Infection Prevention in High and Middle Income Countries
Bruce Gamage, Dr. Pierre Parneix, Prof. Li Han
Broadcast live from the German Society for Hospital Hygiene

Infection Prevention and Control in Canada: From VRE to CRE
Bruce Gamage, RN BSN CIC President, IPAC Canada 2013/2014

Outline
- IPAC in Canada
- Recent Trends in Antibiotic Resistant Organisms in Canada
- Changing Approaches
- Emerging Organisms

My thanks to Dr Linda Hoang and Dr Michael Gardam

IPAC in Canada

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IPAC – Canada
› IPAC Canada is a national, multidisciplinary association committed to the wellness and safety of Canadians by promoting best practice in infection prevention and control through education, standards, advocacy and consumer awareness.

IPAC Canada’s Roles
› initiating and coordinating effective communication and cooperation among all disciplines united by infection control activities
› supporting and/or developing effective and rational infection control practices
› standardizing infection control practices
› promoting research in areas related to infection control
› promoting and facilitating infection control education for both infection control practitioners and other personnel working in hospitals, nursing homes and related institutions.

Public Health Agency of Canada
› National Surveillance (CNISP)
› Surveillance data submitted from 52 large hospitals from across Canada
› Centre for Communicable Disease and Infection Control – National IPAC Guidelines

Provincial Bodies
› Public Health Ontario (PIDAC/RICN)
› Manitoba Department of Health
› Alberta Health Services
› BC Provincial Infection Control Network
› Infection Control Nova Scotia
› Infection Control Newfoundland and Labrador

› Each Province produces their own guidance documents!

Recent Trends in ARO in Canada

C. difficile Infections (CNISP)

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Vancomycin Resistant Enterococci (CNISP)

Provincial Surveillance Programs
- Variations in laws around reportable organisms
- Some provinces require reporting of HAI (e.g. Ontario and Quebec)
- In BC CDI, MRSA and Hand Hygiene Compliance are collected provincially
- Reports are available at www.picnet.ca

Rate healthcare - associated CDI, BC

Rate of healthcare-associated MRSA, BC

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Provincial hand cleaning compliance

New Approaches
- Changes to approach to VRE in Ontario and BC
- Evaluation of changes

Early concerns about VRE
- Emerging organism
- Highly drug resistant
- Poor therapeutic options
- Resistance gene transfer to more pathogenic organisms i.e. MRSA

VRE
- Enterococci in general are intrinsically drug resistant
- Do not produce toxins
- Frequently found with other organisms
- Infections typically occur in patients with considerable pre-existing morbidity
- High mortality rate but contribution of vancomycin resistance is not clear

Typical VRE infections in adults
- Urinary tract
  - Infection vs. colonization
  - Often catheter-associated
- Bacteremia >> endocarditis
  - Often catheter associated
  - Frequently polymicrobial (GI source etc.)
- Deep tissue infections and wounds
  - Usually polymicrobial

Very rarely caused by VRE
- Respiratory tract infections
- Meningitis
- Skin, soft tissue infections

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Specific versus non-specific control measures
- Specific control measures
  - Admission screening
  - Contact isolation, periodic screening
- Non-specific control measures
  - Hand hygiene
  - Environmental cleaning
  - Practice bundles
  - Antimicrobial stewardship

Does VRE increase length of stay?
- Yes, but why?
  - Marker for severe morbidity
  - Small percentage of patients develop significant infections
  - Infection control measures themselves
  - Increase LOS
  - Isolation
  - Slowing of patient transfers

Decision
- Stop specific VRE control measures
- 2010 Vancouver Island Health screening only patients admitted to designated units.
  - Patients in other patient care areas are not placed on additional precautions unless they have diarrhea
- 2012 4 Hospitals in Ontario stopped screening for VRE, isolating cases or reporting outbreaks
- 2013 2 other health authorities adopted similar policies
- Prospectively collect data to inform future practice.

Evaluation
- Results Pending...
- Negative clinical impact has been negligible
  - Substantial decrease in isolation costs
  - Increased ability to focus on other organisms

What are Carbapenemase Producing Organisms (CPO)?
- Carbapenemases are a class of enzymes that inactivate carbapenem antibiotics by hydrolysing them.
- Carbapenem antibiotics, often referred to as “last resort antibiotics”:
  - Imipenem
  - Meropenem
  - Eradapenem
- Carbapenemases most commonly in E. coli and Klebsiella spp., (Enterobacteriaceae) but have also been found in other Gram-negative species.

Emerging Organisms CPO

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Beta-lactamase Family

<table>
<thead>
<tr>
<th>Molecular Class</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>TEM, SHV, CTX-M, KPC, GES, SMC, IMI, PER, NMC-A, SFO, SFC, BIC, IBC</td>
</tr>
<tr>
<td>B</td>
<td>NDM-1, IMP, VIM, GIM, SIM, DIM, AIM, KHM</td>
</tr>
<tr>
<td>C</td>
<td>CMY, ACT, FOX, MOX</td>
</tr>
<tr>
<td>D</td>
<td>OXA, PSE, OXA-48</td>
</tr>
</tbody>
</table>

New Delhi Metallo-beta-lactamase (NDM-1)

- Reports in 2008 of Swedish and UK travelers to Indian subcontinent
- Since then, reports of high-endemicity in Indian, Pakistan and Bangladesh hospitals
- NDM-1 genes in sewage and water reservoirs in some Indian cities
  - 5% (7/131) waste water seepage
  - 2% (5/250) communal drinking water samples

Webster et al. PLoS Infectious Diseases, 2011; 7: 355-62

Global Distribution NDM-1

Carbapenem Producing Organisms in Canada

- One isolate contained NDM and OXA

Carbapenemase Producing Organisms by Species, 2008-Current

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Enterobacteriaceae with NDM

CPE by Health Authority (BC)

How are these organisms transmitted?

1. Patient-to-patient
2. Shared Health Care equipment
3. Environmental Contact (environmental reservoirs)
4. Health care workers (Primarily hands)

Risk factors for Colonization and Infection with CPO

Risk factors for acquisition of CPO
- Prolonged hospitalization
- Poor functional status
- ICU stay
- Invasive devices
- Immunosuppression
- Multiple antibiotic agents

Risk factors for infection once colonized with CPO
- Previous invasive procedure
- Diabetes mellitus
- Solid organ tumor
- Tracheostomy
- Urinary catheter
- Prior exposure to antipseudomonal penicillin

If colonized with CPE, 9-47% of patients may develop infection

CPO Measures Implemented

- Screening/Active surveillance
  - On admission to unit
  - Weekly point prevalence
  - All contacts of suspect or confirmed cases, at 0, 7 and 21 days

- Precautions
  - Private room and staff cohorting and dedicated equipment

- Cohorting of patients and staff
  - “CPO” nursing assignments & dedicated ward
  - Hand hygiene & PPE (goal: 100%)
  - Weekly audits
  - Antimicrobial stewardship

CPO Measures Implemented

- Avoid discarding any bodily fluids in sinks
- Cleaning
  - Enhanced cleaning including daily 2nd clean of high touch surfaces in affected rooms/units
  - Use hydrogen peroxide
  - Terminal clean on discharge of colonized patients:
    - Discard all supplies, terminal clean, audit of clean
  - Daily CHG baths for all colonized patients

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Infection Control Processes

- Screening for all admitted patients
  - Question: “Have you been hospitalized or had renal dialysis outside of Canada anytime in the previous 6 months?”
  - If yes: patient will have rectal screen for CPO

Next Steps and Challenges

- Better and faster testing
  - Develop Real-time PCR method for screening specimens directly
- Maintain aggressive infection control state & CPO alerts between facilities
- Continued Provincial level surveillance with infection control data
  - Collaboration with PICNet
- Further explore genomic characteristics of BC strains and transmission behaviour
  - Whole Genome Sequencing

Summary

- CPO are an emerging pathogen with global spread, now in Canada
- CPE can spread within institutions
- The most vulnerable patients are the most at risk to become colonized and infected
- Treatment of infections is complex
- Control of spread requires full compliance with precautions and antibiotic stewardship

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Surgical wound infection prevention
4 recommendations (4%):
- Skin preparation = 1
- Surgical attire = 1
- Antibiotic prophylaxis = 1
- Environment quality = 1
- Patients’ risk factors = 0

117 pages - Arial 10

It is strongly recommended to perform a cleansing with antiseptic soap solution followed by wide disinfection of the surgical site (A-1)

SF2H – Consensus statement 2004

Hospital hygiene in France

National strategy
18 Novembre 2004

Second national nosocomial infections’ prevention programme
Objectives 2005-2008
100% of hospital performing surgery are surveying targeted procedures in each specialty
At least 75% of hospitals are performing yearly evaluation of practices

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Face the real life – 2003-2007
Preoperative skin preparation evaluation through observational audit
Southwestern France HAI control centre (Célin So)

<table>
<thead>
<tr>
<th>Practices</th>
<th>2003 (2,255 observations)</th>
<th>2007 (6,683 observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hair removal</td>
<td>85.1%</td>
<td>94.8%</td>
</tr>
</tbody>
</table>

Face the real life – 2003-2007
Preoperative skin preparation evaluation through observational audit
Southwestern France HAI control centre

<table>
<thead>
<tr>
<th>Practices</th>
<th>2003 (2,255 observations)</th>
<th>2007 (6,683 observations)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning</td>
<td>53.9%</td>
<td>71.6%</td>
</tr>
<tr>
<td>Disinfection</td>
<td>99.0%</td>
<td>96.9%</td>
</tr>
</tbody>
</table>

The scientific approach
No recommendation can be issued for cleansing before performing disinfection on clean skin. (B2)
SF2H – Consensus statement Update 2013

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The RCA approach

- Think risk/benefit and do not forget to include Picc-associated care burden in your balance
- Analyze the vulnerabilities of your information system in terms of monitoring intravenous devices and integration of targeted transmissions
- Check in every organization that supervision of care and recourse to expertise are in place

Hospital hygiene in France
www.sf2h.net

National strategy
New programme in preparation...

Fourth national HAI and nosocomial infections' prevention programme
14-18
15-19

Conclusion

- Think patient safety:
  - High quality skin preparation is now a basis to build more safety around,
  - Develop new strategies to tackle remaining problems:
    - Focus on organizational and human factors,
    - A need to fit with the shortage of resources,
    - But stay strong for ongoing and future challenges!

Brief review on the prevention and control of Healthcare-Associated Infections and Multidrug-Resistant Organisms in China

Li Han, Yong Chen, Jinqiu Zhao, Xiaolin Han, Shuguang Tian, Fangyin Chen, Ju Zhao, Xiangzhao Meng
Dep. Hospital Infection Control
Chinese PLA Institute for Disease Control & Prevention

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Outlines

- Literature introduction on epidemiology of major healthcare-associated infections and multidrug-resistant organisms responsible for these infections in China
- Introduction of ongoing efforts to control healthcare-associated infections in China: guidelines and surveillance
- Introduction of our work.

Cross sectional survey-2008 by China Healthcare-associated infection surveillance system

The prevalence of nosocomial infection in different hospitals

<table>
<thead>
<tr>
<th>Hospital type (no. of beds)</th>
<th>No. of hospitals</th>
<th>No. of patients included</th>
<th>Prevalence rate (%)</th>
<th>The percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;300</td>
<td>79</td>
<td>11962</td>
<td>2.28</td>
<td>0.00 0.77 1.86 3.16 5.26</td>
</tr>
<tr>
<td>300-599</td>
<td>76</td>
<td>27055</td>
<td>3.08</td>
<td>0.64 1.91 2.61 4.49 5.79</td>
</tr>
<tr>
<td>600-889</td>
<td>42</td>
<td>36785</td>
<td>4.36</td>
<td>2.64 3.00 4.07 5.12 6.71</td>
</tr>
<tr>
<td>&gt;900</td>
<td>72</td>
<td>97278</td>
<td>4.44</td>
<td>2.27 3.00 4.22 5.89 6.97</td>
</tr>
</tbody>
</table>

Pathogens in healthcare-associated infection and community-associated infection (% of isolates), 2010

China Healthcare-associated infection surveillance system

Pathogens in healthcare-associated infection and community-associated infection (% of isolates)

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Healthcare-associated infection</th>
<th>Community-associated infection</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerobic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anaerobic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enteric</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungi</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yeasts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Viroles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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**SSI(2)**

- Retrospective analysis
- Patients: 481 neonates, neonatal intensive care unit, mechanical ventilation ≥ 48 hours
- Time: From January 2000 to February 2012
- Pathogens: Gram-negative bacteria (97%), including Klebsiella pneumoniae (51%), Acinetobacter baumannii (17%) and Escherichia coli (12%) as the three most frequent ones.
- Resistance: amoxicillin, amoxicillin/clavulanic acid, piperacillin, cefotaxime, ceftazidime, and ceftriaxone, with a susceptibility rate of below 15%, and demonstrated decreased sensivity to imipenem and meropenem, with a susceptibility rate of below 75%.
- Five independent risk factors for VAP: birth weight (OR=1.399, P<0.01), duration of mechanical ventilation (OR=1.946, P<0.01), length of hospital stay (OR=1.812, P<0.01), times of tracheal intubation (OR=1.950, P<0.01), 1 min Apgar score (OR=1.814, P<0.01).

**VAP(1)**

- Study design: prospective multicenter study
- Settings: 13 Chinese urban tertiary hospitals.

**HAP(1)**

- Resistance:
  - A. baumannii: more than 70% resistance rates to carbapenems, and the susceptibility to ceftepime/subactam, polymyxin B and tigecycline were 40.8%, 99.3% and 95.8%, respectively.
  - E. aureus: 87.8% MRSA

- Mortality rate of HAP cases: 34.5%

- Hospital stay of patients with HAP was 23.8±28.5 days; Average for inpatients 13.2±13.6 days (P<0.01).

- Mean costs of HAP: 108,950±116,608 yuan; average hospital costs of respiratory inpatients (17,999±33,364 yuan (P<0.01)).

**VAP(2)**

- Probiotics for Preventing Ventilator-Associated Pneumonia: A Systematic Review and Meta-Analysis of High-Quality Randomized Controlled Trials

- Systematic review and meta-analysis
- 8 studies involved (874 patients)
- Probiotics did not significantly decrease the incidence of VAP (RR=0.94, 95%CI 0.82-1.09, I^2=72%)
- Probiotics reduced the risk of VAP caused by Pseudomonas aeruginosa (RR=0.46, 95%CI 0.22-0.95, P=0.04)

**UTI(1)**
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Rates of methicillin resistance amongst S. aureus and CoNS in China

<table>
<thead>
<tr>
<th>Location</th>
<th>5%</th>
<th>10%</th>
<th>15%</th>
<th>20%</th>
<th>25%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital 1</td>
<td>76%</td>
<td>81%</td>
<td>85%</td>
<td>90%</td>
<td>95%</td>
</tr>
<tr>
<td>Hospital 2</td>
<td>78%</td>
<td>82%</td>
<td>86%</td>
<td>91%</td>
<td>95%</td>
</tr>
<tr>
<td>Hospital 3</td>
<td>79%</td>
<td>83%</td>
<td>87%</td>
<td>92%</td>
<td>96%</td>
</tr>
</tbody>
</table>

Laws, Regulations and Guidelines

<table>
<thead>
<tr>
<th>Law</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious Disease Control &amp; prevention in people’s republic of China (2004)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regulation on Hospital Infection Management (2006)</td>
</tr>
<tr>
<td>Regulation on Management of Medical Waste (2003)</td>
</tr>
<tr>
<td>Regulation on Disinfection Management (2002)</td>
</tr>
</tbody>
</table>

Technical guidelines

- Guideline for Prevention and Control of Surgical Site Infection (GB 7480—2012)
- Guideline for Diagnosis of Nosocomial Infection (trial) (2001)
- Guideline for Endoscope Cleaning and Disinfection (2012)
- Specification of Nosocomial Outbreaks Reporting and Disposal Management (2009)
- Standard for construction of Hospital Clean Operation Department (2002)

Academy of Military Medical Sciences (Chinese PLA Center for Disease Control & Prevention)

Chinese PLA Institute for Disease Control & Prevention

Division of Hospital Infection Control

- Surveillance
- Outbreak Investigations
- Recommendation and Standard
- Intervention Implementation
- Research: MDRO (Acinetobacter and Fungus); infection mechanism

Hospital Infection Surveillance Network in military hospitals

70 hospitals, 7 different districts covering the whole China, automatic data flow

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Outbreak investigation

Recommendation and Guideline

- Committee for standard in the field of medicine and pharmacy.
- “Guideline for surgical site infection prevention and control”. (GJB-2012)

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The ward change in a surgical ICU

Detection of MRSA in patients, HCWs and environment

---

MRSA prevalence, acquisition and transmission in ICUs

---

Detection of MDR-Ab in patients and environment

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The nurse cohorting level and hand hygiene compliance are strong predictors of MDROs transmission in ICUs.

Dissemination and Characterization of NDM-1-Producing Acinetobacter pittii

- NDM-1, new metallo-beta-lactamase highly resistant to carbapenem, frequently found in Enterobacteriaceae, world-wide spread.
- Predominantly in Acinetobacter baumannii, no transmission in ICU was reported.

All NDM-1 positive strains were Acinetobacter pittii

<table>
<thead>
<tr>
<th>Source</th>
<th>Total isolates N</th>
<th>NDM-1 Positive N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sabh sample</td>
<td>1425</td>
<td>5(0.4)</td>
</tr>
<tr>
<td>Clinical sample</td>
<td>230</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Health care workers</td>
<td>104</td>
<td>0(0.0)</td>
</tr>
<tr>
<td>Environmental sampling</td>
<td>1354</td>
<td>22(1.6)</td>
</tr>
<tr>
<td>Total</td>
<td>3114</td>
<td>27(0.9)</td>
</tr>
</tbody>
</table>
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Summary

In the past decade, the dedicated human resources and funds, expertise in epidemiology and infection control and microbiological laboratory capacity for healthcare associated infection control were obviously improved in China. However, still some needed:

- More real emphasis from administration;
- More participation of professionals who work in preventive medicine and public health area;
- Expertise in epidemiology and infection control; RCT study;
- Enhanced application of standard definitions of HAI.

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Miao Zhu;
Xiaodong Jia;
Yuhua Song;
Changlian Zhang;
Xiaoyqing Meng;
Wenjie Mo

Thanks for your attention!

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Congress of the German Society for Hospital Hygiene

1. Infection Prevention in Canada
   Bruce Gamage (Vancouver)
2. Hospital Hygiene in France
   Dr. Pierre Pameix (Bordeaux)
3. Infection Prevention in China
   Prof. Dr. Li Han (Beijing)

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