
norden

Interventions aimed at reducing the risk of acquiring Campylobacter from poultry products

Editors:

Hjörleifur Einarsson and Franklin Georgsson

Working group:
Franklin Georgsson, Environment and Food Agency, Chairman, Iceland
Gudrun Sandø, Danish Veterinary and Food Administration, Denmark
Susanna Kangas, National Food Agency, Finland
Merete Hofshagen, Norwegian Zoonosis Centre, Norway
Lars Plym Forshell, National Food Administration, Sweden

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Nordic Council of Ministers
Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0200
Fax (+45) 3396 0202

Nordic Council
Store Strandstræde 18
DK-1255 Copenhagen K
Phone (+45) 3396 0400
Fax (+45) 3311 1870

www.norden.org

Nordic co-operation

Nordic co-operation, one of the oldest and most wide-ranging regional partnerships in the world, involves Denmark, Finland, Iceland, Norway, Sweden, the Faroe Islands, Greenland and Åland. Co-operation reinforces the sense of Nordic community while respecting national differences and similarities, makes it possible to uphold Nordic interests in the world at large and promotes positive relations between neighbouring peoples.

Co-operation was formalised in 1952 when *the Nordic Council* was set up as a forum for parliamentarians and governments. The Helsinki Treaty of 1962 has formed the framework for Nordic partnership ever since. The *Nordic Council of Ministers* was set up in 1971 as the formal forum for co-operation between the governments of the Nordic countries and the political leadership of the autonomous areas, i.e. the Faroe Islands, Greenland and Åland.

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Preface

Food safety is one of the main priorities of the Nordic ministers for agriculture, fisheries and food and has been underlined by the ministers Greenland declaration:
http://www.norden.org/webb/pressrelease/pressrelease.asp?id=754.

One of the hazards associated with food consumption is *Campylobacter*. In many countries the incidence of human campylobacteriosis has increased considerably and even extended salmonellosis in recent years. In some countries this increase has mainly been traced to the consumption and cross contamination from poultry products. Several of the Nordic countries, which have good experience in tackling *Salmonella* in poultry, have now started with some successful interventions programmers to fight Campylobacter in poultry. These include educational programs for farmers on how to produce Campylobacter-free chicken, extensive surveillance programs for Campylobacter in poultry, changes in production methods and education of consumers.

Campylobacter has been the topic of several projects under the auspice of the Nordic Council of Ministers. This is the third workshop specifically on Campylobacter and there has also been a workshop on risk analysis involving Campylobacter and caffeine.

The first workshop was held in Denmark in November 1997 with the title “Nordic Workshop on Campylobacter”. Participants were 30-50 from all the Nordic countries. The situation regarding Campylobacter in each of the Nordic countries was presented, also the use of case control studies and sub-typing of Campylobacter as a tool in epidemiological investigations (TemaNord: 2000:503)

The second workshop, “Discussions on the risk assessment of Campylobacter”, was held in Denmark in June 2000. Participants were approximately 20 from the Nordic countries. The aim of the workshop was to exchange information regarding the risk assessment of Campylobacter and to compare methods and techniques used to collect information for risk assessment in the Nordic countries (TemaNord 2001:538).

The workshop on Campylobacter and caffeine illustrated a practical approach to the application of the risk analysis process. The workshop was held in Helsingør, Denmark in June 14th to 16th 2000 and the workshop outcome is reported in an internal report from July 2001.

The aim of the workshop presented in this report was to collect information and to exchange views on policies and interventions used in the Nordic countries to reduce the risk of acquiring Campylobacter from poultry products by bringing together experts from all Nordic countries in

the field of food borne pathogens, risk analysis and production of poultry products.

The expected outcome was comprehensive information on the Campylobacter situation in each of the Nordic countries concerning current or planned interventions and recommendations for future measures at lowering the risk of acquiring campylobacteriosis.

The outcome of the workshop could underpin a Nordic position (Nordic arguments) in coming discussions regarding food safety issues in international forums.

The workshop was supported by a grant from the Nordic Council of Ministers (grant No: 681048-30230).

The workshop was organised by the following persons:

Franklin Georgsson, Environment and Food Agency, Iceland, Chairman.
Gudrun Sandø, Danish Veterinary and Food Administration, Denmark
Susanna Kangas, National Food Agency, Finland
Merete Hofshagen, Norwegian Zoonosis Centre, Norway
Lars Plym Forshell, National Food Administration, Sweden

Hjörleifur Einarsson was project secretary and participated in the planning and the practical arrangement regarding the workshop.

The workshop was held in Reykjavik, Oct. 9th to Oct. 11th 2003.

The workshop programme and list of participants is given in Appendix 1 and Appendix 2.

Franklin Georgsson and Hjörleifur Einarsson edited this report.

The Nordic Working group on Food Microbiology and Risk Assessment (NNM) under the Nordic Committee of Senior Officials for Food Issues (EK-LIVS) approved the report in August 2005.

Summary

Food safety is one of the main priorities of the Nordic ministers for agriculture, fisheries and food and has been underlined by the ministers Greenland declaration. The incidence of human campylobacteriosis in many Western countries (including the Nordic ones) has increased considerably in recent years. In many countries this increase has manly been traced to the consumption and cross contamination from poultry products.

In order to elucidate the problem a workshop named: ”Interventions aimed at reducing the risk of acquiring *Campylobater* from poultry products” was held in Reykjavik, Oct. 9th to Oct. 11th 2003.

The aim of the workshop was to collect information and to exchange views on policies and intervention used in the Nordic countries to reduce the risk of acquiring Campylobacter from poultry products by bringing together experts from all Nordic countries in the field of food borne pathogens, risk assessment and risk management and production of poultry products. The workshop assembled and evaluated information and experience of interventions programmes in the Nordic countries that have led to improvements in the Campylobacter situation in poultry. The outcome can be used for the implementation of harmonized Nordic intervention guidelines to reduce or prevent Campylobacter contamination in poultry products. Such guidelines could be of use to influence similar harmonized intervention in the European Union and Codex Alimentarius Commission.

The workshop programme was organised in presentations, group discussions and presentations of final results and recommendations. The oral presentations were separated into four topics: General overview of the Campylobacter situation on a global level, Surveillance of Campylobacter in the Nordic countries, Interventions in the Nordic countries and Research activities on Campylobacter aimed at reducing the contamination level in broilers. The layout of this report follows the organisation of the workshop.

At least three experts from each of the participating countries were invited to the workshop. The experts had background in risk management, risk assessment and from industry. The countries represented were Denmark, Finland, Sweden, Norway and Iceland.

The main findings of the workshop can be summarized as follows:

- Strikingly similar seasonal variation in Campylobacter-positive broiler flocks was observed in all Nordic countries with a clear peak in the summer.
- Infection to flocks is either by horizontal transmission (from one flock to another) or from the environment.
- The information given to the producers do not seem sufficient to eradicate Campylobacter in all cases. An important piece of the puzzle is missing. Training should be focused on later stages in the production. Retail and restaurants should have the same training.
- Information should be provided on how to avoid cross contamination.
- Methods for detection, enumeration and identification must be improved and there is a lack of validated methods. Both culture and rapid methods definitely have their place in the surveillance of Campylobacter.
- Measures at farm level like bonus to farm workers can be effective interventions. These depend on good environmental control and control of buildings, disinfection of drinking water and good hygiene practices by workers.
- One of the most effective interventions is channelling Campylobacter positive broilers to freezing or heating through official surveillance program.

Other effective interventions are information campaigns aimed towards consumers, food handlers and farmers. This can include warning labels on distributed broilers. Another important intervention is the use of leak proof packaging.

Recommendations.

GMP should be followed all along the production line from flock houses (incl. depopulation and buildings in general). Logistic slaughter and hygienic measures at slaughter are recommended.

Campaigns against Campylobacter should be focused on limited aspects, such as cross contamination and/or heating. Best preventive measure in the domestic kitchen is to stress cross contamination, proper heating and personal hygiene (e.g. hand washing).

Standardized and validated methods should be used but Polymerase Chain Reaction (PCR) (or other rapid methods) should bee used for screening purposes and then cultivation of the positive samples should be done if needed. Methods should be chosen according to the purpose of the work, scientific, production surveillance, control etc.

An inter-Nordic project to develop propaganda material should be initiated and to establish a Nordic archive of food hygiene training material.

A web site should be established for easy access of people working on this subject to compare and exchange data

Future research.

The workshop found several topics important as a base for Nordic (and international) research projects. One of the most important one is to find the explanation for the seasonal variation of Campylobacter infection. An approach to or an project outline could be to identify few farms in each country (both pos. and neg.), investigate environment and flocks at intervals during the year, collect information on geography, climate, management, perform case-control study and molecular typing of isolates.

Sammendrag

Fødevaresikkerhed prioriteres meget højt af de ansvarlige nordiske ministre, som understreget af ministrenes Grønlandsdeklaration. Incidensen af humane campylobactertilfælde i de vestlige lande (inkl. de nordiske) er steget markant de seneste år. I flere af landende forbindes denne stigning med indtag af og krydskontamination fra fjerkræprodukter.

Med henblik på at belyse dette problem blev der den 9.–11. oktober 2003 i Reykjavik afholdt en workshop: ”Interventions aimed at reducing the risk of aquiring Campylobacter from poultry products”.

Målet med workshoppen var at indsamle viden og erfaringer på området, samt at udveksle synspunkter på den håndtering og de tiltag de nordiske lande anvender med henblik på at reducere risikoen for at mennesker smittes med Campylobacter fra fjerkræprodukter, ved at samle eksperter på områderne fødevarebårne patogener, risikovurdering, risikohåndtering samt produktion af fjerkræprodukter fra de nordiske lande. Workshoppen samlede og evaluerede viden om og erfaringer fra interventionsprogrammer i de nordiske lande, som har bevirket en forbedring af Campylobacter situationen i fjerkræ. Det er formålet, at resultaterne af workshoppen skulle kunne danne grundlag for fælles nordisk vejledning for tiltag der kan reducere eller forebygge Campylobacter kontamination af fjerkræprodukter. Denne vejledning kunne endvidere benyttes i forbindelse ved udformningen af lignende harmoniserede interventioner i EU og i Codex Alimentarius.

Programmet for workshoppen var adskilt i præsentationer, diskussion i grupper og præsentation af endelige resultater og anbefalinger. De mundtlige præsentationer var inddelt i fire emner: Generelt globalt overblik over Campylobacter situationen, Overvågning af Campylobacter i de nordiske lande, Tiltag i de nordiske lande og forskningsaktiviteter der fokuserede på reduktion af Campylobacter kontaminationen i slagtekyllinger.

Der var inviteret mindst tre eksperter fra hvert af de deltagende lande til workshoppen. Disse eksperter havde en baggrund indenfor risikohåndtering, risikovurdering eller fra industrien. De deltagende lande var Danmark, Finland, Sverige, Norge og Island.

Hovedkonklusionerne fra workshoppen kan sammenfattes som følger:

- Bemærkelsesværdig ens sæsonvariation i Campylobacter-positive flokke er observeret i samtlige de nordiske lande, med en udpræget top i sommerperioden.

- Flokkene inficeres ved horisontal smitte (fra den ene flok til den anden) eller fra miljøet.
- Den information producenterne får, er tilsyneladende ikke tilstrækkelig til at udrydde Campylobacter i alle tilfælde. En vigtig brik i puslespillet mangler. Rådgivning(training?) skal målrettes senere trin i produktionen. Detailleddet og restauranter skal/bør modtage samme rådgivning/undervisning.
- Der skal sørges for information om hvordan krydskontamination undgås.
- Metoderne til detektion, tælling og identifikation skal forbedres, og der er mangel på validerede metoder. Såvel dyrknings- som hurtigmetoder har afgjort en plads/rolle i overvågningen af Campylobacter.
- Tiltag hos producenten, som f.eks. bonus til producenter, kan være en effektiv intervention. En sådan vil afhænge af krav til og kontrol med omgivelserne, drift og indretning af husene, desinfektion af drikkevand og i øvrigt opretholdelse af god hygiejne praksis.
- Et af de mest effektive tiltag er sortering af flokkene, baseret på et overvågningsprogram, så Campylobacter-positive flokke anvendes til produktion af frosne produkter.

Andre effektive tiltag er oplysningskampagner rettet mod forbrugere, folk der håndterer fødevarer og producenter. De kan f.eks. omfatte mærkning af kyllinger, f.eks. hygiejneråd ved tilberedning. Et andet vigtigt tiltag er anvendelse af tæt og drypfri emballage.

Anbefalinger.

GMP skal følges hele vejen gennem produktionskæden, fra flokkene (inkl. udtynding og indretning af bygninger generelt). Logistisk slagtning og hygiejnetiltag under slagtning anbefales.

Kampagner mod Campylobacter skal være målrettede, f.eks. mod krydskontamination og/eller varmebehandling. I private køkkener er de bedste forebyggende forholdsregler at lægge vægt på at undgå krydskontamination, sikre tilstrækkelig varmebehandling og god personlig hygiejne (f.eks. vask af hænder).

Standardiserede og validerede metoder bør anvendes, men Polymerase Chain Reaction (PCR) (eller andre hurtigmetoder) bør anvendes til screening hvorefter dyrkning af positive metoder prøver, kan udføres hvis det er nødvendigt. Ved metodevalg, skal formålet for analysen overvejes, d.v.s. om det drejer sig om forskning, overvågning af produktionen, kontrol o.s.v.

Der bør iværksættes et internordisk projekt, med henblik på at udvikle informationsmateriale og at etablere et nordisk arkiv indeholdende undervisningsmateriale vedrørende fødevarehygiejne.

Der bør etableres en hjemmeside, for at fremme muligheden for at personer der arbejder med disse emner, kan sammenligne og udveksle data.

Fremtidig forskning.

Workshoppen udpegede adskillige vigtige emner som basis for nordiske (og internationale) forskningsprojekter. Et af de vigtigste er at finde forklaringen på sæsonvariationen i Campylobacter infektioner. En tilgang til eller projektskitse for dette kunne være at udpege enkelte flokke i hvert land (både positive og negative), undersøge omgivelser og flokke med intervaller året igennem, indsamle information vedrørende geografi, klima, management, udføre case-kontrol studier og molekylær typning af isolater.

1. Introduction

The incidence of human campylobacteriosis in many Western countries (including Nordic countries) has increased considerably in recent years. In many countries this increase has manly been traced to the consumption and cross contamination from poultry products. Zoonosis – including Campylobacter – is one of the subjects covered by the Council of Minister's Greenland declaration for increased food safety in the Nordic countries, and a subject of a special interest and increased Nordic collaboration, also with regard to increased influence in international fora.

What triggered the idea for this project was the big epidemic peak in human Campylobacter cases in Iceland in 1999 followed by a dramatic reduction in domestic cases in 2000 as a result of strict interventions in the poultry industry and information campaigns aimed towards consumers, farm workers, and food handling personal. The other Nordic countries were at the same time also experiencing steady and considerable increase in the incidence of human campylobacteriosis.

The Nordic countries, which have good experience in tackling *Salmonella* in poultry, have now started with some successful interventions programmes to fight Campylobacter in poultry. The programmes are directed at the primary production level, at slaughter and processing level and at the retail and consumer level. These include educational programmes for farmers on how to produce Campylobacter-free chickens, extensive surveillance programmes for Campylobacter in poultry, changes in production methods and education of consumers. The interventions include biosecurity at production level, channeling of slaughter flocks, freezing presumptive positive flocks, labelling instructions and consumer campaigns stressing the importance of sanitation and thorough cooking.

The aim of this workshop was to assemble and evaluate information and experience of interventions programmes in the Nordic countries that have led to improvements in the Campylobacter situation in poultry. The outcome could be used for the implementation of harmonized Nordic intervention guidelines to reduce or prevent Campylobacter contamination in poultry products. Such guidelines could be of use to influence similar harmonized intervention in European Union and Codex.

The workshop programme was organised in presentations, group discussions and presentations of final results and recommendations. The presentations were separated into four topics: general overview of the Campylobacter situation on a global level, surveillance of Campylobacter in the Nordic countries, interventions in the Nordic countries and research activities on Campylobacter aimed at reducing the contamination level in

broilers. The layout of this report follows the organisation of the workshop.

At least three experts from each of the participating countries were invited to the workshop. The experts had background in Campylobacter research, risk analysis and poultry breeding and processing. The countries represented were Finland, Sweden, Denmark, Norway and Iceland.

2. International situation – Overview

Summary of the presentation “International perspective on risk assessment and management of Campylobacter in poultry” *By: Peter K. Ben Embarek, Food Safety department, WHO, Geneva, Switzerland*

Background

There is and an increased awareness of and emphasis on food safety. New and emerging hazards lead to new risks and challenges. This is due to changes in methods of food production at farm and processing level as well as emergence and re-emergence of food borne pathogens and changes in consumption patterns and consumer demands.

To address these problems an integrated approach to food safety involving all relevant parties is needed. Risk analysis and risk assessment provides framework to do that.

The World Trade Organization (WTO) - sanitary and phytosanitary measures (SPS) Agreement states that if countries are not applying internationally recognised standards then they need to base their standards on sound science and risk assessment. Also Codex has embraced a risk based approach to the elaboration of international standards.

FAO/WHO Microbiological Risk Assessment (MRA) Activities

The FAO/WHO MRA activities include generation of scientific information for risk assessments, data collection and generation of data, elaboration of guideline documents, information and technology transfer and finally the use of risk assessment within a risk management framework.

A two-year process aimed at the generation of scientific information for risk assessments is underway. The work is carried out on specific-pathogen-commodity combinations and these combinations are selected based on needs of Codex and member countries. The expected outcome is a comprehensive technical document for use by scientists/risk assessors for risk assessment purposes and a summary document, summarising the work including limitations, uncertainties - primarily for use by risk managers. The ongoing work so far includes *Salmonella* spp. in broiler

chickens and eggs (published in 2003), *Listeria monocytogenes* in ready-to-eat foods (to be published in Jan 2004), Campylobacter spp. in broiler chickens (to be published in 2004) and *Vibrio* spp. in seafood (to be published in 2004).

Campylobacter risk assessment

The objective is to generate a risk assessment model for Campylobacter *jejuni* that extends from the farm to consumer and to provide a framework for a model that could be adapted to individual countries, but also to provide insight into potential management strategies to reduce risk.

The approach will include a review of the existing database of information on the issues (including WHO / FAO call for data), evaluation of existing national risk assessment models, incorporation of components if appropriate and generation of new models where necessary. Modular approach will be used to ease the adaptability.

The *C. jejuni* risk assessment model at slaughter and a commercial processing operation will estimate the probability that a retail chicken product will be contaminated and estimate the likely level of contamination.

The *C. jejuni* risk assessment model at preparation and consumption will calculate the probability of being exposed to Campylobacter and the estimation of the levels exposed considering the preparation and consumption behaviour that s likely to vary from region to region. This needs to be adjusted appropriately as does the level of cross-contamination during preparation. This is a complex area and it is not possible to consider all routes.

For hazard characterisation and calculation of dose response the model will be fitted to *C. jejuni* data.

Results

Results can be presented in the form of various scenarios to reflect potential management strategies. The model does not represent any one location / country as absolute risk estimates are meaningless in the current context. Individual countries need to customize with specific data and relative risk comparisons can provide management guidance

The model can be used to elucidate different scenarios. Examples of general nature are change in overall prevalence and change in overall level of contamination. More specific scenarios include changes in farm level flock prevalence and farm level within flock prevalence and also

change in internal and surface contamination before and through processing.

In scenario 1 the question was: “What is the effect on relative risk reductions of reducing the prevalence of contaminated chicken going to retail? According to the model the relative risk reduction of reducing prevalence of contamination in chickens going to retail has a linear (one-to-one) relationship meaning that a 50% reduction in prevalence of contaminated chickens results in 50% reduction in risk

In the second scenario the question was: “What is the effect on relative risk reductions by reducing the level of contamination on chicken going to retail”? The model shows that risk reduction by reducing the level of contamination depends upon the initial starting contamination level. Thus high contamination levels a 50% reduction in contamination will result in less than 50% risk reduction but at low contamination levels a 50% concentration reduction will result in more than 50% risk reduction.

Summary of these two scenarios shows that any management strategy that alters the prevalence of contaminated chicken at retail is estimated to have a proportional impact on mean risk. Also if the level of contamination is high, small additional reductions will have only a small effect but if the mean level of contamination is lower, additional contamination level reductions will have greater than proportional effect on risk.

In the third scenario the question was: “What effect does changing between flock or within flock prevalence have? A significant reduction is observed by reducing overall flock prevalence but within flock prevalence reductions by themselves have a minimal effect due to cross contamination during transport and processing.

In scenario four the question was: “What effect does changing the internal and surface contamination of chickens before and through processing have? In summary the findings showed that reducing surface contamination after evisceration could have a significant impact on reducing the risk. Additional contamination being deposited negates reductions of surface contamination prior to this. Targeting the internal colonization levels at the farm level has a significant effect on reducing the risk (reducing the overall pool of contamination entering the system).

In the fifth and last scenario the question was: “What is the difference in risk for refrigerated or fresh chicken compared to frozen chicken? Frozen chicken is estimated to result in lower risk. However, these results can be complicated as preparation practices could reverse the effect and it is possible that cooking effectiveness could be diminished for frozen chicken compared to fresh chicken. Frozen chicken poses a lower expected risk than refrigerated or fresh chicken. This may not always apply for instance, inadequate thawing may result in insufficient cooking (cold spots) resulting in greater risk.

Overall conclusions

Extensive review of available information was performed but lack of systematic and consistent investigation into some key processes cannot create a “Global risk assessment”. The differences exist in systems, areas, countries, and regions. There is variation in processing or farming practices, variability in broiler contamination, variability in farming practices and variability in consumer behaviour.

The model provides a framework that can be adapted and customized for specific situations. The model provides insight into potential management strategies but success of strategies needs to be considered in light of other factors (e.g. costs, stakeholder priorities, etc.).

Risk assessment and the risk assessment process aids the understanding of the system regarding process modification and risk interventions but also provides guidance in the area of research and data collection.

Risk manager and risk assessor interaction is essential. The risk management question is important in determining how the risk assessment is conducted. Specific and focused questions target the point in the entire chain upon which to focus activity and it ensures that the issues of concern to the risk manager are accounted for.

3. The situation in the Nordic countries

This chapter summarizes the latest information regarding the situation of Campylobacter in the Nordic countries. It is divided into three parts: Surveillance of Campylobacter (3.1), Interventions in the broiler industry (3.2) and Research activities on Campylobacter aimed at reducing the contamination level in broilers (3.3).

3.1 Surveillance of Campylobacter in the Nordic countries.

Information regarding occurrence and distribution of Campylobacter has been gathered in the Nordic countries ever since the bacterium was identified as one of the main cause of food born infections some 20 to 25 years ago.

The sharp increase in human campylobacteriosis in the later part of last decade led to new surveys and surveillance programmes. Several national bodies have supervised these programmes. The main purpose of these programmes has been to gain knowledge regarding ecology and epidemiology of Campylobacter in order to support effective interventions and risk analysis programmes.

3.1.1 Human cases of Campylobacter

One of the main findings is that the upward trend in reported human campylobacteriosis has been broken (Figure 1) in all the Nordic countries. This downward trend started in 1999 in Iceland and in 2001 in other Nordic countries. The figure shows the total number of human campylobacteriosis acquired domestically and abroad. As expected Sweden with the biggest population has the highest number of registered cases and Iceland with its less than 300.000 inhabitants has the lowest number.

For comparison of trends, these numbers have been adjusted to show incidence (number of cases per 100.000 inhabitants) (Figure 2). The figure shows clearly the high incidence peek in Iceland in 1999 followed be rapid reductions in cases in the following years as a result of the intervention programmes implemented. In 2003 the incidence of campylobacteriosis in all the Nordic countries was lower when compared

to the peek values in 2001. The incidence that year was between 33 (Iceland) and 80 (Sweden).

From other countries similar trend has been noticed and published in a recent FAO/WHO[1] report. The number of infections per 100.000 is between 10 and 100 exempt for New Zealand were in 1998 some 350 infections occurred per 100.000 inhabitants.

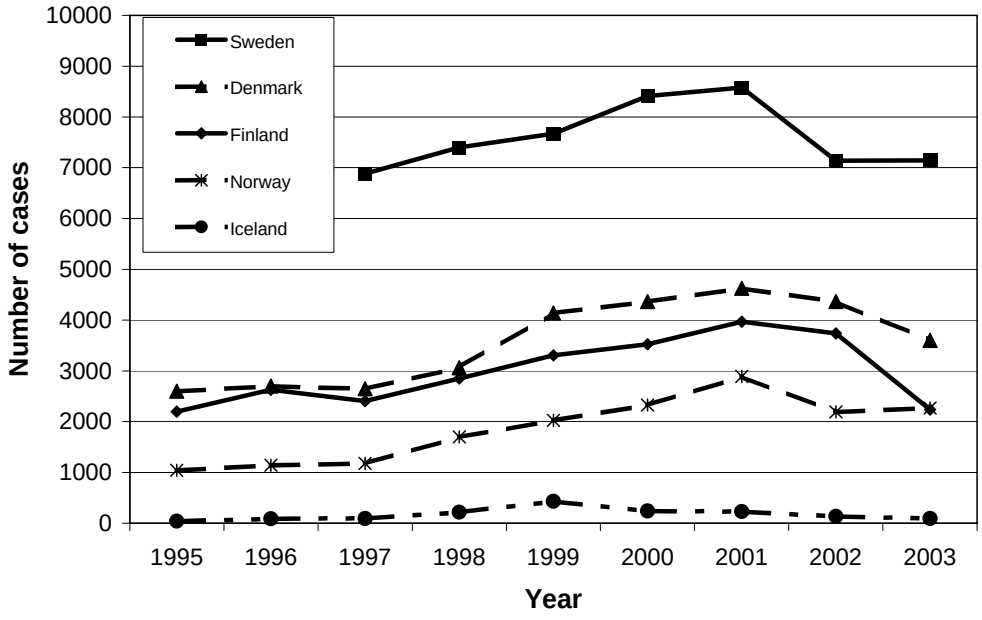

Figure 1. Total number of human campylobacteriosis cases in the Nordic countries 1995 to 2003

[1] Hazard identification, hazard characterization and exposure assessment of *Campylobacter* spp. in broiler chickens. Ed. E. Hartnett et.al. FAO/WHO, Rom. 2004 (page 9)

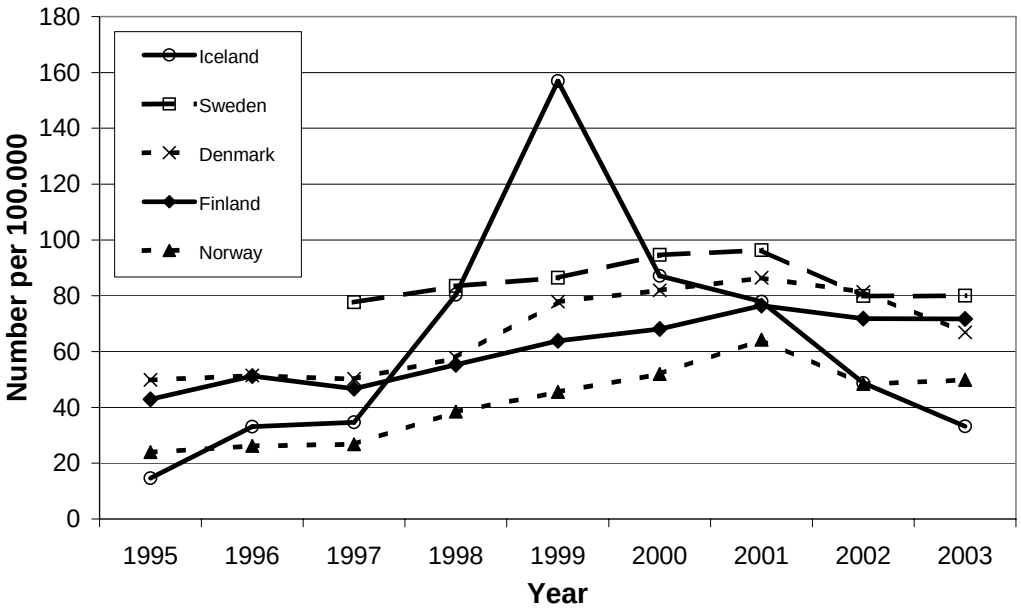

Figure 2: Incidence of human campylobacteiosis in 5 Nordic countries from 1995 to 2003

3.1.1.1 Age distribution

The data presented showed that there are basically two age groups that are most likely to acquire campylobacteriosis in the Nordic countries, e.g. infants (<5 years) and young adults (15-40 year). To demonstrate this data from Iceland is presented in figure 3 showing the incidence of campylobacteriosis in different age groups.

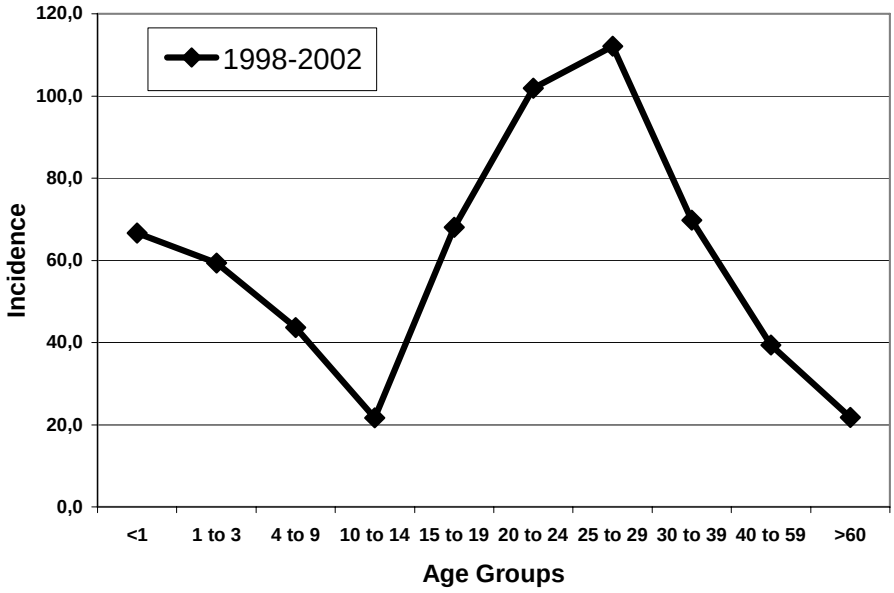

Figure 3: Domestically Acquired Human Campylobacter Cases Age Group Based, Iceland (Hardardottir)

Similar situation for age distribution of campylobacteriosis is observed in other countries as reported in the previously mentioned WHO/FAO report[2].

3.1.1.2 Seasonal variation of human cases

The infection rate is not constant during the year as clearly shown in figure 4. All countries have a clear top during the summer months and the top appears at the same time in all the Nordic countries.

According to information from the FAO/WHO report[3] seasonal tops are less pronounced in southern Europe than in the north or "the significance of seasonality seems to increase with increasing latitude".

[2] Hazard identification, hazard characterization and exposure assessment of *Campylobacter* spp. In broiler chickens. Ed. E. Hartnett et.al. FAO/WHO, Rom. 2004. (Appendix)

[3] Hazard identification, hazard characterization and exposure assessment of *Campylobacter* spp. In broiler chickens. Ed. E. Hartnett et.al. FAO/WHO, Rom. 2004. (page 79)

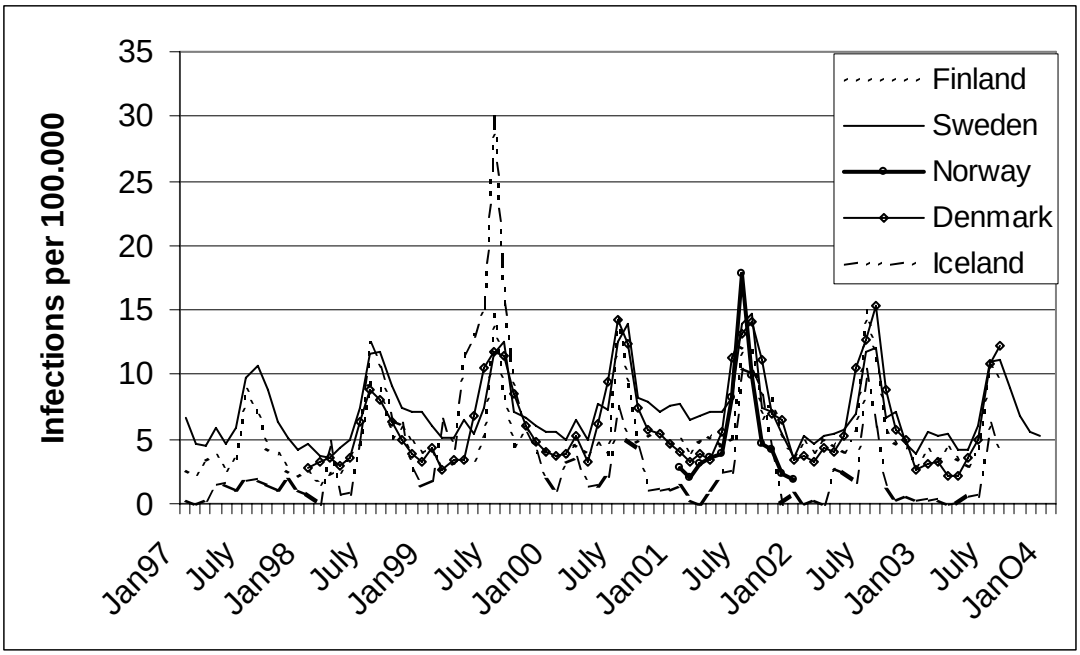

Figure 4: Seasonal variation of campylobacter infections (per 100.000 inhabitants) in the Nordic countries

3.1.1.3 Geographical distribution

In Denmark and Finland campylobacteriosis was most frequent in and near urban areas and other areas with relatively high population.

3.1.1.4 Origin of Campylobacter infections

In order to set effective intervention strategies it is important to know the source of Campylobacter infections in humans. Figure 5 shows the distribution between domestic and foreign acquired Campylobacter infections together with the proportion of cases of unknown origin.

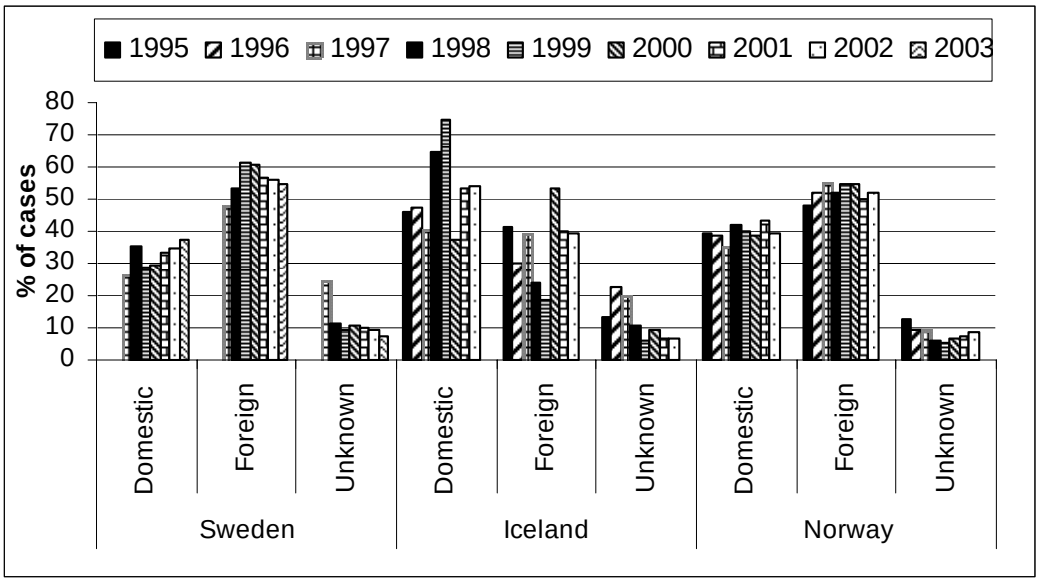

Figure 5: Origin of campylobacteriosis in three Nordic countries from 1995 to 2003.

Imported vs. domestic cases

In Sweden and Norway more people get infected abroad while in Iceland most infections are of domestic origin. The same applies for Denmark and Finland where approximately 80% respectively 60% of infections were domestic in the year 2002.

The increase observed in domestic cases is partly explained by drop in the "unknown origin", most likely due to increased focus on Campylobacter and emphasis on surveying and solving the problem in the Nordic countries.

While the combined data show that most of the cases are either domestic or imported there can be important differences when the data is broken down e.g. into age groups. As shown above the majority of Campylobacter cases in Norway are "imported". This applies for the age groups from 15 to 70 years old while a closer look at data shows that children are more likely to be infected in Norway. Generally the same applies for the other countries, that is the very young and old get infected at home as they don't travel as much.

Outbreaks or sporadic cases

The domestic cases of campylobacteriosis in the Nordic countries are mostly sporadic but outbreaks do also occur. Two outbreaks in Denmark (2002) involved fried chicken, potatoes and salad in one outbreak and steaks of beef, turkey and pasta salad in the other. Outbreaks in Norway have been linked to contaminated drinking water, un-pasteurised milk, crabmeat and chicken.

Iceland had a nationwide epidemic from 1998 to 2000. This epidemic was linked to increase in consumption of fresh broilers. Earlier outbreaks in Iceland were linked to contaminated drinking water and salads. In one outbreak the salad contained fried chicken.

The situation is similar in other countries. According to WHO[4] "common-source outbreaks account for a rather small proportion of cases, the vast majority of reports are made sporadically, with no easily discernible pattern".

3.1.2 Prevalence and surveillance data of Campylobacter *-from environmental-, feed-, animal- and food samples.*

Campylobacter has been isolated from several sources e.g. food (incl. water), feed, environment and live animals.

Table 1 shows prevalence data from Norway were the frequency of Campylobacter was found at various levels from 0 to 100% for different type of samples. The table clearly indicates that wild animals and surface water are important reservoir of Campylobacter.

Table 1: Results of surveys for Campylobacter in water, animals and food in Norway (1986-2003)

Category	Year	Authors	N	% pos.	Details
Water	1986-87	Brennhovd *et.al.*	3*32	15 - 52	Surface, not drinking w.
Wild birds	2003	Nat. Vet. Inst.	200	4	Pidgeons
	1980-81	Kapperud/Rosef	540	4 - 90	Pidgeons 4, Crows 90
Wild animals	1982	Rosef/Kapperud	542	0.2	One hare
Pet animals	2000-01	Sandberg *et al.*	595/332	24/18	Dog/Cat (*C. upsal.*)
	1982	Rosef/Kapperud	147/85	22/12	Dog/Cat
Farm animals	1982	Rosef/Kapperud	720	0 - 100	Goat/horse 0, Pig 100, Sheep/cattle <10
	1999	Herikstad *et al.*	325	36	Cattle
Food	1983	Nesbakken *et al.*	152	0	Pork

In a Norwegian study (2001) 174(7.7%) of 2270 poultry flocks were positive for Campylobacter and 228(6.3%) of 3627 flocks in the year 2002. That year 87 (8.1%) of 1069 poultry products were positive.

In several studies in Denmark (1996, 2001 and 2003) Campylobacter was found in various animals e.g. dogs (14.7%), cats (23.1%), puppies (29%), kittens (2%), wild birds (18.1%), rodents (7.5%), flies and insects (8-11%).

Figure 6 shows results from a national Swedish project from the year 2000. Poultry and water stands clearly out as the most frequently

[4] http://www.who.int/mediacentre/factsheets/fs255/en/

contaminated of the 4.463 meat- and 660 water samples tested. Further in that project it was found that during June to October the prevalence in poultry was 9% in frozen chicken and 16% in fresh chicken. During November to May the frequency was lower or 5% and 11% in the frozen respectively fresh samples.

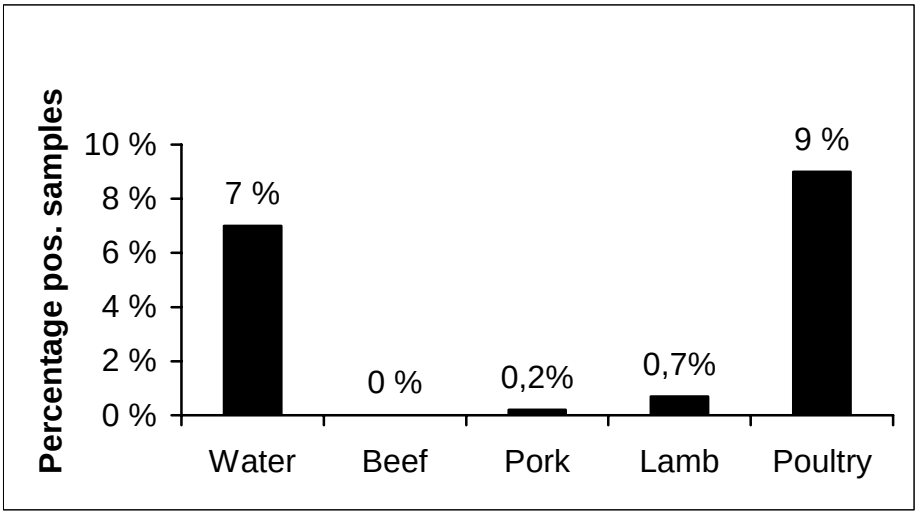

Figure 6: Prevalence of Campylobacter in some food products in Sweden (National project 2000, Lindblad and Lindmark)

In another project carried out 2002-2003 (named “Microprofile Chicken”), 128 (20%) out of 615 broiler samples that were sampled at slaughterhouse level were positive for Campylobacter.

In a third project, called “CampySET”, 32% of fresh poultry samples at retail level were positive.

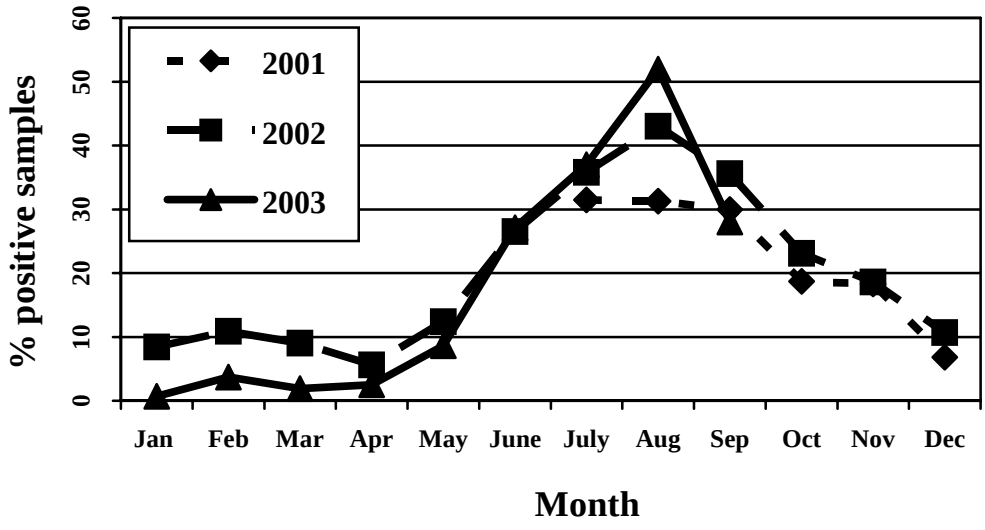

Figure 7: Campylobacter in broilers in Sweden ("Campylobacter surveillance program for broilers in Sweden", Hansson)

Swedish research projects have shown that poultry at processing and retail level show similar seasonality in Campylobacter prevalence as observed in human campylobacteriosis cases (Figure 7).

In Finland the prevalence of Campylobacter in raw poultry samples from retail shops in Helsinki was 11.5% on average in the years 1995 to 2001, ranging from 4.1% (in 1999) to 22.8% (in 2001). Also in Finland the highest frequency was in the summer months July and August.

In Iceland Campylobacter has likewise been isolated from various samples including wild and domestic animals, food and drinking water from small and private waterworks. Table 2 shows results from several studies on raw food products and drinking water from municipal waterworks. What stands out is the high prevalence of contamination in fresh and frozen chicken products in the years before 2000 and the decrease in prevalence following the drastic interventions that were undertaken after the epidemic in 1999.

Table 2: Special surveys on Campylobacter in retail foods, raw milk, and drinking water in Iceland

% positive samples (total number of samples)						
Product	**Period – Year**	**1986-1998**	**1999**	**2000**	**2001**	**2002**
Fresh chicken		72.9 (181)	44.9 (89)	6.9 (144)	8.6 (140)	9.6 (73)
Frozen chicken		83.2 (119)	40.0 (10)	20.0 (40)	27.8 (18)	23.1 (13)
Heated chicken					0.0 (7)	0.0 (2)
Raw beef products		0.0 (34)	0.0 (51)	0.0 (11)	0.0 (1)	
Raw lamb products			0.0 (55)	0.0 (15)		
Raw pork products			0.0 (44)	0.0 (12)		
Other raw meat products			0.0 (13)	0.0 (10)	0.0 (7)	
Raw fish products		0.0 (50)	0.0 (33)	0.0 (6)	0.0 (2)	
Raw vegetables			0.0 (46)	0.0 (13)	0.0 (1)	
Raw milk			0.0 (28)	0.0 (2)	0.0 (57)	
Drinking water		0.0 (246)	0.0 (18)		0.0 (13)	

Contrary to the results from municipal waterworks, a study in 2000 on drinking water from small and private waterworks demonstrated Campylobacter prevalence of approximately 10%.

In a survey (1999-2000) on prevalence of Campylobacter in domestic and wild animals in Iceland, Campylobacter was isolated from 20%, 25%, 28%, 69%, 71% and 100% of turkey (n=10), poultry (n=71), sheep (n=40), pigs (n=26), ducks (n=14) and cattle (n=32) herds respectively. Campylobacter has also been isolated from wild animals like geese, ducks and seagulls.

3.1.3 Case Control Studies

Relatively few case control studies have been conducted in order to identify important risk factors for acquiring campylobacteriosis.

In one such study in Finland, drinking un-boiled tap water was found to increase the risk (OR=11.1) and in another study tasting under-cooked meat (OR=12.0), drinking untreated ringwell-water (OR=3.09) and swimming in natural waters (OR= 2.43) were found to be important risk factors.

A case control study in Norway identified: drinking un-disinfected water, eating poultry-bought raw, eating at a barbecue and occupational exposure to [farm] animals as independent risk factors.

According to WHO[5] most studies have identified handling raw poultry and eating poultry products as important risk factors, but also cross-contamination of Campylobacter from raw chicken to ready to eat foods.

3.2 Interventions in the broiler industry.

The seriousness of the Campylobacter problem has led to several intervention strategies in the Nordic countries. The interventions are of different nature from legislations, direct actions to information campaigns. This chapter summarize the most important of these interventions.

It is clear that the intervention programmes are different between the Nordic countries, both in terms of scale and direction. Still basically interventions are based on four to five common actions:

- legal framework
- official surveillance programmes
- reduction of the level of contamination and
- information and education.

[5] Hazard identification, hazard characterization and exposure assessment of *Campylobacter* spp. In broiler chickens. Ed. E. Hartnett et.al. FAO/WHO, Rom. 2004. (page 14)

The table below list the interventions used in the Nordic countries as presented at the workshop.

Table 3: List of interventions used in the Nordic countries

Iceland	**Interventions**
Legal framework	• Amendment of the Food Act. no.168/2002 • ("reglugerð um alifuglaeldi og alifuglaslátrun")
At broiler production level (primary production, slaughterhouse, processing and retail)	• Official surveillance program • Information and seminars (incl. visits on farms) • Biosecurity management (incl. pest programmes) • Environment and buildings • Drinking water supply • Bonus to farm workers • Slaughter management • Order of processing • Freezing of Campylobacter positive lots • Leak-proof packaging • Traceability of products
At consumer level	• Information campaign • Whole-page advertisements in national newspapers • A booklet on food borne diseases and how to prevent them distributed to every home in Iceland • Special labelling on packaging of poultry o Blood from poultry must not come into contact with other foodstuffs or utensils o Poultry should be thawed in its packaging o Be hygienic o Poultry meat must be thoroughly cooked • Market surveillance twice a year – results made public
Denmark	
At production level	Research • Flock prevalence • Infection sources • Biosecurity measures • Rapid method development Interventions: • Guidelines to farmers • Bonus for farmers supplying Campylobacter-free flocks • Specific requirements for ante rooms. • Area around and between houses • Pest control • Handling and storage of feeding stuffs and bedding • Disposal of dead chickens • Personal hygiene • Cleaning and disinfection's of houses • Cleaning and disinfections of cages, catching equipment and trucks • Thinning Reduction of Campylobacter in poultry meat • Channelling – as far as possible • Treatment with steam and ultrasound. • Other
At consumer level	Communication of information to consumers • General consumer information on food hygiene • (posters, pamphlets, press-releases) • Textbooks on food hygiene for elementary and secondary schools • Specific consumer education campaign on Campylobacter, directed towards young people with focuse on cross contamination in domestic kitchens
Norway	

Legislative requirements:	• General obligations not to place on the marked food that is unsafe (The interpretation of «unsafe» in the context of poultry products and Campylobacter is given) • Regulation on the monitoring and control of Campylobacter in poultry and poultry meat at the slaughterhouses: (Actions to be taken are determined by the Campylobacter status of the flock prior to slaughter is defined) • Official microbiological guidelines (April 2002) - 1
At production level	• Surveillance; broiler flocks slaughtered < 50 days old • Follow-up of positive farms • Survey of poultry meat products Flocks positive before slaughter • Hygienic slaughter, at the end of the day • Heat treatment or freezing of carcasses (5 w.) • Farmer will receive consultation Flocks positive at slaughter only • No consequences for current flock, farmer will receive consultation Largest company: • Sponsoring UV-disinfection of non-municipal water • Economical punishment of positive farms (2nd. positive flock) Transport crates • Better cleaning routines Slaughterhouses • Better cleaning routines
At consumer level	Information to the consumer • Leaflet • Guidelines on safe cooking • Information issued at Internet in advance of the annual barbecue season • Media contacts Retail level, five cities, a total of 100 samples/month
National action plan to reduce consumers exposure to Campylobacter via domestic produced poultry products	• Funding • Implementation of the legal basis for the actions to be taken at the slaughterhouses.
Sweden	
	The Campylobacter surveillance program for broilers in Sweden
Finland	
	• No official control programmes • Voluntary own-check monitoring in slaughterhouses • Compulsory own-check starts in 2004 (planned)
At farm level	Farms with positive flocks • Advice to the farmer • Reduction in price (in some companies)

3.3 Research activities on Campylobacter aimed at reducing the contamination level in broilers.

3.3.1 Topic 1: Methods for detecting and identifying Campylobacter *and Virulence and host response.*

Summary of the presentation: **Detection, enumeration and typing of Campylobacter spp. in Foods** by *Niels Ladefoged Nielsen, Institute of Food Safety and Nutrition, Danish Veterinary and Food Administration*

There is a need for analysis for Campylobacter along the food chain and to use the results as a basis for risk assessment, surveillance and control purposes. There are now two new methods available for detection and enumeration of Campylobacter one from ISO and the other from NMKL (”Nordic Committee on Food Analysis”). Further there is a need for typing methods, methods for “Pathogenic account”, species typing and for further sub-typing. Introduction of the Risk Analysis concept stresses the need for qualitative as well as quantitative data related to Campylobacter in the food chain. This includes data for risk evaluation, risk profile analysis, risk- and exposure assessment. Methods for monitoring purposes include analysis of samples from e.g. logistic operations, slaughter, surveillance and control.

The new ISO (“International Organization for Standardization”) method (ISO 10272) is a horizontal method for the detection and enumeration of Campylobacter growing at 41.5 ºC in food and feed. It is in two parts: Detection method and Colony count technique. The media are “Bolton broth” and “Preston broth” for enrichment and mCCDA for plating.

The current NMKL method (Nr. 119, 2. ed., 1990) is a qualitative technique for detection of Campylobacter jejuni/coli in foods. The media are “Preston broth” for enrichment and Preston agar, CBSF agar and mCCDA for plating.

There is a proposal for a new NMKL method: “Detection and enumeration of thermotolerant Campylobacter in foods” (Franklin Georgsson, Hanne Rosenquist and Niels Ladefoged Nielsen)

The background for the new method is that there is a need for a quantitative method in data generation for quantitative risk assessment. Also it is possible that the Preston broth could be too toxic to injured cells and new (less) selective enrichment broths are introduced internationally (ISO 10272, FDA/BAM). Bolton broth seems to perform better than Preston broth in naturally contaminated samples[6].

[6] Baylis et al. J. of Applied Microbiology, 2000

The principles in the proposal are that the method includes three separate steps. Preliminary tests on the impact of media, antibiotic supplement, incubation -temperature and atmosphere - has so far been done with the following strains: MS 7398 (*C. jejuni*), MS 7426 (*C. coli*), CCUG 10368 (*C. jejuni*) and CCUG 11283 (*C. coli*).

Significant difference in the number of Campylobacter/ml was seen in the batches of the 4 (pure) cultures and in the recovery rate of Campylobacter plated on AHB and mCCDA respectively.. AHB shows a better recovery rate than mCCDA.

No significant effect on recovery of the 4 cultures was seen whether or not the media are supplemented with antibiotic. Incubation at 37 or 41.5 °C makes no significant difference between the 4 cultures.

There was a significant interaction between strain and media, which means that the difference between media depends on the strain used. For the strains 10368, 7398 and 7426 there were no significant difference in recovery on the two media.

Bolton broth yielded significantly better growth of *C. jejuni* strain (10368) and both *C. coli* strains (7426, 11283) compared to growth in Preston broth. *C. coli* strain (7426) did not grow or only to very low levels in Preston broth during 48 hours.

Microaerophilic incubation yielded significantly better growth of the *C. coli* strain (7426). The remaining three strains did not show differences related to atmosphere.

An incubation temperature of 41,5°C yielded significantly better growth of the strains *C. jejuni* (10368) and *C. coli* (11283) compared to 37°C. For the remaining two strains there was no differences related to incubation temperature.

Typing is needed in order to investigate relevant sources of Campylobacter and their relative importance i.e. “Pathogenic account” and in outbreak investigations.

Typing at species level includes traditional biochemical tests, hydrolysis of hippurate, hydrolysis of indoxylacetat and antibiotic resistance. The problems associated with these methods are unclear reaction, mixed cultures and intrinsic resistance

Alternatively typing at species level includes methods like immunological methods (agglutination), PCR typing (single primer) and multiplex-PCR. The problems associated with these methods include: specificity of antibodies, specificity of primers and mixed cultures.

For sub-typing methods like: serotyping, phage typing, ribotyping, RAPD, AFLP, PFGE, DDGE are available or possible.

In summary:

- Qualitative as well as quantitative data are needed in the Risk Analysis process.

- New methods (media and quantitative approach) for detection and enumeration of Campylobacter are introduced.
- Methods for subtyping should be chosen according to the purpose – preferable more than one technique should be applied.

3.3.2 Topic 2: Preventive methods – at primary and production level and cost – benefit analysis

Eva Olsson Engvall and Ivar Vågsholm
Swedish Zoonosis Center
National Veterinary Institute
Sweden

Pre-harvest

Knowledge about the situation at farm level is necessary in order to create control and preventive measures. Sweden has experience of systematic monitoring of Campylobacter in broiler flocks since 1991. In July 2001, a new Campylobacter programme was implemented. In this programme, more samples representing flock prevalence (cloacal swabs) are taken at slaughter and samples representing carcass contamination (neck skin samples) were introduced. Main findings are:

- pronounced seasonal variation with a peak of positive slaughter groups in July – August. In January – March almost all slaughter groups are negative, even from producers that otherwise frequently deliver positive flocks.
- variation in within-flock prevalence at slaughter. Not all cloacal samples from a positive flock are positive.
- The majority of positive flocks become positive 1-2 weeks before slaughter
- Transport crates contaminated with Campylobacter may contaminate chicken during transport to slaughter

Preventive measures

Strictly follow hygiene rules. Avoid contact between chicken and outside environment. Apply insect and rodent control. Avoid split slaughter. Ensure good water quality. Don't accept contaminated transport crates. Vaccination, however no vaccines are available yet. Competitive exclusion flora, but studies have not given any conclusive results of benefits yet.

During harvest

- Findings of slaughter groups with negative cloacal swab samples but positive neck skin samples indicate that carcass contamination occur during the slaughtering process.

- A great variation between slaughterhouses was found with slaughter groups that were contaminated at the slaughterhouse.
- Subtyping of Campylobacter isolates indicate that a positive slaughter group could contaminate the following group but also that unique untraceable subtypes contaminated otherwise negative groups

Preventive measures

Implement and strictly follow HACCP rules. Apply logistic slaughter.

Post-harvest control, risk reduction

- Freezing reduces 1 – 2 log cfu Campylobacter/g. Since most contaminated carcasses have a low level of Campylobacter, freezing could solve a significant part of the problem.
- Chemicals, or antimicrobial substances for treatment of poultry carcasses have been considered by the Scientific Committee on Veterinary Measures relating to Public Health (SCVPH). The effect is similar to freezing, i.e. the number of Campylobacter is reduced, and high numbers are not eliminated.
- Education of personnel working in restaurants, community lunch cafeterias, food stores, etc
- Information to the public, brochures, etc.

Cost-benefit analysis

Difficulties with estimating costs. What costs should be included? For human illness could costs for medical care, tests, medicine, hospitalization, childcare, loss of income, loss of production, and costs for unreported cases be included? Other types of costs that should be estimated are costs for control in primary production and at production level for producers, organizations, industry, and authorities etc. And then there are costs if no control measures were taken, that also should be estimated.

Reported studies on estimated costs for Campylobacter infection are few and differ because costs are estimated in different ways. A study from UK estimated the costs for a Campylobacter case to be approx £ 315 (approx €455), and in a couple of Swedish studies the total annual costs for domestic Campylobacter cases have been estimated to be from 10 – to 19 MSEK (M€ 1.1 to 2.1).

The Campylobacter situation in the Nordic countries is quite similar. It could be suggested that the countries jointly apply for financial support for a project with the aim to determine costs and benefits of Campylobacter control in the Nordic countries.

4. Results from workgroup discussions

The participants were divided in to five groups – based on the topics presented. Each group got a list containing several questions and topics to be considered. The participants were asked to list the main observations under each heading, some future tasks, to set goal for that topic and to give indication of expected result if that goal was reached.

The outcome of these discussions is given below.

4.1 Group 1: Environment and origin of contamination

Group one focused on two main questions:

- What is happening in the environment during summer?
- How does Campylobacter get into broiler houses?

The strikingly similar seasonal variation in Campylobacter-positive broiler flocks in all Nordic countries was one of the main observations of this workshop. Therefore it is a very important task to find out the reasons and possibly the biological mechanisms behind this phenomenon.

The goal is to find out if this is due to common or different environmental factors in the individual countries. The expected effect would be a focus on preventive measures that can be used to limit the influences of these environmental factors in order to reduce the prevalence of Campylobacter positive flocks.

On the second issue “How does Campylobacter get into broiler houses?” no clear indication of mode of transport was identified. As the summer peak is obvious in all the Nordic countries it is likely that this is linked to other summer specific “activity”, temperature, flies, birds etc. It is a clear task to identify the most important route(s) of introduction and to use this information to target/focus preventive measures. The expected outcome could be fewer Campylobacter positive flocks entering the food chain

For both these topics the group recommended a Nordic research project. The project outline would be to identify a few farms in each country (both pos. and neg.), investigate the environment and broiler flocks at intervals during the year, collect information on geography,

climate, management and perform case-control study and molecular typing of isolates.

4.2 Group 2: Distribution and amplification in breeding and transport

The group discussed the possible means of infection i.e. vertical transmission (from parent animals to offspring), horizontal transmission (between flock infections) and contamination from the environment.

The control strategies of WHO from 1994 are still valid. These include genetic control, vaccination, feed modification and the use of probiotics / antibiotics, but also technical improvement of houses and equipment, improved hygiene routines and quality assurance and economic incentive are important. In accordance WHO recommends change of clothes incl. footwear as well as disinfection of drinking water and filtered air is important to keep Campylobacter out of the rearing area. It is also very important that birds, rodents, insects and pets are kept off the rearing area. An all in/all out strategy and no partial depopulation are also recommended.

After depopulation and prior to restocking, removal and safe disposal of all litter followed by thorough wash and disinfection of rearing room and ante-room is recommended. Washing and disinfection of footwear, clothes, vehicles, crates and equipment is a must. Sufficient empty period prior to restocking should be allowed.

Regarding buildings it is important to have closed houses (incl. feed silos) with controlled environment and hygiene barrier in ante-rooms that should be equipped with washing facilities. Sufficient distance between houses is important and different age groups should be kept separate. Here as elsewhere disinfection of equipment for drinking water is essential.

Possible areas for research are: (i) methods for disinfections, (ii) length of down period and (iii) secure ventilation.

4.3 Group 3: Slaughter, process and distribution. Traceability

Slaughter

The group observed that there is a need to identify positive flocks as late as possible before slaughter and it is an important task to define and validate a reliable rapid method and a uniform sampling plan for this purpose. The expected result would be information on whether the flock is infected or not before arrival thus allowing for a plan for the slaughter

process according to the infective status. A Nordic/EU research project would include topics regarding validation of already existing methods and development of sampling plans.

The spread and level of contamination at different processing steps in slaughter of Campylobacter positive broilers

It was observed that Campylobacter are present at different levels during the slaughter process, e.g. at scalding, de-feathering and after evisceration. Detailed data on the effects of various steps are limited. A task would be to define effects of adjustments of machinery and processes at various steps. Expected outcome would be a possibility to measure the effect of different intervention measures and also to obtain the lowest possible level of Campylobacter contamination with present equipment and procedures in a cost effective manner. Intervention studies are needed in this area.

The risk of Campylobacter free flocks being contaminated during slaughter processing?

It was observed that there is a risk of infection of negative flocks that are slaughtered after positive ones. It is important to avoid cross-contamination and this can partly be done by better logistics at slaughter and hygienic measures.

What is the difference in risk of acquiring Campylobacter from refrigerated or fresh chicken compared to frozen chicken?

It was clearly shown during the workshop that levels of Campylobacter are lower in frozen chickens than in fresh chicken before freezing. An important task is to define reduction in risk by freezing in order to be able to evaluate risk management options better. The expected outcome would be optimised risk management measures. Risk estimates are available from risk assessments but there is a need to define the rate of decrease during freezing in order to define the necessary freezing period.

The effect of different packing material/methods on Campylobacter levels on broiler carcasses

Although “ready-to-cook” packages are likely to reduce the risk of cross contamination by consumers, Campylobacter may leak from damaged packages. The effects of modified atmosphere packaging are unknown, consequently there is a need to quantify the risk reduction obtained by ready-to-cook, leak-free and other packaging methods and to define the effects of modified atmosphere packaging (MAP). The development of

new packages should be supported. This should hopefully reduce the risk of cross-contamination during handling by the consumer and thus reduce exposure. Research in this area should be directed towards the effects of ready-to-cook packages and possibly by using case-control studies and studies on the effects of MAP on Campylobacter survival.

Application of other untraditional processing methods

Current EU legislation restricts the use of many decontamination methods. However, the new hygiene directive allows for decontamination under certain conditions. Steam could be one feasible method. At present it's not possible to totally reduce prevalence at flock level, so other measures are needed to reduce the prevalence and contamination levels in processed broilers. The reducing effect of different decontamination methods should be determined in order to find a method that can significantly reduce the of levels of Campylobacter.

Summary on the main research priorities

- Validation of already existing methods for testing before arrival at slaughterhouses, development and improvement of sampling plans.
- Intervention studies of the effects of different processing steps at slaughterhouses.
- There is a need to define the rate of decrease of Campylobacter levels during freezing in order to define the necessary freezing period.
- Testing of different decontamination methods.
- Studies on effects of ready-to-cook packages, maybe case-control studies.
- Studies on the effects of MAP on Campylobacter survival.

4.4 Group 4: Education and training - Staff and consumers - Law and regulation

Best preventive measure in the domestic kitchen is to point out and stress the risk of cross contamination and proper heating. Campaigns against Campylobacter should be focused on limited aspects, such as cross contamination and/or heating. It is not well known exactly what people are doing wrong in the kitchen. It is important to keep the Campylobacter "in the broiler" until they are killed and have effective killing methods if they escape. Hand washing is one of the important methods.

Regarding information to consumers it was found very important to have the message focused. It has been shown (Denmark) in a follow up study that radio spots reached people between 20 to 30 years of age. TV

spots were not applied. School children should be targeted in a proactive campaign. These should be general, not focused only on Campylobacter and followed up with focused campaign for older groups. The group recommended a initiation of a inter Nordic project to develop propaganda material and to try to find out how best to "get to peoples minds". Also to study the impact of training programs as a preventive measures for farm workers, retail personal, and restaurant personal on the final health risk to consumers.

The information given to the producers does not seem sufficient to eradicate Campylobacter in all cases. An important piece of the puzzle is missing. New or revised training programs in primary production will perhaps not make much impact. Therefore resources should be focused on later stages in the production. Training program for people working in the retail and slaughter operations should be developed and retail and restaurant staff should have the same training.

The most important messages to be delivered to processors and retailers is to stick to HACCP (Hazard Analysis Critical Control Point) plans for broiler slaughter (processors) and for retailers to give education on cross contamination. It will be necessary to produce information material for this purpose and to establish a Nordic archive of food hygiene training material. At the same time it is also important to identify the stages in the food chain where the interventions can be most effective. Reduction in positive flocks in the primary production is the first step and then methods like freezing and irradiation of the chickens can be considered.

It must also be borne in mind that the presence or absence is not only important, but also the number of Campylobacter on each carcass. Prevalence and number of Campylobacter on carcasses is highly dependent on circumstances during breeding, slaughter and further processing of broilers. A project aiming at producing guidelines for production of low risk poultry should be initiated.

It was observed that the official authorities have implemented several intervention strategies at this step: Iceland has regulation on logistic slaughter, traceability, freezing, labelling and surveillance program. Denmark has guidelines and agreement on channelling (positives frozen on a voluntary basis). Sweden has voluntary surveillance program. Norway has guidelines on logistic for slaughtering, channelling toward heat treatment or freezing, also guidelines for microbiological criteria. Norway has a policy statement saying that Campylobacter on fresh meat should not be accepted, it applies for marinades as well.

Several law and regulations have been developed in the Nordic countries to implement interventions. In Iceland *Campyobacter* in humans, animals and foods is a notifiable event.

Channelling positive flocks to freezing is regarded as one of the most effective intervention methods, regulated by laws/legislations, and the least expensive.

It's possible and necessary to measure and quantify the impact of intervention methods.

It was discussed if it was possible to establish a non-zero tolerance as microbiological criteria for Campylobacter in poultry? One problem is that there is a lack of validated methods. Another problem is at what point should the criteria be applied, at slaughter, at the point of consumption or in ready to eat foods? What is the accepted level of contamination if zero tolerance cannot be met?

The group found it likely that it was possible to have zero-tolerance in the future but we are not there yet. The recommended goal is to bring down the prevalence to a desired level, wherever it is possible.

Summary of the main research priorities in this field.

- Establish a Nordic archive of information and teaching material.
- Construct Nordic generic HACCP programs. Encourage industry to develop generic plans. Nordic authorities should amalgamate these into Nordic generic HACCP programs.
- How do we get people to do what we want them to do? Nordic project on risk communication.

4.5 Group 5: Methods

The group discussed the importance of using traditional analytical culture methods with and without enrichment steps and also the use of rapid methods in connection with control procedures and management options. The observation was made that both culture and rapid methods definitely have their place in the surveillance of Campylobacter. The importance of quantitative information, obtaining live bacteria for sensitivity testing, sub-typing and further research must be weighted against the pros of rapid detection and consequently the opportunity of faster responses/interventions since some culture methods are very rapid (~24 hrs) (Campy-Cefex Method)

Another observation was made that different culture and sub-typing methods are used in the various countries. It was also pointed out that the Nordic countries have different experience in the use of enrichment methods. Polymerase Chain Reaction (PCR) methods are only in use in Denmark, starting in Sweden and maybe recently in Norway. PCR is not used in Finland or Iceland. Problems observed with rapid methods are that validations are lacking and sensitivity and specificity has not been compared with culture methods.

It is important to ensure that the different countries have access to validated protocols for both culture- and PCR methods e.g. on a certain website i.e. on NMKL (www.nmkl.org).

While waiting for the "golden standard" protocols, the individual laboratories could present their methods/protocols on that website for inspiration or comments from others

The goal is to have harmonized methods (whether they are culture or rapid) in order to obtain comparable data. The expected outcome is an option for everyone to use the recommended method, when that would be desirable.

The group recommends that methods should be chosen according to the purpose of the work (scientific/production surveillance/control). An example could be the use of PCR for screening, and then cultivate the PCR positive samples where desired

Important research topics include validations of rapid methods within the Nordic countries and to keep up-do-date on ongoing PCR validation work under the auspices of the EU and other international bodies.

The group discussed the effect of sampling methods and sampling time that would give the best results for discovering positive flocks prior to slaughter.

The observation was made that different sampling plans, methods and time of sampling are used in the various countries. Thus sampling plans can be compulsory or voluntary, proportion of flocks tested before slaughter is different, also the number of birds/droppings in each flock to be analyzed or the number of samples pooled together.

There is also a difference in sampling methods regarding what is sampled like droppings, cloacal swabs, neck skins etc. Different transport media and transport time of the samples to the laboratory was observed between the countries and also the time of sampling before slaughter was different. The difference is from 2 to 8 days if samples are taken at all before slaughter (Sweden and Finland don't cultivate flocks before slaughter)

If sampling is performed, the timing should be as close up to the time of slaughter as possible and confidence of the sampling plan must be high. Sampling plan should be standardized and must be designed according to the purpose and level of sensitivity accepted. These measures should increase the level of detection of Campylobacter positive flocks before slaughter and improve the general knowledge regarding the Campylobacter situation.

Research topics necessary to under pin these goals are on standardization of sampling methods and on the loss of sensitivity by pooling samples with respect to different methods (culture/rapid).

Further it was observed that methods used for collection of analytical data in the Nordic countries are not comparable. The goal is that they should be made comparable and this should apply both to how they are

generated and how they are gathered. In order to accomplish this a web site for easy access of people working on this subject to compare and exchange data should be opened and comparison of the Campylobacter situation in the Nordic countries should be done (therefore the previous recommendations of standardization will become necessary).

The group identified further discussion topics that need to be addressed. These included:

- Use of models to estimate the risks of infection by poultry meat.
- Case-control studies. What do they tell us?
- Information from cost-benefits studies in relation to interventions.
- Environment and origin of contamination.
- Disinfections of all incoming material.
- Design of flock houses.
- Improved and validated fingerprinting methods.

5. Results and recommendations

The last part of the workshop was to compile and summarise the results and to collect and present the recommendations. The results and recommendations from the workshop are given below. Also listed are the main intervention methods that have proved to be effective in the Nordic countries and the research topics that the workshop found to be important as a base for Nordic and international cooperation.

5.1 Main observations from the workshop

Here the main observations from the workshop are summarised under the different topics discussed.

Breeding flocks

- Strikingly similar seasonal variation in Campylobacter-positive broiler flocks was observed in all Nordic countries and there was a clear peak in the summer.
- Infection to flocks is either by horizontal transmission (from one flock to another) or from the environment.
- At present it's not possible to totally eliminate contamination at flock level, so other measures are needed.
- There is a need to identify positive flocks as late as possible before slaughter in order to be able to impose the correct interventions. The current methodologies for Campylobacter analysis are slow.

Slaughter, processing and distribution

- If negative flocks are slaughtered after positive ones the infection risk is clear.
- Campylobacter are present at different levels during the slaughter process, e.g. at scalding, defeathering and after evisceration. Detailed data on the effects of various steps are limited.
- An important observation was that freezing lowers the levels of Campylobacter in chicken and this is one of the most effective interventions according to Icelandic sources.
- Current EU legislation restricts the use of many decontamination methods. However, the new hygiene directive allows for decontamination under certain conditions. Steam could be one feasible method.

- Presence/absence is not only important, but also the number of Campylobacter on each carcass.
- It is important to keep the integrity of packaging as Campylobacter may leak from packages.
- The effects of modified atmosphere packaging are unknown.
- Ready-to-cook packages are likely to reduce risk of cross contamination by consumers.

Training, education and risk communication

- The information given to the producers does not seem sufficient to eradicate Campylobacter in all cases. An important piece of the puzzle is missing.
- Training should be focused on later stages in the production. Retail and restaurants should have the same training.
- Information should be provided on how to avoid cross contamination.

Analytical methods and sampling

- Methods for detection, enumeration and identification must be improved and there is a lack of validated methods.
- Both culture and rapid methods definitely have their place in the surveillance of Campylobacter.
- The importance of quantitative information, obtaining live bacteria for sensitivity testing, sub-typing and further research must be weighted against the pros of rapid detection and consequently the opportunity of faster responses/interventions.
- Some Culture Methods are very rapid (48 hrs) (Campy-Cefex Method).
- Different culture and sub-typing methods are used in the various countries and the use of enrichment gives conflicting results. PCR is only in use in Denmark. Sweden and Norway will possibly start using PCR soon. PCR is not used in Finland or Iceland.
- Validation of rapid methods is not available yet. It is important that sensitivity and specificity is at least the same as with the current methods.
- Different sampling plans, methods and time of sampling are used in the various countries.
- Time of sampling before slaughter is different in the Nordic countries between 2 and 8 days it sampled at all. (Sweden and Finland don’t cultivate flocks before slaughter).
- Sampling methods are different in the Nordic countries. Some sample droppings while others use cloacal swabs. Different transport media and transport time of the samples to the lab was also noted.

5.2 Recommendations

The workshop recommends the following:

- GMP should be followed all along the production line from flock houses (incl. depopulation and buildings in general). Logistic slaughter and hygienic measures at slaughter are recommended.
- Campaigns against Campylobacter should focus on limited aspects, such as cross contamination and/or heating. Best preventive measure in the domestic kitchen is to avoid cross contamination and secure proper heating. Hand washing when working in the kitchen is important.
- An inter-Nordic project to develop propaganda material should be initiated and a Nordic archive of food hygiene training material should be established.
- Analytical methods should be chosen according to the purpose of the work, scientific, production surveillance, control etc. Standardized methods should be used but PCR (or other rapid methods) should bee used for screening purposes and then cultivation of the PCR positive samples should be done if desired.
- A web site should be established for easy access of people working on this subject to compare and exchange data.

5.3 Interventions

This part lists some of the interventions methods that have proofed to be effective in the Nordic countries.

- Channelling Campylobacter positive broilers to freezing or heating through official surveillance program has given good results in Iceland and some other Nordic countries.
- Bonus to farm workers for producing Campylobacter free flocks can be effective interventions.
- Environmental control and control of buildings, disinfection of drinking water and good hygiene practices by workers are necessary interventions if Campylobacter free flocks are to be produced.
- Information campaigns aimed towards consumers, food handlers and farmers are important. This can include warning labels on distributed broilers.
- Leak proof packaging can be important intervention.
- From the official side, effective interventions may include law on notification, bio-security management and regulation regarding traceability of products.

5.4 Research Topics

The workshop found several topics important as a base for Nordic (and international) research projects.

One of the most important research topics is to find the explanation for the seasonal variation of *Campylobater* infection. An approach to or an project outline could be to identify few farms in each country (both pos. and neg.), investigate the environment and flocks at intervals during the year, collect information on geography, climate, management, perform case-control study and molecular typing of isolates.

The effect of disinfection, down period, and ventilation of breeding houses can be an important basis for future research.

Validation of already existing methods for testing breeding flocks before arrival at slaughterhouses and development and improvement of sampling plans are important issues for future research.

Intervention studies of the effects of different processing steps at slaughterhouses should be carried out.

Standardization of sampling methods and validation of rapid methods within the Nordic countries is important. Ongoing PCR validation work under the auspices of the EU/internationally must be kept up-do-date. One topic is the loss of sensitivity by pooling samples with respect to different methods (culture/rapid).

There is a need to define the rate of decrease of Campylobacter levels during freezing in order to define the necessary freezing period.

Testing of different decontamination methods can give rise to several interesting research projects.

Studies on the effects of ready-to-cook packages should include case-control studies.

Studies on the effects of modified atmosphere packaging (MAP) on Campylobacter survival and growth are important research topics.

Several research projects regarding more sociological problems were identified i.e.: How do we get to peoples minds? How do we get people to do what we want them to do? This calls for a Nordic project on risk communication.

Further comparison of the Campylobacter situation in the Nordic countries is necessary as well as EU/Nordic research programs on reducing risk of Campylobacter in broiler.

A Nordic archive of information and teaching material should be established. This should include Nordic generic HACCP programs and the encouragement to the industry to develop generic HACCP plans.

Appendixes

Appendix A: Programme for the Work shop

Work Shop Program
Grand Hotel Reykjavik
Oct. 9th – 11th 2003

Thursday Oct. 9th	
9.00-9.15	**Welcome**, by Franklin Georgsson
9.15-10.00	**Overview – International perspective on risk assesment and management of Campylobacter in poultry.** ***Keynote speaker:*** **Peter Karim Ben Embarek, Food Safety Department, *WHO* Geneva**
10.00-10.20	Coffee break
	The situation in the Nordic countries: I. Surveillance of Campylobacter in the Nordic countries.
	Expected outcome: Prevalence data in humans Domestic and imported Sporadic vs. outbreaks Prevalence data in feed, animals, products, water, environmental samples and other Time series analysis Tracing back the source of infection (e.g. case control) Origin and documentation of campylobacteriosis in humans.

10.20-10.45	**Finland:** Johanna Takkinen
10.45-11.10	**Sweden:** Hans Lindmark, Mads Lindblad
11.10-11.35	**Norway:** Georg Kapperud, Merete Hofshagen
11.35-12.00	**Denmark:** Hanne Rosenqvist
12.00.12.25	**Iceland:** Hjördís Harðardóttir, Franklin Georgsson, Vala Friðriksdóttir
12.25-13.30	Lunch
	The situation in the Nordic countries: II. Interventions in the broiler industry.
	Expected outcome Extensive information on intervening methods from farm to fork e.g. in breeding, herds, during transport (incl. stress control, cleaning and disinfections of cages), during process, packaging and distribution. Control programmes. Education and training programmes for workers in the industry Information, advice and campaigns directed toward the consumer. Law and regulations guidelines. Import regulation as intervention
13.30-13.55	**Iceland:** Jarle Reiersen, Elín Guðmundsdóttir
13.55-14.20	**Denmark:** Gudrun Sandö
14.20-14.45	**Norway:** Kjell Hauge, Merete Hofshagen
14.45-15.10	**Sweden:** Ingrid Hansson
15.10-15.35	**Finland:** Marjaana Hakkinen
15.35-16.00	Coffee
	The situation in the Nordic countries: **III. Research activities on Campylobacter aimed at reducing the contamination level in broilers.**

16.00-17.30	Topic 1: Methods for detecting and identifying Campylobacter –new, fast, sensitive, fingerprinting, genomics, proteonomics etc. Virulence and host response. Speaker: Niels L. Nielssen (DK)
	Topic 2: Preventive methods – at primary and production level. Are the current methods reducing the risk Cost –benefit analysis Speaker: Eva Olsson (S)
Friday Oct. 10th	
9.00-9.15	**Work group –introduction**
9.15-12.30	**Work group discussion** **– coffee at 10.30-10.50**
	1. Environment and origin of contamination
	2. Distribution and amplification in breeding and transport
	3. Slaughter, process and distribution. Traceability
	4. Education and training. Staff and consumers
	5. Methods
	6. Law and regulation
12.30- 13.30	Lunch
13.30-17.00	**Work group presentation and discussion** **–coffee 15.30-16.00**
	1. Environment and origin of contamination
	2. Distribution and amplification in culture and transport
	3. Slaughter, process and distribution. Traceability
	4. Education and training. Staff and consumers
	5. Methods
	6. Law and regulation
Saturday Oct.11th	
9.00-12.30	**Work group – results and recommendations –coffee at 10.30-10.50**
	Observations

	Tasks
	Goal
	Expected results

Appendix B: List of Participants

Cristina Galliano	DK	Danish Veterinary and Food Administration	crg@fdir.dk
Gudrun Sandø	DK	Danish Veterinary and Food Administration	gus@fdir.dk
Hanne Rosenqvist	DK	Danish Veterinary and Food Administration	hrq@fdir.dk
Jan Pedersen	DK	The Danish Poultry Association	jp@poultry.dk
Mogens Madsen	DK	Danish Veterinary Institute (DVI)	mm@vetinst.dk
Niels Nielssen	DK	Danish Veterinary and Food Administration	nln@fdir.dk
Søren Kent Pedersen	DK	Danish Veterinary and Food Administration	skpe@fdir.dk
Elín Guðmundsdóttir	IS	Environment and Food Agency	elin@ust.is
Franklin Georgsson	IS	Environment and Food Agency	franklin@ust.is
Hjörleifur Einarsson	IS	University of Akureyri	hei@unak.is
Jarle Reiersen	IS	Keldur -Institute for Experimental Pathology of the University of Iceland	jarle@hi.is
Sigurborg Daðadóttir	IS	Móar ehf	sigurborg@moar.is
Hjördís Harðardóttir	IS	Landspítali - University Hospital	hjordish@landspitali.is
Eggert Gunnarsson	IS	Keldur -Institute for Experimental Pathology of the University of Iceland	eggun@hi.is
Vala Friðriksdóttir	IS	Keldur -Institute for Experimental Pathology of the University of Iceland	valaf@hi.is
Sigrún Guðmundsdóttir	IS	Icelandic fisheries laboratories	sigrun@rf.is
Ásmundur Þorkelsson	IS	SSS (Sambands sveitarfélaga á Suður-nesjum)	asmundur@sss.is
Eystein Skjerve	N	Norwegian Scool of Veterinary Science	eystein.skjerve@veths.no
Georg Kapperud	N	Norwegian Institute of Public Health	george.kapperud@fhi.no
Kjell Hauge	N	Norwegian Food Control Authority	hjell.hauge@snt.no
Kristian Hoel	N	Centre for Poultry Science	kristian.hoel@fjorfe.org
Merete Hofshagen	N	Norwegian Zoonosis Centre	merete.hofshagen@vetinst.no
Eva Olsson	S	National Veterinary Institute	eva.olsson@sva.se
Hans Lindmark	S	National Food Administration	hans.lindmark@slv.se
Ingrid Hansson	S	National Veterinary Institute	ingrid.hansson@sva.se
Lars Plym Forshell	S	National Food Administration	lapl@slv.se
Mats Lindblad	S	National Food Administration	mats.lindblad@slv.se
Pia Gustafsson	S	National Board of Agriculture	pia.gustafsson@sjv.se
Johanna Takkinen	SF	National Public Health Institute	johanna.takkinen@ktl.fi
Marjaana Hakkinen	SF	Veterinary and Food Research Institute	marjaana.hakkinen@eela.fi
Susanna Kangas	SF	National Food Agency	Susanna.kangas@nfa.fi

Appendix C: Questions and topics for discussion in the discussion groups

The participants were split into five groups. Each group was asked to discuss the following items under their heading:

- Observations
- Task
- Goal-Results
- Effect-impact
- Recommendations
- Nordic/EU research topic

Group 1: Environment and origin of contamination

- Which are the major reservoirs of Campylobacter in the natural environment and among animals?
- Are there regional differences in the origin of contamination? If so, why?
- Which are the main infection routes contributing to initial introduction of Campylobacter into poultry flocks?
- Survival of Campylobacter in the environment
- What is the likelihood and significance of vertical transmission of Campylobacter from parent breeders to broilers?
- Is feed and litter important source of infection?
- Reasons for seasonal variation in flock infections?
- Why is it difficult to predict which flocks become contaminated?
- Possible intervention measures that should be used to reduce or eliminate Campylobacter colonization at farm level?
- What data is lacking?
- Identify the main research priorities in this field.

Group 2: Distribution and amplification in breeding and transport

- Which are the major factors (biosecurity measures and farm practice) that influence the in-flock prevalence and flock prevalence of Campylobacter.
- Use of vaccination to prevent/reduce the contamination levels and prevalence of positive flocks.
- Use of antibiotics and bacteriocins to reduce levels of Campylobacter in broilers.
- Dietary manipulation i.e. acidified feed
- Depopulation procedures: Risk factors associated with partial depopulation?

- Application of testing and impact on distribution as an intervention to protect consumers.
- The effect of transport on contamination levels and spread of contamination. Possible intervention?
- Cleaning and disinfections of crates. Prevention of cross-contamination.
- Identify the main research priorities in this field.

Group 3: Slaughter, process and distribution. Traceability

- The spread and level of contamination at different processing steps in slaughter of Campylobacter positive broilers.
- The risk of Campylobacter free flocks being contaminated during slaughter processing?
- What is the difference in risk of acquiring Campylobacter fro refrigerated or fresh chicken compared to frozen chicken?
- The effect of different processing procedures on Campylobacter levels on broiler carcasses (e.g. scalding. Plucking, evisceration, water chilling vs. air chilling, decontamination agents, cutting, freezing, packaging materials and packaging methods).
- Application of other untraditional processing methods like heat treatment (steaming), chemicals washes and irradiation.
- Identify the main research priorities in this field.

Group 4: Education and training of consumers

- Which are the best preventive methods when handling fresh and frozen poultry products in the kitchen?
- What impact will training programs in preventive measures for farm workers, retail personal, and restaurant personal have on final health risk to consumers?
- Which are the most important messages to be delivered to a) processors, b) retailers and c) consumers?
- Which actions have been taken in terms of consumer education?
- Describe the stages in the food chain where the interventions can be most effective.
- Which intervention strategies have been implemented by the official authorities at this step?
- Which law are regulations have been developed in the Nordic countries to implement interventions?
- Which intervention methods regulated by laws/regulations are the most effective and least expensive?
- Can the impact of intervention methods be measured and quantified?
- Is it possible to establish a non zero tolerance as microbiological criteria for Campylobacter in poultry?

- Identify the main research priorities in this field.

Group 5:Methods

- The importance of using traditional analytical culture methods with and without enrichment steps vs. rapid methods. In connection with control procedures and management options.
- Effect of sampling methods and sampling time in flocks prior to slaughter on discovering flocks that are positive at slaughter
- Are methods used for collection of analytical data in the Nordic countries comparable?
- Use of models to estimate the risks of infection by poultry meat.
- Case-control studies. What do they tell us?
- Information from cost-benefits studies in relation to interventions.
- Identify the main research priorities in this field.