Salmonella in Relation to Agriculture[1]

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Abstract

Some of the more extensive programs directed to the control of salmonellosis in domestic animals, which have been conducted by the U.S. Department of Agriculture, are identified. These have been singularly successful, insofar as the economics of production is concerned. However, they fall short of meeting the present market demand for food free from all of the 900–1,200 odd serotype species of *Salmonella* considered potentially infectious for man. The increasing incidence of salmonellosis in man, and the identification of domestic animals as a major reservoir of various species of *Salmonella,* has made it necessary to broaden the objective of existing programs, expand the research effort, and intensify testing schedules in many of the existing regulatory control programs. The activities of a special salmonella task force set up to coordinate research with the needs of the various regulatory agencies specifically concerned are reviewed. Data developed by the Animal Health Division in a market survey of feed and feed ingredients as carriers of salmonella are presented. The more pressing problems and the current programs within other Divisions are discussed, insofar as the findings to date may serve to identify future needs.

The dimensions of infection in human life including such measurements as death, disability and impairment of body function are great. By these same measurements the dimensions of infection in the life of the domestic animal are also great but there are additional dimensions which change the character of the control problem. The primary function of the life of a domestic animal is usually limited to the support of human life. Thus, the farmer and the veterinarian must give equal weight to two additional dimension measurements; namely, agricultural economics and the potential danger of the animal as a carrier of infection to which man may also be susceptible.

The life span of the farm animal is commonly controlled to accommodate the economic needs of man. Thus, the average exposure time or period of infection risk may be only a matter of weeks as in broilers, months with lambs and slaughter hogs, one to two years with beef cattle, or eight to ten years with dairy animals, as compared to 60 to 80 years in man. Epizootics are more common since farm animals are maintained in large restricted colonies; and, individual infections are more likely to be terminated by death either as a result of high virulence in the infecting agent or election by man. Humans are susceptible to infection by many bacteria and viruses that cause disease in the domestic animal and there can be no quarrel with the thesis that human life takes priority over animal life in any calculated risk situation connected with infection control programs.

With the reported increase in salmonellosis in man and the identification of the farm animal as a major reservoir of the species of the genus *Salmonella* identified with these infections, attention was immediately focused on the endemic nature of the farm as far as these organisms are concerned; also, on isolated epizootics in farm animals due to these species, in the hope that careful investigations in these areas might provide a keystone upon which more adequate control measures could be developed.

A number of rather intensive studies have been conducted along these lines during the past two years. Up to this time, the findings have raised more questions than they have resolved. This is unfortunate in that the demand for salmonella free agricultural foods is of such an urgent nature that affirmative control actions must be initiated even while research commitments are being carried out.

Peterson and Coon (1) in a rather comprehensive study of an explosive epizootic of a *Salmonella typhimurium* infection in a 70-cow dairy during which 80% of the adult herd showed clinical manifestations of the disease and nine cows died, were only able to isolate the organism from the feces of five cows during the active course of the disease and from only one cow 25 days later; calves running with infected cows did not contract the disease and the organisms could not be isolated from the feces. Nevertheless, a possible human-animal relationship was established in that three children on this farm developed the disease. Since the children and the cows developed the disease at the same time, it could be postulated that they were both infected at the same time from a common source; but, this apparently was not the water supply. No apparent reason could be developed for failure of the calves which are normally more susceptible to infection by salmonella than are cows, to contract the disease.

The urgency of the situation, insofar as the Department of Agriculture is concerned, arises from the necessity for the production of foods which can be judged by public health officials as safe for the consumer. In that farm animals have been incriminated as the largest single reservoir of salmonella which are potentially infectious to man, and since animal foods have been linked more often than other types of foods to human infections, it is understandable that the USDA Salmonella Work Group, established to provide interdiscipline and interagency planning of such research, regulatory and educational programs as might be necessary to achieve Salmonella-free foods, has devoted a great deal of its time to this phase of the problem. However, the role of vegetable and cereal foods is not being ignored. Animal feeds are considered a major source of salmonella infection in animals and cereal products and oil seed meals are major components of animal feed. Thus, they cannot be ignored in developing a comprehensive understanding of the situation.

The activities of the Department of Agriculture as they relate to the present salmonella infection problem were recently summarized by the Salmonella Work Group of the Department for a National Academy of Science-National Research Council Study Committee (2) jointly sponsored by the Department of Agriculture and the Department of Health, Education and Welfare for the purpose of establishing common guide lines to both Departments with respect to the development of those programs most likely to be helpful in meeting existing demands within the areas of public health, food production and animal health.

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The activities of the Department of Agriculture within these areas are many and of a diverse nature. This is to be expected in view of the assigned responsibilities for both consumer protection and the production of adequate supplies of foods. It is not possible within the time available to review these activities in depth but a brief listing according to the agencies within the Department directly involved should be sufficient to emphasize deep concern with the problem.

The Animal Husbandry Research Division, in the interest of preventing salmonella infection in hatching eggs, chicks and turkey poults has for over 30 years conducted a blood testing program in chicken flocks for *S. pullorum* and fowl typhoid. In 1967, over 38 million birds were tested. It is encouraging that the percentage of reactors was only .001 as compared to 3.66 in 1936. These two figures and the constant decrease in the percentage of reactors over the intervening years indicate clearly that it is possible to obtain statistically significant clinical evidence of efficacy of disease control methods used with poultry flocks. Severe as the pullorum-poultry typhoid infection problem was that led to the initiation of this very large program, it should be noted that less than 4% of the total population in breeding flocks was involved, and epidemiologists frequently despair in attempts to develop meaningful data in any situation where less than 10% of the total population is involved. The findings in this program are encouraging since they indicate that it is possible to have a successful, broad, comprehensive program involving all species of farm animals even though the investigator must deal with an endemic situation with only a small percentage of the total population at issue.

Under the National Turkey Improvement Program initiated in 1944 approximately 4.5 million birds were tested in 1967 with only two reactors for pullorum-fowl typhoid. Here again, there has been a continuous decrease in the percentage of reactors from 2.0 in 1944 to .00005 in 1967.

The Animal Disease and Parasite Research Division is currently studying the possibilities for developing polyvalent type antigens through which current and new blood testing programs might be made more effective from the standpoint of the total of 1200 existing serotype species of *Salmonella* now considered as potentially infectious for both man and animal. They also have research projects on the preincubation fumigation of hatchery eggs, egg shell contamination control, and epidemiology of Salmonellosis in turkeys.

The Eastern Utilization Research Laboratories are conducting studies on methods for the elimination of salmonella contamination in meat products and the factors affecting survival of salmonella in the manufacture of cottage cheese.

The Western Utilization Research Laboratories are continuing their vital studies on heat resistance in *Salmonella* species and egg pasteurization which have already provided the background data upon which present requirements for pasteurization in commercial egg products have been developed.

The Market Quality Research Division through contracts and cooperative agreements with four State Universities, and direct investigations in their own laboratories at Beltsville, Maryland, are conducting studies on methods for controlling salmonella in poultry and dairy products and the role of insects in spreading salmonella contamination in stored feed and foods.

The Transportation and Facilities Research Division in a cooperative state agreement has been investigating equipment and methods for pasteurizing liquid whole egg.

The Human Nutrition Research Division has assigned some of its funds to studies on the control of salmonella in food handling in homes and institutions.

In the State Agricultural Experiment Stations 24 of the States are utilizing Hatch Act funds and 14 other States are utilizing non-Federal funds in studies related to salmonella control. The projects here are directed largely to the control of these organisms in livestock, poultry and animal feeds.

The Inspection and Grading Branch of the Dairy Division, Consumer and Marketing Service, initiated and is conducting a salmonella surveillance and testing program for dairy plants producing dry milk and for some cereal plants producing blended foods utilizing dry milk.

The Grading Branch of the Poultry Division, Consumer and Marketing Service has instituted a salmonella surveillance testing program in all egg plants operating under their voluntary inspection service to provide a guide to the effectiveness of the mandatory pasteurization processes as well as assurance that the end products are salmonella-free.

The Processed Meat Inspection Division, Livestock Slaughter Inspection Division, Poultry Inspection Division, and the Technical Services Division of the Consumer and Marketing Service are conducting a series of integrated studies directed to the development of a better understanding of the existing situation as it relates to the control of salmonella contamination in meat and poultry products. These include a one-year national survey to determine the incidence of salmonella carriers in chickens, turkeys, swine and cattle as they are received for slaughter; a short-term national study on the incidence of salmonella in whole chicken carcasses; a detailed study on the techniques of chicken evisceration as they relate to overall sanitation and the incidence of salmonella in dressed poultry, as well as applied microbiological studies on the various processing steps in the carcass disassembly lines found in modern slaughter houses for animals and poultry.

The Animal Health Division of the Agricultural Research Service presently operates three regional serotyping laboratories and a central reference center in support of Federal and State animal disease diagnostic laboratories as well as the various research and control programs in the other Departmental services and the State Agricultural Experiment Stations. It is estimated that 9000 or more cultures of *Salmonella* will be typed during the 1968 fiscal year. These typing laboratories are located in Atlanta, Georgia; Phoenix, Arizona; Orono, Maine; and Ames, Iowa.

A series of training courses is being conducted to improve the technical competence of personnel in local diagnostic laboratories.

This Division is also coordinating State-Federal surveys to determine the rates of salmonella contamination in such feed ingredients as grain, oilseed meal, fish meal, tankage and bone meal, as well as finished feeds. Considerable data obtained in these studies have already been published.

A four phase cooperative control program with animal by-product and marine product feed manufacturers has been initiated to eliminate salmonella contamination from these critical feed ingredients. These were clearly identified in the State-Federal survey as the two major sources of salmonella in feeds. A total of 742 plants in 41 States have entered

this program; 490 plants have already had two or more inspections. It is estimated that during the fiscal year 1969, starting July 1, 1968, and ending June 30, 1969, 903 plants in 45 States will be enrolled in this program and that the surveillance will require at least 2,709 plant inspections and the testing of 27,090 samples.

While it is recognized that salmonella transmission through feeds is only one of many potential sources of infection for flocks and herds, it is a significant source that is vulnerable to attack and it is believed to be a critical link in a chain of transmission from a single highly infected farm, to animal feed manufacture, back to the many farms purchasing finished feeds.

The Veterinary Biologics Division, Agricultural Research Service, monitors all *Salmonella* antigens for potency that are used in the blood testing programs.

The Cooperative Agricultural Extension Service, the Animal Health Division, Agricultural Research Service, and various Divisions within the Consumer and Marketing Service are carrying out continuing education programs directed at poultry and livestock producers, processors of agricultural products, food distributors and consumers.

Infection control programs are always demanding and exacting even when all of the factors involved have been identified in epidemiological studies and can be dealt with in an effective and economic manner. Where all of the epidemiological factors involved have not been clearly identified and where the economic aspects of the problem weigh heavily in any decision that is made, as is the case in the Salmonellosis problem, they become even more demanding. All studies to date simply verify the vast dimensions of this very serious infection problem insofar as Agriculture is concerned. Enlightened self-interest and assigned consumer protection responsibilities demand dedication by the Department of Agriculture to the resolution of this problem in the interest of a continuing adequate and safe supply of foods.

REFERENCES

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2. U.S. Department of Agriculture, "Activities and Programs of the United States Department of Agriculture pertaining to *Salmonella*," Mimeographed Report, 1967, 43 p.

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