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Friday, August 11, 2017
16:55 - 17:20 What Do GPs Need to Know About Drinking Water?
Drinking Water: What GPs need to know

Alistair Humphrey MPH FRACGP FAFPHM
10th August 2017
This presentation

• What is the burden of water borne disease?

• How does NZ reduce the risk from drinking water?

• Algal blooms

• Nitrates

• Microbial contamination and a few outbreaks

• Conclusions
Infection Pathway

Raw water

Disease reservoir

X% removal

X% removal

Process 1

Treatment Plant

Process 2

Finished water

Human disease
Monitoring, compliance and the law

1. Drinking Water Source
   - Resource Management Act 2013
     - Ministry for the Environment, Regional Councils
   - RMA Tools
   - Council Officers
   - Rivers
   - Groundwater

2. Treatment
   - Health (Drinking Water) Amendment Act 2007
     - Ministry of Health, Public Health Units, Territorial Authorities, Water suppliers
   - NZ Drinking Water Standards, Ministry of Health
   - Risk Management Plans
   - Drinking water assessors

3. Supply
   - Building Act 2004
     - Territorial Authorities
   - Building inspectors
   - Territorial Authorities

Source to tap approach
Key health issues wrt water

- Cyanobacteria – toxic blooms
- Elevated nitrates
- Microbiological contaminants
Cyanobacteria toxic bloom

- Cyanobacteria bloom development in response to reduced river flows, increasing temperatures, nutrients.

- Diverting water may transfer contaminants from one water body to another.
Health effects of cyanobacteria

• Microcystins (hepatoxic)
• Anacystin A (neurotoxic)
• Symptoms:
  – stomach pains, vomiting, diarrhea, and skin rashes
• Signs:
  – Nerve and liver damage after long term exposure
• Dogs die quickly as they chew the algae
Cyanobacteria contd..

• River catchments impacted by cyanobacterial blooms include: Selwyn, Ashley, Waiau, Ashburton, Pareora, Opihi rivers.

• A number of these rivers have water intakes for community and private water supplies.

• Nutrient discharge has to be carefully monitored and managed. Eg. Land & Water Regional Plan
Nitrates and Blue Baby Syndrome

- What is Blue Baby Syndrome?
- What causes Blue baby syndrome?
- Why are New Zealand babies more at risk now?
- Can Midwives and other LMCs mitigate this risk?
  - Understanding some basic drinking water science
  - Assisting their clients to test their drinking water
  - Newborns must avoid nitrates
The physiology of blue baby syndrome

Nitrates → Gut
Methaemoglobin^{3+} → Reduced
Cytochrome b5 Reductase
NADH → NAD
Nitrites
Haemoglobin^{2+}
Gut
Why are babies < 6/12 more susceptible to methaemoglobinaemia?

- Fetal hemoglobin oxidizes more easily than adult hemoglobin
- The level of NADH reductase is low at birth and increases with age; it reaches adult levels by age 4 months
- Higher gastric pH in infants may facilitate bacterial proliferation, resulting in increased conversion of dietary nitrates to nitrites
- Diarrhoea causes acidosis in infants (due to loss of bicarbonate in stool). Acidosis further impairs immature methaemoglobin reductase

1. Chocolate brown (Methaemoglobinaemia 70%)
2. Chocolate brown (Methaemoglobinaemia 70%)
3. Methaemoglobinaemia 20%
4. Normal blood
Physical Findings of Methaemoglobinaemia

Methaemoglobin fraction

- 0-3% - Normal range – Normal Baby
- 3-15% - Slight discoloration (eg, pale, grey, blue) of the skin
- 15-20% - Cyanosis, though patients may be relatively asymptomatic
- 25-50% - Headache, dyspnoea, light headedness* and syncope, weakness, confusion, palpitations, chest pain (symptoms reported by adults)
- 50-70% - Abnormal cardiac rhythms; altered mental status, delirium, seizures, coma; profound acidosis
- >70% - Usually, death

Physical signs

- Discoloration of the skin, mucous membranes, and blood (the most striking physical finding)
- Cyanosis - This occurs with the presence of greater than 1.5 g/dL of methaemoglobin (compared with 5 g/dL of deoxygenated haemoglobin)
- Pallor of the skin or conjunctiva suggests anaemia which can mask cyanosis.
- Seizures
- Coma
- Cardiac dysrhythmias (bradyarrhythmia or ventricular dysrhythmia)
- Acidosis
- Symptoms associated with cardiac and/or neurologic ischemia

* Associated with nitrite’s conversion to nitric oxide and its effect on smooth muscle
Breast is Best

- Even when mothers consume water with high nitrate concentration (100ppm) nitrate is not excreted in breast milk
- Lactobacillus species (in the guts of breast-fed infants) do not reduce nitrate to nitrite
- Beans, carrots, spinach and beets contain high levels of nitrate – solid foods are not necessary before six months of age

Nitrates

• Emerging issue throughout Canterbury in the 2000s

• Trend for increasing nitrate levels in ground water
The biggest source of nitrogen in New Zealand’s waterways is urine from farm animals.
Declining water quality is attributed to dairy farming:

1. Intensification:
   More cows per hectare

2. Expansion:
   More hectares for cows

Dr. Jan Wright – Parliamentary Commissioner for the Environment
Dairy intensification

- Irrigation
- Nitrogen fertilisers
- Palm kernel

© CS Ling

Orphaned Orang-utan
© CS Ling
...as an aside…

- Palm kernel is expensive -
- More cows does not mean more profit…
- ...but it does mean more nitrate…
The 2015 update report* contains new information on land use that was not available in 2013.

It shows that the conversion of sheep/beef farms to dairy farms has continued.

However, the predicted increase in forested land has not begun to occur.

This is not good news for water quality.

The modelling in the 2013 report is likely to have underpredicted the nutrients that will be lost from land into water.
‘standard’ mitigation was not enough to keep nitrogen losses constant, let alone reduce them.

Figure 4.1. ‘Standard’ mitigation techniques on dairy farms struggle to keep nitrogen losses from rising as productivity rises.

Data source: Monaghan and De Klein, 2014

Update Report

Water quality in New Zealand: Land use and nutrient pollution
June 2015
Nitrate-Nitrogen in the Ealing Hinds area

Samples with *E. coli* also detected:
How are nitrate levels set?

• The Maximum acceptable value (MAV) for nitrate in drinking water was set in the US in the early 1960s based on 214 human cases of methaemoglobinaemia

• The value was based on no observed adverse effect level (NOAEL)

• No margin of error was required under the Risk Assessment Information System (RAIS) as the risks were considered to be well understood so no safety factor was built in.

• This level is set by the World Health Organisation and the New Zealand Drinking Water Standards as 50mg/l nitrate, or 11.3 mg/l nitrate nitrogen

• Consumption of drinking water below this level has resulted in no recorded cases of methaemoglobinaemia

• The US still experiences sporadic cases of methaemoglobinaemia in bottle-fed infants on private bores where the nitrate MAV has been exceeded

• Levels of nitrate in groundwater in New Zealand are increasing, and are now exceeding the MAV in many parts of Canterbury and elsewhere
2015 Nitrate Risk for shallow groundwater

NITRATE RISK
(shallow groundwater)
- high
- moderate
- low
How is our drinking water protected?

- Monitoring by ECAN and suppliers
- Oversight by Public Health Drinking Water Assessors (a collaborative approach)
- Legal framework
- New Zealand Drinking water standards

- The system works well for community supplies, but private supplies tend not to be well monitored
Multiple barrier approach

Barriers work by reducing risk: they are not absolute

Nitrate can be removed – But the systems are expensive

Raw water

Process 1

Treatment Plant

Process 2

Finished water
### CWMS: Drinking Water Targets vs Irrigated Land Area Targets

#### From 2015 Targets

<table>
<thead>
<tr>
<th>Started</th>
<th>Some Progress</th>
<th>Good Progress</th>
<th>Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set catchment load limits for nitrate consistent with drinking water quality targets for each zone, identified priority areas where targets are not met and implemented actions to ensure there is no further enrichment.</strong>&lt;br&gt;<strong>Comments:</strong> Achieved for Hurunui River Catchment, scheduled for other zones. Work underway to identify priorities &amp; implement actions to ensure no further enrichment.</td>
<td></td>
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<td>✓</td>
</tr>
</tbody>
</table>

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<td><strong>Increase the area of irrigated land and/or the reliability of irrigation.</strong>&lt;br&gt;<strong>Comments:</strong> Information is available on consented irrigated area. Work is being progressed to increase both irrigated land area and reliability.</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
2017:

9 wells (4%) showed a decrease

55 wells (25%) showed an increase

160 wells (71%) showed no decrease

Progress?
Canterbury Water Management Strategy: Targets by 2040

- Average annual nitrate levels in all groundwater wells are below 50% of MAV for drinking water.

- 850,000 hectares of irrigated land
So what is the solution to pollution for rural Cantabrian babies?
Process for LMCs to ensure drinking water does not cause methaemoglobinaemia

- If your client is *not* on a town drinking water supply:

1. Check maps to see whether they live in a high or moderate risk zone

2. If *yes* – ensure that their drinking water supply is checked for nitrates and *e.coli* (about $50)
   - *Lists of accredited laboratories are available on the CPH website*

3. Provide leaflet for mother
• Individual maps for each CWMS zone.
Nitrate in Drinking Water:

Pamphlet

Where can I get my water tested?

Testing for nitrate and bacterial contamination should be carried out at an approved laboratory. Community and Public Health and the Environment Canterbury website have a list of accredited laboratories that can be used for testing.

Further Information

Community and Public Health
03 364 1777
www.cph.co.nz

Environment Canterbury (ECAN)
03 353 9007
0800 324 636
0800 EC INFO
www.ucan.govt.nz

Nitrate maps are available from:
Community and Public Health
www.ccphe.co.nz

Nitrate in Drinking Water
“BLUE BABY” Syndrome

Is my baby at risk?

Canterbury
District Health Board
Te Poari Hauora o Waitaha
Community and Public Health
310 Manchester Street
Christchurch
Phone: 03 364 1777
Fax: 03 3796125
www.cph.co.nz
Published September 2013
• Information now provided on health pathways for GPs.
• Acts as a prompt for GPs to ask questions about drinking water source.
• If on own bore, information available.
Water Testing results:

- If the level of Nitrate-Nitrogen exceeds the MAV (>11.3mg/l)...

- Only use bottled water for making up infant formula

- In any case – Breast is *always* Best:
Microbial Contamination of Water

- Legionella
- e. coli
- Pseudomonas
- Hepatitis A
- Norovirus
- Cryptosporidium
The burden of water borne disease in New Zealand

• Wide estimates: 18,000 to 34,000 an underestimate

• People with gastro do not always visit their GP

• Not all cases are notified
  – STEC, Giardia, Crypto, Hep A, Campylobacter should be
Campylobacteriosis rates for four regions included in Regional Implementation Plan

Average Annual Rates of Campylobacteriosis in Ashburton, Selwyn, Hurunui, Waimakariri and New Zealand By Age Rates: 2007 - 2011

- Ashburton, Hurunui, Selwyn and Waimakariri
- New Zealand

<table>
<thead>
<tr>
<th>Age Group (yrs)</th>
<th>Rates (per 100,000 population)</th>
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</thead>
<tbody>
<tr>
<td>0-4</td>
<td>620</td>
</tr>
<tr>
<td>5-9</td>
<td>465</td>
</tr>
<tr>
<td>10-14</td>
<td>310</td>
</tr>
<tr>
<td>15-19</td>
<td>260</td>
</tr>
<tr>
<td>20-29</td>
<td>155</td>
</tr>
<tr>
<td>30-39</td>
<td>105</td>
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<tr>
<td>40-49</td>
<td>90</td>
</tr>
<tr>
<td>50-59</td>
<td>80</td>
</tr>
<tr>
<td>60-69</td>
<td>60</td>
</tr>
<tr>
<td>70+</td>
<td>50</td>
</tr>
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Chart shows the comparison of average annual rates of Campylobacteriosis by age group for Ashburton, Hurunui, Selwyn and Waimakariri, and New Zealand from 2007 to 2011.
The Walkerton Tragedy

- >2,300 cases of gastroenteritis (E coli and campylobacter) in a town of 5,000 people
- 7 deaths
- Boil water notice for 6 months
- Business suffered, real estate values dropped
- Stigma
- Direct economic impact $64,000,000
- An opportunity for us to learn from others' mistakes
Betty Trushinksii

She died in the hospital away from her home, hooked up to machines and tubes in a coma.

She suffered terribly for ten days. She never had a chance to understand her illness.

She couldn’t put her affairs in order or say goodbye. There was no time.

She just got sicker and sicker … and we were always ten steps behind the illness.

Her dreams of her retirement with Dad and travelling were stolen, all because the water was unsafe and nobody told her.
Haemolytic Uraemic Syndrome

- STEC a common cause in children
- Up to 1/3 develop renal failure
- UP to 1/3 of these require long term dialysis
- Mortality is about 3-5%
• 118 cases of gastro – 29 *Campylobacter*

• Infiltration gallery water supply

• Failure of chlorine analyser

• Flooding
Dunsandel Contamination 2009

- *E. coli* transgressions
- Animal source
- 70M well
Springston Outbreak, February 2008

- Nearly 50% of township affected
- Most cases identified as *campylobacter*
- At least one case *e.coli 0157*
- Cracked bore with intensive farming
Havelock North August 2016

- 5500/14000 residents infected
- 45 hospitalizations with 3-5 deaths
- Two bores implicated
- Campylobacter from sheep faeces

“Drinking Water Assessors were too hands-off in applying the Drinking-water Standards. They should have been stricter in ensuring the District Council complied with its responsibilities”
69ZM Drinking-water assessors accountable to Director-General for performance of functions

(1) A drinking-water assessor is accountable to the Director-General for the discharge of the assessor’s statutory functions.
Conclusions

• Be aware of general water quality in your area, particularly if you live in a rural area.

• Notify on suspicion (*all* notifiable diseases!)

• Encourage nitrate and *e.coli* testing of private bores on booking for pregnancy.
Questions?