Reports

Distribution of Phage Groups of Staphylococcus aureus in the Years 1927 through 1947

Abstract. The phage typing patterns of 194 typable strains of *Staphylococcus aureus* isolated in the years 1927 through 1947 and preserved as stock cultures revealed that 43 strains were of phage type 80/81. The occurrence of other typable strains in the broad phage groups I, II, and III corresponded closely to the frequency distribution of staphylococci reported in 1945 by Wilson and Atkinson.

Strains of *Staphylococcus aureus* of phage type 80/81 have assumed a position of some prominence during the past few years, especially in relation to their role as causative agents of some hospital-acquired infections. It has been possible to identify these strains only since about 1955–56, when phage 80 was described by Rountree and Freeman (*1*), and phage 81 by Bynoe, Elder, and Comtois (*2*). For this reason it would almost appear that there has been a tendency to regard type 80/81 as a "new" staphylococcus which has just recently made its appearance. This is by no means the case, for Rountree (*3*) found that the Bundaberg strain of *S. aureus,* which was responsible for a series of fatalities in Australia in 1928, exhibits the phage pattern 52/52A/80/81, and the present report demonstrates that strains *S. aureus* of phage type 80/81 have been not uncommon during the past 33 years. Specifically, this report describes the examination of a series of strains that were isolated between August 1927 and December 1947.

In "phage type 80/81" are included, for the purpose of this report, all strains of coagulase-positive staphylococci that show the phage patterns 80/81 or 52/52A/80/81, or any combination of these phages, or that are lysed only by phage 80 or by phage 81. Recent reports by Asheshov and Rippon (*4*) and by Rountree (*3*) on the changes in phage typing patterns of staphylococci of type 80/81 after lysogenization suggest strongly that strains which exhibit patterns comprised of various combinations of these phages are so closely related as probably to represent an entity. Work now under way in our laboratory confirms their observations and inferences.

A total of 276 strains of coagulase-positive staphylococci was examined. Of these, 256 were isolated in our laboratory from pathologic material submitted for bacteriologic diagnosis between August 1927 and December 1947. The strains were isolated from 242 individuals; when more than one strain was available from a single individual, only those isolates which showed distinctly different phage patterns, and represented obviously different strains, were included in the tabulation. The series represents a random selection of cultures that were collected during the period mentioned; they were saved and placed in stock because of their varied clinical sources or because of their range of toxigenic and other properties. Twenty strains were received from other investigators during the same period.

Stock cultures were maintained on Difco brain-heart-infusion agar slants at room temperature. The culture tubes were sealed with sterile cork stoppers, and the stoppers and upper portion of the tubes were then coated with paraffin. Transfers were made at an average interval of about 1 year. Fresh transfers on agar were made when the cultures were about to be phage typed.

The phages used for typing were as follows: group I—phages 29, 52, 52A, 79, 80; group II—phages 3A, 3B, 3C, 55, 71; group III—phages 6, 7, 42E, 47, 53, 54, 73, 75, 77, 83; group IV—phage 42D; miscellaneous—phages 81, 187. The methods employed were those described by Blair and Carr (*5*) and conform to the recommendations of the International Committee on Phage Typing of Staphylococci. All cultures were typed first with the phages at their routine test dilutions. Those cultures which were not lysed or which showed only weak reactions at routine test dilutions were retyped with the phages in concentrations 1000 times stronger. The patterns were recorded in terms of those phages which produced significant reactions of from 50 plaques to confluent lysis. Cultures which showed no pattern of significant lysis either at routine test dilutions or at concentrations 1000 times stronger were recorded as nontypable.

This report is based upon the phage typing of all strains of the series during the spring of 1960. While a primary object of the study was to determine the presence of strains of type 80/81 in the collection, the opportunity also was provided of demonstrating the distribution of the other strains among the broad phage groups. It may be noted that several of the cultures had been typed on one or more occasions previously during the past 12 years. The basic stability of the phage patterns of staphylococci is indicated by the fact that patterns exhibited by such cultures in the earlier typings were confirmed during our examination.

In the series of 276 strains, 194 (70.3 percent) were typable and 82 (29.7 percent) were nontypable. The number of typable strains which showed phage patterns in the several broad groups or types was as follows: group I, 63 (32.5 percent); group II, 42 (21.6 percent); group III, 17 (8.8 percent); group IV, 9 (4.6 percent); "type 187," 5 (2.6 percent); "type 80/81," 43 (22.1 percent); and mixed (patterns overlapping two or more groups), 15 (7.7 percent).

Six phage patterns were found among the 43 strains of type 80/81. The several phage patterns (all considered to indicate the broad type 80/81) were as follows: 52/52A/80/81, 14 strains; 52/52A/80, 15 strains; 52A/80, seven strains; 52/80, one strain; 80/81, one strain; 80, two strains; and 81, three strains. The earliest of these strains, with the pattern 52/52A/80/81, was isolated in August 1927. The majority of the strains of type 80/81 were isolated from various clinical forms of staphylococcal disease, including acute and chronic osteomyelitis, soft-tissue abscesses, boils, carbuncles, and bacteremia; a few were isolated from miscellaneous other conditions such as cervical adenitis, cellulitis, conjunctivitis, and meningitis. In the light of current observations on infections due to type 80/81, it may be noted that two strains were responsible for postoperative infections and one for a breast abscess.

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Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Forty-nine of the total number of strains in the series were isolated during the period 1944 to 1947—that is, during the early era of penicillin therapy. Seven of these strains were type 80/81, and of these, six were sensitive to penicillin as determined by the tube-dilution method. The one resistant strain had been isolated before the patient received penicillin, and the strain was inhibited by 6.25 units of the antibiotic. In one instance a penicillin-sensitive strain with the pattern 52/52A/80 was isolated from an osteomyelitic lesion before the start of antibiotic therapy; after the administration of penicillin for 1 month, a strain (not included in the tabulation) showing the same phage pattern was isolated from the same lesion and was found to be inhibited by 50 units of the antibiotic.

The only previous report with which our observations can reasonably be compared is that by Wilson and Atkinson (*6*) in 1945, in which are described the techniques of staphylococcal phage typing upon which current methods are based. The majority of the strains examined by Wilson and Atkinson were derived from a variety of infections during a part of the same period covered in our report. Although the typing schema of Wilson and Atkinson is rather different from that in current use, they did recognize certain broad categories which now correspond to groups I, II, and III. When their figures for the frequency distribution of "types" are rearranged to correspond to groups I, II, and III, it is found that the proportion of typable strains encountered in the three groups by Wilson and Atkinson and by us, respectively, are as follows: group I, 33.4 and 32.5 percent; group II, 19.4 and 21.6 percent; and group III, 9.4 and 8.8 percent. Type 80/81, as such, was not identified until 10 years after publication of the report of Wilson and Atkinson. Lysis in the pattern 52/52A was not mentioned specifically by Wilson and Atkinson, and it can be only a matter of conjecture whether any of the strains which they reported to be lysed by phage 52 or phage 52A actually represented type 80/81. It is of some interest, however, to note that five strains of type 80/81 in the present series had been submitted to phage typing 10 or 12 years ago and had been found to be lysed by phages 52 or 52A, or both.

The low incidence of group III strains reported by Wilson and Atkinson and encountered in this series is in striking contrast to the predominance of these strains that became apparent not long after the introduction of antibiotic therapy (*7*). A trend in this direction was seen in the present series, for group III strains, among the strains isolated from 1944 through 1947, were increasingly more numerous, and more frequently penicillin-resistant.

Although the incidence of strains in this series is reported in terms of percentage, we do not intend to imply that the figures necessarily indicate the true distribution of staphylococci among the broad groups during the 20 years in question. We feel, however, that the figures have some degree of validity, to the extent that they express the broad relationships of the several groups and correspond closely to the observations made by Wilson and Atkinson at a similar period of time. There is little question that type 80/81 was a not insignificant cause of staphylococcal disease long before its recent rise to prominence (*8*).

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8. We are pleased to acknowledge the technical assistance of Marianne Molins and Nellie Alexander; the data reported here were obtained in the course of an investigation, now in progress, supported by grant No. E-2597 from the National Institute of Allergy and Infectious Diseases, U.S. Public Health Service.

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Nomenclature of Devices Which Simulate Biological Functions

Abstract: The suffix *-mime* is proposed to create generic names for the general class of man-made devices which simulate biological functions. The suffix is used after the stem of the word that describes the organ or cell being simulated; for instance, artificial neurons are described as neuromimes.

With increasing knowledge of the mechanisms of many biological functions, and concomitant development of technology, it has become possible in recent years to construct (or computer-simulate) devices of one sort or another which, to a specified extent, can act like and even replace parts or organs of the living organism. Such artifices as heart-lung systems, which allow prolonged surgery on the heart and pulmonary system, artificial kidneys, which take over renal function temporarily or even semipermanently, and most recently, artificial neurons, which are providing a valuable tool in neurophysiological research, are examples. In the near future many more developments in this direction may be anticipated.

In discussing these devices authors unavoidably make comparisons between the performance of their inventions and the "real thing," draw conclusions on the basis of experiments with their analogs which they wish to apply to the living structure, and attempt to correct their artifacts as a result of apparent discrepancies between artificial and biological behavior.

In all of such activity, juxtaposition of the same names referring to the device and to the "prototype" is likely to become confusing to the reader who may be at a complete loss in trying to find out whether the "neuron" the author is discussing is the real or the simulated thing. The author, anticipating this, can find several ways to avoid confusion.

One obvious way is to label his device, whenever he is talking about it, "artificial"; but this becomes clumsy, and after a few papers on the subject, authors tend to assume that by now everybody knows what they are writing about, and drop the adjective. Another method is to baptize the device with some arbitrary name, for example, ARKID for artificial kidney, or CARDIOTRON for an artificial heart-lung system; the -tron suffix seems to be especially popular. The trouble is, again, that the author (usually after the first paper) neglects to clarify the name, or at most refers to it in a footnote.

There seems to be reason, therefore, to make a case for universal nomenclature specifically designed for artificial devices which simulate to some extent biological functions. Such a nomenclature should meet several criteria: (i) It is desirable, for purposes of orientation, that the stem of the word which refers to the original cell or organ be retained; so, in artificial kidney systems the stem *nephr-* or *ren-* should occur, in heart-lung systems *card-* or *pulm-* should be present, and artificial neurons should have *neur-* or *nerv-* in their names; (ii) For convenience in writing and speaking, a single word of not more than three or four syllables should suffice. This leads immediately to the necessity of using prefixes or suffixes; (iii) The affix, then, should be easily recognized for meaning: -like, simulating, analog of, behaving as if, and so forth; (iv) Affixes already much in use, such as *para-*, *meta-*, *-oid* and *-id* should, where possible, be avoided, so as not to evade one confusion by creating another.

The choice now narrows down to a few relatively little-used affixes, of which the prefix *sim-* or *simu-* (from