Summary

Three cases of sarcoidosis of the nervous system of the predominantly peripheral type are described.

The response to steroid therapy appeared to be good, as no fresh nervous lesions developed after treatment had begun.

Attention is drawn to the frequency of incomplete recovery of the facial palsies. In one patient a further sequel was a condition closely resembling the Argyll Robertson pupil.

I am indebted to Professor D. V. Hubble for permission to describe Case 1.

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PERINEAL CARRIAGE OF STAPH. AUREUS

BY

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The possibility that the perineal region might be a carrier site on which *Staph. aureus* could multiply was suggested in a previous paper (Hare and Ridley, 1958), but no information was available on the proportion of the population who are perineal carriers, whether they can disperse the organisms into free air, or the relationship between nasal and perineal contamination or carriage. This investigation of 50 male medical students was designed to answer some of these questions.

Experimental Methods

Media and Isolation of Staph. aureus.—Nutrient agar containing phenolphthalein diphosphate, as used by Hare and Thomas (1956), was employed for the isolation of *Staph. aureus*. In general, only colonies giving a positive slide coagulase test (Cadness-Graves *et al.*, 1943) were counted as *Staph. aureus*, but the tube test was used for all strains which were phage-typed or which gave a doubtful positive in the slide test. It is possible, therefore, that a small number of staphylococci which lack bound coagulase (Duthie, 1954), but are nevertheless able to produce free coagulase, were missed by this method of identification.

Nasal and skin swabs were taken in the same way as described by Hare and Ridley (1958). The areas of skin covered by the perineal and adjacent swabs were each very small compared with other skin samples, measuring approximately 3 square cm., and were defined as follows: (*a*) The left and right perineal swabs covered the area bounded by the base of the penis in front, the upper part of the thighs on each side, and a line at least 1 in. (2.5 cm.) anterior to the anus behind. (*b*) The anal fold swab was drawn over the anal orifice in an anterior–posterior direction, and this swab was invariably taken after the perineal swabs to avoid artificial contamination of the perineum from the anus. (*c*) The whole of the lateral surface of the scrotum on each side comprised the right and left scrotal areas. (*d*) The dorsal surface of the penis was also swabbed.

Faeces Culture.—A loopful of each specimen was inoculated directly on to one plate containing nutrient agar and phenolphthalein diphosphate and on to a second nutrient agar plate containing 8% sodium chloride. The remainder of the specimen was then emulsified in about 4 ml. of broth, and 0.1-ml. and 0.5-ml. amounts were immediately spread on nutrient agar and 8% salt plates respectively. The plates were incubated at 37° C. and examined daily for five days; any colonies resembling *Staph. aureus* were subcultured on nutrient agar without the addition of salt before coagulase-testing. Culture in fluid media was avoided in order to get some idea of the amount of faecal contamination.

Results

Two groups comprising 15 final-year clinical students and 35 preclinical students, who rarely entered the hospital itself, were studied during the period October, 1957, to February, 1958. Cultures were made of each nostril and 16 skin sites, and press plates were taken from the front and back of the drawers. The latter cultures were made by impressing an area of the inside of the drawers directly on the surface of the medium in a Petri dish with a circular wooden block, with a diameter of 3 in. (7.5 cm.), held on the outside of the material. The results of this initial investigation are given in Table I under the heading Survey I.

It will be seen that, of the 50 students, 26 had no *Staph. aureus* in the nose or on any of the perineal areas; ten had *Staph. aureus* in the nose but not on the perineum; while no fewer than 14 had this organism on the perineal area, some of them with *Staph. aureus* in the nose as well. It is therefore apparent that *Staph. aureus* can be isolated from the perineal area of a comparatively large proportion of the male population.

In several instances, however, very few *Staph. aureus* were isolated from the perineum and adjacent structures —no more, in fact, than were found on other areas of the skin, such as the abdomen and thighs. It would therefore be inadvisable to regard such individuals as perineal carriers. Many were much more heavily contaminated, and, if a total of 30 colonies from the six perineal sites be taken as the dividing line, it is evident that on the results of the initial survey 10 of the subjects can on this basis be regarded as perineal carriers.

It is of some importance, however, to determine whether the presence of *Staph. aureus* on the perineum is due to contamination of the area by the organism coming from the faeces or to its ability to multiply in or on the skin of this region.

To obtain an answer to the first of these questions, samples of faeces were obtained from 14 subjects at the time the original survey was made, while another 10 were reinvestigated, nasal and perineal examinations being carried out at the same time as the faeces were obtained. The results of these investigations are given in Table II.

It is at once evident that faecal contamination alone cannot be responsible for the presence of *Staph. aureus*

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on the perineum, since no fewer than five of the nine subjects with heavy perineal growths of *Staph. aureus* had faeces from which this organism could not be cultivated. Even when *Staph. aureus* was present in the faeces the numbers were too small to account for the heavy contamination of the perineum.

In regard to the second question, an experiment was described by Hare and Ridley (1958) which strongly suggested the possibility that *Staph. aureus* could multiply in the perineal area, and the opportunity was taken to carry out similar investigations with two persistent perineal carriers who apparently did not carry *Staph. aureus* in the nose. After an initial skin survey for *Staph. aureus* each subject washed in a shower-bath for 20 minutes, concentrating on the perineal area, dried himself with a sterile towel, and put on sterile underclothes, shirt, and trousers. Surveys were then carried out at intervals up to 24 hours, using skin swabs moistened with saline rather than broth.

Table III shows that washing greatly reduced the number of *Staph. aureus* wherever this organism was initially present in large numbers, and that during the five or six hours after washing the only areas of skin showing any significant increase in *Staph. aureus* isolated were the left perineum in the case of Den and the right and left perineum and the left scrotum in the case of Rut. All the other skin sites sampled showed a progressive fall in the number of *Staph. aureus* isolated. However, by 24 hours all the areas originally found to have large numbers of *Staph. aureus* were again in the same state. It seems likely, in the case of Rut at any rate, that many of these areas were simply contaminated from the right and left perineum, which after only six hours were the first sites on which very large numbers of *Staph. aureus* were again demonstrated.

The local increase in *Staph. aureus* observed in these experiments was clearly not due to contamination from any area in the immediate vicinity. It is much more probable that it was due either to multiplication of the *Staph. aureus* that remained after washing or to the appearance on the surface of organisms sequestrated in the glands of the skin. Which of these two possibilities is correct must await further research, but it is clear that in the case of one individual, Rut, the numbers increased very rapidly. Furthermore, the area from

TABLE II.—*Presence of Staph. aureus in the Faeces*

Subject	Total Colonies from		
	Nose	Perineum	Faeces
Reg	∞	∞	17
Reb	∞	281	5
Ilt	∞	∞	0
Son	∞	2,387	0
Ter	∞	1,097	0
Mel	∞	114	0
Den	0	∞	4
Rut	13	∞	1
Hir	0	253	0
Tic	∞	0	4
Ous	∞	7	0
Ham	∞	7	0
Net, Lab, Gan, Ley	∞	0	0
Toy	50	0	0
Vem	0	0	10
6 other non-carriers	0	0	0

TABLE III.—*Increase in Perineal Staph. aureus After Washing*

	Subject Den				Subject Rut				
	Before Washing	After Washing	5 Hours Later	24 Hours Later	Before Washing	After Washing	2 Hours Later	6 Hours Later	24 Hours Later
L. perineum	∞	26	198	∞	∞	224	600	∞	∞
R. perineum	248	75	16	1,512	∞	53	400	∞	∞
L. scrotum	14	19	7	2,112	∞	45	25	480	∞
R. ,,	128	2	0	1,050	∞	550	592	360	∞
Anal fold	53	14	7	14	200	41	48	50	∞
Penis	5	0	0	37	∞	100	168	100	∞
Axillae	50	36	9	0	200	16	2	0	160
Abdomen	1	0	1	1	300	33	11	5	2,000
L. groin	0	4	0	0	∞	33	8	2	1,500
R. ,,	1	7	5	0	∞	180	19	16	1,280
L. thigh	4	29	16	10	∞	71	50	46	∞
R. ,,	16	11	6	0	∞	280	224	57	

TABLE I.—*Presence and Distribution of Staph. aureus Among 50 Male Medical Students. (The Figures Refer to the Total Number of Colonies of Staph. aureus Isolated from Each Site.)*

Subject	Survey I																	Survey II			Survey III		
	Nasal Swabs		Perineal Swabs							Drawers	Axilla		Abdomen	Umbilicus	Groins		Thighs		Interval in Weeks	Total Nose	Total Perineum	Interval in Weeks	Total Nose	Total Perineum
			Perineum		Scrotum		Penis	Anal Fold	Total															
	R.	L.	R.	L.	R.	L.					R.	L.			R.	L.	R.	L.						
Ilt	∞	200	223	∞	24	100	50	340	∞	93	6	12	30	0	71	18	50	0	4	161	1			
Reb	∞	∞	14	16	66	78	103	4	281	36	0	0	2	0	0	0	1	3	4	∞	3	2	∞	23
Ter	∞	∞	56	14	504	520	2	1	1,097	4	0	1	0	0	0	5	3	2	4		3			
Son	500	∞	20	6	1	8	0	0	35	2	0	0	0	0	0	0	0	0	6	∞	2,387			
*Mel	∞	100	7	∞	0	∞	16	40	∞	102	3	0	0	19	0	28	10	200	14		114	11	∞	327
*Ley	60	∞	2	2	13	7	9	0	33	0	0	0	3	0	2	0	11	0	12	∞	0	5	∞	0
*Net	∞	∞	0	1	0	1	5	0	7	21	0	0	3	3	33	8	0	0	18	∞	0	18	∞	3
*Ham	100	∞	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	∞	7			
*Ain	150	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	∞	0			
*Ous	∞	∞	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	7	∞	7			
Sed	∞	150	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	7	∞	0			
Lab	80	∞	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0						
Tic	∞	∞	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	∞	0			
Ten	∞	∞	0	1	0	1	5	0	7	10	21	0	2	0	0	0	200	0						
Yam	200	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						
Toy	0	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	16	65	5			
Con	0	80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	43	0			
Hat	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	∞	1			
*Reg	3	26	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	11	∞	8	5	∞	334
*Gan	1	0	36	3	156	96	48	0	339	72	0	0	0	0	0	84	0	0	9	∞	0	17	∞	777
Hir	0	5	300	150	7	5	0	∞	∞	20	0	0	0	0	4	0	0	1	6	0	18	4	0	253
Den	0	0	21	∞	39	32	6	26	∞	113	1	3	1	0	0	1	39	2	1	1		15	0	179
Rut	0	0	0	19	0	0	0	0	19	0	0	∞	0	0	0	0	0	0	5	13	∞	15	0	156
Yen	0	0	0	0	0	200	0	0	200	0	0	0	0	0	0	0	0	0	9	0	0			
26 other students	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						

* Clinical students.

which the largest number of *Staph. aureus* can be obtained may be quite limited. Table IV gives the results of repeated swabbings of Den over a period of four months. It shows that the comparatively small area of skin referred to as the left perineum was always more heavily contaminated than other areas. Indeed, it is probable that the latter areas were being contaminated from the left perineum and were not sites of multiplication.

TABLE IV.—*Distribution of Staph. aureus on the Perineum and Adjacent Areas of Subject Den*

	Jan. 23	Jan. 28	Feb. 19	May 15
L. perineum ..	∞	∞	200	100
L. scrotum ..	32	128	16	50
R. perineum ..	21	248	6	2
R. scrotum ..	39	14	0	2
Anal fold ..	26	53	0	21
Penis	6	5	0	4

Persistence of Perineal Carriage

Repeated nose and skin surveys were carried out on the majority of the nasal and perineal carriers revealed by the initial tests. For brevity, only the total number of *Staph. aureus* isolated from the nose and the perineal areas are included in Table I for these repeated tests.

Although 5 of the 12 heavy perineal carriers (Mel, Reg, Rut, Den, and Son) demonstrated in the course of this investigation appeared to maintain this state over a period of six weeks to six months, five others (Ilt, Ter, Ley, Reb, and Yen) became non-carriers, while one subject (Reg) acquired large numbers of perineal *Staph. aureus* which were not present initially. Finally, Table I shows that two subjects (Gan and Hir) passed from heavy carriage to non-carriage and then back to heavy carriage again. It is, however, possible that these two subjects were really persistent perineal carriers despite the intervals of non-carriage mentioned. The strain of *Staph. aureus* isolated from Gan did not produce phosphatase, so that the recognition of colonies of this organism in the heavy growth from perineal swabs was difficult at all times, and most of all at the second swabbing when the growth on the perineal plates was confluent. The other subject, Hir, had a heavy growth of *Staph. aureus* from the perineal area on the first occasion, but six weeks later only 18 colonies were isolated. This, however, may have been connected with the use of oral antibiotics one week before the second test. In any event, after a further four weeks the perineal area had apparently been recolonized, because a total of 253 *Staph. aureus* organisms were isolated from this region. It is clear from these results that perineal carriage is not as stable as nasal carriage, although about half of the perineal carriers described seemed to maintain this state for a considerable time.

Dispersal of Staph. aureus

Using the cubicle described by Hare and Ridley (1958) the ability to disperse *Staph. aureus* was determined for a number of nasal, perineal, mixed nasal and perineal carriers and non-carriers. Although the results of these experiments are probably affected by a number of factors difficult to control, such as the time since the last bath or change of clothes, several broad conclusions drawn from the results given in Table V seem justifiable.

Firstly, Hare and Ridley (1958) described one perineal carrier without nasal *Staph. aureus* who was able to disperse 4.8 organisms per sq. ft. of medium per minute. The results in Table V confirm that under certain circumstances those with perineal *Staph. aureus* alone can in fact disperse even larger numbers of this organism. Thus Rut and Hir dispersed 25.6 and 7.6 *Staph. aureus* per sq. ft. of medium per minute respectively. However, another subject (Den), who had an equally large number of perineal and no nasal *Staph. aureus*, consistently dispersed only a small number of organisms, and on one occasion no more than were dispersed by the non-carriers (Nes and Raf). It seems, therefore, that dispersal of *Staph. aureus* by perineal carriers with an equal amount of contamination of the area is as variable as dispersal by nasal carriers with the same degree of nasal contamination was found to be by Hare and Ridley (1958).

TABLE V.—*Skin and Clothing Contamination with Staph. aureus and Ability to Disperse this Organism into the Environment*

Subject	Total Colonies *Staph. aureus* Isolated					Dispersal *Staph. aureus* per sq. ft. of Medium per min.
	Nose	Perineum	Skin	Fingers	Clothing	
Son	∞	2,387	46	71	130	20·2
Ilt	∞	∞	187	∞	17	12·2
Ter	∞	1,097	11	2	58	10·2
Reb	∞	281	6	17	40	8·0
Mel	∞	∞	260	44	9	7·8
	∞	114	1	22	28	2·8
Reg	∞	∞	15	—	2	4·8
Tic	∞	0	0	155	246	24·4
Ley	∞	0	8	400	—	4·4
	∞	0	0	162	11	3·0
Sed	∞	1	0	12	7	5·4
	∞	0	10	—	9	1·8
Lab	∞	0	1	—	2	0·8
Rut	13	∞	1,100	∞	38	25·6
Hir	0	253	9	0	20	7·6
Den	0	∞	47	0	15	0·4
	1	∞	52	0	17	2·0
	0	222	0	0	3	1·2
Nes	5	0	0	0	5	0·8
Raf	0	0	0	0	2	0·2

Secondly, comparison of the number of organisms dispersed by pure nasal carriers and mixed nasal and perineal carriers suggests that those with *Staph. aureus* in both sites generally disperse more. Table V shows, however, that exceptions to this occurred; for both Mel and Reg, who had large numbers of *Staph. aureus* in both the nose and on the perineum, gave rather low figures; these low results may have been due to some factor such as a recent change of clothing. Furthermore, one subject (Tic) who was a nasal carrier without any perineal contamination dispersed so many that 24.4 *Staph. aureus* settled on 1 sq. ft. of medium per minute; this was the second highest figure obtained in the series, but although this subject was never demonstrated to have perineal *Staph. aureus* he was the only pure nasal carrier from whom faecal *Staph. aureus* was isolated. Although it is possible that faecal excretion of *Staph. aureus* may lead to widespread contamination of the body surface and clothes, as suggested by Brodie *et al.* (1956), and thus bring about an increase in the ability to disperse this organism, this does not invariably occur, for Den dispersed very few *Staph. aureus* despite the fact that he was a faecal carrier.

Skin and Clothing Contamination with Staph. aureus

Table V also gives the total number of colonies of *Staph. aureus* isolated from the external layer of clothing, from the fingers of both hands, and from six skin areas apart from the area covered by the six perineal swabs. In general there was good correlation

between the degree of dispersal and the number of *Staph. aureus* isolated from the clothes and fingers.

Those with perineal *Staph. aureus* usually had much greater contamination of other areas of skin than the purely nasal carriers. This is demonstrated both in Table V and in Table I, where the actual distribution of *Staph. aureus* for each subject is given. It is perhaps not surprising, therefore, that the mixed nasal and perineal carrier with this widespread contamination of the skin may often disperse more *Staph. aureus* than the purely nasal carrier.

Phage-typing

Phage-pattern determinations, kindly carried out by Dr. Patricia Jevons, of the Central Public Health Laboratory, Colindale, showed that all the double nasal and perineal carriers had strains with the same phage pattern in these two sites, and repeated phage-typing showed that these strains persisted for many weeks or months. Similarly, the purely perineal carriers (Hir, Rut, and Den) persistently carried the same strain on the perineum when tested on different occasions. There was no evidence that any particular phage type of *Staph. aureus* had any predilection for survival on the perineum. In fact, the distribution of phage types found on the perineum was similar to the distribution found in nasal carriers.

In general, *Staph. aureus* isolated from the faeces had the same phage pattern as the nasal or perineal strain, but one individual, Den, was an exception. On January 25 strains of *Staph. aureus* classified as belonging to phage groups I, II, and III, with very different individual patterns of lysis, were isolated from his perineum, faeces, and nose respectively. Two weeks later this subject was again found to be excreting in his faeces a group II *Staph. aureus* with the pattern 3C/55, which was identical with the strain previously isolated from this source. This same strain was isolated from the faeces for the third time on February 21, when it was also isolated from the throat. On this last occasion, however, a group I strain was again isolated from the perineum. Clearly, therefore, the perineum could not have been contaminated from the nose, throat, or faeces.

Discussion

The investigations reported in this paper show that a comparatively large proportion of individuals have sufficient *Staph. aureus* on the skin of the perineum and adjacent structures to suggest that the organism is able to colonize this area. Many of these individuals have this organism in the nose as well, while a few are primarily perineal carriers with few or no *Staph. aureus* in the nose; in such individuals multiplication of staphylococci on the perineum appears to be the most likely explanation for the persistence of large numbers of the organism in this site for considerable periods of time. Certainly for one subject (Den), who came into this category, the persistence of perineal *Staph. aureus* could not be attributed to contamination from the nose, the throat, or the faeces, as the strains of *Staph. aureus* isolated from these sources belonged to phage groups different from the perineal strain.

When, however, there is heavy nasal carriage in addition to apparent perineal carriage it is possible that repeated contamination from the nose may be responsible for the large number of *Staph. aureus* on the perineum. Frequent and heavy contamination in this way, however, is unlikely, as the perineum is a long way from the nose, while neighbouring areas of skin—for instance, the abdomen, the groins, and even the skin round the anus—are contaminated to a much less extent. Nevertheless, occasional contamination of the area from the nose, together with prolonged survival in the glands of the perineal skin, as described by Devenish and Miles (1939) and Gillespie *et al.* (1939) for the skin of the hands in some individuals, might explain the persistence of perineal *Staph. aureus* in those who are also nasal carriers.

It is interesting that both the nasal vestibule and the perineal skin are areas where large apocrine glands are found (Rothman, 1954). It has previously been suggested that in nasal carriers *Staph. aureus* lives in the glands of the skin lining the nasal vestibule (Gould, 1955). It may therefore be that these glands offer a suitable environment for the survival and multiplication of this organism and that their presence in the perineal skin accounts for the large number of staphylococci found there in some individuals compared with other neighbouring areas of the skin.

Whatever the explanation, however, it is apparent that *Staph. aureus* is able to multiply or at least survive in large numbers on the perineal skin of about 14% of the male population. It was not possible to extend this survey to include women, but Professor Hare has informed me that he has recently isolated very large numbers of *Staph. aureus* from the perineum of a female patient. This suggests that women may act as perineal carriers in the same way as men.

Summary

A survey of 50 male medical students showed that 52% had no *Staph. aureus* in the nose or on the skin, that 26% had this organism in the nose, generally in very large numbers, but that the perineal area yielded fewer than 30 colonies from the six sites chosen for examination. A further 12% had much greater degrees of contamination of the perineal area and were heavy nasal carriers as well. The remaining 10% had an equal degree of contamination of the perineal area, but no *Staph. aureus* in the nose or only one or, at most, five colonies.

Thus sufficiently large numbers of *Staph. aureus* can be isolated from the perineal area of 22% of male adults to class them as perineal carriers.

Further investigations showed that this state may persist for months in about 14% of individuals, that it is not due to faecal contamination alone, that the organisms are able to multiply in or on the perineal skin, that they may be of different phage type from those found in the nose or faeces, and, finally, that they may be dispersed into free air when the subject exercises in a cubicle.

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