

## Unusual Outbreaks of Postoperative Staphylococcal Infection in Surgical Clinic

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Infectious complications in the postoperative course of gastrointestinal surgery are quite different in origin from those seen in the fields of internal medicine. Firstly, postoperative patients are much more liable to infection inasmuch as incisional opening, inadequate respiration caused by pain, abnormal pulmonary circulation, and nasal tube insertion aids the development of pulmonary infections immediately following major surgery. Secondly, inadequately ligated anastomoses often give rise to peritonitis and pyothorax which ordinarily prolong their clinical courses accompanying additionally developing infections. Thirdly, since a great number of such postoperative patients are usually accommodated in a clinic at any one time they are exposed to cross infection. Also vigorous administration of preventative antibiotics causes the occurrence of resistant strains. We experienced an outbreak of *Staphylococcus aureus* infection in our clinic in October 1956, and four other times. Here we follow them mainly by means of bacteriophage typing and discuss "hospital strain".

### Method

I. R. T. D. (Routine Test Dilution) was used for phage typing. The twenty strains of the National Collection of Type Cultures were used for qualifying outbreaks in 1957 and 1958 and 42B, 51, 80, 81, and 847B were added for use in 1960 and 1961. The method of determination of lysogenicity has been reported in our previous paper<sup>1</sup>. The herein defined *Staphylococcus aureus* is coagulase-positive and produces acid from mannitol.

Following are the reports of four outbreaks of *Staphylococcus aureus* infection.

(1) In June 1956, *Staph. aureus* was isolated from four suppurations seen on operative incisions, all of which developed almost simultaneously on the same

ward. Four out of six strains isolated at that time were 52 in phage pattern. At the same time, a physician in charge of that ward was found to have a furuncle on his neck from which pattern 52 was isolated. His furuncle developed priorly and it was at its height when the infection outbreak occurred on his ward. These four strains of phage pattern 52 were identical in their lysogenicity, too (Table 1).

Table 1. Phage Types of *Staphylococcus aureus* isolated from Postoperative Infection Sites during the October 1956 Outbreak

Case Number	Infection Site	Phage Type	Lysogenicity
1	Operative wound	52	—
2	Operative wound	52	—
3	Operative wound	52	—
4	Operative wound	52	—
Doctor	Furuncle on neck	52	—
5	Operative wound	47/54/53/77	
6	Operative wound	47/54/53/77	

(2) In September 1960, a similar outbreak of incisional suppuration was observed where all of twelve postoperative patients showed *Staph. aureus*, four of which were 52/52A/80 and three of which were 52/80 in phage pattern. In this instance, the silk thread used in surgery was found to have been contaminated and thus considered to explain the route of that outbreak. That silk, however, having been well disinfected under a pressure of fifteen pounds for thirty minutes in an autoclave, contamination of the silk threads by air-borne germs during the preparation of instruments for surgery was the only feasible possibility. These infections subsided upon disinfection of the wards and operation rooms with Formalin Spray (Table 2).

(3) In September and October 1957, there was

another outbreak where again severe postoperative complications of pneumonia, pyothorax, and peritonitis were experienced and we had two deaths. *Staph. aureus* isolated then were phage Group III and 6/7/47/54/75 or 6/7/47/54/75/53 in phage pattern (Table 3).

Table 2. Phage Types of *Staphylococcus aureus* isolated from Postoperative Infection Sites during the September 1960 Outbreak

Case Number	Infection Site	Phage Type
1	Operative wound	52/52A/80
2	Operative wound	52/52A/80
3	Operative wound	52/52A/80
4	Operative wound	52/52A/80
5	Operative wound	52/80
6	Operative wound	52/80
7	Operative wound	52/80
8	Operative wound	52/52A/29/54
9	Operative wound	54
10	Operative wound	Untypable
11	Operative wound	Untypable
12	Operative wound	Untypable

Table 3. Phage Types of *Staphylococcus aureus* isolated from Postoperative Infection Sites during the Outbreak from September to October 1957

Case Number	Infection Type	Phage Type
1	Pneumonia	6/7/47/54/75/53/77
2	Peritonitis	6/7/47/54/75/53/3A
3	Peritonitis	6/7/47/54/75/53/77
4	Peritonitis	6/7/47/54/75/53/3A
5	Pyothorax	6/7/47/54/75
6	Wound infection	6/7/47/54/75
7	Septicemia	6/7/47/54/75
8	Furunculosis	6/7/47/54/75

(4) In August 1961, nine postoperative patients developed severe pyothorax and pneumonia caused by *Staph. aureus* six of which were 47/54/53 in phage pattern (Table 4). The same strains were isolated from many infectious wounds of other admitted patients, especially from their upper respiratory tracts. In the outbreaks in 1957 and 1961, the organisms isolated from postoperative patients suffering from severe complications of pyothorax, pneumonia, etc. were exactly the same in their phage

pattern as those isolated at the same time from the upper respiratory tracts of the other people on the wards (Table 5). Also we found that the majority of those from whom above mentioned staphylococci were isolated were patients who had had major gastrointestinal surgery in their early postoperative days while the hospital staff and preoperative patients whose pharynx showed the staphylococci were only 6.5 and 4.0 per cent respectively (Table 6). This can be explained by the administration of the broad spectrum antibiotics such as tetracycline (TC), chloramphenicol (CP), etc. during the postoperative periods of those major surgeries<sup>20</sup>. We had a similar

Table 4. Phage Types of *Staphylococcus aureus* isolated from Postoperative Infection Sites during the August 1961 Outbreak

Case Number	Infection Type	Phage Type
1	Pyothorax	47/54/53
2	Pyothorax	47/54/53
3	Pyothorax	47/54/53
4	Parotitis	47/54/53
5	Pneumonia	47/54/53
6	Wound infection	47/54/53
7	Wound infection	52/52A/80/81/847B

Two cases of infectious diseases caused by other type bacteria were also diagnosed.

Table 5. Phage types of *Staphylococcus aureus* isolated from Throats of Admitted Patients in 1957, 1960, and 1961

	1957	1960	1961
Number of cases examined	154	44	30
Number with <i>Staph. aureus</i>	78	23	20
Typable	44	22	19
Untypable	34	1	1
Phage Type	Number of Strains		
6/7/47/54/75	11	0	0
6/7/47/54	7	0	0
47/54	12	1	3
47/54	0	4	0
47/54/53	0	5	7
47/54/53	0	4	5
52 or 52A	1	1	0
52/52A	2	0	0
52/52A/80	0	1	0
52/52A/29/79	0	0	1
Other types	11	6	3

Table 6. Pharyngeal Carrier Rates in Admitted Patients of *Staphylococcus aureus* with Phage Type 6/7/47/54/75 or 47/54/53

Type of Surgery	Number of Patients Inspected	Number of Carriers Cases Percentage	
Esophageal surgery or total gastrectomy	59	36	61 %
Other gastrointestinal surgery	90	23	25 %
Non-gastrointestinal surgery	16	1	
Prior to surgery	71	3	4 %
Hospital personnel	107	7	6.5%

result from seventeen cases of stomach resections, i.e., *Staph. aureus* (47/54/53 or 6/7/47/54/75) was isolated from five out of nine TC or CP given cases, only one out of seven penicillin (PC) or streptomycin (SM) given cases, and only one out of six cases to which no antibiotics were given.

Thus we found that the antibiotics used postoperatively greatly influenced the bacteria populations commonly seen in the patients' upper respiratory tracts and subsequently the population of bacteria in the whole hospital.

Reviewing the above four outbreaks of *Staph. aureus* infections, we see the tendency that Group I caused more postoperative wound infections than Group III did and that type III caused more pneumonia, pyothorax, and peritonitis.

Out of thirty-two cases of postoperative wound infections found in our clinic in 1961, twenty-two cases showed 52/52A or 52/52A/80 phage pattern whereas phage pattern 47/54/53 was isolated from only seven cases. On the other hand, from nineteen out of twenty-six cases of postoperative pneumonia and pyothorax, the 47/54/53 type *Staph. aureus* was isolated.

Here we presume that the persistent administration of broad spectrum antibiotics such as TC and CP helps the growth of *Staph. aureus* in the admitted patients' upper respiratory tracts which causes the outbreak of pneumonia, pyothorax, peritonitis, etc.

Since the majority of pyothoraxes following upper digestive tract surgery are an extension of postoperative pneumonia, although many pyothorax and peritonitis incidents are due to insufficient sutures, the population of bacteria in the upper respiratory tracts plays important roles in the prognosis of those patients.

It is too early to conclude the outbreak of *Staph. aureus* infections as one of cross infections if the infection routes have been detected only by phage typing.

In our previous papers, phage pattern 6/7/47/54/75 was reported as hospital strain. However, we further found that bacteria showing the same phage pattern may be divided into different groups according to lysogenicity and resistance to antibiotics.

*Staph. aureus*, 6/7/47/54/75 and 52 in phage pattern, for example, include two or three subdivisions in

Table 7. Lysogenicity of *Staphylococcus aureus* of the Lytic Pattern 6/7/47/54/75 or 52

Phage Type	Number of Strains	Lysogenicity Host Range
6/7/47/54/75	9	52/47 <sup>+</sup> 3 strains 52/52 1 strain — 5 strains
6/7/47/54/75/73	3	54/47 1 strain — 2 strains
6/7/47/54	5	47 2 strains — 3 strains
52	7	6/7/73 2 strains — 5 strains

+ Number of WILLIAM's Propagating Strains lysed by phage derived from lysogenetic strains.

Table 8. Resistance to Antibiotics of *Staphylococcus aureus* with Phage Types 6/7/47/54/75 and 47/54/53

Antibiotics	Phage Type 6/7/47/54/75 isolated in 1957				Phage Type 47/54/53 isolated in 1960			
	Resistant Type		Sensitive Type		Resistant Type		Sensitive Type	
PC	100	1 U.	0.1	I. U.	100	I. U.	1	I. U.
SM	100	mcg/cc	1	mcg/cc	100	mcg/cc	1	mcg/cc
CP	3	mcg/cc	3	mcg/cc	10	mcg/cc	1	mcg/cc
TC	100	mcg/cc	0.3	mcg/cc	100	mcg/cc	0.1	mcg/cc
EM		0.03 mcg/cc	0.03	mcg/cc	1	mcg/cc	0.1	mcg/cc
OM					10	mcg/cc	0.1	mcg/cc
Si	100	mcg/cc	0.3	mcg/cc				

their lysogenicity and also there are both antibiotics resistant and non-resistant types (Tables 7 & 8). Therefore, simultaneous occurrence of more than two *Staph. aureus* infections the same in phage pattern does not necessarily indicate cross infection.

However, most of the time when many *Staph. aureus* infections were observed almost simultaneously, we were able to isolate that same organism from extensive areas in the hospital and regardless of the identity of their phage patterns, the disinfection plan of those areas has to be vigorously activated. The term "hospital strain" should not designate more than those organisms isolated in extensive areas of the hospital, resistant to multiple antibiotics, and causing various infections and it seems to be of little value to search for a bacteria phage pattern alone.

#### Discussion

The outbreaks of *Staph. aureus* infections among postoperative patients seem to be roughly divided into two groups. In the first group, the simple origins of the infections are always found as the furuncle on a doctor's neck we experienced in 1956 and the furuncle on the surgeon's forearm reported by McDONALD and TIMBURY<sup>3)</sup> and the route of infection expansion can be traced one to the other.

In the second group, outbreaks are the simultaneous occurrence of multiple infections caused by some certain type of bacteria widely populated in the hospital as the groups of pyothorax, peritonitis, and pneumonia we experienced in September 1957 and 1961. The larger part of this second group in our findings was caused by Group III.

As often reported previously by others<sup>4)5)</sup>, we believe the majority of resistant *Staphylococcus aureus* are classified as Group III. WILLIAMS also reported that 6/7/47/54/53 and 7/47/54/53 are the common patterns<sup>6)</sup>. Most of Group III we isolated were 6/7/47/54/75 or 47/54/53, many of which were from upper respiratory tracts of postoperative patients given broad spectrum antibiotics.

Also noted was that the *Staph. aureus* encountered in postoperative infections such as pneumonia, pyothorax, and peritonitis were often the same in phage pattern as those isolated from patients' upper respiratory tracts and it is postulated that the *Staph. aureus* in patients' upper respiratory tracts

is one of the sources of outbreak in the hospital.

Recently reported was that the type 80/81 of *Staph. aureus* was isolated from the noses and throats of a high percentage of hospital personnel<sup>7)</sup>. However, as seen in ROUNTREE's papers<sup>8)</sup>, the above phage pattern of *Staph. aureus* was also isolated from the noses of the majority of patients upon hospital admission and therefore it is not considered reliable to take all of the 80/81 pattern as the hospital strain.

It is postulated that the marked difference in host range of phages used for phage typing may explain a part of the reasons for the above.

Aside from the interest of their epidemiology, of the greatest importance for we clinicians is the prevention of the outbreak of resistant strains, which requires: the proper use of antibiotics, the complete sterilization of the bed rooms, safe operative techniques, and good postoperative care.

#### Summary

The four occasions of unusual outbreaks of postoperative *Staphylococcus aureus* since 1956 were analysed and discussed from the viewpoint of phage typing of their causative organisms.

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