diaphragm central line insertion preferably avoided
2. Judicious use of multilumen catheters
3. CVC prevention bundles
4. CVC BSI Surveillance

Acknowledgements

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Thank you

CLABSI rates (Per 1000 PICC line days)	
CIABSI rate for LC confirmed infection	8.2
CLABSI rate for LC and clinical infection	
CLABSI rate for SGA babies (Combined)	11.3
CLABSI rate in SGA babies LC confirmed	5.3
SGA babies in less than 28 weeks (Combined)	8
SGA babies in less than 28 weeks(LC confirmed)	2

Central venous catheter analysis results					
Veins used					
Saphenous	54	170	224	24.1	0.005
Antecubital fossa	33	207	240	13.8	0.02
Femoral	12	47	59	20.3	
Jugular	1	9	10	10	
Forearm	14	49	63	22	
Scalp	5	48	53	9.4	
Others(Scalp,subclavian,wrist)	0	4	4	0	

CVC Manipulation					
Line note manipulated	93(78%)	458(78%)	551	16.9	0.6
Line manipulated	26(22%)	115(22%)	141	18.4	

SGA					
SGA	17	129	146	11.6	0.02
AGA	102	405	507	20.1	

SGA in less than 28 weeks					
SGA less than 28 weeks	12	41	53	22.6	0.002
SGA more than 28 weeks	5	88	93	5.4	

Infusate					
TPN/IL	78	274	352	22.2	0.007
Multiple infusions	41	260	301	13.6	

CVC breaks					
No Line breaks	99	437(82%)	536	18.5	0.7
Line breaks	20	97(18%)	117	17	
Total	119	534	653		
Total line breaks - 17.9					

Duration of line					
Median	7(6-9)	8(5-12)			0.4
Less than 5	39	146	185	21	(for lines less than 10 versus more than 10 and also when analyzed less than 5 versus more than 5)
6 to 10	45	212	257	17.5	
11 to 15	17	98	115	14.8	
16 to 20	15	49	64	23.4	
More than 20	3	29	32	9.4	

Number of lumen for CVC					
1	99	504(94%)	603	16.4	0.00
More than 1	20	30(6%)	50	40	
Total	119	534	653		

Previous PICCS				
Previous PICC	54	59	113	47.8	0.00
None	65	312	377	17.2	

Personnel inserting the PICC				
Senior Registrar	21	147	168	12.5	0.04
Consultant	43	186	229	18.8	0.6
Others	47	183	230	20.4	
Total	111	516	627		
Not recorded	8	18	26		

Type of catheter					
24G	8	41	46	17.4	0.7
+28G	104	444	486	21.4	0.3
Others	7	49	52	13.5	
Total	119	534	653		

Underlying severe disease					
GIT	45	106	151	29.8	0.00
Non GIT	74	428	502	14.7	

Multiple CVC's					
No	108	485 (91%)	593	18.2	0.9
Yes	11	49(9%)	60	18.3	
Total	119	534	653		

Outcome					
Normal	60(50.4%)	391(73%)	451	13.3	0.00
Abnormal (Dev delay, Stoma…)	59(49.6%)	143(27%)	202	29.2	
Total	119	534	653		
Death	14	24	38	36.8	0.00

Total Saphenous vein %	34.3%				
Total Antecubital fossa %	36.7%				
Total line manipulated – 21.6%					
Management basis					
Clinical	35(70%)				
Clinical and septic blood	11(22%)				
Septic blood	4(8%)				
Consequence of infection					
No increase in supports	24(48%)				
Intervention	26(52%)				
Underlying medical problem					
Total % with GIT problems	23				
Total % without GIT problems	77				
Total % of Multiple PICCS	9.2				