NEONATAL INFECTION OUTBREAKS

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Outbreaks: *more cases* in a time / place / population *than expected*; > 2 linked cases

**Modes of transmission:**
- contact
- respiratory
- ingestion
- inoculation
- trans-placental

**Infection types and pathogens:** majority are bloodstream infections (BSI)
- Bacteria: *K. pneumoniae*, *S. aureus*, *A. baumannii*, *S. marcescens*
- Viruses: Rotavirus, Norovirus, RSV, influenza
- Fungi: mostly *Candida* spp; occasionally: TB, HIV

**Detection:**
Routine surveillance activities (*you only find what you’re looking for!*
Hospitalized neonates are vulnerable to infection:
• pathogen exposures occurring in utero, intrapartum, and postnatally
• immature immunity, reduced physical barriers, invasive devices, antibiotic exposure, frequent handling, prolonged hospitalization
• overcrowding, understaffing, and shared equipment

High income neonatal unit experience 10 outbreaks/year (> 2 linked cases); burden of neonatal unit outbreaks in Africa is unknown.
What is known about neonatal outbreaks and healthcare-associated infections in Africa

What is yet to be researched!

You cannot manage what you cannot measure.
The situation at Tygerberg hospital neonatal unit

>7000 deliveries per year, LBW rate = 40 %
134 beds: 8 NICU, 4 high care, 4 wards with high, intermediate and KMC care

Increasing survival of inborn ELBW infants (<1000g):
43% - 55% - 76% - 85% (1994-2010)

Insufficient facilities and staffing ratios
Insufficient isolation rooms (< 5% of beds)

OVERCROWDING
INFECTION
Gram negative pathogens predominate (neonatal HA-BSI at Tygerberg Hospital)

Top 10 BSI pathogens (n= 717; 93% of total pathogens)

- K. pneumoniae: 30%
- S. marcescens: 11%
- A. baumannii: 9%
- E. coli: 7%
- E. cloacae: 2%
- P. aeruginosa: 2%
- S. aureus: 14%
- Enterococcus spp: 11%
- Group B streptococci: 5%
- Candida spp: 4%

Gram negatives (65%)  Gram positives (31%)  Fungi (4%)

Dramowski Paeds Int Child Health 2015
<table>
<thead>
<tr>
<th><strong>TBH neonatal unit</strong></th>
<th><strong>African neonatal units</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Neonatal outbreaks attended by paediatric infections diseases and infection prevention teams</td>
<td>Neonatal outbreaks reported in PubMed</td>
</tr>
<tr>
<td>May 1, 2008 to April 30, 2016</td>
<td>January 1, 1996 - January 1, 2016</td>
</tr>
<tr>
<td>Pathogens reported, outbreak size, crude mortality rates, outbreak source and control measures</td>
<td></td>
</tr>
<tr>
<td>Tygerberg hospital neonatal unit</td>
<td>African neonatal units</td>
</tr>
<tr>
<td>---------------------------------</td>
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<tr>
<td>13 outbreaks over 8 years</td>
<td>20 outbreaks over 20 years</td>
</tr>
<tr>
<td>148 babies</td>
<td>524 babies</td>
</tr>
<tr>
<td>(11 deaths; 7% overall mortality; 16% mortality for bacterial pathogens)</td>
<td>(177 deaths; 34% crude mortality)</td>
</tr>
<tr>
<td>Viruses: rota, influenza, measles</td>
<td>50% of outbreaks were caused by ESBL-producing <em>K. pneumoniae</em></td>
</tr>
<tr>
<td>Bacteria: <em>S. marcescens</em>, <em>A. baumannii</em>, MRSA, VRE</td>
<td></td>
</tr>
</tbody>
</table>
January 2017 – Prospective surveillance at TBH

All positive lab reports for TBH – focus on alert organisms

Central Data Warehouse, JHB

Data sifted

Reports back to managers

Microbiology

Alert organisms

Clinicom

Inpatient days

UIPC

1

2 a

2 b

3

All positive lab reports for TBH – focus on alert organisms
January 2017: prospective BSI* surveillance

<table>
<thead>
<tr>
<th>Bloodstream Infections on the Neonatal Platform</th>
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<tbody>
<tr>
<td><strong>Patient</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>30/06/2017</td>
</tr>
<tr>
<td>27/06/2017</td>
</tr>
<tr>
<td>29/06/2017</td>
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<tr>
<td>20/06/2017</td>
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<td>23/06/2017</td>
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<td>20/06/2017</td>
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<tr>
<td>21/06/2017</td>
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<tr>
<td>17/06/2017</td>
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<tr>
<td>15 &amp; 16/05/2017</td>
</tr>
<tr>
<td>10, 16 &amp; 18/05/2017</td>
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<tr>
<td>17/05/2017</td>
</tr>
<tr>
<td>16/05/2017</td>
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</tbody>
</table>

HAI BSI rate = \( \frac{\text{total isolates}^1}{\text{patient days}^2} \times 1000 \)

1. total monthly blood culture pathogen isolates
2. sum of wards in-patients at midnight for a calendar month

*Includes maternal-derived BSI/EONS
Multiple pathogens:
- carbapenem resistant *Acinetobacter baumannii* (CRAB)
- methicillin resistant *Staphylococcus aureus* (MRSA)
- carbapenem resistant *Klebsiella pneumoniae* (CRE)
  i.e. unlikely to be a common / point source outbreak

Infection profile:
65 confirmed infection episodes
- most were bloodstream infections (BSI)
- few cases of central line associated BSI, ventilator-associated pneumonia (VAP)

Crude mortality rate = 34% (22/65)
Factors contributing to increasing BSI infection rates

1. Shortage of *alcohol handrub*

2. Shortage of *carers* to assist with *cleaning* medical equipment (incubators) and the environment

3. **Cluttered environment** (made cleaning difficult, and exposed items to contamination)

4. **Damaged equipment** e.g. mattresses, cabinets with drawers that could not close – contamination of contents

5. Potential contamination from *washing basins* in clinical areas (reservoir for gram negative pathogens)
1. Availability of **alcohol rub**
2. Incubator cleaning
(takes 25 minutes/incubator)
Motivation for 1 full time carer per neonatal ward (5 carers: A9NICU; G2, G1, J3 and G8)

Job description for the previous carer working in G8 (30 bed neonatal ward)
- low care ward (the requirements are higher in G2 and A9NICU)

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Time per item</th>
<th>Equipment per day</th>
<th>Equipment per month (30 days)</th>
<th>Total time per month</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cleaning of incubators</td>
<td>(25 minutes per incubator)</td>
<td>6 incubators</td>
<td>180 incubators</td>
<td>75 hours</td>
</tr>
<tr>
<td>2. Cleaning of phototherapy lights</td>
<td>(5 minutes)</td>
<td>6 lights</td>
<td>180 lights</td>
<td>15 hours</td>
</tr>
<tr>
<td>3. Cleaning of infusion pumps (used for iv fluids and nasogastric tubes)</td>
<td>(5 minutes)</td>
<td>10 pumps</td>
<td>300 pumps</td>
<td>25 hours</td>
</tr>
<tr>
<td>4. Cleaning of milk fridge</td>
<td>(25 minutes)</td>
<td>2 fridges</td>
<td>60 fridges</td>
<td>25 hours</td>
</tr>
<tr>
<td>5. Cleaning of glass containers for expressed breast milk and packing them for milk kitchen*</td>
<td>(1 minute)</td>
<td>80 glass containers</td>
<td>2400 bottles</td>
<td>40 hours</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>180 hours per month</strong></td>
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</tbody>
</table>

* Each baby get 2 hourly feeds (12 feeds per 24 hours): 12 feeds x 30 babies = 360 feeds/ per day = minimum of 80 bottles to be washed per day within each 25-30 bedded ward
3. Equipment to support uncluttering of clinical areas (bedside cabinets)
4. Damaged equipment
(blood stained, puncture marks - new bed mattresses and covers ordered)
5. Potential contamination from washing basins in clinical areas (reservoir for gram negative pathogens)

- Washing basins were removed in room 5 and room 6
- Room for hand washing created opposite NICU
- Sluice room adjacent to the handwash area
1. Key steps: assembly of the outbreak team

2. Key role players: - Neonatal consultants and nursing team, UIPC, Microbiology, Hospital managers, Pharmacy, Infectious Diseases, Engineering, Procurement.

3. Regular outbreak meetings, follow-up, equipment audit, liaison with engineering and procurement teams.

4. Continued surveillance with the UIPC, microbiology

5. Adapted antimicrobial prescription recommendations
TCH NEONATAL SEPSIS ALGORITHM

* stable neonate = suspicion of sepsis, but no major clinical deterioration
* unstable neonate = new requirement for nCPAP/ventilatory or inotropic support/shocked neonate
# Assumes blood culture/s, urine and CSF sent as indicated clinically. Inoculate at least 1-2ml blood into culture bottle to increase yield.
For culture-confirmed sepsis, most pathogens require 7 days therapy only (if unsure, discuss with microbiology or ID teams)

Option 1:
- Ampicillin + Gentamycin
- Cefotaxime + Ampicillin (if suspected meningitis)

Option 2:
- Piptaz + Amikacin
- Meropenem (if suspected meningitis)

Consider adding Vancomycin (if recent central lines or phlebitis)

If BC and CRP negative @ 48 hours stop IV AB

If BC and CRP negative @ 48 hours consider stopping IV AB OR complete 5 days therapy

Option 1: Meropenem ± Colistin (discuss with consultant)

Consider adding Fluconazole (if further deterioration)

Option 2:
- Meropenem (if suspected meningitis)
- Consider adding Vancomycin (if recent central lines or phlebitis)

Option 1:
- Piptaz + Amikacin

Option 2:
- Cefotaxime + Ampicillin (if suspected meningitis)

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- Ampicillin + Gentamycin

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Version 2.0 Amended May 2017
Neonatal unit outbreak: outcome

NEONATAL PLATFORM
Bloodstream Infection Rate

BSI rate per 1000 patient days

Jan-17: 4.4
Feb-17: 3.8
Mar-17: 2.9
Apr-17: 2.7
May-17: 1.8
Jun-17: 2
Jul-17: 3.6
Aug-17: 3
Sep-17: 3.2
Oct-17: 4
Nov-17: 4.5
Dec-17: 4.5
Jan-18: 3.9
Feb-18: 2.5
Mar-18: Goal

[Graph showing the bloodstream infection rate over time, with a peak in May-17.]
Commence outbreak response if 1/more of these criteria are met:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Frequency</th>
<th>Suggested threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total neonatal unit HA-BSI rate</td>
<td>Monthly</td>
<td>≥ 4 / 1000 PD</td>
</tr>
<tr>
<td>Individual pathogen HA-BSI rate</td>
<td>Quarterly</td>
<td>≥ 0.7 / 1000 PD</td>
</tr>
<tr>
<td>Pathogen cluster in prior 7 days</td>
<td>Weekly</td>
<td>≥ 3 BSI episodes (same species)</td>
</tr>
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</table>
Total neonatal unit HA-BSI rate

Suggested HA-BSI threshold for outbreak response

= 4 /1000 PD

**April-May
Suggested BSI pathogen threshold

Klebsiella

Staph aureus

Suggested pathogen BSI threshold for outbreak response = 0.7 /1000 PD

Acinetobacter

Serratia

Enterococci
Pathogen cluster in prior 7 days*

(*pathogen cluster in prior 7 days: ≥ 3 BSI episodes of same species)
Neonatal outbreaks: conclusions

- Outbreaks are frequent, but underreported
- Many patient risk factors are not modifiable
- Multiple infection prevention challenges that contribute to risk of neonatal outbreaks

KEY FACTORS FOR DETECTION OF OUTBREAKS

- Local BSI surveillance + analysis in real time
- Enhanced surveillance with outbreak detection thresholds can give clinicians an early warning
ACKNOWLEDGEMENTS

• KPA
• Angela Dramowski
• UIPC team
• Department of microbiology
• Neonatal colleagues