Current Trends in Salmonella:
Epidemiology, infection and control

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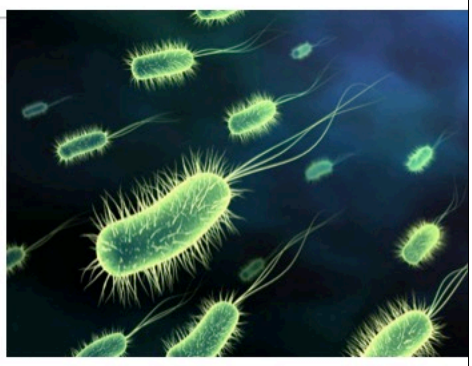
Outline

- Description of *Salmonella* -- classification, sources, physiology, and mode of drug resistance
- Recent outbreaks and recalls linked to *Salmonella*
- Routes of introducing and the dissemination of *Salmonella* in the food chain
- Overview of the *Salmonella* Action Plan and implications to the industry
- On farm interventions
- Processing interventions
- Trends in *Salmonella* diagnostics
- Conclusions and research needs

Salmonella

- Gram negative
- Facultative anaerobe
- Acid tolerant
- Member of Enterobacteriaceae family
- One Species: *S. enterica*
- >2500 serotypes



- 1.2 million cases
- Number 1 cause of bacterial foodborne illness

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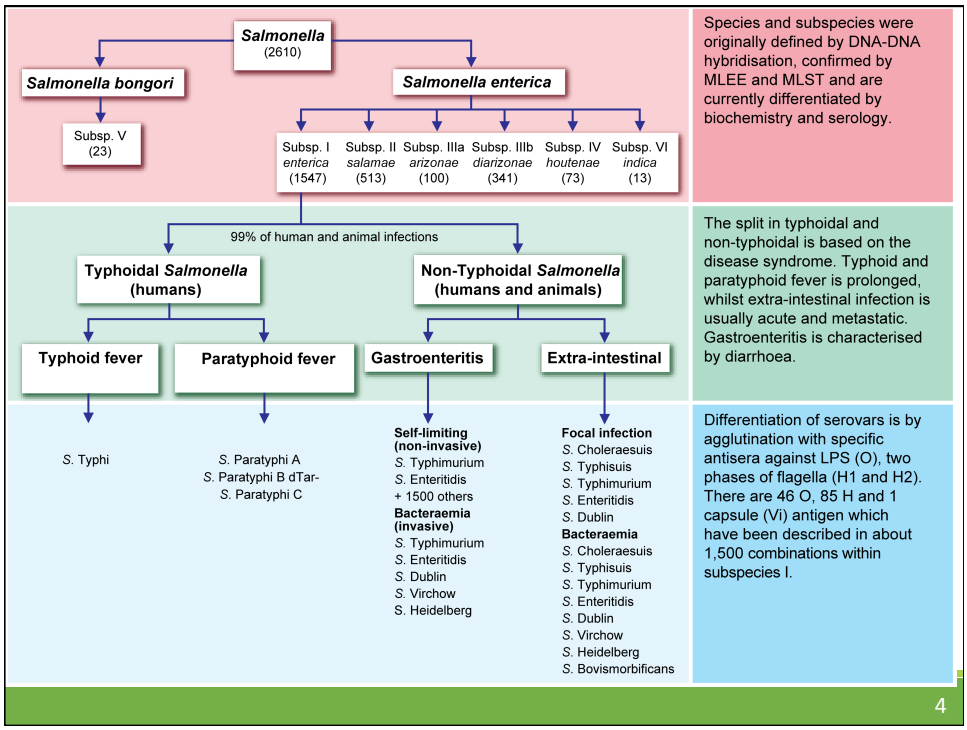

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Rank	Serovar	Number of Cases	Incidence per 100,000
1	Enterititis	1062	2.33
2	Typhimurium	1006	2.17
3	Newport	656	1.44
4	I, 4,[5], 12, i	383	0.79
5	Javiana	347	0.76
6	Heidleberg	243	0.53
7	Montevideo	211	0.46
8	Muenchen	194	0.43
9	Tennessee	140	0.31
10	Saint Paul	117	0.26

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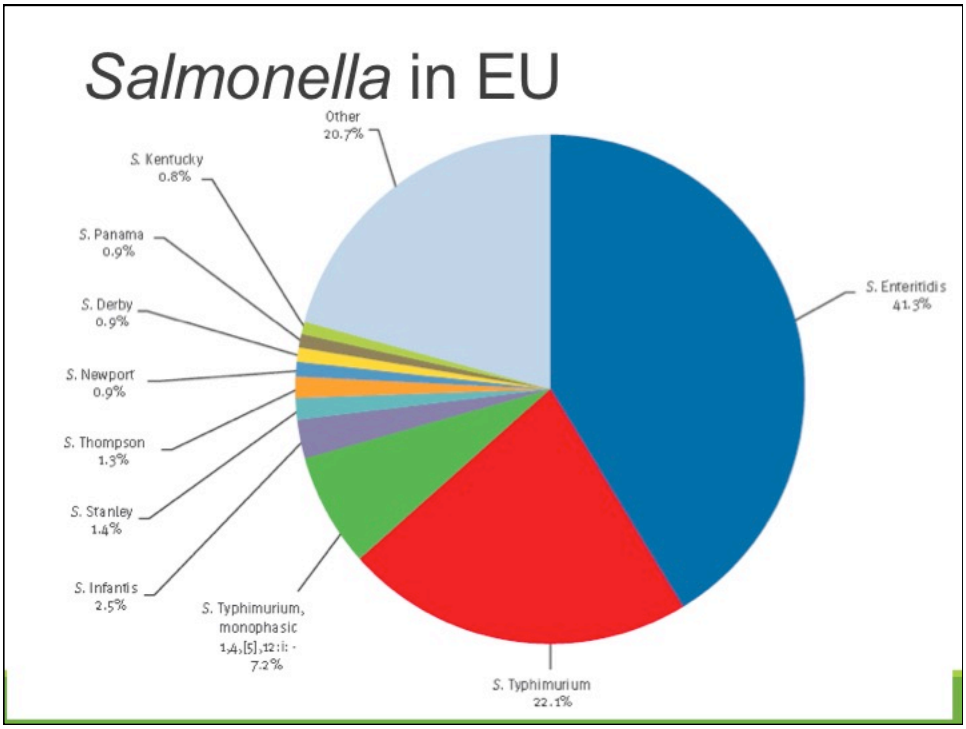
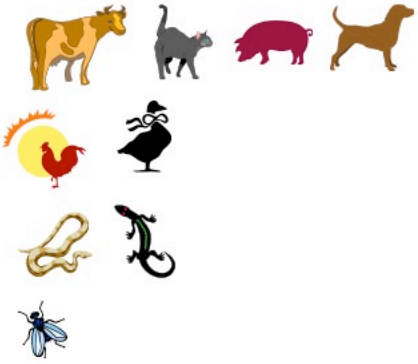


Where does *Salmonella* come from ?

Inhabitant of intestinal tract of

- animals
- birds
- reptiles
- insects



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Asymptomatic Carriage

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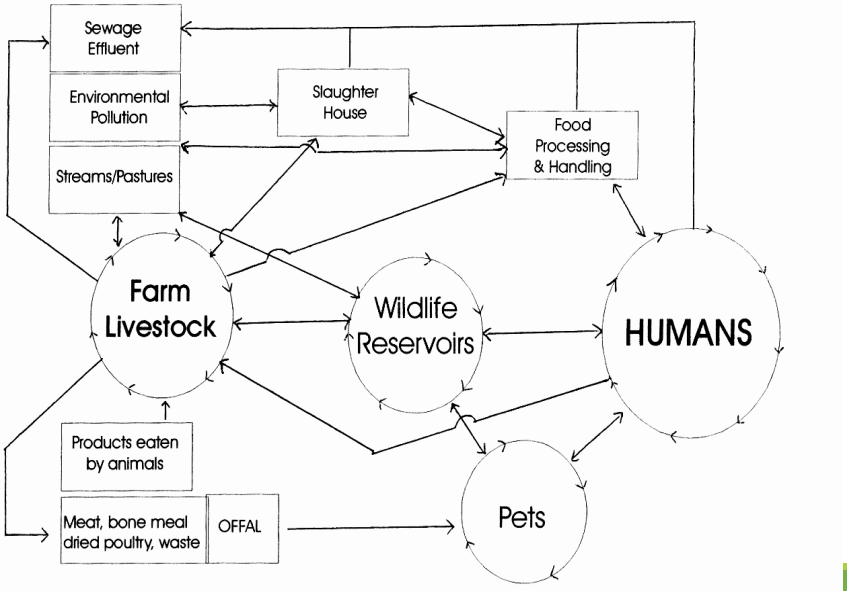
Salmonella Cycling and Recycling



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Pasture and soil ---- 200 days

Garden soil ---- 251 days

Liquid manure --- 27 days (*S*. Dublin), --- 286 days (*S*. Anatum)

Slurry - 84 to 250 days

Infected feces stored in cans - 159 days

(*S*. Dublin)

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Growth Parameters

Temp: 7 – 49°C Opt 37°C Some serovars grow <7°C

pH 3.8 – 9.5 Opt 7.0 – 7.5 (less acid resistant compared to *E. coli*)

Facultative anaerobe: Can grow in presence of 20-80% carbon dioxide.

Water Activity: 0.94-0.99

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Controls

Survives freezing

Thermal resistance is serovar specific

Growth inhibited by 0.1% acetic acid

Irradiation: D 0.5-0.8

Low water activity: enhances *Salmonella* survival and increased thermal resistance

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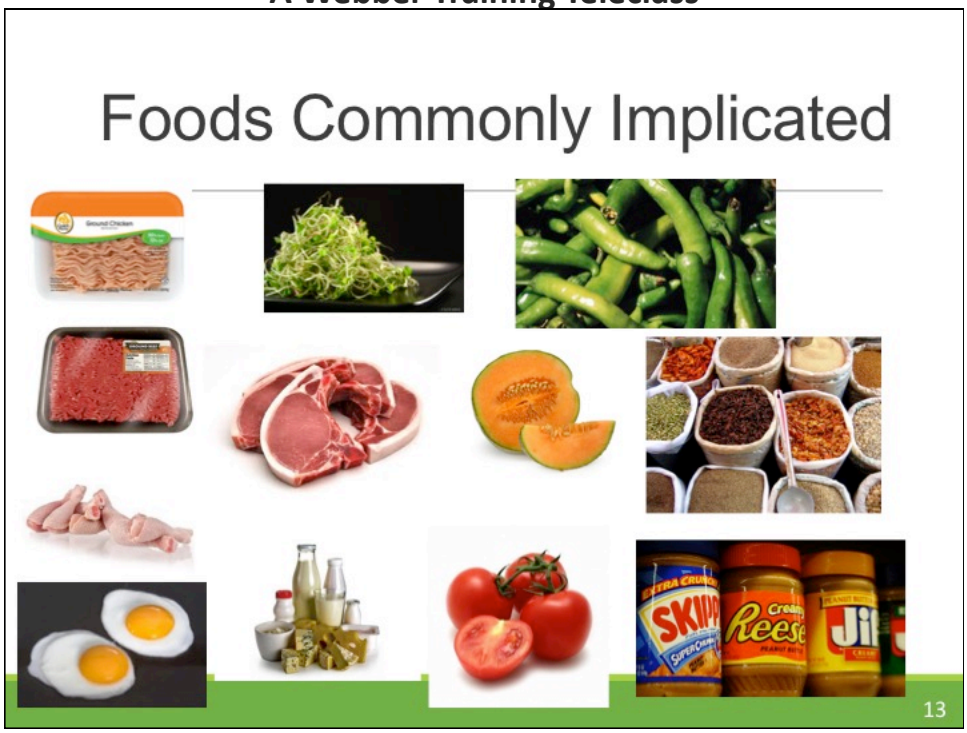
Foods Commonly Implicated
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Pets and Pet Food
RECALL
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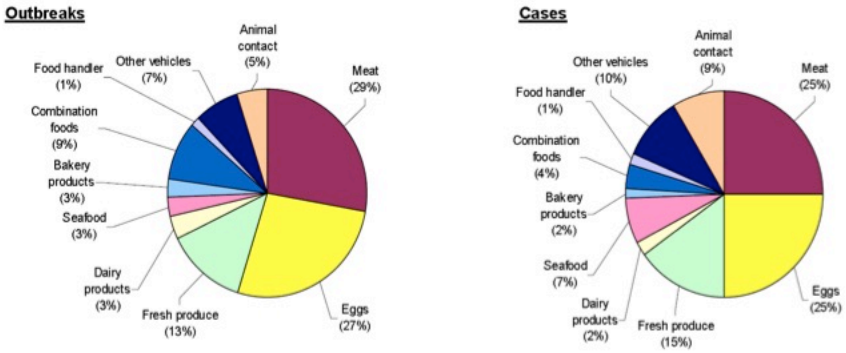
Vehicles for *Salmonella*



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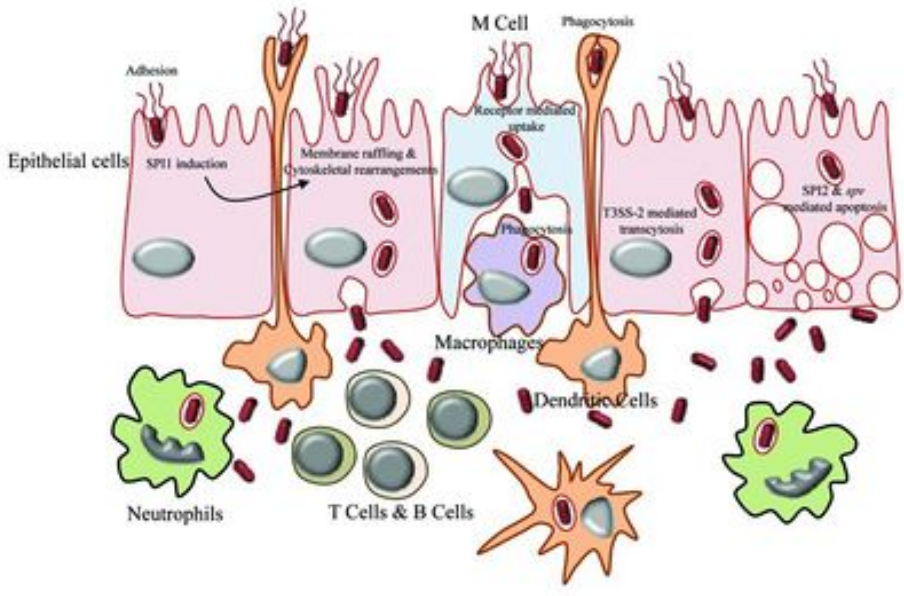

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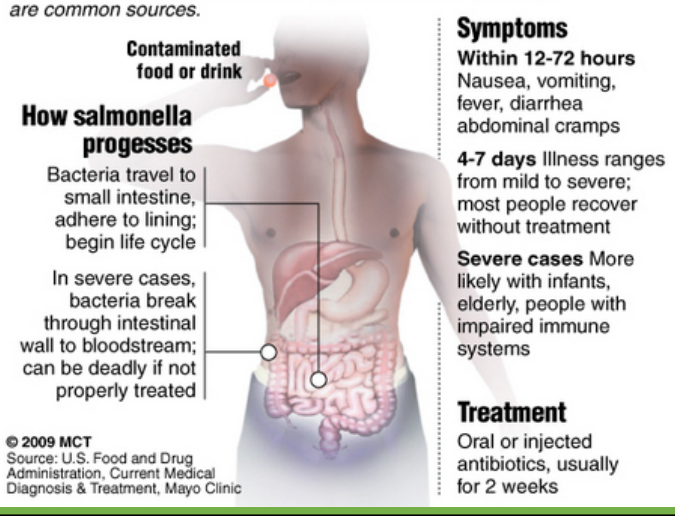
Illness



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Treatment

None: Let infection run its course; fluid replenishment

Antibiotics: Ciprofloxacin for 10-14 days

Antibiotics for immuno-compromised, infants and elderly

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Long Term (secondary) Symptoms

Somatization

Anxiety

Depression

Arthritis

Encephalopathy
- $8m damages

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2014 FOOD SAFETY PROGRESS REPORT

Pathogen	Healthy People 2020 target rate	2014 rate*	Change compared with 2006-2008†	
Campylobacter	8.5	13.45	13% increase	☹
E. coli O157§	0.6	0.92	32% decrease	☺
Listeria	0.2	0.24	No change	😐
Salmonella	11.4	15.45	No change	😐
Vibrio	0.2	0.45	52% increase	☹
Yersinia	0.3	0.28	22% decrease	☺

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

*Culture-confirmed infections per 100,000 population
†2006-2008 were the baseline years used to establish Healthy People 2020 targets
§Shiga toxin-producing *Escherichia coli* O157

For more information, visit www.cdc.gov/foodnet

Selected Outbreaks

Year	Serovar	Number of Cases	Product
2012	Typhimurium	19	Ground Beef
2011	Heidelberg	190	Chicken Livers
2011	Heidelberg	111	Turkey meat
2010	Newport	24	Alfalfa sprouts
2010	Enteritidis	1700	Eggs
2010	Typhimurium	23	Bagged lettuce
2010	Montevideo	204	Pepper
2009	Typhimurium	714	Peanut butter
2009	Saint Paul	235	Alfalfa sprouts
2008	Saint Paul	1400	Tomato/Peppers
2007	Montevideo	37	Chocolate
2007	Typhimurium	167	Pot Pies
2006-2008	Schwarzengrund	32	Dry Pet Food
2002	Poona	46	Melon

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Outbreaks 2014

Serotype	Source	Cases
Stanley	Raw Cashew Cheese	17
Heildelberg	Tyson Chicken	9
Cothan and Kisarawe	Bearded Dragons	150
Infantis and Newport	Live Poultry	251
Typhimurium	Feeder Rodents	41
Newport, Hartford, Oranienburg	Sprouted Chia Powder	21
Typhimurium	Lab Exposure	41
Stanley	Turkey meat	700 (2011-Present)
Typhimurium	Seaweed	19
Enteritidis	Raw Egg	>200
Heidelberg	Foster Farms Raw Poultry	574 (2013-2014)

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Outbreaks 2015

Serotype	Source	Cases
Typhimurium	Restaurant	280
Enteritidis	Breaded poultry	44
Enteritidis	Poultry Entrees US)	24
I, 4, 5, 12:i	Pork (Pig Roast)	90
Enteritidis	Chicks	6
Typhimurium	Pet frogs	200
Paratyphoid	Frozen tuna	62
Typhimurium	Portland Conference	51
Enteritidis	School	175
Newport	Cucumber	780
Enteritidis	Bean Sprouts	115
Infantis	Unknown	34

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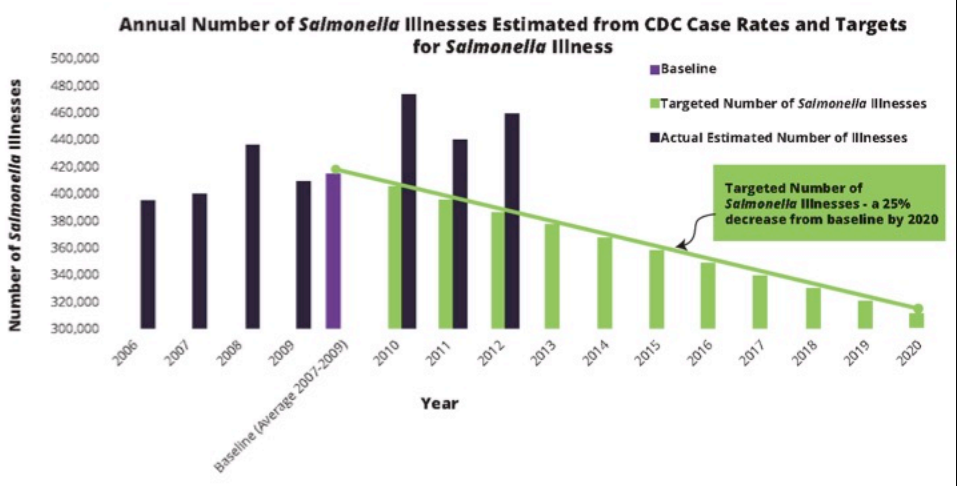

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Foodborne Pathog Dis. 2014 Dec;11(12):974-80. doi: 10.1089/fpd.2014.1802.

Effects of climate change on Salmonella infections.

Akil L[1], Ahmad HA, Reddy RS.

Author information

Abstract

BACKGROUND: Climate change and global warming have been reported to increase spread of foodborne pathogens. To understand these effects on Salmonella infections, modeling approaches such as regression analysis and neural network (NN) were used.

METHODS: Monthly data for Salmonella outbreaks in Mississippi (MS), Tennessee (TN), and Alabama (AL) were analyzed from 2002 to 2011 using analysis of variance and time series analysis. Meteorological data were collected and the correlation with salmonellosis was examined using regression analysis and NN.

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Food Safety Inspection Service Salmonella Action Plan

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Salmonella Action Plan Dec 13

FSIS Strategic Performance Working Group (SPWG)

Proposed Poultry Slaughter Rule

Baseline data

New Plant Strategies

Sanitary Dressing of Hogs

Processing Plant Scores

Revise Performance Standards

Salmonella associated with lymph nodes and interventions

Outreach and Education

Final Rule approved – Aug 2014

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Poultry Products Inspection Act (1968)

HACCP

Sanitation Standard Operating Procedure

Generic *Escherichia coli* testing: Trend analysis

Salmonella performance standards

Inspection (Postmortem)

- Head
- Viscera
- Carcass

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Verification Testing in Poultry Processing

One carcass per day for 51 consecutive processing days

Carcass rinse

>13 positive indicates failure

Provide 30 days to correct

Failure for second sampling: Write a corrective action plan

Third failure: Withdraw inspection – plant closure

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Salmonella Performance Standards

- FSIS 2011
- Carcass rinse or sponge samples
- 5 positive/51 carcasses Chicken
- 4 positive/56 for turkey

- Cat 3: Failure to meet standard >7.5% Positives
- Cat 2: Meet Standard 7.5% Positives
- Cat 1: Exceed Standard <7.5% Positives

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Poultry Slaughter Rule

Processing plant personnel to inspect carcasses: Verified by FSIS

Reduce FSIS inspectors (one per line)

Inspectors to verify off-line activities (documentation, sanitation)

Permit faster line speeds

Abolish Finished Product Standards: Ready to Cook Poultry Standards

More efficient FSIS inspection

Finished Product Standards

- Stop Generic *E. coli* testing
- Poor indicator for presence of Salmonella

Ready to Cook Poultry Standards

Sample at points at CCP's

Processor must establish sample frequency and target

Standards to be established

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Sampling Activities

FSIS Annual Sampling Plan Microbiological and Residual Sampling Program 2014

Establish baseline for comminuted poultry and parts

Testing ground beef for *Salmonella*, in addition to STEC

Develop *Salmonella* sampling plan for raw pork and raw pork products: Currently not performed

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Develop New in Plant Strategies

Identify developing in-plant conditions (i.e. increasing trend of non-compliance, inability to control *Salmonella*)

Categorize plants based on *Salmonella* control performance (C1, C2 and C3): Positing operators names in C2 and C3 classes

Food Safety Assessment of comminuted poultry operations

Extend Hazard Analysis Verification in poultry operations

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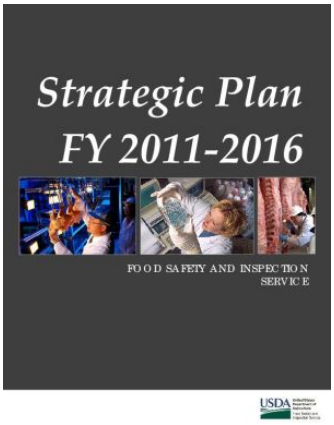
Pre-Harvest Related Activities and Outreach

Identify practices that leads to increased *Salmonella* prevalence

Evidence based interventions

Transparency and closer links with industry

Provide *Salmonella* specific food safety advice to consumers



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Will the Action Plan Work?

Essentially deregulation of poultry industry: Self policing throw back to 1990's

Increased line speeds: Increase efficiency or increased risk?

Failure to address multi-drug resistant *Salmonella*

More focus on testing that introduction of novel decontaminating technologies

Implications for beef and pork processors

Focus on data gathering rather than interventions

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What does it mean to industry?

In theory carriage of *Salmonella* decrease by 4.5%; Save FSIS $90m per year

Greater responsibility of the processor to reduce Salmonella carriage

Cost saving (abolish *E coli* testing)

Increased costs

Extended Salmonella testing (pre- and post chill points)

Interventions

Personnel for inspection

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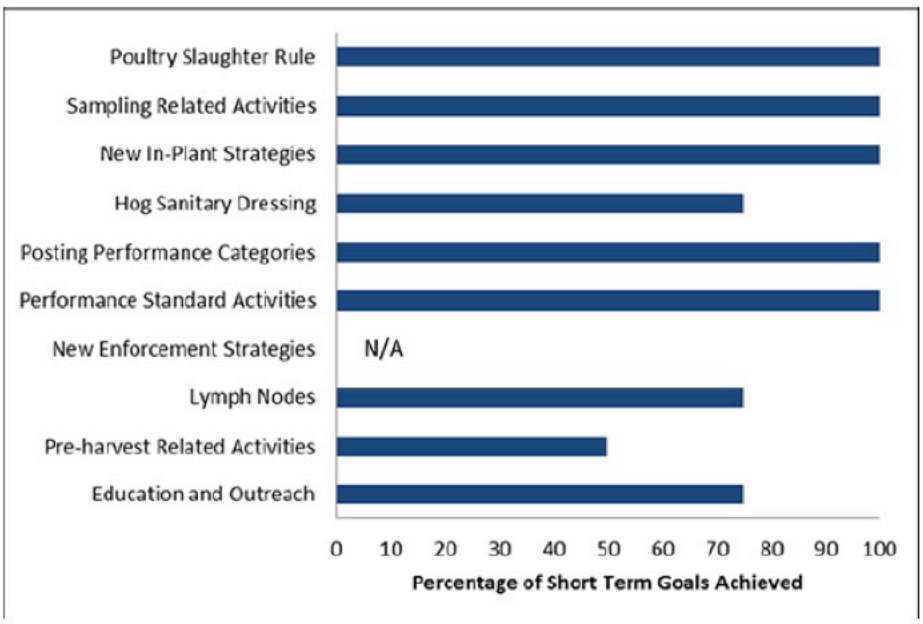

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USDA

Species	*Salmonella* Prevalence 2011	*Salmonella* Prevalence 2012
Steers	0.5%	1.1%
Market bulls and cows	0.8%	0
Poultry	6.5%	4.3%
Ground poultry	30.9%	28%
Pork	3.3%	1.3%

FSIS

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Opening the door for Zero Tolerance for *Salmonella*

- *Salmonella* is not considered an adulterant in meat

Petition to class top 4 serovars as adulterants

- Heildelberg
- Newport
- Hadar
- Typhimurium

- Technically achievable?

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Is Zero Tolerance Achievable?

EU Danish and Swedish models: <1% Salmonella

North America

Centralized and intensive production

Reliance on antimicrobials

Lack of interventions or willingness to adopt

Definition of zero: Depends on diagnostics

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Foster Farms

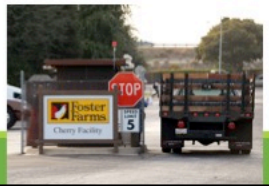
Est 1939 in California by Max and Verda Foster (Poultry and Dairy)

Fully integrated poultry production – processing

Revenue: $2bn

Employ 10, 500

Reputation for quality and innovation



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Foster Farms

On-Farm
- *Salmonella* screening of breeder hens
- Probiotic supplements
- Vaccination
- Biosecurity
- Sanitation

Processing Plant
- Increase sanitation
- In-line conveyor disinfection
- Steam pasteurization
- Anti-microbial washes

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Incidence

1997: Strike due to labor practices

1998: Dumped 11 million gallons manure polluted water into a lake

2013

- *Salmonella* Heidelberg
- 278 cases

Refused to recall

Eventual recall due to insect infestation

Salmonella Hiedelberg

High virulence

Rapid mutation rate

Antibiotic resistant

Strains

B182

SL476

SL486

>700 cases

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Salmonella Heidelberg SL476

- 111 Confirmed Clinical Cases
- 31 States
- Link to ground turkey meat and products
- Recall of 36 million pounds of meat (Production from Feb 2011)

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Multi-Drug Resistant *Salmonella*

- Resistant to two or more antimicrobial agents
  - Plasmid
  - Chromosome
- 3rd generation cephalosporin
- Quinolone
- Fluroquinolone
- Ciprofloxacin
- Nalidixic acid

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Sources of Antibiotic Resistant *Salmonella*

- Widespread use of antibiotics
- Imported foods
- Travel
- Zoonotic

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Antibiotic Usage

- Agriculture: 12 million kg per year
- 5.1 million kg: Pig production
- 5.2 million kg: Poultry production
- 1.6 million kg: Cattle

- Prevent infection
- Compensate for high density of animals and poor sanitation
- Promote growth

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Reasons for Emergence of Antibiotic Resistance in Developing Countries

- Little or no regulation on antibiotic usage
- Poor quality antimicrobial products (low activity)
- Poor infection prevention and control
- Lack of surveillance
- Antibiotics in environment

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Preservation of Antibiotics for Medical Treatment Act

- FDA banned enrofloxacin (fluroquinone) 2005 in poultry production
- Removal of antibiotics from feed: 30 years in the pipeline
- Phase out medicated feed
- Sparing use of antibiotics for treating animals
- No restriction of antibiotics for non-food animals- pets.

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FDA

22nd Dec 2011: FDA withdrew partition

Industry must self-regulate antibiotic use

Ban "non-label use" cephalosporins

- <1% of antibiotics used in agriculture
- Pressure from lobby groups (Dark Money)

Weight of evidence connecting antibiotic use with drug-resistant pathogens
Consumer groups taking legal action against FDA
Guidance 209: Antibiotics should not be used for growth promotion

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Antibiotic-resistant superbugs drive chicken producers to change

Foster Farms raises chickens in facilities like this one in Livingston, California, where the feed processor is based. The company was linked to four salmonella outbreaks from 2004 to 2014. In the last, dominated by antibiotic-resistant strains, the hospitalization rate was nearly double the usual. (Bill Mattos/California Poultry Federation)

Most Read

Presidential candidate Bernie Sanders speaks at Portland rally

Suicide from downtown

COSTCO WHOLESALE

HARVEY'S

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Health Canada

Ban antibiotics as growth promoters July 2014

No change on disease prevention

No significant reduction in antibiotic use

Industry being pro-active at finding alternatives

Health Canada Santé Canada

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How to Reduce Antibiotic Resistance

- Develop/isolate new antibiotics
- Removal of antibiotics
- Seek alternative antimicrobial agents
- Regulations

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New Antibiotics

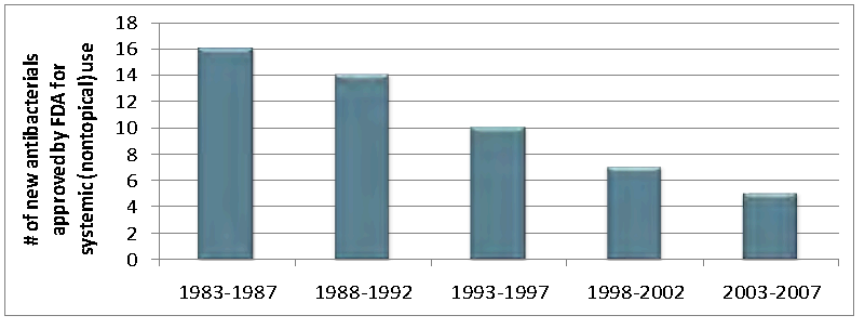

Figure 5. Number of New Antimicrobials Approved by the U.S. FDA between 1983 and 2007

No new class of antibiotics have been discovered in the last 30 years

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Decreasing Antibiotic Resistance

Remove antibiotics from animal production

Denmark

Removal of avoparcin: 80% reduction in vancomycin resistance

Ban of antibiotics as growth promotors

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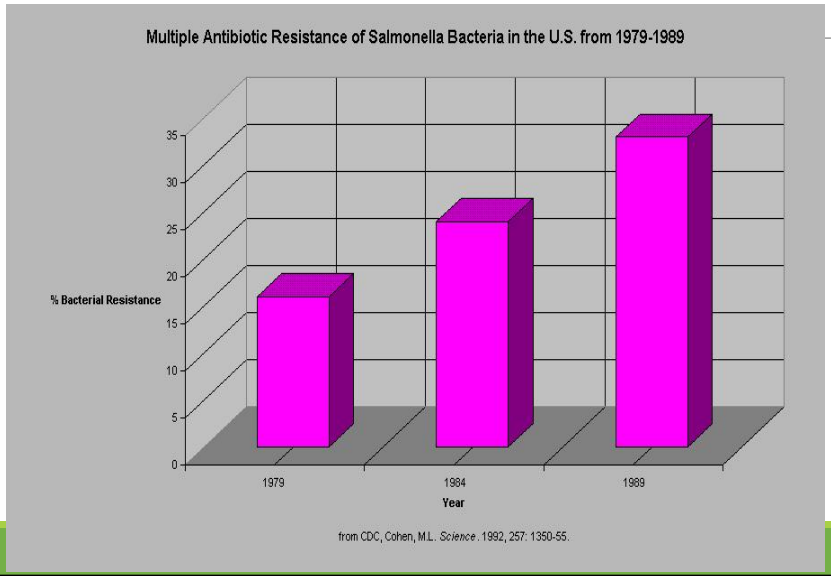
Medicated Feed (Antibiotics)



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Denmark Experiment

- Withdrew mass use of antibiotics in animal production 12 years ago
- Decrease in prevalence of drug resistant Salmonella
- Decreased efficacy in animal production
- Net benefit through increased exports and reduction in health care costs.

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EU Ban

- 2006: Ban on growth promoting antibiotics
- Decrease in avoparcin resistance with no significant effect on animal health
- Long term effects yet to be determined
- Proposal to take all antibiotics (medicated and therapy) out of animal production

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Antibiotic Alternatives

Vaccination

Competitive exclusion

Antimicrobial peptides

Bacteriocins

Natural antimicrobials

Management practice and surveillance

Consumer education

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Vaccination

- Prime immune system to detect multiple drug resistant strains of *Salmonella*
- Oral administration of antibodies
- Cost effective production of antibodies using transgenic plants. ($0.1/g)
- Potential allergic reactions

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Competitive Exclusion

Probiotics

Engineered *E. coli* to detect signaling molecules from pathogens then release of anti-microbial agents

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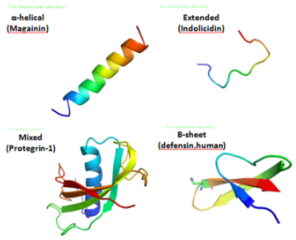
Antimicrobial Peptides

D-amino acid containing peptides: Disrupt cell membranes

Absorb onto pathogen surfaces to block binding

Bind intracellular molecules



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Salmonella Control

Focus on high risk foods

Prevention is key

- Fresh produce (e.g. sprouts and tomatoes)
- Poultry and eggs
- Low moisture foods

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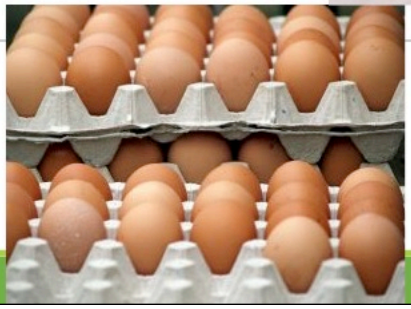
Poultry & Eggs



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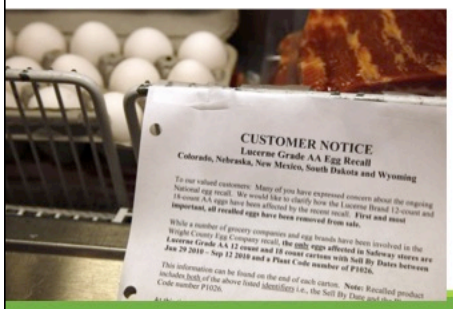
Eggs

UK: 136 cases from Spanish imported eggs

US: >1000 cases 0.5bn eggs recalled



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Salmonella in Poultry - Industry

Broiler hatchery

Broiler grow-out

Breeders

Processing

Rearing breeders

Feed; Equipment; Environment

Parent hatchery

Grandparentstock

Retail

Kitchen

Vertical transmissions | Horizontal transmissions

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Poultry Production

Feed from HACCP certified mills

Pest-control program

Biosecurity (animals, facility equipment, GAP)

Manure management

Vaccination

Competitive exclusion

Medicated Feed

Surveillance

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Manure Management

Compost for at least 120 days

3-12 month period from manure application to planting.

Biosolids < 4 cfu/g *Salmonella* (US); Not detected (Canada).

50 meter separation from open water

Minimize run off

Liquid manure decreases persistence of *Salmonella*.

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Vaccination

Live (attenuated) *Salmonella* spray or dead cells incorporated into feed.

Pork farms: No evidence of benefit

Poultry: Permitted but not applied universally in North America.

UK: Extensive vaccination: SE prevalence <1% of flocks.

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Competitive Exclusion

Pre- and Probiotics

Produce antimicrobials

Biological buffer

Prevent colinization by *Salmonella*

Saccharomyces boulardii produce mannose that inhibits attachment of *Salmonella*

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Surveillance

Sampling buildings: Drag swabs

Boot swabs

Fecal samples

Boxes and other contact surfaces

Incoming chicks: 1 week old

If positive for SE the flock destruction eggs diverted to processing.

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Transovarian Transmission of SE

Salmonella Enteritidis

Contaminates yolk before laying

Sufficient cooking essential

(no sunny side up eggs)

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Egg Handling

Rapid cooling can cause shell fracture

Minimize temperature fluctuations

EU: Maintain eggs <15°C cannot vary more than 4°C throughout handling and distribution

FDA: Maintain <7.2°C

Condensation: Surface growth, increased penetration

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Egg Washing

ADVANTAGES

Improve egg appearance

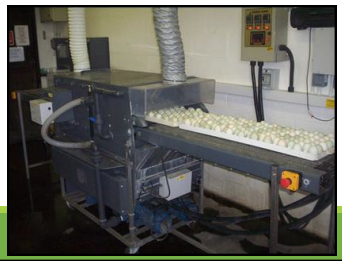
Reduction in surface bacterial counts

DISADVANTAGES

Remove cutical layer

Potential ingress of water into the shell (use warm water)

No conclusive evidence of efficacy to decrease incidence of *Salmonella*



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Alternative Techniques

Gamma irradiation: 1.5 kGy Impact on sensory quality

Microwave 0.75-2 W/g: Problems with scale-up

Hot air: 600°C for 8s. Effective no changes to egg quality 1 log reduction *Salmonella*

Gas plasma*:* 1-5 log reduction Lab based

UV light: Limited efficacy

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Liquid Egg Pasteurization

56 – 60°C (3-4 weeks shelf life)

Dielectric and gamma irradiation

- Reduction in *Salmonella* although changes in functionality

High Hydrostatic Pressure: Cold pasteurization
protein denaturation (minimize by addition salt or adjusting pH to >7.7)
Pulsed Electric Fields: SE tolerant to PEF treatment

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Egg Rule 2010

Clean and disinfect poultry houses that have tested positive for *Salmonella* Enteritidis –

Refrigerate eggs at 7.2°C during storage and transportation no later than 36 hours after the eggs are laid

Egg producers must maintain a written *Salmonella* Enteritidis prevention plan and records documenting their compliance.

Egg producers must also register with the FDA.

Mandatory: July 2012.

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FDA Guidelines

Biosecurity

Reduce cross-contamination

Distances of farms from houses

Time period between depopulation and repopulation

Sanitation

http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodSafety/ucm222469.htm

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Poultry Processing

Scald tank
- Counter current water flow
- Temp >50°C
- Sanitizers (limited selection)

- Chill tanks
- 50 ppm chlorine pH 7 (Only in US)
- Counter-flow
- Fresh water recharging
- Air chilling using ozone

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Carcass Decontamination Methods

Hot water wash: 75-80°C 1-3 log reduction *Salmonella*

Steam pasteurization: 90°C for 12s 3 log reduction in *Salmonella*

Organic acid wash: 2 % lactate 5 log reduction

Ozonated water: negligible efficacy

Irradiation: *Salmonella* more sensitive than *E. coli* D 0.62-0.80.

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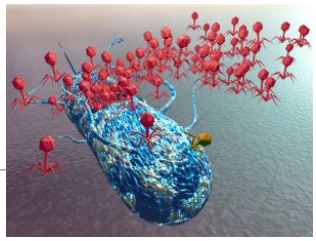
Bacteriophages



- Viruses that infect bacteria
- Specific to Broad host range
- Extensively used in Eastern Europe

- High doses required (MOI)
- Natural equilibrium establishes between host and phage
- Replication in the environment limited
- Resistance
- Possible route to control *Salmonella* in lymph nodes

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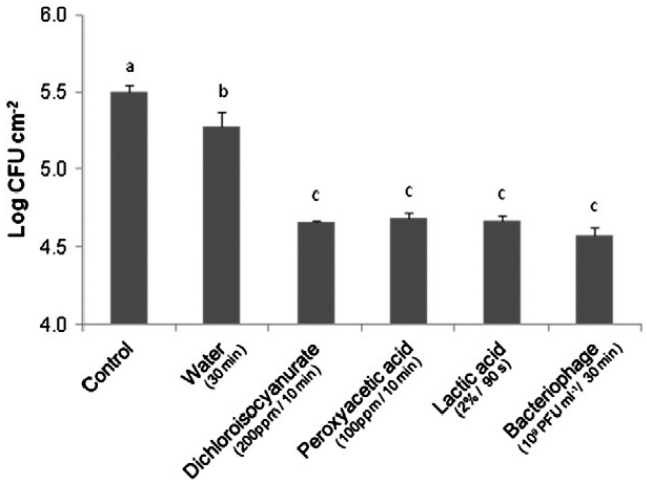
Hide/Skin Treatment

Surface	Target	MOI	Log Reduction	Reference
Cattle Hide	*E. coli* O157	10,000	1.5	Coffey et al., 2003
Poultry	*Campylobacter*	100, 000	2.0	Goode et al 2003
Poultry	*Pseudomonas*	1000	2.0	Greer, 1982
Pig skin	*Salmonella*	10	4.0	Hotton et al., 2011

82

Salmonella bacteriophages on Poultry Skin



Hungaro et al., 2013

83

Chemical Sprays

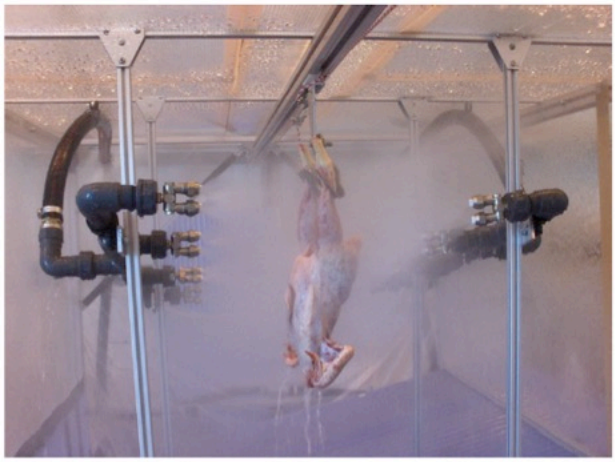
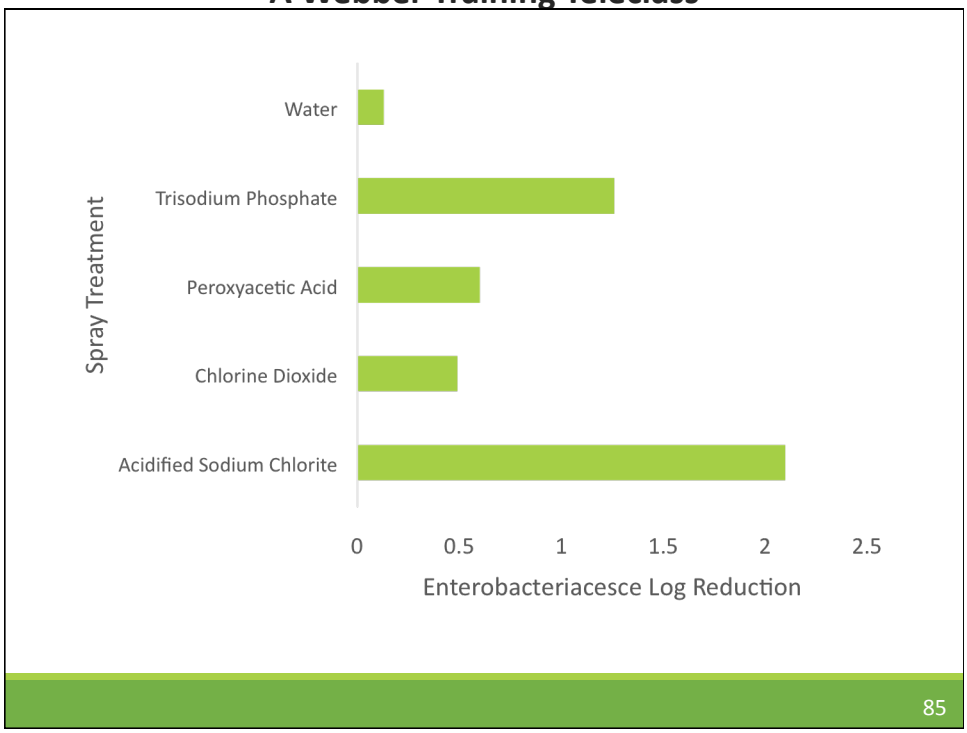


Fig. 2 Carcass during spray treatment

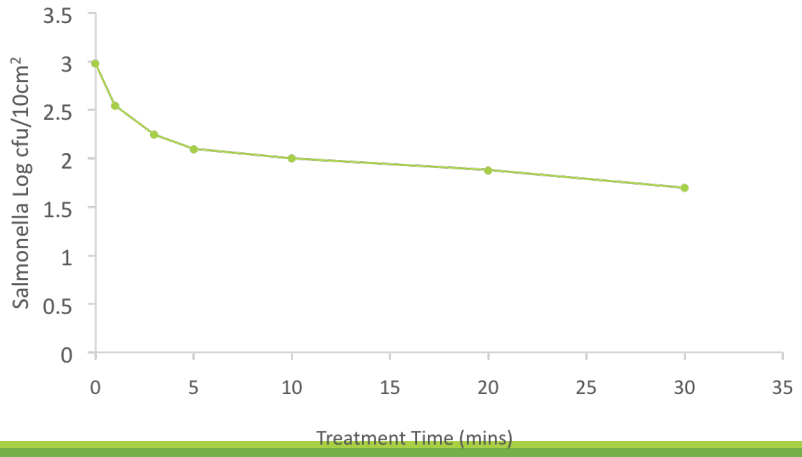
Purnell et al., 2014

84


Water
Trisodium Phosphate
Peroxyacetic Acid
Chlorine Dioxide
Acidified Sodium Chlorite
Spray Treatment
0
0.5
1
1.5
2
2.5
Enterobacteriacesce Log Reduction
85


Chilling
Immersion in hypochlorite (50 ppm) baths: 0.3 – 0.4 log cfu reduction of Enterobacteriaceae
Air chilling: minimal log reduction
Potential cross contamination
Ozone gas
Water Chilled Chicken
The Bell & Evans Air Chill System

Ozone Gas (2000ppm) Chilling of Poultry Carcasses



87

Commercial HPP systems

Hyperbaric

Wave 6000 /55 L – 420 L

Maximum pressure : 600 MPa

Pressure Hold Time: 3 min

Toll facilities

AVURE TECHNOLOGIES

- Lab and industrial
  0.1L – 2 L
  100 L – 687 L
- Toll facilities

88

Sampling and Detection

89

Sampling and Detection

Egg sampling (composite)

Carcass sampling (Carcass rinse)

90

Enumeration and Enrichment

Buffered Peptone Water

37°C 24h

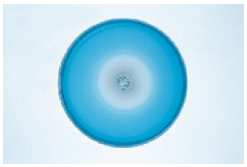
Semi-solid RV Medium

42°C for 16h

XLD agar

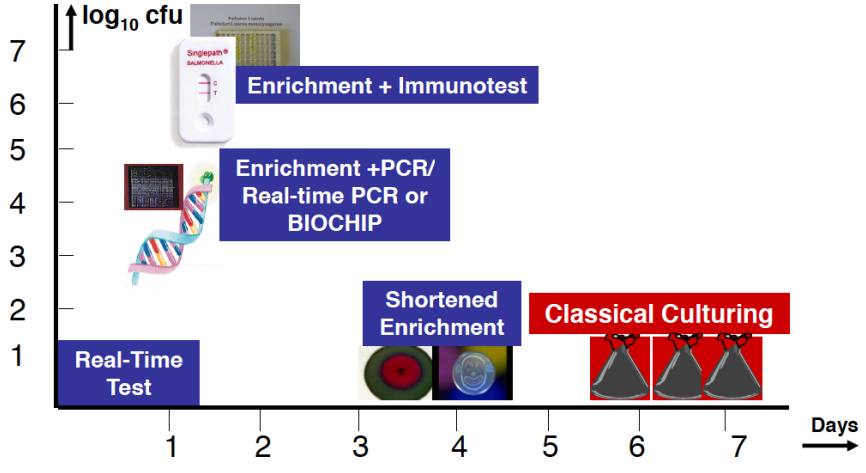
37°C 24h

Confirmation (genetic, Immuno, Physiological test)



91

Overview of Rapid Methods for Sensitivity vs. Time



From Christina Harzman Biotecon diagnostics

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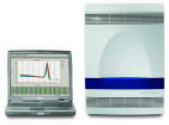
Chromagenic Agar

93

Diagram of TaqMan® *Salmonella* Enteriditis Egg Testing Workflow

Prepare the pre-enrichment of pooled shelled eggs in growth media and allow SE to multiply to detectable levels — 24Hrs

Automated DNA extraction with the MagMax™ Express 96 Instrument with PrepSEQ® NA reagents — 1Hr



Real-time PCR detection with the TaqMan® *Salmonella* Enteritidis Detection Kit on the 7500Fast Instrument — 2Hrs

Result in approximately 27 Hours

94

SureTect *Salmonella*

RT-PCR identification

AOAC approved

Single enrichment

Inclusivity and exclusivity

20 mins analysis time

95

Modular PCR Cyclers

Large Sample throughput

Low cost

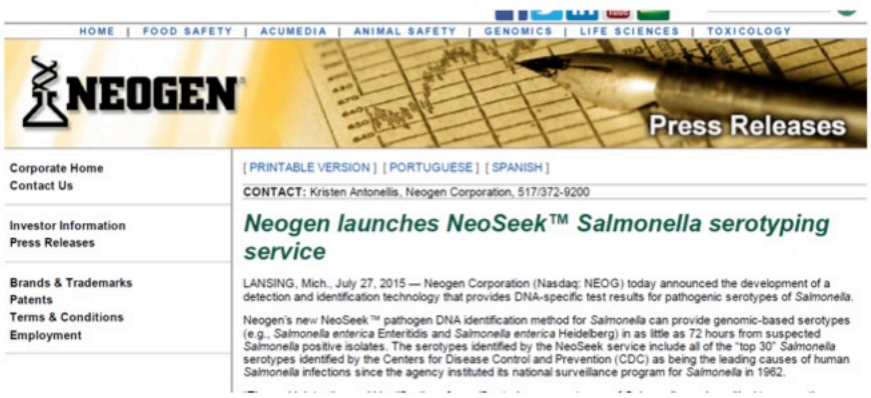
Time to Detection

Combine IMS with PCR

96


Isothermal Amplification
Simplified equipment: No need for thermal cycling
Adaptable to miniaturization
Pathogen testing.
Pure and simple.
97


Bst DNA Polymerase
PPi
PPi
PPi
PPi
APS
ATP-Sulfurylase
ATP
ATP
ATP
ATP
Luciferase
Light
Light
Light
Light
98



99

DNA Typing

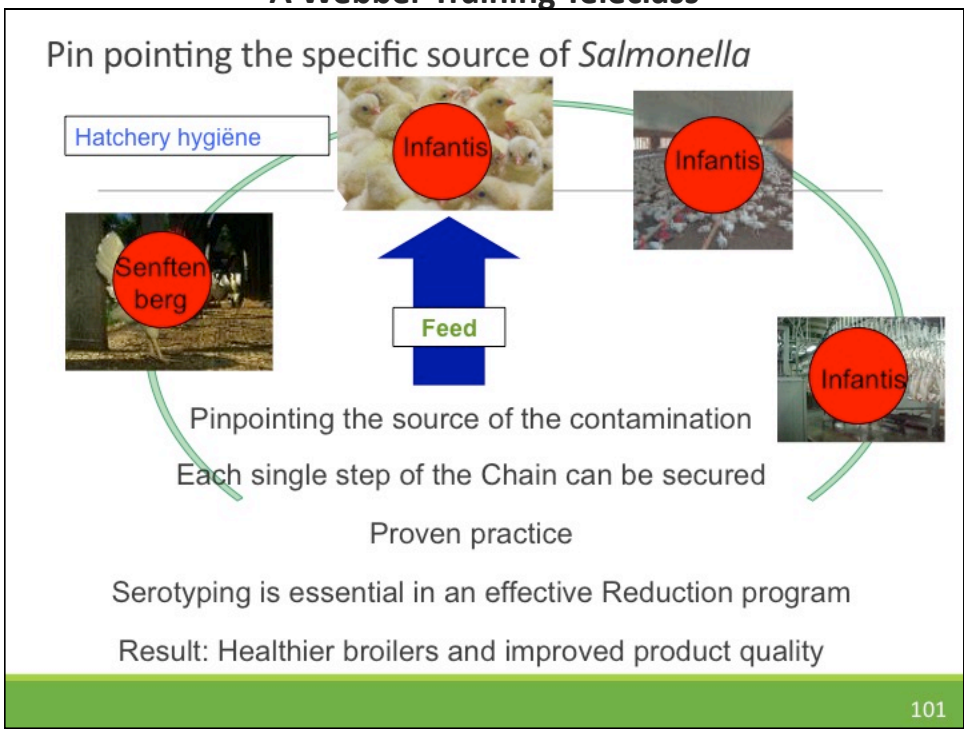
Track origins of *Salmonella*

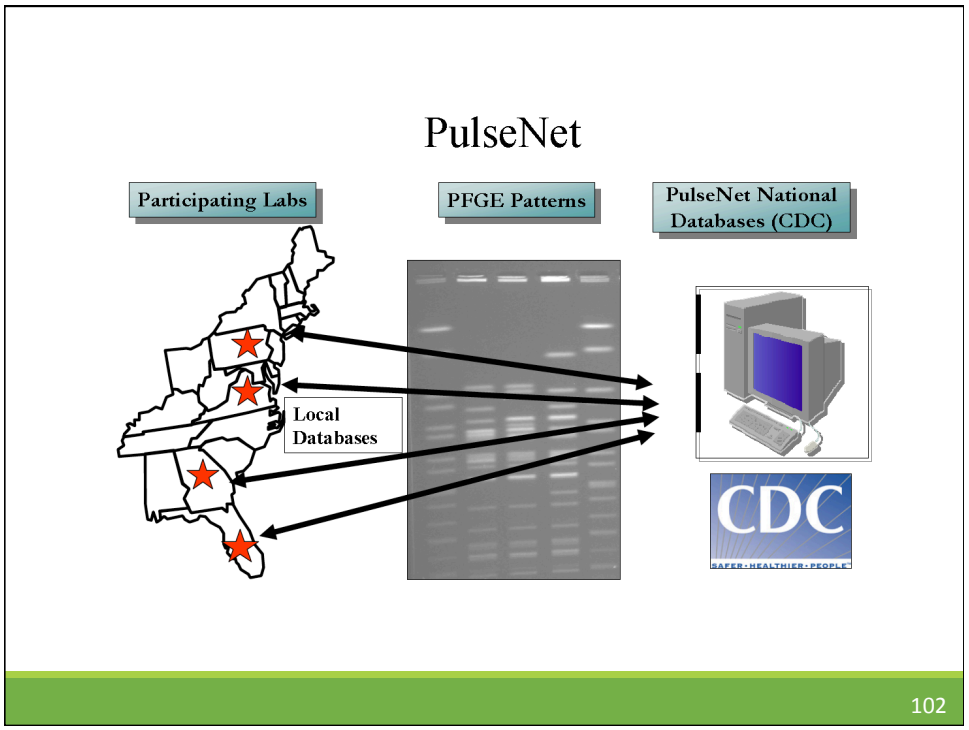
Identify endemic populations

Link between contamination sources

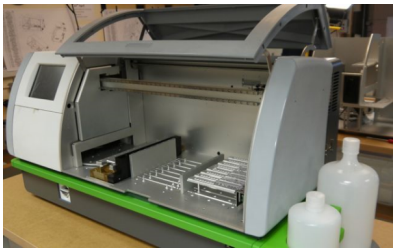
Surveillance

100


Pin pointing the specific source of *Salmonella*
Hatchery hygiëne
Infantis
Infantis
Senften berg
Feed
Infantis
Pinpointing the source of the contamination
Each single step of the Chain can be secured
Proven practice
Serotyping is essential in an effective Reduction program
Result: Healthier broilers and improved product quality
101


PulseNet
Participating Labs
PFGE Patterns
PulseNet National Databases (CDC)
Local Databases
CDC
102

PathoGenetix's Genome Sequence Scanning



10 million bases per second

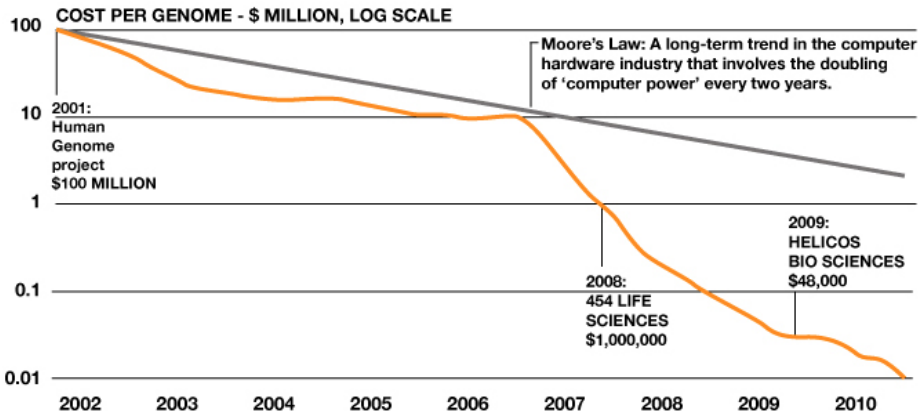
5 h assay (40 samples per 24 h)

No specific target pathogen

Current being evaluated by CDC ($40m project)

103

DNA sequencing costs have gone down



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Almost $10 million for salmonella research

Last upd

News

Genomic research to identify Salmonella strains that cause human disease

PUBLISHED: 21 JUL 2015

Poultry used to be the usual suspect in cases of Salmonella poisoning. Today, however, most outbreaks of the illness come from fruit and vegetables that have become infected when the soil in which they grow is polluted by animal waste or non-potable water. There currently is no method of reducing the growth of Salmonella on such produce.

Poultry used to be the usual suspect in cases of Salmonella poisoning. Today, however, most outbreaks of the illness come from fruit and vegetables that have become infected when the soil in which they grow is

105

Consumer Education

Sanitation

Food storage

Minimize cross-contamination events

Thermometers to verify adequate cooking

106

Food Standards Agency UK

Don't wash chicken

Coordinated media campaign

- Public health units
- TV
- News outlets
- Twitter
- Facebook
- National and International

>20 million goggle hits

Simple message but reinforced

107

Conclusions

Salmonella remains a key foodborne pathogen

Adaptable and high virulence

Broad range of food types affected

Multi-drug resistance needs to be addressed

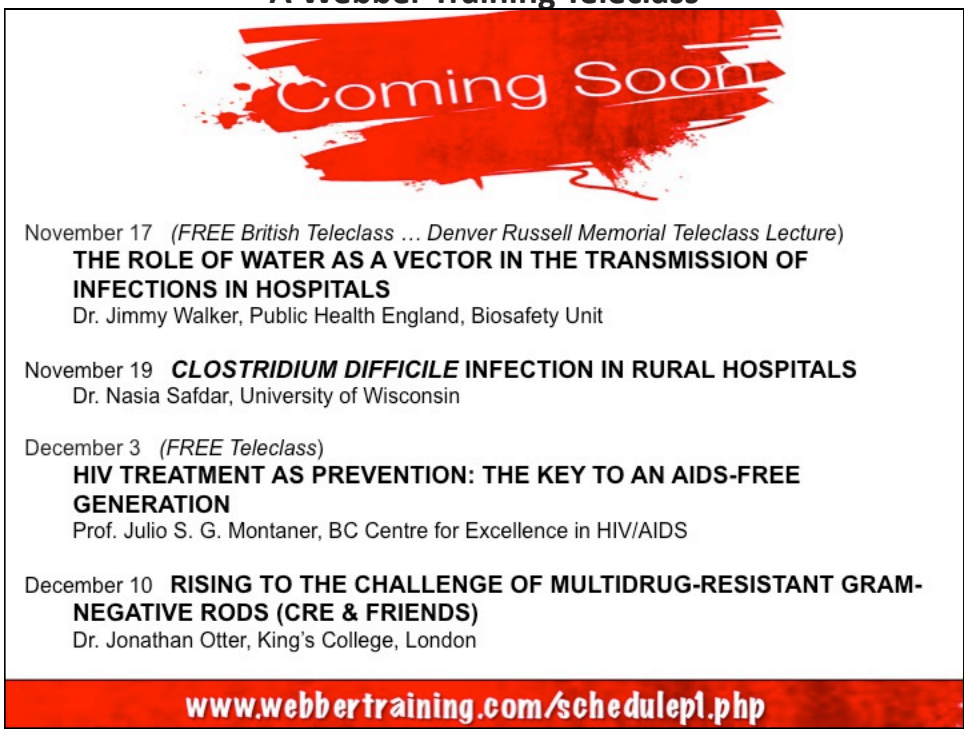
Interventions and diagnostics available

Is FSIS Strategic Plan going to work?

Can *Salmonella* be eliminated?

108

Current Trends in Salmonella: Epidemiology, infection and control
Dr. Keith Warriner, University of Guelph
A Webber Training Teleclass



Hosted by Nicole Kenny, Virox Technologies Inc.
www.webbertraining.com

Current Trends in Salmonella: Epidemiology, infection and control
Dr. Keith Warriner, University of Guelph
A Webber Training Teleclass

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