A NOTE ON SURFACE-ACTIVE AGENTS AND SURGICAL DRESSINGS

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Introduction

There are two properties of a surgical dressing which are important as measures of its ability to absorb water or secretions in a satisfactory manner. One is the absorbency, that is to say, the rate at which the liquid is absorbed and the other is the water retention coefficient, that is to say, the quantity of liquid which the dressing can retain. In this paper, the absorbency is considered as the main subject, but water retention coefficient has been examined because the possibility exists that there is sometimes an inverse relationship between the two properties. It is unfortunately true that absorbency is not always a permanent property of a surgical dressing. Sometimes a dressing will remain highly absorbent for years, but at other times, one similar in all apparent respects will lose its absorbency, and may in time, usually after some years, become so non-absorbent that it will float on water indefinitely. Two theories have been proposed to account for this change. One (Savage[1]) is based on the fact that by the empirical practice of the trade, absorbent cotton of commerce has upon the surface of the fibres a layer of material largely composed of fatty acids. It is known that such a layer can exist in two orientated forms, in one of which it is the carboxyl group which faces outwards, and in the other the non-wettable terminal methyl group. It would be expected by this theory that absorbent cotton would normally exist in wettable or non-wettable forms, irrespective of the quantitative analysis of the material, that reversal of orientation could occur after various treatments and that cotton with very low quantities of fatty extract (lower than obtainable by normal commercial methods) would be permanently absorbent, because there would then be insufficient material to cover the fibres. These conditions were in fact reproduced experimentally. The other theory, which has some general currency, but has perhaps not been established, attributes loss of absorbency to the slow passage of fatty material from the lumen of the fibre to the outside. It does not, however, fit the facts very well, for high absorbencies and good keeping properties occur in samples with a high fatty content, and poor samples may have a low fatty content. Moreover, the reversal of absorbent properties by treatment with heat and with steam cannot be explained, for it is hardly likely that fatty material would return to the lumen. The paper cited contains more details.

The layer of fatty material is of universal occurrence, and the usual range of fatty extractive is from 0·15 to 0·5 per cent., more than enough completely to coat the fibres. Some of this material is there because by commercial means, it cannot be removed, but in many cases the rest is

intentionally added. If there must be fatty material present, it is apparently better that fatty acids should be present as well as the unwettable residue of cotton waxes, rather than to have these alone. In a sense, therefore, it is already the fact that "wetting agents" are used in surgical dressings, and have been so used for very many years.

It is clear from what has already been said that these traditional wetting agents are not entirely efficient. Loss of absorbency continues to occur, and there is an element of chance in the behaviour of a dressing. It cannot be said that trouble is very widespread—loss of absorbency is perhaps best regarded as a sporadic nuisance, but on occasion, it can be quite a serious matter. Ships serving in tropical waters for long periods are cases in point—the dressings they carry can become non-absorbent and useless, and specifications are in force which require very low values for extractive, a method which does achieve a certain amount of success, for bare cellulose is always wettable, and if the fatty content is kept low enough, there must be areas of bare cellulose. It is unfortunate that this ideal method is so difficult to use in practice that the specification limits cannot be set low enough for complete safety. Moreover, the mechanical properties of the cotton are changed by such complete extraction, and it is doubtful if the users would appreciate the handle of the material if they had it. The price of a dressing is one of its important properties, and solutions of this problem which are scientifically possible are generally commercially impossible if they involve an increase in price.

There are nowadays many other wetting agents. Some of these, for example, sodium lauryl sulphate, have passed into use in medicine, and it seemed of interest to examine the effect of using materials of this type in dressings.

EXPERIMENTAL

Some preliminary experiments were made in which quantities of cotton wool, bleached and finished by conventional methods, were treated with

TABLE I

SINKING TIMES OF COTTON WOOL AFTER TREATMENT WITH VARIOUS WETTING AGENTS

	Treatment								
		Heated for 1 hour at			The 150° C. samples 4 days later, seconds	The 110° C. samples 5 days later, seconds	Unheated		
	Initial seconds	170° C. seconds	150° C. seconds	110° C. seconds			38 days, seconds	98 days, seconds	204 days, seconds
A	2·1	45	5·5	3·1	4·6	5·3	2·2	2·5	2·3
B	3·3	∞	80	4·7	33·6	4·3	2·6	3·1	4·8
C	3·6	∞	46	3·6	40	4·8	3·2	2·6	4·6
D	2·8	∞	13	2·7	26·7	5·2	3·3	6·4	4·4
E	1·8	12	3·1	1·3	2·7	2·0	1·5	1·8	2·0
F	4·0	∞	11·2	3·3	75	5·8	7·8	6·4	7·4
G	2·4	29	3·2	1·7	2·2	1·9	2·2	2·4	1·8
H	∞	∞	∞	∞	∞	∞	∞	∞	∞
I	2·8	∞	13	3·6	11·7	4·1	3·9	5·0	5
J	6·1	∞	25	7·9	38	16·6	6·7	9·0	12
K	2·7	∞	14	3·8	13	7·8	2·3	3·8	7
L	∞	∞	∞	∞	∞	∞	∞	∞	∞
M	—	∞	∞	18·4	∞	26·6	20·4	26·3	39
N	21·5	∞	∞	25	∞	75	12·0	23·2	36

∞ means that the sample did not sink during the period of observation. The wetting agents used were:—A, B and C—different grades of sodium lauryl sulphate; others—various commercial wetting agents H—a non-ionic material; G—a cationic amine; the remainder—uncertain composition; N—contol.

0·5 per cent. of the wetting agent dissolved in a sufficient quantity of water. The cotton wool was then dried, and mixed by passing through a Shirley analyser. The cotton wool was then subjected to dry heat, and other samples were stored for various periods with and without previous heat treatment. These experiments showed (Table I) that most of the wetting agents did in fact produce cotton wool whose absorbency withstood drastic treatments which altogether destroyed the absorbency of the untreated material. The untreated material, poor at all times, became less absorbent on simple storage and failed to comply with the B.P.C. requirements.

There seems therefore good reason for the opinion that by the use of these reagents cotton wool can be produced which is much less likely to lose absorbency than the existing B.P.C. material, even when drastically treated, or stored for a long time. There are, however, other considerations which must be examined before such a material could be considered suitable as a dressing.

Effect of the Treatment on the Water Retention Coefficient. In a previous paper (Savage, Bryce and Elliott[2]), it was suggested that the use of a wetting agent in the water tended to lower the water retention coefficient If the effect were large, it would be a disadvantage. Two wetting agents (Cithrol A and sodium lauryl sulphate) were used for detailed investigation (Table II). The results were subjected to statistical analysis, and

TABLE II

EFFECT OF SODIUM LAURYL SULPHATE* ON THE WATER RETENTION COEFFICIENT† OF COTTON WOOL AND VISCOSE RAYON WOOL

Series	Cotton wool pressure 3 cm. Hg.						Viscose rayon wool pressure 3 cm. Hg.					
	percentage of wetting agent					Water	percentage of wetting agent					Water
	2	0·4	0·08	0·016	0·0032		2	0·4	0·08	0·016	0·0032	
1	9·7	11·2	11·0	11·2	11·5	12·0	8·9	10·0	9·9	10·9	10·5	10·6
2	10·8	10·8	12·0	11·7	11·0	11·7	10·0	9·3	10·8	10·1	9·9	10·9
3	11·3	11·6	11·7	11·3	11·3	11·6	10·1	10·1	11·0	10·0	10·2	11·1
4	11·7	11·1	11·5	11·4	11·7	11·5	9·3	10·3	10·6	10·5	10·7	10·1
5	11·3	11·2	11·6	11·4	11·8	11·6	9·7	10·4	10·0	10·2	9·2	10·3
Means	10·9	11·1	11·5	11·4	11·4	11·6	9·6	10·0	10·4	10·3	10·1	10·6

* 40 per cent. sulphonated lauryl alcohol powder + sodium sulphate filler.
† Piston type apparatus 3·9 cm. diameter with 1g. of sample.

showed that there was a significant decrease in the water retention coefficient, but it was not a large effect, and is probably of no practical importance, being less than 10 per cent., even at high concentrations much beyond those likely in practice.

Physiological Effects. At one time, such materials were not used in medicine, and there was no information on their effect when used in a wound. But nowadays, ointment bases frequently contain sodium lauryl sulphate, and there seems no reason for anticipating adverse physiological effects. It would, however, seem preferable not to use wetting agents of the industrial type, of unknown composition, and any specification should, we consider, require the use of a material such as the B.P. product. It must here be pointed out (following suggestions by Mr. J. R. Elliott) that

cotton wool is not always used for absorbing secretions and liquids, but may be used for bacteriological swabs and for filtering liquids. For both these purposes the presence of a soluble wetting agent is probably undesirable and if such dressings do come into use, a small demand may still justifiably exist for the present product. This fact emphasises our belief that soluble wetting agents should not be used until fully investigated and officially approved, notwithstanding the fact that the B.P.C. limits for water extract would not necessarily be exceeded if they were used, and treated material might be considered as complying with the B.P.C. specification.

TABLE III

SURFACE TENSIONS OF EXTRACTS OF COTTON WOOL

	Aqueous extract*	Surface tension, dynes per cm. (extract evaporated to 5 ml.)
1	Clear	72
2	,,	52
3	,,	48
4	,,	59
5	,,	63
6	,,	67·5
7	Opal	70
8	Clear	67·5
* 9	,,	50
†10	,,	59

* 1 g. extracted with 100 ml. cold distilled water.
† 1 to 8 were samples of commercial cotton wool, 9 and 10 were the samples treated with sodium lauryl sulphate and with Cithrol A respectively.

Detection of Wetting Agents. Since quite small quantities of wetting agents are effective, and the extraction of cotton wool requires large quantities of liquid, which may also extract other water-soluble material, the detection and estimation of wetting agents is not chemically simple. We have found that by extracting with water and concentrating the solution, wetting agents may be detected by measuring the surface tension of the extract, using the method of capillary rise. By comparison with solutions of known composition, some idea of the quantity can be obtained, but further work would be needed before the method could be accepted as quantitative. It has, however, enabled us to carry out a survey of cotton wools purchased by retail, and as a result, we conclude that the products of one maker sometimes contain soluble wetting agents of the type discussed here.

TABLE IV

SURFACE TENSIONS OF SOLUTIONS OF WETTING AGENTS

Concentration, per cent.	Cithrol A, surface tension	Sodium lauryl sulphate	
		Concentration, per cent.	Surface tension
10	35	2	29
2	38	0·4	35
0·4	43	0·08	45
0·2	46	0·016	60·5
0·08	57	0·0032	71
0·02	71·5	Water	73
0·016	70	—	—
0·0032	73	—	—
0·00064	73	—	—
0·00013	73	—	—
Water	73	—	—

After some preliminary experiments, the general method adopted was to percolate 1 g. of cotton wool with 100 ml. of hot water, and concentrate to 5 ml. The capillary rise of this solution was then measured by the

usual method and the surface tension calculated. Water gave a result of 73 dynes per cm., and the extracts from treated cotton gave results of 50 and 59 (Table III). Of the purchased samples, 2 gave results of 48 and 52, and the solutions from these frothed on shaking. No alteration of surface tension or other properties occurred when calcium chloride solution was added so that soap residues were not responsible for the lowering of surface tension.

SUMMARY

1. Theories of absorbency are discussed, and it is pointed out that normal surgical cotton absorbent dressings do not consist of pure cellulose, but have a wettable surface of other materials.

2. By using soluble surface active agents in small amounts cotton dressings can be made which retain absorbency better than the conventional types.

3. The ethics of treating dressings in this way are discussed, and it is concluded that such agents should not be used unless officially recognised because they would not be suitable for certain minor uses.

4. Methods of detecting and roughly estimating soluble wetting agents are given.

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REFERENCES

1. Savage, *J. Soc. chem. Ind.*, 1934, **53**, 3797.
2. Savage, Bryce and Elliott, *J. Pharm. Pharmacol.*, 1952, **4**, 944.

DISCUSSION

The paper was presented by DR. R. MAXWELL SAVAGE.

MR. J. R. ELLIOTT (London) asked whether the experiments at 110° C. were carried out in hot air or by autoclaving, and also whether the author had any experience of the effect of repeated autoclaving of dressings treated with wetting agents. If wetting agents were incorporated with dressings, in his view, labels should carry information to that effect.

DR. R. RUYSSEN (Belgium) suggested that water-soluble saponins when used as wetting agents could not be detected by the method of capillary rise, because the surface tension of the saponin solution was similar to that of pure water.

MR. R. L. STEPHENS (Brighton) referred to the antagonism between anionic types of wetting agent and the quaternary ammonium and acridine type of antiseptics, and said that it would obviously be a serious matter for the user of a dressing if such wetting agents were present.

DR. R. MAXWELL SAVAGE, in reply, said that the experiments were carried out in hot air. He had no information as to the effect of repeated

autoclaving but thought it would not have such a serious effect in diminishing absorbency as the hot air treatment. In fact, it could improve it. He agreed that there should be some means of indicating to a user what he was getting. He was surprised that the method of capillary rise was not suitable for such preparations because he had used it to a considerable extent quite successfully. It might be a matter of relative concentrations. The quantity of wetting agent on fibres would be very small. It might be insufficient to offer antagonism to quaternary ammonium compounds and antiseptics of the acridine type.