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

UNITED against infections

hand in hand
fighting infection together

DO YOUR BIT. WASH YOUR HANDS

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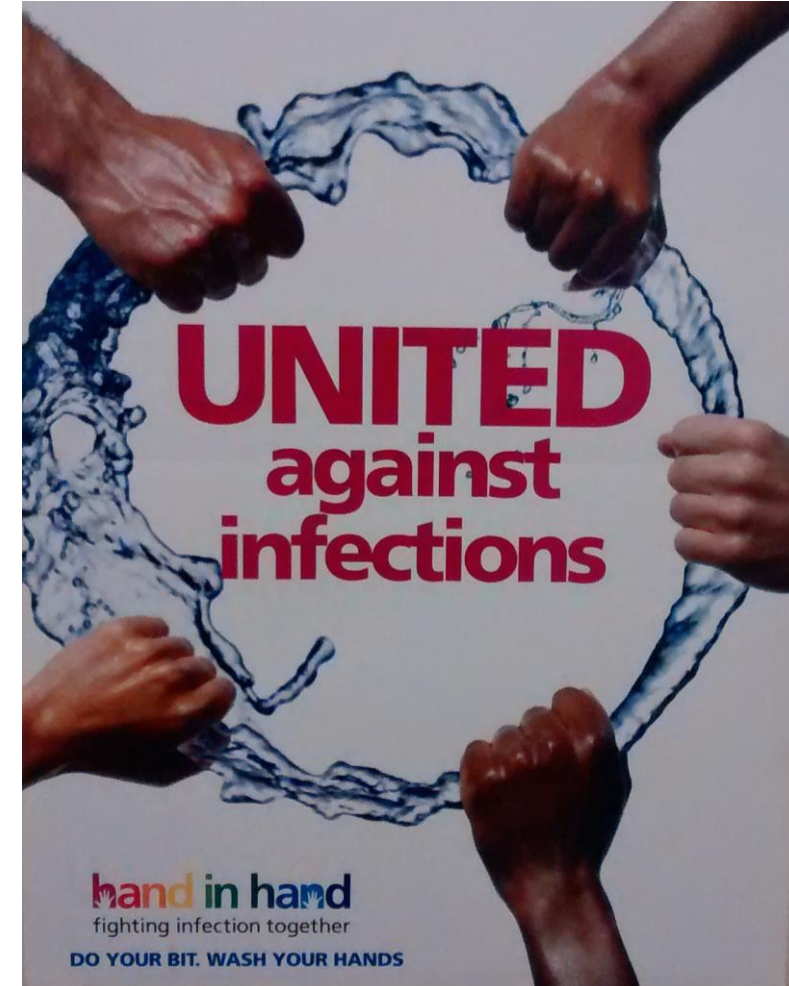
Introduction

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

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Chlorine concentration testing

Which chlorine test methods are accurate, precise, and easy for testing 0.5% and 0.05% chlorine?
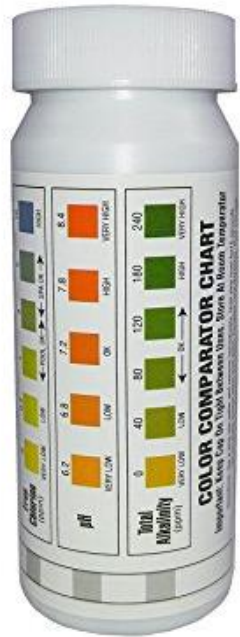
- Test methods: Titration, DPD with dilution, Test strips

- 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

Ebola Prevention and Treatment in Conakry, Guinea by United Nations Photo licensed under CC BY-NC-ND 2.0

Chlorine shelf-life

0.5% HTH (pH=11)

Concentration (%) vs Days
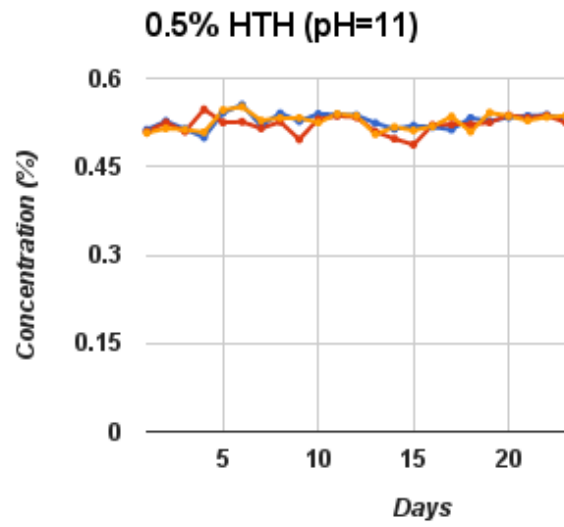
Use conditions (Continuous flow vs stored in tanks)

Precipitate formation (clog pipes)

Place of manufacture & transport

Disinfection not tested

- 25 C mean
- 30 C mean
- 35 C mean
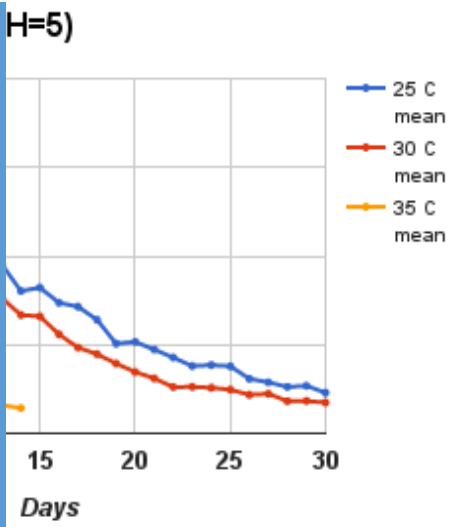
Surfaces disinfection

What are the 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

Test org.		Soil load		Surfaces		Rec.		Chlorine
E. coli		With		Stainless steel		Nothing		Generated NaOCl
	×		×		×	Wipe	×	Stabilized NaOCl
				Nitrile		Cover spill		
Phi6		Without						HTH
				Heavy duty tarp		Wipe & cover		NaDCC

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

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Handwashing safety

Which handwashing products are gentlest on skin?

Nurse at redemption hospital washes her hands by World Bank Photo Collection
licensed under CC BY-NC-ND 2.0

- 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

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

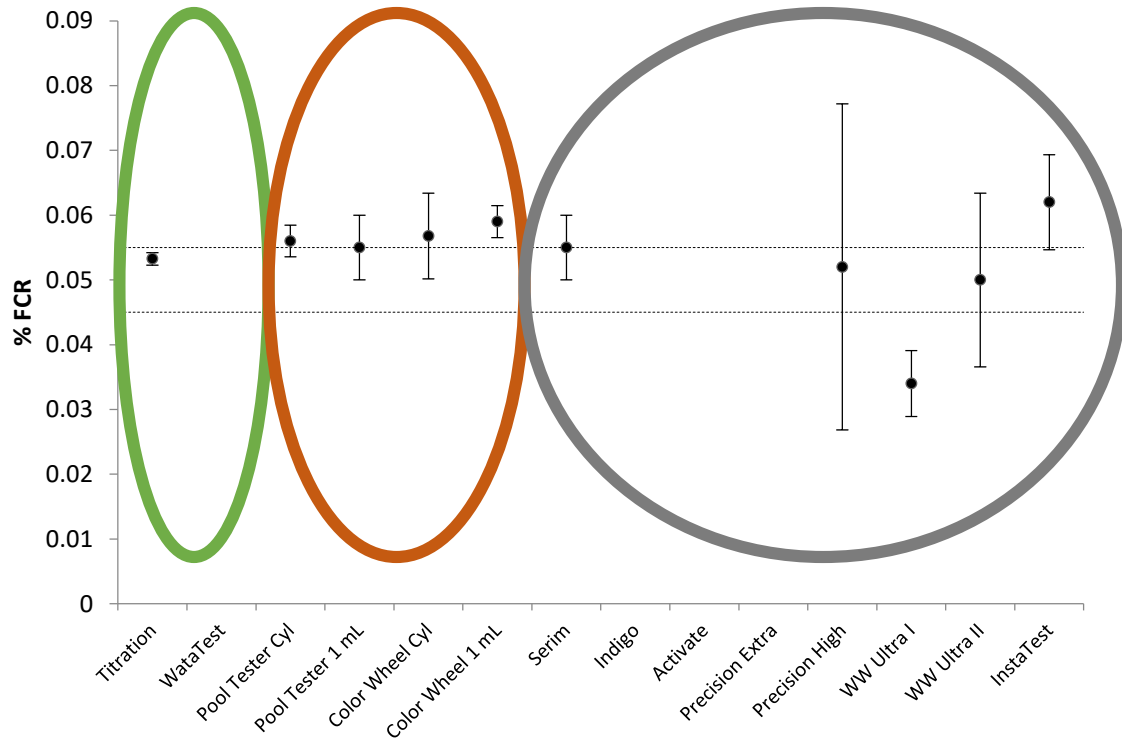Thank you to OFDA and R2HC for funding this work

Thank you!!

Questions?

Related Publications

1. Branz, Ariel, Matthew Levine, Lilian Lehmann, Andy Bastable, Syed Imran Ali, Khalid Kadir, Travis Yates, David Bloom, and Daniele Lantagne. 2017. "Chlorination of drinking water in emergencies: a review of knowledge to develop recommendations for implementation and research needed." *Waterlines* 36 (1):4-39.

2. Gallandat, Karin, and Daniele Lantagne. 2017. "Selection of a Biosafety Level 1 (BSL-1) surrogate to evaluate surface disinfection efficacy in Ebola outbreaks: Comparison of four bacteriophages." *PloS one* 12 (5):e0177943.

3. Gallandat, Karin, Marlene K Wolfe, and Daniele Lantagne. 2017. "Surface Cleaning and Disinfection: Efficacy Assessment of Four Chlorine Types Using Escherichia coli and the Ebola Surrogate Phi6." *Environmental science & technology* 51 (8):4624-4631.

4. Iqbal, Qais, Maya Lubeck-Schricker, Emma Wells, Marlene K Wolfe, and Daniele Lantagne. 2016. "Shelf-life of chlorine solutions recommended in Ebola virus disease response." *PloS one* 11 (5):e0156136.

5. Wells, Emma, Marlene K Wolfe, Anna Murray, and Daniele Lantagne. 2016. "Accuracy, Precision, Ease-Of-Use, and Cost of Methods to Test Ebola-Relevant Chlorine Solutions." *PloS one* 11 (5):e0152442.

6. Wolfe, Marlene K, Karin Gallandat, Kyle Daniels, Anne Marie Desmarais, Pamela Scheinman, and Daniele Lantagne. 2017. "Handwashing and Ebola virus disease outbreaks: A randomized comparison of soap, hand sanitizer, and 0.05% chlorine solutions on the inactivation and removal of model organisms Phi6 and E. coli from hands and persistence in rinse water." *PloS one* 12 (2):e0172734.

7. Wolfe, Marlene K, Emma Wells, Brittany Mitro, Anne Marie Desmarais, Pamela Scheinman, and Daniele Lantagne. 2016. "Seeking Clearer Recommendations for Hand Hygiene in Communities Facing Ebola: A Randomized Trial Investigating the Impact of Six Handwashing Methods on Skin Irritation and Dermatitis." *PloS one* 11 (12):e0167378.

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USAID FROM THE AMERICAN PEOPLE — **Action Research on Common Under Researched WASH Interventions** *Tufts University, in collaboration with response organizations*

USAID FROM THE AMERICAN PEOPLE — *Applied Research on Disinfection to Prevent Ebola Transmission* *Tufts University, with the University of Brighton and Brigham and Women's Hospital*

Chemistry: Test Kit Accuracy (NaOCl - pH 9)

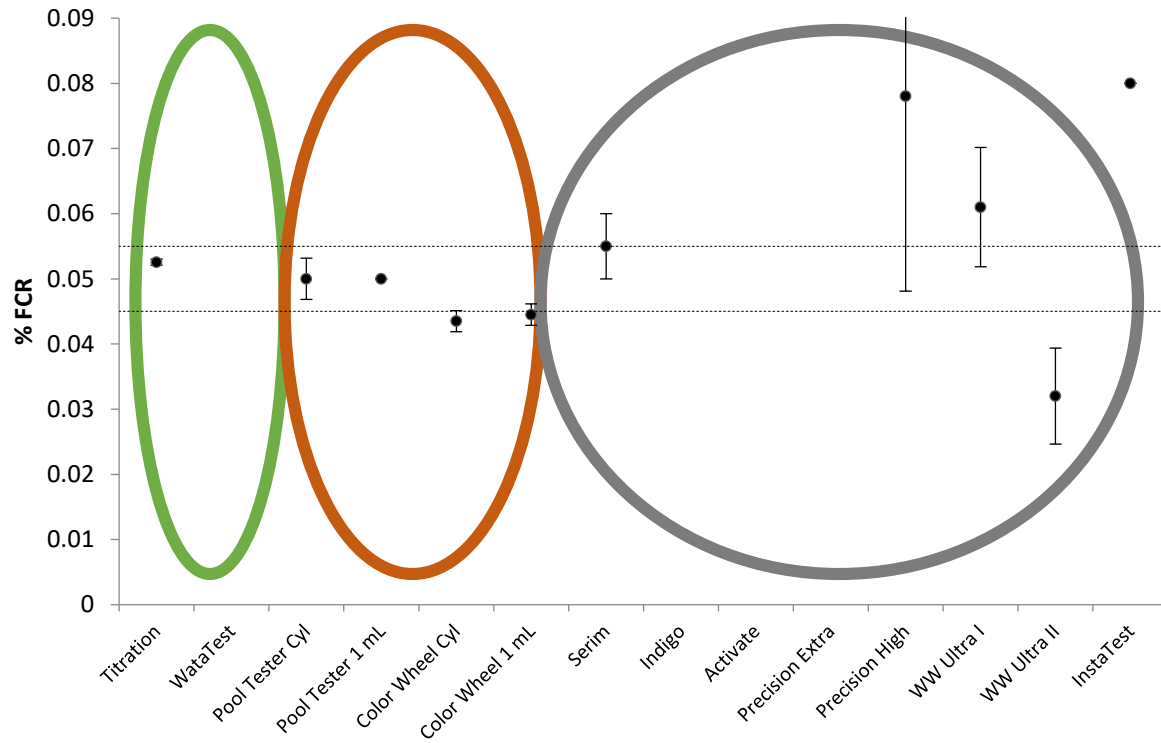0.05% Titration, DPD, Test Strips
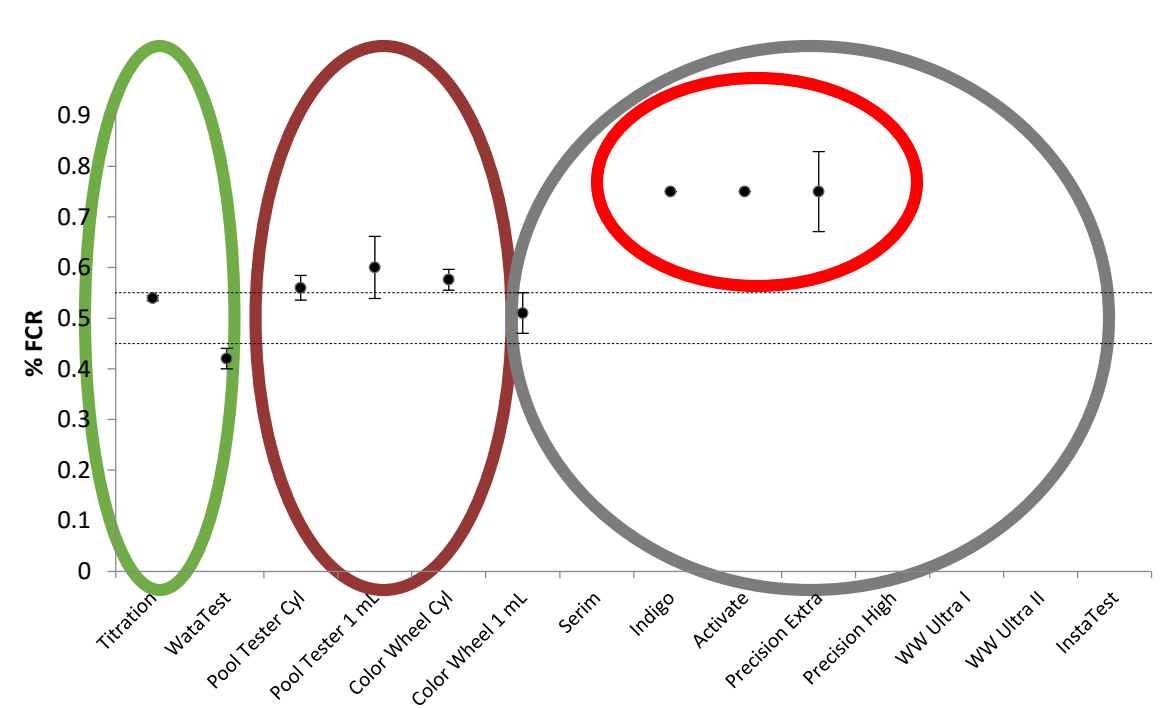
0.5% Titration, DPD, Test Strips
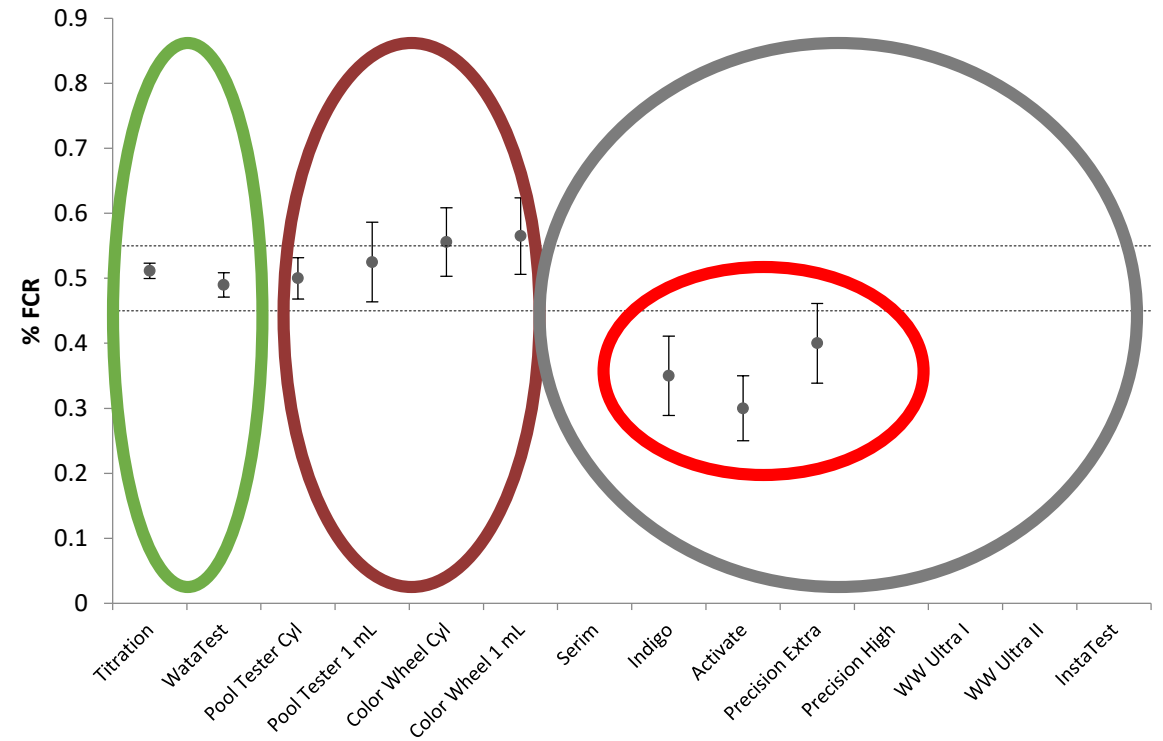
Chemistry: Test Kit Accuracy (NaDCC - pH 6)

0.05% Titration, DPD, Test Strips

0.5% Titration, DPD, Test Strips

Chlorine Selection: Benefits and Drawbacks

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