Nosocomial Infection Control Children's Healthcare of Atlanta

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Problem

The Neonatal Intensive Care Unit (NICU) at Scottish Rite has been experiencing a higher than expected rate of nosocomial infections.

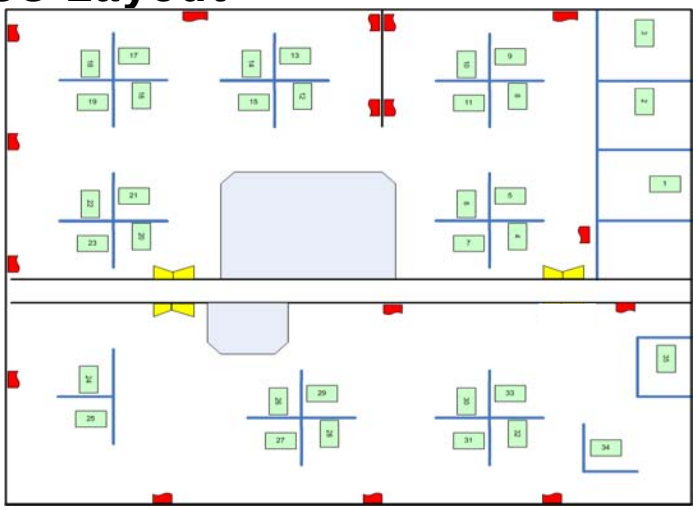
Project Goals

- To understand how infections flow
- To uncover reasons for infection
- To model the current state with simulation software
- Recommend process improvements and show the benefit of intervention techniques

Methods

- Shadow and observe in the NICU
- Interview key employees
- Analyze administrative and clinical data
- Define assumptions and model parameters
- Build the simulation model
- Test interventions
- Provide results and recommendations

NICU Layout



NICU Details

- 2 Patients per Nurse
- Nurse interacts with the patient every 4 hours
- 3 Day Doctors, 1 Night Doctor doing rounds
- About 60% of patients require a Respiratory Therapist
- Visitors allowed 22 hours a day
- Current Isolation Process - patient is isolated if:
  - MRSA upon admission (48 hour results delay)
  - Shows signs of infection

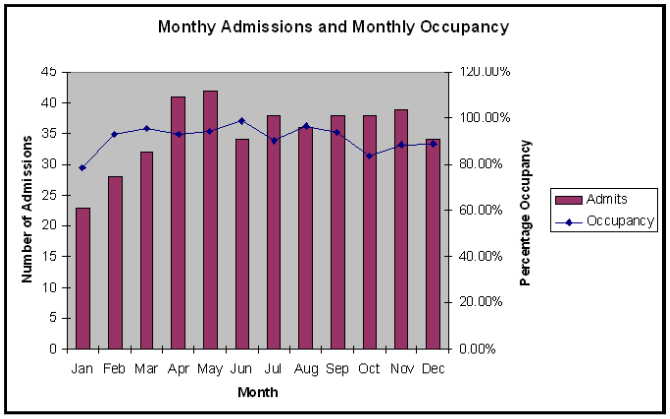
Reasons for High Infection Rate

- Low birth weight
- Technology dependency
- Required touching
- Pacifiers and diapers
- Dark, warm environment
- Suboptimal visitor hand hygiene and cleaning compliance
- Many procedures performed in unit
- Patients not in separate rooms

2007 NICU Statistics

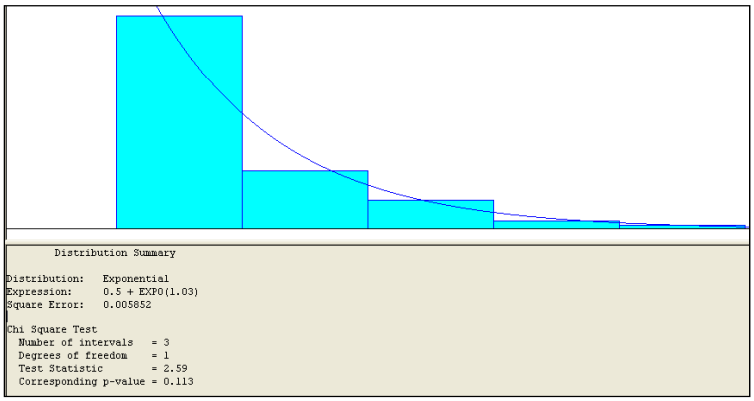
	No Infection	With Infection
Average LOS	23.19 Days	82.20 Days
Average Cost	$101,752.42	$387,828.71
# Patients	406	44

Admissions and Occupancy



91% Average Occupancy

Patient Arrival Rate



- No arrivals if NICU is at 100% occupancy
- Otherwise patients arrive according to a Poisson Process
- The inter-arrival rate is Exponential with a mean of 1.03 days

Hand Hygiene Compliance*

Health Care Worker	Rate
Doctors	82%
Nurses	98%
Respiratory Therapists	100%

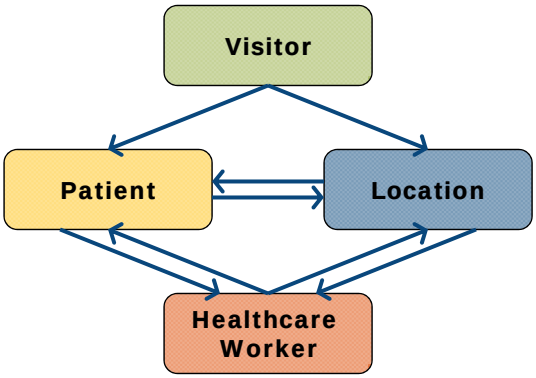
*2007 data from CHOA infection control compliance reports

Model Infection Flow

Two types of bacteria: Susceptible and Resistant

Visitors and patients may bring pathogens from outside.

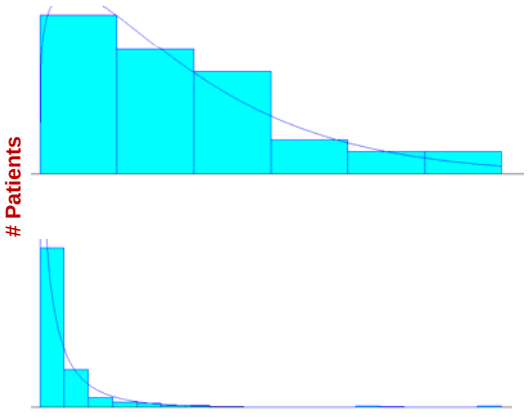
Patients, visitors, HCWs can be colonized, but only patients are assumed to arrive with or develop infections.



Risk Factors For Infection

Patient Factor	p-value	Significant?
Low Birth Weight (LBW) <1000g	0.684071	Not Significant
Number of Diagnoses	0.506719	Not Significant
Number of Procedures Performed	0.000105	Significant

Length of Stay Distributions



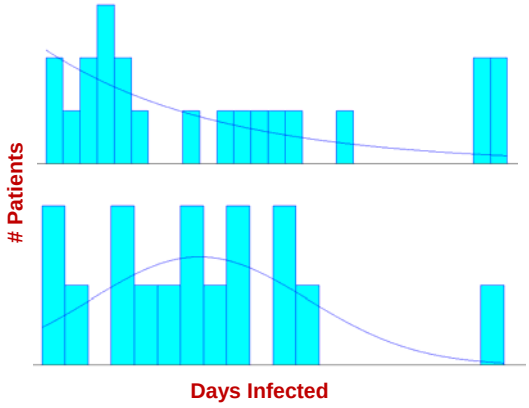
Patients that have had infections
LOS = 6 + W(1.18, 79.8)
Square Error: 0.004302
Chi-squared test p-value = 0.384

Patients without infections
LOS =W(0.709, 18)
Square Error: 0.004302
Chi-squared test p-value = 0.0323

Note: W = Weibull(shape, scale)

Length of Infection

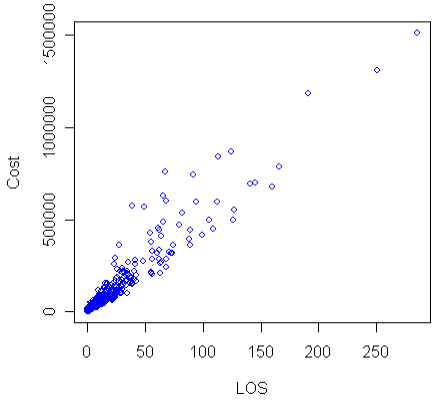
- Performed chart audit of all infected patients to record number of days on antibiotics after date of infection



Resistant Bacteria Infection
Days Infected = 6.5 + E(10.2)
[E is Exponential(mean)]
Chi-squared test p-value = .521

Susceptible Bacteria Infection
Days Infected = N(10.3, 4.7)
[Normal(mean, standard deviation)]
Chi-squared test p-value = .521
Square Error = .036134

Cost Analysis



Cost($) = 7947.2 + 5239.04*LOS + 18387.54*InfInd
p-value < 0.001 R^2 = 0.9035

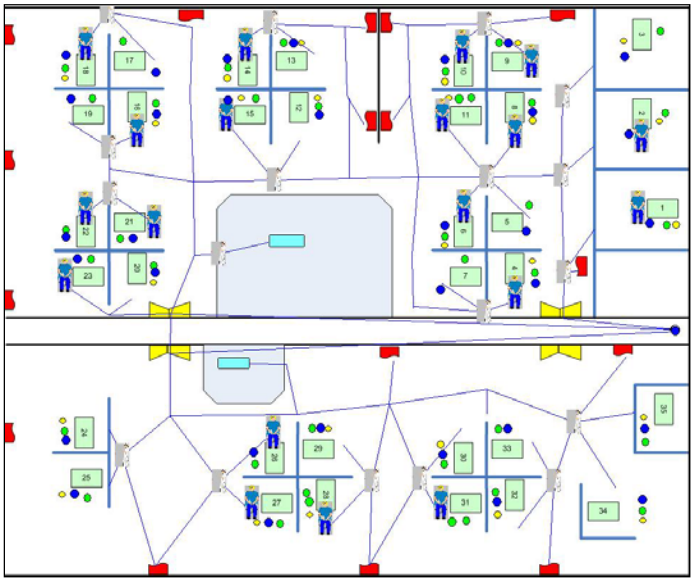
Infection Chain

More Procedures

Poor Hygiene & Disinfection

→ Increased chance of Infection → Increased LOS → Increased Cost

Simulation Model



Increased Visitor Hand Hygiene Model

Problem: NICU visitors aren't educated on proper hand hygiene procedures

Recommendation

Develop infection control education materials and training for patient families

Modeled Benefits

- Decrease Infections by 22%
- Decrease total cost per year by over $1.7M

- Increase of visitor hand hygiene efficacy by 30%

Patient and Family Education

Why should my child keep his hands clean?

- It can help prevent the spread of germs.
- Germs that cause the common cold, pinkeye, diarrhea and sometimes serious illnesses are often found on the hands.
- You and your child come in contact with germs every day when you use items such as doorknobs, toys, books, telephones, and grocery carts.
- Germs can enter your child's body when unclean hands come in contact with the nose, mouth, eyes, or open cut or sore. Teach your family good hand hygiene. Insist that baby sitters and childcare workers do the same.

Five simple steps for washing your child's hands to help fight germs:

- **Wet** - use warm running water. Using warm water is a comfort measure but it does not kill germs.
- **Lather** - use soap until you get lots of bubbles. You do not need to use anti-bacterial soap unless your child's doctor tells you to.
- **Wash** - Rub hands together, washing the entire hand (all of the fingers, both thumbs, between and under fingernails, back of hands, palms, and wrists) for at least 10 seconds. Singing one verse of "Happy Birthday To You" is about 10 seconds.
- **Rinse** - rinse hands well under running water. Rub your hands together while rinsing to remove all the soap, dirt and germs.
- **Dry** - dry with a paper towel instead of rubbing with a cloth towel.
  In the hospital and public restrooms, use a dry paper towel to turn off the faucet.

When to clean hands

You should clean your hands **before**:

- Eating or feeding your child
- Drinking
- Treating a cut or scrape
- Caring for someone who is sick
- Giving medicines

Improved Disinfection Model

Problem: Unclear role definition for disinfection processes

Recommendation

Clearly define cleaning roles and policies for nurses & Environmental Services

Modeled Benefits

- Decrease Infections by 13%
- Decrease total cost per year by just under $1M

- Increase the probability of disinfecting the location at each nurse-to-patient interaction by 40%

Testing and Isolation

Problem: Patient is tested for MRSA and isolated 48 hours later if results are positive

Possible Recommendations

- Use MRSA quick results test (<1 hr)
- Run full panel infection tests upon admission
- Use sign designating "waiting for results"

Modeled Benefits

- Decrease Infections by 22%
- Decrease total cost per year by over $1.7M

- Decrease the probability of passing the colonization from patient to healthcare workers by 30%

Future Research

- Multiple years of data for additional risk factors
  - Bed location and infections
  - Ventilator days and infections
  - Nurse sick days and infections
- Additional Units
- Other Hospitals

Questions and Comments