BLANKET LAUNDERING AND STERILIZATION

REPORT OF A TRIAL AT THE CITY GENERAL HOSPITAL, SHEFFIELD

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Trials have recently been carried out at the City General Hospital, Sheffield, with various types of blankets as follows:

(1) All wool blankets to B.S. 1681: 1951, nominal size 76 in. × 96 in., weight 5 lb. 2 oz., cost 53s. 10d. each.

(2) All wool blankets to B.S. 1681: 1951, nominal size 76 in. × 96 in., weight 5 lb. 2 oz., cost 53s. 10d. each, treated for shrinkage resistance at an approximate cost of 7s. 1½d. per blanket.

(3) Cellular cotton blankets (loom state), nominal size 76 in. × 96 in., weight 3 lb. 6 oz., cost 29s. 11d. each.

(4) Turkish towelling blankets (bleached), nominal size 80 in. × 100 in. made from two pieces 100 in. × 40 in. joined up the centre, weight 5 lb. 4 oz. per blanket, cost 66s. 6d. each.

Preparation

All blankets were laundered before being put into use in the wards. This was particularly necessary in the case of the cellular cotton blankets as these were supplied in the loom state.

A small patch of white material, 6 in. by 3 in., was stitched on one corner of each blanket and a mark was placed thereon after each laundering.

Distribution

All blankets were put into use on January 7, 1958.

Ward 2A (16 beds).—Three cellular cotton blankets per bed were allocated at a total cost of £4 9s. 9d. per bed.

Ward 2B (21 beds).—Two wool blankets and one treated wool blanket per bed were allocated at a total cost of £8 8s. 7½d. per bed.

Ward 2C (21 beds).—Two cellular cotton blankets and one Turkish towelling blanket were allocated per bed at a total cost of £6 6s. 4d. per bed.

Equipment and Materials Used

Washing Machine.—A 100-lb. dry weight open-end washer fitted with interrupter gear by James Armstrong & Co.

Hydro Extractor.—A 36-in. J.B. by Thomas Broadbent, Huddersfield. Speed 1,440 revolutions per minute.

Drying Machine.—A Lister air speed drier with a continuous dry room temperature 200–212° F. where the blankets are hung by clips on a continuous belt taking 15 minutes to pass through (Lister Bros., London).

Syndet 54.—A powdered non-ionic detergent combined with a mildly acid builder, used at the rate of 2 lb. per 70 lb. load, manufactured by Laporte Chemicals Ltd., Luton.

Steravol.—A quaternary ammonium compound, cetyl trimethyl ammonium bromide, using 2 pints per 70 lb. load, supplied by Laporte Chemicals Ltd.

Escolite N.—An alkaline blended product of high active alkalinity; at 70° F. a 0.1% solution has a pH value of 11.6 (Laporte Chemicals Ltd.).

Comprox TL.—An anionic detergent (British Petroleum Products Ltd.).

Pure Soap.—Chips or powder at a high titre for use at high temperatures.

Cotton Wash Solution.—For cleaning the cotton blankets a solution was made up of 800 gallons water, 36 lb. "escolite," 10½ lb. "comprox TL," and 7 lb. pure soap. This was pumped into the machine at 2 gallons per minute.

Laundering

Woollen blankets, untreated and treated, were given a 10-minute wash at about 100° F. in "syndet 54" and a five-minute cold rinse, both on interrupted gear. The blankets were next treated for five minutes with "steravol." The blankets were put into a clean canvas trolley and transferred to a hydro extractor where they were rough-dried for eight minutes. They were then replaced in the clean canvas trolley and taken to the continuous hot air drier and dried at 200 to 212° F. (air temperature) for 15 minutes.

Cellular cotton blankets and Turkish towelling blankets were given a 10-minute wash at 160° to 170° F. and at 180° to 200° F. respectively using a solution of "escolite," "comprox TL," and pure soap (chips or powder). This was followed by a continuous cold rinse for six minutes. The blankets

TABLE I
LAUNDERING PROCESSES

	Temperature (°F.)	Time (min.)
<i>Wool*</i>		
1. Wash, "syndet 54"	100	10
2. Rinse, water	Cold	5
3. Sterilized, "steravol"	"	5
4. Hydro extraction	"	8
5. Dried on continuous belt (air temperature)	200-212	15
<i>Cotton</i>		
1. Wash ("escolite," "comprox TL," and soap):		
(a) Cotton cellular	160-170	10
(b) Turkish towelling	180-200	
2. Rinse	Cold	6
3. Hydro extraction	"	10
4. Dried on continuous belt (air temperature)	200-212	15

* This process is slightly modified to that originally recommended by Laporte Chemicals Ltd.

were then transferred in a clean canvas trolley and treated in a hydro extractor for 10 minutes and then transferred to the air drier where they were dried like the woollen blankets for 15 minutes at 200 to 212° F. (air temperature). The processing is summarized in Table I.

Findings after Ward Use and Laundering

Untreated wool blankets received normal usage reports. After 15 washings the blankets showed some felting and slight dullness of colour.

Treated wool blankets also received normal usage reports. After 15 washings the blankets were of good appearance and in moderately good condition.

Cellular cotton blankets caused "fluff" originally, but this gradually ceased. In a few blankets some loose threads were seen and several end seams became unstitched at the end of the first wash. The patients were glad to have the light blankets and the nursing staff found them better in bed-making than woollen blankets. After 10 launderings done according to the prescribed procedure the blankets were rather hard to the touch. After five more washings, the blankets, having been dried as a comparison in a tumbler dryer each time, were much softer to the touch.

Turkish towelling blankets were much heavier than woollen and not so warm. They were more difficult to handle owing to their extra length and

TABLE II
MEASUREMENTS AND SHRINKAGE CALCULATIONS

	Size			Shrinkage from Original Size			Weight lb. oz.	Remarks
	Length (in.)	Width (in.)	Area (sq. in.)	Length (%)	Width (%)	Area (%)		
<i>Untreated Wool Blankets</i>								
Original size ..	96-70	78-60	7,600	—	—	—	5 2	Average of 10 blankets
After 1 wash ..	95-40	76-10	7,260	1-34	3-18	4-47	4 15	
" 5 washes ..	94-45	74-08	6,996	2-32	5-75	7-95	4 13	
" 10 " ..	88-33	69-00	6,095	8-66	12-21	19-80	4 13	
" 15 " ..	87-20	68-50	5,973	9-82	12-85	21-41	4 12	
<i>Treated Wool Blankets</i>								
Original size ..	96-70	78-60	7,600	—	—	—	5 2	" " 10 blankets
After treatment ..	95-22	75-75	7,213	1-53	3-63	5-09	4 10½	
" 5 washes ..	94-33	73-66	6,948	2-45	6-28	8-58	4 4	
" 10 " ..	93-45	72-87	6,810	3-36	7-29	10-39	4 3½	
" 15 " ..	92-83	72-75	6,753	4-00	7-44	11-14	4 3½	
<i>Cellular Cotton Blankets</i>								
Original size ..	96-00	76-00	7,296	—	—	—	3 6	" " 9 blankets
After 1 wash ..	92-28	74-14	6,842	3-88	2-45	6-22	3 4½	
" 5 washes ..	93-80	73-60	6,903	2-29	3-16	5-39	3 4	
" 10 " ..	88-50	62-66	5,545	7-81	17-55	24-00	3 4	
(a)	89-56	68-94	6,174	6-70	9-29	15-38	—	
" 15 " ..	84-60	61-20	5,178	11-87	19-47	29-03	3 4	(a) After stretching the same blankets in a dry condition Average of 5 blankets (b) After stretching the same blankets in a dry condition (c) After stretching the smallest blanket (82 in. × 66½ in.) in a wet condition Measurements taken after the blanket was dried at room temperature
(b)	83-50	67-00	5,595	13-02	11-84	23-31	—	
(c)	90-33	73-00	6,594	5-91	3-95	9-62	—	
<i>Turkish Towelling Blankets</i>								
Original size ..	100-00	81-00	8,100	—	—	—	5 4	Average of 10 blankets
After 1 wash ..	100-28	80-00	8,022	—	—	0-96	5 3	
" 5 washes ..	100-14	79-71	7,982	—	—	1-45	5 3	
" 10 " ..	99-80	77-00	7,685	0-20	4-94	5-12	5 5	
" 15 " ..	100-50	76-50	7,688	—	5-55	5-09	5 5	

width. After 15 washings the blankets were of good appearance and normal texture.

The measurements and weights taken on woollen blankets and cotton blankets at various stages and also the shrinkage calculations are shown in Table II.

Both patients and nurses prefer the cellular cotton blankets to the Turkish towelling. They are cheap, easily laundered, and are giving satisfactory service after 11 months' wear. Moreover they combine the qualities of lightness and warmth.

The cellular cotton blankets shrank excessively. About 20 to 30% of this shrinkage could be recovered by stretching in the dry state, and a further 40% approximately by stretching in the wet state, but leaving a final shrinkage of 9% of the original size. These blankets also stretch somewhat in the normal process of bed-making. The laundering of cellular cotton blankets, if adopted, would have to be carefully controlled in the laundry.

The untreated woollen blankets were only fairly satisfactory as they shrank considerably with some felting and loss of colour.

The treated woollen blankets were better in all respects than the original wool blankets.

Bacteriological Examinations

Blankets were sampled by the "sweep plate" technique as described by Blowers and Wallace (1955). The area sampled was the same for all blankets. The blanket was laid on a laundry trolley which was covered with a clean sheet. The same method of sweeping was made each time, first in the shape of a St. George's cross (+) and then of a St. Andrew's cross (x). The size of the side of the trolley was 26 in. x 34 in. and the length of the sweep was approximately 10 ft. Petri dishes, 4 in. diameter, were used containing nutrient agar with $\frac{1}{2}\%$ "lubrol" (I.C.I.) and $\frac{1}{4}\%$ sodium stearate in order to inactivate the effect of any residual quaternary ammonium compound which might inhibit bacterial growth. The plates were counted after 24 hours' aerobic incubation. It was noticed that 48 hours' incubation produced larger colonies but did not increase the colony count appreciably, so that 24 hours was taken as the standard incubation time.

Preliminary sweep plate cultures before laundering of all types of blankets under test gave counts of 300 to >500, usually uncountable.

Before laundering many pathogens could be isolated, especially *Staph. aureus* (coagulase positive), *Bact. coli*, and *Proteus*. After laundering no pathogens were isolated.

A preliminary test of the detergent used in the laundry, "syndet 54," showed that most of the blankets were nearly sterile and some were sterile. The bacteriological results of the trial are shown in Table III.

TABLE III
BACTERIOLOGICAL RESULTS OF THE TRIAL

Blanket	Laundry Process	Wash Temperature (°F.)	No. Tested	Average Sweep Count
Wool ..	Syndet 54 alone	100	50	16
" ..	" " " " + " " " " " "	100	80	5
Cotton, cellular	Escolite, "comprox TL," and pure soap	160-170	50	3
Turkish towelling	Escolite, "comprox TL," and pure soap	180-200	50	4

Syndet 54 when used alone appears to wash out the dirt and remove practically all bacteria, leaving an article nearly sterile. The results obtained show that this process reduces most of the potential danger of contaminated blankets being returned to the ward.

Syndet 54 plus "steravol," on the other hand, produces an article as nearly sterile as could be obtained under the conditions of sampling. The sterilizing solution probably killed any pathogens not removed by the detergent alone. Although quaternary ammonium compounds are not very effective against *Ps. pyocyanea* this organism was not isolated, in spite of the fact that it was responsible for a ward infection during part of the time the trial was in progress.

The laundry process of the two types of cotton blankets at the relatively high temperatures of 160 to 200° F. did produce an article as nearly sterile as could be obtained under the conditions of sampling. As the dirt and bacteria were thoroughly removed in the wash the high temperature apparently killed any remaining vegetative bacteria.

Discussion

Our results are in keeping with those described by Blowers and Wallace (1955), by Blowers, Potter, and Wallace (1957), and by Frisby (1957). The 20% shrinkage of the untreated and 11% of the treated preshrunk woollen blankets was less than that reported by Blowers *et al.* (1957), possibly because an acid washing detergent was used as recommended by the laundry industry. This detergent had been in use in the hospital for some time so that, when the investigation was begun, the blankets returning from the laundry were exceptionally clean and relatively free from

bacteria, giving sweep plate counts of 10 to 20. There had also been no complaints of serious shrinkage; this was borne out by the careful measurements made in the trial.

Obviously if a hospital wishes to continue purchasing new woollen blankets they should be preshrunk. As most of the blankets in hospitals are woollen it is obvious that they must be used until worn out. To prevent excessive shrinkage and to produce a blanket as near as possible to sterility, the method used in this trial is recommended.

Cotton cellular blankets are, however, easier to sterilize by using temperatures near to that of boiling. The shrinkage in this trial appeared excessively high, possibly because the blankets were not deliberately pulled at the time of measurement. However, if they are stretched intentionally much of the shrinkage can be overcome, although there was 9% loss in our experience.

One disadvantage of the loom state type was the excessive fluff, even after one or two washings, which could disseminate bacteria through a ward. Possibly better quality blankets would prevent this. Calnan (1959) reports most favourably on a new type of cotton cellular blanket—a warp-knitted mesh fabric sewn between two outer coverings of a rayon cotton sheet.

The Turkish towelling blankets can also be sterilized by high temperatures and they showed the least shrinkage of the three. However, they appeared to be heavier and more clumsy to handle in the wards and were not popular with those who had to use them, the patients and the nurses.

Since this investigation was started other types of blanket have been on trial in other hospitals. Schwabacher, Salsburg, and Fincham (1958) have shown that woollen blankets can be disinfected by quaternary ammonium compounds with a resultant reduction in the bacterial contamination of the air. They also showed that "terylene," and more so cotton, blankets reduced the air contamination and also the cross-infection, because there was much less fluff. Pressley (1958), who sampled ward dust at bed height, found that 96% of the fibres were from cotton material and not from woollen, but that of the dust swept up on floors the woollen content was nearly 40%. It is clear, therefore, that fluff from wool or cotton blankets is a serious cause of air contamination. Thomas, Liddell, and Carmichael (1958) reported their investigations into the laundry process of a hospital, but as no disinfection by a quaternary compound or by heat was used the blankets after

laundering were still contaminated by *Staph. aureus*.

It is felt that more investigation must be made into the temperatures used in washing and in drying as the texture of the blankets made of any material may be affected by too high or even too low a temperature, possibly resulting in felting and shrinkage.

Stark (1959) reports that even woollen blankets may be boiled without resulting felting or shrinkage if the conditions are carefully controlled. He did, however, note some discoloration.

Now that there are satisfactory ways of washing and sterilizing blankets, all blankets should automatically be sent to the laundry whenever a patient goes home or dies and also fairly frequently, possibly every two to three weeks, from patients remaining in hospital for some time, especially when they are suffering from some infective illness whether surgical or medical.

General Conclusions and Recommendations

Cotton cellular blankets proved the most satisfactory. They are cheap, warm, light, and liked by patients and nursing staff. They are easily sterilized by laundering at temperatures high enough to kill bacteria in the vegetative form. To prevent shrinkage it is advisable to stretch them at the time of laundering, preferably while still wet. It is recommended that cotton cellular blankets be purchased in the future.

Woollen blankets are also satisfactory and can be laundered at 100° F. and "sterilized" in a cold rinse by "steravol," a quaternary ammonium compound, most vegetative bacteria being killed. They do, however, to some extent shrink and felt, but if the laundering is carefully controlled and an acid detergent, such as "syndet 54," is used, this may be reduced to a minimum. This process is recommended for all woollen blankets used in hospitals until they require to be replaced.

Our thanks are due to the laundry manager, Mr. E. Jones, and his staff, and to the matron, sisters, and nursing staff who made this investigation possible, and to the representatives of Laporte Chemicals Ltd. for helpful advice.

REFERENCES

- Blowers, R., Potter, J., and Wallace, K. R. (1957). *Lancet*, 1, 629.
- and Wallace, K. R. (1955). *Ibid.*, 1, 1250.
- Calnan, J. S. (1959). *Ibid.*, 1, 300.
- Frisby, B. R. (1957). *Brit. med. J.*, 2, 506.
- Pressley, T. A. (1958). *Lancet*, 2, 712.
- Schwabacher, H., Salsburg, A. J., and Fincham, W. J. (1958). *Ibid.*, 1, 709.
- Stark, T. (1959). *Supplies*, 10, 18.
- Thomas, C. G. A., Liddell, J., and Carmichael, D. S. (1958). *Brit. med. J.*, 2, 1336.