THE MORTALITY OF THE HAEMOLYTIC *STREPTOCOCCUS* ON THE SKIN AND ON OTHER SURFACES

By J. M. L. BURTENSHAW

From the Department of Pathology and Bacteriology, Welsh National School of Medicine, Cardiff

Introduction

The work of Colebrook in this country and of Arnold, Cornbleet and others in America has stirred interest in the self-disinfecting power of the skin. The experiments described in this paper are an attempt to confirm and amplify their work.

Their method for recovering organisms from the skin consisted of swabbing the area under investigation with a pledget of lint or similar material soaked in broth or saline, and then washing out the pledget in broth or rubbing it on the surface of an agar plate. Such methods in my experience gave but very incomplete recovery of the organisms, and my first task was to invent a more satisfactory technique for their recovery.

Technique

The procedure in the majority of my experiments can be summarized as follows. An approximately known number of organisms suspended in normal saline was spread over each of two similar areas of the skin or other surfaces to be tested for disinfectant power. The suspension was allowed to evaporate, and after a definite interval from the disappearance of all visible moisture (about 5 min.) the deposited organisms were washed off from one of each pair of surfaces, and the survivors estimated by plating out part of the washings in blood agar. After a further interval (1 or 2 hr.) the organisms from the remaining members of the pairs of surfaces were in like manner washed off and the survivors estimated.

In all except four of the experiments five strains of the haemolytic *Streptococcus* were used. Strains Lewis and Wilson were isolated from diseased mastoid processes. Strains Beechwood and Morgan were cultured from two scarlatinal throats. Strain Thomas was grown from empyema pus. The remaining four experiments were done with a strain of *Staphylococcus aureus* obtained from a boil.

Suspensions in normal saline of a 12–48 hr. growth on blood agar were first used. An older growth tended to lose surface viability rapidly during the course of an experiment. In the later experiments the organisms were suspended in distilled water, in order to avoid any additional dehydration

from the tremendous rise of osmotic pressure which must occur around the organisms during the evaporation of a salt solution. It does not seem, however, from the protocols that mortality was reduced by this measure. In most of the experiments the suspension was used in a dilution of about 500 millions to the c.c.

The living skin used as a test surface was that of my own finger-tips, palms and forearm. It was sterilized by thoroughly washing with soap and warm water, but the scrubbing brush was used sparingly, since, as Colebrook has shown, too much washing leaves an unphysiological surface, with perhaps impaired bactericidal power. I found that an inch square on the surfaces tested allowed the standard quantity of bacterial suspension (0·025 c.c.) to spread out in a film which quickly dried. On the limited space of the finger-tips only half this area and half the standard amount of suspension could be used. Marking out was done with a metal tube 1 in. square pressed firmly on the palmar and forearm skin. For the fingers a tube measuring $1 \times 0{\cdot}5$ in. was used. The corners of the resulting impression, which tended to fade, were marked in with pencil dots. The standard quantity (0·025 c.c.) of the organismal suspension was then pipetted on to the skin, spread out with a platinum loop, and evaporated in a warm current of air.

For recovery of organisms from the fingers I used a rectangular glass cell, $3\frac{1}{2}$ in. long and $1\frac{1}{2}$ in. wide $\times$ 1 in. deep, made by cutting down a specimen jar. The dorsum of the bent finger rested on the bottom of the cell, and for a standard period (3 min.) the film was scraped off with a narrow glass slide into 20 c.c. of saline, of which 0·31 c.c. (1/64th part) was incorporated in a blood-agar plate.

For the palm of the hand or forearm I used the following device. A rectangular frame made from brass angle-girder was clamped down by means of an elastic band upon a low glass cylinder surrounding the organism-coated area. Into the clamped-down cylinder was pipetted 2 c.c. of saline, and the coated area scraped with the end of a glass slide just over an inch wide, so that each scrape completely covered the area. This motion was repeated four times in each direction in two planes at right angles to one another. The 2 c.c. of saline was then drawn off with a Pasteur pipette and transferred to a corked test-tube. This procedure was repeated with a further 2 c.c. and the cylinder rinsed out with a final 2 c.c. of saline. Of the 6 c.c. of wash-off saline 0·19 c.c. (1/32nd part) was incorporated in a blood-agar plate.

At the beginning, and often at the end, of every experiment the number of viable organisms in a standard quantity (0·025 c.c.) of the suspension in use was estimated in the following way. Into a tube containing 4 c.c. of saline 0·025 c.c. of suspension was pipetted, 0·1 c.c. from the first tube was transferred to a second containing 10 and 0·5 c.c. from the second was incorporated in a blood-agar plate (1/800th part). The aliquot parts of washings or of bacterial suspension plated out were determined simply by the convenience of obtaining an easily countable number of colonies.

After about 16 hr. incubation an eighth to the whole of the colonies in the plates according to their concentration were counted with the help of a Veeder Counter through a transparent Pake's disk over an illuminated box.

The control surfaces used comprised dead skin, glass and rubber. In a few experiments tinfoil and Cellophane were used, but were found unsuitable and abandoned. The dead skin was obtained from the abdomen of corpses not more than 24 hr. old or from surgical excisions. A few square inches of the skin and its subcutaneous layer, which helps to keep the skin moist and flexible, were tightly stretched over a piece of board. Preparation of the surface and recovery of organisms was carried out as for living skin. Glass was conveniently provided by ordinary microscope slides 1 in. wide which were sterilized by boiling. The suspension was spread out on the terminal inch of these, evaporated in the incubator, and the dried organisms washed off by scraping into 8 c.c. of saline in a Petri dish $1\frac{3}{4}$ in. in diameter and 1 in. deep. 0·25 c.c. (1/32nd part) of the washings was then incorporated in a rabbit blood agar plate. The rubber used was of two kinds: red canvas-centred rubber sheeting, of the kind used to make rubber aprons, and thin white rubber sheet derived from condoms. The first kind was laid, the second stretched over a piece of flat board, and both were sterilized by scrubbing with soap and water. Evaporation of the spread suspension was done in the incubator, and recovery of organisms was carried out as for dead skin.

ANALYSIS OF EXPERIMENTS

The figures headed F.V.R. in the protocols need some preliminary explanation.

Owing to the differing efficiency of the methods used for recovering organisms from the various surfaces it is unsafe to draw conclusions about the relative disinfectant powers of two surfaces by comparing the recovery from a given wash-off of the one with the recovery from the corresponding wash-off of the other. A more accurate measure of relative disinfectant power is to calculate the ratio of organisms recovered at the first wash-off to those recovered at the second wash-off, hereinafter called the *fall in viability ratio* (F.V.R.), for each surface tested, and then to compare these ratios.

The experiments in series I and II illustrate the differing disinfectant power of the skin and control surfaces employed. The experiments of series I, done with a strain of *Staphylococcus aureus*, are a control on the main body of about fifty experiments, represented by series II and III, which were done with strains of *Streptococcus pyogenes*.

It is clear from series I how little the yellow *Staphylococcus* is susceptible to an adverse environment. First, the number of staphylococci recovered at first wash-off from the skin surface, either living or dead, amounts to about half the number applied, a much higher proportion of recovered organisms than is ever attained with the *Streptococcus*. The proportion of applied

Series I. *Staphylococcus aureus*

				Left palm			Dead skin			Rubber sheet			Tinfoil		
No.	Date	W.O. No.	Susp. Cont.	E.T. min.	W.O.	F.V.R.	E.T. min.	W.O.	F.V.R.	E.T. min.	W.O.	F.V.R.	E.T. min.	W.O.	F.V.R.
*1	1. iv. 37	1	2568·0	8	1414·4	1·37	10	1560·0	1·3	7	807·0	3·6	11	973·4	5·0
		2		90	921·6		90	1200·0		99	224·3		100	194·7	
				(82)			(80)			(92)			(89)		
†2	7. iv. 37	1	3459·2	7	1692·8	1·43	6	2437·6	1·4	6	923·6	4·8	8	1011·2	3·2
		2		65	1180·8		70	1741·1		92	192·4		96	316·0	
				(58)			(64)			(86)			(88)		

* Dead skin obtained from abdomen of old man.

† Dead skin obtained from abdomen of boy.

F.V.R. = fall in viability ratio.

E.T. = exposure time.

W.O. = recovery at wash-off.

organisms recovered from tin and rubber is much less: this is due partly to technical inadequacy at this early stage of the work, partly, as will be seen later, to a toxic effect of the rubber employed. Secondly, the low F.V.R.'s and the almost identical F.V.R.'s for live and dead skin show that the skin, either live or dead, has little sterilizing action on the *Staphylococcus*.

The experiments of series II and III illustrate the far greater sensitiveness of the *Streptococcus* to environment. In the first place, the greater disinfection caused by drying or by some specific property is clear from the far smaller proportion of applied organisms recoverable at first wash-off from any of the test surfaces. In the second place, if the F.V.R. is used as criterion, there is marked differential sterilization of the *Streptococcus* on the various surfaces. Particularly striking is the superiority of the right palm over the left as a sterilizing surface, at any rate in myself; this is well shown in series III. I thought it possible that inequalities of technique, due to left-handed manipulations on the right palm, might account for this, so a few experiments (e.g. 11 and 12) were done by an assistant, they show the same difference in disinfectant power between left and right palms.

Comparison of the averages of the F.V.R.'s for the various test surfaces allows them to be arranged in descending order of disinfectant power as follows:

(1) Palmar skin.
(2) Apron rubber.
(3) Glass.
(4) Finger-tip skin.
(5) Forearm, dead skin, condom rubber.

The significance of the differences in disinfectant power between the skin surfaces will be discussed later, but the remarkable differences revealed between the control surfaces may be dealt with here.

That the average F.V.R. for glass is rather higher than that for dead skin or for condom rubber is perhaps explicable by the moister surface of skin and rubber preventing such complete drying as on glass. The much higher average

Series II. *Streptococcus pyogenes*

No.	Date	W.O. No.	Susp. cont. W.O.	Susp. cont. F.V.R.	Fingers E.T. min.	Fingers W.O.	Fingers F.V.R.	Palm E.T. min.	Palm W.O.	Palm F.V.R.	Forearm E.T. min.	Forearm W.O.	Forearm F.V.R.	Dead skin E.T. min.	Dead skin W.O.	Dead skin F.V.R.	Glass E.T. min.	Glass W.O.	Glass F.V.R.	Rubber (apron) E.T. min.	Rubber (apron) W.O.	Rubber (apron) F.V.R.	Rubber (condom) E.T. min.	Rubber (condom) W.O.	Rubber (condom) F.V.R.
3	25. vi. 37	1	1270·4	1·6	2	329·73	3·6	2	70·8	59·0	4	69·0	3·5	3	90·3	3·2	5	45·0	4·5	4	9·6	6·3	4	65·0	3·5
		2	803·2		114	90·10		110	1·2		105	20·0		106	22·6		122	10·0		120	1·5		121	18·6	
			(240)		(112)			(108)			(101)			(103)			(117)			(116)			(117)		
4	30. vi. 37	1	1971·2	1·3	3	435·6	2·3	4	142·0	5·9	2	96·0	1·8	3	88·2	2·3	3	132·2	5·6	4	4·8	12·0	4	93·6	2·3
		2	1542·4		92	190·0		80	24·0		83	53·1		78	38·3		84	23·3		80	0·4		78	40·2	
			(225)		(89)			(76)			(81)			(75)			(81)			(76)			(74)		
5	20. vii. 37	1	2880·0	1·5	4	960·0	5·8	5	384·0	12·3	4	212·4	2·1	3	176·4	3·3	6	328·6	4·8	5	295·7	8·6	5	360·1	2·2
		2	1897·6		90	166·4		85	31·2		83	101·3		86	53·7		79	68·5		88	34·2		87	163·7	
			(145)		(86)			(80)			(79)			(83)			(73)			(83)			(82)		
6	22. vii. 37	1	2329·6	1·9	3	763·9	4·0	4	259·1	5·1	4	201·2	1·3	4	302·6	1·3	4	14·6	3·5	5	6·1	15·2	5	175·7	2·1
		2	1228·8		54	190·9		54	50·6		64	157·9		65	232·8		60	4·2		63	0·4		68	85·0	
			(320)		(51)			(50)			(60)			(61)			(56)			(58)			(63)		
7	13. viii. 37	1	852·0	1·8	3	111·6	10·7	3	70·7	35·3	5	32·0	2·8	5	52·1	2·6	6	54·4	8·7	6	35·3	11·4	6	38·2	1·4
		2	720·0		84	10·4		85	2·0		85	11·2		85	20·0		85	6·2		85	3·1		85	27·0	
			(169)		(81)			(82)			(80)			(80)			(79)			(79)			(79)		
8	15. viii. 37	1	583·2	1·7	4	40·4	13·0	4	26·1	81·6	4	40·3	5·2	4	32·0	2·2	10	35·2	3·4	9	12·0	5·6	10	18·2	3·4
		2	339·2		118	3·1		120	0·32		120	7·8		120	14·2		105	10·2		105	2·1		105	5·3	
			(270)		(114)			(116)			(116)			(116)			(95)			(96)			(95)		
Average F.V.R. for exp. of series II				1·63			6·57			33·20			2·78			2·48			5·08			9·85			2·48
Average F.V.R.'s for 40 exp.				1·76			4·58			29·90			2·73			2·95			5·96			8·10			2·75

COMMENTS

No. 3. Strep. Beechwood—Dead skin from abdomen of man aged 72.
No. 4. Strep. Beechwood—Dead skin from excision of ventral hernia in young woman.
No. 5. Strep. Thomas—Dead skin from excision of breast in young woman.
No. 6. Strep. Thomas—Dead skin from abdomen of young woman.
No. 7. Strep. Lewis—Dead skin from abdomen of boy.
No. 8. Strep Lewis—Dead skin from medial side of thigh of young man.

Series III. *Differential disinfection of two palms of J. M. B.*

		Susp. cont.		Left palm		Right palm		Glass		
No.	Date	W.O. No.		E.T. min.	W.O.	E.T. min.	W.O.	E.T. min.	W.O.	Comments
9	2. vii. 36	1	48·8	4	0·22	4	0	4	12·5	Strep. Lewis. Exposure of glass 2 considerably less than left palm 2 and right palm 2: even so survival in glass 2 is greater than on palms.
		2	34·4	64	0	66	0	43	9·4	
			(132)	(60)		(62)		(39)		
10	15. vii. 36	1	611·20	4	18·3	4	2·0	18	20·0	Strep. Lewis (48 hr. culture). Exposure of glass 1 much greater than that of left palm 1 and right palm 1: otherwise recovery from glass 1 would have been higher.
		2	515·20	75	0·64	75	0	88	10·4	
			(120)	(71)		(71)		(70)		
11	9. ix. 36	1	816·0	4	129·9	4	99·2			Strep. Beechwood. This experiment besides differential disinfection shows the diminished rate of disinfection when the applied number of organisms is greater.
		2	704·0	55	69·2	55	9·3			
			(100)	(51)		(51)				
12	16. ix. 36	1	1616·0	5	121·6	4	36·8	6	57·6	Strep. Beechwood (48 hr. culture). (This experiment performed by J. P. N. to exclude possibility of left-handed technique being responsible for lower recovery and higher F.V.R. from right palm.)
		2	1472·0	79	8·9	79	0·54	69	25·6	
			(120)	(74)		97	0·32	(63)		
						(75)				
						(93)				

F.V.R. and the erratic, often very low recovery figures for apron rubber were explained as a result of the observation that the wash-off saline from apron rubber always contained very fine particles in suspension, sometimes in sufficient number to produce a milky fluid. In one or two experiments plating out of this wash-off saline had to be postponed, and the resultant plates were sterile. This induced me to inoculate with a known number of organisms a tube of saline containing scraped-off rubber in suspension and a similar tube containing saline alone. Plating out from the two tubes was done at half-hourly intervals; sterilization was far more rapid in the rubber-contaminated saline. It seemed possible that this sterilizing property belonged not to rubber itself but to some impurity introduced during manufacture. Enquiry elicited that the "filling" incorporated in this rubber consists largely of various compounds of zinc, which would of course account for the sterilizing power observed. As in the experimental routine there is usually a lapse between the wash-off and the plating out of 3–5 min., during which the recovered organisms would be in contact with the suspended rubber particles, it is probable that rapid dying occurs during this interval, and this, together with the possibly less perfect removal by scraping from the slightly grained surface of apron rubber, would account for recovery being much more imperfect than from glass. The zinc content of the rubber "filling" presumably accounts too for the F.V.R. on rubber sheeting being higher than that on glass.

In the experiments of series IV is shown the progressive deterioration in surface viability of organisms still surviving in suspension. The skin group in this series was originally designed to reveal any differential disinfection of the palmar skin, but, if any such difference exists, it is quite masked by the fall in surface viability of the organisms during the course of an experiment. As there is progressive death amongst organisms in water suspension, one would expect recovery from a dried film made from a standard volume 5 min. after the preparation of the suspension to be higher than from a similar film made 120 min. after its preparation. Also, provided that the films were exposed for similar periods, one would expect the following equation to hold:

$$\frac{\text{Organisms recovered from 1st film}}{\text{Viable orgs. in susp. at time of making first film}}(1) = \frac{\text{Organisms recovered from 2nd film}}{\text{Viable orgs. in susp. at time of making second film}}(2)$$

Actually in every experiment of series IV (2) is smaller than (1). This observation demonstrates that, in addition to a progressive increase with time of the proportion of dead organisms in water suspension, there is a progressively greater proportion of the still surviving organisms which are somehow rendered less viable, so that they easily succumb to drying and other hostile influences in surface films.

Exp. 18 is detailed in order to show the superiority of the wash-off technique finally adopted, using three quantities of 2 c.c. saline, over a shorter technique using only one wash-off with 2 c.c. saline.

Series IV

No.	Date	Susp. Cont.	F.V.R.	W.O. No.	E.T. min.	Intervals between W.O.'s min.	Intervals between 1st and last W.O.	W.O.	F.V.R. of 1st and last W.O.	Positions in left palm	Comments
Palm											
13	29. ix. 37	153·6	1·2	1	10	0		5·312	4·0	1 2	Strep. Beechwood
		123·2		2	15	20		3·520		3	
		(80)		3	13	50	(70)	1·344			
14	6. x. 37	1425·6	1·2	1	23	0		199·68	1·7	1 4	Strep. Beechwood (48 hr.).
		1222·4		2	25	22		170·00		3	W.O. 2 and 3 show a reversal
		(172)		3	25	22		176·64		5 2	of the usual progressive
				4	28	26		120·00			decline in viability
				5	25	22	(92)	114·18			
15	21. x. 37	640·0	1·5	1	23	0		48·77	3·2	1 4	Strep. Morgan
		440·0		2	29	25		51·10			
		(120)		3	28	23		25·00		3 2	
				4	24	22	(70)	15·40			
16	3. xii. 37	848·0	1·3	1	23	0		7·04	2·1	1 3	
		640·0		2	27	30		6·08			
		(120)		3	25	22		3·80		4 2	
				4	27	25	(77)	3·39			
Glass											
17	12. xi. 37	460·8	1·2	1	5	0		4·96	2·1		
		396·8		2	6	19		4·29			
		(70)		3	7	13		3·20			
				4	5	19	(51)	2·40			
Apron rubber											
18	16. xi. 37	480·0	1·2	1	10	0		0·960	6·0		
		408·0		2	13	23		0·384			
		(70)		3	12	26	(59)	0·160			

Control. *Experiments done to test advantage of the longer washing-off technique*

No.	Date	Susp. cont.	Left palm	E.T. min.	w.o.	Comments
19	19. ix. 36	2643·2	(1) Distal centre *Full technique:* wash-off with two quantities of 2 c.c., rinse with 2 c.c.	3	147·33	Somewhat better recovery given by the full technique
			(2) Proximal centre *Short technique:* wash-off with one quantity of 2 c.c., no rinse	2	120·83	

EXPLANATORY NOTES ON TABLES

In the control and w.o. columns unity = 1000 organisms recovered.

As an example of reading results take Exp. 3. The first control gave a recovery of 1,270,400 organisms, the second 803,200 organisms. 240 min. elapsed between the performance of the controls. 2 min. elapsed between drying and the first wash-off of organisms from the left palm, and 70,800 organisms were recovered. 110 min. elapsed between drying and the second wash-off, and 1200 organisms were recovered. The interval between wash-offs was 108 min. The F.V.R. for the palm was 59·0.

In series IV all the preparation and washing off of films was done between the performance of the two controls. The figures of the "positions in palm" column show diagrammatically the position of the films on the left hand of an observer.

Suspensions of streptococci prepared from 24 hr. growths, except where otherwise mentioned.

DISCUSSION

At the outset it must be emphasized that all the results on living human skin here considered were obtained on my own skin, and the majority of them on the skin of my left forearm and hand.

In the light of the work of Karns & Arnold (1930) and of Hill & White (1933) it is clear that the disinfecting power of different living skins varies widely. Therefore my results cannot be considered generally valid until confirmed on a number of individuals.

Using the ingenious method of Hill & White I find that my finger-tip skin has no inhibiting effect on the growth of the haemolytic *Streptococcus* in a poured plate. Hill & White found that a variable proportion of their volunteers' finger-tips, from 5 to 100% according to the organism tested, inhibited the growth of such different organisms as *Staphylococcus aureus*, *Escherichia coli* and anthrax spores in agar plates, but they did not extend their work to streptococci. Assuming that their results apply also to the *Streptococcus*, my skin belongs to their category lacking in inhibitory power, and such disinfectant power as it possesses would presumably be much more marked in a person belonging to their growth-inhibiting category.

That the *Streptococcus* is far more susceptible than the *Staphylococcus* to an unfavourable environment, as Colebrook (1930) and Arnold & Gustafson *et al.* (1930, 1934) have found, is shown by the contrast between the results of the admittedly small group of experiments with the *Staphylococcus* and the remainder with the *Streptococcus*.

Again, this investigation shows quite conclusively that certain areas of the human skin possess a sterilizing power on streptococci deposited on them, and that this power is by no means the same in these different areas. If the very low disinfectant power of the skin of the forearm or of dead skin is accepted as a standard, this work confirms Colebrook's findings that the finger-tip skin has specific disinfectant properties. Yet in this work the palmar skin was found to sterilize far more effectively than that of the fingers.

Colebrook has stated that skin disinfection is very rapid, and that most of the organisms are irrecoverable within 5 min. of application. Also Arnold & Bart (1934) have found that the rate of disappearance is such that one half vanish from the skin surface during every minute of exposure.

The results recorded above, if the recovery from successive wash-offs is considered, point to a much less rapid rate of disappearance either of streptococci or staphylococci. It is true that there is very rapid disappearance of streptococci in the interval between application and first wash-off, but during this period rapid desiccation and the manipulations of recovery must cause a heavy death-roll. A reasonable conclusion is that there occurs under experimental conditions very rapid death amongst the exposed streptococci during the initial process of drying, but that this death-rate is much slowed, even on the most powerfully disinfecting surfaces, during the rest of the exposure, when the specific disinfectant power is chiefly at work.

There is evidence afforded by these experiments that, as Arnold and his associates assert, the sterilizing power of the skin can be overtaxed by a surfeit of organisms. Where recovery from the skin was high, the F.V.R. was usually smaller than where recovery was low. Contrast, for example, Exps. 3–6 with Exps. 7 and 8.

The problem of the nature of the disinfectant power exerted by the skin is not solved by this investigation, which indeed was not designed to solve it, but the relative importance of one or two of the factors involved is more clearly defined. Norton & Novy (1931, 1932) have attributed a large role in skin disinfection, Arnold only a small one, to drying. It was concluded above that under experimental conditions, where the organisms are applied in watery suspension, there is great mortality during the drying-off process. It is questionable, however, whether there is this initial heavy death-roll when under natural conditions a few streptococci are smeared on the skin with very little accompanying fluid. The further mortality during the period of exposure, particularly well shown in this work by the high F.V.R.'s on palmar skin, is certainly due only in very small part to drying. The degree of dryness is probably greater on the forearm than on the palm; yet on the forearm there is practically no disinfectant action, no more, indeed, than on dead skin.

Another possible sterilizing agent, which has been suggested by Schade & Marchionini (1928) and others, is the acid secretion of the sweat glands. Hall & Fraser (1921) have found that *Staphylococcus aureus* will grow in a medium of *p*H 2·6–10·0, whilst Avery & Cullen (1919) and Dernby (1935)

contrast the much more restricted range of acidity allowing growth of the *Streptococcus pyogenes*, namely *p*H 5·5–8·0. Marchionini (1928) has observed that the *p*H of many different parts of the skin surface (excluding areas richly supplied with apocrine glands, such as the axilla and perineal regions) varies between 3 and 5, but he gives no comparative figures for the finger, palm, and forearm, which might allow correlation between my findings and the degree of acidity prevailing over these areas. He has observed also that the greater the sweating the less the acidity over the surface; this he ascribes to a diminished rate of evaporation of an increased volume of sweat and consequently a less rapid rise in its acidity. I often noticed during an experiment beads of sweat pearling on the finger-tips, but only rarely on the palms, which experiment proves to be the more efficient sterilizing surface. It may well be that more copious sweating from the fingers, or—a more probable alternative in view of the anatomical facts mentioned below—quicker evaporation from the palm, which owing to its cupped posture is usually warmer, favours a higher acidity and therefore a higher disinfectant power of the palm.

Approaching the problem from a different angle, I have made comparative counts of the sweat ducts in the finger, palmar and forearm skin of six necropsy subjects. The ducts are nearly twice as numerous in the palm as in the fingers, in the forearm very sparsely scattered. Other factors remaining equal, it may be assumed that a greater concentration of glands implies a greater secretion of sweat, and, if sweat is an important sterilizing agent, the more that is secreted on a surface, the greater that surface's sterilizing power. This argument from anatomical premises places the three skin surfaces in the same order of disinfectant efficiency as emerges from my other experimental work.

On the whole the evidence here brought forward supports the view that some areas of the skin exert a disinfectant action by virtue of their secretion of sweat.

SUMMARY AND CONCLUSIONS

1. A new technique is described for recovering applied organisms from the skin and other surfaces.

2. Experiments are analysed, in which staphylococci and streptococci are recovered by this technique from various areas of the skin and from glass and rubber.

3. It is concluded that the surfaces examined can be arranged in a definite order of decreasing disinfectant power.

4. The peculiar disinfectant power of rubber is considered.

5. The deterioration in surface viability of streptococci still surviving in saline suspension is described.

6. The experimental results are discussed in the light of previous investigations.

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