T. L. DORMANDY: REFERENCES

1. Dormandy TL. Free radical reactions in biological systems. *Ann Roy Coll Surg* 1980; **62:** 188–93.
2. McCord JM, Fridovich I. Superoxide dismutase: a history. In: Michelson A, McCord JM, Fridovich E, eds. Superoxide and superoxide dismutases. New York: Academic Press, 1977: 1–11.
3. Dormandy TL. Free-radical oxidation and antioxidants. *Lancet* 1978; i: 647–50.
4. Willson R. Iron, zinc, free radicals and oxygen in tissue disorders and cancer control. In: Iron metabolism. *Ciba Foundn Symp* 51 (new series). Amsterdam: Elsevier, 1977: 331–54.
5. Babior MB. Oxygen-dependent microbial killing of phagocytes. *N Engl J Med* 1978; **298:** 659–80.
6. McCord JM, Wong K, Stokes SH, Petrone WF, English D. A mechanism for the anti-inflammatory activity of superoxide dismutase. In: Autor AP, ed. The pathology of oxygen. New York: Academic Press, 1982: 75–82.
7. Hammerschmidt DE, Jacob HS. The stimulated granulocyte as a source of oxygen toxicity compounds in tissue injury. In: Autor AP, ed. The pathology of oxygen. New York: Academic Press, 1982: 59–74.
8. Del Maestro RF, Thaw HH, Bjork J, Plankern N, Arford K-E. Free radicals as mediators of tissue injury. *Acta Physiol Scand* 1980; **492** (suppl): 43–57.
9. Harman D. The free radical theory of ageing. In: Pryor WA, ed. Free radicals in biology, vol 6. New York: Academic Press, 1982: 255–71.
10. Pryor WA. Free radicals in biology. The involvement of radical reactions in ageing and carcinogenesis. *Med Chem* 1977; **5:** 3310–33.
11. Sohal RS. Metabolic rate, ageing and lipofuscin accumulation. In: Sohal RS, ed. Age pigments. Amsterdam: Elsevier, 1981: 1–14.
12. Siakotos AN, Munkres KD. Recent developments in the isolation and properties of autofluorescent lipopigments. In: Armstrong D, Koppang N, Rider JA, eds. Ceroid lipofuscinosis (Batten's disease). Amsterdam: Elsevier Biomedical Press, 1982: 165–87.
13. Gutteridge JMC, Rowley DA, Halliwell B, Westermarck T. Increased non-protein-bound iron and decreased protection against superoxide-radical damage in cerebrospinal fluid from patients with neuronal ceroid lipofuscinosis. *Lancet* 1982; ii: 459–60.
14. Westermarck T, Santavouri P, Marklund S, Pohja P, Salmi A. Studies on the effects of selenium administration to neuronal lipofuscinosis patients. In: Armstrong D, Koppang N, Rider JA, eds. Ceroid lipofuscinosis (Batten's disease). Amsterdam: Elsevier, 1982: 392–407.
15. Heys AD, Dormandy TL. Lipid peroxidation in iron-overloaded spleens. *Clin Sci* 1981; **60:** 295–301.
16. Dormandy TL. Caeruloplasmin: acute-phase antioxidant. In: Rainsford KD, Brune K, Whitehouse MW, eds. Trace elements in the pathogenesis and treatment of inflammation. Basel: Birkhauser, 1981: 185–97.
17. Al-Timini DJ, Dormandy TL. Inhibition of lipid autoxidation by human caeruloplasmin. *Biochem J* 1977; **168:** 283–88.
18. Mason RP. Free radical intermediates in the metabolism of toxic chemicals. In: Pryor WA, ed. Free radicals in biology, vol 2. New York: Academic Press, 1976: 159–78.
19. Slater TF. Lipid peroxidation. *Biochem Soc Trans* 1982; **10:** 70–71.
20. Recknagel RA, Glende EA Jr, Hruszkewycz AM. Chemical mechanisms in carbon tetrachloride toxicity. In: Pryor WA, ed. Free radicals in biology, vol 3. New York: Academic Press, 1977: 97–132.
21. Albano E, Lott AKK, Slater TF, Stier A, Symons MCR, Tomasi A. Spin trapping studies on the free-radical products formed by metabolic activation of carbon tetrachloride. *Biochem J* 1982; **204:** 593–603.
22. Cawood P, Wickens D, Braganza JM, Iversen SA, Dormandy TL. Diene conjugation in biological fluids. In: Bors W, ed. Proceedings III International Congress on Oxygen Radicals, Munich 1983 (in press).
23. Schauenstein E. Autoxidation of polyunsaturated esters in water. *J Lipid Res* 1967; **8:** 417–28.
24. Gutteridge JMC. The consequences of lipid autoxidation in biological material. PhD Thesis: University of London, 1974.
25. Goetzl EJ. Oxygeneration products of arachidonic acid as mediators of hypersensitivity and inflammation. *Med Clin N Am* 1981; **65:** 809–28.
26. Braganza J, Wickens DG, Cawood P, Dormandy TL. Lipid peroxidation (free-radical-oxidation) products in bile in patients with pancreatic disease. *Lancet* 1983; ii: 375–79.
27. Wickens DG, Norden AG, Lunec J, Dormandy TL. Fluorescence changes in human gamma-globulin induced by free-radical activity. *Biochem Biophys Acta* 1983; **742:** 607–16.
28. Tso POP, Caspary WJ, Lorentzon RJ. The involvement of free radicals in chemical carcinogenesis. In: Pryor WA, ed. Free radicals in biology, vol 3 New York: Academic Press, 1977: 251–303.
29. Burton GW, Cheeseman KN, Ingold KU, Slater TF. Lipid antioxidants and products of lipid peroxidation as potential tumour protective agents. *Biochem Soc Trans* 1983; **11:** 261–62
30. Benedetto C, Bocci A, Dianzani MU, et al. Electron spin resonance studies on normal human uterus and cervix and on benign and malignant uterine tumours. *Cancer Res* 1981; **41:** 2936–42.
31. Lunec J, Dormandy TL. Fluorescent lipid peroxidation products in synovial fluid. *Clin Sci Mol Med* 1979; **56:** 53–59.
32. Wickens DG, Dormandy TL. Further studies of fluorescent free-radical products in synovial fluid. *Clin Rheumatol* 1982; **1:** 151–52.
33. Gutteridge JMC, Rowley DA, Halliwell B. Superoxide-dependent formation of hydroxyl radicals and lipid peroxidation in the presence of iron salts. *Biochem J* 1982; **206:** 605–09.
34. Wills ED. Mechanism of lipid peroxide formation in tissues. Role of metals and haematin proteins in the catalysis of the oxidation of unsaturated fatty acids. *Biochem Biophys Acta* 1965; **98:** 238–51.
35. Gutteridge JMC. Fate of oxygen free radicals in extracellular fluid. *Biochem Soc Trans* 1982; **10:** 72–74.
36. Blake DR, Hall ND, Bacon P, Dieppe PA, Halliwell B, Gutteridge JMC. Effect of a specific iron chelating agent on animal models of inflammation. *Ann Rheum Dis* 1983; **42:** 89–93.

Hospital Practice

WEIGHT GAIN AND MOVEMENT PATTERNS OF VERY LOW BIRTHWEIGHT BABIES NURSED ON LAMBSWOOL

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Summary 34 very low birthweight babies (mean 1143 g) in incubators were randomly assigned to be continuously nursed on lambswool (n = 17) or ordinary cotton sheets (n = 17). The weight gain for the periods when babies were well was significantly larger for the wool group, 22·7 g/day vs 18·6 g/day for cotton control ($p<0·02$). The overall weight gain (which included weight change during periods of illness) revealed a similar picture in favour of the wool group, 21·5 g/day vs 18·2 g/day ($p<0·05$). Movement patterns for the two groups showed no differences, but for all babies a strong correlation was noted between moving and lying supine ($p<0·001$), having eyes open ($p<0·001$), a cooler incubator ($p<0·01$), and faster weight gain ($p<0·01$). Lambswool seems to have advantages over cotton sheets as a bedding material for very low birth weight babies.

INTRODUCTION

OUR pilot study on the use of lambswool in special-care baby units suggested that very low birthweight babies (VLBW) gain weight faster and move less when nursed on lambswool instead of on cotton sheets.[1] However, the numbers involved were small, and each baby was alternated between wool and cotton several times, so the differences could have been due to withdrawal from wool—hence this study to find out whether there might be any benefit from continuous nursing on lambswool.

METHOD

Subjects

Babies were randomly assigned, by the drawing of envelopes, to either the experimental group (nursed on wool) or the control group (nursed on cotton). The wool group was split into two subsets, one nursed on lambswool woven into an artificial backing ('Lamb-Pads', Dermalex Co, London), the other on natural lambskins ('Winganna', Sandy Hill Enterprises, Haverfordwest, Dyfed, and 'Babycare', GL Bowron, Bristol). These wool products are specially designed for babies.

All the babies were in incubators at the Special Care Baby Unit, Cambridge Maternity Hospital, between October, 1980, and September, 1981. 36 babies were entered into the trial and randomised when they met the following criteria—(1) when they were no longer on artificial ventilation or intravenous therapy; (2) when they weighed less than 1425 g and were no more than 31 days old, and (3) when they had gained weight for two consecutive days.

They were withdrawn from the study when they died or when they needed artificial ventilation, which made accurate weighing and movement studies impossible. Two babies were withdrawn: 1 in the cotton group, who died from multisystem failure following

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necrotising enterocolitis, and 1 in the wool group, who needed artificial ventilation after an extensive intraventricular haemorrhage. This left 17 babies in each group, whose characteristics are shown in table I.

TABLE I—CHARACTERISTICS OF BABIES IN WOOL AND CONTROL GROUPS

	Wool (n=17)		Control (n=17)	
	Mean	Range	Mean	Range
Birthweight (g)	1167	600–1550	1118	647–1494
Weight at entry to study (g)	1117	867–1350	1054	578–1421
Age at entry to study (days)	8·0	3–24	11·1	2–31
Days in study	14·9	6–37	17·0	4–35
Percent girls	47		47	

Measures

Weight gain.—This was recorded with a 'Sartorius' digital-readout electronic balance by the regular nursing staff at the same time each day as part of the normal routine care for all babies.

Health.—For each 24 hour period the baby's health was categorised as "well" or "ill". A baby was ill if he had four or more minor items or one major item. Minor items included sticky eyes; more than three bradycardic or apnoeic spells not requiring stimulation; more than two loose stools; more than two small vomits; body temperature <36·7 or >37·3°C; tachypnoea >60/min for more than 10 but less than 20; tachycardia >160/min for more than 10 but less that 20 min; serum urea >4 but <8 mmol/l; and need for swabs to be taken for culture, blood gas determination, theophylline, or phototherapy. Major items included exceeding the limit for minor items; pneumothorax; patent ductus arteriosus; shock; bloody stools; fits; need for supplemental oxygen, blood transfusion, antibiotics, parenteral feeding. More details are available on request (from the Child Care and Development Group, Cambridge). Weight-gain data were classified according to the baby's health: (i) the "well" weight-gain for periods when the baby was well as defined above, and (ii) an "overall" gain for the total period of study. Some babies never had a well period; others were well only for some of the time.

Movement.—Each baby was observed for an hour five days a week by one of us (P. L.), who categorised the maximum movement made during each twenty second period on an 8-point rating scale, which has previously been validated and is described elsewhere.[1] The scale points can be multiplied by the amount of time spent in each to give a single decimal movement score for correlation use. Some other aspects of behaviour were also noted (whether the eyes were open or shut and frequency of smiles, grimaces, startles, twitches, and yawns), as well as position (prone or supine) and operative temperature (incubator temperature minus one degree for every seven the room was colder than the incubator[2]). No attempt was made to record state of alertness,[3,4] which is very hard to do reliably with VLBW babies. All the babies in the wool group and the first 7 controls were observed as described; the remaining controls could not be observed for reasons of time.

Procedure

Before use, the lambswool mats were brushed to remove any loose fibres. They were changed for another of the same type after three days or earlier if soiled. All babies were nursed naked apart from napkins and were alternated between prone and supine positions every 3 h. As far as is known babies in both groups were treated in exactly the same way by medical and nursing staff—for example, as regards feeding regimens, nursing practices, clinical management, and so on. None of the researchers was responsible for the care of the babies. Informed consent was obtained from all babies' mothers before the start of the study.

RESULTS

Weight Gain

Well babies (table II).—The wool group (n=12) showed a mean gain of 22·7 g/day and the control group (n=14) 18·6 g/day (p<0·02, two-tailed t test). Birth weight, entry weight, entry age, and sex had no effect on gain.

Overall gain (table III).—The wool group (n=17) showed a mean gain of 21·5 g/day and the control group (n=17) 18·2 g/day (p<0·05, two-tailed t test). Birth weight, entry weight, entry age, and sex had no effect on gain.

There was no significant difference in weight gain between those nursed on artificially backed wool (n=8) and those nursed on natural lambskin (n=9).

TABLE II—WEIGHT GAIN OF BABIES IN WOOL AND CONTROL GROUPS WHILE WELL

	Gain (g/day)			Days	
	Mean	Range	SE	Mean	Range
Control (n=14)	18·6	14·0–24·3	1·06	13·1	3–27
Wool (n=12)	22·7*	17·7–32·4	1·56	10·7	5–20

*t(df=24)=2·61; p(2-tailed)=0·02; % variance explained=18·9.

TABLE III—OVERALL WEIGHT GAIN OF BABIES IN WOOL AND CONTROL GROUPS, IRRESPECTIVE OF HEALTH

	Gain (g/day)			Days	
	Mean	Range	SE	Mean	Range
Control (n=17)	18·2	14·0–24·3	1·05	17·0	4–35
Wool (n=17)	21·5*	15·0–29·3	1·48	14·9	6–37

*t(df=32)=2·24; p(2-tailed)=0·05; % variance explained=10·9.

Health

The two groups did not differ significantly in the proportion of days during which the babies were well (wool group 51% *vs* 63% control group). No untoward effects from being nursed on lambswool were observed. In particular, no baby was found with wool fibres in its mouth or up its nostrils.[5,6] No mother expressed dissatisfaction about her baby being nursed on lambswool; several in the control group asked why their babies were not on it.

Movement

There were no significant differences in amount of movement between wool and control groups, or between the two wool subsets. The correlation matrix for all babies of the movement score with other variables showed a number of significant associations: supine position (p<0·001), eyes open (p<0·001), low operative temperature (p<0·01), and weight gain (p<0·02).

DISCUSSION

The results show that babies nursed on lambswool gain more weight than do those nursed on cotton sheets. The effect is likely to be due to the texture of lambswool rather than any other property such as thermal insulation, especially since the babies were in, or close to, a thermally neutral environment.[2] We have previously speculated that the contact provided by lambswool may have a calming effect on infants similar to that seen with swaddling.[7] Our results would be compatible with the idea that babies nursed on cotton undergo more stress than when they are nursed on lambswool, but other interpretations are possible. Illness reduced the rate of gain for all babies and diminished the extra gain on wool.

The similarity of movement patterns in the two groups does not confirm our earlier finding[1] of decreased movement with wool. The differences found during our pilot study could have been due to its on/off design, which caused short-term differences in movement as the babies reacted to the change. Certainly many mothers of babies in the earlier study had the impression that movement increased markedly on the days the wool was taken away.

The general association of movement with supine position,[8,9] a cold environment,[10] and eye opening[11] is in agreement with other studies, but we are not aware that the association with weight gain has been reported before.

We have had some experience in the unit with artificial fibre, in the form of imitation wool mats. They are altogether different from the wool in being slippery and causing the skin of babies lying on them to become damp because they do not absorb moisture. They also shed a lot of loose fibres and are not suitable for nursery use. We also caution against the use of any wool products not specifically designed for use with babies.

The implications of using lambswool are important. Apart from promoting faster growth (and hence presumably better health), it allows earlier discharge from hospital, thus releasing cot space for others and reducing the disruptive effect that hospital admission has on parents' ability to develop a satisfying relationship with their babies.[12]

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REFERENCES

1. Scott S, Richards M. Nursing low-birthweight babies on lambswool. *Lancet* 1979; i: 1028.
2. Hey E. Thermal neutrality. *Br Med Bull* 1975; **1:** 64–74.
3. Wolff P. Observations on newborn infants. *Psychosom Med* 1959; **21:** 110–18.
4. Prechtl H, Beintema D. The neurological examination of the full term newborn infant. *Clins Devel Med no 12*, London: Heinemann, 1964: 1–12.
5. Tyler RM, Dammerks J, Van der Linden C. Babies eat "sheepskins". *Lancet* 1981; i: 211
6. Scott S, Richards MPM. Lambswool is safer for babies. *Lancet* 1981; i: 556.
7. Chisholm JM, Richards MPM. Swaddling, cradleboards, and the development of children. *Early Human Devel* 1978; **2:** 255–75.
8. Keikl HG, Cohn R, Harmisch D. Diaper rash, self-inflicted excoriations, and crying in full term newborn infants kept in the prone or supine position. *J Pediat* 1960; **57:** 884–86.
9 Brackbill Y, Douthitt TC, West H. Psychophysiologic effects in the neonate of prone versus supine placement. *J Pediat* 1973; **82:** 82–84.
10. Bruck K. Temperature regulation in the newborn infant. *Biol Neonat* 1961; **3:** 65.
11. Prechtl HFR. Polygraphic studies of the full-term newborn. *Clins Devel Med no 27*, London: Heinemann, 1968: 1–40.
12. Richards MPM. Effects on development of medical interventions and the separation of newborns from their parents. In: Shaffer D, Dunn J, eds. The first year of life. Chichester: Wiley, 1979: 167–289.

Round the World

From our Correspondents

Sudan

DEVELOPING A LABORATORY SERVICE IN A NEW AFRICAN MEDICAL SCHOOL

Juba in the southern Sudan is the home of the newest medical school in Africa. The medical school has been established not by the building of a major modern hospital but by the gradual transformation of the regional hospital, built mainly in the 1940s.[1] The development of the laboratory service has been one small component in that metamorphosis.

The laboratory is housed in a converted ward and is staffed by three recently trained technicians and twenty laboratory assistants. In 1981 the diagnostic facilities available were measurement of haemoglobin and erythrocyte sedimentation rate, blood films, microscopy, and culture of stool and urine. White-cell counts were done occasionally and differential counts very rarely. No records are available from this period, since each request was completed by any of the laboratory assistants and the result returned unrecorded to the ward. Verification of results was impossible; medical staff lost faith in the results, requested few tests, and did not act on results they did receive.

The blood transfusion service also operates from the laboratory. Blood storage facilities consist of one domestic refrigerator, which also stores other reagents and culture plates to be used in the laboratory. Therefore, no blood is stored for longer than 48 h, and even the small amount stored has to be discarded when the special generator for this fridge fails overnight, as happens once or twice a month. In addition, the water supply fails one or two days a week. Supplies for tests come only when fetched by a member of staff from the regional store, for simple stains and diluting fluids, or from Khartoum, for grouping sera. There was, and is, no ordering system for any reagents not available in the country since there is a severe shortage of hard currency in the Sudan. Even local currency is limited since the Regional Ministry of Health budget scarcely covers its staff's salaries.

From this starting point, and given the considerable financial constraints, what is the goal for the laboratory? What is needed is a reliable service in a selected range of tests suited to meet both the clinical needs and the financial budget. To attain that goal certain intermediate aims can be outlined. First, to do efficiently those tests that are already being done in a haphazard way. Secondly, to discover and implement other tests that can be done with unused staff skills and available reagents. Thirdly, to determine what new methods need to be established to attain the minimum level of facilities that is essential in a developing teaching hospital.

The first area in which changes had to occur was in the administration of the laboratory service. The concept of efficiency is alien to many of us, but especially so to the indigenous staff whose primary orientation is towards personal relationships within the web of the family, clan, and tribe. Such simple measures as registration of specimens, allocation of work, personal responsibility for tests carried out, and, above all, reliable attendance were fundamental to the initial development of the laboratory. Lapses in attendance are most frequently due to family funerals, personal sickness, and follow-up of pay claims at the Ministry of Health. Despite progress in this area, assisted particularly by the appointment of a Sudanese medical officer in charge of the laboratory, efficiency is continually handicapped by failure of the support services, of electricity, water, and essential supplies, such as immersion oil and cover slips. Also, an after-hours emergency service has been difficult to maintain. This difficulty reflects the lack of implementation of disciplinary measures to ensure staff attendance, which pertains in many working environments in the region.

Once the staff had begun to work with great reliability, it was

1. Woodruff AW. A new medical school in central Africa. *Lancet* 1982; ii: 545–46.