illness. Among children in good home conditions 25% of the total absenteeism was due to causes other than illness; among children in poor home conditions the proportion was 36 to 41%.

Nutrition

Children graded as of poor nutrition in Salford had about 15% more total absenteeism and absenteeism due to illness than had children of good nutrition, while in Stoke the differences between the children with good and those with poor nutrition was 30 to 40%. Absenteeism among boys living in Whiteacre camp school was considerably less than that of boys living at home at Salford—total absenteeism being 23.6 days, compared with about 37 days—and that due to illness 9.4 days, compared with about 24 days for boys aged 7–14 years in the two localities. The relatively high absenteeism through causes other than illness was due to the fact that the children lived in the camp school and occasionally visited relatives and friends. The difference in the sickness rate of the Salford children from that of the camp school children was due almost entirely to absence from respiratory conditions; this averaged about 12 days for the Salford boys and 2 days for the Whiteacre camp school boys.

Discussion

Analysis shows that there is a relationship between on the one hand social conditions as represented by home and economic conditions and the number of children in the family, and on the other hand the health of the Salford children as represented by the somewhat limited range of conditions noted at the clinical examination and by the growth data—the poorer the social conditions the worse the health levels. Yudkin (1944), in a study of the nutritional condition of children in Cambridge, found that children in a school in a fairly poor district, compared with those in a school in a comparatively well-to-do district, were on the average 0.8 in. (2.03 cm.) shorter, and 2.6 lb. (1.18 kg.) lighter, and had 2% less haemoglobin and a grip 1.25 kg. weaker. The absenteeism data suggest that social conditions did not affect absence from school due to illness, although with worsening home conditions there was a substantial increase in absence due to causes other than illness. It is important, however, to note (*a*) that absenteeism among children graded "poor nutrition" was considerably greater, both in Stoke and in Salford, than among those graded "good nutrition"; and (*b*) that there was a general lowering of the nutritional grading with worsening social conditions. Further, the average number of days' absence through illness among the camp school children was 9.4, compared with about 24 for boys living in Salford and about 14 for boys living in Stoke. It is also noteworthy that total absenteeism in Salford was about 65% greater than in Stoke, and that due to illness about 33% greater. The amount of absence due to illness, particularly respiratory conditions, appears to vary considerably from locality to locality, and the point arises as to how much of this is due to bad environment. It is not suggested that figures for the camp school children, extending as they do over one year only, represent the long-term morbidity rate of children living under such conditions, but the difference between them and the figures for Stoke and Salford at least suggests some association between morbidity of children and their living conditions.

Summary

Data of 2,945 children aged 5–14 years attending day schools in Salford, and of 82 children living in a residential camp school, were analysed to show the relation between home, family, and economic conditions on the one hand and rate of growth, state of health, and school attendance on the other. Information obtained from data collected in Stoke-on-Trent relating absence from school with certain social conditions is also included.

An increase in the number of children in the family and worsening home and economic conditions were associated with a reduced rate of growth and state of health. Absence from school was not related to family size, but increased with worsening home conditions and state of nutrition. There was greater absenteeism among young than among older children and among girls than boys.

Absence from school from all causes and from illness was greater in Salford than in Stoke-on-Trent, and absence in both localities was greater than that in the residential camp school, which suggests that environmental factors were at least in part responsible for absence from school and for child morbidity.

We wish to express our thanks to the parents of the children participating in the test and to the staffs of the Education and Health Departments of Stoke-on-Trent and Salford for collecting the experimental data. Thanks are also due to Mr. S. H. Quayle, Controller, Statistical Branch, Customs and Excise, for analysis of the data on Hollerith machines, and to Dr. H. O. Hartley, of the Scientific Computing Service, for computations. Particularly we wish to thank Dr. V. C. Veitch for her assistance after the retirement of the late Dr. D. M. MacKecknie.

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THE EVALUATION OF BARRIER CREAMS

BY

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AND

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The ability of barrier creams to prevent deleterious substances reaching the skin of operatives has been amply proved in practice, and it can be asserted that the so-called "invisible glove" produced when these preparations are properly applied has done much to limit the incidence of dermatitis. Much has been written and spoken about the principles which must be obeyed if a satisfactory barrier cream is to be arrived at. Some formulators have included substances with the idea of increasing the scope of these preparations, but sometimes these additions are based on premises which are either hypothetical or, at the best, ill-founded. Others have attempted to medicate them, but whether in doing so the product has an added value as a protective cream is quite another matter. Although it may be that in theory a universal elixir could be made, the experience of those whose job it is to produce an article of real worth leads to the sound belief that it is always better to keep the product as simple as possible and to concentrate on making one which is as perfect as it can be to fulfil the essential requirements.

Barrier creams are expected to form a barrier against deleterious substances. That is the essence. They are not supposed to be cure-alls for any local erythema. They must be easy to apply and they must leave a coherent film which is impervious to extraneous substances. But they must be comfortable in wear. They should not produce a feeling in the mind of the user that the part anointed is encased; the invisible glove should preferably be imperceptible. Neither should the film be tacky or greasy so that it can contaminate any article which has to be handled; it is very important that articles handled should not slip from the grasp. Naturally, too, the film must be flexible so that it does not crack or form fissures. A case can be made out for the inclusion of substances which can neutralize or render inert specific irritants, but although in some instances this is advisable, and indeed desirable, the efficiency of a film of barrier cream to do this cannot be other than of a low order. If it is remembered that a proper film is only about 10 to 20μ in thickness it will quickly be appreciated that the amount of neutralizing agent per square centimetre of skin surface is very small. Such additions cannot, therefore, deal with more than traces of the irritant; they are really useful only when the irritant is highly toxic even when present in minute quantities. Finally, in view of the general reluctance of people to take prophylactic measures, the interest of the user has to be titillated, and this can be done in no small measure by making the cream pleasant in appearance and texture. A minute trace of an odoriferous principle is a useful addition provided that it does not lead to the scenting or perfuming of the product which is to be handled.

Owing to the diversity of industrial processes and products it is not possible to make one cream which can give protection against everything. Neither is it a practical proposition to make individual creams for every specific hazard. The compromise is to classify the known deleterious substances into groups. Investigation suggests that four types of barrier cream are necessary, and the four classes of hazard are: (1) irritant dusts; (2) aqueous materials; (3) solvents and oils; (4) aqueous and oil-containing substances. Barrier creams which will give protection against the first class must produce a coherent film which adheres well to the skin and which will prevent the dust penetrating or gaining access into the hair follicles and sweat ducts. The film must be non-tacky and non-greasy. Barrier films which are to give protection against the second class must produce a flexible water-repellent and water-resistant film, free from tackiness and greasiness. Protection against solvents and oils—class 3—can be obtained only if the film is composed of oil-insoluble materials. Provided this is accomplished and the requirements as to adherence, flexibility, and non-tackiness are fulfilled, a satisfactory protective barrier can be produced. The fourth class is probably the one which raises most difficulties, since the two main components, water and oil, are diametrically opposed in their properties, and their simultaneous presence makes the formulation of an efficient barrier cream difficult. However, by a careful compromise creams can be made which, when allowed to dry out into a film, have a reasonably high resistance to both water and oil.

The measurement of the efficiency with which a barrier cream prevents deleterious substances from producing dermatological rashes or oedemas can be carried out in a number of ways. The most logical one is the clinical experiment; but, with this form of appraisal, reliable estimations of value can be obtained only as a result of the statistical analysis of a large population. The inherent difficulties in mass clinical trials are too numerous and well known to be described here, although it is to be borne in mind that such tests are, in the long run, the final arbiters of efficiency.

The quick assessment of value demands some form of laboratory procedure of a somewhat empirical nature. When the conditions under which the film of barrier cream has to fulfil its functions are considered, it is immediately obvious that to devise an apparatus in which all these conditions—such as flexibility, resistance to friction, adherence to a non-rigid base which is subject to varying degrees of moisture on one side owing to perspiration, etc.—are imposed becomes wellnigh impossible. Even if such an apparatus could be designed it is most unlikely that answers free from ambiguity would be produced. It is really far better to use simple tests and simple apparatus which, while functioning in quite an artificial way, are more likely to yield consistent results. Provided that the artificiality is realized and that no attempt is made to read into the answers anything more than the test professes to do, then such means of evaluating barrier creams are justified and of considerable value.

Qualitative Tests

One of the means of testing consists in spreading the barrier cream on a suitable glass surface and allowing it to dry into a film. This film is then carefully taken off the glass and immersed in the liquid against which it is supposed to be a barrier. By comparing the times taken for the film to disintegrate the comparative efficiency of creams can be assessed. This method was advocated in a "Memorandum on the Prevention of Industrial Dermatitis," with special reference to the use of barrier substances, Form 330, December, 1942, issued by the Factory Department of the Ministry of Labour and National Service. It is not very easy, however, in all cases to produce films which can be peeled off a sheet of glass, and in the experiments which have been carried out the film was allowed to remain on the glass while being treated with various reagents.

This method has been used for a number of commercial creams of different manufacture. In order to identify the creams they have been numbered as follows:

1. Barrier against fine dusts and for handling dry materials
2. Barrier against aqueous liquids
3. Barrier against oils and solvents
4. Barrier against both oils and water

} Made by firm "A"

5. Barrier against non-aqueous material
6. Barrier against aqueous solutions

} Made by firm "B"

7. Barrier against non-aqueous material
8. Barrier against aqueous solutions

} Made by firm "C"

Under the test the films made from Nos. 3, 5, and 7 rapidly disintegrate, especially if the test liquid be either acid or alkaline. No. 1, although not claimed as water-resisting, is definitely better than either 6 or 7, while No. 4 is remarkably resistant to solutions of acid. No. 6, which is claimed to be water-repellent, breaks down quickly when subjected to the test. It is to be noted that when a film is not stable to the solvent it becomes opalescent in a short time; the onset of the opalescence is a fairly good indication that the film is absorbing the liquid and will soon disintegrate. Carried out under standard conditions of time and temperature, this test is very useful, but the results can easily be vitiated if care is not taken to make the films as nearly as possible all of the same thickness.

Another qualitative method is merely to shake up some of the cream with aqueous solutions. If the cream is truly water-repellent it will not disperse in the aqueous solution. If it is partially resistant to water it will not fully disperse, whereas if its resistance to water is poor it will wholly disperse. By this means differentiations can be made between the various creams, and it has been found that creams Nos. 5 and 7 do not stand up at all well under this treatment. On the other hand, No. 2 cannot be dispersed in the aqueous solutions, while both No. 1 and No. 4 show a resistance to dispersion which indicates that they possess resistance to water. This method can show quite considerable differences between acid and alkaline solutions. In general the acid solutions, as is perhaps to be expected, prevent dispersion of the creams, and all the creams, especially Nos. 2 and 6, have some resistance to acids. In respect to the alkaline solutions the only satisfactory cream is barrier cream No. 2. This method cannot be used for testing the resistance to non-aqueous solvents, since all the oil-resistant creams are obverse emulsions—i.e., water is the outside phase and they therefore cannot mix with oils.

Another method of investigating the resistance of the film to water followed the method described by Grant for measuring the degree of water-resistance of paper. The method consists in sprinkling the surface of paper with a small amount of icing sugar to which has been added 0.5% of "rhodamin 6G." The paper is floated on the surface of some distilled water and the surface examined under ultra-violet light. As soon as the dyestuff becomes wetted it shows a bright fluorescence, and the time taken for this to occur can be noted. The method does not, however, give a very sharply defined end-point, the fluorescence growing in intensity rather than appearing suddenly. At the same time the results are also subject to the variations in the thickness of the film; but if a rough allowance be made for this by repeating the observations several times, the creams can be differentiated one from another. In Table I figures are given for average results of a number of barrier creams, together with the time taken for the moisture to penetrate the untreated paper. In these experiments thin writing-paper or typing-paper was used for the membrane and not filter-paper.

TABLE I.—*Rate of Penetration of Water through Films of Barrier Cream, using the Fluorescence of a Dyestuff in the U.V. as a Measure of Penetration*

Cream Used	Time Taken for Fluorescence to Appear
Blank: paper only	14 seconds
Barrier cream No. 1	21 "
" " No. 2	121 "
" " No. 3	19 "
" " No. 4	75 "
" " No. 7	17 "
" " No. 8	25 "

It will be noticed that this method differentiates between No. 2 and No. 3 creams, which, when tested by directly measuring the volume of water penetrating a direct film of the cream (see Table IV), indicated that No. 3 had a high resistance to penetration. It should be borne in mind that the ultra-violet light will detect extremely small amounts of moisture on the upper surface of the film, the least trace causing solution of a minute quantity of the dyestuff, which is then strongly fluorescent. The test certainly seems to place the creams in the order which would be expected.

It is also possible to measure the resistance of the barrier film in a rough quantitative way by allowing a drop of a solution of dye to fall on to the surface of a piece of typing-paper which had previously been coated with the cream and allowed to dry. Ordinary red ink was used as the dye solution, and the drop was allowed to remain on the surface for exactly four minutes, when it was dried off by means of a piece of filter-paper. Drops of the ink were placed on typing-paper and allowed to remain on for varying lengths of time, ranging from 1/2 to 4 minutes, when they were blotted off. The series of spots showing on the reverse side of the paper was used as the standard to compare against the colour obtained on the reverse side of the paper when barrier creams had been used. In this way it was possible to assess the resistance of the film of barrier cream. The results are given in Table II. In expressing the results the permeability of the untreated paper has been taken as 100, and the depth of shade produced when the barrier cream is present is expressed as a percentage of this. Thus a low figure indicates low permeability.

TABLE II.—*Percentage Permeability of Films of Barrier Cream as Determined by the Penetration of a Solution of Eosin*

Cream	Percentage Permeability
No. 1	85
No. 2	30
No. 3	80
No. 4	10
No. 5	70
No. 6	10
No. 7	70
No. 8	20

It is to be noted that when this test is carried out some creams cause the drop of ink to spread out a little, whilst in others the size of the drop does not alter in the four minutes taken for the test. Creams Nos. 5 and 7 cause the spot to spread considerably. This is due to the low contact angle between the ink and the film, and it is suggested that this may be a defect in the creams when it occurs.

Quantitative Tests: pH Value

There is abundant evidence that creams with a high degree of alkalinity can, of themselves, cause irritation of the skin of many people. The Medical Branch of the Factory Department of the Ministry of Labour is well aware of this. It must be realized, however, that to define the *p*H value of a cream is by no means simple, as obviously it will depend on the state of dryness of the cream when the determination is made. To attempt to determine the *p*H value of a pasty material is not easy, and accordingly it was decided to dilute the creams with an equal quantity of distilled water before making the determination.

In a comparatively rough way the *p*H value of creams can be determined by direct spotting with an indicator, but the results obtained must always be treated with some little reserve owing to the error of the indicator itself. All the creams, except Nos. 2 and 6, have been examined by diluting with an equal part by weight of distilled water and measuring the *p*H value of the mixture by means of a glass electrode. Table III gives the *p*H values for a number of creams as determined by this method.

TABLE III.—*pH Value of Barrier Creams diluted 50/50 (Glass Electrode)*

Cream	*p*H
No. 1	7·7
No. 3	8·0
No. 4	8·0
No. 5	9·3
No. 7	9·8
No. 8	9·1

NOTE.—It is impossible, of course, to determine the *p*H value of barrier cream No. 2, which is a reverse emulsion. The *p*H value of the dispersed water, however, is approximately 7·0. In the same way it was not possible to determine the *p*H value of barrier cream No. 6, as it does not mix with water.

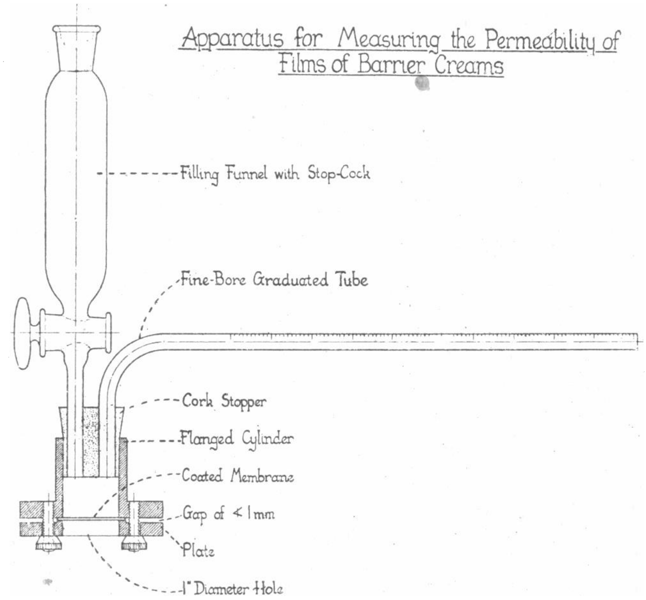
It is to be noticed that Nos. 5, 7, and 8 have very high *p*H values and must be condemned on this ground.

Permeability Tests

Although the above methods of examination give results which enable reasonable comparisons to be made, it was felt that something of a more practical character was desirable. For the first experiments it was considered that, ideally, thin horizontal "splits" of sheepskin—the form known commercially as flywing skiver—would form the best membrane on which to spread the creams, but owing to the close texture of the skin itself, and the fact that when it became wetted with water the skin fibres themselves swelled so that the membrane became less and less permeable to moisture, the time taken to carry out a test was so long that this material had to be abandoned. After experimenting with other materials, such as "cellophane," writing-paper, and typing-paper, the conclusion was reached that for laboratory work it was better to have a very permeable material, so that the resistance produced by the presence of a film of the barrier cream made a large alteration in the rate at which the liquid could penetrate the membrane itself. Filter-paper was found to be suitable, especially the type known as "Whatman No. 5," which, although a little rough on the surface, was sufficiently hard and rigid not to break down when wetted or during the application of the cream.

The method adopted originally consisted in applying a small quantity of the cream by means of the finger to the filter-paper, which had previously been weighed. It was found that one application did not usually produce a continuous film, and later two or three layers were rubbed on, the film being dried between each application. After drying, the disks of filter-paper were weighed, the difference between the dried weight of the filter and the dried weight of the filter plus cream being taken as a measurement of the thickness of the actual film, the area of course being constant. A further improvement of the method was to stain the filter-paper with red dye, "rhodamin," and then to dry before applying the barrier creams. By this means it was possible to see more clearly where the film was thinnest, so that in the second or third applications these parts could receive a little more of the cream than the other portions. This led to a substantial improvement, although perfection was not achieved.

The films were then placed in an apparatus which consists of a plate and a flanged cylinder of phosphor bronze, machined so that the surfaces fit perfectly together (see Diagram). In the centre of the plate there is a hole of 1 in. (2.5 cm.) diameter—i.e., equal to that of the bore of the flanged cylinder—and the two parts are fastened together by means of six thumbscrews, the coated membrane being thus securely held and forming the septum through which the experimental liquid is to pass. The cylinder is closed by means of a tight-fitting



cork through which two orifices are bored. The apparatus is filled by means of a small separating funnel which passes through one of the orifices, and water or other liquid is admitted until it runs out of the graduated tube, which passes through the second hole in the cork. As soon as the apparatus is full the cock of the separating funnel is turned off and the passage of water through the membrane is measured by observing the reading of the meniscus in the graduated tube at different time intervals. The graduated tube is calibrated in hundredths of a millilitre. The membrane is placed in the apparatus with the film side uppermost. The machined surfaces are made so that when the membrane is secured the metal surfaces beyond the area of the coated membrane are at least 1 mm. apart; otherwise, when the film is breaking down, end-effects come into play through capillary action in between the two phosphor-bronze surfaces that tend to vitiate the results.

Experiments to investigate the effect of the thickness of the film did not lead to any really satisfactory results, although, in general, the rate of penetration became less the thicker the film. This lack of uniformity in the experimental figures has been attributed to the lack of evenness of the film. Various attempts have been made to overcome this difficulty, and apparatus has been made with sintered glass in place of filter-paper, the sintered glass being fused into a tube and ground off dead level with the end of the tube. This tube was placed inside a wider metal tube and the height adjusted so that the surface of the sintered glass was approximately one-fifth of a millimetre below the top surface of the outer metal tube. This space was then filled with cream and wiped level by means of a straight-edge. It was found that the films obtained by this means were quite regular; but, unfortunately, the cream did not always adhere to the sintered glass, and peeling could occur when the disk and film were treated with water. It was obvious that sintered glass was not an ideal surface, and experiments have now been carried out which suggest that satisfactory films can be spread on filter-paper, using a microtome, in which the filter-paper is dropped into the hole of the microtome to an adjusted depth, the space filled with cream and wiped off with a straight-edge using the top surface of the microtome as a guide. A piece of apparatus on these lines is being made so that filter-papers of suitable size can be coated.

It was found that in order to get figures with any meaning at least six tests had to be made with each sample of cream, rejecting those figures which were violently different from the general run of the other determinations. In calculating the permeability figures an attempt was made to compensate for the variations in the actual amount of cream on the filter. In the absence of accurate data for the relationship between the permeability and the actual thickness of the film, it was assumed that the volume of liquid transmitted was inversely proportional to the weight of the cream per unit area of the filter. It was realized that this relationship was not a straight-line function, but was probably a function to some power of the thickness. Nevertheless, by multiplying the volume of liquid transmitted by the weight of the cream the figures for different films came closer together and did permit some general comparison to be made between the different creams, especially when it is borne in mind that the calculated values contain a not inappreciable error.

The difficulties in obtaining a uniform film have led to the carrying out of a large number of experiments which, in the long run, had to be rejected, but by using tinted paper and applying the cream in three portions a series of figures has been obtained showing the differences between a number of barrier creams, the data being given in Tables IV and V. The method of expressing the results was to take the arithmetic mean of the volume of water or liquid as determined by the reading on the graduated tube for a number of membranes coated with the same cream. The readings were taken at intervals of fifteen minutes, and the amount which penetrated in successive periods of fifteen minutes was divided by fifteen to bring it to the rate per minute; this value was then multiplied by the average weight of the film per standard area. The weight figure was used as an indication of the volume of the film and, although the specific gravity of the creams may vary slightly, no notice was taken of this variation except in the case of barrier cream No. 2, which contains no fillers and which has a specific gravity considerably less than that of the others. The figures of No. 2 are therefore calculated back as though the dried cream has a specific gravity of 1.6, which is approximately the specific gravity of the other creams when dried to a film.

It will be seen from Table IV that of the creams which are designed to resist the penetration of water No. 4 is the most efficient. Next comes No. 2. Nos. 6 and 7 are not satisfactory.

It is interesting to note that No. 3 cream shows a very low water permeability, although it is designed to prevent oil penetrating. The reason for this anomalous behaviour is that it contains hydrophilic colloids which imbibe water without, of necessity, allowing *liquid* water to pass through. It will be appreciated that this type of cream will give very low figures when used in the apparatus, although it is quite unsuitable as a protection for the skin against water. Films composed of hydrophilic colloids such as gelatin, etc., will allow water to diffuse but will not easily transmit water in bulk. It is also worthy of note that cream No. 5, which gives such a low permeability to water, is the one which is advocated as a protection against oils and non-aqueous materials, whereas cream No. 6, which is recommended as a water-repellent, appears to be the worst of the whole range. Cream No. 8 has only a medium resistance to water. It is probable that the poor results given by creams Nos. 5, 6, 7, and 8 are due to the large amount of soap which is their main constituent, and there is no doubt that the film produced when the cream dries can readily be re-emulsified by the addition of water. It would appear that in formulating creams Nos. 1, 2, 3, and 4 efforts have been made to produce an emulsion with the minimum amount of emulsifying agent so that the danger of the dried material being re-emulsified when coming into contact with water would be at a minimum.

TABLE IV.—*Rate of Penetration of Water through Films of Barrier Creams*

Cream	Ml. × 10^{-5} of Water Transmitted per Minute per Unit of Cream during					
	First 15 min.	Second 15 min.	Third 15 min.	Fourth 15 min.	Fifth 15 min.	Sixth 15 min.
No. 1	310	141	78	104	97	95
No. 2	104	81	79	73	71	56
No. 3	174	96	70	52	40	33
No. 4	200	115	45	34	30	15
No. 5	340	90	59	44	34	31
No. 6	970	770	670	410	334	261
No. 7	310	205	190	190	166	181
No. 8	274	173	142	115	104	81

In testing creams for their resistance to oil and solvents only white spirit has been used. Other solvents should, of course, be tried if the barrier action is to be assessed for any particular set of works conditions. Only those creams were tested which are claimed to be protectors against oils, and the experimental results are given in Table V.

TABLE V.—*Rate of Penetration of White Spirit through Films of Barrier Creams*

Cream	Ml. × 10^{-5} of Oil Transmitted per Minute per Unit of Cream during					
	First 15 min.	Second 15 min.	Third 15 min.	Fourth 15 min.	Fifth 15 min.	Sixth 15 min.
No. 3	194	105	68	62	57	60
No. 5	172	132	130	152	125	119
No. 7	178	120	120	101	89	72

With regard to the oil permeability, it will be seen that barrier cream No. 3 is superior to either of Nos. 5 and 7, and especially to No. 5.

Conclusions

The experimental work recorded above indicates that laboratory tests can be used in order to evaluate the quality of the different types of barrier cream which are on the market. In drawing this inference from the experimental work, however, we are aware that the *in vitro* testing cannot simulate, in all details, what actually happens when the barrier creams are applied to the skin and are subjected to the stresses imposed during manual work. At the same time, from the experience which has been gained by the use of some of these creams under actual working conditions, it can be stated that the laboratory tests have been well substantiated and those creams which failed under the laboratory conditions also failed when used in the factory.

It can be recommended, therefore, that medical officers, or those engaged in industrial welfare, can gain a very good indication of the value of the various preparations on the market before they go to the extent of introducing them to the workers. It is to be borne in mind that it is not logical to say that because a particular preparation stood up to the laboratory tests it must, *ipso facto,* be an excellent cream as a barrier against dermatitis-producing substances.

Summary

Means of testing the efficiency of barrier creams have been described of both a qualitative and a quantitative character. It has been shown that there are a number of simple tests which can give rough evaluations of the value of these preparations.

Where a more quantitative assessment is desired the apparatus and methods described in the paper are put forward as means which enable the assessments to be made in a more precise manner.

It is to be stressed, however, that the final arbiter of quality must rest on the clinical testing of the creams.

AN AID TO THE MEASUREMENT OF VENOUS FILLING IN THE NECK IN CONGESTIVE HEART FAILURE

BY

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Clinicians a hundred years ago were aware that the jugular veins became engorged when the heart failed, but the phenomenon attracted no special attention. It was left to Lewis (1930), of our generation, to point out the practical value of this sign in diagnosis. It is due to his wise insistence that inspection of neck veins now takes its place alongside cardiac auscultation as a routine part of clinical examination.

Lewis indicated that a rough but adequate estimate of venous pressure (i.e., pressure within the right auricle) could be made by noting the vertical height of the blood column in the external jugular veins above the " zero level " represented by the " angle of Ludwig." The angle does not, of course, correspond anatomically to the vena cava opening, which lies behind the right sternal border at the level of the third interspace, but it is convenient for measurement and in practice suitable. Examination of a number of normal subjects confirms Lewis's statement that venous filling extends to an average height of 2 cm. below the horizontal plane of the angle when the subject is supine, but with increasing inclination of the trunk the zero level approaches this plane. As patients with congestive failure will seldom be examined in the recumbent position the error is likely to be small and the vertical height of the blood column above the angle can be taken as a true measure of the increased venous pressure.

Absolute measurements of venous blood pressure can be made, but even the newest and neatest instrument, called by its designers (Winsor and Burch, 1943) a " phlebomanometer," suffers the inevitable disadvantage that a needle has to be introduced into a vein. Measurement of intra-auricular pressure by cardiac catheterization will hardly be claimed as a bedside manœuvre even by the greatest enthusiast. The state of the neck veins therefore remains the clinician's principal guide to venous pressure.

It is the usual practice to measure increased venous filling with one horizontal and one vertical ruler; accurate measurements by this means, however, demand an unusually skilled eye, and experience shows that two persons attempting the same measurement seldom agree; the record of day-to-day readings in the same patient therefore loses much of its value. On the other hand, if comparable measurements can be made there is much to be learned from serial records, in particular as an index of the response of congestive failure to treatment. For example, in a case where digitalization is achieved by the intravenous route a record of venous pressure over a period of an hour may be most illuminating.

A simple measuring instrument (Fig. 1) which eliminates the personal errors inherent in the ruler method has been designed. It consists of a vertical pillar graduated in centimetres and millimetres, with a pointed rubber-covered base: sliding on the pillar is a horizontal arm which by means of a rack-and-pinion can be raised or lowered on turning a wheel. The arm, which is accurately maintained at a right-angle to the pillar, bears upon its upper surface a small spirit-level.

To make a measurement (Fig. 2) one hand holds the instrument by the knob at the top of the column and the pointed base is placed upon the manubrio-sternal angle; the other hand, by rotating the wheel, raises or lowers the arm until its lower edge is aligned with the level of the top of the blood column in the vein, at the same time maintaining the bubble in the spirit-level at the central mark. The instrument is then lifted and the height of the arm read off the scale on the pillar; this necessarily represents the vertical height of the blood column above the sternal angle irrespective of the angle of inclination of the patient.

The actual measurement can be made single-handed in a few moments. There can, however, be no economizing on time spent in identifying the level of venous filling. Lewis himself advised that the neck should be examined in a " thoughtful manner." Experience confirms the soundness of this counsel. A measurement made after a cursory inspection is likely to be entirely false. The pitfalls which may ensnare the careless are many, but once recognized they can be by-passed and measurements made with confidence.

Without wishing to stress the difficulties unduly, it may be helpful to indicate briefly the common sources of error. The level to which the veins are filled may be obvious, but in a fat patient or where the veins in their upper course run deeply

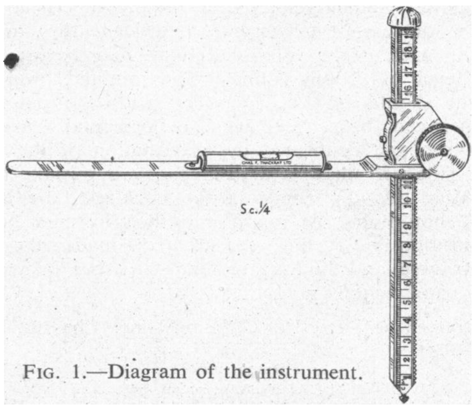

FIG. 1.—Diagram of the instrument.

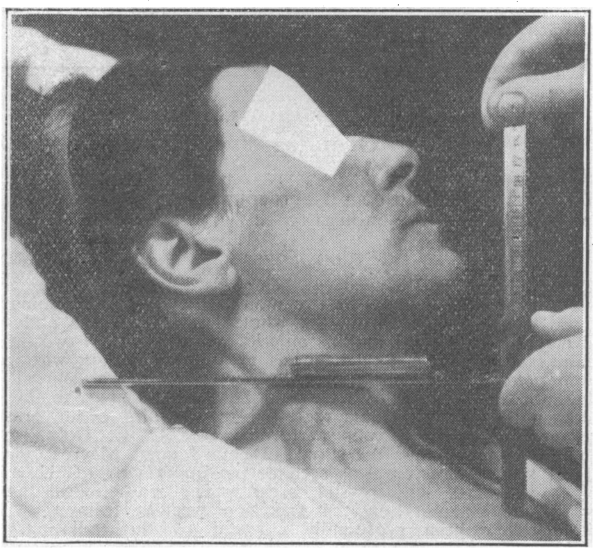

FIG. 2.—The instrument in use.

this is not the case. On the other hand, in a thin subject the veins may be easily visible throughout their course and some difficulty be experienced. Lewis advised that the vein should be obstructed at the base of the neck by light finger-pressure and the level noted to which the blood column fell on release.