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Epizootiology and control measures for *Salmonella* in pigs

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Abstract

Pigs and pork meat products are often causes of *Salmonella* in humans. *Salmonella* can enter the human food chain at any part of the meat production process. Contamination of pork can be reduced by lowering the contamination of pigs at primary production. Production of “*Salmonella* free pigs” will reduce the risk of this zoonosis in people. It is possible to determine the serological status of pig farms. Prevention of *Salmonella* in humans should aim at: prevention of entrance of *Salmonella* to the pig farm, reduction of the number of infected animals and stopping the spreading of microorganism.

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1. Introduction

Salmonella is one of the most important food borne pathogens. For pigs, the sources of infection are infected animals, contaminated food, stables, equipment, manure, dogs, cats, rodents, etc. Infection of pigs most usually appears in subclinical form. The most usual type of infection is the condition in which the carriers do not have any symptoms, but they can serve as a reservoir.

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Salmonella can enter the human food chain at any part in the meat production process: at animal feeding, production on the farm, in the slaughter house, during the packing process, and during shopping or even preparation of the food in households. Contamination of pork can be reduced by lowering the contamination of pigs at the level of primary production. These measures demand the understanding of *Salmonella* epidemiology within and among connected parts of production chain¹. Pork meat and products are an important source of *Salmonella* in humans. In Denmark and the Netherlands, the number of cases of *Salmonella* in humans from pork met and products is considered to be 10 do 15%².

Production of “*Salmonella* free pigs” would reduce the risk from occurrence of this zoonosis in people, but it is hard to achieve for many practical and financial reasons. Different countries apply different control models for *Salmonella* in pigs, but all of them include feed and feed components control, microbiological and serological monitoring of a percentage of animals (piglets, sows and fatteners) in defined time frames³. In order to successfully resolve the problem of *Salmonella* in humans, control measures are needed at the same time at all levels in the meat production chain. In most EU countries, control and examination programs are implemented n the national level. In Denmark for example, by implementing defined control programs, the percentage of *Salmonella* in pigs has dropped from 3.5% in 1993 to 0.7% in 2000, and by 2014, it was reduced even further, to 0.4%. This trend was followed by a reduced number of cases of *Salmonella* in humans; for the same period, cases reduced ten times on the annual level^{2,4}. In our country, we have conducted analysis using an ELISA method, and the presence of *Salmonella* reactivity was detected in farmed pigs. Altogether, 628 blood sera samples of fatteners from five different farms were examined. In total, 46.5% of animals reacted positively for *Salmonella*, with the cut off at 10%. The sample: positive ratio for the farms was between 0.25 and 3.147⁵. After analysis of 256 sera samples from sows and boars with an ELISA test, 25.9% were found to be sero-positive with a serology test⁶. Feed and feed components can be contaminated with *Salmonella* and as such, can be a potential source of *Salmonella*. Davies and Wray⁷ have found a very high level of contamination with *Salmonella* on the cooling equipment inside the manufacturing building, on the fresh feces of wild birds collected in the warehouse and on the crane for unloading in some mills.

2. Epidemiology of *Salmonella* in pre-harvest stage

The basic goal that has to be achieved in control and epidemiology of *Salmonella* is prevention of infection from entering the farm and also prevention of transmission and maintenance of the infection. Farms are not closed systems, as in herds there is constant intake of feed and new animals, and these can be potential sources of *Salmonella*. This was found in different studies which deal with risk factors⁸. Feed mixtures treated with heat can help to prevent *Salmonella* in serologically negative herds, but in herds where *Salmonella* is already present, this measure cannot help much. In many studies, a protective effect of feed with low pH (in the form of added organic acid, whey or fermented additives) was described⁹.

Control of birds, flies and rodents is necessary in pigsties and warehouses as is also keeping small animals, such as cats and dogs, out of pigsties. Hygienic practice should be implemented inside the facilities and drains. Purchase of new animals should be only from certified *Salmonella*-free herds. New animals should be kept in quarantine with health monitoring. The number of farms from which new animals are purchased should be limited, After every turn out or movement of animals, all animal boxes have to be thoroughly washed and disinfected, following defined procedures. Toilets, bathrooms, rooms for changing clothes and shoes should also be in accordance with standard operating procedures.

Changes in the strategy of feeding can help in reduction of exposure to *Salmonella* and increase pig resistance to this microorganism⁹. The use of sufficiently high partitions and pen walls can be useful in prevention of spreading of infection between boxes and buildings. Also a facility for keeping sick animals should be in use^{10,11}. Application of only one control measure is not effective to prevent the spread of *Salmonella*. For every farm, defined measures and strategies, based on the realistic current situation on the farm, are necessary. Multifactorial infection such as one with *Salmonella* in pigs demands a complex approach to the matter, after which the procedures will be defined between farms, within the farm itself and within a single animal on the farm¹⁰.

3. Epidemiology of *Salmonella* during shipping and transportation of animals

Pigs which are infected with *Salmonella* can have a subclinical form of disease and only occasionally shed *Salmonella* in the feces. In cases of stress, carriers of *Salmonella* may increase shedding of these bacteria, and also, animals which were not infected before may have increased susceptibility for infection. During transportation, the pigs are exposed to many stress factors such as noise, smell, mixing with other pigs that were not in the same facility, many pigs in a small area, duration of transportation, temperature changes and other ambient changes¹². As a consequence of transportation and handling of pigs, the number of pigs that are shedding *Salmonella* at the moment of entry to the farm can be significantly increased^{13,14}. Infection of *Salmonella*-negative pigs can occur in the transport vehicle if it has not been well-cleaned after previous transportation of animals infected with *Salmonella*. Contaminated trucks can then be a source of infection also for other farms and slaughter houses.

After transportation to the slaughter house, pigs are usually kept in lairage before slaughter and this period of time can vary. This area allows pigs to recover from stress caused by transportation and handling. The number of pigs which excrete *Salmonella* is increased, depending on the time spent in lairage¹⁵. This area is usually cleaned only at the end of the day and represents a potential source of infection for *Salmonella*-negative pigs or those with weakened immune system.

Mixing animals from different farms should be avoided and pigs should be treated as quietly and as gently as possible¹². If possible, groups of pigs should be delivered directly to the slaughter house in separate trucks¹⁵. Trucks should be cleaned and disinfected between different transports¹⁴. Waiting time should be as minimal as possible, at least for *Salmonella*-negative pigs, with no mixing with other herds¹⁵. Pigs should be kept in smaller groups, less than 15 animals, and the lairage should be cleaned between different groups of pigs and at the end of slaughter¹⁰.

4. Control measures

4.1. Prevention of *Salmonella* entering the farm

The best way to prevent *Salmonella* in pigs is to prevent the entrance of the pathogen to the farm. When haulage of pigs to a facility is necessary, this must be only from other farms which are free of *Salmonella*. Purchase of pigs should be from only one or from a small number of herds that are certified as having no problem with *Salmonella*. Vehicles must be thoroughly cleaned and disinfected before shipping the pigs for transportation. When pigs arrive at the farm, quarantine has to be provided. Vehicles and trucks should not enter inside the farm and the shipping of animals and feed should be completed in front of the entrance of the farm. If the vehicles have to enter into the farm, they have to be disinfected. Dead animals should be disposed into a secured container, which is regularly disinfected. No other animals should be allowed to go near the pigs or the feed warehouse. Dogs and cats are not advisable on pig farms, because they carry a high risk. Rodents, birds or cats must have no access to warehouses.

Pigs should be separated from other production animals, if there are any. The risk of *Salmonella* entering pig farms from foxes, birds and other pests should be reduced by collecting dead animals immediately. Feeding dishes should be covered and there should be solid fences around the buildings. If buildings are close to public roads, they should be at least 5m away with a double fence. All the machines and equipment should be cleaned and disinfected before entering the farm and before leaving the farm. Unemployed persons must have no access or if necessary, be supplied with protective clothes. Feed and water must be purchased from reliable warehouses and public water supply. If this is not possible, water must be disinfected.

4.2. Reduction of the number of infected animals and prevention of *Salmonella* spreading

Salmonella is present on the farm, the pathogen will most probably spread all around the farm, wherever there is contamination with pig feces or liquid manure. The microorganism will die very soon if the environment is dry, clean (no organic matter), warm and disinfected. Places where *Salmonella* can remain are dirty dishes, dust and cobwebs, corners and wall cracks, taps, tools and machines, dirty boots, clothes, warehouses, feed containers, contaminated roads. Thorough cleaning is of prime importance because the disinfectants are ineffective on dirty surfaces. The ideal strategy is all in – all out. Facilities which are filled with animals all the time cannot be properly

cleaned. However, if they are empty for one-two weeks before the next round of pigs, the infection risk can be reduced with thorough cleaning and disinfection. Everyday work on the farm should always start from the youngest pigs and then move to older groups. The facilities housing sick animals must be left to the last. The golden rule is not to mix pigs of different ages. If there are any pigs smaller and weaker than the others, it might mean that they are infected or they may be carriers of *Salmonella*. There should be pools for boot disinfection near every pigsty.

The use of antibiotics is forbidden in control of *Salmonella*. They do not help in reducing the level of infection and they can even increase the shedding of *Salmonella*, prolong the period of excretion and cause the development of resistance to antibiotic treatment.

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