Salmonella Enteritidis: Control and Eradication

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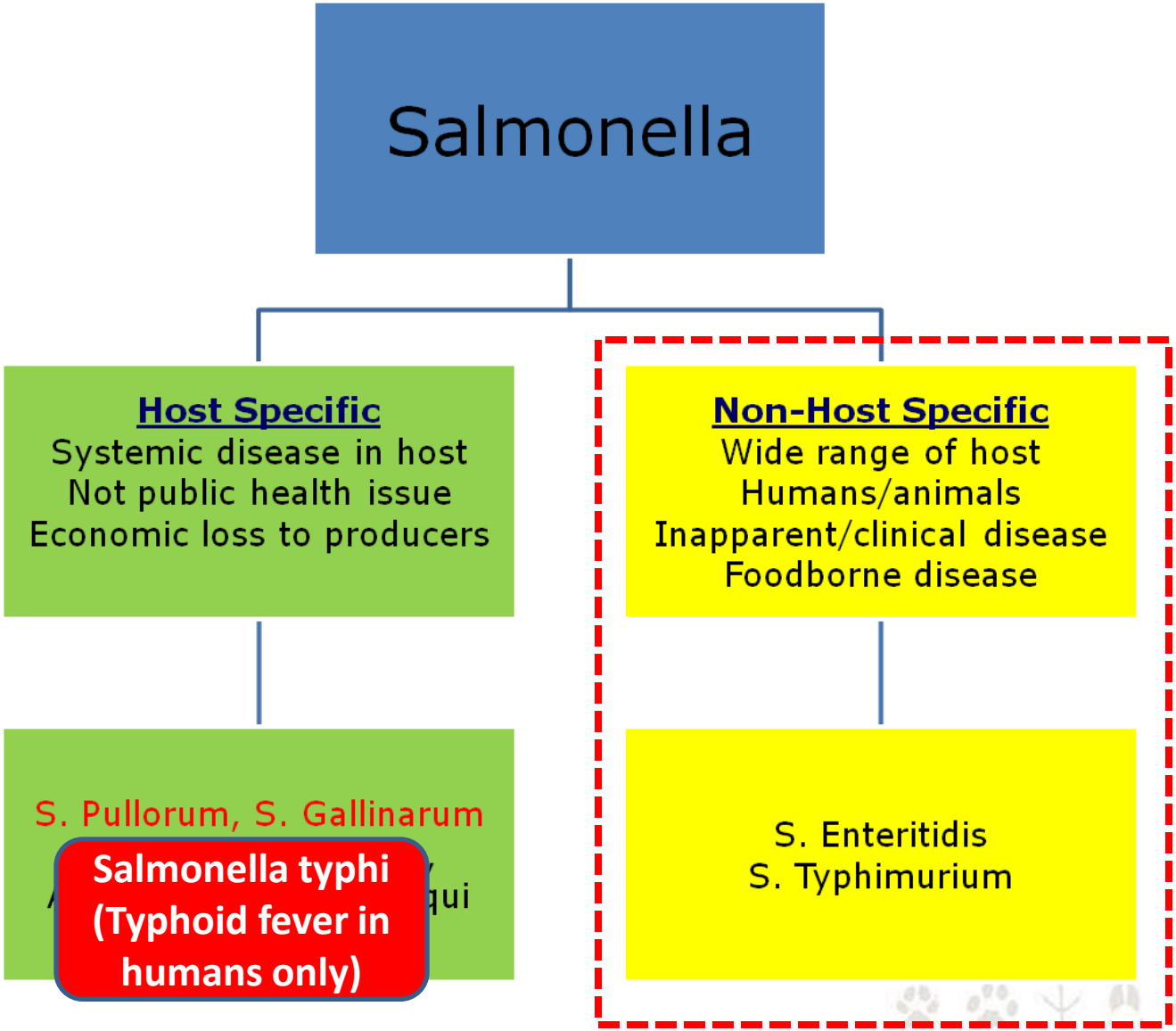
Merial Asia

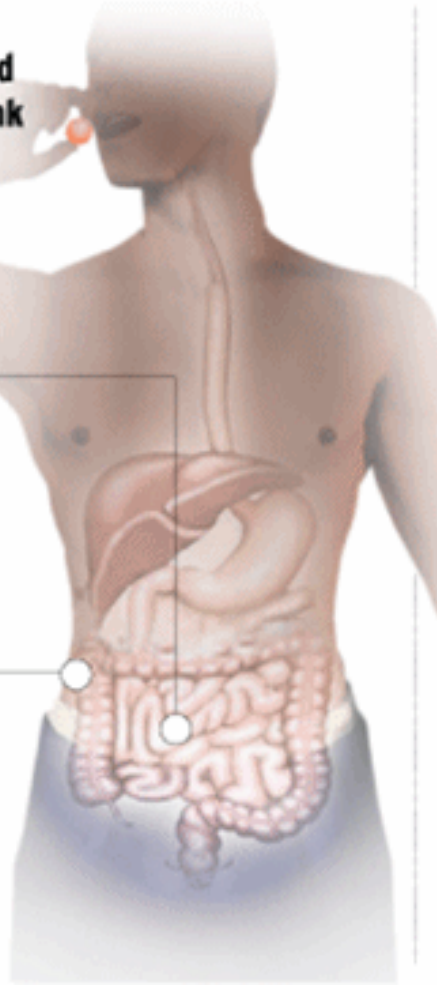
23rd Sept 2015

Epidemiological groups



Salmonella infection

Almost any kind of food or beverage can carry the bacteria that causes salmonella infection, although meat and eggs the most are common sources.



Symptoms

Within 12-72 hours Nausea, vomiting, fever, diarrhea abdominal cramps

4-7 days Illness ranges from mild to severe; most people recover without treatment

Severe cases More likely with infants, elderly, people with impaired immune systems

Treatment

Oral or injected antibiotics, usually for 2 weeks

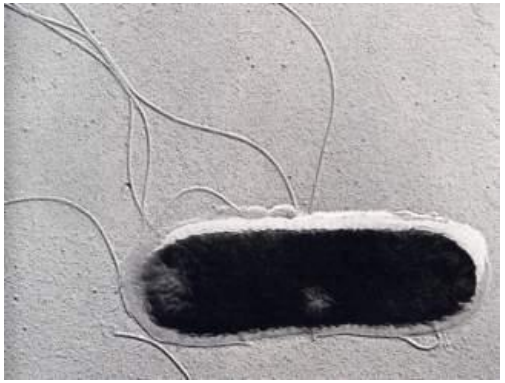
Source: U.S. Food and Drug Administration, Current Medical Diagnosis & Treatment, Mayo Clinic

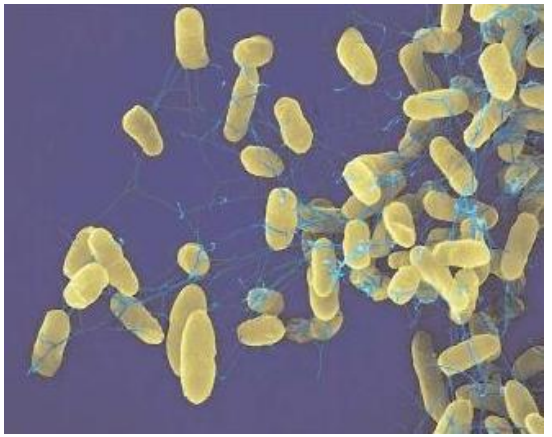
McClatchy-Tribune

Source: US FDA

Salmonella Enteritidis

- Gram-negative bacteria
- Non-sporing rods
- No capsule.
- Motile
- Long flagella.
- Can survive several months away from the host.





Zoonotic Salmonella epidemiology

- Common asymptomatic colonization in the gut of chickens
- Chicken and chicken products are the most frequent sources of zoonosis
- Eggs: Shell contamination / Internal (SE)
- S. Enteritidis (SE) and S. Typhimurium (ST) are the serovars most frequently associated with non-typhoidal salmonellosis in humans through the food chain

Salmonella Epidemiology

- Many biological reservoirs and vectors
- Resistant in the environment
- Feed can be a source of contamination
- Several routes of infection:
  - Vertical transmission (SE)
  - Oral infection / inhalation (rare)

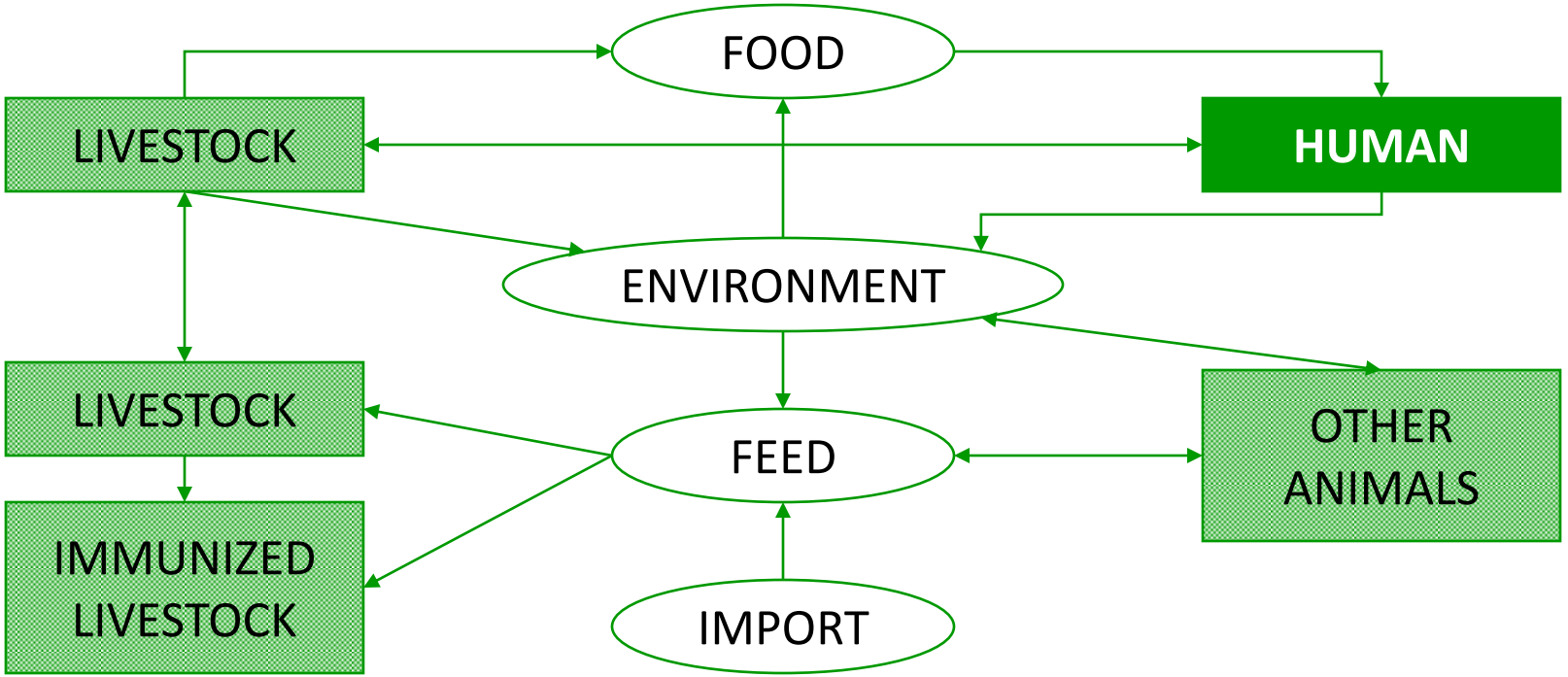
TRANSMISSION

- VERTICAL TRANSMISSION
  - Directly through the Ovary and/or the Oviduct .
  - Shell contamination at the point of laying
  - Shell contamination from the environment

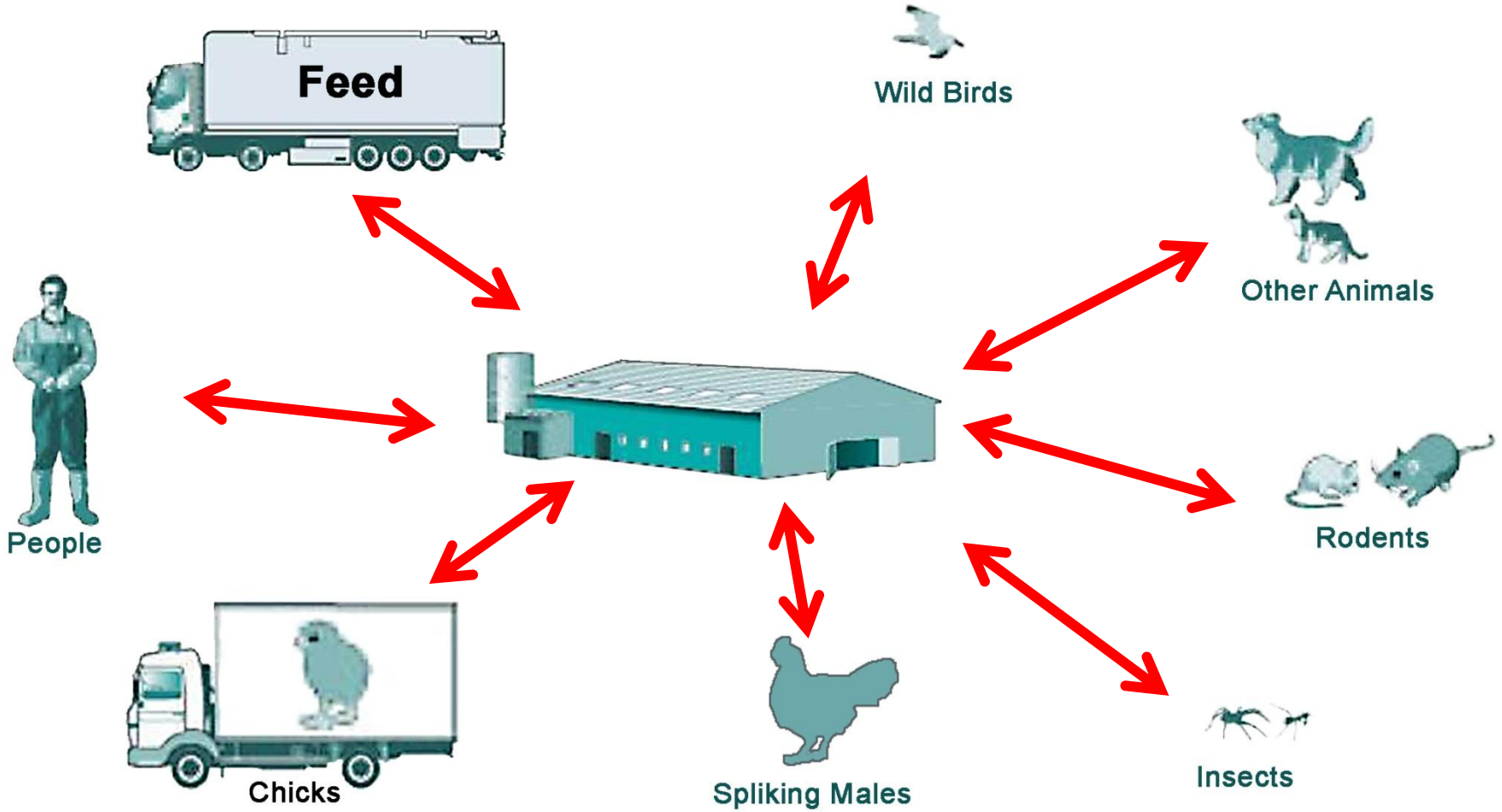
- HORIZONTAL TRANSMISSION
  - Lateral spread in hatchery
  - Direct bird-to-bird contact
  - Litter, feed, water
  - Personnel, equipment
  - Insects- flies, cockroaches, darkling beetles
  - Rodents (amplifiers)
  - Other animals

Epidemiological chains Non-host specific *Salmonella*

Non adapted *Salmonella* serovars produce infectious chains which are hard to survey and to control due to **their broad host spectrum** and their **relatively great resistance in the environment**



Salmonella Introduction into a Farm



S. Enteritidis Control Program

- The main objective of a comprehensive SE control program is to minimise or eliminate the risk of contamination of poultry meat and eggs

Farm Intervention- Biosecurity

- Prevent introduction/spread of SE among poultry houses
- Salmonella free chicks!
- Traffic- feed trucks, visitors
- Employees not allowed to keep birds at home

Farm Intervention-
Keep Other Animals Out

Farm Intervention- Cleaning and Disinfection

- All In All Out system (broilers/breeders)
- Terminal cleaning and disinfection
- Adequate downtime
- Prevents the gradual buildup of pathogens in the farm

Farm Intervention- Rodents & Vermin Control

- Keep farm surrounding clean- debris and dense vegetation harbor pests.
- Monitor vermin levels
- Take appropriate action if levels unacceptable

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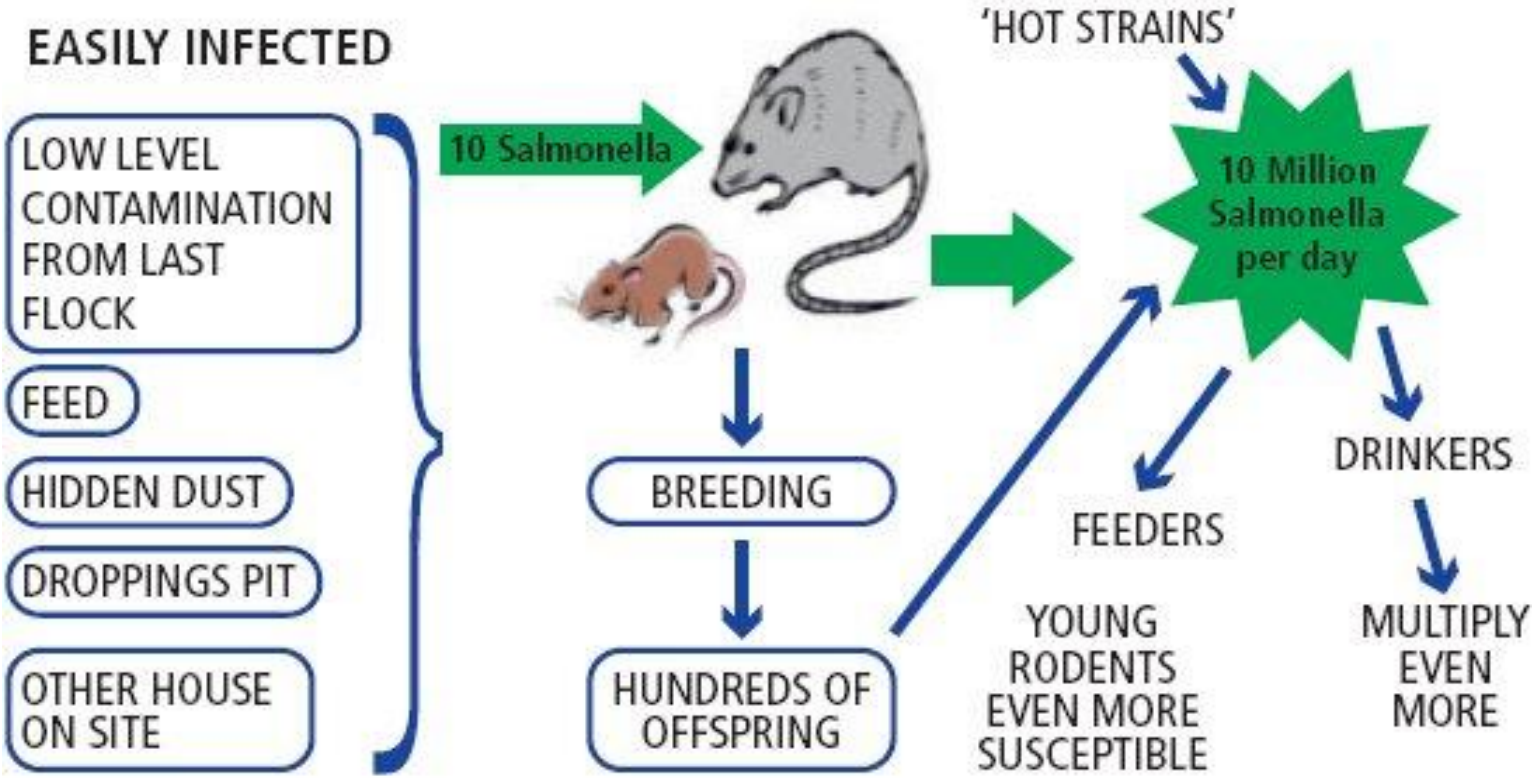


Source: DEFRA, UK

Feed

- Contaminated raw feed ingredients
  - Feed treatment
- Contaminated in Feedmill
  - Vermins, feed sacks, trucks etc.
- Contaminated in farm
  - Proper storage

Feed Treatment

- Chemical treatment
  - Organic acids
- Heat treatment
  - 75-80°C for 10-12 min or 80-85°C for 4-5 min at 15-16% humidity
- Irradiation

Vaccination

1. Increasing the resistance of the chicken against infection
2. Prevent clinical signs and mortality
3. Reduces excretion and transmission

Vaccination

1. Increasing the resistance of the chicken against infection
2. ~~Prevent clinical signs and mortality~~
3. Reduces excretion and transmission
   - Transovarian transmission
   - Reduction in colonization of intestines >> less faecal excretion and contamination

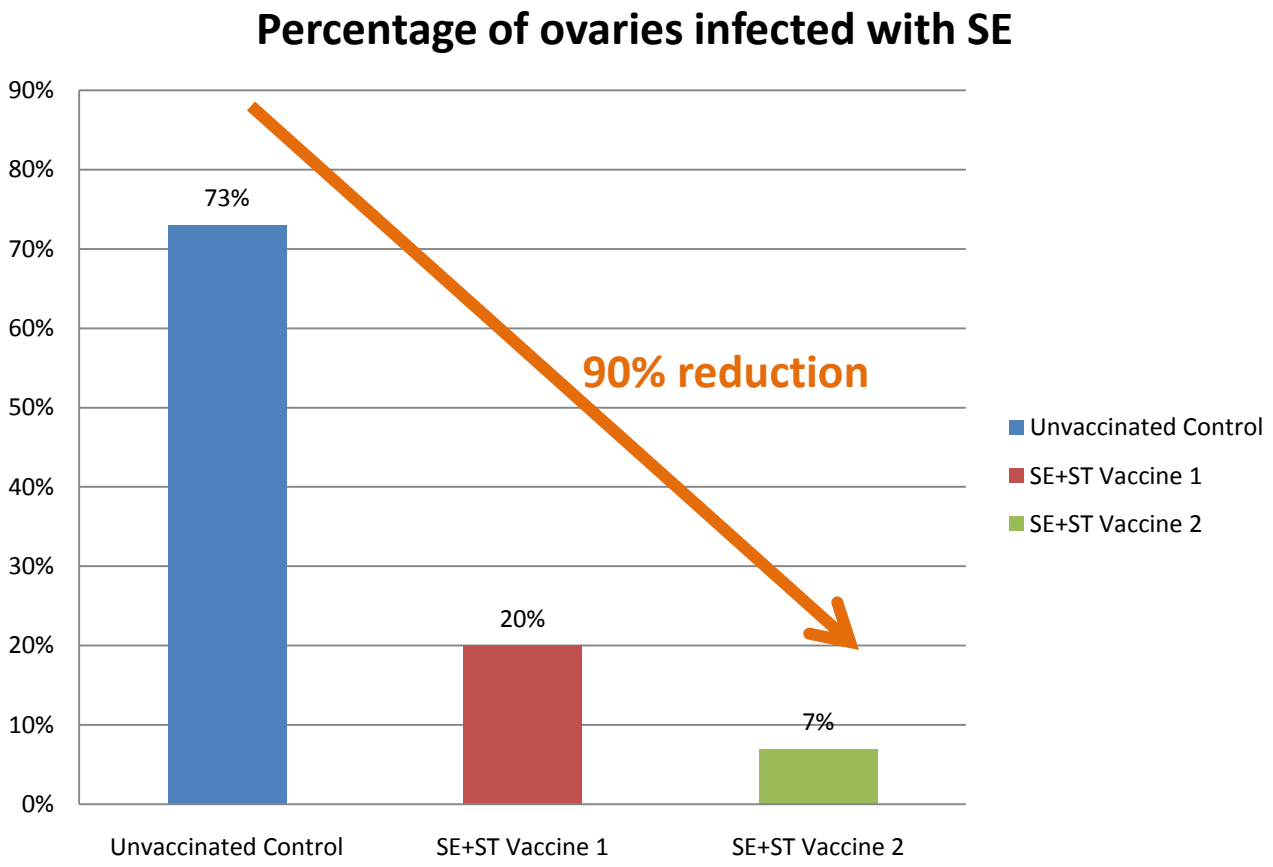
Vaccination- Live Vaccines

- Attenuated avirulent mutant strains
- Genes deletion or chemical mutagenesis
- Usually 2 or 3 vaccinations
- Immunisation via natural route can lead to early colonization of gut in young chicks
- Binds to receptor sites- Competitive exclusion
- Must be ability to differentiate from wild strains (Monitoring)

Vaccination- Killed Vaccines

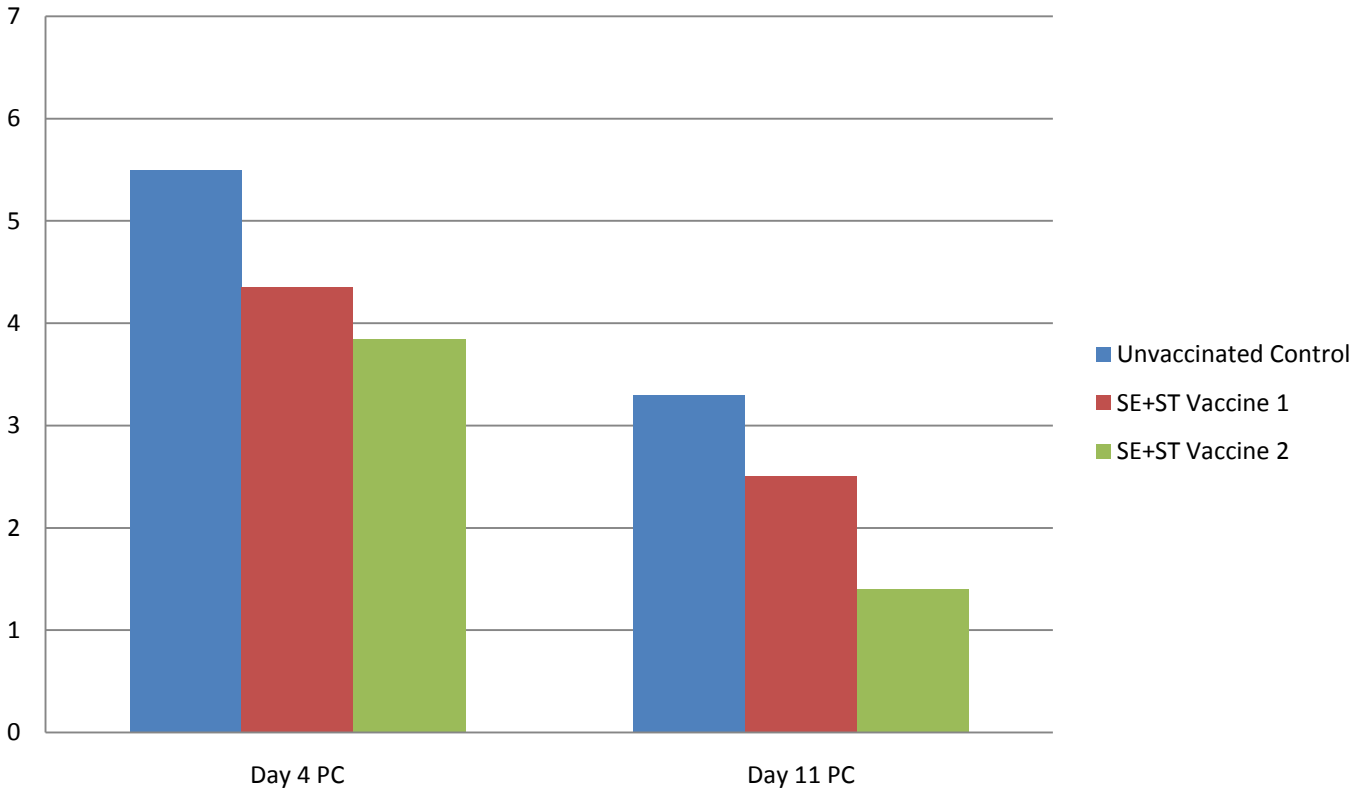
- Efficacy confirmed several EU studies
- Adjuvanted vaccines
- Stimulate significant humoral antibody levels
- Effectiveness demonstrated in EU
- USDA studies confirmed a high level of protection but not absolute elimination of vertical transmission

Vaccination- Killed Vaccines



Merial Internal Study

SE Fecal Shedding at D4 and D11 Post Challenge



Merial Internal Study

UK- Poultry Vaccination vs. Human Cases

Clin Infect Dis. 2013 Mar;56(5):705-10. doi: 10.1093/cid/cis967. Epub 2012 Nov 19.

The "decline and fall" of nontyphoidal salmonella in the United Kingdom.

O'Brien SJ.

Source

University of Liverpool Institute of Infection and Global Health, National Consortium for Zoonosis Research, Neston, United Kingdom.

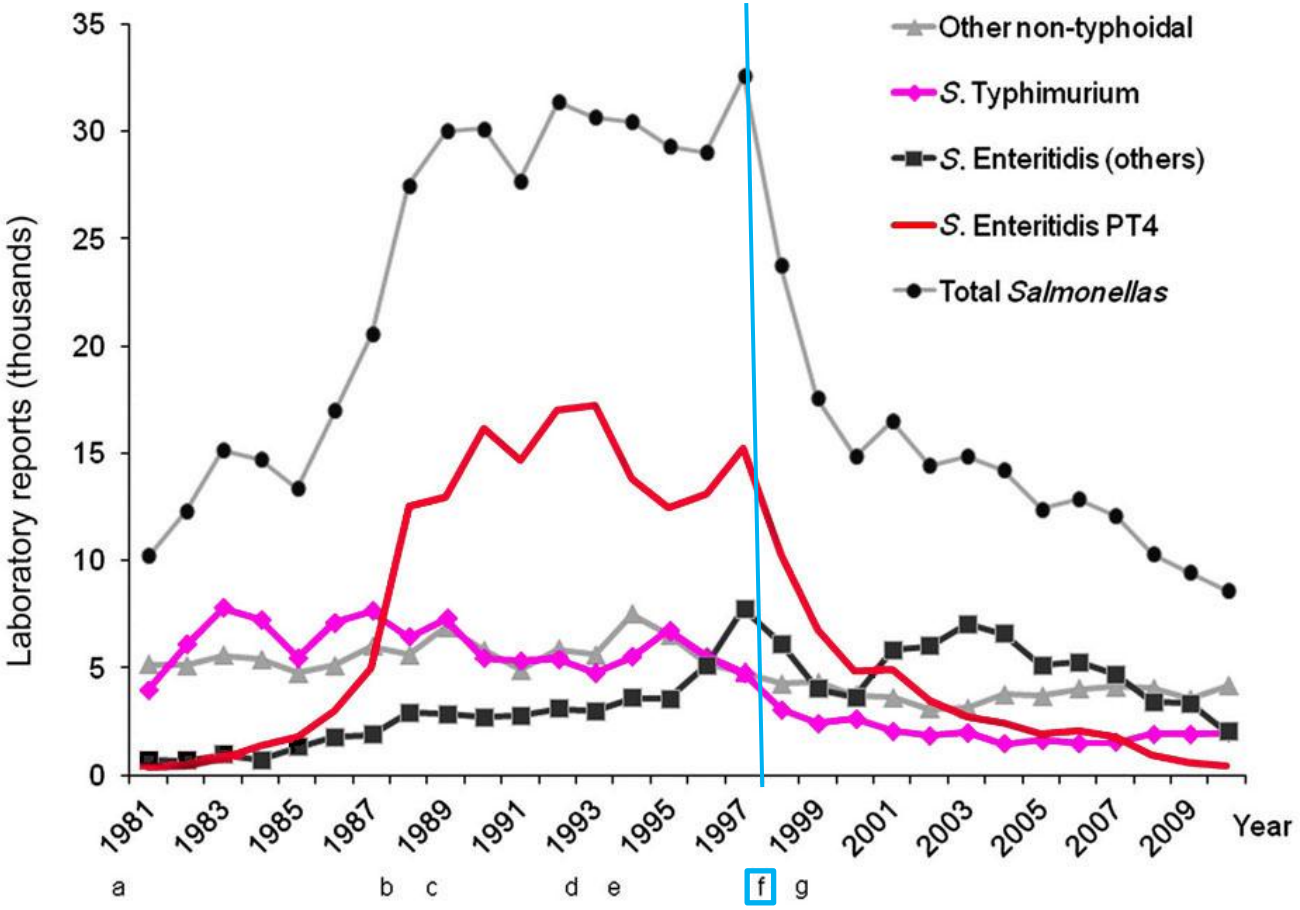
Abstract

Remarkable changes in the epidemiology of human nontyphoidal salmonellosis have occurred in the United Kingdom over the last century. Between 1981 and 1991, the incidence of nontyphoidal salmonellosis in the United Kingdom rose by >170%, driven primarily by an epidemic of Salmonella enterica subspecies enterica serovar Enteritidis phage type (PT) 4, which peaked in 1993. Measures introduced to control this epidemic included legislation, food safety advice, and an industry-led vaccination program in broiler-breeder and laying poultry flocks. The incidence of Salmonella Enteritidis has been falling since 1997, and levels of Salmonella Enteritidis PT4 have fallen to preepidemic levels and have stayed low. The temporal relationship between vaccination programs and the reduction in human disease is compelling and suggests that these programs have made a major contribution to improving public health.

Source: O'Brien SJ, Clin. Infect. Dis. 2013

UK- Poultry Vaccination vs. Human Cases

Laboratory reports of human Salmonella cases in the United Kingdom, 1981–2010



Key: (a) *S.* Enteritidis phage typing began; (b) CMO issued advice to vulnerable groups; (c) Compulsory slaughter began; (d) Compulsory slaughter revoked; (e) Vaccination of broiler-breeder flocks began; (f) Vaccination of laying flocks began; (g) "Lion Flock" fully vaccinated.

Salmonella data sources: Health Protection Agency; Health Protection Scotland; Public Health Agency of Northern Ireland

Source: Sarah J. O'Brien; Clin Infect Dis. 2012;cid.cis967

Other Control Measures

- Competitive Exclusion
  - Lactic acid producing bacteria
  - Prevent SE colonization of the gut
- Acidifiers- suppress Salmonella replicaton
- Transport and storage of eggs- 7˚C
- Chemicals- immersion chilling in processing plants.

Monitoring

- Silent infection in poultry
- Various method of monitoring- cloacal swabs, environmental, eggs, chicken carcass etc.
- Normally within the framework of a national control program
- Monitoring → Control measures

Monitoring- Broiler carcass sampling

- Carcass rinse
- 25g of neck skin
- A sample of deep breast muscle

Post Production Intervention

- Proper storage of food products- time and temperature
- Poor hygiene during food preparation
- Cook eggs until yolks are firm, and cook foods containing eggs thoroughly
- Aware of the risk of raw/ lightly cooked food

Post Production Intervention Processing Plant

S. Enteritidis Infection in humans Malaysian Perspective

Malaysian Perspective

Top 10 Nontyphoidal Salmonella Serotypes identified and reported to the Laboratory-Based Surveillance database, 2003-5

2003			2004			2005		
Serotypes	**total**	**%**	**Serotypes**	**total**	**%**	**Serotypes**	**total**	**%**
Enteritidis	244	26.7	Enteritidis	206	25.0	Enteritidis	155	28.1
Weltevreden	200	21.9	Weltevreden	165	20.0	Weltevreden	142	25.7
Corvallis	115	12.6	Corvallis	117	14.2	Corvallis	57	10.3
Typhimurium	49	5.4	Typhimurium	43	5.2	Typhimurium	37	6.7
Stanley	32	3.2	Albany	37	4.5	Limete	9	3.3
Tshongwe	29	3.2	Limete	18	2.2	Stanley	8	1.4
Biegdam	19	2.1	Braenderup	15	1.8	Agona	7	1.3
Albany	17	1.9	Tshongwe	15	1.8	Albany	5	0.9
Braenderup	12	1.3	Stanley	11	1.3	Rissen	5	0.9
Newport	10	1.1	Bovismorfibicans	10	1.2	Virchow	5	0.9
Total	915			682			460	

Source: Lab Surv. Bulletin, Disease Control Division, Ministry of Health Malaysia (October 2005)

KL Thong, Surveillance and Subtyping of Salmonella spp. in Malaysia

Foodborne Diseases in Malaysia

- Half of the foodborne related diseases from the early 1990s until today were associated with outbreaks in institutions and schools
- In Malaysia, the main contributing factor to foodborne diseases was identified as insanitary food handling procedures which accounted for more than 50% of the poisoning episodes.
- Hygiene status or cleanliness of the food handlers

Soon et al, Food Control 22(6):823-830, 06/2011

Number of Cases and Incidence rate of Food and water borne diseases, Malaysia, 2000 – 2009.

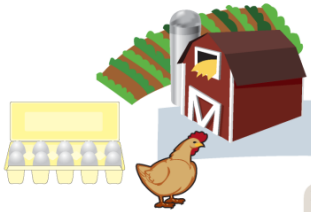
Year	Food Poisoning		Typhoid		Cholera		Dysentery		Hepatitis A	
	Case	IR	Case	IR	Case	IR	Case	IR	Case	IR
2000	8129	34.9	765	3.3	124	0.5	447	1.9	-	-
2001	7137	30.7	695	3	557	2.4	384	1.5	453	1.9
2002	7023	28.6	853	3.5	365	1.5	292	1.2	295	11
2003	6624	25.4	785	3	135	0.5	310	1.2	-	-
2004	5957	23.3	484	1.9	89	0.4	356	1.4	107	0.4
2005	4641	17.8	1072	4.1	386	1.5	141	0.5	44	0.2
2006	6938	26	204	0.8	237	0.9	105	0.4	64	0.2
2007	14,455	53.2	325	1.2	133	0.5	146	0.5	94	0.4
2008	17,332	62.5	201	0.7	93	0.3	92	0.3	36	0.1
2009	10,238	36.2	303	1.1	276	1	154	0.5	40	0.1

Source: Department of Statistic Malaysia, 2011

Sharifa E, et al; Malaysian Journal of Public Health Medicine 2013, Vol. 13 (2):98-105

Prevention from the Farm to the Table

Lessons learned from *Salmonella* outbreaks



Production

Risky eggs, 2010:
Chicken and feed contamination results in 500M eggs recalled. Cause: *Salmonella* Enteritidis (SE).

Prevention
Require preventive controls for egg producers such as buying chicks from suppliers with SE control programs, testing poultry houses for SE, and setting temperature requirements for storing and transporting eggs.

Manufacturing

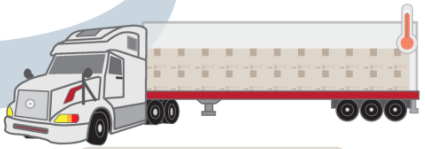
Peanut butter crackers to pet treats, 2009:
Processing plant contamination results in many foods causing sickness in 46 states. Cause: *Salmonella* Typhimurium.

Prevention
Keep factories clean, separate raw and processed foods, ensure that steps to reduce contamination work.

Manufacturing

Tainted turkey burgers, 2011: 50,000 lbs of ground turkey recalled following illness in 10 states. Cause: *Salmonella* Hadar.

Prevention
Employ pre-harvest food safety strategies to reduce *Salmonella* in animals, prevent contamination at slaughter, reduce contamination of ground product from all sources, ensure that steps to reduce contamination work.



Distribution and Delivery

Contaminated ice cream, 1994: Trucks hauling raw eggs, then ice cream, sicken 200,000 nationwide. Cause: *Salmonella* Enteritidis (SE).

Prevention
Clean and disinfect trucks between loads, keep cold shipments at correct temperatures, track shipments and storage.

Preparation and Consumption
(Restaurants/Grocery stores)

Germs spread in restaurants, 2008: Poor kitchen practices cause food to be undercooked and cross-contaminated. Cause: *Salmonella* Montevideo.

Prevention
Cook chicken and meats thoroughly, separate raw chicken and meats from other foods, train and certify managers in food safety in all restaurants.

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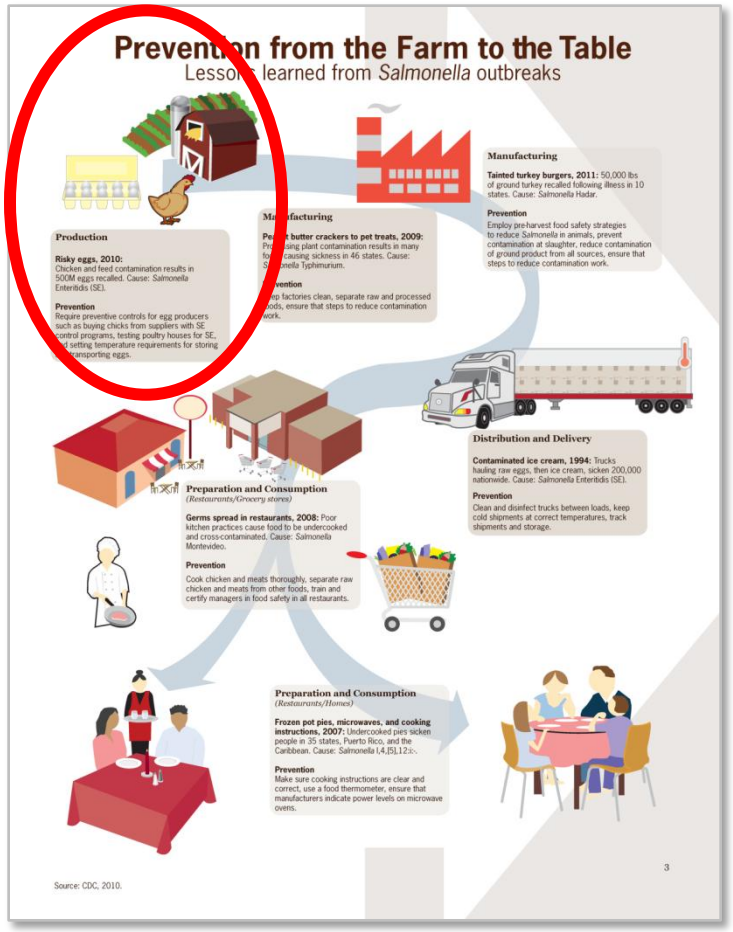
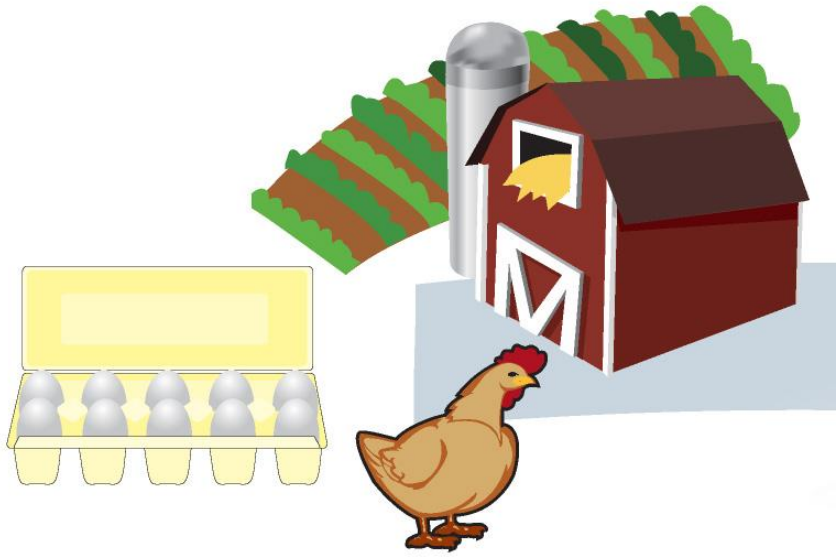
Frozen pot pies, microwaves, and cooking instructions, 2007: Undercooked pies sicken people in 35 states, Puerto Rico, and the Caribbean. Cause: *Salmonella* I,4,[5],12:i:-.

Prevention
Make sure cooking instructions are clear and correct, use a food thermometer, ensure that manufacturers indicate power levels on microwave ovens.

Source: CDC, 2010.





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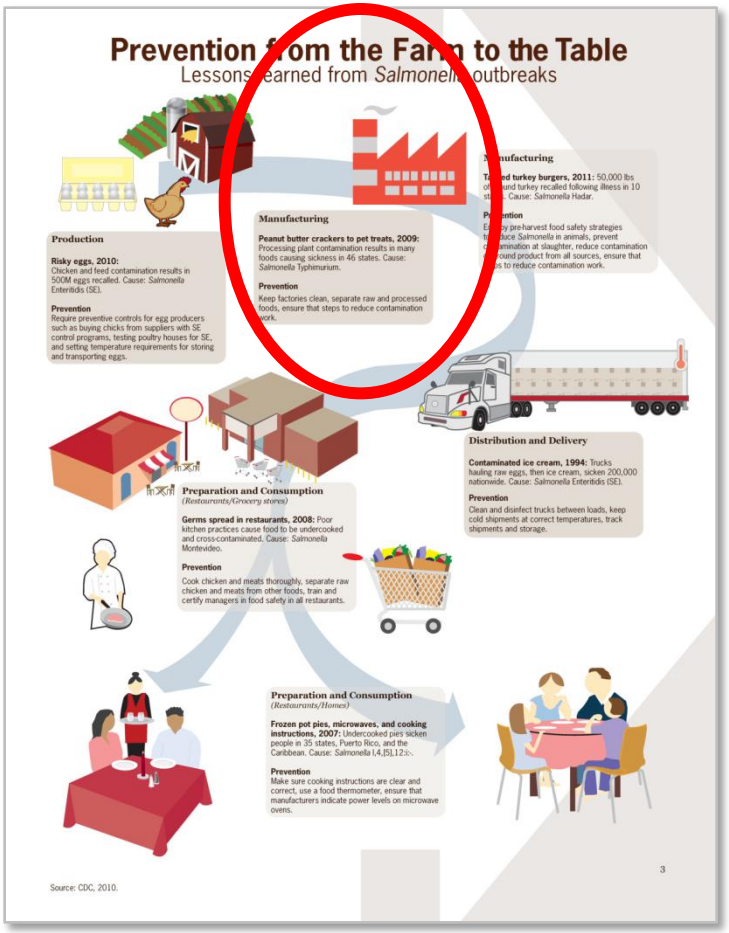

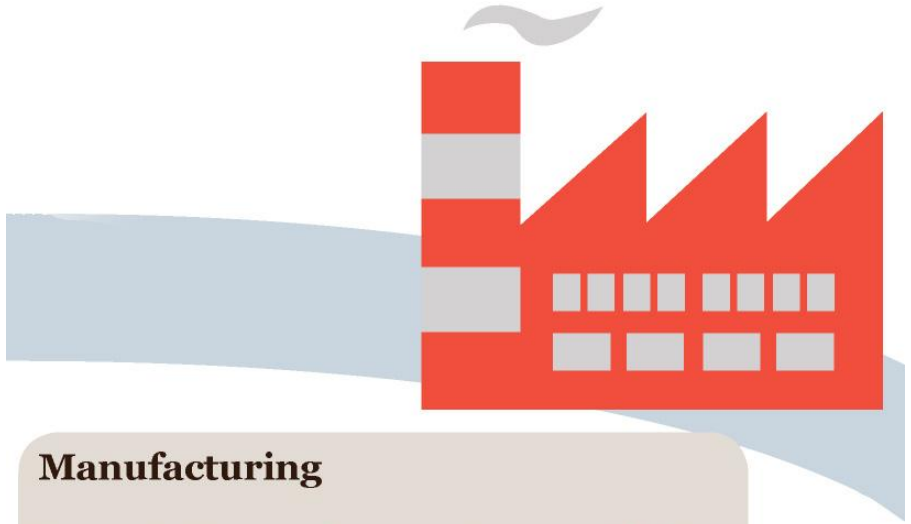

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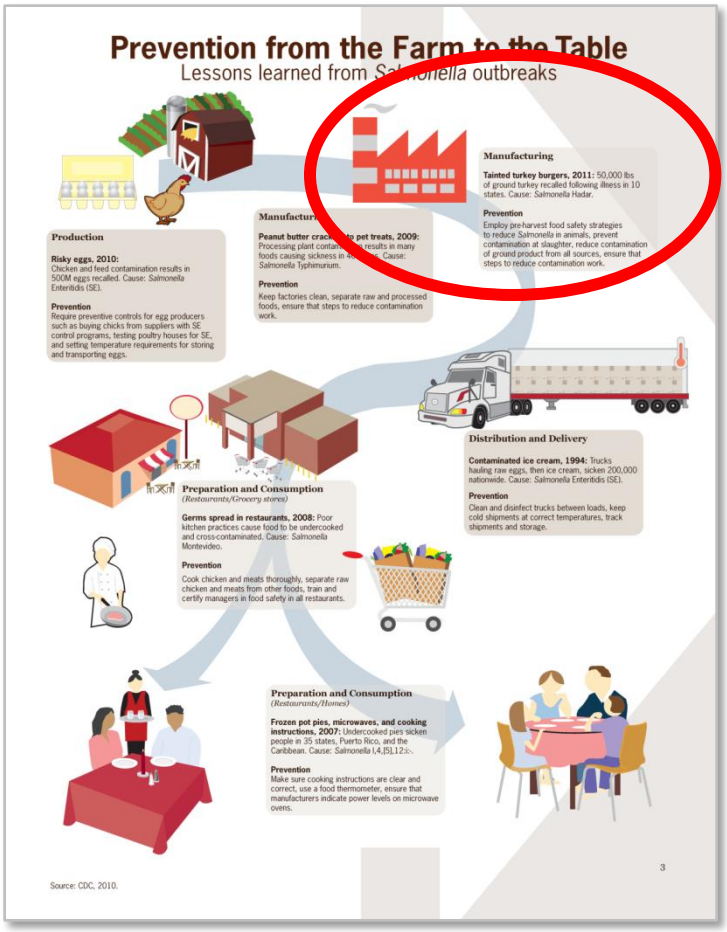

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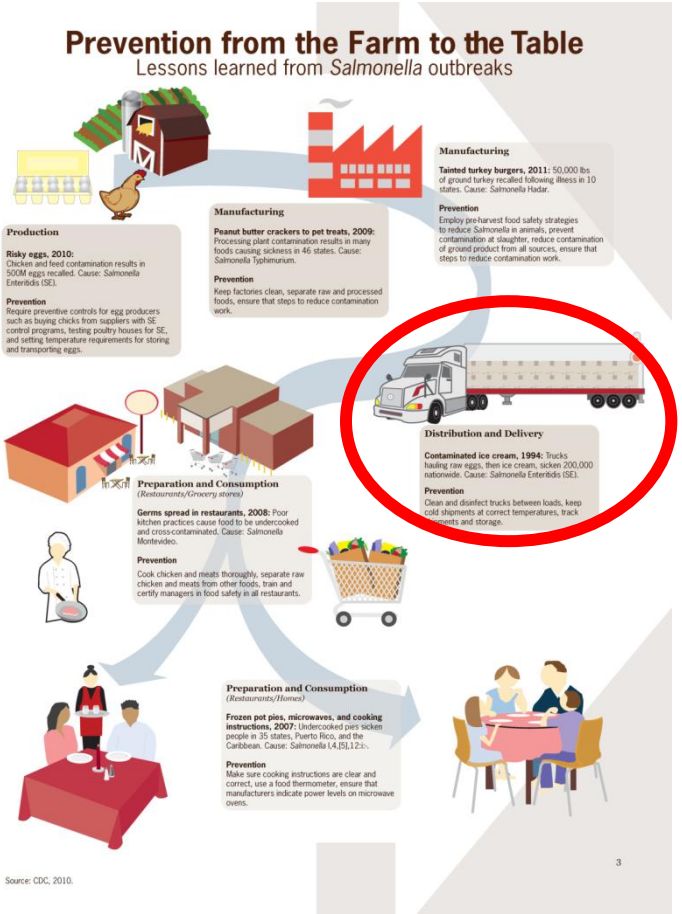

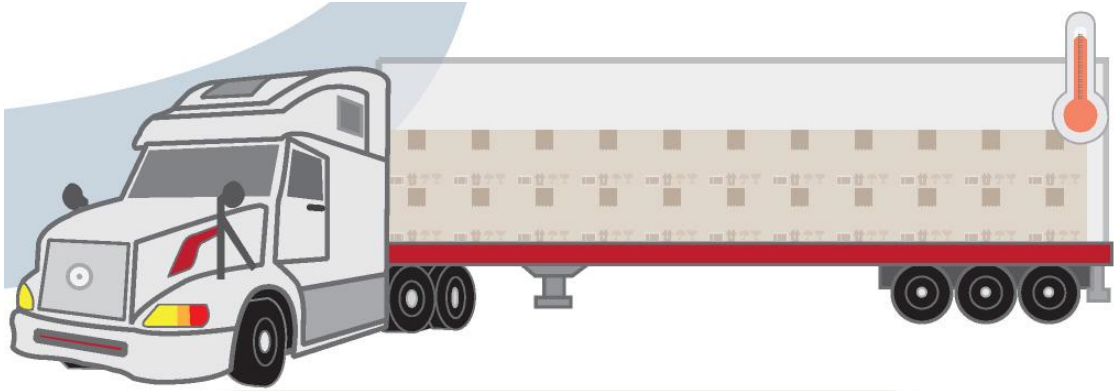

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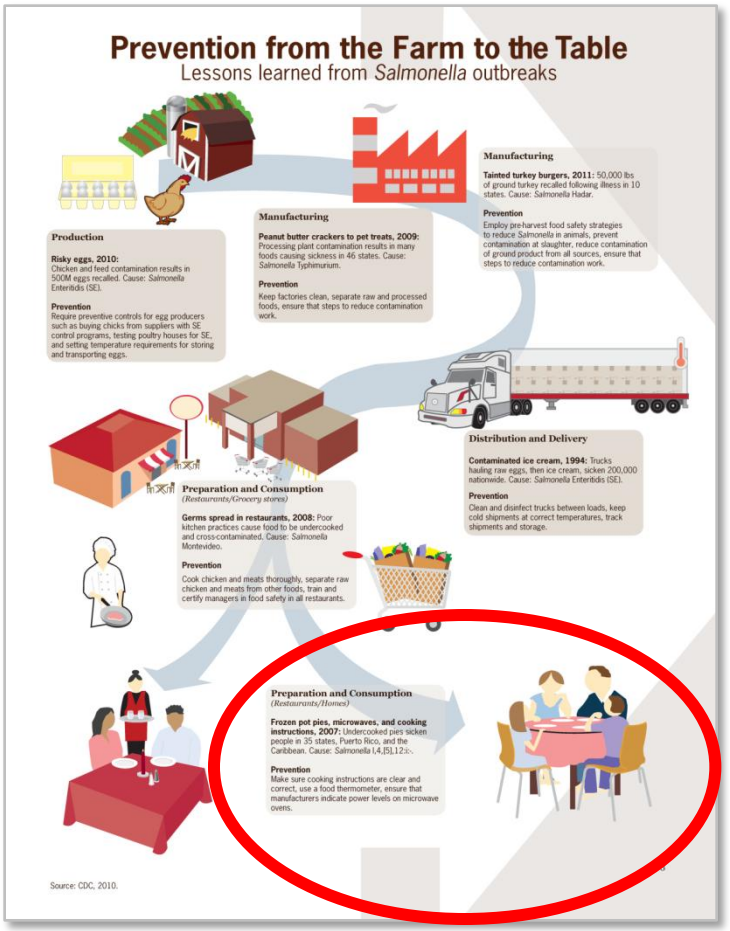

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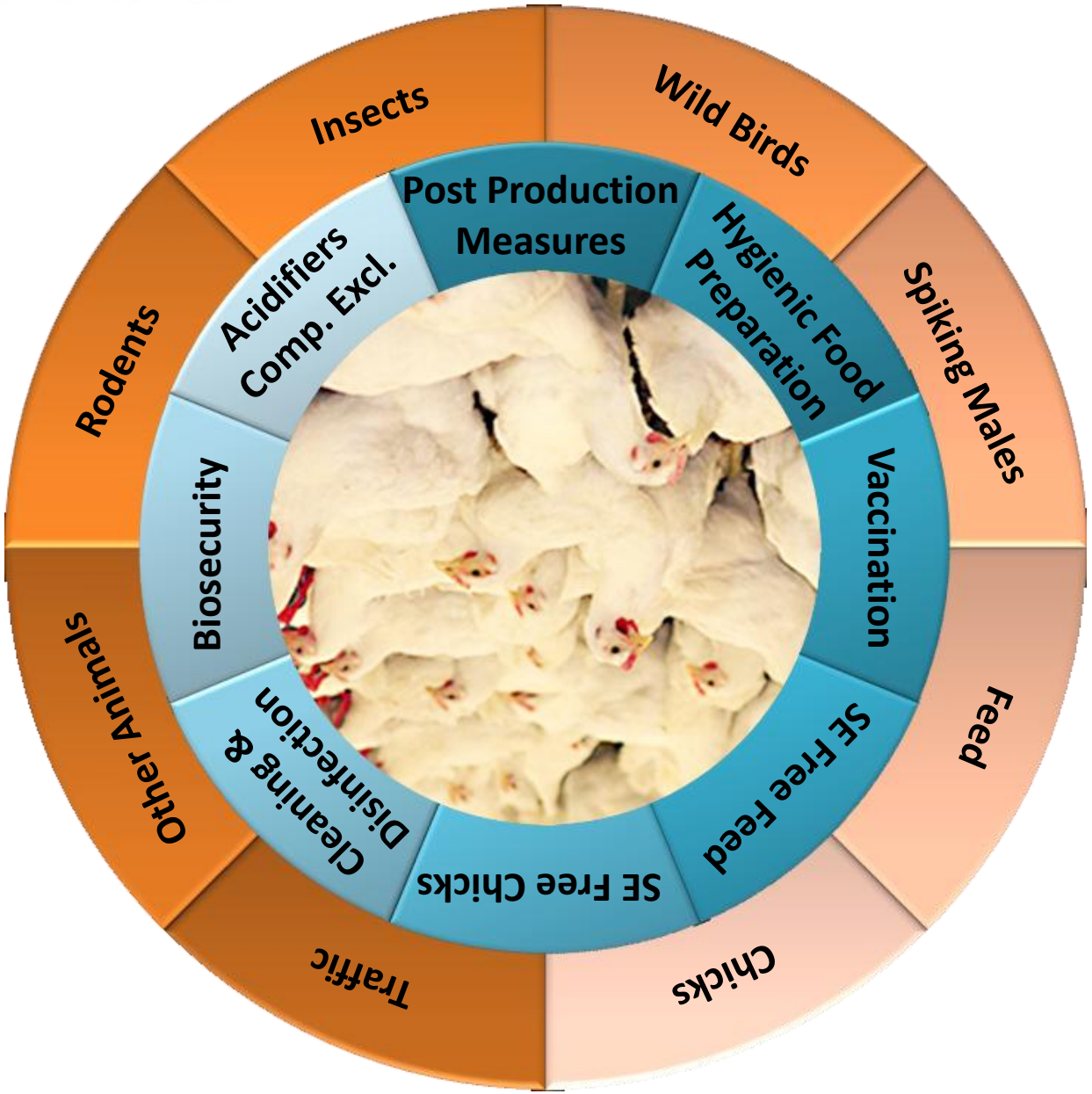
Insects
Wild Birds
Spiking Males
Feed
Chicks
Traffic
Other Animals
Rodents
Post Production Measures
Hygienic Food Preparation
Vaccination
SE Free Feed
SE Free Chicks
Cleaning & Disinfection
Biosecurity
Acidifiers Comp. Excl.

Conclusion

- Salmonella Enteritidis is a public health issue
- Poultry eggs and meat are the most frequent source of non-typhoidal human salmonellosis
- Many other sources of contamination
- Control involves farm intervention, post-production intervention, consumer education
- Need to consider the economics of SE control
- Salmonella free or Salmonella control?