Environmental spread of antimicrobial resistance: Bangladesh perspective

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Ecological cycle of antibiotics in different environments

Globally 20–80% of antibiotics are released into the environment

Andersson & Hughes, 2014
The annual per capita chicken consumption in Bangladesh is only 3.74 kg, which is expected to reach 8.42 kg by 2020.

Bangladesh's poultry industry is expected to grow by an average of 16% a year for the next 5 years.
# Use of Antibiotic in Animal Feed in BD

Approximate market size of medicine and feed additive/supplements in Bangladesh

<table>
<thead>
<tr>
<th>Year</th>
<th>Market size</th>
<th>Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(BDT in crore)</td>
<td>(USD in billion)</td>
</tr>
<tr>
<td>2012</td>
<td>980</td>
<td>12.45</td>
</tr>
<tr>
<td>2011</td>
<td>920</td>
<td>11.69</td>
</tr>
<tr>
<td>2010</td>
<td>790</td>
<td>10.04</td>
</tr>
<tr>
<td>2009</td>
<td>630</td>
<td>8.01</td>
</tr>
<tr>
<td>2008</td>
<td>450</td>
<td>5.72</td>
</tr>
</tbody>
</table>

Source: [http://www.dumarketing.ac.bd/](http://www.dumarketing.ac.bd/)
Waste management - poultry

About 3079 metric tons poultry manures are produced daily from a total of 42 million chickens in Bangladesh (Waste concern, 2005)

- ~50% of poultry waste are directly used in fish culture
- ~10% are used for fertilizer in crop production
- ~20% biogas
- ~10% is unused
Human exposure

Urban and peri-urban Areas
Urban Areas

Human exposure
NDM-1 in waste water in Dhaka city

- Of the 113 waste water samples, 57 (50%) were positive for NDM-1-producing organisms
- None of the 113 tap water samples were positive for NDM-1

Islam et al, 2015. ICAAC
NDM-1 in surface water in Dhaka city

~62% of environmental water samples in Dhaka were positive for NDM-1

Toleman et al. 2015. EID
Antibiotic resistant bacteria in supply water in Dhaka city

• 80% sample positive for fecal coliform (FC) bacteria (38% with >100 CFU/ml)
• 63% samples were positive for *E. coli*.
• 36% isolates (n = 84) were resistant to ≥3 classes of antibiotics and 7% were pathogenic
• 10% (n=22) of isolates were ESBL-producing:
  - 90% were positive for CTX-M-1 and CTX-M-15.
  - 32% were positive for OXA-1 and OXA-47.
  - None were positive for NDM-1

Talukdar Prabhat et al, 2013. PlosOne
Characterization of pathogenic *E. coli*

<table>
<thead>
<tr>
<th>Strain ID</th>
<th>Virulence gene</th>
<th>Pathotype</th>
<th>AB susceptibility pattern</th>
<th>Plasmid pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>149C1</td>
<td>st</td>
<td>ETEC</td>
<td>Amp-Cip-NA</td>
<td>120,62,7</td>
</tr>
<tr>
<td>174fC1</td>
<td>st</td>
<td>ETEC</td>
<td>Amp-Cip-Cro-NA-Te</td>
<td>120,62</td>
</tr>
<tr>
<td>149C2</td>
<td>st</td>
<td>ETEC</td>
<td>All S</td>
<td>No plasmid</td>
</tr>
<tr>
<td>156C1</td>
<td>st</td>
<td>ETEC</td>
<td>Amp-Cro</td>
<td>120,62,27</td>
</tr>
<tr>
<td>56C3</td>
<td>bfp, eae</td>
<td>EPEC</td>
<td>All S</td>
<td>36</td>
</tr>
<tr>
<td>57C1</td>
<td>bfp, eae</td>
<td>EPEC</td>
<td>All S</td>
<td>36</td>
</tr>
<tr>
<td>149C3</td>
<td>st</td>
<td>ETEC</td>
<td>Amp-Cip-NA-Te</td>
<td>120,62,46,3</td>
</tr>
<tr>
<td>90mf3</td>
<td>It</td>
<td>ETEC</td>
<td>NA</td>
<td>70</td>
</tr>
<tr>
<td>40C1</td>
<td>bfp, eae</td>
<td>EPEC</td>
<td>All S</td>
<td>1.5</td>
</tr>
<tr>
<td>39C3</td>
<td>It</td>
<td>ETEC</td>
<td>Amp</td>
<td>90</td>
</tr>
<tr>
<td>185C2</td>
<td>It, st</td>
<td>ETEC</td>
<td>Amp-Cro-Te</td>
<td>&gt;140,100,36</td>
</tr>
<tr>
<td>90mf1</td>
<td>bfp, eae</td>
<td>EPEC</td>
<td>Amp-Sxt-NA-Te-Mel</td>
<td>62,36,5,3,1,2,7</td>
</tr>
<tr>
<td>91mf2</td>
<td>st</td>
<td>ETEC</td>
<td>NA</td>
<td>90,50</td>
</tr>
<tr>
<td>180C3</td>
<td>It, st</td>
<td>ETEC</td>
<td>Amp-NA-Mel</td>
<td>100,30,5</td>
</tr>
<tr>
<td>190fC1</td>
<td>bfp, eae</td>
<td>EPEC</td>
<td>Amp-NA-Te</td>
<td>120,1,4</td>
</tr>
<tr>
<td>125C4</td>
<td>It</td>
<td>ETEC</td>
<td>Amp-Sxt-Te</td>
<td>42</td>
</tr>
</tbody>
</table>
AMR in fresh produce in Dhaka city

~60% of fresh produce samples from Dhaka city markets were positive for ESBL-producing organisms, mostly *E. coli* and all were positive for CTX-M gene
Antibiotic resistance in wild birds

- 59% crows foraging on waste had ESBL producing EB in their feces
- Majority were *K. pneumoniae* and *E. coli*
- Predominant ESBL genes were CTX-M-1, CTX-M-15
- *E. coli* from crows had identical sequence types with *E. coli* from human patients, including the epidemic 025b-ST131 clone

Hasan et al, 2015. CMI
Antibiotic resistance in domestic birds

~90% *E. coli* isolates from pigeon were resistant to ≥1 critically important human antibiotics.

-5% isolates were ESBL-producing and had *bla*$_{CTX-M-15}$ genes.

- Pigeon *E. coli* shared identical clone with human *E. coli*

## Antibiotic resistance in *E. coli* from poultry feces

<table>
<thead>
<tr>
<th>No. of sample tested</th>
<th>Organisms isolated</th>
<th>No (%) of MDR</th>
<th>No (%) ESBL</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 poultry feces</td>
<td>25 <em>E. coli</em></td>
<td>100</td>
<td>100</td>
<td>Parvez et al., 2016</td>
</tr>
<tr>
<td>279 sick poultry feces</td>
<td>101 path <em>E. coli</em></td>
<td>37%</td>
<td>0</td>
<td>B Hasan 2011</td>
</tr>
<tr>
<td>52 backyard poultry feces</td>
<td>51 <em>E. coli</em></td>
<td>7 (14%)</td>
<td>2 (4%)</td>
<td>Islam et al (unpub)</td>
</tr>
</tbody>
</table>
Existing policies/acts and ordinance/guidelines for animal health

• Final Draft of National Agricultural Extension Policy-2013
• Slaughter Act -2011
• Animal Feed Act -2010
• Bangladesh Zoo Act, 2009 (Draft)
• National Poultry Development Policy, 2008
• Animal Disease Rule- 2008
• Avian Influenza Compensation Strategy and Guidelines, 2008
• National Livestock Development Policy, 2007
• National Livestock Extension policy 2013 (Final Draft)
• Animal Disease Act, 2005
• Bangladesh Animal and Animal Product Quarantine Act, 2005
Existing policies/acts and ordinance/guidelines (Cont.)

The Animal Feed Act 2010

“prohibits the use of antibiotics, growth hormones, steroids or other harmful chemicals in animal feed. For violating this law, a person might face up to one year's imprisonment or up to Tk. 50,000 (~650 USD) in fine or both.”
Existing policies/acts and ordinance/guidelines

A. National Steering Committee (NSC)
B. National Technical Committee
C. Core Working Group at DGHS
D. Committee for Tertiary Level Hospital
E. District Multisectoral Committee
F. Upazilla Multisectoral Committee
G. Committees in Clinical Services Delivery setup
National Action Plan on AMR-current status

• Core working group at DGHS
• 2 consultative workshops
• Technical committee has been formed
• Draft national Action plan
• Consultative workshop with WHO
• Revision of the draft
• By 2017 National Action Plan will be finalized
Challenges

1. Development of national action plan and its implementation

Lack of communication and coordination among different sectors including human health, animal health and environment
2. Adequate surveillance and laboratory capacity

Improvements are necessary in three areas of surveillance capacity:

a) Data collection and data sources, data management, analysis and interpretation;
b) Information reporting, dissemination, communication and use.
c) Focused and targeted international cooperation

Logistic support and trained staff development are the major challenges for establishment of a reference laboratory for AMR in Bangladesh
Challenges

3. Access control to antimicrobial medicines and rationale use of them

- Weak regulatory systems and law enforcement
- OTC sale of antibiotics
- Lack of antibiotic treatment policy for both human and animal health.

4. Awareness

- Lack of awareness among health care professionals and mass population
Challenges

5. Infection prevention and control programmes along with supervision & monitoring of these programs

- National infection prevention and control programme
- Proper maintenance of IHR
- Strict & timely monitoring plan
- Waste management
- Biosafety and Biosecurity
How to overcome these challenges

Need a separate body in the government who will take care of these issues and coordinate the activities with different sectors.

AMR is expected to be included as a separate OP of the DGHS, MoHFW in the next 5 years plan (2016-2021)
Thank you

icddr,b thanks its core donors for their on-going support