What are we aiming for?

- Preferably absence in flocks, second best: reduced cecal concentration at slaughter
- If colonization cannot be prevented in primary production, the processing plant is in charge
- Eliminate the heavily contaminated carcasses

Quantitative risk assessment models indicate that “the incidence of campylobacteriosis associated with consumption of chicken meals could be reduced 30 times by introducing a 2 log reduction of the number of Campylobacter on the chicken carcasses”
What measures in primary production?

- Prevention of introduction of *Campylobacter* into the broiler houses
  - reduced fraction of positive flocks

- Increased resistance of broilers to become colonized
  - reduced fraction positive flocks and (potentially) decreased *Campylobacter* counts/gram cecal contents

- Decreased concentration of *Campylobacter* in intestines just before slaughter
  - Decreased concentration in gut contents associated with lower carcass counts.
Prevention of introduction of *Campylobacter*: biosecurity

poultry farm
Prevention of introduction of *Campylobacter* farm
Prevention of introduction of *Campylobacter*

25 gram cecal content $\times 10^9 \times 50,000$ broilers = $10^{15}$ campylobacters/day

1 broiler can be become colonised with 50 campylobacters
Risk factors for farms to be \textit{Campylobacter} positive (input for intervention)

\textbf{Positive association with colonization}
- Thinning
- Other animals
- Other poultry houses
- Age
- Water supply

\textbf{Negative association with colonization}
- Implementation of biosecurity measures
On-farm interventions

- Biosecurity (including fly screens)
  - Thinning, consistently & rigorously applied, only indoor!

- Feed and water additives (acids, competitive exclusion, probiotics)

- Vaccination

- Phage therapy

- Genetic resistance

- Bacteriocines
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Foodborne Disease Prevention and Broiler Chickens with Reduced *Campylobacter* Infection

Simon Bahrmndorf, Lena Rangstrup-Christensen, Steen Nordentof, and Birthe Hald
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Campylobacter colonization: bacteria only

- Average CFU
- Average PFU

Campylobacter inoculation
Campylobacter colonization: therapeutic treatment

The graph shows the change in Campylobacter colony-forming units (CFU) and plaque-forming units (PFU) over time after inoculation with Campylobacter. The graph includes data points indicating the average CFU and average PFU, with arrows indicating the phage dosage applied and the time of inoculation. The x-axis represents time in days, ranging from 0 to 45, and the y-axis represents the number of CFU and PFU per gram (cfu/g and pfu/g). The peak of the curve occurs around day 20, with a decrease following the phage dosage application. The graph demonstrates the impact of therapeutic treatment on the colonization of Campylobacter.
On-farm interventions

- Biosecurity (including fly screens)
  - Thinning, consistently & rigorously applied, only indoor!

- Feed and water additives (acids, competitive exclusion, probiotics)

- Vaccination

- Phage therapy

- Genetic resistance

- Bacteriocines
On-farm interventions

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- Phage therapy

- Genetic resistance

- Bacteriocines

Review

Bacteriocins to control *Campylobacter* spp. in poultry—A review

E. A. Svetoch* and N. J. Stern††
Quantification of measures
Effect of interventions based on QMRA
(request from EFSA)

- 100% risk reduction can be achieved by irradiation/cooking

- > 90% risk reduction can be achieved by freezing for 2-3 weeks or reduction of the concentration in intestines at slaughter by > 3 log units;

- 50-90% risk reduction can be achieved by freezing for 2-3 days, hot water or chemical carcass decontamination with lactic acid, acidified sodium chlorite or trisodium phosphate

- 50-90% risk reduction by fly screens on farms (based on data from Denmark only)

- Up to 50% risk reduction by modifications of primary production,
  - restriction of slaughter age to a max 28 days (only indoor flocks)
  - discontinued thinning
SCIENTIFIC OPINION

Scientific Opinion on *Campylobacter* in broiler meat production: control options and performance objectives and/or targets at different stages of the food chain\(^1\)

EFSA Panel on Biological Hazards (BIOHAZ)\(^2, 3\)

European Food Safety Authority (EFSA), Parma, Italy
Economic aspects

Analysis of the costs and benefits of setting certain control measures for reduction of Campylobacter in broiler meat at different stages of the food chain

Fiscal Report

http://ec.europa.eu/food/food/biosafety/salmonella/other_act_en.htm
Campylobacter

On request of the Commission EFSA has published the "Scientific Opinion on Campylobacter in broiler meat production: control options and performance objectives and/or targets at different stages of the food chain"

The Commission has asked for an analysis of the costs and benefits of setting control measures for Campylobacter based on the EFSA opinion. The cost model is available in an easy-to-use excel file and can be adjusted to Member States’ individual situations."

See also "Implementation of the Directive" for baseline surveys on zoonoses others than Salmonella.
## Costs and benefits analysis

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Reduction in incidence (%)</th>
<th>EU cost of control € million</th>
<th>EU cost of illness saved € million</th>
<th>EU Net cost per DALY averted €</th>
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</thead>
<tbody>
<tr>
<td>F1</td>
<td>Enhanced Biosecurity</td>
<td>44%</td>
<td>36.7</td>
<td>333.8</td>
<td>-6,102</td>
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<tr>
<td>F2</td>
<td>Early Slaughter</td>
<td>15%</td>
<td>288.1</td>
<td>116.1</td>
<td>10,154</td>
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<tr>
<td>F3</td>
<td>No Thinning</td>
<td>12%</td>
<td>43.6</td>
<td>87.4</td>
<td>-3,438</td>
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<tr>
<td>F4</td>
<td>Vaccination</td>
<td>64%</td>
<td>297.7</td>
<td>478.8</td>
<td>-2,594</td>
</tr>
<tr>
<td>F5</td>
<td>Bacteriocins</td>
<td>64%</td>
<td>297.7</td>
<td>478.8</td>
<td>-2,594</td>
</tr>
<tr>
<td>S1</td>
<td>Best practice hygiene</td>
<td>23%</td>
<td>54.0</td>
<td>166.1</td>
<td>-4,626</td>
</tr>
<tr>
<td>S2</td>
<td>Chemical Decontamination</td>
<td>60%</td>
<td>116.1</td>
<td>442.9</td>
<td>-5,060</td>
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<tr>
<td>S3</td>
<td>Freezing (2-3 weeks)</td>
<td>93%</td>
<td>346.5</td>
<td>682.9</td>
<td>-3,377</td>
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<tr>
<td>S4</td>
<td>Hot Water</td>
<td>70%</td>
<td>272.2</td>
<td>516.8</td>
<td>-3,245</td>
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<tr>
<td>S5</td>
<td>UV Irradiation</td>
<td>100%</td>
<td>341.3</td>
<td>738.2</td>
<td>-3,687</td>
</tr>
</tbody>
</table>
Dutch approach: process hygiene criterion

- To control contamination of end-products in industrial slaughter plants for broiler chickens (carcasses after chilling)
- Threshold based on risk assessment models
- 1000 cfu/gram neck/breast skin
- Not complying is a sign that hygiene of the slaughter plant should be improved (=> develop and implement a plan for improvement)
- Not complying batches will not withdrawn
- Discussion about introduction at EU-level
The role of the consumer!!!
Dr. Henk van der Zee, Food Inspectorate, the Netherlands
Take home messages

- Up to 80% of human campylobacteriosis is poultry derived with 20-40% through poultry meat.

- Options for intervention in primary production are still (economically) limited and restricted to indoor production (animal welfare conflicting with food safety!)

- Efforts on primary production AND postharvest

- Elimination of the highly contaminated carcasses reduces the human burden considerably

- Potential approach: process hygiene criterium
<table>
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<tr>
<th>Thanks to...</th>
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<tbody>
<tr>
<td>Albert de Boer</td>
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<tr>
<td>Ria van der Hulst</td>
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<td>Frans Putirulan</td>
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<td>Fimme Jan van der Wal</td>
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<td>Peter Willemsen</td>
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