The authors of this paper report a series of investigations of subtypes of certain strains of staphylococci. They point out as well the epidemiologic application of these findings to hospital problems.

LABORATORY OBSERVATIONS ON THE LYSOGENIC PROPERTIES OF HOSPITAL STAPHYLOCOCCI AND THEIR POSSIBLE EPIDEMIOLOGICAL IMPLICATIONS

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IN RECENT YEARS intensive laboratory investigations have been undertaken by several investigators to determine the biologic and epidemiologic relationships of staphylococcus strains showing similar but not identical phage typing patterns.[1-3] Such studies have been stimulated by the world-wide occurrence of hospital-acquired staphylococcal infections, particularly those caused by phage types 80/81, 52/52A/80/81 and 52/52A/80. When these strains were first seen in the United States 80/81 was predominant.[4,5] However we, as well as others, have observed a gradual, but steady increase in the appearance of 52/52A/80/81 and 52/52A/80 strains in association with hospital staphylococcal infections.[6] Furthermore, in studies of surgical problems in Atlanta, strains of two of the phage types were isolated from a single culture from one surgeon,[7] and from cultures taken at the same time from different sites of other individuals, both personnel and patients.[6]

It has been known for some time that the phage type of a staphylococcus strain may be changed by lysogenization; i.e., by the introduction of a new phage into the strain by in vitro exposure of the strain to a phage, or presumably by contact with lysogenic (phage carrying) staphylococci in nature.[8-10] It seemed likely that this phenomenon could be responsible for the existence of the three strains 80/81, 52/52A/80/81, and 52/52A/80. Accordingly investigations were undertaken to study the relationships of the lysogenic and lysogenizing properties of these strains. It was found that distinct subtypes existed within each of the three original types, that conversion from one type to another could be induced by lysogenization, and that phages isolated from the strains could be used to clarify epidemiologic relationships of personnel to postoperative staphylococcal infections in an Atlanta hospital.[6]

During the course of this study, in vitro conversions of the 80/81 and 52/52A/80/81 strains to 52/52A/80/81 and 52/52A/80 strains, respectively, were reported independently by others.[1,2] Our results supply further independent confirmation of such conver-

sions and demonstrate the reverse conversion from 52/52A/80/81 to 80/81.

Materials and Methods

Cultures—The strains used in this study were selected from specimens received for phage typing from various state laboratories and hospitals. Most of the cultures had been stored by the sand desiccation method.[11] Since routine clinical specimens are sometimes mixed cultures of staphylococci,[1,12] the strains were streaked from a single colony for three consecutive subcultures prior to use in the experiment. In addition, to determine whether such transferring assured homogeneous cultures, 100 separate colonies of each of four strains (80/81 strain DA 226-6, 80/81 strain DA 594-8, 52/52A/80/81 strain DA 100-9, and 52/52A/80 strain DA 223-8) were picked and typed with the phages in routine use in this laboratory. Each of the four strains showed complete homogeneity with respect to their phage pattern.

Phages—Routine typing was done with the 21 phages of the international basic set and three additional phages as follows: 29, 52, 52A, 79, 80, 3A, 3B, 3C, 55, 71, 6, 7, 42E, 47, 53, 54, 73, 75, 77, 42D, 187, 83(VA4), 44A, 81. The typing technic was that described by Williams, et al.,[13] with minor modifications.[14] Other phages used for typing and/or lysogenization were isolated in this laboratory from hospital strains of 52/52A/80/81, 52/52A/80, 80/81, and 80. The detection and isolation of phages from lysogenic staphylococci was accomplished by overlaying one on the other on agar medium according to the method of Fisk.[15] To distinguish the phages isolated in this study from the standard phages the letter S was prefixed to the phage number. All phages were filtered through a porcelain filter and tested for sterility before use.

Media—Trypticase Soy Broth* and Trypticase Soy Agar* were used throughout the study.

Lysogenization — This was accomplished by placing a drop of concentrated phage—usually 100 x the routine test dilution (RTD)—on an agar plate seeded with a four-hour broth culture of the staphylococcus strain to be lysogenized. The plate was incubated at 37° C for four hours and left at room temperature overnight. Secondary growth, if present, usually arose within 12 hours and in some cases was evident immediately after the four-hour incubation. Cells from the secondary growth within a lysed area were picked and seeded to a fresh agar plate. After overnight incubation at 37° C single colonies from the latter plate were picked and subcultured. All cells of the secondary growth were not always lysogenized but mixed lysogenic and nonlysogenic colonies could be recognized by their transparent, glassy, degenerated appearance on first subculture or the presence of lytic plaques on the second subculture. Such mixed cultures were not used in any tests. The proportion of lysogenic response was not estimated. The lysogenicity of lysogenized cultures was tested by Fisk's method[15] of placing each one on its parent strain and on the indicator strain for the lysogenizing phage, and by demonstrating its resistance to the lysogenizing phage. The conversion of phage type after lysogenization was tested with the standard phages. Lysogenized strains were designated by placing the number of the lysogenizing, and therefore now carried, phage in parentheses after the original strain number; for example, DA 226-6 (S-36) designates a culture of strain DA 226-6 lysogenized with phage S-36.

Definitions—Prophage: A phage precursor carried by a cell without lysing that cell. Lysogenic: carrying a pro-

* Baltimore Biological Laboratories.

Table 1—Lysogenizations with Phages from Staphylococcus Strains with Phage Pattern 52/52A/80

Source of Lysogenizing Phage		Lysogenizing Phage	Susceptible to Lysogenizing Phage		Induced by Lysogenization	
Type	Subtype		Type	Subtype	Type	Subtype
52/52A/80 (DA 779-8)*	I	S-39	52/52A/80	II & III	52/52A/80	I
			52/52A/80/81	II & IV		
			80/81	I & III		
			80/81	II	under study	
52/52A/80 (DA 16-9a)	II	S-85a	52/52A/80	I & III	52/52A/80	II
			52/52A/80/81	I & IV		
			80/81	I & III		
			80/81	II	under study	
52/52A/80 (DA 412-8)	III	S-41	52/52A/80	I & II	52/52A/80	III
			52/52A/80/81	I, II, & IV		
			80/81	I & III		
			80/81	II	29/52/52A/80/(79)†	

* For details on strains and phages see text and appendixes.
† Weak reaction with 79; variable with 29.

phage. Lysogenic to: yielding a phage which can lyse and lysogenize. Lysogenize: introduce a phage into. Lysogenization: introduction of a phage into.

Results

On the basis of their lysogenic properties each of the three phage types under study was divided into three or more subtypes which we designate by Roman numerals. Within each type and between the types lysogenizations were accomplished, often reciprocally and usually with conversion to a strain having the characteristics of the parent strain of the lysogenizing phage. For example: strains 52/52A/80 II lysogenized by the phage of strains 52/52A/80/81 I are converted to 52/52A/80/81 I, and strains 52/52A/80/81 I lysogenized by the phage of strains 52/52A/80 II are converted to 52/52A/80 II. Details of our observations are as follows*:

1. 52/52A/80 Subtypes—Three have been identified.

(a) Subtype I (S-39 type). Table 1—Strains of this subtype are characterized by their identity to strain DA 779-8 from which phage S-39 was originally isolated. S-39 can lyse and lysogenize 52/52A/80 II and III, and 52/52A/80/81 II, the phages from all of which can in turn lyse and lysogenize the 52/52A/80 I strains. Phages from subtype I strains can also lyse and lysogenize 80/81 I, II, and III, and 52/52A/80/81 IV strains but the reciprocal relationship

* To simplify the textual and tabular presentations of general concepts, most of the specific information on cultures, phages and conversions is given in Appendixes 1 and 2.

has not been observed. In every case except 80/81 II the lysogenized cultures are converted to the parent strain of the lysogenizing phage. Reactions with 80/81 II are of particular interest and will be discussed in more detail later. In our collection of cultures we have found many strains of this subtype, most of which were received in July, 1956, from the California State Health Department Laboratory.

Further studies on the interrelationships of lysogenic properties of the three major types under study indicate that there are two additional subdivisions within this subtype. Details will be reported at a later date.

(b) Subtype II (S-85a type). Table 1—Only the original strain of this subtype has been found; i.e., DA 16-9a from which phage S-85a was isolated. This strain is lysogenic to 52/52A/80 I and III, and 52/52A/80/81 I which are in turn lysogenic to it. It is also lysogenic to 52/52A/80/81 IV and 80/81 I, II, and III but the reciprocal relationship has not been observed. Conversion is to the parent strains except with 80/81 II.

(c) Subtype III (S-41 type). Table 1—These strains are characterized by their identity to DA 412-8 from which phage S-41 was isolated. They are reciprocally lysogenic to 52/52A/80 I and II, and 52/52A/80/81 I and II. They are also lysogenic to 52/52A/80/81 IV and 80/81 I, II, and III but the reciprocal relationship has not been observed. Conversion is to the parent strain except with 80/81 II. Many strains of this subtype have been recovered in 1959 from sporadic infections in an Atlanta hospital.

2. 52/52A/80/81 Subtypes — Three have been identified.

(a) Subtype I (S-36 type). Table 2—This subtype is considered to correspond to subtype I of 52/52A/80 because of similarities in the lytic spectra of phages S-36 and S-39 and also because of more basic interrelationships of both phages and organisms, interrelationships which will be reported elsewhere. These strains are characterized by their identity to DA 16-7 from which phage S-36 was isolated. These 52/52A/80/81 strains are reciprocally lysogenic to 52/52A/80 II and III, and 52/52A/80/81 II. They are also lysogenic to 52/52A/80/81 IV and 80/81 I, II, and III but the reciprocal relationship has not been observed. Conversion is to the parent strain except with 80/81 II. We have found many strains of this subtype from babies and personnel involved in an outbreak in a nursery in South Carolina in January, 1957.

(b) Subtype II (S-85b type). Table 2—This subtype corresponds to subtype II of 52/52A/80. The strains are characterized by their identity to DA 16-9b from which S-85b was isolated. They are reciprocally lysogenic to 52/52A/80 I and III, and 52/52A/80/81 I. They are also lysogenic to 52/52A/80/81 IV and 80/81 I, II, and III but the reciprocal relationship has not been observed. Conversion is to the parent strain except with 80/81 II. Several strains were found in 1958 and 1959 from sporadic infections in an Atlanta hospital both during and following the 1958 outbreak of postsurgical infections mentioned above.

(c) Subtype III—As yet we have found no strains which correspond to subtype III of 52/52A/80.

(d) Subtype IV (O-type). Table 2—As yet we have found no strains of 52/52A/80 which correspond to this subtype. The strains are designated O-type since no phage has been isolated from them. They are characterized by their identity to DA 736-8 which can be lysed and lysogenized by all subtypes of 52/52A/80 and by 52/52A/80/81 I and II, in each case with conversion to the parent strain of the lysogenizing phage. Several strains were found in 1958 and 1959 from carriers and in-

Table 2—Lysogenizations with Phages from Staphylococcus Strains with Phage Pattern 52/52A/80/81

Source of Lysogenizing Phage		Lysogenizing Phage	Susceptible to Lysogenizing Phage		Induced by Lysogenization	
Type	Subtype		Type	Subtype	Type	Subtype
52/52A/80/81 (DA 16-7)*	I	S-36	52/52A/80/81	II & IV	52/52A/80/81	I
			52/52A/80	II & III		
			80/81	I & III		
			80/81	II	29/52/52A/80/81/(79)†	
52/52A/80/81 (DA 16-9b)	II	S-85b	52/52A/80/81	I & IV	52/52A/80/81	II
			52/52A/80	I & III		
			80/81	I & III		
			80/81	II	29/52/52A/80/81/(79)†	
52/52A/80/81 (DA 736-8)	IV	None isolated	—	—	—	—

* For details on strains and phages see text and appendixes.
† Weak reaction with 79; variable with 29.

fections in the Atlanta hospital with the 80/81 postsurgical problem.

3. 80/81 Subtypes—Three have been identified among hospital strains. In addition, a fourth subtype has been produced in vitro from three different strains.

(a) Subtype I. Table 3—These strains are characterized by their identity to strain DA 226-6 which shows a distinctive "inhibition" reaction[14] to 1,000 x RTD concentrations of phages 52 and 52A. These strains have not been shown to be lysogenic in spite of intensive efforts to find susceptible cultures. They are lysed and lysogenized by the phages from 52/52A/80 I, II, and III, and 52/52A/80/81 I and II, in each case with conversion to the parent strain. This conversion seems to be identical to one of those reported by Rountree[1] and Asheshov and Rippon.[2] They are differentiated from other 80/81 subtypes by their lytic pattern with phages at 1,000 x RTD and/or by their resistance to phage S-90, the page with which in vitro conversion to 80/81 was accomplished, as will be described later. The majority of our 80/81 strains belong to this subtype.

(b) Subtype II. Table 3 — These strains are characterized by their identity to strain DA 594-8 which gives the lytic pattern 80/81/7/73 with phages at 1,000 x RTD concentrations. They are not lysogenic to any of our strains of the 80/81 complex but are lysogenic to two untypable strains, DA 358-9 and DA 359-9. Details of the latter reactions will be given in another report. Subtype II strains can be lysed and lysogenized by phages from strains of 52/52A/80 I, II, and III, and 52/52A/80/81 I and II. However, in contradistinction to all the other conversion reactions observed in this study the phage pattern of the converted strains is not identical to the pattern of the parent strains of the lyso-

genizing phage. For example: Lysogenization with phage S-41 from 52/52A/80 III strain produced a strain with the phage pattern 29/52/52A/80/(79) and lysogenization with S-36 from a 52/52A/80/81 I produced 29/52/52A/80/81/(79). As indicated by the parentheses around the number, the reactions with 79 were usually weak. Furthermore, the reactions with 29 were somewhat variable, but with 1,000 x RTD phages other faint but critical reactions were apparent. An additional report will be made after further study of these reactions. Subtype II strains are resistant to phage S-90. Four strains of this subtype have been found in our collection. All were isolated on the same day from the air in an operating room of a hospital in Savannah, Ga., in June, 1958.

(c) Subtype III. Table 3—Only the original type of this subtype has been found, i.e., DA 670-9. It is characterized by its lytic pattern of 52/52A/80/81 with phages at 1,000 x RTD, its susceptibility to S-90, and its susceptibility to lysogenization by the phages from 52/52A/80 I, II, and III, and 52/52A/80/81 I and II. Conversion is to the parent strains. It has not been shown to be lysogenic.

(d) Subtype IV. Tables 4 and 5—Three distinct types have been included temporarily in this subtype. They have been identified only after in vitro lysogenization of other strains of the 80/81 complex. No identical strains have been found among many tested from our collection accumulated from 1955-1959 from various state health department and hospital laboratories. Although much work remains to be done to interpret the reactions, the results so far obtained seem to have sufficient basic implications to warrant a preliminary report. The experiment was designed to produce, if possible, an 80/81 strain by lysogenization of any other staphylococcus strain, thereby indicating a possible origin of these common hospital strains. The results herewith reported were obtained with a phage S-90 isolated from strain DA 1203-9 of phage type 80 (no reaction apparent to 81 at RTD). S-90 lyses 52/52A/80 I, II, and III, 52/52A/80/81 I, II, and IV, and 80/81 III. As yet the phage patterns after lysogenization with S-90 have been studied only on the three strains 52/52A/80/81 II and III, and 80/81 III. The strains resulting from these lysogenizations have been designated as subtypes

Table 3—Characteristics of Subtypes of Naturally Occurring Staphylococcus Strains with Phage Pattern 80/81

Strain*				
Type	Subtype	Pattern at 1,000 x RTD	Phage	Susceptible† Strains
80/81 (DA 226-6)	I	52°/52A°/80/81	none isolated	—
80/81 (DA 594-8)	II	80/81/7/73	S-91	DA 358-9‡ DA 359-8
80/81 (DA 670-9)	III	52/52A/80/81	none isolated	—

* For details on strains and phages see text and appendixes.
† Susceptible to phage in preceding column.
‡ Not typable with phages in routine use (see text).
° Inhibition.

Table 4—In vitro Conversion to Staphylococcus Strains with Phage Pattern 80/81

Source of Lysogenizing Phage	Lysogenizing Phage	Susceptible to Lysogenizing Phage		Induced by Lysogenization	
Type		Type	Subtype	Type	Subtype
		52/52A/80/81 (DA 736-8)	IV	80/81	IV A
80 (DA 1203-9)*	S-90	52/52A/80/81 (DA 709-8)	II	80/81	IV B
		80/81 (DA 670-9)	III†	80/81	IV C†

* For details on strains and phages see text and appendixes.
† Patterns with phages at 1,000 x RTD: III = 52/52A/80/81; IV C = 80/81.

IV A, B, and C with histories and characteristics as follows:

(1) Subtype IV A: Strain DA 736-8 of 52/52A/80/81 IV was converted with S-90 to an 80/81 strain which shows "inhibition" reactions to phages 52 and 52A at 1,000 x RTD, reactions characteristic of 80/81 I, the common hospital strain. However, this conversion was not always complete since some of the cells from the lysogenized culture showed very faint reactions to 52 and 52A although they yielded a phage identical or similar to the lysogenizing phage. (The 52 and 52A reactions were evident only with 6-9X magnification.) In contrast to 80/81 I these IV A strains are lysogenic to all subtypes of 52/52A/80 and 52/52A/80/81.

(2) Subtype IV B: Strain DA 709-8 of 52/52A/80/81 II was converted with S-90 to an 80/81 strain which resembles the IV A strain in the "inhibition" reactions to 52 and 52A, the occasional incomplete conversion, and the lysogenicity to all subtypes of 52/52A/80 and 52/52A/80/81. As expected, neither IV A nor IV B is able to lyse the parent strain (DA 1203-9) of the lysogenizing phage. IV B is differentiated from IV A by the fact that it is lysogenic to IV A, a relationship shared by the parent strains of the two subtypes, although lysogenization in both cases was accomplished with the S-90 phage and hence the converted strains carry a common prophage; i.e., IV B [DA 709-8 (S-90)] is lysogenic to IV A [DA 736-8 (S-90)] just as DA 709-8 is lysogenic to DA 736-8. This phenomenon will be reported in more detail after further observation.

(3) Subtype IV C: Strain DA 670-9 of 80/81 III (52/52A/80/81 with 1,000 x RTD phages) was converted with S-90 to an 80/81 strain which does not show the 52 and 52A reactions with 1,000 x RTD phages; IV C is lysogenic to all subtypes of 52/52A/80 and 52/52A/80/81. It is susceptible to IV B with relationships between strains similar to those described between IV A and IV B; i.e., IV B [DA 709-8 (S-90)] is lysogenic to IV C [DA 670-9 (S-90)] just as DA 709-8 is lysogenic to DA 670-9. Further observations on these phenomena will be reported later.

Epidemiologic Application to Hospital Problems

The differentiation into subtypes of strains of the 80/81 complex has proved helpful in clarifying some epidemiologic

problems. For example, in the outbreak of postsurgical infections reported elsewhere[7] epidemiologic studies pointed very strongly to one individual, Surgeon C, as the source of the infections in 13 patients. However, the initial laboratory results showed that the five patients from whom cultures were available were infected with an 80/81 strain while Surgeon C carried a 52/52A/80/81 strain. The strength of the epidemiologic evidence led to additional study of Surgeon C who was then found to carry both the 80/81 and 52/52A/80/81 strains. Subsequent work on the 80/81 strains from Surgeon C and the patients showed all to be subtype I, thus strengthening the evidence that Surgeon C was the source of the infecting organisms. In the meantime, Intern J, who served on the surgical team with Surgeon C, developed a lesion from which a 52/52A/80/81 strain was isolated. It was assumed that Intern J acquired his infecting strain from Surgeon C, but later subtyping indicated that this was an erroneous assumption since the two strains proved to be different subtypes of 52/52A/80/81 (Table 6).

Discussion

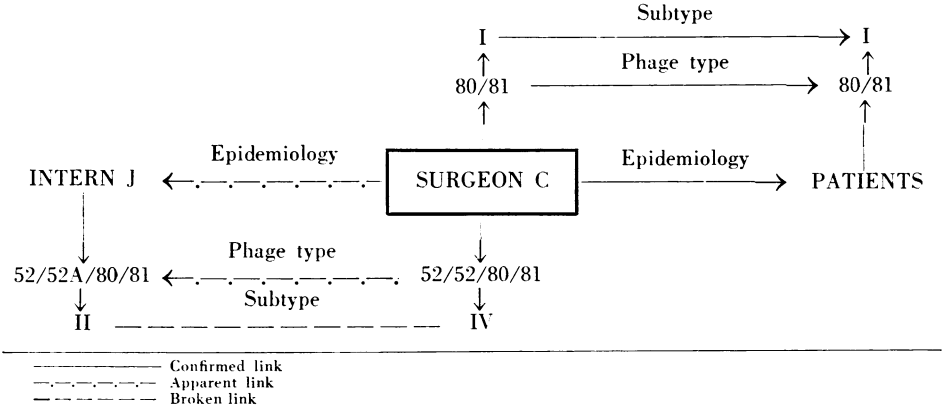
The laboratory investigations reported here were undertaken to determine whether in vivo lysogenizations could explain changes occurring in phage patterns of staphylococcus strains found in nature; e.g., 80/81, 52/52A/80/81, 52/52A/80, and so forth. The demonstrations of in vitro conversions support this hypothesis. It is also supported by simultaneous isolations from one individual of two of these related strains. Both carriers and patients have been observed to harbor two related types either at one site or different sites.[1,2,6] Stronger evidence suggestive of in vivo conversion is afforded by lysogenicity studies such as described by Rountree.[1] She reports on a patient with an 80/81 strain in empyema fluid and a 52/52A/80/81 strain in sputum and was able to convert the former to a 52/52A/80/81 with a phage isolated from the latter. The hypothesis would be further strengthened if two strains with such a lysogenic relationship were isolated from the same site at the same time, although this may be difficult to achieve

Table 5—Characteristics of in vitro Induced Staphylococcus Strains with Phage Pattern 80/81

Strains Induced by Lysogenization with S-90*			Lysogenic to:	
Type	Subtype	Pattern at 1,000 x RTD	Type	Subtype
80/81	IV A	52°/52A°/80/81	52/52A/80	All subtypes
			52/52A/80/81	" "
			80/81	III
	IV B	52°/52A°/80/81	52/52A/80	All subtypes
			52/52A/80/81	" "
			80/81	III, IV A & C
	IV C	80/81	52/52A/80	All subtypes
			52/52A/80/81	" "
			80/81	III

* For details on strains and phages see text and appendixes.
° Inhibition.

Table 6—Use of Subtyping to Clarify Epidemiologic Relationships



since lysogenization and conversion may occur rather rapidly and preclude coexistence of the two strains long enough for in vitro isolation and identification.

Among the cases which we have observed and studied one patient with extensive burns had two strains isolated at different times, one of which was demonstrated to be lysogenic to the other by in vitro tests; i.e., 52/52A/80 to 80/81. In view of the extent of the lesions and limited follow-up studies no clear-cut evidence of in vivo conversion could be established. In another case which will be reported in detail at a later date, an intern has carried simultaneously two types, one of which was lysogenic to the other; i.e., 52/52A/80 to 52/52A/80/81. In other cases which have been studied the individuals with two types had strains of which neither was lysogenic to the other whether they carried the two types at the same time and site or at different times and sites.

It is apparent that dual infection with different types does occur, sometimes without and sometimes with lysogenic relationship between the two strains. The fact that the latter situation has been observed lends support to the in vivo conversion hypothesis as one possible explanation for the naturally occurring variations in phage patterns of the 80/81 complex. The ease with which these strains become lysogenized suggests, as implied by Lowbury and Hood,[9] that phage therapy would result in rapid development of phage resistant strains and would thus be of little value unless a phage could be found which is capable of converting all strains to quite different, less virulent strains. It might be well to mention here that strains with phage patterns including 29 and 79 reported in Tables 1 and 2 are not peculiar to in vitro manipulations but are isolated occasionally from nature.

The present studies point out two important areas of serious potential consequence in the application of phage typing results to the resolution of staphylococcal problems in hospitals: (1) The isolation of two different strains of the 80/81 complex from both carriers and patients; and (2) the existence of distinct subtypes within each of the three major groups; i.e., 80/81, 52/52A/80/81, and 52/52A/80. Both of these problems were encountered in the study of postsurgical infections although in that particular situation the subtyping evidence was of relatively little consequence since the important element was Surgeon C's relation to the patients.

However, in other situations the subtyping, or at least lysogenicity studies, may prove to be the only means of determining the true relationship between personnel and patients, thereby hastening the control of an outbreak or preventing the unnecessary removal of key personnel from duty.

We do not mean to suggest that multiple cultures should be made, multiple colonies picked, and/or subtyping attempted in every case. However, we do believe that our observations reemphasize the need for complete and careful epidemiologic investigations in conjunction with phage typing, for close cooperation between the epidemiologist and laboratorian, and for extremely careful evaluation and special laboratory investigations of situations with such serious implications as the case of Surgeon C.

Summary

52/52A/80/81 and 52/52A/80 staphylococcus strains have been shown to include at least three subtypes each. 80/81 strains include four subtypes, one of which has been found only after in vitro lysogenization.

Lysogenization can be accomplished with phages isolated from the strains themselves, and results in changes in types both within and between the major types. The lysogenized strain usually, but not always, takes on the characteristics of the parent strain of the lysogenizing phage.

Strains of two or more of these major types have been isolated on several occasions from a single individual, either carrier or patient, at the same or different times, or from the same or different sites.

Epidemiologic implications and applications of the subtype, lysogenization and multiple type phenomena are discussed.

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APPENDIX 1

Culture, Source, Date Received:

DA 226-6, Michigan,* 10/26/56; DA 16-7, baby, South Carolina,* 1/24/57; DA 223-8, Georgia,* 4/1/58; DA 412-8, Georgia,* 5/27/58; DA 594-8, operating room air, Georgia†; DA 709-8, abscess, Georgia‡; DA 736-8, nose, Georgia,‡ 11/18/58; DA 779-8, sputum, Georgia,‡ 12/9/58; DA 16-9a, abscess, Georgia,‡ 1/12/59; DA 670-9, nose, Georgia,‡ 6/8/59; DA 1203-9, nose, Georgia,‡ 7/20/59; DA 100-9, nose, Georgia,* 2/9/59; DA 358-9, nose, Georgia,‡ 4/15/59; DA 359-9, nose, Georgia,‡ 4/13/59.

* State Health Department Laboratory.
† CDC, Technology Branch, Savannah, Ga.
‡ CDC Epidemiology Branch, Atlanta, Ga.

Phage, Parent Strain, Propagating Strain:

S-36, DA 16-7, DA 226-6; S-39, DA 779-8, DA 226-6; S-41, DA 412-8, DA 226-8; S-85a, DA 16-9a, DA 226-6; S-85b, DA 16-9b, DA 226-6; S-90, DA 1203-9, DA 670-9, 709-8 and 736-8; S-91, DA 594-8, DA 358-6.

APPENDIX 2

In vitro conversions by lysogenization: Strain and phage.

80/81 - - - - - - - - - - - - - - to - - - - - - - - - - - 52/52A/80

DA 226-6 plus S-39 gives DA 226-6 (S-39) Subtype I
DA 226-6 " S-85a " DA 226-6 (S-85a) " II
DA 226-6 " S-41 " DA 226-6 (S-41) " III
DA 679-9 " Corresponding to DA 226-6 conversions.

80/81 - - - - - - - - - - - - - - to - - - - - - - - - 52/52A/80/81

DA 226-6 plus S-36 gives DA 226-6 (S-36) Subtype I
DA 226-6 " S-85b " DA 226-6 (S-85b) " II
DA 670-9 " Corresponding to DA 226-6 conversions.

52/52A/80 - - - - - - - - - - - - to - - - - - - - - - 52/52A/80/81

DA 412-8 plus S-36 gives DA 412-8 (S-36) Subtype I
DA 226-6 (S-41) " S-36 " DA 226-6 (S-41) (S-36) Subtype I
DA 779-9 " S-86b " DA 779-9 (S-85b) Subtype II
DA 412-8 " S-85b " DA 412-8 (S-85b) " II
DA 226-6 (S-41) " S-85b " DA 226-6 (S-41) (S-85b) Subtype II

52/52A/80/81 - - - - - - - - - - - to - - - - - - - - - - - 52/52A/80

DA 16-9B II plus S-41 gives DA 16-9b (S-41) Subtype III
DA 16-7 I " S-41 " DA 16-7 (S-41) " III
DA 226-6 (S-85b) II " S-41 " DA 226-6 (S-85b) (S-41) Subtype III
DA 226-6 (S-36) I " S-41 " DA 226-6 (S-36) (S-41) " III

Information on other conversions is available upon request.

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