Control and Management of Multiple Resistant Organism – MRSA, MRPA, VRE, MDRTB, ESBL

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What are they?  
Are they common?  
Why are they important?  
How are they transmitted?  
How can we control the spread?

- MRSA
- MRPA
- VRE
- ESBL
- MDRTB

CONTACT

AIRBORNE
Part I: MRSA, ESBL, VRE, MRPA
What is MRSA?

MRSA stands for **Methicillin –resistant *Staphylococcus aureus***

Define as: Resistant to **CLOXACILLIN**
What is MRSA?
Figure 1: Worldwide prevalence of MRSA displayed by country

*All presented MRSA proportions are from peer-reviewed studies undertaken since 1998. Prevalence estimates for Morocco, Algeria, Tunisia, Egypt, Jordan, Lebanon, and Turkey are from the antimicrobial resistance in the Mediterranean region website at www.slh.gov.mt/armed/earss.asp. Studies providing most recent estimate of the MRSA proportion taken into account. If more than one study reported over same period, study including different types of clinical isolates was preferred over studies including only one specific type of specimen. †=Prevalence estimates are based on a study that included only one hospital. ‡=Prevalence estimates are based on studies between 1993 and 1997.
## MRSA proportion across European countries (1999-2002)

<table>
<thead>
<tr>
<th>MRSA Proportion</th>
<th>Country</th>
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<tbody>
<tr>
<td>&gt;20%</td>
<td>Belgium, Bulgaria, Croatia, France, Greece, Ireland, Israel, Italy, Malta, Portugal, Spain, UK,</td>
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<tr>
<td>5-20%</td>
<td>Austria, Czech Republic, Hungary, Luxemburg, Poland, Slovakia, Slovenia</td>
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<tr>
<td>&lt;5%</td>
<td>Denmark, Estonia, Finland, Iceland, Netherland, Sweden,</td>
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*EID 2004; 10: 1627-1634*
Why is MRSA important?

- ↑ clinical impact as increasing bacteremic rate (eg UK 8%→44% from 1993 to 1998)
- MRSA bacteremia: ↑ mortality as compared to MSSA (14% vs 8%, p<0.05)
- ↑ mortality and morbidity in other invasive MRSA infections, VAP, SSI
- Financial impact: healthcare, familial and societal costs
What is ESBL?

- ESBL stands for Extended Spectrum Beta-Lactamases.
- Mutations in common β-lactamases such as TEM-1, and SHV-1.
- Confer resistance to 3rd gen. & aztreonam.
- First reported in 1983 from Germany in Kp and spread rapidly worldwide.
- ESBL are inhibited by β-lactamases inhibitors: clavulanate, sulbactam and tazobactam.
Non-ESBL

ESBL Key-Hole Effect:
# ESBL Worldwide Prevalence

<table>
<thead>
<tr>
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<th>Brooklyn NY 1997</th>
<th>HK 2006</th>
<th>Latin Am</th>
<th>Worldwide</th>
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<tbody>
<tr>
<td><strong>E. coli</strong></td>
<td>4.7%</td>
<td>18-20%</td>
<td>12.5%</td>
<td>10-15%</td>
</tr>
<tr>
<td><strong>Kleb. pneu</strong></td>
<td>44%</td>
<td>15-20%</td>
<td>22%</td>
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</table>
E. coli antibiotic susceptibility pattern
Sources of ESBL producing *E. coli*
### E. coli BSI

<table>
<thead>
<tr>
<th>ESBL</th>
<th>+ ve</th>
<th>- ve</th>
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1. Episodes of E.coli (BSI)\(^a\):  97  401  
2. Crude mortality rate\(^b\) BSI:  35%  21%  
Worldwide reported  50%  13%  

Note:

- a. Count different sites of infection, but eliminate duplicate if same site and same hospital number.
- b. Death during that episode of admission (by hospital number) and within 8 weeks of diagnosis, though might not be directly related.
VRE stands for Vancomycin Resistant Enterococcus.

Why is VRE Important?
• potential to cause outbreak of infection.
• resistant to common antimicrobials
• possibility for vancomycin resistant genes being transferred to other organisms, e.g. Staph. aureus.
WHAT IS VRE?
VRE-Prevalence

- VRE first reported in France in 1986
- then spread over the European countries & USA
- In HK, 1st VRE case was detected in 1997 as an imported case. Then subsequent sporadic cases of colonization were later identified in several hospitals as follows:

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<tbody>
<tr>
<td>No. of VRE cases</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
</tbody>
</table>
Why is the Hospital Environment an important Reservoir for VRE?

- Relative resistant to killing by heat or washing with bland soap
- Inoculation onto bed surface, persist for 24 hrs
- Enterococcal strains may survive for > 4 months under dry conditions
- VRE were isolated from many environmental sites
Which Group of Patient is at Risk of Colonization?

- patients receiving multiple antibiotics and/or vancomycin therapy.
- patients having a prolonged hospital stay;
- patients in ICUs (including PICU), HDU, CCU, Renal units, oncology, transplant units;
- patients with severe underlying disease or immunosuppression
What is MRPA?

MRPA stands for **Multi-resistant** *Pseudomonas aeruginosa*

Define: resistant to AMK, CIP, CAZ & IMP

**Why is MRPA important?**
1. Virtually no treatment readily available
2. Polymixins is the only option with high toxicity
3. Ubiquitous in environment, especially in hospital settings
What is MRPA?

- Define: resistant to AMK, CIP, CAZ & IMP
MRPA – reservoirs

- Colonized human body sites, with a preference for moist areas, such as perineum, axilla, ear, nasal mucosa and throat as well as stool
- Environmental areas such as sink, mop, disinfectant solutions, respiratory equipment, food mixers
MRPA- high risk groups

Patients with:
- Prolonged hospitalization
- Board-spectrum antibiotics therapy
- Mechanically ventilated
- Chemotherapy
- Burn
- Immunocompromised
How could MDRO be Acquired?

- patient-to-patient contact;
- indirectly by transient carriage on the hands of health care workers;
- via contaminated environmental surfaces or equipment.

- **MRSA, MRPA, VRE & ESBL DO NOT spread by airborne route**
Ross-Macdonald model of indirect transmission of MDRO
CID2000
Control Strategies: Evidence – based Practices

1. **Guideline for the control and prevention of methicillin-resistant Staphylococcus aureus (MRSA) in healthcare facilities**
   
   *Joint work by Joint Working Party of the British Society for Antimicrobial Chemotherapy and the Hospital Infection Society*

2. **Management of multidrug-resistant Organisms in Healthcare settings, 2006**

   *Healthcare Infection Control Practices Advisory Committee (HICPAC). CDC*
“Search and Destroy”

- Implemented in some low prevalence eg European countries (Netherlands & parts of Scandinavia)
- Components:
  1. Screening of patients
  2. Isolation of affected patients
  3. Offer of decolonization therapy
- Advocated by SHEA Guideline for preventing nosocomial transmission of multidrug-resistant strains for *Staphylococcus aureus* and *Enterococcus*
Reservoir for Spread of MDRO

Colonized (asymptomatic) Patients

Clinical Infections
Targeted approach - Control of MDRO

- Debatable, but possible to control spread and minimize the clinical impact
- **Multi-faceted** MDRO control program
  1. **Screening** cultures for **high-risk patients / units** early detection & isolation
  2. **Use of standard and contact precaution**
  3. **Hand hygiene** either by hand washing or use of alcoholic hand rub
  4. **Automatic alerts** of readmission of colonized patients
  5. **Antibiotic control program** (restriction use of fluoroquinolones)
CMS alert system
Isolation Precautions

- Hand hygiene
- PPE
- Patient placement
- Patient transport
- Linen & laundry
- Decontamination
- Waste Management
Standard and Contact Precaution
Perform hand hygiene:

- After touching blood, body fluid, excretions, secretions, mucus membranes, non-intact skin, contaminated items and environment
- Before touching face
- Before leaving wards and hospital/clinics
- After removal of gloves
- Before and after patient contact
- Use alcohol-based handrub when hands are not visibly soiled
PPE - Gloves

1. When exposed to blood, body fluid, secretion, excretions, mucous membrane and non-intact skin, and contaminated items

2. Change gloves when heavily contaminated

3. Perform hand hygiene immediately after glove removal

4. Disposable glove should not be reused
PPE - Gown

1. When splashes or sprays of blood and body fluid, secretion and excretions to skin and working clothes are likely

2. When working clothes has substantial contact with patient, environmental surfaces or patient items

3. Select an appropriate gown for the procedure
Decontamination -
*Patient Care Items*

1. Dedicated non-critical patient care items for suspected and confirmed cases

2. Clean and disinfect reusable equipment before used on other patients.
   - Use 1,000 ppm of hypochlorite solution (i.e. add 1 part of 5.25% hypochlorite in 49 parts of water) to disinfect non-critical items
   - Use 70% alcohol on metallic surfaces

3. Reusable respiratory equipment should undergo high level disinfection before reused on other patients
Decontamination - Environmental Control

Disinfect isolation and procedure rooms after use by a high risk patient

- Set up regular schedule of cleaning and disinfection of the environment and additional session for frequently touched surfaces
- Use 1,000 ppm of hypochlorite solution (i.e. add 1 part of 5.25% hypochlorite in 49 parts of water) to disinfect facilities contaminated with body fluid, secretions and excretions
- Use 10,000 ppm of hypochlorite solution (i.e. add 1 part of 5.25% hypochlorite in 4 parts of water) to disinfect spills or splashes of blood
Transport of MDRO patients

1. **Limit** patient transport unless clinically indicated
2. Lesion should be covered with an impermeable dressing
3. Wear disposable gown *when* come into contact with patient
4. Gloves only indicated *if* transporting patients with skin abrasions/lesions
5. Encourage patients to wear *surgical mask (MDR-TB)* if no contraindication

6. **Inform** the receiving service/department of concern beforehand
7. **Clean / disinfect** transport vehicles after use
Linen and laundry management

1. **Proper handling of soiled linen:**
   - Avoid sorting
   - Minimum agitation and shaking
   - Well pack soiled linen to prevent leakage
   - Wear appropriate PPE when handling soiled linen
   - Clean linen should be transported and stored separately to prevent recontamination

2. **Follow hospital policy**
What should we do to prevent the problem from occurring?

**Do NOT** use vancomycin for the following situations:

- Empirical treatment of febrile condition, except in neutropenic patient, or when there is a high prevalence of β-lactam resistant Gram positive organism, (stop vancomycin when the culture results are negative for such organism)
- Routine surgical prophylaxis unless the patient has a life threatening allergy to β-lactams
- Treatment of a single blood culture positive for coagulase-negative staphylococcus, always exclude contamination of blood culture during collection, which is a more likely cause.
- Systemic or local use for prevention of central or peripheral intravascular catheters.
- Selective decontamination of digestive tract.
- Eradication of MRSA colonization.
- Use of vancomycin for topical application or irrigation.
Part II: MDRTB
What is MDRTB?

MDRTB stands for Multiple drugs resistant TB

Defined as resistance to at least isonizid and rifampin

Why is it important?
MDRTB requires the use of second line drugs that are less effective, more toxic, and costlier than first line drugs.
Prevalence of MDRTB

WHO/IUATLD Global Project on Drug-Resistance Surveillance

- MDRTB about 1% (median) (range 1-14%) in 64 countries / geographical sites surveyed
- Hot spot: Estonia, Latvia, the Oblasts of Ivanovo, Tomsk in Russia, and the provinces of Henan and Zhejiang Provinces in China
- Limitations: two thirds of the world’s countries have not yet provided the data
- Among the previously treated cases, the prevalence of resistance to at least one drug was 23% and NDRTB was 9%
Figure 1: Distribution of tuberculosis in the world in 2003.
Extensively drug-resistant TB (XDR-TB)

- A strain of MTB resistant to isoniazid and rifampin (which defines MDR TB) in addition to any fluoroquinolones and at least one of the three following injectable drugs: capreomycin, kanamycin, and amikacin (MMWR Nov 3 2006)
53 patients with XDR TB were diagnosed in South Africa in early 2005.

All but one died of XDRTB, with a median survival periods of only 16 days from the time the first sputum specimen was collected.

Genotyping reveals most of the isolates belonged to the KwaZulu-Natal family of TB strains which has been recognized in the province for a decade.
How common is XDRTB?

- Population-based data

<table>
<thead>
<tr>
<th>Country</th>
<th>% = XDR/MDRTB</th>
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<tbody>
<tr>
<td>USA (1993-2004)</td>
<td>4</td>
</tr>
<tr>
<td>South Korea (2004)</td>
<td>15</td>
</tr>
<tr>
<td>Latvia (2000-2002)</td>
<td>19</td>
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</tbody>
</table>
Emerging factors:

- The inappropriate use of the second-line drugs in a patient for whom first-line drugs are filing. Patients then spread the infection to close contacts, who acquire primary XDR TB.

- Multiple errors have probably contribute to the development of XDR in South Africa.
Transmission

- **Droplet nuclei** (1-5 \(\text{um}\))
- Created by cough, talking and singing
- **Airborne** for prolonged period
- **Incubation**: variable, at least 2 weeks
- Extrapulmonary rare, except larynx and during autopsy and tissue irrigation
Risk of transmission depends on:

1. The infectiousness of the TB patient
2. The environmental characteristic of the ward setting
3. The characteristic of the contact exposure
Patient factors: Infectiousness
Characteristics of a patient with TB disease that enhance infectiousness include:

- Positive AFB sputum smear
- Cavitation on CXR
- Presence of cough, and failure to cover the mouth and nose when coughing
- Laryngeal TB
- Undergo cough-inducing or aerosol-generating procedures
- Lack or short duration of TB treatment
Characteristics of contact exposure: High Risk Procedures

- Bronchoscopy
- Endotracheal intubation
- Suctioning
- Sputum induction
- Aerosol treatment that induce coughing
- Open abscess irrigation
- Autopsy
Indicator for non-infectiousness, and release from isolation:

1. On adequate anti-TB therapy for at least 2 weeks, AND
2. Clinically improvement, AND
3. AFB smear negative for 3 consecutive sputum samples
TB: Infection Control Measures:

- **Administrative control** to reduce exposure
- **Environmental control** to control spread and concentration of droplet nuclei
- **Personal respiratory protection**
Administrative control

- **Prompt detection and diagnosis, isolation and treatment of the infectious cases**
  - clinically suspicious
- Training and education of HCWs
- Education to patients
  - reason of isolation;
  - covering the mouth and nose when coughing or sneezing
- Risk assessment
- screening
  - annual CXR screening for high risk group
Engineering Control

- **Ventilation**
  - negative pressure
  - ACH: at least 6 ACH, usually 12 ACH
  - unidirectional airflow

- **HEPA filtration**
  - supplementary devices to ventilation system
  - 99.97% filter out particles $\geq 0.3 \ \mu m$
  - to filter air before it is exhausted to outside, re-circulated within the same room or other areas
Personal respiratory protection

- Supplementary to administrative and engineering controls
- **N95 respirator**: fit-test and fit-check
- Indications: entering AII area, or performing high-risk procedures
- Surgical mask when patients are outside isolation room or coughing
N95 Respirator

Fit test

Fit check
Infection control strategies – local applications

Leadership / Senior Manager Support: (MUST)

1. **Standardized surveillance** (ESSENTIAL)
2. **Antibiotic stewardship program** (ESSENTIAL)
3. **Screening**: (NOT A ROUTINE)
   - Indications:
     - Patients: targeted at high risk groups and units
     - Staff: outbreak or ongoing transmission with epidemiologically linked to staff
     - Discharge screening: not recommended
   - Frequency: local policy
   - Eradication: at least 3 screens a week apart after 24 hours of therapy
   - Lab support: CHROMOGENIC AGAR / Molecular test
4. **Decolonization therapy** (NOT A ROUTINE)
   - Indicated in outbreak and high-risk patients undergo invasive surgeries, such as Orthopaedic or CTS
Infection control strategies – local applications

5. **Isolation categories** *(risk assessment to local policy)*
   - High risk or low risk groups
   - single room / corhorting / physical barriers

6. **Hand hygiene** *(ESSENTIAL)*

7. **PPE:** *(ESSENTIAL)*
   - come into contact with patient and their immediate environment

8. **Discharge and transfer** *(ESSENTIAL)*
   - Notification of receiving parties
   - Identification system: alert system, signage

9. **Environmental / decontamination according to local policy** *(ESSENTIAL)*
**Risk assessment**

Perform admission assessment to check for existing infection and if patient is colonized with MRSA, e.g. if from high-risk area or history of recent hospital admissions. Recognize the patient has/could have MRSA early, i.e. check notes for sticker. Screen on admission if part of policy or patient admitted with devices or wounds.

**MRSA Surveillance / Prevalence Survey**

IC team to undertake surveillance of incidence and MRSA strains, and feedback to clinical staff. Clinical and IC staff to undertake audit of the environment and clinical procedures.

Communicate to others, e.g. AHPs, ambulance staff and other departments, if patients have MRSA and the additional precautions required.

**Hand hygiene practices**

- Perform hand hygiene before and after direct patient contact regardless of glove use.
- Use PPE to minimize contamination. Remove PPE when task completed and decontaminate hands.
- Isolate MRSA patients and follow IC care pathway.
- Avoid use of invasive devices – remove any devices as soon as possible.
- Decolonize patient, replacing soap with antiseptic wash.
- Use antibiotics judiciously.

**HCW training / education, compliance & audit**

**HCW training / education, compliance & audit**

**Hard wares**

- Isolation facilities
- Hand hygiene facilities

**Soft wares**

- Contact precaution
- Aspen (ASP)

**Clinic environment**

- There must be effective leadership at corporate and clinical level developing a supporting environment for IC.
- Keep environment free of dust/dirt and MRSA. Do not use fans inappropriately or have dirty air grills, which could contaminate the air. Keep linen clean do not expose supplies to airborne contamination.
- There must be sufficient wash hand basins and alcohol hand gel within reach of every bed space.
- There must be ample isolation facilities and space between beds to allow high-quality nursing and IC.
- Minimizing MRSA cross-infection
- To identify changes in communicability or pathogenicity, use reference laboratory for strain analysis.

**Equipment**

Sundries used for hand hygiene must not be detrimental to HCWs skin.

**Patients/relatives**

Involving relatives/visitors in good IC practices, e.g. hand hygiene. Keep the public informed/involved.
Thank you for washing your hands