Chlorine Use in Emergencies and Outbreaks

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Infection Prevention and Control

- Health care-associated infections (HAI)
  - ~5% of patients in the US (CDC)
  - ~10% of patients worldwide (WHO)

- Infection Prevention and Control (IPC) programmes aim to prevent HAI and the spread anti-microbial resistance (AMR)
  - Comprehensive programme, standard precautions
    - Hand Hygiene
    - Environmental hygiene
Introduction

Chlorine is used to limit the spread of disease, but many uses lack evidence-base.

We conducted research to evaluate:
1. Chlorine concentration testing
2. Chlorine shelf-life
3. Surfaces disinfection
4. Handwashing efficacy
5. Handwashing safety
6. Chlorine tablet distribution
Chlorine concentration testing

Which chlorine test methods are accurate, precise, and easy for testing 0.5% and 0.05% chlorine?

- Test methods: Titration, DPD with dilution, Test strips
- Chlorine types: NaOCl (stabilised, neutral, generated), HTH, NaDCC
- Concentrations: 0.5% and 0.05%
- Results: variability across methods, chlorine types & concentrations
  - Test strips easy to use but accuracy & precision low
- Recommendation: test strip development
Chlorine shelf-life

What is the shelf-life of 0.5% and 0.05% chlorine solutions?

- Tested (HACH digital titration):
  - Chlorine types: NaOCl (stabilised, neutral, generated), HTH, NaDCC
  - Concentrations: 0.5% and 0.05%
  - Time: over 30 days
  - Temperatures: stored at 25°C, 30°C, 35°C

- Shelf-life = time until <90% of initial concentration

- Shelf-life ranged from <1 to >30 days

- Chlorine compound selection and use guidelines
Chlorine shelf-life

Use conditions (Continuous flow vs stored in tanks)

Precipitate formation (clog pipes)

Place of manufacture & transport

Disinfection not tested
Surfaces disinfection

What are the most efficacious methods for disinfecting surfaces in Ebola outbreaks?

- Laboratory testing of recommended disinfection methods
- Recommend: 15 min exposure to 0.5% chlorine
  - Independent of chlorine type, surface, pre-cleaning and organic matter
- Field and lab work ongoing for surface disinfection in cholera outbreaks
Handwashing efficacy

Which handwashing products are most efficacious at removing test organisms?

- Lab testing: *E. coli* and Phi6
- Products: soap, hand sanitizer, four chlorine solutions (0.05%)
- Volunteers: hands contaminated then washed
- All handwashing methods were similarly efficacious
- Chlorine may avoid introduction into the environment
- Responders should use what is available
Handwashing safety

Which handwashing products are gentlest on skin?

- Tested: soap, hand sanitizer, 0.05% chlorine solutions (4 types)
- 91 volunteers washed hands, 10x daily, 28 days
- Evaluated daily
  - Increased irritation & redness
  - No clinically significant differences among methods
- Responders should use what is available

Nurse at redemption hospital washes her hands by World Bank Photo Collection licensed under CC BY-NC-ND 2.0
Chlorine tablet distribution (in progress)

How can we form a system to guide coordinated selection of chlorine tablets in emergencies?

• Chlorine tablets (NaDCC) used to treat drinking water
  • Various strengths distributed
• Working group to define a selection process
  • Water quality
  • Taste
  • Odor
  • Availability, etc
• Unified selection based on this data can limit confusion
Conclusion

These projects provide data to inform best practice recommendations for disinfection with chlorine

- Chlorine use should be informed by evidence
- Research on cholera disinfection is ongoing
- Further work on handwashing is planned

Thank you to OFDA and R2HC for funding this work
Thank you!!

Questions?


Chemistry: Test Kit Accuracy (NaOCl - pH 9)

0.05% Titration, DPD, Test Strips

0.5% Titration, DPD, Test Strips
Chemistry: Test Kit Accuracy (NaDCC - pH 6)

0.05% Titration, DPD, Test Strips

0.5% Titration, DPD, Test Strips
## Chlorine Selection: Benefits and Drawbacks

<table>
<thead>
<tr>
<th>Benefits</th>
<th>HTH</th>
<th>NaDCC</th>
<th>NaOCl</th>
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<tbody>
<tr>
<td></td>
<td>Easy to ship</td>
<td>Easy to ship</td>
<td>Can be produced locally/on-site</td>
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<tr>
<td></td>
<td>(high-concentration powder)</td>
<td>(high-concentration powder)</td>
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<tr>
<td>Long shelf-life of powder</td>
<td>3–5 years</td>
<td>3–5 years</td>
<td>Long shelf-life of solution if stabilised</td>
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<td></td>
<td>Long shelf-life of solution</td>
<td>Does not clog pipes</td>
<td>Does not clog pipes</td>
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<td></td>
<td>(&gt;30 days)</td>
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<td>Drawbacks</td>
<td>May be explosive</td>
<td>Short shelf-life of solution</td>
<td>Shorter shelf-life of stock</td>
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<td>Precipitate may clog pipes</td>
<td>2 days</td>
<td>(3–12 months)</td>
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<td></td>
<td>Short shelf-life of solution if unstabilised (1–4 days)</td>
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<td></td>
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<td>Heavy to ship</td>
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