International Commission on Microbiological Specifications for Foods (ICMSF)

EMERGING FOODBORNE PATHOGENS

JEFFREY M. FARBER

Health Canada, Ottawa, ON, Canada

Punta del Este, Uruguay
Monday
5 October 2009

COLMIC 2009

What are emerging pathogens?

1. **Infectious diseases whose incidence has increased in the past 2 decades or threatens to increase in the near future**
2. **New infections resulting from changes or evolution of existing organisms**
3. **Known infections spreading to new geographic areas or populations**

Modified Definition from "Emerging Infectious Diseases"

Health Canada Santé Canada

What are emerging pathogens?

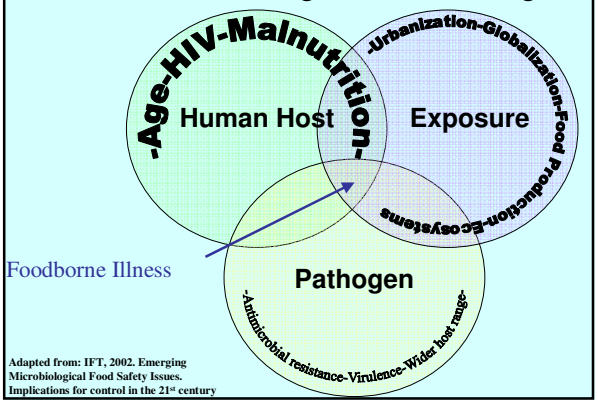
4. **Old infections reemerging as a result of their appearing in new vehicles**
5. **Previously unrecognized as potential foodborne infections**

'6.' Organisms on which to keep a watchful eye

Modified Definition from "Emerging Infectious Diseases"

Health Canada Santé Canada

Factors in the Emergence of Pathogens



Adapted from: IFT, 2002. Emerging Microbiological Food Safety Issues. Implications for control in the 21st century

Factors in the Emergence of Pathogens

- Microbial adaptation and change
- Human susceptibility to infection
- Climate and weather
- Changing ecosystems
- Human demographics and behaviour
- Economic development and land use
- International travel and commerce
- Technology and industry
- Breakdown of public health measures
- Poverty and social inequality
- War and famine
- Lack of political will
- Intent to harm

Morens et al., 2004

Health Canada Santé Canada

Food and Chemical Toxicology 47 (2009) 1009–1021

Contents lists available at ScienceDirect

Food and Chemical Toxicology

journal homepage: www.elsevier.com/locate/foodchemtox

Climate change and food safety: An emerging issue with special focus on Europe

M. Miraglia [a,*], H.J.P. Marvin [b], G.A. Kleter [b], P. Battilani [c], C. Brera [a], E. Coni [a], F. Cubadda [a], L. Croci [a], B. De Santis [a], S. Dekkers [d], L. Filippi [e], R.W.A. Hutjes [f], M.Y. Noordam [b], M. Pisante [f], G. Piva [c], A. Prandini [c], L. Toti [a], G.J. van den Born [g], A. Vespermann [b]

ARTICLE INFO

ABSTRACT

‘Chikungunya is coming,’ expert warns of virus

BY DAVID MORGAN

WASHINGTON

North America and Europe face a new health threat from a mosquito-borne disease far more unpleasant than the West Nile virus that swept into North America a decade ago, a U.S. expert said Friday.

Chikungunya virus has spread beyond Africa since 2005, causing outbreaks and scores of fatalities in India and the French island of Reunion. It also has been detected in Italy, where it has begun to spread locally, as well as France.

“We’re very worried,” Dr. James Diaz of the Louisiana University Health Sciences Center told a meeting on airlines, airports and disease transmission sponsored by the independent U.S. National Research Council.

“Unlike West Nile virus, where nine out of 10 people are going to be totally asymptomatic, or may have a mild headache or a stiff neck, if you get Chikungunya you’re going to be sick,” he said.

“The disease can be fatal. It’s a serious disease,” Diaz added. “There is no vaccine.”

Chikungunya infection causes fever, headache, fatigue, nausea, vomiting, muscle pain, rash and joint pain. Symptoms can last a few weeks, though some suffers have reported incapacitating joint pain or arthritis lasting for months.

The disease was first discovered in Tanzania in 1952. Its name means “that which bends up” in the Makonde language spoken in northern Mozambique and southeastern Tanzania.

The virus could spread globally now because it can be carried by the Asian tiger mosquito, which is found in Asia, Africa, Europe, the Americas, Australia and New Zealand.

In the U.S., the mosquito species tends to live in southern regions east of the Mississippi but has been found as far afield as western Texas, Minnesota and New Jersey.

Health officials are concerned about the appearance of Chikungunya in the islands of the Indian Ocean — Mauritius, Seychelles and Reunion — which have beach resorts frequented by European tourists.

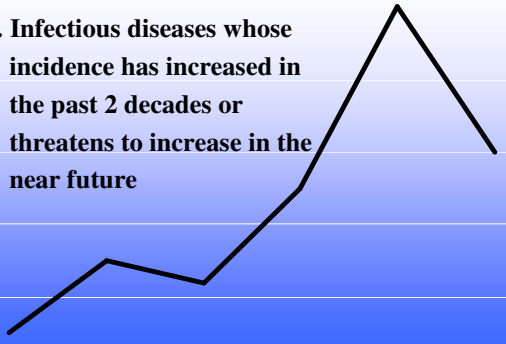
“It is hyper-endemic in the islands of the Indian Ocean,” Diaz told the meeting. “Travel by air will import the infected mosquitoes and humans. Chikungunya is coming.”

Diaz warned of possible double-infections involving Chikungunya and dengue fever or malaria, also carried by the Asian tiger mosquito.

REUTERS

Emerging Pathogens

1. **Infectious diseases whose incidence has increased in the past 2 decades or threatens to increase in the near future**



Foodborne Viruses

Virus	Family	Culturable	Disease
Hepatitis A	Picornaviridae	Yes[1]	Hepatitis
Hepatitis E	Hepeviridae	No	Hepatitis
Norovirus	Caliciviridae	No	Gastroenteritis
Sapovirus	Caliciviridae	No	Gastroenteritis
Rotavirus	Reoviridae	Yes	Gastroenteritis
Astrovirus	Astroviridae	Yes[1]	Gastroenteritis
Adenovirus	Adenoviridae	Yes[1]	Respiratory, eye and GI infection
Enterovirus	Picornaviridae	Yes[1]	Poliomyelitis, meningitis and encephalitis

[1] Not all strains within the genus are culturable; wild-type strains are often difficult to culture

Adapted from: Greening G.E., Human and Animal Viruses in Food *In* Viruses in Foods (2006)

Viruses

- Norovirus
- Rotavirus
- Hepatitis E

Health Canada Santé Canada

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 11, No. 5, May 2005 735

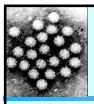
Are Noroviruses Emerging?

Marc-Alain Widdowson,* Stephan S. Monroe,* and Roger I. Glass*

In 1972, noroviruses (previously called “Norwalk-like viruses”) were discovered as the first viruses definitively associated with acute gastroenteritis. During the next 2 decades, researchers were unable to develop simple methods to detect these common viruses or to find the etiologic agents of nonbacterial gastroenteritis outbreaks and hospitalizations. Indeed, of >2,500 foodborne outbreaks reported to the Centers for Disease Control and Prevention from 1993 to 1997, <1% were attributed to noroviruses, and 68% were of “unknown etiology” (1). As a result, noroviruses were out of sight and mind and thus relegated which has stimulated speculation about zoonotic transmission (15). However, a fundamental question remains—is the increased detection of norovirus the result of better application of improved diagnostics or does evidence exist that norovirus disease is an emergent problem?

Recent reports have established that norovirus strains can periodically emerge either globally or nationally, displace other strains, and increase disease incidence (16,17). In winter 2002, a new virus variant was attributed to a well-publicized surge of norovirus outbreaks on cruise ships and in nursing homes in the United States (18,19)

Health Canada Santé Canada



Role of Noroviruses in Sporadic Gastroenteritis

- Leading cause of epidemic gastroenteritis in all age groups, causing >90% of non-bacterial and ≈50% of all-cause epidemic gastroenteritis worldwide
- The second most common cause of severe childhood gastroenteritis, following rotavirus
- Global burden estimate: >1 million hospitalizations and 200,000 deaths / year among children <5 years of age
- GII.4 NoV appear to be the most prevalent strain; may be the primary target for vaccine development
- Found in retail meat samples (Mattison et al., 2007)

EMERGING INFECTIOUS DISEASES®

Research

Human Noroviruses in Swine and Cattle

Kirsten Mattison,* Anu Shukla,* Angela Cook,† Frank Pollari,† Robert Friendship,‡ David Kelton,‡ Sabah Bidawid,* and Jeffrey M. Farber*
*Health Canada, Ottawa, Ontario, Canada; †Public Health Agency of Canada, Guelph, Ontario, Canada; and ‡University of Guelph, Guelph, Ontario, Canada

Suggested citation for this article

Abstract
Human noroviruses are the predominant cause of foodborne gastroenteritis worldwide. Strains of norovirus also exist that are uniquely associated with animals; their contribution to the incidence of human illness remains unclear. We tested animal fecal samples and identified GIII (bovine), GII.18 (swine), and GII.4 (human) norovirus sequences, demonstrating for the first time, to our knowledge, that GII.4-like strains can be present in livestock. In addition, we detected GII.4-like noroviral RNA from a retail meat sample. This finding highlights a possible route for indirect zoonotic transmission of noroviruses through the food chain.

Norovirus linked to Raspberries

Peer-reviewed European information on communicable disease surveillance and control

:: Home > Archives : Eurosurveillance weekly releases 2006 > Volume 11 / Issue 9 [previous page]

Eurosurveillance weekly release — Surveillance Report — volume 11 issue 9 date 7 September 2006

Four outbreaks of norovirus gastroenteritis after consuming raspberries, Sweden, June-August 2006

M Hjertqvist[1] (marika.hjertqvist@smi.ki.se), A Johansson[2], N Svensson[2], PE Åbom[3], C Magnusson[4], M Olsson[2], KO Hedlund[1], Y Andersson[1]

[1]Swedish Institute for Infectious Disease Control, Stockholm, Sweden
[2]Department of Communicable Disease Control, Västra Götaland, Sweden
[3]Department of Communicable Disease Control, Jönköping, Sweden
[4]Municipality of Gnosjö, Sweden

So far in 2006, in Sweden, there have been four outbreaks of norovirus gastroenteritis where raspberries were the suspected vehicle of infection. The first outbreak occurred at the end of June, the second was at the beginning of August and the third and fourth at the end of August. All the outbreaks occurred in the south western part of the country. In total, 43 people became ill and all these people had eaten raspberries as part of various different dishes.

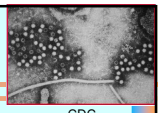
Rotaviruses

- Acute gastroenteritis in children/infants
- Faecal-oral transmission, highly infective
- Global burden estimate: 138 million infections, over 600,000 deaths each year
- Severe disease preventable by live attenuated oral vaccines
- Vaccination programs being evaluated in Europe
- Found in raw retail meats; 18 % of retail poultry, beef or pork in Canada were positive for group A rotaviruses

Epidemiol. Infect. (2006) 134, 908-916; Mattison, K. personal communication

Health Canada Santé Canada

Hepatitis E



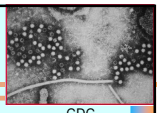
CDC

- Asia, Africa, Mexico; drinking water
- 20% mortality rate in pregnant women; 1-3% in the rest of the population
- Increase in UK non-travel related cases, target population men around age 55; same for other countries?
- In US, low prevalence of anti-HEV (<2%) found in healthy populations

Veterinary Laboratories Agency, No.16, 2006; CDC, 2003

Health Canada Santé Canada

Hepatitis E



CDC

- Reports of HEV have been increasing in Germany since 2002
- In 2005, large waterborne HEV outbreak occurred in Hyderabad, India with 1611 cases of illness
- Cross-species infection of HEV is probable
- Pigs may be reservoir; undercooked raw meat may partially explain occurrence of autochthonous HEV in industrialized countries
- People working with swine are at a higher risk of HEV infection

JID, 2008:198; Epi Infect 2008:136; 2009;139

Health Canada Santé Canada

Hepatitis E virus in pig livers

Journal of General Virology (2007), 88, 912–917 DOI 10.1099/vir.0.82613-0

Short Communication

Detection and characterization of infectious *Hepatitis E virus* from commercial pig livers sold in local grocery stores in the USA

A. R. Feagins,[1] T. Opriessnig,[2] D. K. Guenette,[1] P. G. Halbur[2] and X-J. Meng[1]

Journal of Food Protection, Vol. 70, No. 12, 2007, Pages 2889–2895

Research Note

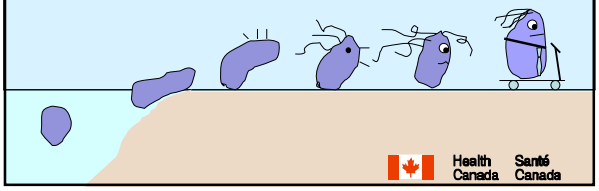
Hepatitis E Virus RNA in Commercial Porcine Livers in The Netherlands

MARTIJN BOUWKNEGT,[1,2]* FROUKJE LODDER-VERSCHOOR,[1] WIM H. M. VAN DER POEL,[2] SASKIA A. RUTJES,[1] AND ANA MARIA DE RODA HUSMAN[1]

Health Canada Santé Canada

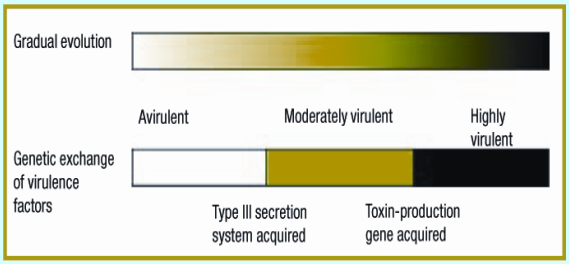
Emerging Pathogens

2. New infections resulting from changes or evolution of existing organisms



Health Canada Santé Canada

Contrasting views of pathogen evolution



Source: IFT, 2002. Emerging Microbiological Food Safety Issues. Implications for control in the 21st century

What are verotoxigenic *E. coli*?

- A diverse group of *E. coli*
  - All produce exotoxins, called verotoxins (VT), Shiga toxins (STX), Shiga-like toxins (SLT)
- VTEC vary in their ability to cause disease
  - Virulent VTEC such as *E. coli* O157:H7 cause:
    - Diarrhea; Bloody diarrhea (hemorrhagic colitis)
    - Hemolytic uremic syndrome (HUS)
  - Children and the elderly are most susceptible
  - Most infections (80%) are sporadic
- Over 400 VTEC serotypes isolated from humans
  - >90% of known infections are caused by fewer than 10 serogroups

R. Johnson, 2006

Health Canada Santé Canada

Non-O157 *E. coli* outbreaks in North America

Year	Serogroup	Location	# of cases	Vehicle of exposure
2004	O111:NM	Quebec	2	Ground beef
2005	O111	NY, N. Carolina	212	Unpasteurized apple cider
1999	O111:H8	Texas	58	Salad
2006	O121:H19	Utah	4	Lettuce
1999	O121	Connecticut	11	Lake water
2001	O26	Minnesota	4	Lake water
2000	O103	Washington	18	Punch
2005	O45	New York	52	Infected food handler

Health Canada Santé Canada

LETTER TO THE EDITOR

Re: Isolation of *Escherichia Coli* O157:H7 strains that do not produce Shiga toxin from bovine, avian and environmental sources

Karl Ikettelheim
Flat 5, Rosedale Lodge
220 Chase Side
London N14 4PH
United Kingdom
E-mail: ikettelheim@talktalk.net

Dear Sir—In the recent paper, Wetzel and Lehrane (2007) show the presence of non-toxigenic strains of otherwise typical *Escherichia coli* O157:H7 being present in multiple animal and environmental sources. These observations are in line with our earlier observations (Ikettelheim *et al.* 2005), where we noted that cattle, especially if suffering from gastrointestinal disease, harboured strains of *E. coli* O111 which were indistinguishable from typical enterohaemorrhagic *E. coli* O111, apart from lacking the ability to produce Shiga toxin(s) and the absence of the stx-converting bacteriophage. Further, it was recently shown (Bielaszewska *et al.* 2007) that patients infected with enterohaemorrhagic *Escherichia coli* (EHEC) O26 carry both toxigenic and non-toxigenic variants. The importance of these findings should not be underestimated, because in the diagnosis of EHEC infections only looking for stx-producing strains may well give misleading results and provide totally misleading answers of the epidemiological situation. In addition the potential virulence of these non-toxigenic strains must be considered in any disease or outbreak situation. If it is shown that animals such as cattle and sheep regularly harbour these non-toxigenic potential EHEC which acquire their stx-converting bacteriophages only under certain as yet undefined conditions. It throws a *completely* new light onto the epidemiology of EHEC infections.

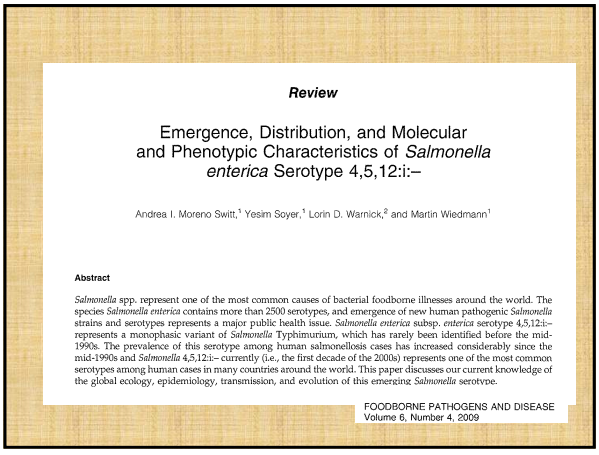
References

Bielaszewska, M., Prager, R., Köck, R., Mellmann, A., Zhang, W., Tschäpe, H., Tarr, P.I. and Karch, H. (2007) Shiga toxin gene loss and transfer in vitro and in vivo during enterohaemorrhagic *Escherichia coli* O26 infection in humans. *Appl Environ Microbiol* **73**, 3144–3150.

Hornitzky, M.A., Mercieca, K., Bettelheim, K.A. and Djordjevic, S.P. (2005) Bovine feces from animals with gastrointestinal infections are a source of serologically diverse atypical enterohaemorrhagic *Escherichia coli* and Shiga toxin-producing *E. coli* strains that commonly possess intimin. *Appl Environ Microbiol* **71**, 3405–3415.

Wetzel, A.N. and Lehrane, J.T. (2007) Isolation of *Escherichia coli* O157:H7 strains that do not produce Shiga toxin from bovine, avian and environmental sources. *Lett Appl Microbiol* **45**, 504–507.

Letters in Applied Microbiology ISSN 0266-8254



Review

Emergence, Distribution, and Molecular and Phenotypic Characteristics of *Salmonella enterica* Serotype 4,5,12:i:–

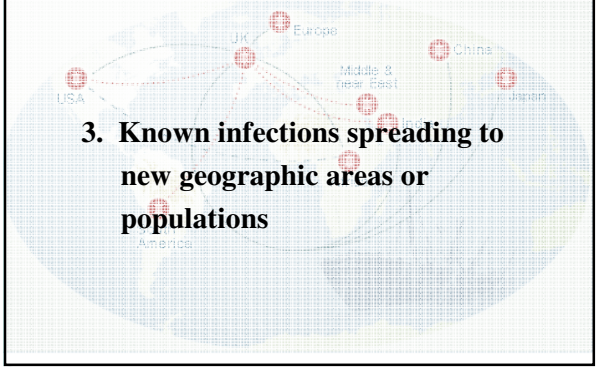
Andrea I. Moreno Switt,[1] Yesim Soyer,[1] Lorin D. Warnick,[2] and Martin Wiedmann[1]

Abstract

Salmonella spp. represent one of the most common causes of bacterial foodborne illnesses around the world. The species *Salmonella enterica* contains more than 2500 serotypes, and emergence of new human pathogenic *Salmonella* strains and serotypes represents a major public health issue. *Salmonella enterica* subsp. *enterica* serotype 4,5,12:i:– represents a monophasic variant of *Salmonella* Typhimurium, which has rarely been identified before the mid-1990s. The prevalence of this serotype among human salmonellosis cases has increased considerably since the mid-1990s and *Salmonella* 4,5,12:i:– currently (i.e., the first decade of the 2000s) represents one of the most common serotypes among human cases in many countries around the world. This paper discusses our current knowledge of the global ecology, epidemiology, transmission, and evolution of this emerging *Salmonella* serotype.

FOODBORNE PATHOGENS AND DISEASE
Volume 6, Number 4, 2009

Emerging Pathogens



3. Known infections spreading to new geographic areas or populations

Vibrio cholerae

- The Latin American epidemic strain found off the coast of southern US in 1991 may have been introduced when a cargo ship discharged contaminated ballast water
- Likely a similar mechanism led to the introduction of cholera for the first time this century into Peru in 1991 from Asia and Africa
- Serogroups O1, non-O1 and O139 (which emerged in Bengal, India in 1992) are foodborne illness threats
- Seven distinct pandemics have occurred since 1817
- Able to directly take up DNA present in the environment

Source: Pruzzo et al., 2008
Pazzani et al., 2006; Meibom et al., 2005

Health Canada Santé Canada

Severe Diarrhea Caused by Cholera Toxin–Producing *Vibrio cholerae* Serogroup O75 Infections Acquired in the Southeastern United States

Melissa Tobin-D'Angelo,[1] Allison R. Smith,[2] Sandra N. Bulens,[2,4] Stepy Thomas,[1] Mary Hodel,[1] Hidemasa Izumiya,[7] Eiji Arakawa,[7] Masatomo Morita,[7] Haruo Watanabe,[7] Constance Marin,[5] Michele B. Parsons,[2] Kathy Greene,[2] Kara Cooper,[2] Danielle Haydel,[6] Cheryl Bopp,[2] Patricia Yu,[2] and Eric Mintz[2]

[1]Georgia Division of Public Health and [2]Centers for Disease Control and Prevention, Atlanta, Georgia; [3]Alabama Department of Health, Montgomery; [4]Anteon Corporation, Germantown, Virginia; [5]Louisiana Office of Public Health Laboratory, New Orleans; [6]South Carolina Department of Health and Environmental Control, Columbia; and [7]National Institute of Infectious Diseases, Tokyo, Japan

Background. From 2003 through 2007, *Vibrio cholerae* serogroup O75 strains possessing the cholera toxin gene were isolated from 6 patients with severe diarrhea, including 3 in Georgia, 2 in Alabama, and 1 in South Carolina. These reports represent the first identification of *V. cholerae* O75 as a cause of illness in the United States. *V. cholerae* O75 was isolated from a water sample collected from a pond in Louisiana in 2004. Subsequently, 3 *V. cholerae* isolates from Louisiana (2 from patients with diarrhea in 2000 and 1 from a water sample collected in 1978) that had been previously reported as serogroup O141 were also discovered to be serogroup O75.

Results. All 8 patients who were infected with *V. cholerae* O75 were adults who became ill after consuming seafood; 2 had eaten raw oysters traced back to the Gulf Coast of the United States. All 10 isolates possessed the cholera toxin gene and were susceptible to 10 antimicrobials. One clinical isolate and 1 environmental (water) isolate had the same pulsed-field gel electrophoresis pattern; 4 clinical isolates shared a common pulsed-field gel electrophoresis pattern.

Conclusions. The occurrence of these cases over many years and the concurrent identification of *V. cholerae* O75 in water from a Gulf Coast state suggest that these strains may survive for long periods in this environment. The patients' exposure histories suggest that infection can be acquired from consumption of raw oysters from the Gulf Coast. Clinicians and public health authorities should be vigilant for the occurrence of new toxigenic serogroups of *V. cholerae* that are capable of causing severe diarrhea.

Clinical Infectious Diseases 2008; 47:1035–40

Vibrio vulnificus

Recent Foodborne Outbreaks of Cyclosporiasis in North America

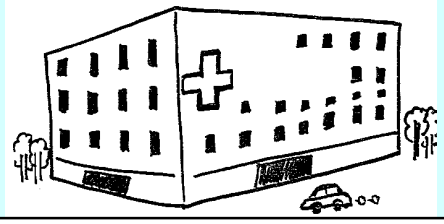
Location	Date	# of cases	Vehicle
Atlanta GA	May 2000	21	raspberries (Guatemala)
Vancouver BC	May 2001	17	Thai basil
Vermont	Jan 2002	22	raspberries (Chile?)
Vancouver BC	Jun-Jul 2003	10	cilantro?
Texas/Illinois	Feb 2004	95	basil/mesclun?
Vancouver BC	May-Jun 2004	9	cilantro?
Pennsylvania	Jun-Jul 2004	<100	snow peas (Guatemala)
Florida	Mar-Apr 2005	293	basil (Peru)
Ontario	Apr 2005	40	basil
Quebec	Jun 2005	220	basil
Vancouver BC	Jun-Jul 2006	14	basil / garlic?
BC	May-Jul 2007	23	fresh herbs?

Source: B. Dixon, 2008

Health Canada Santé Canada

Emerging Pathogens

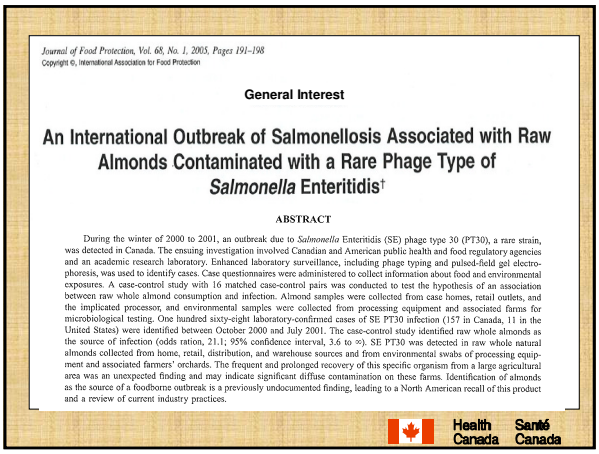
4. Older pathogens reemerging as a result of their appearing in new vehicles



Adult Colonization Botulism

- Three cases reported in Ontario from Nov 2006 to Feb 2007
- All three patients had Crohn's disease – risk factor?
- One case linked to consumption of peanut butter
- Only 10 cases documented worldwide from 1973 to 2007

Health Canada, 2009; Manuscript in preparation



Journal of Food Protection, Vol. 68, No. 1, 2005, Pages 191–198
Copyright ©, International Association for Food Protection

General Interest

An International Outbreak of Salmonellosis Associated with Raw Almonds Contaminated with a Rare Phage Type of *Salmonella* Enteritidis†

ABSTRACT

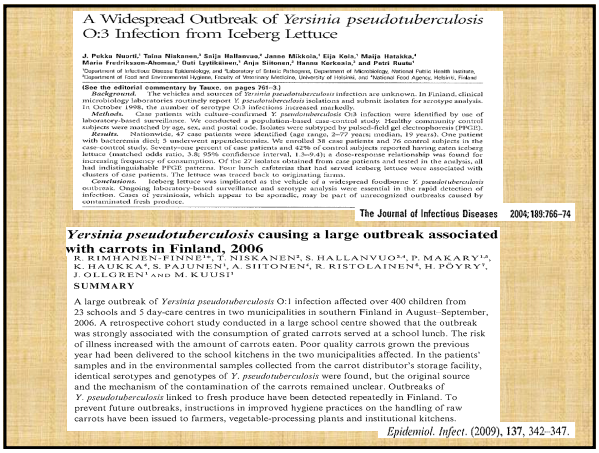
During the winter of 2000 to 2001, an outbreak due to *Salmonella* Enteritidis (SE) phage type 30 (PT30), a rare strain, was detected in Canada. The ensuing investigation involved Canadian and American public health and food regulatory agencies and an academic research laboratory. Enhanced laboratory surveillance, including phage typing and pulsed-field gel electrophoresis, was used to identify cases. Case questionnaires were administered to collect information about food and environmental exposures. A case-control study with 16 matched case-control pairs was conducted to test the hypothesis of an association between raw whole almond consumption and infection. Almond samples were collected from case homes, retail outlets, and the implicated processor, and environmental samples were collected from processing equipment and associated farms for microbiological testing. One hundred sixty-eight laboratory-confirmed cases of SE PT30 infection (157 in Canada, 11 in the United States) were identified between October 2000 and July 2001. The case-control study identified raw whole almonds as the source of infection (odds ration, 211; 95% confidence interval, 3.6 to ∞). SE PT30 was detected in raw whole natural almonds collected from home, retail, distribution, and warehouse sources and from environmental swabs of processing equipment and associated farmers' orchards. The frequent and prolonged recovery of this specific organism from a large agricultural area was an unexpected finding and may indicate significant diffuse contamination on these farms. Identification of almonds as the source of a foodborne outbreak is a previously undocumented finding, leading to a North American recall of this product and a review of current industry practices.

Health Canada Santé Canada

Salmonella Outbreaks in Low-Moisture Products

Year	Product	Serotype	Country	Cases	Reference
1998	Cereal	Agona	US	209	MMWR 1998 47/(22)
2000-01	Raw almonds	Enteritidis	US/Canada	168	Eurosurveillance vol12 issue 3-6
2001	Peanuts	Stanley, Newport	Multiple	109	Epidemiol. Infect. (2004), 132, 571–577
2001	Chocolate	Oranienburg	Multiple	400+?	BMC Infect Dis. 2005 Feb 3;5(1):7.
2002	Tahini, Halva	Montevideo	Australia	55	Eurosurveillance Vol 7 Issue 38
2003-04	Raw almonds	Enteritidis	US/Canada	29	MMWR 53(22);484-487
2006	Chocolate	Montevideo	UK	37?	Food Production Daily 25/Jul/2006
2006-07	Peanut butter	Tennessee	US	628	MMWR 56(21);521-524
2007	Children's snack	Wandsworth/ Typhimurium	US	65?	CDC, July 18, 2007
2008	Cereal	Agona	US	28	CDC, May 14, 2008
2008	Infant formula	Give	France	6?	Eurosurveillance Vol 13 Issue 39
2008-09	Peanut butter	Typhimurium	US	691	CDC, March 17, 2001

Adapted from Scott, (2009) IAFP



A Widespread Outbreak of *Yersinia pseudotuberculosis* O:3 Infection from Iceberg Lettuce

J. Pekka Nuorti,[1] Taina Niskanen,[2] Saija Hallanvuo,[2] Janne Mikkola,[1] Eija Kela,[1] Maija Hatakka,[1] Maria Fredriksson-Ahomaa,[3] Outi Lyytikäinen,[1] Anja Siitonen,[2] Hanna Korkeala,[3] and Petri Ruutu[1]

[1]Department of Infectious Disease Epidemiology, and [2]Laboratory of Enteric Pathogens, Department of Microbiology, National Public Health Institute, [3]Department of Food and Environmental Hygiene, Faculty of Veterinary Medicine, University of Helsinki, and [4]National Food Agency, Helsinki, Finland

(See the editorial commentary by Tauxe, on pages 761–3.)

Background. The vehicles and sources of *Yersinia pseudotuberculosis* infection are unknown. In Finland, clinical microbiology laboratories routinely report *Y. pseudotuberculosis* isolations and submit isolates for serotype analysis. In October 1998, the number of serotype O:3 infections increased markedly.

Methods. Case patients with culture-confirmed *Y. pseudotuberculosis* O:3 infection were identified by use of laboratory-based surveillance. We conducted a population-based case-control study. Healthy community control subjects were matched by age, sex, and postal code. Isolates were subtyped by pulsed-field gel electrophoresis (PFGE).

Results. Nationwide, 47 case patients were identified (age range, 2–77 years; median, 19 years). One patient with bacteremia died; 3 underwent appendectomies. We enrolled 38 case patients and 76 control subjects in the case-control study. Seventy-one percent of case patients and 42% of control subjects reported having eaten iceberg lettuce (matched odds ratio, 3.8; 95% confidence interval, 1.3–9.4); a dose-response relationship was found for increasing frequency of consumption. Of the 27 isolates obtained from case patients and tested in the analysis, all had indistinguishable PFGE patterns. Four lunch cafeterias that had served iceberg lettuce were associated with clusters of case patients. The lettuce was traced back to originating farms.

Conclusions. Iceberg lettuce was implicated as the vehicle of a widespread foodborne *Y. pseudotuberculosis* outbreak. Ongoing laboratory-based surveillance and serotype analysis were essential in the rapid detection of infection. Cases of yersiniosis, which appear to be sporadic, may be part of unrecognized outbreaks caused by contaminated fresh produce.

The Journal of Infectious Diseases 2004; 189:766–74

***Yersinia pseudotuberculosis* causing a large outbreak associated with carrots in Finland, 2006**

R. RIMHANEN-FINNE[1*], T. NISKANEN[2], S. HALLANVUO[2,3], P. MAKARY[1,4], K. HAUKKA[4], S. PAJUNEN[4], A. SIITONEN[4], R. RISTOLAINEN[4], H. PÖYRY[4], J. OLLGREN[1] AND M. KUUSI[1]

SUMMARY

A large outbreak of *Yersinia pseudotuberculosis* O:1 infection affected over 400 children from 23 schools and 5 day-care centres in two municipalities in southern Finland in August–September, 2006. A retrospective cohort study conducted in a large school centre showed that the outbreak was strongly associated with the consumption of grated carrots served at a school lunch. The risk of illness increased with the amount of carrots eaten. Poor quality carrots grown the previous year had been delivered to the school kitchens in the two municipalities affected. In the patients' samples and in the environmental samples collected from the carrot distributor's storage facility, identical serotypes and genotypes of *Y. pseudotuberculosis* were found, but the original source and the mechanism of the contamination of the carrots remained unclear. Outbreaks of *Y. pseudotuberculosis* linked to fresh produce have been detected repeatedly in Finland. To prevent future outbreaks, instructions in improved hygiene practices on the handling of raw carrots have been issued to farmers, vegetable-processing plants and institutional kitchens.

Epidemiol. Infect. (2009), **137**, 342–347.

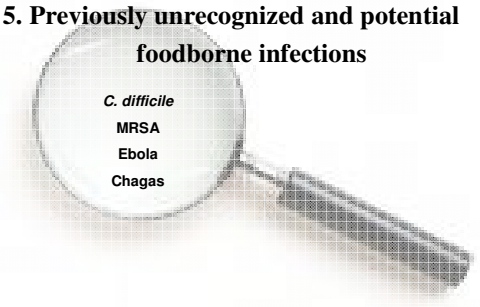
Produce – "New" Vehicles

Pathogen	Vehicles
E. coli O157:H7	melons
Salmonella	tomatoes, melons, mango, fruit salad
Cyclospora	raspberries, basil, snow peas
C. botulinum	carrot juice
Campylobacter	snow peas
Shigella	sugar snaps, baby corn
Hepatitis A	watercress, green onions
Norovirus	fresh-cut fruit

L. Harris, 2006; Nuorti et al., 2004; Löfdahl et al., 2009

Emerging Pathogens

5. Previously unrecognized and potential foodborne infections



- *C. difficile*
- MRSA
- Ebola
- Chagas

C. diff: The next O157?

An "opportunistic bug" could pose a food-safety threat in meat products…or maybe not

Wien Klin Wochenschr (2009) 121: 91–95
DOI 10.1007/s00508-008-1127-x
Printed in Austria
© Springer-Verlag 2009

Wiener klinische Wochenschrift
The Middle European Journal of Medicine

***Clostridium difficile:* a new zoonotic agent?**

Alexander Indra[1], Heimo Lassnig[2], Nina Baliko[1], Peter Much[3], Anita Fiedler[1], Steliana Huhulescu[1], Franz Allerberger[1]

[1]Austrian Agency for Health and Food Safety, Institute of Medical Microbiology and Hygiene, National Reference Center for Clostridium difficile, Wien, Austria
[2]Austrian Agency for Health and Food Safety, Institute of Veterinary Medicine, Graz, Austria
[3]Austrian Agency for Health and Food Safety, Center for Infectious Diseases Epidemiology, Wien, Austria

Health Canada Santé Canada

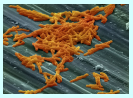
Clostridium difficile

- Increasing prevalence of "outbreak strain" 027/NAP1 in various countries :
  - Hospitals; Outbreaks, severe disease
  - Animals – cattle, pigs
  - Food – retail ground meat (20% positive in Canada, 2005, similar to 027/NAP1), raw vegetables
- Animal isolates often indistinguishable from pathogenic human strains
- Animal reservoirs via food are possible sources of *C. difficile* infection

Rodriguez-Palacios et al., 2007; Weese, 2006

Clostridium difficile

- Vulnerable populations – elderly, children, antibiotic use
- **Antimicrobial resistant,** heat-tolerant, disinfection-resistant
- Some of the community-acquired *C. difficile* infections do not appear to be linked to recent antibiotic therapy, increased age, co-morbidity or prior hospital admission
- Rate of community-acquired *C. difficile* is increasing; 3% of healthy adults and up to 80% of infants are carriers



Meat and Poultry, Feb 2009; Kuijper; 2006, 2008

Health Canada Santé Canada

Risk factors for community - acquired *C. difficile* - associated disease

Risk factor	Community-acquired CDAD
Disruption of normal colonic microflora	Usually limited or no antibiotic exposure Minor use of fluoroquinolones Chronic GI conditions
Exposure to *C. difficile*	Home surfaces? Family members Pets? Soil? **Foods?**
Host factors	Young children Post-partum women Use of PPIs
Microbial factors	Unknown (?)

McFarland LV, 2008; *Nat Clin Pract Gastroenterol Hepatol.* 5(1): 40-80 Review

MRSA as a foodborne pathogen?

Annals of Clinical Microbiology and Antimicrobials
BioMed Central

Research
Open Access

Community-acquired MRSA and pig-farming

Xander W Huijsdens*[1], Beatrix J van Dijke[2], Emile Spalburg[1], Marga G van Santen-Verheuvel[1], Max EOC Heck[1], Gerlinde N Pluister[1], Andreas Voss[3,4], Wim JB Wannet[1] and Albert J de Neeling[1]

High prevalence of methicillin resistant Staphylococcus aureus in pigs

A J de Neeling, M J M van den Broek, E C Spalburg, M G van Santen-Verheuvel, W D C Dam-Deisz, H C Boshuizen, A W van de Giessen, E van Duijkeren, X W Huijsdens

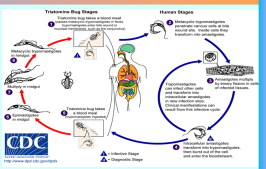
Short communication

Transmission of methicillin-resistant *Staphylococcus aureus* strains between different kinds of pig farms

E. van Duijkeren[a,*], R. Ikawaty[b], M.J. Broekhuizen-Stins[a], M.D. Jansen[b], E.C. Spalburg[a], A.J. de Neeling[a], J.G. Allaart[d], A. van Nes[d], J.A. Wagenaar[a], A.C. Fluit[b]

Chagas' Disease

- Transmitted by the protozoan parasite *Trypanosoma cruzi*
- Worldwide incidence estimated at 200,000 cases per year
- WHO estimates that about 5-6 million people are infected in Andean and Central America
- Acute and chronic phases of infection occur
- Principally transmitted by infected insects which contaminate fruits under inadequate harvest, transport, storage and manufacturing conditions
- Where Chagas' is endemic, it should now be considered a potential foodborne disease



J. Food Protect. (72):441-446; Pereira et al., 2009

Volume 15, Number 4–April 2009

EMERGING INFECTIOUS DISEASES®

Dispatch

Oral Transmission of Chagas Disease by Consumption of Açaí Palm Fruit, Brazil

Aglaêr A. Nóbrega, Marcio H. Garcia, Erica Tatto, Marcos T. Obara, Elenild Costa, Jeremy Sobel, and Wildo N. Araujo
Author affiliations: Brazilian Ministry of Health, Brasília, Brazil (A.A. Nóbrega, M.H. Garcia, E. Tatto, M.T. Obara, W.N. Araujo); Secretariat of Public Health, Belem, Brazil (E. Costa); Centers for Disease Control and Prevention, Atlanta, Georgia, USA (J. Sobel); and Gonçalo Muniz Institute, Salvador, Brazil (W.N. Arau

Suggested citation for this article

Abstract
In 2006, a total of 178 cases of acute Chagas disease were reported from the Amazonian state of Pará, Brazil. Eleven occurred in Barcarena and were confirmed by visualization of parasites on blood smears. Using cohort and case–control studies, we implicated oral transmission by consumption of açaí palm fruit.

Ebola Reston

World Health Organization

Ebola Reston in pigs and humans in the Philippines

3 February 2009 -- On 23 January 2009, the Government of the Philippines announced that a person thought to have come in contact with sick pigs had tested positive for Ebola Reston Virus (ERV) antibodies (IgG). On 30 January 2009 the Government announced that a further four individuals had been found positive for ERV antibodies: two farm workers in Bulacan and one farm worker in Pangasinan - the two farms currently under quarantine in northern Luzon because of ERV infection was found in pigs - and one butcher from a slaughterhouse in Pangasinan. The person announced on 23 January to have tested positive for ERV antibodies is reported to be a backyard pig farmer from Valenzuela City - a neighbourhood within Metro Manila.

The Philippine Department of Health has said that the people who tested positive appear to be in good health and have not suffered from any significant illnesses in the past 12 months. The investigation team reported that it was possible that all 5 individuals had been exposed to the virus as a result of direct contact with sick pigs. The use of personal protective equipment (PPE) is not common practice among these animal handlers.

From these observations and previous studies of ERV, the virus has shown it can be transmitted to humans, without resulting in illness. However, the evidence available relates only to healthy adults and it would be premature to conclude the health effects of the virus on all population groups. The threat to human health is likely to be low for healthy adults but is unknown for all other population groups, such as immuno-compromised persons, persons with underlying medical conditions, pregnant women and children.

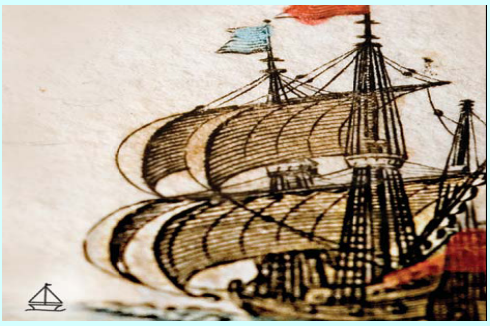
Health Canada Santé Canada

The Unknown

- Unknown etiology for 80% of foodborne illnesses; 64% of deaths
- Detection methods, long incubation, toxins
- 1978 – new disease identified every 10-15 years
- 1988 – new disease identified every 8-9 years
- **Today – new disease identified every 14-16 months**

Sources: Mead et al., 1999; Cynthia Johnson, USDA, from Emerging Animal Health Issues Identification and Analysis Training Course, Ottawa, Sept 15, 2006

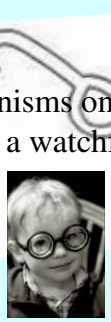
Health Canada Santé Canada



Small boat represents the **Known Biological Diversity** while the great, complex ship represents the number of **Unknown Microbial Species!**

American Academy of Microbiology, 2008

6. Organisms on which to keep a watchful eye



Organisms to Watch

- *Laribacter hongkongensis*
- *Plesiomonas shigelloides*
- *Cronobacter* spp.
- *Mycobacterium avium* subsp. *paratuberculosis*
- *Streptococcus zooepidemicus/S. suis*
- *Campylobacter concisus*
- *Hafnia alvei*
- *Escherichia albertii*
- *Helicobacter pullorum*
- *Enterocytozoon bieneusi*

Concluding thoughts

- Continue to be evolutionary conflicts between rapidly evolving and adapting foodborne pathogens and their slowly evolving hosts
- Compounded by a backdrop of environmental and behavioural changes
- These changes provide new ecological niches into which evolving microbes can easily fit and prosper
- Must do more to try and keep one step ahead

Morens et al., 2004

Nothing microbes do, whether under the duress imposed by antimicrobials or from some less evident pressure, should surprise us. It's their world; we only live in it.

-Sepkowitz. K.A.

Health Canada Santé Canada