JCI The Journal of Clinical Investigation

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J Clin Invest. 1972;51(11):2863-2871. https://doi.org/10.1172/JCI107109.

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Natural History of Impetigo

II. ETIOLOGIC AGENTS AND BACTERIAL INTERACTIONS

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ABSTRACT Intensive observations on 37 children in a population with endemic skin infections provided an opportunity to study the interrelationships between and the significance of the bacterial genera commonly associated with impetigo. Cultures of the respiratory tract, three normal skin sites, and lesions, when present, were taken three times weekly from July to October 1969. Impetigo developed in all 37 children. Group A streptococci alone were recovered from 21% of 361 lesions, *Staphylococcus aureus* alone from 8%, *Staphylococcus epidermidis* alone from 5% and mixtures of streptococci and staphylococci from 61%.

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Phage type 75 accounted for the majority of staphylococcal isolates from all sites, whereas phage type 54 was recovered only from skin lesions.

In contrast to streptococci, the site sequence of staphylococcal spread was from the nose to normal skin to skin lesions.

These studies reveal important differences in the migration of staphylococci (as compared with streptococci) to various body sites and suggest a subsidiary role for staphylococci in nonbullous impetiginous lesions yielding both organisms.

This work was presented in part at the American Pediatric Society meetings in Atlantic City, N. J., 28 April–1 May, 1971.

Dr. Dajani is a recipient of a Research Career Development Award from the National Institute of Allergy and Infectious Diseases. Dr. Ferrieri was a Career Investigator Fellow of the American Heart Association. Dr. Wannamaker is a Career Investigator of the American Heart Association.

Received for publication 11 April 1972 and in revised form 6 July 1972.

INTRODUCTION

In the past two decades, several studies from various parts of the world have amply confirmed that Group A beta hemolytic streptococci and *Staphylococcus aureus* are the two bacterial genera most commonly recovered in human impetigo (1–7). Two separate clinical entities are believed to exist: (*a*) a bullous impetigo, the lesions of which, after rupture, form a thin varnish-like crust and are associated with staphylococci in phage group II, notably type 71; (*b*) a thick crusted variety which may be ephemerally vesicular in the early stages and yields either streptococci alone or a mixture of streptococci and staphylococci. The clinical, bacteriological, and epidemiological contrasts between these two forms of impetigo have been discussed in a recent review (8).

Most previous reports indicate that in the majority of instances, cultures of impetiginous lesions yield mixtures of streptococci and staphylococci (4–8). Some observers propose that such lesions represent a third variety of impetigo, caused by the combined action of the two genera. Conversely, it may be quite possible that this group may merely represent one or the other type of impetigo secondarily infected with the other genus.

The interrelationships between and the significance of these two bacterial genera in impetigo remain poorly understood. This may be due, in large part, to the paucity of information based on serial observations of the early development and the natural history of human impetigo. The present reports describe a prospective study of impetigo designed to investigate the bacteriology and epidemiology of the disease in a group of children before, during, and after the development of skin lesions. In an

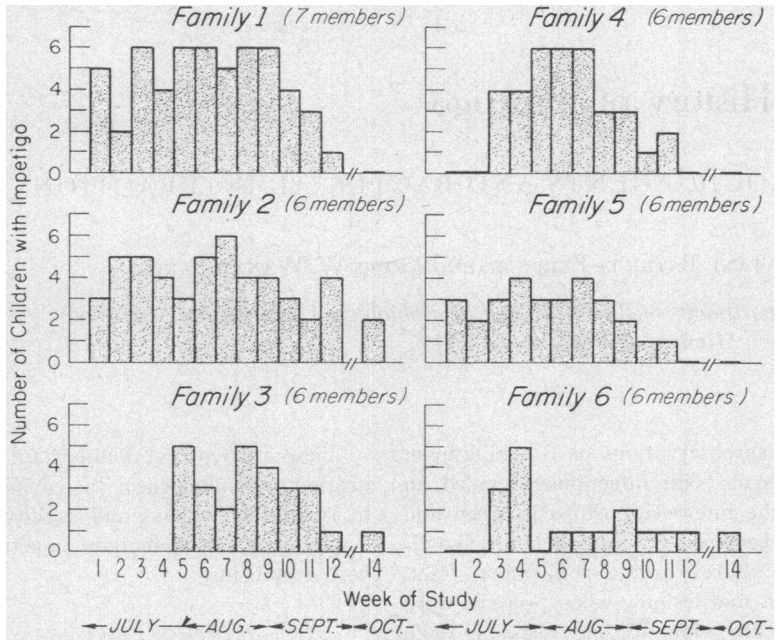

FIGURE 1 Patterns of prevalence of impetigo in six families. (No observations were made during the 13th week. Family 3 was incorporated in the study at the beginning of the 5th wk.)

accompanying communication (9), detailed analysis of the site sequence and familial spread of streptococci is presented. The present communication focuses primarily on the etiology of impetigo and the interaction of the bacterial genera associated with this infection.

METHODS

Clinical material. The subjects of these studies were 37 children belonging to six families at the Red Lake Indian Reservation in northern Minnesota. Details of the duration and frequency of observations, sites of cultures, and streptococcal methods and studies were presented in the previous report (9). The six extra children included in this communication belong to one family that was not included in the companion report (9) because of the infrequent recovery of streptococci from members of that family.

Staphylococcal studies. One bacterial colony morphologically identified as staphylococcal was picked from each original plate. In instances when morphologically different colony forms were detected, several colonies were picked. Pure cultures were propagated in vials containing 3 ml of Tryptic Soy Broth (Difco, Detroit, Mich.) and after incubation at 37°C for 18–24 hr were frozen at −20°C for further testing. All isolates were tested for mannitol fermentation and for coagulase production, the tube test being utilized for the latter. All mannitol negative and coagulase negative strains were considered *Staphylococcus epidermidis.* Coagulase positive, mannitol positive strains were classified as *S. aureus,* and were phage typed by standard techniques (10). If no reaction was demonstrable at routine test dilution (RTD), the concentrated phage was used at 100 × RTD. A disc of methicillin (5 μg) was placed on the agar plate at the time of phage typing to test for any resistant strains (11).

RESULTS

Prevalence and bacteriology of lesions. At the commencement of the studies on July 1, 1969, 11 of 30 children seen at the time had skin lesions. Impetigo developed in all 37 children at one time or another during the study period. A sharp increase in skin lesions was observed in the middle of July, the peak persisted until the end of August, and then a rapid decline occurred. Inter-family differences were observed relative to the prevalence, peak, and persistence of the disease. Fig. 1 graphically illustrates the various patterns in the six families. Comparison of family 1 with family 6 shows that while in the former most members were afflicted for the major part of the study period, little disease occurred in family 6 with only one sharp peak in the 4th wk of July. All 37 children were observed once in November and none had any evidence of impetigo.

A total of 361 skin lesions was cultured, and these lesions represented various stages of impetigo. Lesions were considered in a relatively early stage if they were vesicular or pustular without any evidence of crusting. Crusted lesions were considered of longer duration and representative of a later stage. The 361 lesions were cultured on 755 occasions. Table I shows the distribution of the various bacterial genera recovered from the lesions. In the over-all picture (total cultures at all stages), streptococci and staphylococci coexisted in the majority of instances (61%). *S. aureus* was more com-

TABLE I

Bacterial Genera Isolated from 361 Skin Lesions

Description of lesions	Cultures: Category	Cultures: No.	Distribution of culture results: β-hemolytic strep. only	*S. aureus* only	*S. epidermidis* only	β-hemolytic strep. + *S. aureus*	β-hemolytic strep. + *S. epidermidis*	No organisms
Early stage (before crusting)	Initial	81	29 (36%)	7 (9%)	0	43 (53%)	1 (1%)	1 (1%)
	Subsequent	7	0	0	0	6	1	0
Late stage (crusted)	Initial	280	47 (17%)	35 (13%)	22 (8%)	155 (55%)	13 (4%)	8 (3%)
	Subsequent	387	83 (22%)	23 (6%)	15 (4%)	237 (61%)	4 (1%)	25 (6%)
All stages	Initial	361	76 (21%)	42 (12%)	22 (6%)	198 (55%)	14 (4%)	9 (2%)
	Subseqnent	394	83 (21%)	23 (6%)	15 (4%)	243 (62%)	5 (1%)	25 (6%)
	Total	755	159 (21%)	65 (8%)	37 (5%)	441 (59%)	19 (2%)	34 (5%)

monly associated than *S. epidermidis* with streptococci. In 619 instances (82%) beta hemolytic streptococci, either alone or along with staphylococci, were isolated from the total cultures from lesions. Group A accounted for 611 (98.6%) of the beta hemolytic streptococcal isolates, with Group G accounting for the remaining 8 (1.4%). In 562 instances (74%) staphylococci, either alone or along with streptococci, were isolated from the cultures.

Comparison of lesions in an early stage with ones in a later stage (Table I) indicates that while cultures of both types of lesions were more often pure streptococcal than pure staphylococcal, the streptococcal predominance is more pronounced in the early stage lesions. Furthermore, recovery of streptococci alone from cultures of early lesions occurred more frequently than from cultures of later lesions. Both of these observations suggest the possibility of a primary role for streptococci in the initiation of the process.

Comparison of the initial cultures from the 361 lesions with subsequent cultures from the same lesions (Table I) shows some interesting differences. All subsequent cultures of early stage lesions were mixed (streptococcal and staphylococcal). In later stage lesions recovery of staphylococci alone (*S. aureus* as well as *S. epidermidis*) was half as frequent for subsequent cultures as for initial cultures. However, recovery of streptococci alone from these lesions was somewhat more frequent in subsequent cultures as compared with initial ones.

Among the early stage lesions, approximately equal numbers of vesicular and pustular lesions were noted. No difference as to the distribution of bacterial isolates was observed between the two types of lesions.

The temporal recovery of the various organisms from skin lesions during the study period was analyzed further, and the results are shown in Fig. 2. This figure illustrates the frequency of skin lesion cultures containing beta hemolytic streptococci alone, *S. aureus* alone, *S. epidermidis* alone and mixtures of streptococci with staphylococci for each week of the study period. Recovery of beta hemolytic streptococci, alone or along with staphylococci, gradually increased and reached high levels during the 5th to the 9th wk of the study. This corresponded to the last few days in July and all of August. In sharp contrast, recovery of *S. aureus* alone from skin lesions had an earlier and shorter peak. During the last 2 wk in July (weeks 3 and 4) 43 of the 64 pure *S. aureus* lesions can be accounted for. Little recovery of *S. aureus* alone occurred before or

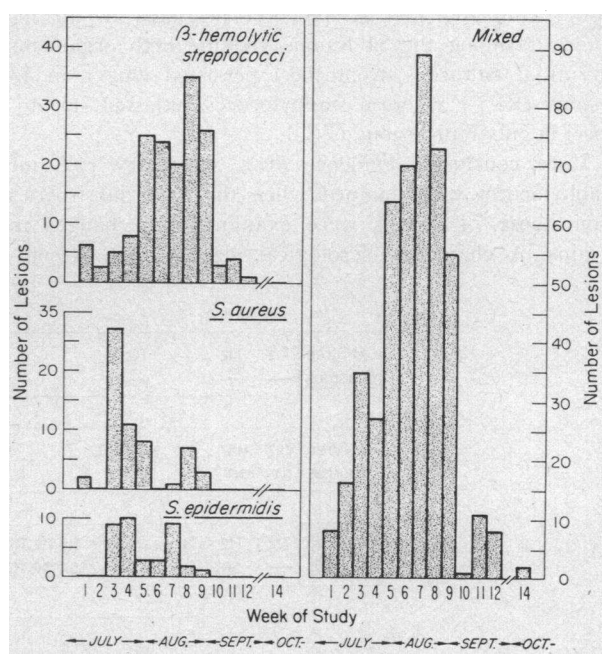

FIGURE 2 Distribution of the 755 lesion cultures as to the organisms recovered by week of study.

TABLE II

Relation of Initial to Final Flora in 74 Lesions Serially Cultured

Initial flora	Final flora
Pure streptococcal (17)*	Pure streptococcal (7) Mixed‡ (10)
Pure staphylococcal (3)	Pure staphylococcal (1) Mixed (2)
Mixed (54)	Pure streptococcal (13) Pure staphylococcal (4) Mixed (37)

* Figures in parentheses refer to number of lesions containing these flora.

‡ Mixed: streptococcal and staphylococcal.

after that period. Additional analyses of the *S. aureus* recoveries will be presented later on in this paper.

Flora of lesions cultured repeatedly. Further confirmation of the primary role played by streptococci in the impetigo seen in this particular population resulted from sequential culturing and close observation of 74 impetiginous lesions. Each such lesion was serially cultured at least three times (range 3–13 times, mean 4.9 times) over a period of 6 days or longer (range 6–31 days, mean 12.6 days) until spontaneous healing occurred. The cultural data, expressed as initial and final flora from these 74 lesions, are shown in Table II. Of 17 lesions yielding only beta hemolytic streptococci on initial culturing, the streptococci persisted in all instances. Among the 54 lesions yielding both organisms on initial cultures, streptococci persisted longer in 13 lesions (24%) whereas staphylococci outlasted streptococci in only four lesions (7%).

More conclusive evidence of a subsidiary role for staphylococci was obtained when the bacterial isolates from these 74 lesions were examined for changes in strains. A change in serological identity of a streptococcal strain was considered present if a definite alteration in T-protein agglutination pattern or M-protein precipitation reaction occurred. A change in staphylococcal phage type (60 of 65 instances) or an alteration of antibiotic sensitivity pattern for a nontypable strain (5 of 65 instances) was considered evidence for a changes in staphylococcal strain. Table III shows an analysis of changes in bacterial strains recovered from sequentially cultured lesions. In 72 lesions where streptococci were repeatedly isolated, the same streptococcal strain persisted in an individual lesion in 61 instances (85%); a change occurred in only 11 instances (15%). In marked contrast, a change in staphylococcal type occurred in 37 of 65 (57%) lesions from which this genus was isolated repeatedly.

TABLE III

*Changes in Strains from 74 Sequentially Cultured Lesions**

Bacterial isolates from initial culture	Distribution of isolates from subsequent cultures	
	Same strain	Different strain
Group A streptococci (72 lesions)	61 (85%)	11 (15%)
S. aureus (65 lesions)	28 (43%)	37 (57%)

* In two lesions streptococci were never recovered, and in nine lesions staphylococci were never isolated.

Fig. 3 presents three examples of sequentially cultured lesions. In the first lesion a streptococcus identified as T-12 by T-agglutination was the sole organism recovered repeatedly over a period of 27 days. In the second lesion streptococci and staphylococci coexisted for the 1st wk, during which time a change in the staphylococcal phage type occurred. The same streptococcal type was recovered throughout the 3 wk period and no staphylococci were present in repeated cultures taken during the last week. The third lesion

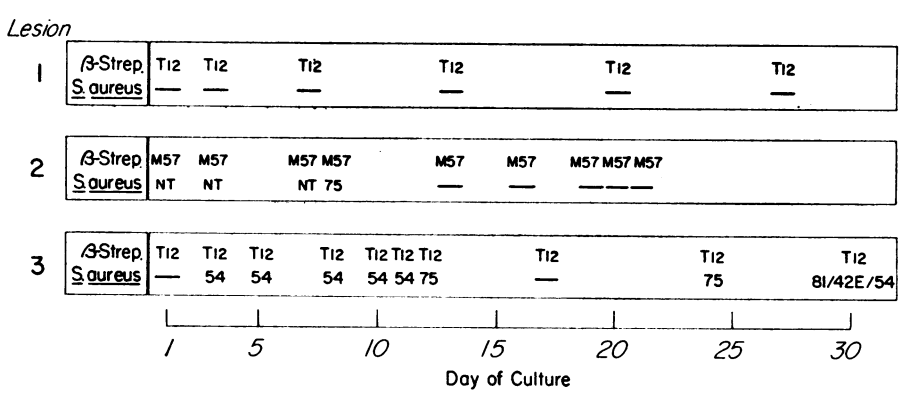

FIGURE 3 Examples of longitudinal bacteriologic findings in sequentially cultured lesions.

again illustrates the persistence of the same streptococcal strain over a period of 1 month with three changes occurring in the staphylococcal phage patterns.

Distribution of staphylococcal phage types. A total of 1252 *S. aureus* isolates was recovered during the study period: 276 isolates from the respiratory tract (predominantly from the nose), 471 isolates from normal skin sites, and 505 isolates from skin lesions. None of the isolates was resistant to methicillin. Phage typing at RTD or 100 × RTD was successful on 978 isolates (78%). The majority of the staphylococcal isolates were typable only with concentrated phage.

The distribution of staphylococcal phage types at various body sites for the total population of 37 children during the study period is shown in Fig. 4. Phage type 75 accounted for the majority of staphylococcal isolates from the respiratory tract (56%), normal skin (68%), and skin lesions (58%). It was encountered throughout the summer with no particular peak at any single time. Phage type 81 staphylococci, like phage type 75, were recovered from the respiratory tract, normal skin, and skin lesions but in much less frequency (approximately 3% for all sites). However, phage type 79 staphylococci were encountered only in the respiratory tract (5%) and phage type 54 were recovered only from skin lesions (12%). The almost total absence of phage group II staphylococci (types 3A, 3C, 55, and 71) should be emphasized.

When the distribution of the staphylococcal types in different families was analyzed, marked variations were noted, as shown in Fig. 5. In this figure, family unit A is a composite of families 1 and 4 since these two families geographically and socially represent an expanded family unit. For similar reasons, families 2 and 3 are represented as family unit B. As can be noted, in family unit A, phage type 75 staphylococcus accounts for virtually all the staphylococcal isolates at all three sites. In contrast, other phage types were more commonly encountered in family unit B although phage type 75 remained the single most common staphylococcus at all sites. Again, the occurrence of phage type 54 in skin lesions only in both family units is evident. In families 5 and 6 almost all the staphylococcal isolates from various body sites were nontypable.

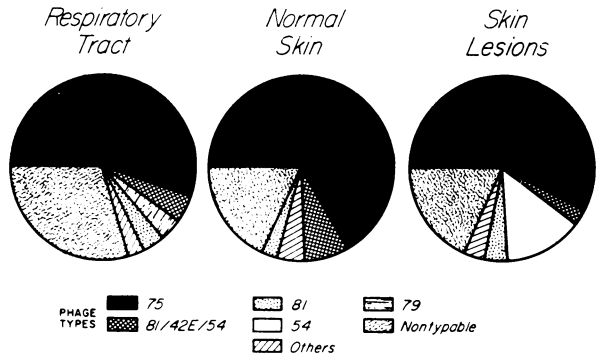

FIGURE 4 Distribution of staphylococcal phage types at different body sites for the total study population.

Family 6 exhibited certain other epidemiologic distinctions when compared with the rest of the study group. It has been pointed out already (Fig. 1) that little disease occurred in members of this family. There was a total of 26 lesions in the six children of this family and these lesions were cultured on 33 occasions.

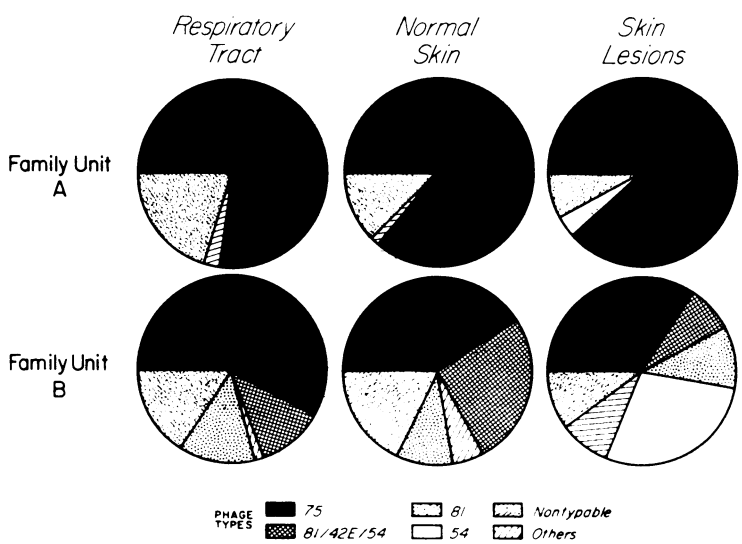

FIGURE 5 Distribution of staphylococcal phage types in two family units.

TABLE IV

Distribution of Various Staphylococcal Phage Types in Mixed and Pure Cultures from Lesions

Phage type	Mixed cultures*		Pure cultures‡	
	No.	Per cent	No.	Per cent
75	263	60.0	30	46.0
81	16	3.6	3	4.6
54	60	13.6	3	4.6
Miscellaneous	21	4.8	10	17.0
Nontypable	80	18	18	27.8
Total	440		64	

* Streptococcal and staphylococcal.

‡ Pure staphylococcal.

17 of these lesions occurred in the two youngest children (ages 4 and 6 yr). Of the 33 cultures of lesions, 22 (67%) were pure staphylococcal (14 *S. aureus* and 8 *S. epidermidis*), four were mixed streptococcal and staphylococcal, and only two had pure beta hemolytic streptococci. In five instances no organisms were recovered. All the pure staphylococcal lesions occurred in July. Because of the very infrequent recovery of streptococci from this family it was not included in the previous report (9).

Pure staphylococcal lesions. Detailed analysis of lesions yielding only *S. aureus* from all 37 children was made in an attempt to differentiate such lesions from ones yielding streptococci or mixtures of streptococci and staphylococci. Of the 64 lesions in which only *S. aureus* was recovered there were 43 single lesions from which the organism was isolated repeatedly in pure culture. Of these 43 lesions, 39 (91%) occurred in July and only 4 (9%) in August or later. The 43 lesions were equally distributed among the various families. The increased frequency of staphylococcal lesions in family 6 mentioned above is perhaps more apparent as a result of the paucity of streptococcal disease in this family.

TABLE V

Site Sequence of Spread of Phage Type 75 S. aureus in 25 Children

Sequence of appearance	Frequency	Duration	
		Range	Mean
		days	
Nose prior to skin	12/20* (60%)	1–27	10.7
Nose prior to lesion	13/20* (65%)	2–32	13.2
Skin prior to lesion	17/25 (68%)	2–20	11.1

* In five children the organism never was isolated from the nose.

None of the 43 pure staphylococcal lesions was bullous in appearance. There were four vesicular and three pustular lesions and the others were crusted. The crusts of these lesions were distinct from others in that the staphylococcal crusts were thin, varnish-like, and light brown in color. Crusts of lesions yielding streptococci either alone or along with staphylococci were similar to each other. They were thick, yellowish, and friable. The 43 pure staphylococcal lesions were equally distributed among younger and older children. It was our clinical impression that these lesions spontaneously healed much faster than ones containing streptococci.

The phage type distribution of the *S. aureus* isolates from cultures of lesions yielding only this organism was compared with the general distribution of the staphylococcal types from cultures of mixed lesions. As shown in Table IV, some differences were found in the distribution of phage types in pure or mixed cultures of lesions. Phage type 75 staphylococci were present less frequently in pure staphylococcal cultures than in mixed ones ($P = 0.05$). Phage type 54 staphylococci were never isolated from normal skin or the respiratory tract, and there was a tendency for less frequent recovery of this phage type 54 in pure form in cultures of skin lesions ($P < 0.1$, > 0.05). Among the staphylococci recovered more frequently in pure form, 18 isolates were nontypable. No particular phage types predominated among the 10 isolates in the miscellaneous group.

Site sequence of staphylococcal spread. The previous communication (9) about the site sequence of streptococcal spread in the same population of children has indicated the appearance of streptococci on normal skin before the occurrence of skin lesions, with delayed appearance in the respiratory tract. When the appearance of staphylococci on various body sites of an individual was examined, a distinctly different sequence of spread was noted. Detailed analysis of the sequence of staphylococcal spread was possible for phage type 75 staphylococcus only, since other phage types were either encountered infrequently or were restricted in distribution to a particular body site. Table V shows the sequence of spread of phage type 75 staphylococci from one site to another in 25 children who developed lesions from which this organism was recovered. In most instances the organism appeared in the respiratory tract before its recovery from normal skin sites or from lesions. Recovery of this staphylococcus from normal skin before the nose occurred in six instances, and in two instances simultaneous appearance of the organism occurred in the nose and on the skin. Similarly, in most instances the organism appeared in the nose before development of lesions with this type. The staphylococcus was recovered from lesions before nose in only six

instances, and was simultaneously recovered from these sites in one instance. In 17 of 25 instances the organism was recovered from normal skin sites before its appearance in skin lesions, and in the remaining eight instances the recovery of the organism from normal skin sites followed its recovery from lesions.

DISCUSSION

The results of this study, in agreement with many others from various parts of the world, indicate that Group A beta hemolytic streptococci and staphylococci are the predominant bacterial genera recovered from impetiginous lesions. The interrelationships between and the significance of these two bacterial genera in impetigo are still poorly understood and have been the subject of considerable controversy among pediatricians, bacteriologists, and dermatologists. Simpson (12) reviewed the literature dealing with the relative importance of streptococci and staphylococci in this disease. The author proposed the "impetigococcus" as the single organism responsible for skin lesions, basing conclusions primarily on epidemiologic observations that contacts of an index case usually develop impetigo but no other clinical manifestations of streptococcal or staphylococcal infection. While subsequent studies have failed to confirm a unitarian etiology of impetigo, they did delineate certain distinctive features of the staphylococcal and streptococcal isolates from impetiginous lesions (8).

Detailed analysis of the streptococcal isolates from the present studies have been presented in a previous communication (9). The data presented now strongly suggest a primary role for streptococci in the pathogenesis of the nonbullous impetigo characteristically seen in this population. Three major observations support this conclusion. Firstly, when pure cultures were obtained from initial cultures of early lesions, streptococci were more commonly isolated (36%) than staphylococci (9%), and streptococci alone were more often recovered from initial cultures of lesions in early stages (36%) rather than from those in a later stage (17%). This suggests that streptococci may be the initiators of the process and that staphylococci are more likely to be secondary invaders. In the case of *S. epidermidis* this seems particularly true since these organisms were never recovered alone from early stage lesions. Secondly, observation on the 74 serially cultured lesions indicate that streptococci outlasted staphylococci in mixed lesions. Of the 54 initially mixed lesions, 13 (24%) ultimately became pure streptococcal, as opposed to only 4 (7%) that became pure staphylococcal. The third and perhaps the most conclusive evidence for the subsidiary role of staphylococci, however, stems from analysis of the changes in type patterns in sequentially cultured lesions. Significant changes occurred in the staphylococcal strains in individual lesions serially cultured, whereas the same streptococcal strain persisted in 85% of the instances. This would suggest repeated contamination of a streptococcal lesion with staphylococci that are part of the resident flora of the skin or the respiratory tract.

Additional evidence for the secondary role of staphylococci in impetigo yielding both staphylococci and streptococci on culture can be found in analyses of treatment studies. In experimental impetigo, healing of pure streptococcal lesions is comparable to healing of mixed lesions containing penicillin-resistant staphylococci in animals treated with penicillin G (13). Similar results have also been reported by other investigators with regard to the efficacy of penicillin G alone in the treatment of nonbullous, human impetigo (14, 15). Such studies do not negate the possibility of staphylococci as initiators of impetigo, but would certainly strongly suggest that in mixed lesions these organisms probably do not play a primary role in perpetuating the process.

In the present study 43 lesions yielded pure cultures of *S. aureus* on repeated culture. These lesions exhibited certain unique features. The great majority of these staphylococcal lesions appeared in July and were virtually absent thereafter, a finding similar to that previously reported by Epstein (16). Their clinical appearance was distinct and they healed faster than streptococcal lesions or mixed streptococcal and staphylococcal lesions. Of interest is that 36 (84%) of these purely staphylococcal lesions were crusted and thus probably represented lesions in a later stage. Since the staphylococcal phage types in the 43 lesions were not unusual and since the same phage types continued to be present throughout the study period, it is difficult to ascribe any special dermatotropic potential to these staphylococci.

That certain staphylococci are primary skin pathogens is a well-documented observation. Phage group II *S. aureus* (3A, 3C, 55, and 71) have been repeatedly incriminated as the etiologic agents of bullous impetigo (5, 8, 17, 18). Phage type 71 *S. aureus* possesses many unique features including production of a bacteriocin (19, 20) which is markedly bactericidal to Group A beta hemolytic streptococci in vitro and in vivo (20, 21). An implication of these experimental studies is that phage type 71 staphylococci may secondarily invade a preexisting streptococcal skin lesion and eradicate the streptococci from it. Since many strains of phage type 71 produce this bacteriocin, these studies also imply that staphylococcal lesions of the bullous type which commonly contain these organisms may resist secondary infection with streptococci. The data presented here neither refute nor support these hypotheses since phage type 71 *S. aureus* was virtually absent from this group of children at all sites throughout the study period.

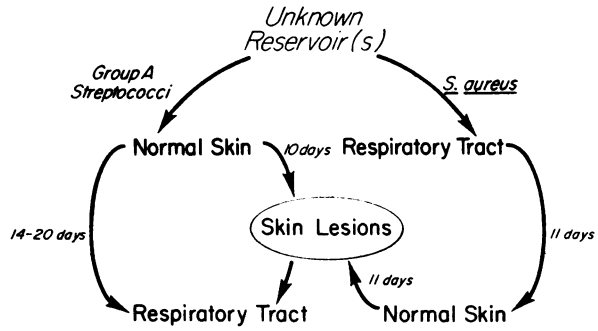

FIGURE 6 Contrasting patterns of streptococcal and staphylococcal sequences of spread. (The pattern for Group A streptococci is shown on the left hand side of the figure; that for *S. aureus* on the right hand side.)

The recovery of phage type 54 staphylococcus from skin lesions only suggests that it, like phage group II, may be a primary skin pathogen. This seems unlikely, however, for several reasons. There were no distinguishing features of the clinical appearance of skin lesions from which phage type 54 staphylococci were isolated, and the distribution of these staphylococci in lesions was similar to that of other staphylococci.

Most studies dealing with the etiology of skin infections indicate the occasional presence of coagulase negative staphylococci in lesions, usually in association with Group A streptococci. While the data presented here does not define a definite role for these organisms, certain considerations deserve some discussion. *S. epidermidis* alone was never recovered in the present studies in early lesions, but was present as the sole organism in 8% of initial cultures of later lesions. The presence of *S. epidermidis* alone in later lesions raises the possibility of production of antibiotic-like substances by these organisms that are bactericidal to streptococci. Such substances have indeed been isolated from coagulase negative staphylococci and much more commonly than from *S. aureus* (22). Studies to define a possible role of this organism in human skin infection are therefore warranted.

Frequent monitoring of this group of children has enabled clarification of several epidemiologic distinctions between streptococci and staphylococci in a population at high risk of developing impetigo. Staphylococci alone were recovered from skin lesions much more commonly in July than in later months. In contrast, streptococcal recovery rates from skin lesions were constant throughout the observation period and paralleled the over-all prevalence of skin infections in the population of children.

Definite differences are also evident in the sequence of spread of the two genera to various body sites. In Fig. 6 is a diagrammatic presentation of this sequence. The reservoir(s) from which both of these organisms originate remains unknown and definitely requires further epidemiologic exploration. For both organisms, appearance of a particular strain on normal skin occurs before recovery from skin lesions in the majority of instances. Once the organisms appear on normal skin, lesions develop if local environmental conditions are appropriate. The role of trauma in initiating the process is probably quite significant. The peak incidence of impetigo in this and other populations occurs in the summer months, at which time skin is more exposed, is more easily traumatized mechanically and the likelihood of insect bites and poison ivy are present. The distribution of lesions as compared with the distribution of streptococci on normal skin (9) and attempts to produce impetigo experimentally in man (8, 23) are also consistent with the view that trauma may play an important role in the initiation of infection.

The initial site of deposition of a streptococcal strain is the normal skin (Fig. 6). A streptococcal strain was never found in the respiratory tract before its appearance on normal skin or in a skin lesion (9). In marked contrast, a staphylococcal strain colonizes the respiratory tract first then appears on normal skin before appearance in lesions. The predominance of staphylococcal recovery early in the season and the differences in sequence of spread of staphylococci and streptococci may have significant epidemiologic implications with regard to the reservoirs of these impetiginous organisms in nature and to their transmission from one individual to another.

ACKNOWLEDGMENTS

The authors acknowledge Dr. Jonathan B. Jensen for his assistance in the epidemiologic studies. Judith Jaqua and Jerry Stanke rendered valuable technical assistance in the staphylococcal identification.

This work was supported by U. S. Public Health Service grant AI-09527 and was conducted under the sponsorship of the Commission on Streptococcal and Staphylococcal Diseases, Armed Forces Epidemiological Board, and supported by the U. S. Army Medical Research and Development Command under contracts Nos. DADA-17-70-C-0081 and DADA-17-70-C-0082.

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