

# Understanding Cholera - A Review.



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# Introduction

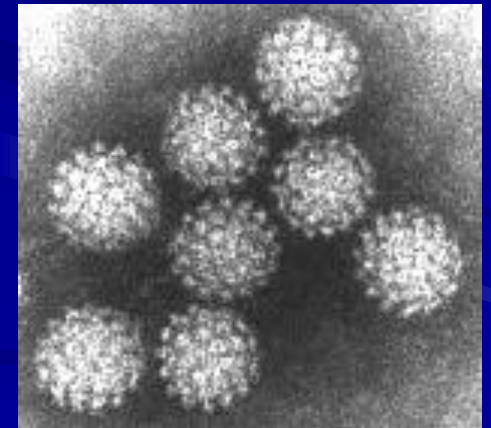
- Water is one of the main ways in which pathogenic microorganisms can spread.
- Drinking water can become contaminated with these pathogens.
- Can include bacteria, viruses and parasites.
- Estimated 1.8 million people infected by water borne diseases every year.

# Water Borne Virus Infections

- Gastroenteritis - caused by Astroviruses, enteric adenoviruses, Parvovirus, Calicivirus – **all naked viruses.**
- Hepatitis – caused by Hepatitis A virus – **naked virus**
- Adenovirus infection – caused by Adenovirus – **naked virus**
- Polio – caused by Poliovirus – **naked virus**
- Polyomavirus infection – caused Polyomavirus – **naked virus**

# All Viruses are not Equally Susceptible to the Action of Disinfectants!

- Two main classes of viruses. – Naked viruses and Enveloped viruses.
- Naked viruses much more resistant to disinfectants.
- All of the water borne viral diseases are **naked viruses**.

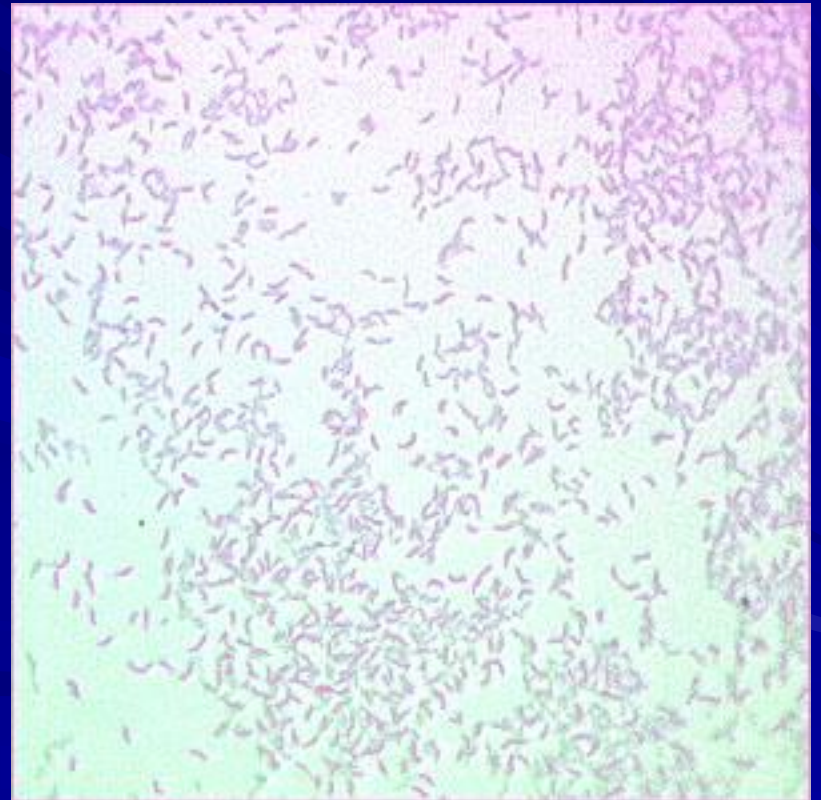
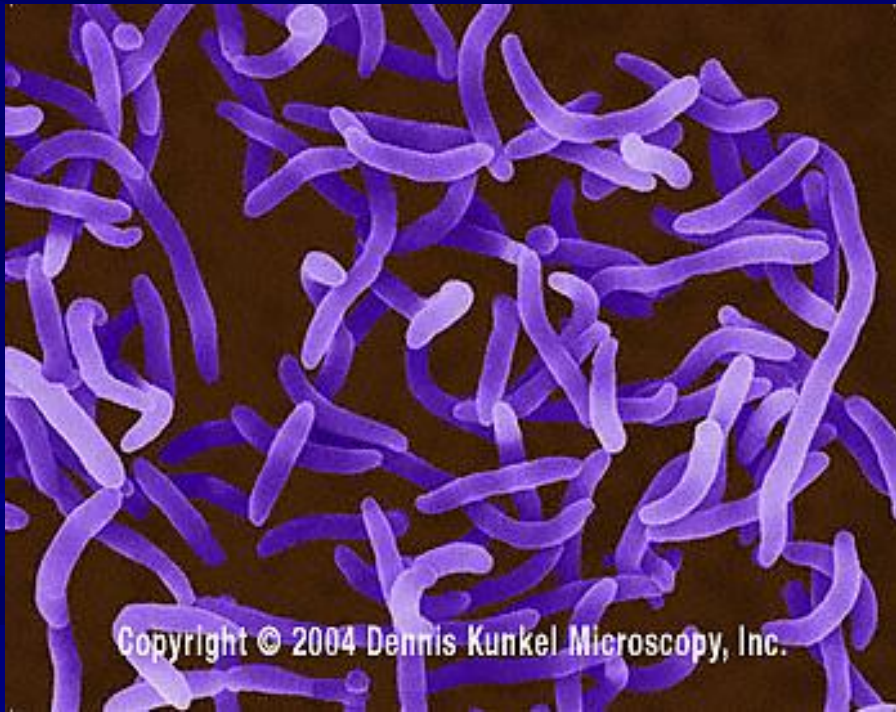


# Water Borne Bacterial Infections

- Botulism – *Clostridium botulinum*
- Campylobacteriosis – *Campylobacter jejuni*
- *E. coli* infection – *E. coli*
- Dysentery – *Salmonella* or *Shigella* species.
- Typhoid fever – *Salmonella Typhi*
- Cholera - *Vibrio cholera*

# Cholera

caused by the bacterium  
*Vibrio cholerae*



# Cholera – The Disease

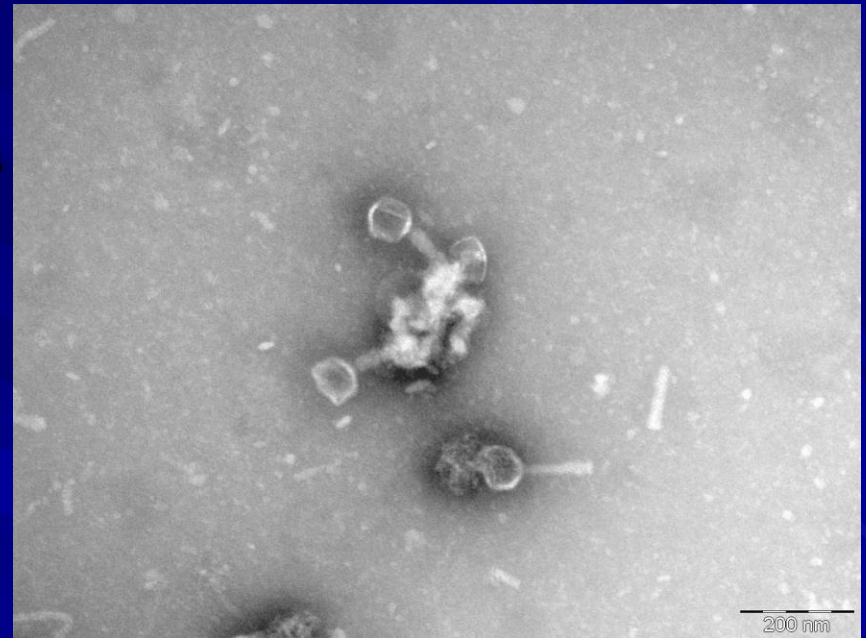
- Exhaustive diarrhea
- Rapidly fatal illness – can be fatal in 3 hours!
- Normal process of disease
  - First liquid stools – within 4 hours
  - Shock – within 12 hours
  - Death – within 18 hours.

# Cholera - The disease

- Caused by the bacterium *Vibrio cholerae*
- Faecal contamination of the drinking water.
- Bacterium can survive in the environment long after the contamination event.
- Normally about 1 000 000 bacteria required to start infection.
- Lower numbers needed in people with weakened immune systems.

# Cholera Toxin

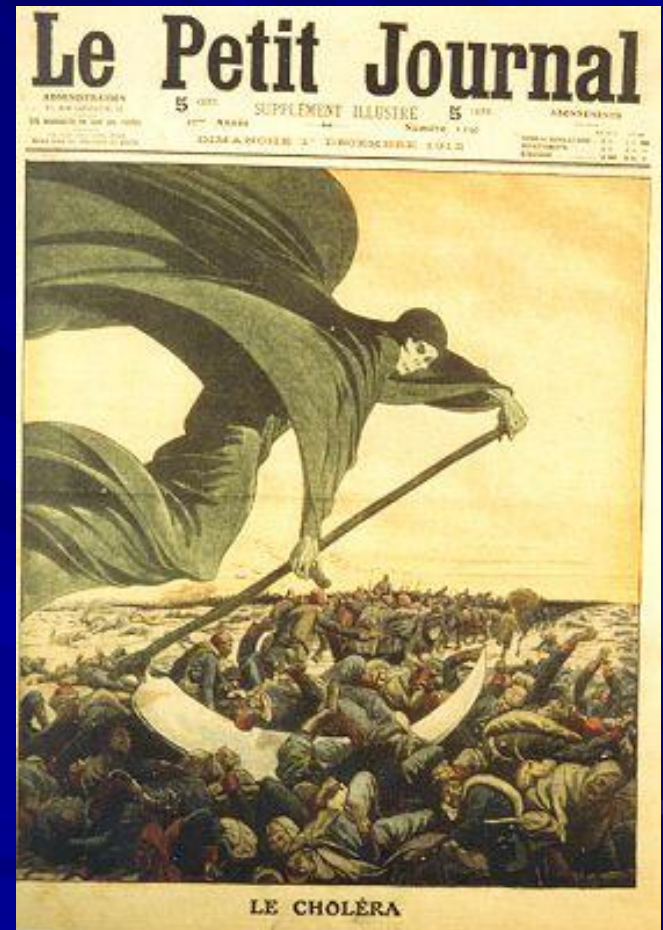
- Exotoxin – acts on mucosal epithelium lining of the small intestine.
- Can get toxic and non- toxic forms of the bacterium. (in other words, just because the bacterium is in the environment does not mean that there will be cholera.)
- Encoded for by lysogenic bacteriophages.
- Bacteriophages are bacterial specific viruses which can either be lysogenic or lytic.





# History of Cholera

- First pandemic – 1816 – 1826
  - Started in India – spread to Indonesia, China and Russia.
  - 10 000 British troop died in India
  - 15 million people died world-wide.
- Second pandemic – 1829 – 1851
  - Spread to Russia, Hungary, Germany, England, France, USA, Canada, Egypt
  - Estimated mortality of 500 000



# History of Cholera

## ■ Third pandemic – 1852 – 1860

- Russia – over 1 million deaths.
- Chicago – 5.5% of the population died.

## ■ Fourth pandemic – 1863 – 1875

- 30 000 out of 90 000 pilgrims to Mecca died.
- Italy – 113 000 dead.
- Total estimated 340 000.



# History of Cholera

## ■ Fifth pandemic – 1881 - 1896

- 250 000 lives in various European countries, 50 000 in Americas and 270 000 in Russia.
- 120,000 in Spain; 90 000 in Japan and 60 000 in Persia.
- In Egypt cholera claimed more than 58 000 lives

## ■ Sixth pandemic – 1899 – 1923

- little effect in Europe because of advances in public health.
- 500 000 people died in Russia
- 200 200 lives in The Philippines, 800 000 in India

# History of Cholera

- Seventh pandemic – 1961 - 1970
  - Started in Indonesia – spread to India, USSR, North Africa, Italy, Japan and South Pacific.
- Eight “pandemic” – 1991 - 1994
  - Ship discharging contaminated ballast water. South America – 1.04 million cases in Peru with 10 000 deaths.
  - Spread to Asia (India)

# Recent Outbreaks

- **2007** – Iraq, India, Vietnam, Congo
- **Aug 2008 – April 2009** – Zimbabwe (1810 recorded mortalities with a 4.2% mortality rate).
- **January 2009** – South Africa – 2276 cases with 19 mortalities.



# Treatment

- **Most important – oral re-hydration**
- Commercial re-hydration products are available.
- Home made possibilities – formulas of water with sugar, table salts or baking soda.
- Fruit juice can also be used.

# Treatment

- Can use antibiotics. Shorten the course of the disease.
- Disease is caused by an exotoxin produced by bacteria. Even if antibiotics kill all bacteria – exotoxins remain.
- Increasing problem with antibiotic resistance.

# Prevention

- Prevented by proper sanitation practices.
- No longer a health risk in 1<sup>st</sup> world countries.
- Last outbreak in USA was in 1910 – 1911.
- Main source of bacteria is fecal contamination of drinking water. If this can be stopped - the disease can be stopped.

# Prevention

- Sterilization of contaminated material from Hospitals.
- All sewage must be treated and no raw sewage to be released into water supply.
- Warning signs on contaminated water sources.
- Water purification – boiling of water and/or addition of antimicrobial chemicals.



# **Emergency Water Treatment**

# Boiling of Water

- Boiling of water before drinking.
- This remains the most effective way of killing bacteria.
- Water should be boiled for at least 1 min before drinking.
- Will kill 100% of the bacteria.

# Addition of Disinfectants

- Addition of bleach (Jik).
- Various reports on different doses.
- South African government Information on Cholera: Add 1 teaspoon of Jik to 20 liters of water.
- North Carolina Extension Services – Add  $\frac{1}{4}$  teaspoon of bleach to 4 liters of water.
- 1 teaspoon is equal to 5 ml.
- Will this work?

# Addition of Disinfectants

- Not all bleach concentrations are the same.
- Jik is a 3.5% Sodium hyperchloride (NaOCl) solution.
- Bleach in the USA is a 5.25% sodium NaOCl.
- However, the recommended concentrations for use is the same!

# Addition of Disinfectants

- Minimum inhibitory concentration (MIC) of **NaOCl** to kill naked viruses in 3%. Jik is only a 3.5% solution of **NaOCl**.
- The recommended dilution of Jik will not kill the naked viruses in the water.
- So will it kill the bacteria?

# Bleach as Antibacterial Agent

- Some published MIC amounts for **NaOCl** against bacteria was found to be 0.02%.
- The 1 teaspoon (5 ml) of Jik in 20 liters water will give a dilution of Jik of 0.025%.
- **This, however, is not the dilution of NaOCl!**
- The dilution of **NaOCl** in this dilution is only 0.000875%! This is way below the MIC value of 0.02%!

# Bleach as Antibacterial Agent

- Experiments performed to test the antimicrobial effects of  $\text{NaOCl}$  by making the recommended dilutions of both the USA and South African suggestions.

# Methods

- 3 bottles of sterile water were contaminated with the same volume of bacteria.
- Bottle 1 was an untreated control.
- Bottle 2 was treated with “1 teaspoon in 20 liters” (SA recommendations).
- Bottle 3 was treated with  $\frac{1}{4}$  teaspoon per 4 liters (USA recommendation).
- Bacterial counts were performed on all three bottles to determine the number of surviving bacteria in each treatment.

# Results

Bottle number	Bacterial count per 0.1 ml	Bacterial count in 1 liter
1 - Control	$6.6 \times 10^7$	$6.6 \times 10^{11}$
2 – SA treatment	$1.39 \times 10^4$	<b><math>1.39 \times 10^8</math></b>
3 – USA treatment	$3.74 \times 10^4$	<b><math>3.74 \times 10^8</math></b>

# Results

- Percentage reduction in bacterial counts with the SA recommendation = 99.98%!
- Percentage reduction in bacteria using USA recommended dose = 99.94%!
- Is this sufficient???

# Comments

- It is estimated that 1 000 000 bacteria are needed for infection.
- SA treatment showed **99.98%** reduction in bacterial count – yet **about only 10 ml** of treated water will still have enough bacteria to cause disease.
- US treatment showed **99.94%** reduction – yet **about only 10 ml** of treated water will still cause disease.

# Comments

- Treatment of water with Jik – at either 1 teaspoon in 20 liters” (SA recommendation) or  $\frac{1}{4}$  teaspoon per 4 liters (USA recommendation) will not remove all of the bacteria in the water.
- These treatments will greatly reduce the number of bacteria.
- However, still sufficient bacteria to cause disease even in small volumes of water.

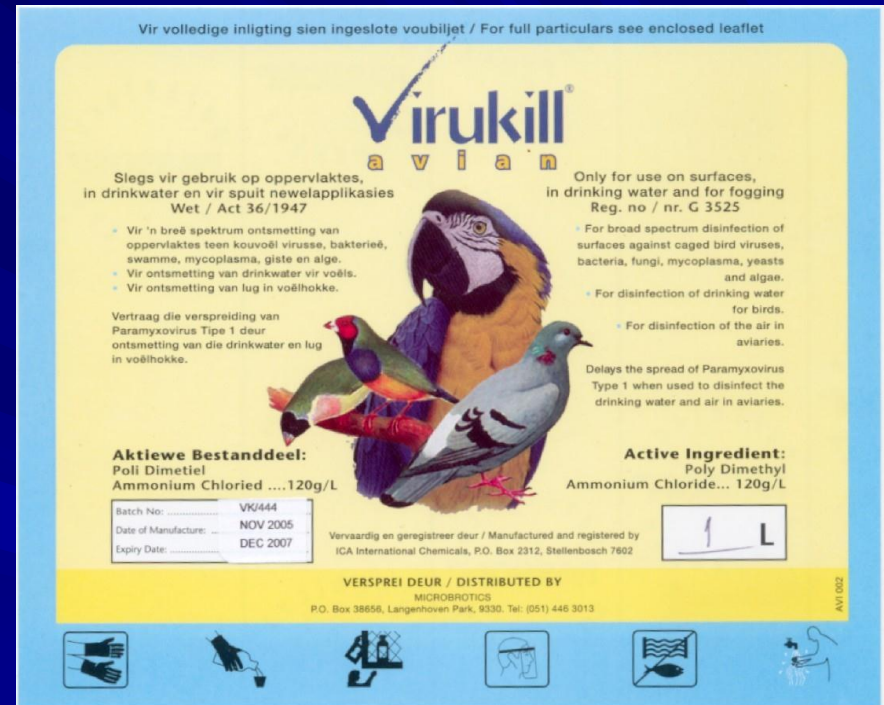
# Alternative Biocides

# Calcium Hyperchloride

- Swimming pool chlorine – 70% solution of Calcium hyperchloride.
- MIC is 200 ppm ( 0.4g in 1 liter).
- MIC tests have been performed in this laboratory.
- This has a strong “chlorine” smell.
- Is this water drinkable?

# Antibacterial activity of QAC based products

- Recent improvements have been made in Quaternary Ammonium based disinfectants.
- MIC of Virukill avian against bacteria has been found to be to range between 0.01% to 0.006% in conditions without high organic load.



# Antibacterial activity of QAC based products

- Virukill avian is registered for use in the drinking water of animals at a dose of 0.01%.
- It is not toxic to animals at that concentration.
- A 0.01% dilution of Virukill avian will kill 100% of the bacteria in water. This is a dilution of 1 ml per 10 liters of water.

# Disaster Preparedness for Cholera

- Need to decide on suitable antimicrobial chemicals which can be used for emergency treatment.
- Prepare education campaigns to educate people about the risks of faecal contamination of drinking water.
- Educate people on emergency drinking water treatment options.



# Conclusions

- **Cholera** is a serious disease threat.
- **Cholera** is no longer a problem in first world countries where good and reliable systems are in place to treat waste water.
- In developing countries, waste water treatment systems are not always in place.
- **Raw sewage running down the street is a common site in many South African cities!**

# Conclusions

- **Cholera** can be treated.
- Most important is re-hydration therapy.
- Antibiotics can be used to limit the severity of the disease, but the exotoxins will still be present even after the bacteria have been killed.

# Conclusions

- Emergency treatment of drinking water must be a priority during an outbreak.
- Boiling of water should be the first choice for emergency drinking water treatments.
- Current recommendations for the addition of bleach to the drinking water is too low to kill microorganisms.
- Other options for disinfection of water should be investigated.

# Thank you.

