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Effect of Operation on Persistence of Inspired Bacteria in the Lungs of Mice.

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(Introduced by O. H. Wangensteen.)

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Both the bronchogenous and embolic theories of the pathogenesis of postoperative pneumonia command attention at the present time. The rôle played by bacteria already present in the respiratory tract or introduced into the body at the time of operation must be evaluated. It is probable that bacteria may enter the lungs through the air passages, that they may be removed in the lungs by some defense mechanism, and that certain factors may inhibit this defense of the lungs against the inhaled bacteria. Such a conclusion seems to be justified by the work of Stillman,¹ who subjected mice to atmosphere laden with various bacteria; when pneumococci Type I were inspired by normal mice they could later be demonstrated in the lungs, but disappeared within 3 hours. However, when alcoholized mice were subjected to the same experiment pneumococci were found in the lungs as late as 5 days after breathing the contaminated air.

Because of these facts we were led to investigate the disappearance or persistence of inspired microorganisms in the lungs of mice after operation in order to determine whether there was any delay in the removal of bacteria which might be a factor in the pathogenesis of pneumonia.

Method. The general technique was similar to that described by Stillman.² Mice were placed in a metal box into which broth cultures of bacteria were sprayed. Some of these mice were normal controls. Others had had operations which consisted of simple laparotomy and closure or simple incision and closure of the skin and muscles of the thorax. These procedures were carried out under novocaine infiltration anesthesia. After having been sprayed for one hour the animals were removed from the spraying chamber. They were sacrificed at definite intervals of time by strangulation and then were immersed in lysol solution for 10 minutes prior to necropsy. The thorax was opened with an electrocautery

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¹ Stillman, E. G., *J. Exp. Med.*, 1923, **38**, 117.

² Stillman, E. G., and Branch, A., *J. Exp. Med.*, 1924, **40**, 733.

and sections of the hilus and periphery of the lung removed by means of sterile instruments for culture. A pneumococcus Type I culture was employed in the spray in the early experiments, but because of difficulty in identifying this organism and because of the inhibiting effect on it of other bacteria, the experiments were repeated with *B. prodigiosus* and Friedländer bacillus. In order to identify the pneumococci we routinely used blood agar plate and veal broth, thereby obtaining simultaneously the advantages of a separating medium as well as one upon which the pneumococcus grew readily. As a final test the bile solubility test was employed.

Results. The results are recorded in the following tables, the time interval referring to the time after removal from the spraying chamber, and the terms positive and negative indicating whether the sprayed organisms could be cultured from the lungs. (Tables I, II, and III.)

TABLE I.
Sprayed with *Pneumococcus* Type I.

A			1	2	3	4	5	6	7	Total mice
Controls	Hours									
	Positive		2	1	2	3	2	0	—	
	Negative		4	5	4	3	4	10	—	40
B										
Abdominal Operations	Positive		—	—	—	0	0	0	0	
	Negative		—	—	—	2	2	5	9	18
C										
Thoracic Operations	Positive		—	—	—	0	0	0	0	
	Negative		—	—	—	1	1	1	6	9

TABLE II.
Sprayed with *B. prodigiosus*.

A			1	2	3	4	5	6	7	Total mice
Controls	Hours									
	Positive		3	0	2	0	1	0	—	
	Negative		0	3	1	3	2	5	—	20
B										
Abdominal Operations	Positive		—	—	—	2	1	1	0	
	Negative		—	—	—	0	1	4	9	18
C										
Thoracic Operations	Positive		—	—	—	0	1	0	0	
	Negative		—	—	—	1	0	1	6	9

TABLE III.
Sprayed with Friedländer Bacillus.

A			1	2	3	4	5	6	7	Total mice
Controls	Hours									
	Positive		3	2	0	1	0	0	—	
	Negative		0	1	3	2	3	5	—	20
B										
Abdominal Operations	Positive		—	—	—	0	2	0	0	
	Negative		—	—	—	2	0	5	9	18
C										
Thoracic Operations	Positive		—	—	—	1	0	0	0	
	Negative		—	—	—	0	1	1	6	9

The inspired organisms were recovered irregularly during the first 5 hours. Only one culture of a mouse operated upon was positive at the end of 6 hours (Table II, B). Although more positive cultures were obtained in the animals operated upon than in the controls 4 or 5 hours after the spraying with *Bacillus prodigiosus* or with Friedländer bacillus, this result was not striking and was contradicted by the experiments with pneumococcus.

Contaminating organisms were present in 29 of 40 cases, particularly the subtilis, micrococcus and pyocyaneus groups which in many instances undoubtedly inhibited the growth of the organisms being studied, and prevented their demonstration (Neisser³ and Jones⁴). This we were also able to demonstrate by mixing cultures of contaminating bacteria with pneumococci and attempting to reisolate the pneumococci. The presence of contaminating bacteria is undoubtedly one of the factors contributing to the irregularity of the recorded results.

Summary. 1. The examination of 80 mice showed that the inhaled pneumococci, *B. prodigiosus* and Friedländer bacilli can remain 5 hours in the lungs. 2. The microorganisms are found in the lung irregularly from one to 5 hours after inhalation. 3. There was no difference between the peripheral and hilus portion of the lungs. 4. Examination of 81 mice showed that abdominal or thoracic operations produced no increase in the period of persistence of the inhaled bacteria in the lungs. 5. No definite evidence was found to justify the belief that surgical operations handicap the mechanism by which bacteria are destroyed or removed from the lungs of mice.

³ Neisser, M., *Z. f. Hyg. u. Inf. Krankheiten.*, 1896, **5**, 12.

⁴ Jones, F. S., *J. Exp. Med.*, 1922, **36**, 317.