Hypothermia in elderly patients: characteristics and prognosis

Study objectives: To assess the characteristics of patients admitted for hypothermia, and to identify the risk factors for in-patient mortality.

Methods: All patients aged 60 or above admitted from of 1st January, 2005 to 31st December, 2008 were included. Records were retrieved and analysed retrospectively. Hypothermia was defined as either one measurement of core body temperature lower than 35°C by rectal thermometer, or the average of two tympanic body temperature readings, measured within 1 hour after the arrival at Accident and Emergency Department, lower than 34°C. Cases were excluded if the body temperature was not rechecked within the first hour of admission, and if the hypothermia was developed intra-operatively, post-operatively, or during hospitalization.

Results: Eight-one patients were eligible to our study. Their mean (± standard deviation) age was 80 ± 9 years and 37 (46%) of them were male. Multivariate analysis showed that bradycardia on admission (OR, 5. 26; 95% CI, 1. 31 to 21. 10; p = 0. 02), a higher serum urea level (29. 9 ± 22. 6 mmol/L in non-survivor group vs. 19. 2 ± 11. 9 mmol/L in survivor group; OR, 1. 04; 95% CI, 1. 00 to 1. 08; p = 0. 05), and hypoalbuminaemia (27 ± 5 g/L in non-survivor group vs. 35 ± 9 g/L in survivor group; OR, 0. 79; 95% CI, 0. 69 to 0. 90; p = 0. 001) were the independent predictors of mortality in elderly hypothermic patients.

Conclusion: Hypothermia is a condition associated with high in-patient mortality. Bradycardia, hypoalbuminaemia and high urea levels were identified as the independent risk factors for mortality, while age,

comorbidity, functional status, social background, severity of hypothermia and different rewarming methods were not.

Hypothermia is defined as core body temperature below 35. 0 °C (95. 0 °F). At this temperature, the coordinated systems responsible for thermoregulation begin to fail because the compensatory physiologic responses to minimize heat loss are very limited (1).

It is well-known that elderly people with impaired thermal homeostasis are vulnerable to the development of spontaneous hypothermia and their prognosis is also much worse than for younger individuals (1). Elderly population is found to have increased risk of dying from hypothermia from epidemiological study (2). Studies from the Western countries have previously reported that the mortality of adult patients presented to Accident and Emergency Department (AED) varies from 34% to 74%, and that of those admitted to Medical Department or Intensive Care Unit (ICU) ranges from 27% to 46% (3-10). Despite the medical advances in rewarming strategies and supportive treatment over the years, the mortality has not declined substantially (Table 1).

Limited number of studies from Western countries have identified various risk factors for hypothermia-related deaths: coma at presentation, high serum the use of vasopressor agents (6), male sex, availability of central heating, high neutrophil count, high serum urea level, high serum amylase level, impairment of consciousness, cardiac arrthymia (8), thrombocytopenia, hypoproteinemia (9), cardiopulmonary resuscitation in the pre-hospital setting, tracheal intubation, nasogastric tube placement,

elevated blood urea nitrogen level and low systolic blood pressure (11). However, local data are lacking. The purpose of this study was to look into the characteristics of hypothermia of elderly patients in our locality, and the factors associated with mortality.

Methods

a) Data Acquisition

All adult patients aged 60 or above admitted to Department of Medicine or ICU of Queen Elizabeth Hospital, with a principle or associated diagnosis of " hypothermia (780. 9)", or " hypothermia due to low environmental temperature (991. 6)", within the 4-year period, from 1st January, 2005 to 31st December, 2008, were identified by the Clinical Data Analysis and Reporting System (CDARS). The diagnostic codes were based on 9th edition of International Classification of Diseases (ICD-9). Hospital notes and electronic patient records of all these patients were reviewed retrospectively.

b) Definition of Hypothermia, Temperature Measurements, Inclusion and Exclusion Criteria

In our study, hypothermia of our patients must be confirmed by the presence of either one measurement of core body temperature lower than 35°C by rectal thermometer, or the average of two tympanic body temperature readings, measured within 1 hour after the arrival at AED, lower than 34°C. The infrared tympanic thermometer, ThermoScan®, is the standard instrument used for measurement of tympanic body temperature in the medical wards. It was reported to be 0. 8 ± 0. 2°C lower than the core body estimates in human hypothermic experiment (12). In view of this, only patients whose mean tympanic temperatures at least 1°C lower than 35°C

were included into the study. Cases were excluded if the body temperature was not rechecked within the first hour of admission, and if the hypothermia was developed intra-operatively, post-operatively, or during hospitalization.

c) Adjustment of Tympanic Temperature Readings

The tympanic body temperature readings were adjusted so that they were closest to their core body temperature estimates, as suggested by the human hypothermic experiment (12). The adjusted body temperature of our patients was calculated by adding 0. 8°C to the mean tympanic temperature of first and second measurements. By using these results, or rectal temperature readings, if available, patients were classified into mild hypothermia group if their temperature was between 32°C and 35°C, moderate hypothermia group if their temperature was between 28°C and 32°C, and severe hypothermia group if their temperature was below 28°C (13).

d) Data Collection

The demographic data, mobility, social condition, body temperature on admission, means of measurement of the body temperature, the month of admission, chronic medical illnesses, long-term medications, acute medical conditions diagnosed during the admission, laboratory findings on admission, certain electrocardiogram (ECG) findings, management, methods of rewarming, duration of hypothermia from the time of arrival at AED and the outcome of patients were recorded and analysed.

Chronic medical illnesses (heart failure, hypertension, chronic ischaemic heart disease, chronic pulmonary disease, previous stroke, other

neurological disease, documented dementia, chronic renal insufficiency, diabetes mellitus, malignancy, hypothyroidism and previous hip fracture) and acute medical conditions (cardiac arrest before and within 24 hours after admission, fell onto ground with subsequent immobilization, pneumonia, urinary tract infection, hypoglycaemia on admission, acute kidney injury and gastrointestinal bleeding) were chosen to be included in our study as they were previously reported as the potential risk factors for impaired thermostability (2-11, 14-16).

The chronic use of certain medications, including beta-blockers, oral hypoglycaemic agents, anti-psychotics, anti-depressants, thyroxine and diuretics, were chosen to be included into out study as these medications were associated with the development of hypothermia

ECGs, performed during the hypothermic state on admission, were reviewed from the records and the presence of the following findings was noted: bradycardia, shivering artefacts, J waves and corrected QT interval, which was calculated according to Bazett’s formula.

Age-adjusted Charlson Comorbidity Index (CCI) was used to measure the severity of underlying chronic medical conditions (17). An electronic application was used for rapid calculation of the age-adjusted CCI score (18).

The mean ambient temperature on the day of admission of our patients was obtained from the website of the Hong Kong Observatory (http://www. hko. gov. hk/wxinfo/climat/specialday/html/select_e. shtm).

e) Definitions of clinical parameters used in our study

i) Chronic diseases

Heart failure referred to patients who had history of exertional or paroxysmal nocturnal dyspnoea and who had responded symptomatically, or on physical examination, to diuretics, digitalis, or afterload reducing agents.

Ischaemic heart disease included patients with history of definite or probable myocardial infarction and those who had been hospitalized for typical symptoms and/or presence of characteristic electrocardiographic or enzyme changes.

Hypertension included patients who had history of high blood pressure or who were receiving anti-hypertensive drugs.

Chronic pulmonary disease included patients suffering from chronic obstructive pulmonary disease, asthma, pneumoconiosis or bronchiectasis.

Old cerebrovascular disease included patients with typical clinical or radiological findings that could be retrieved from the medical records.

Other neurological diseases included patients with Parkinsonism, multiple sclerosis, epilepsy or cord compression.

Dementia included patients with chronic cognitive deficit that affected their activities of daily living.

Renal insufficiency included patients with at least 2 measurements of a serum creatinine level before the occurrence of hypothermia that were

consistent with a creatinine clearance less than 60mL/min, by using Modification of Diet in Renal Disease (MDRD) Study equation.

Malignancy included lymphoma, leukaemia, myeloma, metastatic tumour, or solid tumour which was initially treated in the last 5 years, or under palliative care.

ii) Acute medical problems identified in the admission

Pneumonia was defined by the presence of suggestive clinical features (cough, fever, pleuritic chest pain, dyspnoea and sputum production), and a demonstrable infiltrate by chest radiograph or other imaging technique, with or without supporting microbiological data (19).

Urinary tract infection (UTI) was defined by the presence of white blood cells (WBC) in a freshly voided urine specimen, and either the presence of bacteriuria of more than or equal to 105 colony forming units (cfu)/mL in asymptomatic patients, the presence of more than or equal to 102 cfu/mL in symptomatic women, or the presence of more than or equal to 103 cfu/ml in symptomatic men. The typical symptoms of UTI include dysuria, frequency, fever, chills, loin pain or confusion (20).

Hypoglycaemia on admission was defined as the first haemoglucostix (h’stix) reading lower than or equal to 2. 8mmol/L on ambulance or at AED.

Active gastrointestinal bleeding was defined by the presence of the typical clinical features (haematemesis, gross blood or coffee ground nasogastric tube aspirate of more than 100mL, rectal bleeding, maelena), or the endoscopic evidence of active or recent haemorrhage.

Acute kidney injury was an abrupt (within 48 hours) reduction in kidney function defined by an absolute increase in serum creatinine of more than or equal to 26. 4 micromoles/L, a percentage increase in serum creatinine of more than or equal to 50% (1. 5-fold from baseline), or a reduction in urine output (documented oliguria of less than 0. 5 ml/kg per hour for more than six hours) (21).

Coma on admission was defined as a Glasgow Coma Scale (GCS) lower than 8 out of 15 on admission.

Bradycardia is defined as a heart rate less than 60 beats per minute clinically or on ECG (3).

f) Rewarming Methods

In our hospital, passive external rewarming involved the use of unheated blanket, active external rewarming involved the use of heated blanket, and active internal rewarming involved the infusion of warm intravenous fluid. None of our patients received invasive active internal rewarming or extracorporeal rewarming.

g) Statistical Evaluation

In-hospital death was defined as the outcome variable. Unpaired Student’s t test was used in univariate analysis of parametric groups, while Mann-Whitney U test was used for the non-parametric group (Charlson Comorbidity Index). Chi-square test or Fisher-exact test was used for categorical data, as appropriate. Subsequently, patient factors, including bedridden status, age-adjusted CCI score, coma on admission, first systolic blood pressure (SBP) on

arrival at AED, bradycardia, platelet count, serum potassium levels, serum urea levels, serum albumin levels, pneumonia, hypoglycaemia on admission, use of intravenous antibiotic, use of vasopressor agent(s), taking longer than 12 hours to be rewarmed to 35°C, were used in a multivariate analysis. A stepwise multiple logistic regression analysis was employed to identify variables associated with mortality. A p value of < 0. 05 was assumed as the level of significance. All data were analyzed with Statistical Package for Social Science (SPSS) Statistics 17. 0.

Results

a) Patients Eligible to the Study

Within the 4-year study period, a total of 126 patients aged 60 or above, admitted and coded with principle or secondary associated diagnosis of “ hypothermia (780. 9)”, or “ hypothermia due to low environmental temperature (991. 6)”, were identified by CDARS. Three medical records could not be traced. Therefore, 123 medical records were reviewed. Thirty cases were excluded as their clinical features did not meet the diagnostic criteria of hypothermia in our study. Another 12 cases were excluded as they developed hypothermia during hospitalization. As a result, 81 patients were included in this study (Figure 1).

b) General Characteristics of Patients

i) Demographic

The mean (± 1 standard deviation [SD]) age was 80 ± 9 years and 37 (46%) of them were male.

Thirteen (16%) of them were living alone and 32 (40%) of them were living with family (Figure 2). Thirty-six patients (44%) were living in aged-home and Community Geriatric Assessment Team (CGAT) service was available to the aged-home of 30 (83%) of them. Thirty-seven (46%) of them were bedridden, 21 (26%) of them could walk with aid or assistance, and the rest of them (28%) were able to walk unaided (Figure 3).

ii) Past medical history

Most of them were suffering from chronic medical diseases (Figure 4): 20 patients (25%) had underlying chronic heart failure, 60 patients (74%) had hypertension, 17 patients (21%) had chronic ischaemic heart disease, 5 patients (6%) had chronic pulmonary disease, 26 patients (32%) had previous cerebrovascular accident, 10 patients (12%) had other neurological disease, 23 patients (28%) had dementia, 37 patients (46%) had renal insufficiency, 37 patients (46%) had diabetes mellitus, 8 patients (10%) had underlying malignancy, 20 patients (24%) had history of hip fracture and 3 patients (4%) had hypothyroidism.

iii) Drug history

Twenty-three of them (28%) were taking beta-blocker, 25 patients (31%) were taking diuretic and 3 patients (4%) were taking digoxin (Figure 5).

Twenty-four patients (30%) were taking oral hypoglycaemic agent and 2 patients (2%) were taking thyroxine replacement regularly.

Seven patients (9%) were on anti-psychotic, 5 patients (6%) were taking anti-depressant, and 6 patients (7%) were on regular hypnotic.

iv) Hospital admission

All patients were admitted to medical ward. Fifty-four patients (67%) were admitted with hypothermia in the three winter months — December, January and February, while the remaining 27 patients (33%) were admitted in the remaining nine months (Figures 6). Only four patients (5%) were found outdoors on admission. The mean ambient temperature on the day of admission of the patients ranges from 9. 3â„ƒ to 27. 4â„ƒ.

v) Severity of Hypothermia and Methods of temperature measurement

Sixty patients (74%) were admitted with mild hypothermia, 19 patients (23. 5%) had moderate hypothermia, 2 patients (2. 5%) suffered from severe hypothermia, and both of them died during the hospitalization (Figure 7). Rectal temperature was available in 49 patients (60%). Among them, 42 patients (86%) had their rectal temperature checked in AED, while the rest of them had their rectal temperature checked in medical ward. The first body temperature readings were obtained by infra-red tympanic thermometer in 72 patients (89%), oral thermometer in 5 patients (6%), or rectal thermometer in the remaining 4 patients (5%). The second body temperature readings were obtained by rectal thermometer in 47 patients (58%), infrared tympanic thermometer in 28 patients (35%), or oral thermometer in the remaining 6 patients (7%).

vi) Acute Medical Conditions diagnosed on admission

Ten patients suffered (12%) from cardiac arrest and received cardiopulmonary resuscitation before or within 24 hours after admission (Figure 8). Thirteen patients (16%) had history of fall with subsequent

immobilization. Other diagnoses included pneumonia in 18 patients (22%), hypoglycaemia in 24 patients (30%), acute kidney injury in 28 patients (35%), urinary tract infection in 18 patients (27%), acute myocardial infarction in 10 patients (12%) and active gastrointestinal bleeding in 6 patients (7%).

vii) ECG Findings

ECGs, performed during the period of hypothermia, were available in 78 out of 81 patients. Bradycardia, shivering artefacts and J waves were found on 39 (50%), 54 (69%) and 39 (50%) of the ECGs respectively (Figure 9). The QTc ranged from 351 to 670 milliseconds, with the mean (± 1 SD) being 476 ± 58 ms.

viii) Treatment

Five patients (6. 2%) were admitted to the ICU, 9 patients (11. 1%) required ventilatory support and 26 patients were put on vasopressor agent during the period of hypothermia (Figure 10). Sixty-eight patients (84%) were given intravenous antibiotic and 19 patients (23. 5) were given intravenous hydrocortisone.

ix) The mode of rewarming

Seventy-five patients (92. 5%) were provided with passive external rewarming, 47 (58%) were provided with active external rewarming and 41 patients (52%) were given active internal rewarming (Figure 11).

x) Outcome

Thirty patients (37%) died during hospitalization, among them 12 (40%) died within the first 48 hours after admission.

xi) Epidemiology

Hypothermia accounts for 0. 08% of admissions into the medical department. The annual incidence rate of hypothermia in population aged 60 or above is estimated to be 4 cases per 100, 000.

c) Univariate Analysis

i) Baseline Characteristics

Table 2 shows the baseline characteristics between survivors and non-survivors. Only bedridden state was found to be significantly associated with mortality (63% versus [vs.] 37%, p = 0. 01).

ii) Past Medical History and Long-term Medication use

Table 3 shows the difference in the presence of medical illness among the study subjects. The age-adjusted CCI was significantly higher in the non-survivor group (7. 9 vs. 6. 8, p = 0. 04).

Neither the presence of individual chronic medical disease nor the use of individual long term medication was found to be associated with survival in univariate analysis (Table 3 & 4).

iii) Body and Environmental Temperature

There was no relationship between the season during which the patients were admitted or the mean ambient temperature on day of admission and

the patients' survival (Table 5). There was also no difference in the mortality rate among the patients with mild, moderate or severe hypothermia.

iv) Clinical Features on Admission

A lower SBP (109 vs. 130), coma and bradycardia were found to be associated with mortality during the hospitalization (Table 7 & 8).

Up to nine out of ten patients (90%) suffered from cardiac arrest before and within 24 hours after admission died during the hospitalization and 18 patients (22%) were diagnosed with pneumonia (Table 7). Both were significantly associated with mortality. Hypoglycaemia, defined as the h'stix level lower than or equal to 2. 8mmol/L in our study, was diagnosed in 24 patients (29%) on admission and was associated with survival. Other acute medical conditions identified on admission, including fall with long lie, urinary tract infection, acute kidney injury and active gastrointestinal bleeding, were all not found to be significantly associated with mortality.

Moreover, the platelet count and serum albumin level on admission were significantly lower in the non-survivor group, while serum potassium and serum urea levels were significantly higher among those who died during the hospitalization (Table 7). Blood culture was available in 56 patients (68%) and 5 of them had positive blood culture. Four out of five patients with positive blood culture died during the hospitalization. On the other hands, there was no significant association between the haemoglobin level, white cell count, serum sodium, serum creatinine, troponin I, creatine phosphokinase, arterial pH, bicarbonate, amylase, thyroid stimulating hormone and morning cortisol levels and the mortality, and neither were the

presence of shivering artefacts, Osborn waves (J waves) and the length of QTc on ECG performed during hypothermia (Table 8).

v) Treatment

The mortality rate was significantly higher in patients who had received intravenous antibiotic (97% vs. 77%) and vasopressor agents (22% vs. 50%) during the hospitalization (Table 9). The use of ventilatory support, ICU care and empirical intravenous hydrocortisone were not associated with patient's survival. None of our patients received empirical thyroxine replacement on admission.

While the use of different rewarming methods, including passive external rewarming, active external rewarming and active internal rewarming, did not significantly associated with the survival, the mortality rate was significantly higher in patients who took longer than or equal to 12 hours, after being admitted into AED, to return to 35°C (p = 0. 04) (Table 9). However, the difference was not seen when the cut-off was lowered to 10 hours (p = 0. 09).

d) Multivariate analysis

Those factors that showed a statistically significant difference in univariate analyses, including bedridden status, age-adjusted CCI score, coma on admission, first systolic blood pressure (SBP) on arrival at AED, bradycardia, platelet count, serum potassium levels, serum urea levels, serum albumin levels, pneumonia, hypoglycaemia on admission, use of intravenous antibiotic, use of vasopressor agent(s), and taking longer than 12 hours to be rewarmed to 35°C, were used in a multivariate analysis. It was found that

bradycardia on admission (OR, 5. 26; 95% CI, 1. 31 to 21. 10; p = 0. 02), a higher serum urea level (29. 9 ± 22. 6 mmol/L in non-survivor group vs. 19. 2 ± 11. 9 mmol/L in survivor group; OR, 1. 04; 95% CI, 1. 00 to 1. 08; p = 0. 05), and hypoalbuminaemia (27 ± 5 g/L in non-survivor group vs. 35 ± 9 g/L in survivor group; OR, 0. 79; 95% CI, 0. 69 to 0. 90; p = 0. 001) were the independent predictors of mortality in hypothermic patients (Table 10). Coma on admission (odds ratio [OR], 48. 5; 95% confidence interval [CI], 0. 97 to 2433; p = 0. 05) was a marginally significant factor for mortality of elderly patients admitted with hypothermia.

Discussion

Classification of hypothermia

Hypothermia can be classified into two different categories: primary and secondary (1). Primary hypothermia, or accidental hypothermia, refers to a spontaneous reduction of core body temperature due to a combination of body heat loss by convection, conduction, and radiation to the surrounding ambient air, usually resulting from the prolonged exposure to cold environment without adequate protection. On the other hand, secondary hypothermia usually occurs as a complication of an underlying medical disorder which predisposes an individual to hypothermia by reducing heat production, increasing heat loss, or interfering with the central or peripheral control of thermoregulation.

While primary hypothermia accounts for most of the cases in those countries of higher latitude and hence, with a cold winter, its prevalence is low in Hong Kong, which is located in sub-tropical region, with the outdoor temperatures

rarely drop below 5°C even in winter. While the risk of developing hypothermia is higher in cold environment, its absence does not preclude the diagnosis. It is especially true in elderly whose thermoregulation is progressively impaired (22). Immobilization, malnutrition, endocrinopathy, medications, central nervous system pathology, diminished basal metabolic rate, loss of lean body and muscle mass are all factors contributing to thermoregulatory failure (23, 24). Therefore, it is not surprising that the mean ambient temperature or the day of admission of our hypothermic elderly patients was in the higher temperature range (from 9. 3â„ ƒ to 27. 4â„ ƒ) compared with that in the Western countries (4-6), and up to a third of our patients developed hypothermia during warmer months. Actually, only 17 patients (18. 1%) in our series had a clear history of exposure to cold environment, including the 13 patients who suffered from fall with prolonged lying on floor leading to heat loss by conduction, and the 4 patients who were found outdoors (Table 6). It is most likely that the hypothermic episodes of most of our elderly patients could be considered as secondary. In view of this, hypothermia should be suspected in elderly population even during what are considered as “ mild winter” or “ warm climates”.

Effect of cold weather

The effect of cold weather appeared to affect the admission rate (Figure 6) but not the mortality of hypothermic elderly patients (Table 5). In our study, two thirds of the hypothermic elderly patients (54 patients) were admitted with hypothermia during the three winter months (December, January and February), while the rest were admitted in the remaining nine months. There was no significant difference in the mortality between these two groups of

patients (p = 0. 33). Similar finding was previously reported by Gautam et al (8) and Kramer et al (9). In their study, 49 (57%) hypothermic elderly patients in United Kingdom were admitted in December, January and February, and 37 (69%) hypothermic elderly patients in Israel were admitted in January, February and March, respectively. There was also no difference in mortality between the groups of patients admitted in winter or non-winter months.

Malnutrition

Malnutrition leads to diminished subcutaneous fat, which in turn reduces both the substrate needed to generate heat and the insulating properties needed to conserve heat (23, 24). One of the surrogate markers of the nutritional state was the serum albumin level. In our study, hypoalbuminaemia was found to be predicting morality (27 ± 5 g/L in non-survivor group vs. 35 ± 9 g/L in survivor group; OR, 0. 79; 95% CI, 0. 69 to 0. 90; p = 0. 001). This finding was, in part, consistent with that reported in an Israeli study by Kramer et al. In their study, 54 elderly patients aged 65 or above were reported to have hypothermia over a 4-year study period. Hypoproteinaemia was found to be associated with mortality in their multivariate analysis. From this result, it seems that adequate nutritional support is important for our elderly patients in the face of cold weather.

High serum urea level

An elevated serum urea level was found to be significantly associated with mortality (29. 9 ± 22. 6 mmol/L in non-survivor group vs. 19. 2 ± 11. 9 mmol/L in survivor group; OR, 1. 04; 95% CI, 1. 00 to 1. 08; p = 0. 05). This

finding was consistent with that reported by Danzl et al (11). Serum urea level was actually one of the important prognostic factors included in the Hypothermia outcome score, which was derived from a large hypothermia database from of the Hypothermia Study Group. The database was developed based on reviewing the clinical features of 428 hypothermic patients visiting 13 Emergency Departments. In this series, the elevated serum urea level was found to be one of the important factors associated with mortality of patients, and the likelihood ratio in predicting mortality was as high as 12 when the serum urea level was higher than or equal to 100mg/dL, or 35. 7 mmol/L.

The renal and metabolic response to hypothermia is cold-induced diuresis, which is probably contributed by depressed secretion of antidiuretic hormone. Initially, in response to cold exposure, peripheral vasoconstriction increases core intravascular volume and renal blood flow, thereby decreasing the secretion of antidiuretic hormone. Subsequently, with falling core temperature, the hypothalamic function was impaired, thereby further decreasing antidiuretic hormone levels and promoting diuresis (13, 25). Furthermore, in those hypothermic patients who require admission to ICU, up to 40% suffered from acute renal failure (26). Renal biopsies revealed ischaemic damage to the kidneys during the rewarming phase, following a period of relative protection at lower temperatures (27). Therefore, careful volume replacement is likely to be essential in replacing fluid loss in the “ cold diuresis” and preventing this “ pre-renal failure”. Future randomized control trial will be needed to study whether this form of treatment reduces mortality of hypothermic elderly patients.

Bradycardia and other ECG findings

Bradycardia on admission was found to be one of the factors associated with mortality of hypothermic elderly patients (OR, 5. 26; 95% CI, 1. 31 to 21. 10; p = 0. 02). To the best of our knowledge, bradycardia was not previously reported to be predicting mortality. Pathophysiologically, bradycardia occurs in moderate hypothermia, when the body enters an adynamic state with decreased spontaneous depolarisation of cardiac pacemaker cells (28). It appears that there is a significant overlap in real situation. In our study, bradycardia was present in 39 patients (48%). Two thirds of these patients (26 patients) suffered from mild hypothermia only. Eight patients with moderate hypothermia did not have bradycardia. Among the 39 patients with bradycardia, nine patients (23%) suffered from chronic ischaemic heart disease, 3 patients (8%) had their serum troponin I levels higher than 0. 3 ng/mL within 48 hours after admission, one patient (3%) had their serum thyroid stimulating hormone levels higher than 10 IU/mL, 17 patients (44%) were taking beta-blocker, one patient was taking thyroxine and none of the patients were taking digoxin.

Apart from bradycardia, presence of shivering artefacts, J waves or prolonged QTc on ECG were not found to be associated with mortality. These findings were inconsistent with the prospective, multicenter study reported by Graham et al, in which 73 ECGs were analyzed. Shivering artefact was present on 56% of the ECGs and was associated with survival (p = 0. 047).

Severity of hypothermia

To the surprise of many, the severity of hypothermia was not associated with mortality in our study. Although it should be interpreted cautiously due to small number of patients in the group of severe hypothermia, the relationship between severity of hypothermia and mortality was not demonstrated in many of the previous studies (3, 6, 8, 9, 10 & 11). It appears that the end-organ responses of hypothermia (bradycardia, coma on admission and serum urea level) and nutritional status of patients are more predictive than the presenting core temperature.

Age

Epidemiological study among hypothermic adults reported that as people age, their risk for dying from hypothermia increases (2). Our study, as well as the previous case series among hypothermic elderly patients, failed to demonstrate difference in mortality between younger and older old (3, 4, 6, 8 & 9).

Social background of our subjects

Interestingly, only a minority of our patients (1