between the degree of severity of anaemia and of ventricular dilatation.

If congestive cardiomyopathy in chronically uraemic patients on dialysis is a syndrome of homogeneous origin and similar evolution in all cases then an intensified search for the factors that may cause it is indicated. In this way the syndrome could be diagnosed at an early stage and treated.

Requests for reprints should be addressed to Dr T Drüeke, Départements de Thérapeutique Néphrologique, Hôpital Necker, 161 rue de Sèvres, 75730 Paris Cédex 15, France.

References

[1] Brunner, F P, *et al*, *Proceedings of the European Dialysis and Transplant Association*, 1974, **12**, 1.
[2] Lindner, A, *et al*, *New England Journal of Medicine*, 1974, **290**, 697.
[3] Bailey, G L, in *Cardiovascular Problems, Hemodialysis, Principles and Practice*, ed G L Bailey, p 16. New York and London, Academic Press, 1972.
[4] Riecker, G, *et al*, in *Uremia, an International Conference on Pathogenesis, Diagnosis and Therapy*, ed R Kluthe, G Berlyne, and B Burton, p 72. Stuttgart, Georg Thieme, 1972.
[5] Gueron, M, *et al*, *Nephron*, 1975, **15**, 2.
[6] Prosser, D, and Parsons, V, *Nephron*, 1975, **15**, 4.
[7] Raab, W, *Journal of Laboratory and Clinical Medicine*, 1944, **29**, 715.
[8] Nivatpumin, T, *et al*, *American Journal of Physiology*, 1975, **229**, 501.
[9] Hennemann, H, *et al*, paper presented at VIth International Congress of Nephrology, Florence, Italy, 1975, abstract 555.
[10] Scheuer, J, *et al*, *Proceedings of the Society for Experimental Biological Medicine*, 1975, **150**, 471.
[11] Scheuer, J, and Stezoski, S W, *Journal of Molecular and Cellular Cardiology*, 1973, **5**, 287.
[12] Bailey, G L, *et al*, *Transactions of the American Society for Artificial Internal Organs*, 1967, **13**, 263.
[13] Scheer, R L, *et al*, *Kidney International*, 1975, **8**, 419.
[14] Rodger, J C, *et al*, *Kidney International*, 1976, **9**, 380.
[15] Goodwin, J F, *Lancet*, 1970, **1**, 731.
[16] Grosgogeat, Y, *et al*, *Revue du Praticien*, 1970, **20**, 153.
[17] Di Mattéo, J, *et al*, *Archives des Maladies du Coeur*, 1972, **65**, 19.
[18] Kirkendol, P L, *et al*, *Kidney International*, 1975, **8**, 427.
[19] Greene, D G, *et al*, *Circulation*, 1967, **35**, 61.
[20] Karliner, J S, *et al*, *Circulation*, 1971, **44**, 323.
[21] Le Pailleur, C, *et al*, *Archives des Maladies du Coeur*, 1976, **69**, 239.
[22] Gaasch, W H, *et al*, *Circulation*, 1972, **45**, 746.
[23] Gaasch, W H, *et al*, *American Journal of Cardiology*, 1975, **36**, 193.
[24] Schwartz, D, in *Méthodes Statistiques à l'Usage des Médecins et des Biologistes*. Paris, Flammarion, 1972.
[25] Del Greco, F, *et al*, *Circulation*, 1969, **40**, 87.
[26] Mason, D T, *American Journal of Cardiology*, 1973, **32**, 437.
[27] Grant, C, *et al*, *American Journal of Medicine*, 1965, **39**, 1969.

(Accepted 7 December 1976)

CONDENSED REPORT

Accidental hypothermia and impaired temperature homoeostasis in the elderly

K J COLLINS, CAROLINE DORE, A N EXTON-SMITH, R H FOX, I C MACDONALD, PATRICIA M WOODWARD

British Medical Journal, 1977, **1**, 353-356

Summary

A longitudinal study of the age-related decline in thermoregulatory capacity was made in 47 elderly people to try to identify those at risk from spontaneous hypothermia. During the winters of 1971-2 and 1975-6 environmental and body temperature profiles were obtained in the home, and thermoregulatory function was investigated by cooling and warming tests. Environmental temperature and socioeconomic conditions had not changed but the body core-shell temperature gradients were smaller in 1976, indicating progressive thermoregulatory impairment. People at risk of developing hypothermia also seem to have low resting peripheral blood flows, a nonconstrictor pattern of vasomotor response to cold, and a higher incidence of orthostatic hypotension.

MRC Environmental Physiology Unit, London School of Hygiene and Tropical Medicine, London WC1E 7HT

K J COLLINS, MB, DPHIL, member of scientific staff
CAROLINE DORE, BSC, member of scientific staff

Geriatric Department, University College Hospital, London WC1E 6AU

A N EXTON-SMITH, MD, FRCP, professor of geriatric medicine

***MRC Division of Human Physiology, Hampstead, London NW3 6RB**

R H FOX, DSC, MRCP, member of scientific staff
I C MACDONALD, PHD, member of scientific staff
PATRICIA M WOODWARD, BSC, member of scientific staff

*This division has now been disbanded.

Introduction

Each winter in the British Isles old people die at home as the result of cold. Indeed, accidental hypothermia (deep body temperature below 35°C) is now recognised as one of the natural hazards of old age. The problem is not simply one of unintentional accidental hypothermia resulting from a fall or accident at home and subsequent immobilisation and exposure, nor one entirely associated with concurrent illness[1 2]; spontaneous hypothermia also occurs among apparently fit elderly people.[3 4]

The main objectives of our investigations were to clarify the physiological basis of the ageing process in thermoregulation and to try to identify by physiological means those members of an elderly population sample living at home who seem likely to be at risk of developing hypothermia. We performed cross-sectional and longitudinal studies of a group of elderly volunteers; we obtained temperature profiles in their homes and made subsequent physiological studies in the geriatric research unit at University College Hospital, London, during the winter months (January-March) of 1972 and 1976.

Methods

We studied 47 elderly people (19 men and 28 women) living in the London Borough of Camden. In 1976 their ages ranged from 69 to 90 years, and initially they were part of a randomly selected population of elderly people on whom a large-scale domiciliary temperature survey had been undertaken in winter.[5] In 1972 a subsample of 150 volunteered to attend hospital for thermoregulatory function tests and 120 completed the test. Of these 120, only 47 were available for retesting in 1976, as the remainder had died during the intervening four years (25 people), moved away (28 people), or were too ill to be considered for the tests (15 people). Only five refused to take part in the second investigation.

DOMICILIARY TEMPERATURE INVESTIGATIONS

The thermal environments and socioeconomic conditions in the homes were surveyed by a nurse-interviewer at about the same time of the year (January-March) in 1972 and 1976 and at the same hours of the day for each individual. Homes were visited in the late afternoon (4-6 pm) and again the following morning (9-11 am). On each occasion sublingual and hand temperatures were measured by a clinical low-reading thermometer for five minutes as described previously.[6 7] In the 1976 survey the clinical thermometer recording was followed immediately by a one-minute sublingual reading by the Temtake disposable thermometer (Nicholas Laboratories). A further assessment of the two thermometers was made in the laboratory by reversing the order of the readings. Uritemp measurements[6 7] of deep body temperature were made soon after the sublingual measurements in the evening and again on rising the following morning. Temtake recordings were made simultaneously with the clinical thermometer in the Uritemp funnel. At each domiciliary visit wet- and dry-bulb readings were made of indoor (living room) and outdoor temperature with a sling psychrometer, and a maximum and minimum thermometer was placed in the living room and bedroom for overnight recordings.

Thermal comfort votes were determined according to the 7-point and 5-point scales described previously,[5] and a socioeconomic questionnaire on domestic life-style and heating facilities was completed in both 1972 and 1976.

PHYSIOLOGICAL MEASUREMENTS

Each elderly subject was examined in hospital a few days after the measurements at home had been made. Details of medical history and drug treatment were obtained together with a medical, anthropometric, and mental test score (MTS) assessment. The MTS was used to quantify the subject's intellectual performance by a modified form of the Tooting Bec questionnaire designed to test both short-term and long-term memory.[8]

Thermoregulatory function was tested in 1972 and 1976 by measuring physiological responses to a cycle of neutral, cool, and warm environments created by a specially designed air-conditioned bed.[9] The test used for studies in the elderly was a modification of standard procedures for measuring thermoregulatory function. This was necessary in the interests of reducing stress to a minimum, and attention was confined to studies in the vasomotor zone of thermoregulation—that is, in the zone between the start of shivering and sweating. There were three stages: (*a*) neutral (circulating air temperature at 30°C) for 14 minutes, (*b*) cooling (air temperature at 15°C) for 16 minutes and (*c*) warming (air temperature at 45°C) for 46 minutes or until the subject sweated, whichever occurred first.

During the test the men wore only thin cotton pants and the women wore pants and short sleeveless vests. Deep body temperature was measured by a thermistor inserted deep in the external auditory meatus of each ear but not in contact with the tympanic membrane. The thermistors were well insulated from the external environment by earpads and a hood covering the head but leaving the face exposed. "Weighted" skin temperature was measured by eight thermistors placed on the body surface, heart rate by a pulsimeter on one thumb, and hand blood flow by a volume plethysmograph with automatic cuff inflation recording at 10-second intervals. Sweat onset was indicated by a hygrometer recording from a ventilated capsule attached to the chest wall and by iodine-starch paper applied to the forehead. The onset of shivering during the cooling period was assessed subjectively, by oscillations appearing on the blood-flow tracings, and, in the 1976 tests, by electromyography with electrodes attached to the thigh. In the 1972 and 1976 series care was taken to apply these tests at the same time of day to eliminate diurnal variations in the thermal responses.

Thresholds of thermal perception were investigated by the method described by Cowburn and Fox.[10] This procedure was performed both before and after the thermoregulatory function test and consisted of separate measurements of digital thermal discrimination of warmth and cold by means of small aluminium plates, the temperature of which was varied accurately by Peltier junctions.

All of the above thermoregulatory function tests were also carried out on a group of fit, young adults aged under 45 years. Thirty young subjects were tested in 1972 (with the exception of thermal perception measurements) and a further 10 were tested in 1976.

Results and comment

DOMESTIC TEMPERATURE SURVEYS

The survey in 1976 showed that little had changed in the environmental temperatures in the home or in socioeconomic conditions since 1972 (table I). External environment, room, and deep body temperatures (oral and urine temperature) were not significantly different. In both surveys mean morning living room temperatures were slightly below, and mean evening temperatures slightly above 18·3°C, the minimum level recommended by the Parker-Morris report on council housing.[11] Hand temperature, a measurement of the body shell temperature approximating to the mean of skin and subcutaneous tissue, was slightly lower in 63% of the elderly people in 1976 than in 1972. This was so for both morning and evening hand temperatures, the differences between the two years being significant at the 2% level. The gradient between the deep body and hand temperatures was greater in the 1976 survey, though not significantly so. Thermal comfort votes were the same in 1972 and 1976, but more subjects in 1976 perceived that their hands were "cooler" than in 1972 (table I). The difference was not statistically significant. The number of reports of the hands being "much too cool" (a reading of 7 on the hand comfort scale) increased from 5 in 1972 to 9 in 1976.

TABLE I—*Domiciliary temperature surveys performed in 1972 and 1976 on 47 elderly people living in Camden. Results are mean (±SD) body and environmental temperatures (°C)*

	1972		1976	
	Morning	Afternoon	Morning	Afternoon
Oral:				
Clinical	35·92 ± 0·65	36·39 ± 0·48	36·30 ± 0·45	36·53 ± 0·32
Temtake			36·39 ± 0·44	36·54 ± 0·31
Uritemp:				
Clinical	36·33 ± 0·44	36·56 ± 0·50	36·36 ± 0·32	36·69 ± 0·41
Temtake			36·46 ± 0·34	36·67 ± 0·43
Hand temperature	31·29 ± 3·68*	33·08 ± 2·90	30·31 ± 3·00	31·96 ± 2·82
Uritemp-hand difference	5·28 ± 3·42	3·52 ± 2·75	6·03 ± 3·06	4·77 ± 2·70
Indoor (dry-bulb)	17·38 ± 2·80	19·42 ± 3·14	17·74 ± 2·69	19·00 ± 2·81
Outdoor (dry-bulb)	7·82 ± 4·33	7·83 ± 3·90	7·12 ± 3·26	7·88 ± 3·35
Mean comfort vote†	4/3/4	4/3/4	4/3/5	4/3/4

*Difference between 1972 and 1976 temperatures significant at 2% level.
†4—feeling comfortable at the time of the test, neither warm nor cold; 3—prefer no change in present thermal comfort; 4—hands feel comfortable at time of test; or 5—hands feel comfortably cool.

In more than 90 comparisons (morning and afternoon) for oral temperature and a similar number for urine temperature clinical thermometer and Temtake readings were not significantly different. The Temtake thermometer was regarded as highly acceptable by most of the elderly subjects and the observers found it to be convenient and reliable for taking oral and urinary recordings in the home.

No cases of hypothermia were discovered during the two surveys, though two women were found to be in the "low-temperature" category (Uritemp value below 35·5°C) in 1972 and two other women had morning urine temperatures of 35·7°C in both the 1972 and 1976 surveys.

PHYSICAL AND MEDICAL CHARACTERISTICS

Examination of the subsample of 120 elderly volunteers drawn from the 1972 survey showed a high incidence of mild clinical conditions,[12] including impaired mobility, falls associated with vertigo, postural imbalance, postural hypotension, nocturia (in 70%), and insomnia. In the four years between the tests there was a measurable deterioration both in terms of symptoms and in the incidence of recognisable disease (table II). Both mean height and weight had slightly decreased but surface area per kg body weight and skinfold thickness had not changed significantly. Mean systolic blood pressure had increased over four years and there was a higher incidence of orthostatic hypotension. Overall there was a lower MTS in 1976 but this decrease was not significant. A fall in MTS has been attributed to a rising incidence of dementia with age, particularly in women,[8] a diagnosis of dementia being indicated when the MTS is less than 13. In the present series scores less than 13 were found in three people (two women) in 1972 and in seven (six women) in 1976.

TABLE II—*Physical and medical characteristics of 47 elderly people (19 men, 28 women). Results are means (±SD)*

	1972	1976
Age (years)	70±4	74±4
Height (cm)	163·3±8·8	161·1±8·4
Weight (kg)	67·2±12·0	63·9±13·2
Dubois surface area (m^2)	1·72±0·17	1·66±0·18
Skinfold thickness (mm)*	13·9±5·9	14·2±6·1
Resting pulse (beats/min)	77±9	78±10
Lying blood pressure (mm Hg)	154±26/86±12	157±27/83±13
Standing blood pressure (mm Hg)	145±22/82±13	147±28/81±14
Mental test score (maximum 16)	15·0±1·3	14·6±1·6
No with:		
Orthostatic hypotension		
Systolic pressure difference >10 mm Hg	18	26
Systolic pressure difference >20 mm Hg	9	12
Mild chronic bronchitis	8	9
Arthritis (osteoarthritis, rheumatoid arthritis)	5	6
Hypertension	5	6
Other cardiovascular diseases	2	3
Parkinsonism	1	2
Diabetes mellitus	0	1
Hypothyroidism (treated)	1	1
Hyperthyroidism (treated)	1	1
No with symptoms:		
Dizziness	6	14
Symptom-free	23	14

*Mean of triceps and subscapular skinfolds.

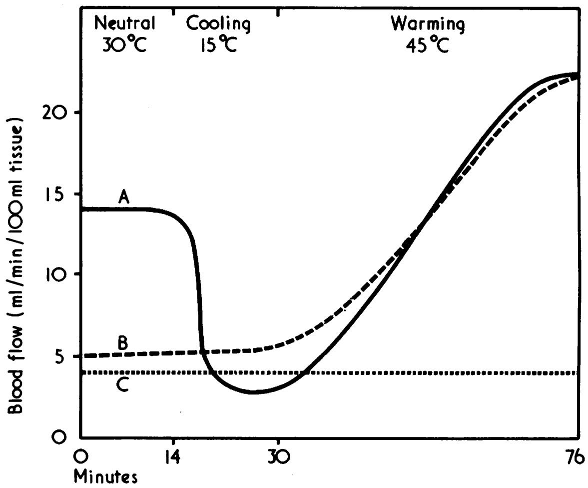
Few of the 47 elderly subjects had been admitted to hospital, and the incidence of the diseases of old age was not high. On the whole these subjects might be considered to be a reasonably fit cross-section of the elderly population.

THERMOREGULATORY RESPONSES

Body temperatures—Forty-five elderly subjects were investigated on the test bed, and two had mild fever at rest (aural temperature >37·5°C). The results of these two subjects were excluded from the analysis. Deep body (aural) temperatures before the test and at the end of the neutral, cooling, and warming stages were not significantly different in 1972 and 1976 (table A*). The weighted mean skin temperature from eight sites on the body surface, however, showed an increase from 1972 to 1976 at all stages except at the end of the warming period. The differences were statistically significant, as were the core-shell temperature gradients for the two years.

Hand blood flow—As has been reported,[9 13] abnormalities in peripheral (hand) blood flow in response to warming and cooling occur often in elderly subjects. Various patterns of this response have been described, but for our analysis we classified blood flows as normal (see figure, A)—that is, with vasoconstriction on cooling and vasodilatation on warming—and abnormal (see figure, B), when vasoconstriction did not occur (or was only slight) during the period of cooling. In 7% of those with non-constrictor responses there was an associated failure to vasodilate during the heating period (see figure, C). Of the 43 elderly subjects examined in 1972 six displayed a non-constrictor abnormality in blood flow and in 1976 14 out of 43 showed non-constrictor responses. Similar thermoregulatory function tests were applied to young control subjects, and 70 tests on 41 subjects showed failure to vasoconstrict on cooling only twice. Two out of three elderly patients tested after recovering from episodes of hypothermia had non-constrictor responses. Hand blood flows in the elderly were smaller in 1976 than in 1972 during all three stages of the thermoregulatory function test (table B). This does not necessarily indicate a true reduction in peripheral blood flow, for a similar difference was observed between the young subjects tested in 1972 and a (different) group of young subjects tested in 1976.

*Copies of tables A-D are available on request from the authors.



Blood flow responses of (A) normal people, (B) non-constrictors, and (C) non-constrictor/non-dilators.

Shivering—Shivering occurred in only four of the 43 elderly subjects in 1972 and in five (the same four together with one other subject) in 1976. In table III deep body and skin temperatures during the cooling period are recorded for three groups: those with a normal blood flow pattern, those with a non-constrictor type of response who did not shiver, and non-constrictors who shivered. There were no statistically significant differences between the body temperatures reached at different stages, indicating that the shivering response was not simply a function of lower skin and deep body temperatures. Shivering occurred only in association with the non-constrictor type of response, and not at all in those with normal peripheral blood flow responses. Mean deep body temperature increased slightly and skin temperature dropped in all groups during the cooling periods. The cooling test was clearly too short to serve as a definitive test of thermally-induced shivering, but by the end of the cooling period 11 of the subjects in 1972 and 15 in 1976 admitted to feeling cold and uncomfortable.

Sweating—All the young subjects started to sweat during the 46 minutes of warming; only half the elderly group started to sweat during this time. The elderly subjects who did not sweat attained similar mean skin temperatures but lower mean deep body temperatures than the elderly who sweated by the end of the warming period (table C). Some of the non-sweaters, of course, may also have been induced to sweat had the warming period been extended. The deep body temperature at sweat onset was not significantly different in the old and young, but it was significantly higher ($P < 0·002$) in the elderly in 1976 (37·11±0·18°C) than in 1972 (36·96±0·17°C).

Thermal discrimination—Digital thermosensation was tested in 1976. In confirmation of the earlier findings, the thermal perception

TABLE III—*Thermoregulatory function tests in the elderly: mean (±SD) deep body and skin temperatures (°C) in shivering and non-constrictor subjects*

	Year	Subject No	Aural temperature: End of neutral stage (30°C)	Aural temperature: Shivering	Aural temperature: End of cooling stage (15°C)	Skin temperature: End of neutral stage (30°C)	Skin temperature: Shivering	Skin temperature: End of cooling stage (15°C)
Non-shivering non-constrictors	1972	2	36·59±0·01		36·70±0·04	30·09±0·56		29·20±1·12
	1976	8	36·57±0·35		36·67±0·35	33·03±0·82		31·73±0·77
Shivering non-constrictors	1972	4	36·65±0·26	36·67±0·24	36·70±0·26	29·31±1·44	28·50±1·11	28·08±1·24
	1976	5	36·82±0·33	36·80±0·34	36·87±0·35	33·42±0·69	32·43±1·21	32·06±1·17
Normal subjects	1972	29	36·90±0·25		36·95±0·24	31·13±2·08		29·37±1·82
	1976	29	36·87±0·20		36·91±0·21	33·45±0·60		32·21±0·72

of warmth and cold was very different ($P < 0.01$) in young and old. Twenty young subjects could perceive mean temperature differences of 0.8 ± 0.2°C (cold) and 0.9 ± 0.2°C (warm), while elderly subjects could discriminate only between a mean temperature difference of 2.3 ± 0.5°C (cold) and 2.5 ± 0.8°C (warm).

Peripheral blood flow patterns—Since the test of thermoregulatory function was designed to study the zone of vasomotor regulation, a logical basis for analysis is to divide the elderly subjects into normal and abnormal (non-constrictor) groups. The 1972 and 1976 data were compared for (*a*) subjects with normal blood flow in both years, (*b*) subjects who were normal in 1972 but abnormal in 1976, and (*c*) all the subjects with abnormal blood flow in 1976 (table D). There was a significant trend in these subject groups showing an increasing incidence of low resting blood flow, the presence of shivering, and postural hypotension. There was a highly significant ($P < 0.001$) difference in resting blood flow levels between normal and non-constrictor subjects for each year. Low resting blood flow seems to be a characteristic of the non-constrictor type of response. There were no differences between the groups in the proportion showing absence of sweating or in the number who had been prescribed psychotropic drugs—for example, chlorpromazine—or cardiovascular drugs—for example beta-blockers, coronary vasodilators.

These variables were also compared with results obtained in three hypothermic patients. The hypothermic responses were similar to those of the non-constrictor subjects and significantly different from those of the normal group.

The results of the analysis of blood flow patterns suggest a possible basis from which early signs of autonomic and thermoregulatory dysfunction may be recognised. Some of the physiological responses of the non-constrictor group closely resembled those of patients who had suffered episodes of hypothermia. These responses might also be considered to characterise the category of elderly people most likely to be at risk from hypothermia.

Discussion

In the survey of temperature profiles in the elderly in 1972[5] 10% of the Camden series were found to be in the low-temperature category with urinary temperatures of 35·0-35·5°C. Many of these elderly people had a diminished core-shell (Uritemp-hand) temperature gradient (mean value 2·9°C, compared with 4·6°C for the rest of the elderly population) and were thought therefore to have some degree of thermoregulatory failure. The smaller subsample considered in this paper showed a slightly increased gradient in the 1976 survey compared with 1972, when hand temperatures were used to estimate the temperature of the body's shell. In the bed tests, however, using a weighted total body measurement of skin temperature, the gradient was found to be significantly smaller in 1976 during the resting, neutral, and cooling stages, which suggests that thermoregulation was less efficient in 1976. Wagner *et al*[14] have also found that older men are less able to maintain their body heat stores by vasoconstriction and have higher heat conductance and body skin temperatures than young subjects.

During the cooling period of the bed test shivering occurred only rarely in both young and elderly subjects. Four elderly subjects shivered in the 1972 tests and five in 1976. Shivering was observed only in those subjects with a non-constrictor type of blood flow response and in two out of three hypothermic patients who also had non-constrictor responses. This finding does not agree with the commonly accepted view that the loss of the shivering response is a primary event in thermoregulatory failure leading to hypothermia. Possibly shivering might occur as a compensatory response in those whose thermoregulatory vasomotor control has become inefficient. Vasomotor and sweating functions share similar efferent sympathetic pathways from the hypothalamic centre but differ from the motor pathways subserving shivering. Another possibility is that the shivering observed in the present tests was not a function of thermoregulation at all but was induced as the result of cerebral cortical activity on cooling. Johnson and Park[15] have reported shivering responses to chilling the feet in two out of three patients examined after hypothermic episodes, though a fall in body temperature induced by cooling the trunk with fans failed to elicit shivering.

Impairment of sweat-gland activity with age has been clearly shown in recent investigations.[16] Our experiments have established that aging is accompanied by a significant increase in the threshold temperature at which sweating is started, and confirm on a longitudinal basis the observations of Fennell and Moore.[17] This finding also argues for an increase in lability of core temperature in the elderly and suggests that the decrease in neuronal cell density and vascular supply of tissues affects the efficiency of the central (hypothalamic) regulating mechanism.

One important manifestation of dysfunction in the autonomic nervous system is orthostatic hypotension, a function of pressoreceptor activity, which seems to deteriorate in many elderly people. Orthostatic hypotension is likely to be a significant factor in predicting the loss of thermoregulatory efficiency since it correlates with abnormal (non-constrictor) patterns of peripheral blood flow. In the incidence of hypothermia it also plays another subsidiary part, for postural hypotension is regarded as a significant cause of falls in the elderly.[12]

The physiological studies reported in this paper confirm, both on a cross-sectional and longitudinal basis, that there is an age-related decline in autonomic nervous function which leads to impairment of thermoregulatory capacity in a high proportion of old people. Apart from identifying those elderly people with deep body temperature in the low range, which may indicate incipient hypothermia, a profile of autonomic nervous dysfunction, orthostatic hypotension, and a diminished core-shell temperature gradient may provide useful clinical signs of an associated thermoregulatory failure. Unfortunately, there is no reliable and inexpensive equipment for measuring peripheral blood flow. Preliminary tests indicate that a digital photoelectric pulsimeter predicts qualitatively the peripheral blood flow measured by volume plethysmography, but the requirements of a reproducible method for clinical investigation have not yet been met.

We acknowledge the generous support given by the Nuffield Foundation and the du Boulay Charitable Trust, and thank Nicholas Laboratories for supplying Temtake thermometers. We also wish to thank staff nurse D Esau for conducting the 1976 home survey and Dr F Mills, Dr Jacqueline Morris, Dr Yau Yung Ng, Dr D Robertson, Mr K Foster, Mr J Hackett, and Mr D Laing for help in the hospital studies. Above all we are indebted to the elderly people who participated so wholeheartedly as subjects in the investigations.

Copies of the unpublished tables may be obtained from Dr K J Collins, MRC Environmental Physiology Unit, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT.

References

1 Royal College of Physicians of London, *Report of Committee on Accidental Hypothermia*. London, RCP, 1966.
2 Royal College of Physicians of London, *Report of a Pilot Study of Low Body Temperatures in Old People admitted to Hospital*. London, RCP, in press.
3 Rosin, A J, and Exton-Smith, A N, *British Medical Journal*, 1964, **1**, 16.
4 MacMillan, A L, *et al*, *Lancet*, 1967, **2**, 165.
5 Fox, R H, *et al*, *British Medical Journal*, 1973, **1**, 200.
6 Fox, R H, *et al*, *Lancet*, 1971, **1**, 424.
7 Fox, R H, *et al*, *British Medical Journal*, 1973, **1**, 21.
8 Denham, M J, and Jefferys, P M, *Modern Geriatrics*, 1972, **2**, 275.
9 Fox, R H, paper on "Hypothermia, Heating and the Elderly: Physiological Aspects" presented at CES symposium, London, 1975.
10 Cowburn, E J, and Fox, R H, *Journal of Physiology*, 1974, **239**, 77P.
11 Ministry of Housing and Local Government, *Homes for Today and Tomorrow*. HMSO, London, 1961.
12 Exton-Smith, A N, in *Care of the Elderly, Meeting the Challenge of Dependency*, ed A N Exton-Smith, and J Grimley Evans. Academic Press, London, in press.
13 Exton-Smith, A N, Green, M F, and Fox, R H, *Proceedings of the Tenth International Congress of Gerontology*. Jerusalem, 1975.
14 Wagner, J A, Robinson, W, and Marino, R P, *Journal of Applied Physiology*, 1974, **37**, 562.
15 Johnson, R H, and Park, D M, *Journal of Neurological and Neurosurgical Psychology*, 1973, **36**, 411.
16 Foster, K G, *et al*, *Age and Ageing*, 1976, **5**, 91.
17 Fennell, W H, and Moore, R E, *Journal of Physiology*, 1974, **240**, 118P.

(*Accepted 29 December 1976*)