Original Articles.

THE ORIGIN OF TYPHOID FEVER IN HOSPITALS, AND THE MEANS SUGGESTED FOR ITS PREVENTION. A CONTRIBUTION.¹

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In his article on "Typhoid Fever," in Pepper's "System of Medicine" (1885, I, 248), Dr. James H. Hutchinson says: "During the past twenty-four years I have been almost uninterruptedly connected with large general hospitals, and during that time have had a large number of cases of typhoid fever under my care, and a still larger number more or less under my observation. During all this time I have never known but one case to originate within a hospital, and that occurred in a servant whose duties did not bring her in immediate contact with the sick."

During my service in the wards of the Massachusetts General Hospital in the summer of 1887, there was admitted a young girl, suffering from debility and hysterical paraplegia. After a stay of four weeks, in which time she had greatly improved, she was transferred to the Convalescent Home in Belmont. On the day following her arrival, symptoms of typhoid fever made their appearance. Three days later she returned to the Hospital, and remained there till her recovery from the attack. The suggestion was so direct that her disease owed its origin to causes existing within the Hospital, that it seemed desirable to make an inquiry into the frequency of such cases, with the view of preventing their occurrence. The visiting physicians appointed Dr. Tarbell and the writer a committee for the above purposes, and the present communication is the outcome of their research.

It is obvious that the discovery of a small number of isolated cases, extending over a given period of years, is of as much importance in demanding a remedy as the occurrence of many cases in the same length of time or in a shorter period. Some of the visiting physicians were able to recall solitary instances, and letters were written to the several gentlemen who had served as medical house-officers during the past ten years. From their intimate relations to the patients, it was thought they would be most likely to remember the class of cases under consideration. Ward-tenders, nurses, and other employes were also asked to assist in the search.

The names of a number of patients were thus secured, and the records of the Hospital were examined for the detailed description of their symptoms. The following abstracts were made from these records:

CASE I. October 24, 1882, medical externe. In charge of the Convalescent Home, but came each day to the Hospital, where he stayed some six hours. Has not felt perfectly well for a week, but his disease began five days before he entered the Hospital as a patient. The symptoms were those of typhoid fever; he died on the eleventh day, and the characteristic lesions were present.

The home at Belmont is designed solely for convalescents, especially for those able to take care of themselves. It contained no cases of typhoid fever. On the contrary, numerous patients with this disease are to be found during the autumn in the Hospital. Although the evidence is insufficient to warrant the as-

sumption that this case arose from causes existing within the Hospital, the possibility of such an origin is obvious.

CASE II. September 11, 1883, medical nurse. She has been a hospital nurse in Lynn for several months, but has been employed at the Massachusetts General Hospital for the past nineteen days. Has felt tired for some time, and for the past two weeks has had nausea and dizziness in the morning. Four days ago was attacked with chills, headache, and pain in the bowels. There is now some tenderness on pressure at the right of the abdomen. The temperature rose gradually during the first week to 105° F., then descended, day by day, for nine days, till it reached the normal point. It remained in the vicinity of 99° F. for several days, and she was discharged well nearly two months after her admission as a patient.

The evidence afforded by this case is rather one of possibility than of probability. If she had become infected with the typhoid poison before her presence in the Hospital as nurse, a period of fifteen days elapsed before suggestive symptoms were apparent. It is evident that with such a period of incubation, the disease may have been contracted before she became employed at the Hospital. On the other hand, an interval of fifteen days is quite sufficient to permit the infection to have occurred from conditions existing within the Hospital, in which case her debilitated state may have acted as a favoring cause.

CASE III. October 26, 1883, medical and surgical nurse. She has been on duty in the Hospital for seven months. During the past three weeks has felt very tired at night, and has suffered from occasional headache. These symptoms have been much worse during the past three days. Two sharp chills to-day, and intense pain in the head. Temperature 103° F. The temperature rose to 105° F. during the first three days, and gradually fell to the normal, being 101° F. at the end of the third week. She was discharged well, 13th of December. The conspicuous symptoms of her attack were headache, nocturnal delirium, and prostration. An eruption resembling rose-spots and sudamina were observed.

The above is regarded as a case of probable intra-hospital origin. It is, of course, possible that the morbid poison may have been obtained from sources without the Hospital. The presence of typhoid patients, and the constant exposure of the nurse to the influences emanating from them, offer a more direct explanation of the origin of the attack.

CASE IV. November 20, 1884, medical ward-tender. For two weeks he has had malaise, with increasing anorexia. Headache for several days. Diarrhoea and chills in the past two days. Temperature 102° F. From this point the temperature rapidly rose to the maximum, 105° F., and gradually fell to normal, which it reached in the fifth week. Recovery then took place. Rose-spots and gurgling in the right iliac fossa are recorded; also diarrhoea, sordes, delirium, and twitching of tendons of wrist.

This patient is reported to have been not over-cleanly in his habits. He is said to have eaten his meals without any preliminary hand-washing, immediately after giving the bed-pan to a typhoid patient. In the light of his habits and exposure, it seems fair to regard this case as having originated within the Hospital.

CASE V. August 10, 1885, medical and surgical

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ward-servant. For the past eight days she has had headache, loss of appetite, epigastric pain and malaise. Five days ago she went into the country but has felt hot and weak. There have been free movements of the bowels during the past three days. She returns to the hospital for treatment with tenderness and gurgling in the right hypogastrium. Temperature 102.4° F. At the end of twelve days the temperature became normal and recovery then took place. Doubtful rose-spots were noted.

The ward in which this person was employed is filled with private rooms, in one of which was a typhoid patient at the time she was taken sick. There seems no reason to suppose that she was infected during her brief absence from the Hospital. She left on account of illness, and was away too short a time for typhoid fever to have been acquired, except in the most violent cases.

CASE VI. November 15, 1886, medical interne. Restless five days ago, since when has had headache, backache and malaise. Death occurred at the end of the third week. The symptoms observed during life and the lesions found after death were characteristic of typhoid fever.

CASE VII. May 24, 1887, medical nurse. She has had several cases of typhoid fever under her care during the past month. In this time she has suffered from headache, general malaise and gradual loss of appetite. Three days ago the headache became very intense; there was severe backache and general weakness. Took her bed yesterday; temperature 103.4° F. Tenderness and gurgling are now present in the right iliac fossa. Rose-spots subsequently made their appearance. The temperature became normal at the end of the fourth week and she recovered.

The last two cases require no comment as the probability is direct that their origin was due to exposure in the hospital.

CASE VIII. June 20, 1887, medical patient. She entered May 18th, suffering from debility, and was sent to the Convalescent Home, June 1st. She remained there ten days, and, when discharged, never felt so well in her life. Three days later she went to a hotel as chambermaid, but after three days' service lost her appetite, was dizzy and chilly. On the following day she had persistent vomiting and the onset of a diarrhoea, which has since continued. There is now tenderness and gurgling in the right iliac fossa. Temperature 104.4° F. Rose-spots subsequently appeared. The temperature reached 105° F., on the second day in the Hospital, and fell to 99° F. at the end of the fifth week. She was discharged well.

It seems probable that the origin of the disease in this case is to be sought rather in influences existing in the hospital than in those at the Convalescent Home, or in the hotel. A period of incubation of at least sixteen days is necessary to support the first assumption. The experience of the hospital in connection with the cases of typhoid fever received from the steamship *Prussian*, shows that infection within this limit is quite possible. This ship landed her passengers in Boston May 10, 1887, having been ten or twelve days on her voyage from Glasgow. Two days later cases of typhoid fever arose among her passengers and eventually, as I am informed by Dr. S. H. Durgin, of the Board of Health, about one-sixth suffered from the disease. Many of the patients were admitted to the hospital. In two of these the symp-

toms did not appear until the 24th and 25th of May respectively. It is, of course, impossible to say at what time the infection of these cases took place. But as an interval of fifteen days occurred between the arrival of the ship and the outbreak of the disease in one case, a period of incubation of sixteen days is evidently quite possible.

The infection of Case VIII is also more likely to have taken place at the Hospital than at the Home, because the latter contains no acute cases. It is least likely to have taken place in the hotel on account of the then necessarily brief period of incubation. The case is classified, however, as one of possible, not of probable, origin in the hospital.

CASE IX. September 18, 1887, medical patient. She entered the Hospital a month ago with hysterical paraplegia, improved rapidly, and was sent to the Convalescent Home September 6th. On the day after arrival she had headache and dizziness, soon followed by diarrhoea, and on the following day she was obliged to take to her bed. She is re-admitted to the hospital with a temperature of 104.2° F., tenderness on pressure in both iliac regions, rose-spots and enlarged spleen. The temperature was at its maximum on the sixth day and remained at the normal point from the twelfth to the nineteenth day. A relapse then took place lasting some five days. She was discharged well. There seems no room for doubt that this case owed its origin to causes existing within the Hospital.

CASE X. September 19, 1887, medical patient. This woman entered without any history of previous illness, on the fifth day of an apparent attack of acute articular rheumatism. A systolic souffle was heard at the apex on the fifth day after admission, and two days later a friction-sound was recognized at the base of the heart. The temperature was 101.8° F. It remained between 100° F., and 101° F., till the sixteenth day when it rose for four days, reached its maximum 104.4° F., then gradually fell to the normal. Defervescence extended over a period of nearly six weeks. Two days after the rise began the abdomen is found to be "full and tympanitic, slightly tender in the right iliac region. Tongue dry, with thick brownish coat, sordes on teeth, mental condition dull. A few hyperæmic papules, redness disappearing on pressure, are present." On the next day "the wrists are tender on pressure," and several movements of the bowels occurred during forty-eight hours. Two days later a systolic souffle is distinctly heard in the pulmonic area and the pulmonic second sound is accentuated.

"The abdomen is covered and the posterior aspect sprinkled with nearly circular spots varying in size from a large pin's head to size of a cent, with intervening healthy skin. These patches are raised above the surface, the larger ones more so at the periphery than at centre. Smaller ones pretty uniformly raised. They have dull red margins, redness disappearing on pressure. 'Annular Roseola.'"

Twelve days later, the general condition of the patient progressing satisfactorily, it is noted, "wrists somewhat painful on motion. An indistinct souffle can be heard over base of heart."

During the rest of her stay in the Hospital, the slight pain and tenderness in the joints persisted for some time. The souffle near the pulmonic area disappeared, but marked pulmonic accentuation persisted.

Although this case is registered as one of typhoid

fever, the possibility of its being one of rheumatism is admitted. Many of its characteristics will be recognized as those occurring in acute ulcerative endocarditis. If the case be regarded as one eventually of typhoid fever, it is obvious that the latter disease may have originated, as a complication, from causes within the Hospital. A period of eleven days had elapsed after her admission before the existence of possible typhoid fever seemed probable. The case is, therefore, included as an illustration of possible typhoid of intra-hospital origin, although this possibility is regarded as doubly remote.

CASE XI. November 28, 1887, medical ward-tender. Well till three days of failing appetite; pain in the back and limbs and cough were followed by pain and tenderness in the right inguinal region, and fever. There was splenic enlargement, crops of doubtful rose-spots, and a continued fever, lasting four to five weeks. Recovery then took place.

The following table summarizes the results of this inquiry: Eleven cases of typhoid fever, of which seven probably and four possibly originated in the Hospital.

		Medical Officers.	Ward- Tenders.	Nurses.	Ward- Servants.	Patients.
1882	Probable Possible	1	..	..	..	..
1883	Probable Possible	..	..	1 1	..	..
1884	Probable Possible	..	1 ..	..	..	..
1885	Probable Possible	..	..	..	1 ..	..
1886	Probable Possible	1 ..	..	..	..	..
1887	Probable Possible	..	1 ..	1 ..	..	1 2
Total		2	2	3	1	3

The degree of probability that these seven cases were infected in the Hospital may present itself differently to each of a number of interested persons. It is impossible that the evidence obtainable in such cases can have more than a relative value.

It being admitted that the diagnosis is correct, the data which must lead towards conviction are based on the known variations in the period of incubation, the presence of typhoid cases in the wards, the occurrence of isolated cases during a period of years, and their exclusive limitation to persons connected with the medical or mixed medical and surgical wards.

In Hutchinson's paper, already referred to (p. 260), the following statement is the result of a consideration of the length of the period of incubation: "The conclusion would seem to be justifiable that the period of incubation in typhoid fever is usually between two and three weeks, but that in many cases it does not exceed ten days, and in rare instances has unquestionably been very much less. On the other hand, there are authentic cases on record in which it is said to have reached, or even exceeded, twenty-eight days."

Of the eleven cases considered in this paper, seven were constantly associated with typhoid patients for months. The remaining four were exposed during periods varying from eleven days to one month. It is thus apparent that all the above cases may have been infected within the Hospital.

If the causes of infection were introduced from without, as by impure water or milk, or by contaminated articles of food, an epidemic of the disease would be expected, not isolated cases. Neither would they at all times be limited to the medical service of the Hospital. The same argument holds here with reference to the possible origin of the disease from leaky drains and sewers. The origin of the poison is, then, to be sought for in those typhoid patients who are regularly brought to the Hospital from Boston and the surrounding country.

The most prolific, if not the sole source of typhoid fever is to be found in the patient himself. His dejections are almost absolutely proven to contain the poison of the disease, and it is possible that secretions from the air-passages may also be infectious. The most thorough-going preventive measures are those which shall destroy the influence of both these agents. The more we regard typhoid fever as contagious in the sense of small-pox and scarlet fever, the more efficient will be our preventive measures. Dried fæces and dried sputum are readily diffused by drafts of air. They are as readily inhaled or swallowed as the emanations from the most contagious of diseases. Prevention is best accomplished by destroying the emanations and burying the remains.

Such views are in no way novel, and, of late years, have been preached and practised more or less generally and with more or less vigor. I am indebted to Dr. H. B. Jacobs, medical house-officer, for the following account of the prophylactic measures used in a female ward of the Massachusetts General Hospital during the year 1887. They relate especially to the disposal of the dejections of typhoid patients. An empty, dry bed-pan is taken to the patient, and, after use, is covered and carried out of the ward to the hopper, where it is emptied. It is then rinsed with corrosive sublimate (1-1000) or with carbolic acid (1-20), and subsequently rinsed with water and dried with a cloth which hangs near the hopper. The latter is rinsed with the corrosive or carbolic solution, and water is allowed to run freely for several minutes. The hopper is scoured every morning with soap and sand. The cloth used in drying the bed-pan is changed every few hours; when wet or soiled, it is taken to the rinse-house with the soiled clothes. The patient is wiped with toilet-paper after the use of the bed-pan, and if unusually soiled, is washed with soap and water. If the dejections are involuntary, the patient is immediately washed, and the bed-clothes are changed. The soiled linen, including the gauze used in washing the patient, is carried to the rinse-house as soon as possible. If the bed-linen is particularly soiled it is sprinkled with a disinfectant before its removal.

Notwithstanding these precautions, which were carried out by intelligent, neat and conscientious nurses, two cases of typhoid fever apparently originated in this ward during the summer of 1887. Either the precautions were insufficient or the cases originated outside the hospital. The former alternative alone is under the control of the hospital authorities.

The requirements of disinfection consist in the ab-

solute cleanliness of the patient and his surroundings. This is accomplished by fresh air, daily baths, frequent changes of bed and body linen, the immediate changing of soiled clothes, and the rapid removal and destruction of all infective matter.

Until the researches instituted by Robert Koch,² concerning the relative value of disinfectants, our knowledge of the subject was very inexact. Disinfectants and deodorizers were essentially one and the deodorizer was usually the one. It was found that sulphur fumes are not to be relied upon to destroy anthrax-spores, the well-known cause for a sharply defined infective disease, namely, malignant pustule. It is, therefore, obvious that they should not be depended upon to destroy the unknown germs supposed to produce other diseases of the same group.

Bromine and chlorine are capable of destroying anthrax-spores with which they are in sufficiently prolonged contact and in sufficient concentration. But their specific gravity is such that as ordinarily used, they cannot reach all parts of the rooms which they are supposed to disinfect.

Even now the recommendations, and, perhaps, requirements, of our boards of health, contain directions which have little in their favor even if they are not worse than useless. In Berlin, according to Pistor³ it was not till 1881 that any essential change was made in methods of public disinfection from those prescribed in 1835. In 1886 a further revision was made.

According to these regulations the use of bromine and chlorine is discontinued on account of the previously stated objections. Sulphur fumigations are not recognized as a trustworthy disinfectant, even when the conditions for their use appear to be most favorable. Corrosive sublimate is not employed in consequence of its poisonous qualities, and because it forms insoluble compounds with sulphuretted hydrogen, ammonia and albumen. In the disinfection of the city of Boston, in 1887, according to the sixteenth annual report of the Board of Health, there were used 16,592 pounds of sulphur in fumigation and 2,250 pounds of corrosive sublimate in solution.

The following suggestions for the prevention of the origin of typhoid fever in hospitals are based upon these revised Police-Regulations for Disinfection in Contagious Diseases. They are presented in the form of special directions to nurses in cases of typhoid fever. They have been examined by Dr. Pratt, the superintendent of the hospital, and have been amended and approved by him. They apply equally well to cases in private practice, and may be employed in all contagious diseases. The knowledge and experience of the physician will lead him to make such deviations from these rules as the individual case seems to demand or permit.

SPECIAL DIRECTIONS IN TYPHOID FEVER.

1. Mattresses and pillows (when liable to become soiled) are to be protected by close fitting rubber covers.

2. Bed and body linen are to be changed daily. Bedspreads, blankets, rubber sheets and rubber covers are to be changed at once, when soiled by the patient. Avoid shaking any of these articles.

3. All changed linen, bath-towels, rubber sheets and covers are to be immediately wrapped in a sheet soaked in carbolic acid (1-40). Remove to the rinse-house as soon as possible, and soak six hours in carbolic acid (1-40). Then boil the linen for a half-hour, and wash with soft soap. The rubber sheets and

covers are to be rinsed in cold water, dried, and aired for eight hours. The bedspreads and blankets are to be aired eight hours daily.

4. Feeding utensils are to be thoroughly cleansed in boiling water immediately after being used.

5. Dejections are to be received in a bed-pan containing half a pint of carbolic acid (1-20). The nates are to be cleansed with paper, and finally with compress cloth wet in carbolic acid (1-40).

6. The bed-pan and cloths are to be carried to the tower. Add two quarts of carbolic acid (1-20) in divided portions to the contents of the bed-pan, mix thoroughly by shaking, and throw the liquid into the hopper. The bed-pan and hopper are to be cleansed with carbolic acid (1-20), and wiped dry. The compress-cloths used for the above purposes are to be burned at once.

7. The corpse is to be covered with a sheet wet with carbolic acid (1-40), and removed to the Allen Street House.

8. After the discharge of the patient, mattresses are to be thoroughly beaten and aired every day for a week. The bedstead is to be washed with corrosive sublimate (1-1000).

9. These directions are to be followed until the patient is free from fever.

PROPER AND IMPROPER METHODS OF DISINFECTION.¹

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FOR the proper practice of disinfection it is first of all necessary to discriminate between true disinfectants and antiseptics, the former of which destroy the vitality of micro-organisms, while the latter merely prevent or retard their development. This distinction is unfortunately not always borne in mind, and many processes of supposed disinfection are for this reason utterly valueless.

It is also of the very greatest importance that of the many agents recommended as true disinfectants none should be employed except those which have been thoroughly tried and proven by the most reliable and scientific methods, and any agent which fails to pass the requirements based on modern scientific research, should, without regard to its popularity, ease of application, cheapness, or long record of supposed efficacy, be abandoned.

Previous to the investigations of Koch and others of the Imperial Board of Health of Germany, the processes used in disinfection were very numerous, and, owing to a lack of definite knowledge of the subject, were applied in a hap-hazard manner. The list of supposed disinfectants was very long, and included many compounds which owed their supposed value to penetrating odors. The most valuable agent for the disinfection of rooms and furniture, ships and cargoes, was for many years considered to be the fumes of burning sulphur, the efficacy of which was demonstrated as early as 1771, though they had been employed many centuries. Fumigation by means of chlorine, bromine, etc., were regarded as valuable, but of rather minor importance compared with sulphur. In the employment of agents which have since been proved to be valuable, no rules were followed as to proper amount or strength.

In 1881 Koch² demonstrated the unreliability of sulphur fumigations by a long series of careful experiments, begun in 1879, and conducted under the most scientific conditions by himself, Hueppe, Proskauer, Westphal, von Knorre, Platt and Seyd. They proved

¹ Read before the Boston Society for Medical Improvement, April 23, 1888.

² Wolffhügel. Ueber den Werth der Schwefeligsäure als Desinfectionsmittel. Mittheilungen aus dem kaiserlichen Gesundheitsamte. Bd. I.

³ Mitth. aus d. Kaiserl. Gesundheitsamte. 1881, I, 234.

⁴ Deutsche. Vrtljschr. f. öff. Gsndhtspflg. 1887, xix, 318.