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Changes in Calcium, Phosphate and Magnesium Homeostasis in Subjects under Standardized Cold Stress

PER-OLA GRANBERG, STEN LENNQUIST, HANS LÖW & SIGBRITT WERNER

Sammanfattning

I ett tidigare arbete har visats att köldinducerad diures hos människa är en osmotisk diures, åtföljd av hög osmolal clearance och negativ fri vattenclearance. Vidare har visats att den starkt ökade natriumsöndringen under dessa förhållanden är en effekt av nedsatt tubulär reabsorption av denna jon, vilken i motsats till diuresökningen uppträder endast när en tillräcklig mängd natrium är tillgänglig och följaktligen saknar etiologisk betydelse för den ökade urinproduktionen. Syftet med denna undersökning var att studera utsöndringen av kalcium, fosfat och magnesium hos försökspersoner exponerade för köldstress under samma standardiserade betingelser som använts i våra tidigare försök.

Två typer av försök utfördes: långtidsförsök, där försökspersonerna tillbringade flera dygn i en klimatkammare, och korttidsförsök på kyloperationsbord för att studera tidsintervallen mellan kylans insättande och de olika reaktionernas inträdande.

En signifikant ökning i kalciumutsöndringen inträdde omedelbart efter kylans insättande, företeende samma mönster som diuresökningen och den ökade utsöndringen av natrium och klorider. Magnesiumutsöndringen följde kalciumutsöndringen vid klimatkammarförsöken men visade ingen ökning i korttidsförsöken. Fosfatutsöndringen följde ett annat mönster än kalcium med en lineär, successiv ökning vad beträffar dygnsmedelvärdena. Under korttidsförsöken noterades ingen ökad fosfatutsöndring. Fosfat i serum ökade signifikant vid kyla. Kalcium i serum ökade i den utsträckning som kunde väntas som följd av den samtidigt inträdande hemokoncentrationen. Magnesium i serum förändrades ej. Genom beräkningen av GFR från såväl C_{Creat} som C_{In} framgick att den ökade kalciumutsöndringen, som ej tidigare observerats hos människor exponerade för kyla, var en följd av en minskad tubulär reabsorption av denna jon.

Introduction

Granberg, Lennquist & Wedin (1971) showed in renal function studies on human subjects under standardized cold stress that the ensuing diuresis was accompanied by a high osmolal clearance, unchanged negative free water clearance and highly increased excretion of sodium and chloride. The possibility that cold diuresis might be an osmotic diuresis, primarily caused by a diminished tubular reabsorption of sodium, was discussed. During these experiments, the subjects were given a standardized diet designed to correspond to an ordinary daily intake and containing 3.6 G (157 mEq) sodium per day. In experiments under the same conditions, but with sodium reduced to 0.46 G (20 mEq) per day, the urinary sodium excretion greatly diminished, although the urine flow still increased significantly and the osmolal clearance remained at a high level (Lennquist, 1971). These experiments suggested that the increased urinary excretion of sodium has no primary ætiological significance for cold diuresis and probably is a secondary phenomenon.

Other substances included in the high osmolal excretion under cold exposure are thus of great interest. The aim of the present investigation was to study the urinary excretion of calcium, phosphate and magnesium in human subjects under standardized cold stress and to correlate these values to the diuresis including changes in clearance conditions.

Surprisingly few studies have been directed to the behaviour of these ions in man under the effect of cold. The urinary excretion of calcium and phosphorus under moderate cold stress was examined by Suzuki, Tonoue, Matsuzuki &

Yamamoto (1967). As regards calcium, no definite increase was recorded by these authors. The excretion of phosphorus, however, rose significantly during the cold-exposure period. A significant increase of magnesium excretion to the same extent as that of sodium was demonstrated in experiments under corresponding conditions by Bass & Henschel (1954).

In the present investigation, the excretion of calcium, phosphorus and magnesium in human subjects was followed during a cold-exposure period of 1—3 days in a climatic chamber. As it also proved of interest to study how quickly the changes occur, this investigation was supplemented by short-time experiments on a hypothermic operating table, which permitted faster cooling and made possible the use of a urinary bladder catheter in order to obtain shorter urine collection periods with effective emptying of the bladder.

Material and experimental conditions

1. *Experiments in climatic chamber*

Material

The experiments were performed on 9 healthy students, 8 men and 1 woman. Five subjects participated twice and the total number of experimental sessions was 14. The ages varied between 22 and 30 years (mean 25 years). Body weight averaged 67.1 kg and body surface area 1.86.

To study the effect of the experimental situation as such, a control group of six of these subjects was selected at random. This group spent 4 days in the climatic chamber under exactly the same conditions as in the other experiments, but without cold exposure, and is in the following referred to as the "normothermic control group" (group NT).

Experimental conditions

The subjects spent 1—3 days without interruption in a climatic chamber at an air temperature of +15 ± 0.5°C, a relative humidity between 39 and 44 per cent, and a wind-speed at no point exceeding 0.3 m/sec. The clothing was bathing trunks, socks and shoes. The supply of nutrients and fluid was carefully standardized and adjusted to an ordinary daily intake of all elementary components. It included 2860 Kcal, 3.6 G sodium, 5.0 G potassium, 0.9 G calcium, 2.2 G phosphate and 0.6 G magnesium per day. The subjects drank totally 1400 ml water per day.

To distinguish the effects of cold stress from possible effects caused by changed activity, physiological activity was strictly standardized, uniformly distributed over the 24 hours. After individual testing, it was adapted to correspond to the ordinary daily activity of the individuals, calculated on the basis of extensive interviews and testing of initial physical condition on a bicycle ergometer. The activities consisted, inter alia, of ergometer bicycling at different loads and walking up and down a staircase in the chamber. Between activities, the subjects rested in recumbent position, except for meal times, sampling and measurements.

A strict daily routine was followed. The experimental 24-hour period started at 3 p m. The 24 hours were divided into five periods, one 8-hour night period and four 4-hour day periods. In order to study the 24-hour rhythm and to make comparisons between the different periods, the day periods were made identical in that each period started with measurements and samplings, immediately followed by meals, which were qualitatively and quantitatively identical in all periods. During the night periods (11 p m—7 a m) the subjects were allowed to use a single sheet, but at other times no covering. Each period of cold exposure was preceded by a control period of 24 hours in the climatic chamber under exactly the same conditions but at an air temerature of +28°C.

The urine for every period was collected in labelled plastic buckets. With the avoidance of stasis, venous blood samples were collected in heparinized tubes on waking at 7 a m and at the end of each 24-hour period at 3 p m. The samples were centrifuged within 30 minutes, after which the plasma was immediately pipetted and refrigerated. The stools were weighed but not analysed. Body weight was determined five times daily, the subjects sitting on a Sauter weighing machine (accuracy ± 10 G) immediately after urinary voiding.

The experimental conditions were indentical with those used in a previous study of renal electrolyte excretion and osmolal balance in standardized cold stress (Granberg et al, 1971). For more detailed description of the methods, see this work.

2. *Experiments on hypothermic operating table*

Material

Five healty students participated, denoted A, B, C, D and E. Their personal data are given in Table I.

Table I. Personal data of subjects participating in experiments on a hypothermic operating table.

Subject	Sex	Age	Body weight kg	Body surface area m^2
A	male	25	76.6	2.03
B	male	24	66.0	1.85
C	male	23	76.0	1.91
D	male	23	76.0	1.91
E	female	28	57.0	1.68

Experimental conditions

The experiments were performed on an Auto Hypotherm Operation Table (Heljestrands Auto Hypotherm Division, Stockholm). Surface cooling was accomplished by placing the subjects naked under a plexiglass-cover in a constant air stream of about 0.5 m/sec from a compressordriven cooling unit. The air temperature was regulated by an electronic realy, the sensitive element of which consisted of a nickel-wire loop placed in the air stream. The same air temperature was used as in the climatic chamber, +15°C. Skin and rectal temperatures were continuously registered. Before the experiment, a Foley catheter was inserted in the urinary bladder under sterile conditions and under local anesthesia with Citanest gel®. The subjects were treated with Sulfapral® for two weeks immediately after the experiment, followed by bacteriologic control of the urine.

In three of the experiments (subjects A, B and C), a heart catheter for central pressure determination and a renal vein catheter for determination of PAH-extraction, were inserted percutaneously with the aid of TV fluoroscopy. The results of these experiments are described in an earlier study of sodium reabsorption in cold diuresis (Lennquist, 1970).

The subjects were fasting on the morning of the experiment, which was divided into six 20-minute periods, three periods of cold exposure and three control periods. Subjects D and E were kept hydrated during the experiment with 100 ml of water at the start of each period. Subjects A, B and C were kept fasting during the experiment. The bladder was evacuated at the end of each period by suprapubic pressure and flushing with 30 ml of distilled water and 50 ml of air. Blood samples without stasis from a catheter in the antecubital vein were drawn in the middle of each period.

Analytical methods

Osmolality was determined in duplicate by freezing point depression with a Knauer osmometer. Reproducibility for values $\leqslant$ 200 mOsm/kg H_2O = 1.2 per cent, for values between 200 and 800 = 0.6 per cent and for values $\geqslant$800 mOsm/kg H_2O = 0.6 per cent.

Creatinine was determined in duplicate by the method described by Taussky (1961). Reproducibility for serum values 2.6 per cent, for urine values 0.4 per cent.

Sodium was determined in duplicate with an IL flame photometer, type 143. Reproducibility for serum 0.4 per cent, for urine 0.6 per cent.

Potassium was determined in duplicate with an IL flame photometer, type 143. Reproducibility for serum 1.6 per cent, for urine 0.5 per cent.

Chloride was determined in dublicate with an Aminco-Cotlove chloride titrometer. Reproducibility for serum 0.5 per cent, for urine 0.5 per cent.

Hematocrit was determined in duplicate by centrifugation of blood in heparinized capillary tubes for 10 minutes at 8000 r p m. Reproducibility 1.5 per cent.

Calcium was determined by flame photometry, the equipment consisting of a Zeiss PMQ II emission flame photometer with a double monochromator according to Mc Intyre (1957). Reproducibility 2 per cent. Normal range for plasma 9.2–10.8 mg%, for urine $\leqslant$ 300 mg/day.

Phosphate was determined by the Gomori method (1941–1942). Normal range for plasma 2.5–4.5 mg%.

Magnesium was determined in duplicate by the method described by Hansen & Freier (1967). Reproducibility 0.5 per cent. Normal range for plasma 1.6–2.0 mEq/l.

Inulin was determined according to Heyrovsky (1956). Reproducibility 1.2 per cent.

Urine volumes and clearance calculations were corrected to a body surface area (BSA) of 1.73 m^2.

Statistical methods and data processing

Common statistical methods (Snedecor & Cochran, 1967) were used. All experimental data were fed for processing with a Fortran IV programme to an IBM 360/75 computer. Details of editing, processing and tabulation are contained in a separate programming report (Löf & Widegren, 1971).

The mean values for each period under cold exposure were compared with the values from corresponding period under the 24-hour control period. A Student's-t-test was used to determine the statistical significance, which was calculated both on the average absolute differences and on the average relative differences between these values. The following probability (p) levels of significance were used:

$p > 0.05$		= not significant
p	0.01–0.05	= probably significant
p	0.001–0.01	= significant
$p < 0.001$		= highly significant

The reproducibility of the methods of analysis was calculated from the formula:

$$f = \frac{100 \times \sqrt{\frac{\Sigma d^2}{2n}}}{\bar{x}} \text{ per cent,}$$

where $\bar{x}$ denotes the mean value, d the difference and n the number of the analysis on which the calculation was based.

Dispersion is generally given as standard deviation, when not otherwise stated.

Results

1. *Experiments in climatic chamber*

Blood changes

Calcium concentration in plasma, morning values after a night's fast, rose from an average of 4.9 ± 0.2 mEq/l during the control period to 5.1 ± 0.6, 5.2 ± 0.4 and 5.4 ± 0.5 mEq/l ($p < 0.05$) during the first, second, and third days of cold, respectively (Fig. 1). The mean relative increase compared with control period was 2, 5, and 8 per cent, respectively.

Phosphate concentration in plasma, morning fasting values, increased successively from an average during the control period of 4.2 ± 0.5 mg% to an average of 5.5 ± 0.3 mg% during the third day of cold (Fig. 1). The mean relative increase was 26 per cent ($p < 0.05$).

Magnesium and potassium concentrations in plasma were not changed during the experiment (Fig. 1).

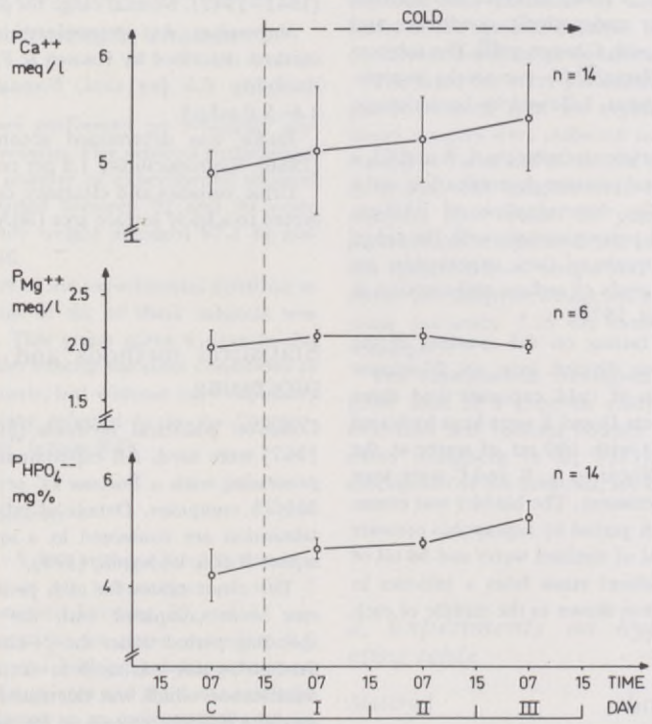

Fig. 1 Plasma concentrations of calcium, phosphate and magnesium. Mean values and standard-deviations for control period (C) and cold exposure (I–III). Day II–III n = 7.

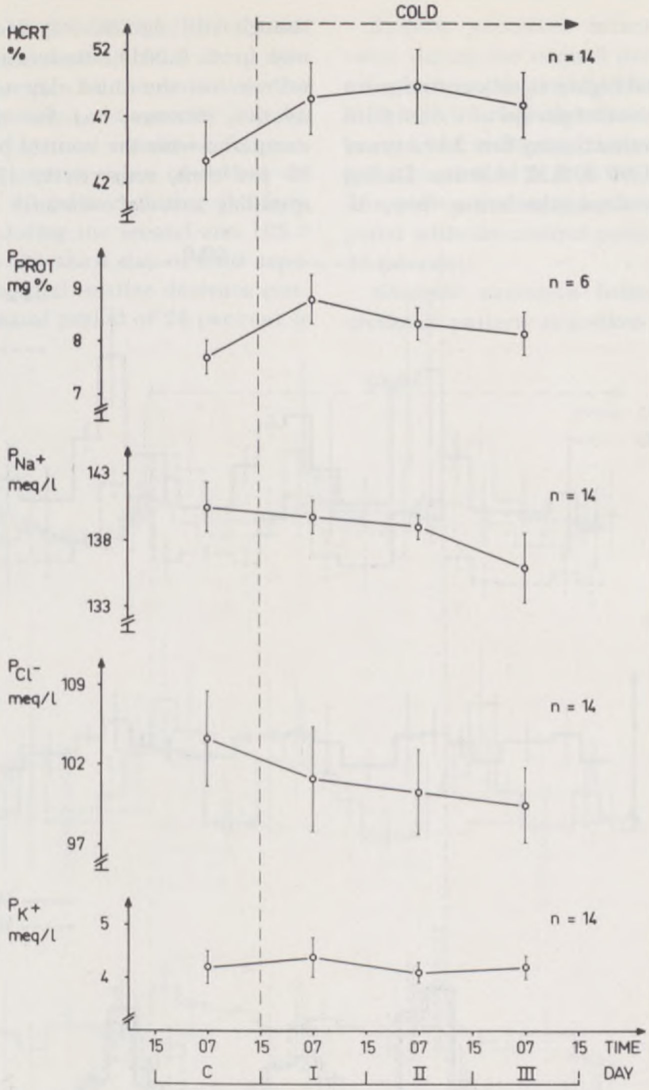

Fig. 2 Hematocrit (HCRT) and plasma concentrations of protein, sodium, chloride and potassium. Mean values and standard-deviations for control period (C) and cold exposure (I–III). Day II–III n = 7.

Sodium concentration in plasma (Fig. 2) decreased continuously from a mean value during the control period of 140.5 ± 1.9 mEq/l down to a lowest value on the third day of cold exposure of 136.0 ± 2.6 mEq/l ($p < 0.01$).

Chloride concentration in plasma (Fig. 2) followed sodium and decreased continuously from a mean value of the control period of 105.0 ± 3.6 mEq/l to a mean value of 100.0 ± 2.8 mEq/l at the end of the experiment ($p < 0.05$).

Mean values for *hematocrit* during the control period and ensuing three days of cold were 44 ± 3, 48 ± 3, 49 ± 3 and 48 ± 2 per cent, respectively. Mean relative increases compared with control period were 12, 14 and 11 per cent, respectively ($p < 0.001$).

Plasma protein concentration showed mean relative increases for the three days of cold compared with control period of 11,5, and 1 per cent (Fig. 2), respectively ($p > 0.05$).

Urinary changes

Urine flow increased highly significantly from a mean value in the control period of 0.82 ± 0.18 ml/min to a mean value during first 24 hours of cold exposure of 1.69 ± 0.32 ml/min. During the following two days, the urine flow, although still significantly increased above normal ($p < 0.001$), diminished to 1.42 ± 0.21 ml/min on the third day of cold. The mean relative increase was for the different days compared with the control period 116, 85 and 86 per cent, respectively (Fig. 3). The corresponding *osmolal clearance* rose from 2.14 ±

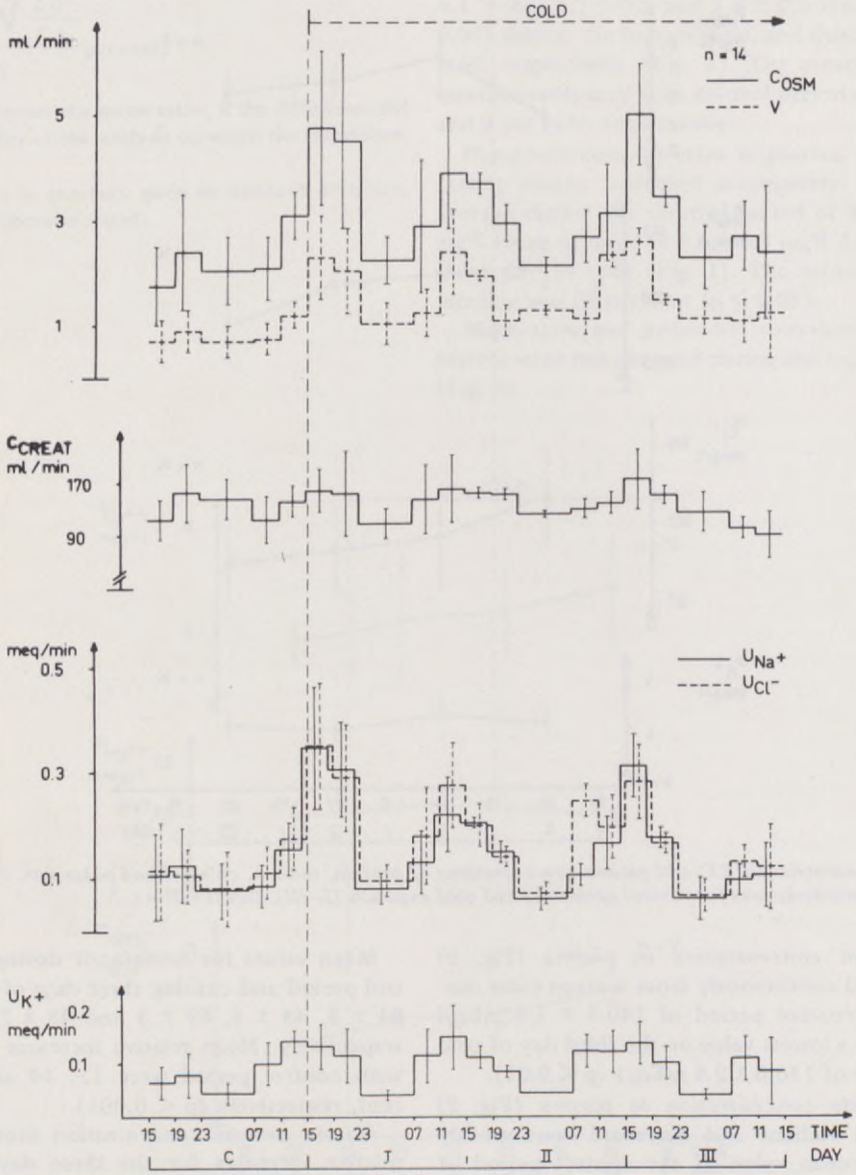

Fig. 3 Urine flow (V), clearance of endogenous creatinine (C_{Creat}), Osmolal clearance (C_{Osm}) and urinary excretion of sodium, chloride and potassium. Mean values and standard-deviations for control period (C) and cold exposure (I–III). Day II–III n = 7.

0.20 ml/min to 3.42 ± 0.99, 2.67 ± 0.29 and 2.49 ± 0.80 ml/min, respectively, a mean relative increase compared with the control period of 65, 22, and 14 per cent, respectively (Fig. 3).

Clearance of endogenous creatinine fell continuously from a control value of 145 ± 16 ml/min to 143 ± 40 ml/min during the first, 133 ± 12 ml/min during the second and 103 ± 30 ml/min during the third day of cold exposure. This meant a total relative decrease compared with the control period of 26 per cent ($p < 0.05$).

Sodium excretion increased from a mean value during the control period of 0.10 ± 0.04 mEq/min to a mean value of 0.19 ± 0.04 mEq/min during the first day of cold. The second and third day the excretions were 0.13 ± 0.02 and 0.11 ± 0.03 mEq/min, respectively. The corresponding mean relative increases compared with the control period were 122, 28 and 13 per cent.

Chloride excretion followed the same excretional pattern as sodium with mean relative

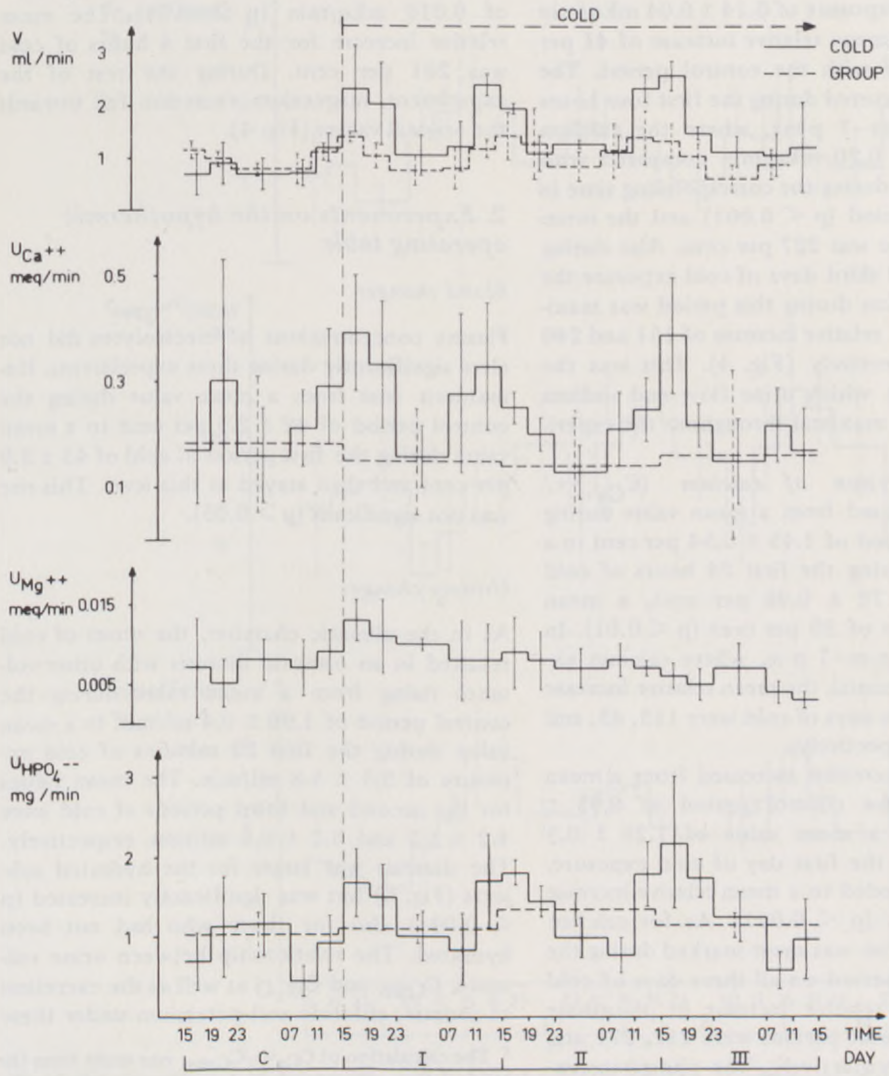

Fig. 4 Urine flow (V) and urinary excretion of calcium, magnesium and phosphate. Mean values and standard-deviations for control period (C) and cold exposure (I–III). Day II–III n = 7.

increases compared with the control period of 120, 31 and 9 per cent, respectively.

Potassium excretion for these subjects showed on the first day of cold a mean relative increase of 29 per cent and on the second day a mean relative increase of 16 per cent compared with the control period, while there was a relative decrease in potassium excretion of 5 per cent during the third day of cold exposure.

Calcium excretion increased from a mean value during the control period of 0.11 ± 0.04 mEq/min to a mean value during the first 24 hours of cold exposure of 0.14 ± 0.04 mEq/min ($p < 0.01$), a mean relative increase of 41 per cent compared with the control period. The greatest rise occurred during the first four hours of cold (3 p m–7 p m), where the calcium excretion was 0.20 mEq/min compared with 0.08 mEq/min during the corresponding time in the control period ($p < 0.001$) and the mean relative increase was 227 per cent. Also during the second and third days of cold exposure the calcium excretion during this period was maximal with mean relative increase of 151 and 240 per cent, respectively (Fig. 4). This was the same period in which urine flow and sodium excretion were maximal throughout the experiment.

Tubular rejection of calcium ($C_{Ca}{}^{++}/C_{Creat}$)[1] increased from a mean value during the control period of 1.45 ± 0.54 per cent to a mean value during the first 24 hours of cold exposure of 1.78 ± 0.46 per cent, a mean relative increase of 30 per cent ($p < 0.01$). In the periods 3 p m–7 p m, where calcium excretion was maximal, the mean relative increase for the different days of cold were 113, 43, and 86 per cent, respectively.

Phosphate excretion increased from a mean value during the control period of 0.93 ± 0.3 mg/min to a mean value of 1.28 ± 0.3 mg/min during the first day of cold exposure, which corresponded to a mean relative increase of 47 per cent ($p < 0.001$). As for calcium excretion, the rise was most marked during the 3 p m–7 p m period on all three days of cold exposure. The relative increase in phosphate excretion for these periods were 212, 271 and 307 per cent, respectively. The phosphate excretion continued to rise during the whole experimental period to a mean excretion of 1.34 ± 0.1 mg/min during the last day of cold, where the mean relative increase compared with the control period was 75 per cent (Fig. 4).

Tubular rejection of phosphate rose continuously during the experiment from an average 12.2 ± 3.4 per cent during control period to 15.6 ± 4.2 per cent in the first, 17.4 ± 2.1 per cent in the second and 19.2 ± 3.9 per cent in the third day of cold (Fig. 5).

Magnesium excretion increased from a mean value during the control period of 0.008 mEq/min to a mean value during the first day of cold of 0.010 mEq/min ($p > 0.05$). The mean relative increase for the first 4 hours of cold was 201 per cent. During the rest of the experiment, magnesium excretion fell towards the original values (Fig. 4).

2. Experiments on the hypothermic operating table

Blood changes

Plasma concentrations of electrolytes did not alter significantly during these experiments. Hematocrit rose from a mean value during the control period of 42 ± 2.5 per cent to a mean value during the first period of cold of 43 ± 3.9 per cent and then stayed at this level. This rise was not significant ($p > 0.05$).

Urinary changes

As in the climatic chamber, the onset of cold resulted in an osmotic diuresis with urine volumes rising from a mean value during the control period of 1.96 ± 0.4 ml/min to a mean value during the first 20 minutes of cold exposure of 5.5 ± 3.8 ml/min. The mean values for the second and third periods of cold were 4.2 ± 1.2 and 3.2 ± 0.8 ml/min, respectively. The diuresis was larger for the hydrated subjects (Fig. 6) but was significantly increased ($p < 0.001$) also for those who had not been hydrated. The relationship between urine volumes, C_{Osm} and C_{H_2O} as well as the excretion of sodium, chloride and potassium under these

[1] The calculation of $C_{Ca}{}^{++}/C_{Creat}$ was made from the total plasma contents of calcium. However, it is to be noted that about half of the plasma calcium is protein bound and not filtrable.

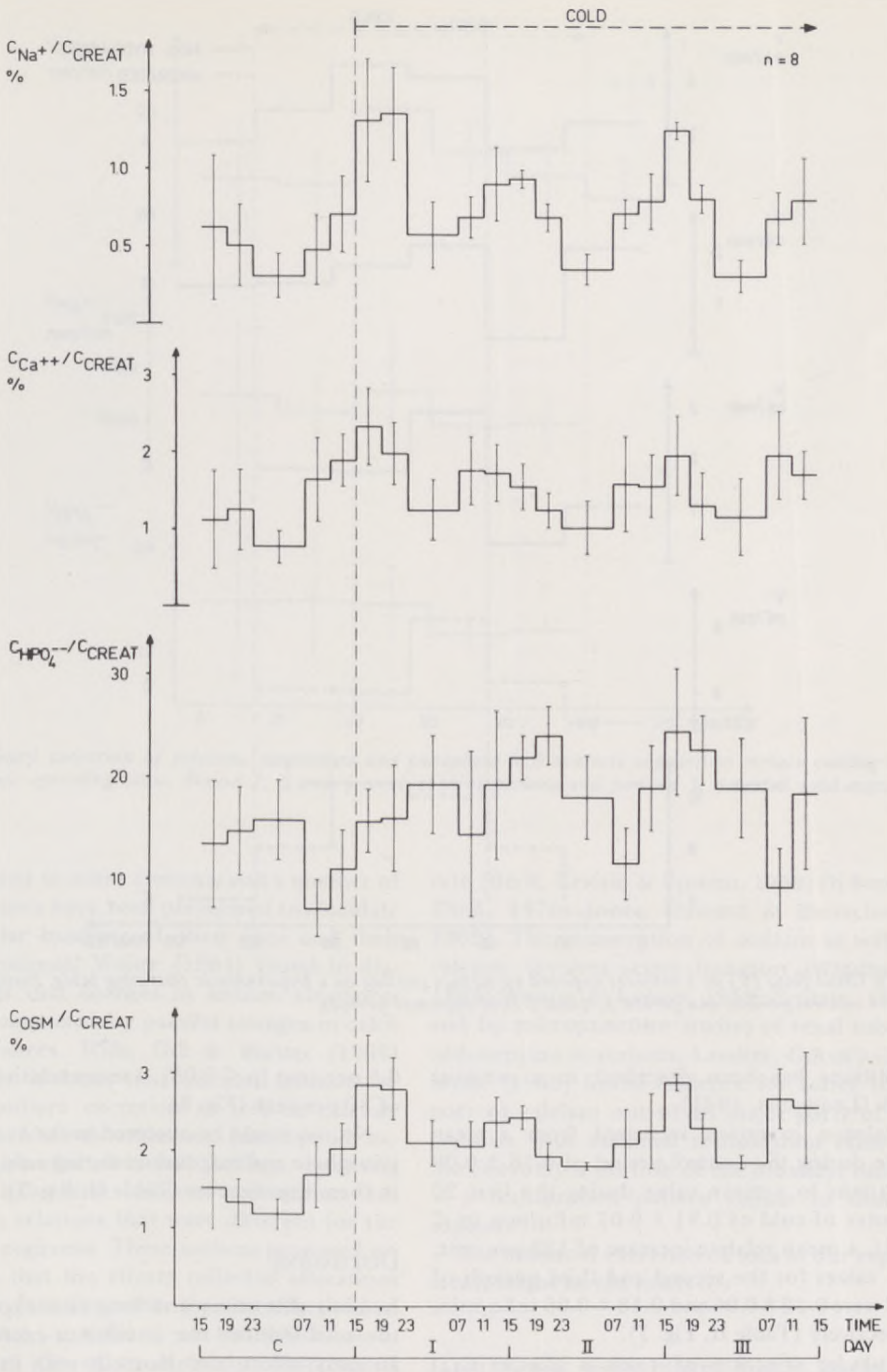

Fig. 5 Tubular rejection of sodium (C_{Na^+}/C_{Creat}), calcium ($C_{Ca^{++}}/C_{Creat}$), phosphate ($C_{HPO_4^{--}}/C_{Creat}$) and osmoles (C_{Osm}/C_{Creat}). Mean values and standard-deviations for control period (C) and cold exposure (I–III). Day II–III, n = 7.

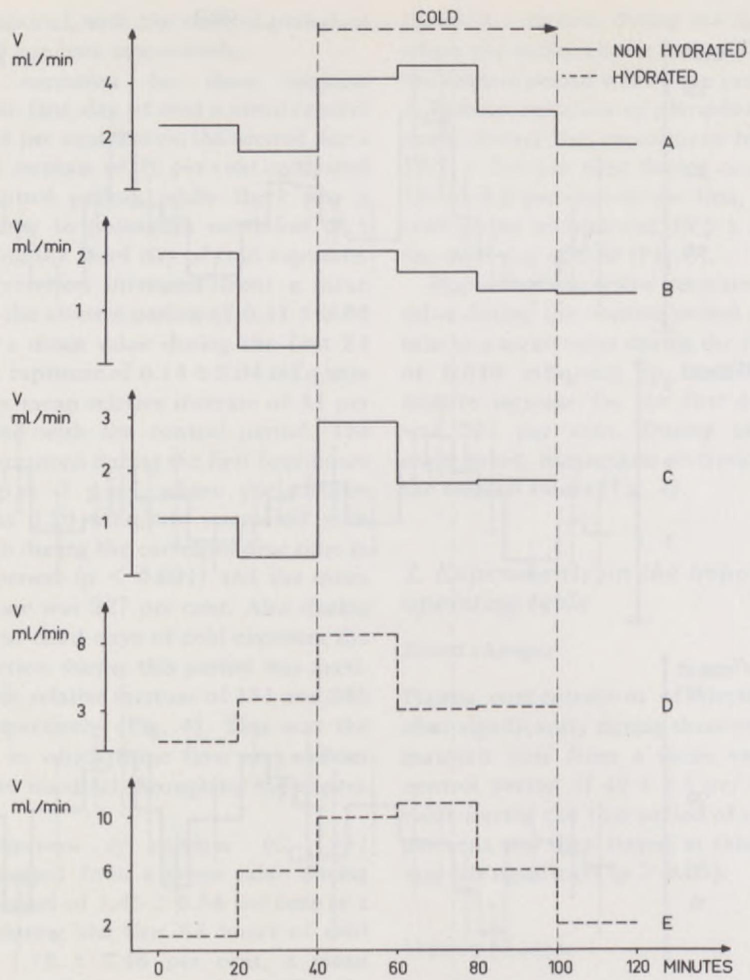

Fig. 6 Urine flow (V) in 5 subjects exposed to surface cooling on a hypothermic operating table. Period 1, 2 and 6 were control periods and period 3, 4 and 5 cold exposure periods.

conditions has been described in a previous work (Lennquist, 1971).

Calcium excretion increased from a mean value during the control period of 0.16 ± 0.08 mEq/min to a mean value during the first 20 minutes of cold of 0.31 ± 0.07 mEq/min ($p < 0.01$), a mean relative increase of 122 per cent. The values for the second and third periods of cold were 0.22 ± 0.06 and 0.18 ± 0.06 mEq/min, respectively (Table II, Fig. 7).

Tubular rejection of calcium ($C_{Ca^{++}}/C_{In}$) increased from a mean value during the control period of 1.2 ± 0.5 per cent to a mean value during the first period of cold exposure of 2.0 ± 0.5 per cent ($p < 0.05$), a mean relative increase of 80 per cent (Fig. 8).

No rise could be observed in the excretion of phosphate and magnesium during cold exposure in these experiments (Table II, Fig. 7).

Discussion

In both short-time and long-time experiments, the cold induced rise in calcium excretion was an early effect, simultaneous with the diuresis and parallel to the increased excretion of sodium and chloride. A close association between the excretion of sodium and calcium is well

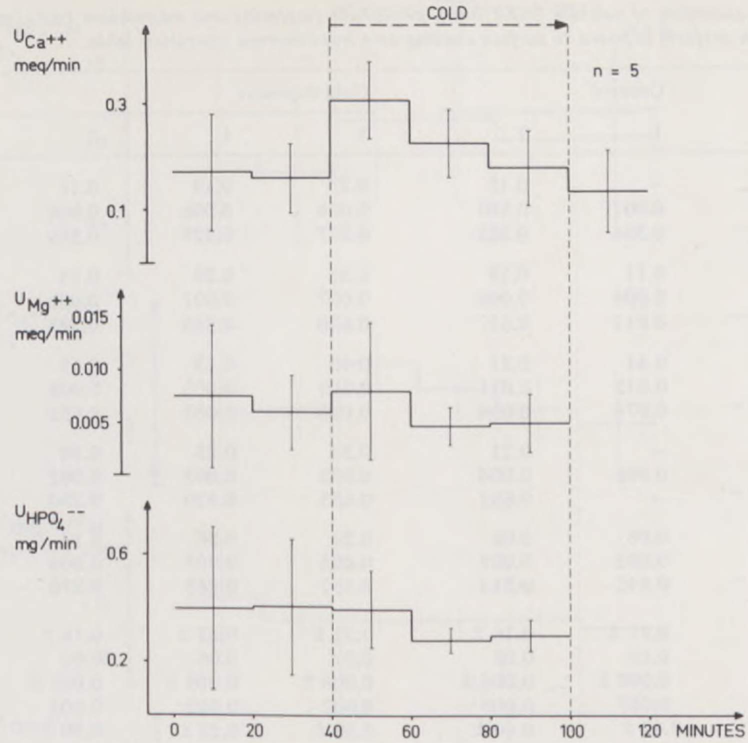

Fig. 7 Urinary excretion of calcium, magnesium and phosphate in 5 subjects exposed to surface cooling on a hypothermic operating table. Period 1, 2 and 6 were control periods and periods 3, 4 and 5 cold exposure periods.

documented in other contexts and a number of investigations have been performed to elucidate the tubular handling of these ions and their interdependence. Walser (1961) found in diuretic dogs that changes in sodium clearances were accompanied by parallel changes in calcium clearances. Wills, Gill & Bartter (1969) showed in humans that calcium infusion increased sodium excretion as well as calcium excretion. Various regimens, parathyroid extract, spironolactone and sodium retaining steroids influenced calcium and sodium excretion in relations that were different for the different regimens. These authors proposed on this basis that the effects reflected alterations of tubular function rather than an effect of one ion, calcium or sodium, on the tubular reabsorption of the other. It is also documented that hypercalcemia leads to impaired reabsorption of sodium by the renal tubules without concomitant changes in glomerular filtration rate (Bech, Levitin & Epstein, 1959; Di Bona & Theil, 1970; Jones, Guinard & Barraclough, 1969). The reabsorption of sodium as well as calcium involves active transport (Windhager, 1961; Wesson & Lanuer, 1959; Epstein, 1968) and by micropuncture studies of renal tubular reabsorption in rodents, Lassiter, Gottschalk & Mylle (1963) found evidence for active transport of calcium out of all major parts of the nephron with maximal reabsorption values in the convoluted portion of the proximal tubules – a reabsorption pattern similar to that of sodium.

The increased excretion of ions in our experiments might be the result of:

1) an increase in the filtered load of ions in the glomeruli as a product of ultrafiltrable ion concentration in plasma and glomerular filtration rate,

Table II. Urinary excretion of calcium (mEq/min), phosphate (mg/min) and magnesium (mEq/min) during the different periods in subjects exposed to surface cooling on a hypothermic operation table.

Subject		Control		Cold exposure			Control
		1	2	3	4	5	6
	$U_{Ca^{++}}$	–	0.13	0.23	0.19	0.16	0.19
A	$U_{Mg^{++}}$	0.007	0.007	0.008	0.006	0.008	–
	$U_{HPO_4^{--}}$	0.366	0.322	0.277	0.228	0.302	–
	$U_{Ca^{++}}$	0.11	0.18	0.36	0.29	0.14	0.08
B	$U_{Mg^{++}}$	0.004	0.004	0.007	0.007	0.003	–
	$U_{HPO_4^{--}}$	0.811	0.617	0.650	0.340	0.395	–
	$U_{Ca^{++}}$	0.34	0.21	0.40	0.13	0.13	–
C	$U_{Mg^{++}}$	0.019	0.011	0.019	0.005	0.008	–
	$U_{HPO_4^{--}}$	0.074	0.056	0.066	0.033	0.052	–
	$U_{Ca^{++}}$	–	0.21	0.30	0.25	0.30	–
D	$U_{Mg^{++}}$	0.006	0.006	0.003	0.003	0.002	–
	$U_{HPO_4^{--}}$	–	0.683	0.683	0.320	0.250	0.250
	$U_{Ca^{++}}$	0.06	0.06	0.24	0.26	0.16	–
E	$U_{Mg^{++}}$	0.002	0.002	0.003	0.003	0.004	–
	$U_{HPO_4^{--}}$	0.342	0.342	0.357	0.288	0.270	–
	$U_{Ca^{++}}$	0.17 ± 0.11	0.16 ± 0.06	0.31 ± 0.07	0.22 ± 0.06	0.18 ± 0.06	0.14 ± 0.07
M ± Sd	$U_{Mg^{++}}$	0.008 ± 0.007	0.006 ± 0.003	0.008 ± 0.007	0.005 ± 0.002	0.005 ± 0.003	–
	$U_{HPO_4^{--}}$	0.40 ± 0.71	0.40 ± 0.25	0.39 ± 0.15	0.28 ± 0.04	0.30 ± 0.06	–

2) a reduction in the tubular reabsorption of ions or
3) a combination of the two.

An increased filtered load as a cause of these electrolytic changes is not probable because filtration rate did not rise significantly, indicated by unchanged or lowered mean creatinine clearances, even if it is notable that the majority of the subjects showed an increase of creatinine clearance during the first 4-hour period of cold. On the other hand, in three subjects, clearance rate diminished during this period, during which they still showed the same highly significant diuresis and the same increase in sodium and calcium excretion as those with unchanged or increased creatinine clearances. This last finding indicates that the increased excretion of these electrolytes during cold cannot be explained by an increased glomerular filtration.

The plasma concentrations of calcium showed a small increase during the experiment. When, for each subject, these values were correlated to the corresponding increase in plasma protein concentration – taken as a reflection of the cold induced reduction of plasma volume – the increase could be accounted for by a rise in the non-filtrable fraction of plasma calcium.

Peacock & Nordin (1968) showed that both tubular reabsorption and excretion of calcium rose linearly with increasing filtered loads of calcium in normal as well as hypercalciuric subjects in normothermia. This was interpreted to mean that when, in any given individual, the plasma calcium concentration is raised above normal, a constant proportion of the increase in filtered load is reabsorbed. In contrast to these findings, tubular reabsorption in our experiments was clearly diminished, indicated by a significant rise in tubular rejection calculated from as well C_{Creat} as C_{In}. This speaks also against an increased filtered load of calcium and for a dramatically changed tubular handling of this ion.

Only one subject, a male student, did not follow this pattern of slight linear increase of

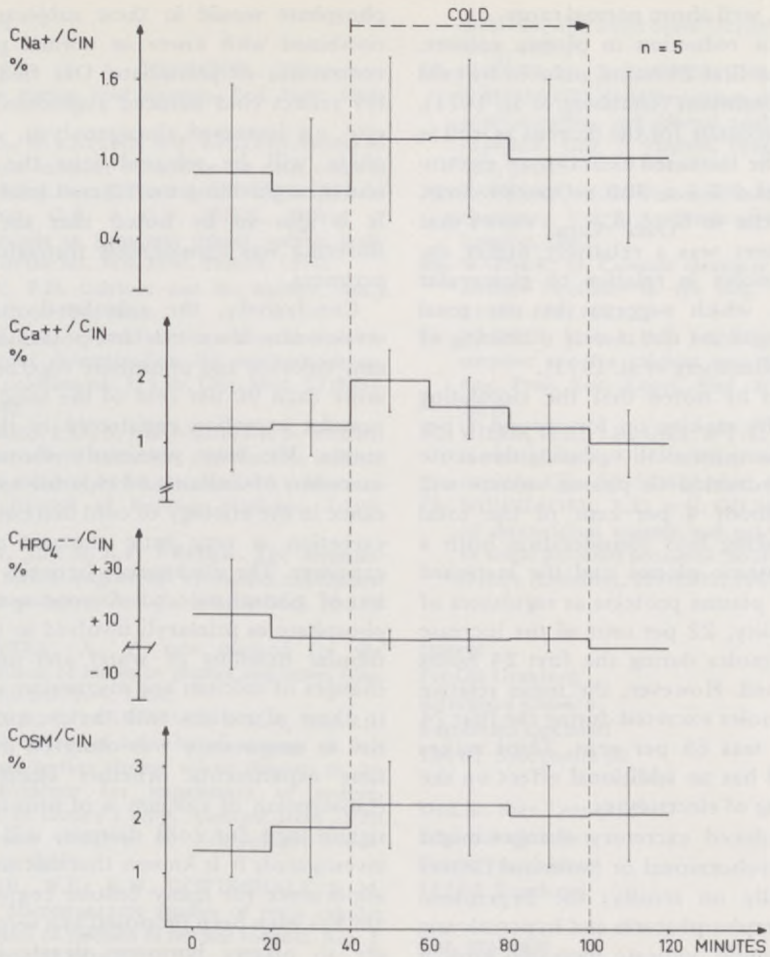

Fig. 8 Tubular rejection of sodium (C_{Na^+}/C_{In}), calcium ($C_{Ca^{++}}/C_{In}$), phosphate ($C_{HPO_4^{--}}/C_{In}$) and osmoles (C_{Osm}/C_{In}) in 5 subjects exposed to surface cooling on a hypothermic operating table. Period 1, 2 and 6 were control periods and periods 3, 4 and 5 cold exposure periods.

plasma calcium concentration; from a control value during normothermia of 4.5 mEq/l, calcium concentration decreased to 4.2 mEq/l. He was also the one who showed the least increase in calcium and sodium excretion as well as osmolal clearance during the first 24 hours of cold. His diuresis, however, was of the same magnitude as the others. His plasma phosphate concentrations were the highest of all, which is in line with the interdependence of these ions.

The rhythmicity of calcium excretion over day and night with minimum excretion values during night was maintained during the whole experiment. The curve for sodium excretion was all the time similar to that of calcium. The excretion curves for these ions are in sharp contrast to that of phosphate, which for all subjects during normothermia had maximum excretion rates during the night period. During cold, all subjects reversed rhythms to maximum excretional values during the day period similar to those of calcium and sodium. In contrast to calcium and sodium excretions, however, the amount of phosphate excreted during the different periods rose continuously during cold exposure, probably reflecting an increased filtered load of phosphate, plasma concentration of which at the end of the experiment had reached values, well above normal range.

The dramatic reduction in plasma volume, 0.7 l during the first 24 hours, induced by cold under these conditions (Granberg et al, 1971), might in part account for the diuresis as well as for a part of the increased excretion of electrolytes – around 0.7 l x 300 mOsm/24 hour. However, the rise in C_{Osm}/C_{Creat} shows that during cold there was a relatively higher excretion of osmoles in relation to glomerular filtration rate, which suggests that the renal excretory changes are not merely a clearing of isotonic fluid (Granberg et al. 1971).

It is also to be noted that the circulating proteins, usually making up for around 2 per cent of the plasma osmolality, during this acute 20 per cent reduction in plasma volume will account for about 4 per cent of the total osmolality. Taking into consideration both a clearing of isotonic plasma and the increased importance of plasma proteins as regulators of plasma osmolality, 22 per cent of the increase in excreted osmoles during the first 24 hours can be explained. However, the mean relative increase of osmoles excreted during the first 24 hours of cold was 65 per cent. Third makes clear that cold has an additional effect on the tubular handling of electrolytes.

The cold induced excretory changes might depend on neurohormonal or hormonal factors acting prerenally on renally; the hyperphosphatemia, hyperphosphaturia and hypercalcuria could, for example, indicate increased growth hormone activity. The hypercalcemia and hypercalcuria might be indicative of an increased TSH-thyroxin stimulation. Thus, an investigation of the relationship between renal and hormonal changes under these conditions would be desirable.

The significant increase in plasma phosphate concentration, mean relative increase compared with the control period of 26 per cent for the whole group, cannot be explained by hemoconcentration alone but must reflect cold induced metabolic changes prerenally. The linear increase in plasma phosphate despite intact glomerular filtration rate and augmented urinary excretion of phosphate speaks against increased parathyroid influence on the renal handling of calcium and phosphate. Parathyroid hormone stimulated excretion of calcium and phosphate would in these subjects have been combined with lower or normal plasma concentrations of phosphate. Our findings probably reflect cold induced augmented metabolic rate, e g increased glucogenolysis, where phosphate will be released into the circulating blood, augmenting the filtered load of the ion. It is also to be noted that the degree of shivering was considerable throughout the experiment.

Conclusively, the calculated increased excretion of sodium, calcium, potassium, magnesium, chloride and phosphate together stand for more than 90 per cent of the total increase in osmolal excretion registrered in these experiments. We have previously shown that the excretion of sodium and chloride has no significance in the etiology of cold diuresis. Potassium excretion is very little changed during cold exposure. The discrepancy between the dynamics of phosphate and diuresis speaks against phosphate as primaryli involved in the changed tubular handling of water and ions. Urinary changes of calcium and magnesium were similar to these of sodium with the exception that no rise in magnesium was observed in the short-time experiments. Whether changed tubular reabsorption of calcium is of primary etiologic significance for cold diuresis, will be further investigated; it is known that calcium is of vital importance for many cellular responses. Calcium has even been proposed as a second messenger to plasma hormone signals in systems, where cyclic AMP is involved (Rasmussen & Tenenhouse, 1968; Rasmussen, 1970). Changes in calcium transfer across plasma membranes as well as intracellular membranes therefore might influence the renal responsiveness to different stimuli and be a prerequisite for the cold induced diuresis.

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Effects on Extra- and Intrathoracic Pressure Pattern and Lung Injuries of rigid and soft Protection of Thorax in air Blast Exposed Rabbits

CARL-JOHAN CLEMEDSON, LARS FRANKENBERG, ARNE JÖNSSON & ANNA-BRITT SUNDQVIST

Sammanfattning

Uretansövda kaniner som var skyddade med kroppsskydd av stel respektive mjuk typ utsattes för verkan av luftstötvågor med lång varaktighet i stötvågstub och med kort varaktighet i fri luft. De två typer av stela kroppsskydd som testades var tillverkade av stål respektive plexiglas och var konstruerade för att i första hand skydda bröstet. De två typer av mjuka kroppsskydd som testades var tillverkade av skumplast respektive skumgummi och skyddade såväl bröst som buk. Fem olika längder av det stela kroppsskyddet testades nämligen 4, 8, 12, 16 och 20 cm. Kroppsskydden med längderna 8, 12, 16 och 20 cm visade sig medföra en avsevärd minskning av maximaltryck och branthet hos tryckpulserna i bröstet och förhindrade effektivt uppkomsten av lungskador. En ökning av kroppsskyddets längd över 12 cm förbättrade inte skyddseffekten när det gäller lungskador men 16 och 20 cm-skydden minskade maximaltryck och branthet hos tryckpulserna också i buken och minskade därigenom risken för bukskador. När 4 cm-skyddet placerades över den centrala delen av bröstet minskade lungskadorna från svåra till måttliga trots att den reducerande effekten på maximaltrycket i bröstet var obetydlig. I detta fall berodde minskningen av lungskadorna antagligen på en minskning av tryckpulsernas branthet.

De mjuka skydden visade sig medföra en ökad i stället för minskad belastningseffekt och därigenom allvarligt försvåra lungskadorna. Såväl maximaltryck som branthet hos tryckpulserna i bröstet ökade avsevärt. Det kan nämnas att maximaltrycket i bröstet ökade med upp mot 100 % i jämförelse med hos oskyddade försöksdjur. Experiment i stötvågstuben visar att den impuls, som överföres till försöksdjurets bröst under en tidsperiod vilken kan anses kritisk för uppkomsten av lungskador, kan öka två till tre gånger genom det mjuka skyddet.

Introduction

When a living body is exposed to a high explosive shock wave, a number of pathophysiological reactions occur, especially involving respiration and circulation[1,4–6,8,16–18,20,32,33]. The pathologico-anatomical changes caused by a shock wave of sufficient strength have been described in a number of publications especially from the time of World War II (for literature see references 4 and 6). The biomechanical events occurring during and immediately after the interaction of the shock wave with the body is of great interest, and they have been subject to an intensified study during the last decade[2,3,7,9,12–15,19,21–28,34,37,38].

From physical experiments it is wellknown that a shock wave can be attenuated through dissipation and absorption of energy by a hard or inhomogeneous material consisting of components with great differences in acoustic impedance interposed in the direction of propagation of the shock wave. With this fact in mind it is surprising that the effectiveness of individual protective materials or devices seem to have attracted only little attention, and that reports on the theoretical and practical aspects of the protective effects of such materials are almost completely lacking in the open literature.

The only observations reported are from the time of the Second World War. In animal experiments Zuckerman[33,39] found that the damaging effects of air shock waves could be reduced or eliminated by sponge rubber wrappings. Zuckerman's experiments showed that it is the pressure of the shock wave which damages the lungs by its action on the chest wall, and that this damaging effect can be prevented or diminished by materials which are able to take up and disperse the shock wave. Desaga[30] checked these results by using sponge rubber and other elastic materials, and he found that "there is no doubt that they offer a certain protection from blast effects". Also Draeger and co-workers[31] briefly discuss protective measures and state that the protection of the human body against the effects of an explosion depends on the possibility of preventing a harmful amount of energy from reaching the body.

Also the protection against underwater blast has been dealt with only cursorily in the literature[29,31,36]. Wakeley[36] maintains that the best way of protecting a person in water seems to be to surround his vulnerable body parts by an air cavity such as a swimming jacket. Such substances as cork or "Sorbo" are supposed also to be of value due to their air content. Protection of the abdomen as well as of the chest is necessary. Corey[29] states that it is well established that a coating of sponge rubber, kapok or other resilient material over the chest and abdomen offers a very high degree of protection from blast.

The present investigation was undertaken with the aim of studying the protective effects of hard as well as soft materials against the damaging effects of air shock waves on the lungs.

Material and methods

One hundred and sixtyeight rabbits were used. Their body weight was 2.1 to 3.2 kg. Rabbits weighing 2.1 – 2.4 kg were classified as small animals, and rabbits weighing 2.5 – 3.2 kg as large animals. The animals were anesthetized with a solution of 20 per cent urethane given in a dose of about 1.5 g/kg body wt in slow intravenous injection in a marginal ear vein.

Generation of shock waves

Two different kinds of shock waves were used in this study, which in this report will be classified as long duration shock waves and short duration shock waves, respectively. The shock waves of the first type, with a duration of the positive or overpressure phase of about 25 ms, were produced in a shock tube. For an animal of the size of a rabbit a duration of 25 ms can be

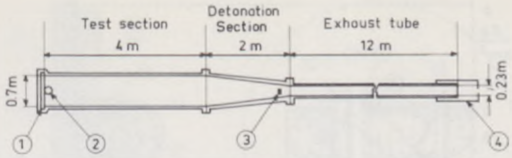

Figure 1. Shock tube used for the long duration shock wave tests. 1. end plate of steel covered with a wooden plate; 2. test object fixed to end plate; 3. cylindrical TNT-charge; 4. silencer.

regarded as a long duration shock wave load. For these experiments 100 animals were used. The short duration shock waves, with a positive duration of about 3 ms, were produced by high explosive charges detonated in the open air. In both types of exposure the blast dose was chosen so that unprotected animals would sustain severe lung injuries.

The shock tube used for generation of the long duration shock waves is shown in Figure 1. It consists of two steel tubes joined together by a conical section, in which the high explosive charge is inserted. The charge is placed 0.25 m from the narrow distal end of the conical section, and consequently the distance from the charge to the test object is about 5.75 m. The proximal, test site end of the shock tube can be completely closed by means of a heavy end plate of steel, which is operated by a pinion and firmly locked to the tube by means of a bayonet socket. The surface of the end plate turned to the charge was covered with a 30 mm thick wooden disk. Along the horizontal diameter of this disk a shallow metal groove was mounted. In this groove the experimental animal was placed on its left side on a 2 mm thick sheet of rubber and restrained by means of soft strings. Thus, the right side of the animal was facing the charge.

Cylindrical charges of TNT were used. The weight of the charge was 50 g in all experiments except a few control experiments with 20 g charges. The charge was ignited by means of an electric blasting cap containing 0.7 g TNT and 0.3 g lead azide and lead trinitroresorcinate.

The major characteristics of the shock wave load are shown in Figure 2. In this figure, curve 1 represents the pressure-time pattern obtained at the bottom surface of the groove. Curve 2 is a pressure-time diagram obtained at a distance of 4 cm above the bottom of the groove, corresponding fairly well to the midpoint of the animal, and curve 3 at a height of 8 cm from the bottom. Curve 4, finally, is the pressure-time pattern recorded with a gage fixed to the front surface of a rabbit, *i.e.* the surface facing the charge.

The short duration shock wave studies, for which 68 animals were used, were performed in the open air

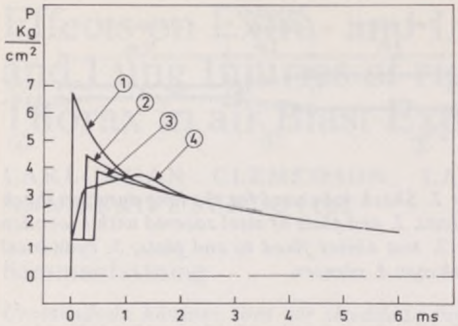

Figure 2. Important features of the loading characteristics at end plate of shock tube. Weight of charge 50 g. 1. at bottom of the groove; 2. 4 cm in front of bottom of the groove or near mid point of the rabbit; 3. 8 cm in front of bottom of the groove or near front surface of the rabbit; 4. at front surface of the rabbit.

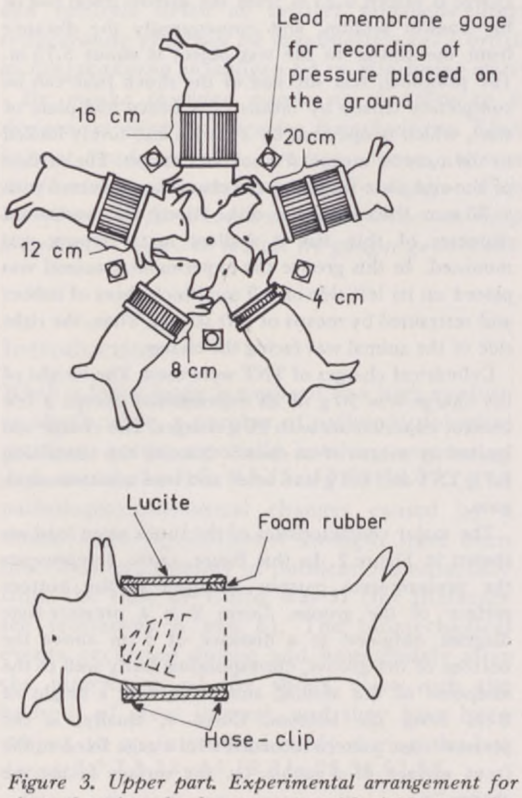

Figure 3. Upper part. Experimental arrangement for short duration shock wave tests with rigid protection of the thorax. Lower part: Cross section of protective device of lucite adapted to thorax of a rabbit.

with the animals lying on a plain ground covered with a layer of fine gravel. The animals, usually five in each experiment, were lying unrestrained on their left side on a piece of canvas and arranged radially in a circle around the vertical line through the center of the charge (see Figure 3). The canvas layer was used in order to minimize the throwing up of gravel and dust by the blast wave, thus improving the conditions for high speed photography, and also providing a certain protection of the experimental set-up.

In these experiments spherical charges of hexotol, consisting of 60 per cent hexogene and 40 per cent TNT, were used. The charge, which weighed 8 kg in all experiments, was suspended in a steel wire with its center 3.9 m above the ground. The charge was ignited by means of a blasting cap of the same type as those used in the shock tube experiments.

Protective devices

Two different types of protective materials were used in these experiments, one of which can be characterized as rigid protection and one as soft protection.

Rigid protection

The experiments with rigid protective materials, for which 138 animals were used, were performed with long duration as well as with short duration shock waves. The experiments with soft protective material for which 38 animals were used, were performed with shock wave loads of long duration only.

The materials used in the rigid protective devices were steel and lucite. For the shock tube experiments, the protective units were made of the same type of steel tube as that used for construction of the groove in which the experimental animal was fixed on the end plate of the shock tube (Figure 4).

Five different lengths of protective device were used, *viz.* 4, 8, 12, 16 and 20 cm. The two ends of the device were partly closed by end plates of lucite in which a part had been cut away in order to fit the curvature of the body of the animal. The openings of the end plates were equipped with collars of plastic material. In this way a good tightness was assured even during the deformation of the animal body which occurs during the exposure to the shock wave. With the animal laying in the shallow groove, the protective device, which consisted of two thirds of the circumference of the steel tube, was fitted to the groove over the thorax and clamped to the groove and to the end plate of the shock tube. Thus the groove and the protective device together constituted the total circumference of a tube.

Since the lungs are the most vulnerable organs to air blast load next to the ear drums, the primary interest in this investigation has been to study the effectivity of the various protective materials in preventing or reducing lung damage. The rigid protective device was placed over the thorax with its proximal end just cranial to the first rib. In order to test the effects of partial shielding of different parts of the lungs, a series of experiments also was performed in which the 4 cm protective device was placed over the central or posterior parts of the thorax. The 4 cm protective device in the anterior position covered the thorax to the fourth or fifth rib, the 8 cm protective device to the eighth or ninth rib, and the 12 cm protection covered the whole chest and the uppermost part of the abdomen. The largest protective devices of 16 and 20 cm length, in addition to the thorax, also offered protection to a large part of the abdomen.

In a series of experiments in the open air, protective devices similar to those used in the shock tube experiments but made of a lighter material such as lucite instead of steel were tested (Figure 3). The lucite tube had an inner diameter of 100 mm and a wall thickness of 5 mm. The same five lengths of protective devices which were tested in the shock tube experiments, were also used in these experiments. In order to facilitate the application of the protective device on the animal, the tube had been cut into two semicylindrical pieces, which were firmly held together by means of metal hose clips. The ends of the protective device were furnished with collars of foam rubber pasted to the inner surface of the tube in order to fit closely to the animal body without impeding the respiratory movements (Figure 3). The thickness of the collars was adapted to give optimal tightness and it varied between 10 and 20 mm depending on the size of the animal and on the position of the protective device. The same locations of the protective device were used as in the shock tube experiments with the exception that the 4 cm protective device was tested only in the anterior position on the thorax.

Soft protection

In these experiments the protective devices were made of plastic foam and sponge rubber. Plastic foam material of two different thicknesses were used, viz. 50 mm and 200 mm. The sponge rubber had a thickness of 20 mm. The animals were lying restrained in the shallow groove as described earlier (Figure 5). In these experiments, however, the whole body of the animal was covered by the protective material, which was restrained and tightened to the end plate of the shock tube. In this way, the shock pressure could reach the animal only through the protective material.

A few experiments with soft protection were performed in the open air. In some of these experiments the

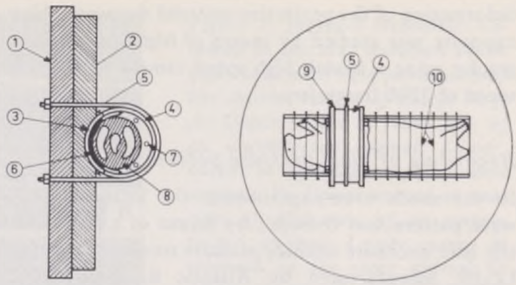

Figure 4. Experimental arrangement for long duration shock wave tests with rigid protection of the thorax. Left: cross section. Right: facing the charge. 1. end plate of shock tube made of steel; 2. wooden plate fixed to end plate; 3 part of steel tube constituting the shallow groove; 4. part of steel tube constituting the rigid protection; 5. bow-shaped holder for fixation of protective device to the groove and to the end plate; 6. rubber sheet, 2 mm thick; 7. gage point within protective device; 8. experimental animal; 9. end plates made of lucite equipped with collars to fit to the animal and fastened to the steel tube by bolts; and 10. soft plastic string restraint.

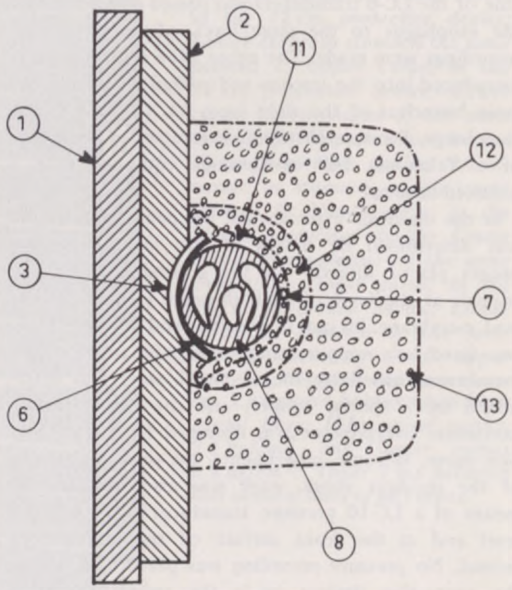

Figure 5. Cross section of experimental arrangements for long duration shock wave tests with soft protection of the trunk. 1.—3. and 6.—8. denote the same as in Fig. 4; 11.—13. soft protective device; 11. of 20 mm foam rubber; 12. of 50 mm plastic foam; and 13 of 200 mm plastic foam.

deformation of the protective material during the blast exposure was studied by means of high speed photography using a Kodak high speed camera with a film speed of 3000 frames/sec.

Recording of blast pressure pattern

In the shock tube experiments, the incident shock wave pattern was recorded by means of a piezo-electric lead zirconate titanate pressure transducer of type LC-10, manufactured by Atlantic Research Corp., Costa Mesa, California, USA. In the experiments with rigid protection, air shock wave load was recorded both at the front surface of the unprotected part of the abdomen and in the protective device. In some of the soft protection experiments, the shock wave pressures were recorded on the body surface of the animal under the protective material.

The pressure patterns in the thorax or abdomen of the experimental animal were also recorded by means of a LC-10 transducer. The transducer was introduced into the esophagus and passed down to the level of the middle part of the lungs or to the stomach. In some experiments two miniature pressure transducers of type LC-6 (Atlantic Research Corp.), were used simultaneously in the thorax in order to compare the pressure patterns in the esophagus and in the lungs. One of the LC-6 transducers was passed down through the esophagus to the same level, where the LC-10 recordings were made. The other LC-6 transducer was introduced into the trachea and passed down into the main bronchus of the right lung, *i.e.* the lung facing the charge. Pressure patterns were recorded by means of a Tektronix 565 oscilloscope equipped with a polaroid camera.

In the open air experiments, the peak overpressure was determined by means of five lead membrane gauges placed directly on the ground between the animals at the level of their thoraces (Figure 3). The lead membrane, 20 mm in diameter and 0.4 mm thick, was fixed in a copper frame. The indentation of the membrane caused by the air shock wave was determined by a special caliper, and the corresponding maximum overpressure was obtained from a calibration curve. In some experiments, the pressure pattern of the incident shock wave was also recorded by means of a LC-10 pressure transducer at the ground level and at the front surface of the unprotected animal. No pressure recording was performed within the protective devices or in the animals in these experiments.

Determination of the blast injury

Thirty minutes after the blast exposure all surviving animals were sacrificed by an intravenous injection of a barbiturate (Narkotal Astra) and autopsied. Each lung was weighed separately after careful removal of the trachea and bronchi. The degree of lung injury was expressed as the quotient (LQ) between the weight of the injured lung, which is increased due to hemorrhages, and the calculated normal weight of the same lung according to Clemedson[4]. The lung injuries were classified into three groups, namely LQ $<$ 1.2 = no or slight injury; LQ = 1.2–1.5 = moderate injury; and LQ $>$ 1.5 = severe injury[4]. The abdominal injuries were subjectively classified into three groups, *viz.* slight, moderate and severe. Petechiae and small superficial hemorrhages were classified as slight injury, and more extensive hemorrhages as moderate. Gut perforations, liver ruptures, etc. were classified as severe injuries.

Results

The results of this investigation will be presented from the basic assumption that the pressure pulses recorded in the animal's body truly represent the stress situation and, therefore, also the risk of damage to the organism, especially to the lungs and other thoracic organs and to the abdominal organs. The pressure records were analysed according to Figure 6 by means of a graphical method, and the degree of blast injury was related to the values of the parameters so determined. Examples of the pressure recordings are presented in Figures 7 and 8. The results based on the analyses of the recordings are presented in Figures 9–15. The bars in most cases represent mean values of experiments with five to ten animals. However, the groups of animals, in which pressure was recorded in the stomach

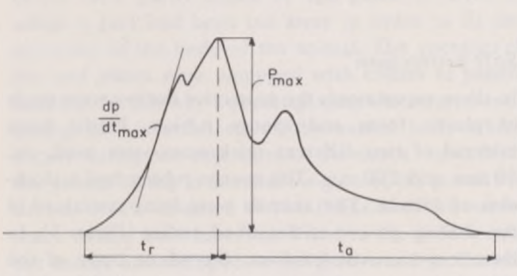

Figure 6. General profile of a pressure pulse recorded, and the parameters determined. P_{max} = peak pressure in kg/cm^2; t_r = rise time to peak pressure in ms; P_{max}/t_r = average rate of pressure rise; dp/dt_{max} = maximum rate of pressure rise of P_{max}; t_a = time for return of pressure to atmospheric level.

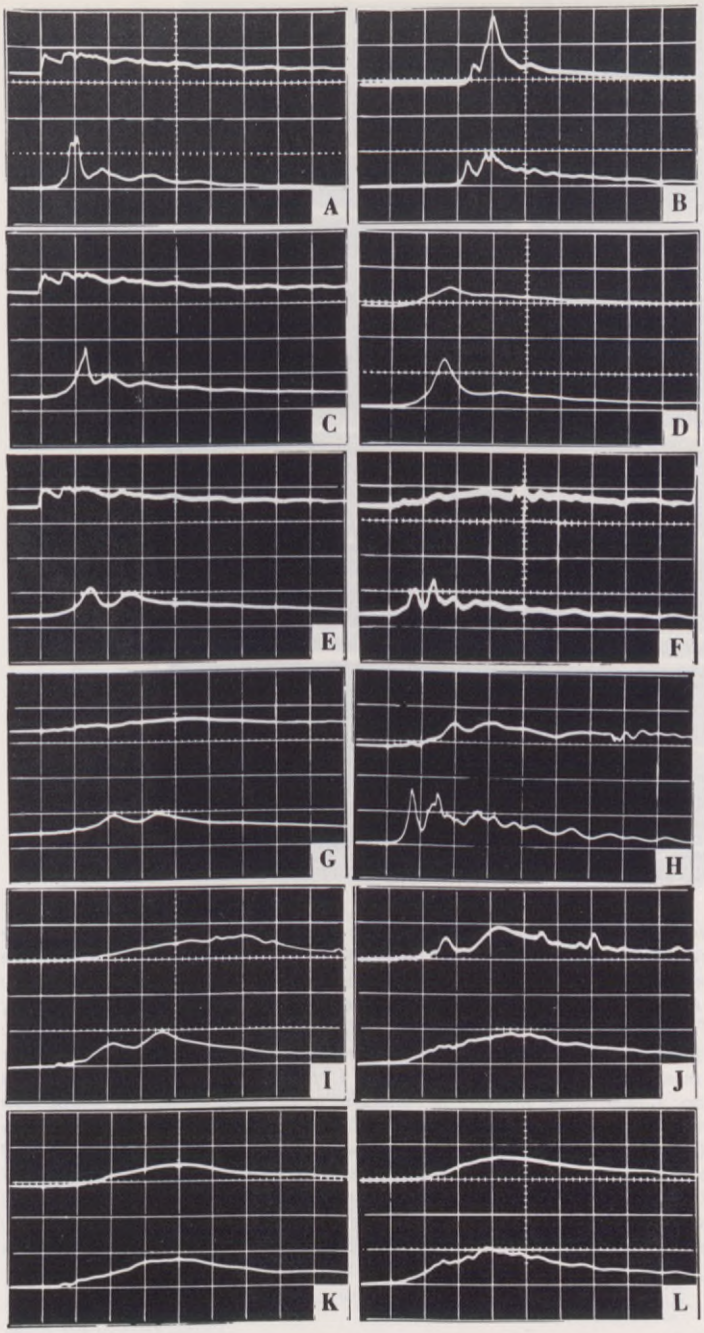

Figure 7. Pressure recordings obtained in the long duration shock wave tests with rigid protection of the thorax. Weight of charge 50 g. A: Upper curve: at front side of an unprotected animal; Lower curve: in esophagus of the same animal; B: Upper curve: at rear side of abdomen of an unprotected animal; Lower curve: in stomach of the same animal; C: Upper curve: at front side of a protected animal; Lower curve: in esophagus of the same animal with 4 cm protective device in central position; D: Upper curve: in the 4 cm protective device; Lower curve: in esophagus of the same animal with 4 cm protective device in central position; E: Upper curve: at front side of a protected animal; Lower curve: in the esophagus of the same animal with 8 cm protective device; F: Upper curve: in 8 cm protective device; Lower curve: in stomach of the same animal; G: Upper curve: in the 12 cm protective device; Lower curve: in esophagus of the same animal; H: Upper curve: in the 12 cm protective device; Lower curve: in stomach the same animal; I: Upper curve: in the 16 cm protective device; Lower curve: in esophagus of the same animal; J: Upper curve: in the 16 cm protective device; Lower curve: in stomach of the same animal; K: Upper curve: in the 20 cm protective device; Lower curve: in esophagus of the same animal; L: Upper curve: in the 20 cm protective device; Lower curve: in stomach of the same animal. Sensitivity: *A–G: upper curves 6.2 kg/cm^2 and lower curves 5.9 kg/cm^2 between two horizontal lines; H-L: upper curves: 3.1 kg/cm^2 and lower curves 2.9 kg/cm^2. Time: 1 ms between two vertical lines in all curves.*

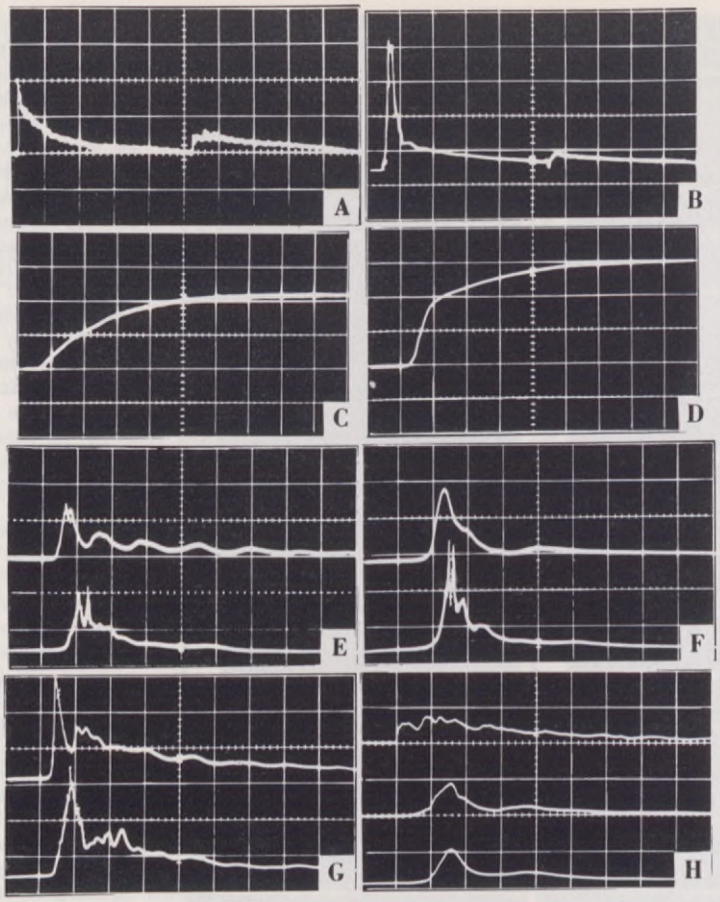

Figure 8. Pressure and impulse recordings obtained in a long duration shock wave test with soft protection of the trunk. Weight of charge 50 g, unless otherwise stated. Curves A–G recorded with LC–10 transducer. A: pressure at bottom of the groove; B: pressure at bottom of the groove covered with 200 mm thick plastic foam; C: impulse at bottom of the groove; D: impulse at bottom of the groove covered with 200 mm thick plastic foam; E: Upper curve: pressure at front of an animal under soft protection of 20 mm foam rubber; Lower curve: pressure in esophagus of the same animal; F: Upper curve: pressure at front of an animal under 200 m thick plastic foam; Lower curve: pressure in esophagus of the same animal; G: Upper curve: pressure at front of an animal under 50 mm thick plastic foam; Lower curve: pressure in esophagus of the same animal; H: comparison of pressures in front lung and in esophagus. Weight of charge 20 g. Upper curve: pressure at front of an unprotected animal recorded with LC–10 transducer; Middle curve: pressure in front lung of the same animal recorded with LC–6 transducer; Lower curve: pressure in esophagus of the same animal recorded with LC–6 transducer. Sensitivity: *A and B: 3.1 kg/cm^2 between two horizontal lines; C and D: 6.2 $gfsec/cm^2$; E and F: upper curve 6.2 kg/cm^2 and lower curve 5.9 kg/cm^2; G: upper curve 3.1 kg/cm^2 and lower curve 2.9 kg/cm^2; H: upper curve 3.1 kg/cm^2; middle curve 6.0 kg/cm^2 and lower curve 6.3 kg/cm^2.* Time: *A and B: 5 ms between two vertical lines; C and D: 2 ms; E, F, G and H: 1 ms.*

comprised three to four animals only, whereas in some of the experiments with unprotected animals and with animals protected with the 4 cm rigid protective device the number of animals in the group exceeded ten.

Figures 9–15 are presented according to the following disposition:

A. Long duration experiments
   a. Rigid protection
      1. External and internal pressures (Figure 9)
      2. External pressures and lung injury (Figure 10)
      3. Internal pressures and lung injury (Figure 11)
   b. Soft protection
      1. External and internal pressures and lung injury (Figure 12)
   c. Comparison of the effects of the rigid and soft protective devices (Figure 13)

B. Short duration experiments with rigid protection
   a. External pressures, weight of protective device and lung injury
      1. Large rabbits (2.5–3.2 kg) (Figure 14)
      2. Small rabbits (2.1–2.4 kg) (Figure 15)

Long duration shock wave experiments

Figure 9 shows that the maximum external pressure, P_{max}, recorded within the rigid protective devices close to the front side of the chest wall of the rabbit, was only about 20 per cent lower than the corresponding P_{max} recorded at the front side of an unprotected animal. This comparatively small reduction of the maximum pressure acting on the thorax apparently cannot be the only reason for the remarkable reduction in lung damage which occurred in all the experiments with the rigid protection. Other factors such as the increase of the rise time of the external pressure pulse also must be involved. This factor will be discussed later on in this paper.

Figure 9 also demonstrates that the P_{max} values recorded within the thorax were considerably higher than the corresponding P_{max} values of the incident shock wave. Thus, in the unprotected animals and in the animals with the 4 cm protective device, the P_{max} recorded in the esophagus was 2 to 2.5 times higher than the P_{max} of the incident shock wave. Only when the protective devices with a length exceeding 8 cm were used, the P_{max} within the thorax was reduced to a value that was slightly lower than that of the incident shock wave. A similar increase in the internal P_{max} as compared to the P_{max} of the incident shock wave was found in the abdomen. The P_{max} values recorded in the thorax, however, were considerably higher than the P_{max} recorded in the abdomen (see Figure 9). Finally, it is also evident from Figure 9 that the length of the rigid protective device must exceed 12 cm in order to bring about an appreciable reduction of the P_{max} in the abdomen.

Figure 10 shows that a rigid protective device with a length of 8 cm or more, in addition to the slight reduction of the external, *i.e.* the incident P_{max} acting on the thorax, also causes an appreciable decrease in the average rate of pressure rise. The increase in the rise time of the front of the incident shock wave from a small fraction of a millisec to about 3 millisec or more definitely seems to be associated with the reduction of the thoracic injuries caused by

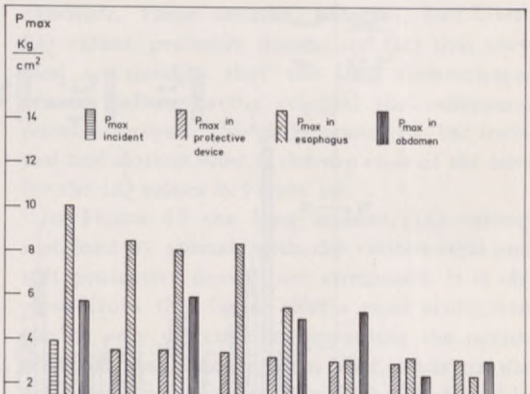

Figure 9. Mean values of external and internal pressures obtained in the long duration shock wave tests with rigid protection of thorax. Weight of charge 50 g. Position of 4 cm protective device: A. anterior, C. central, and P. posterior.

the shock wave. It is also evident from Figure 10 that such a small rigid protective device as the 4 cm one, which only covered about two thirds of the underlying lungs, reduced the lung injuries from severe in the unprotected animals to moderate in the protected ones, provided that the protection covered the central part of the thorax (Figure 10, position 4C). If the protective device is located at the anterior (position 4A) or posterior (position 4P) parts of the thorax, the lung injuries may instead be increased. This seems to be true especially for the posterior position (position 4P). The 8 cm protection reduces the resulting lung injuries from severe injuries in the unprotected to slight or no injuries. The 12, 16 or 20 cm protective devices do not seem to afford any additional protective effect as compared to that of the 8 cm protective device as far as lung damage is concerned. On the other hand, a greater length of the protective device will favourably influence the pressure pattern in the abdomen and thereby reduce the risk of abdominal injuries. A slight increase in the lung hemorrhage quotients was observed in experiments with the 12, 16 and 20 cm protective devices as compared to those obtained with the 8 cm protection.

In Figure 11 the blast produced lung injuries are related to the thoracic P_{max} values recorded. Of special interest are the values of dP/dt_{max} corresponding to the anterior, central and posterior positions of the 4 cm protective device. The P_{max} values recorded in the esophagus do not differ very much for these three different position. Also the average rate of increase in pressure in the esophagus is almost equivalent for the three positions, but the increased lung injuries produced with the protective devices in the anterior and prosterior positions seem to be more closely correlated to the maximum steepness, dP/dt_{max}, of the leading part of the pressure pulse. These dP/dt_{max} values, which have been derived from differentiations of fractions of pressures that amounted to at least 50 per cent of the recorded peak value, however, are uncertain and, therefore, should be regarded only as rough estimations. This uncertainty originates from the difficulties in interpreting the curves, especially the recordings of the steepest pulses, in

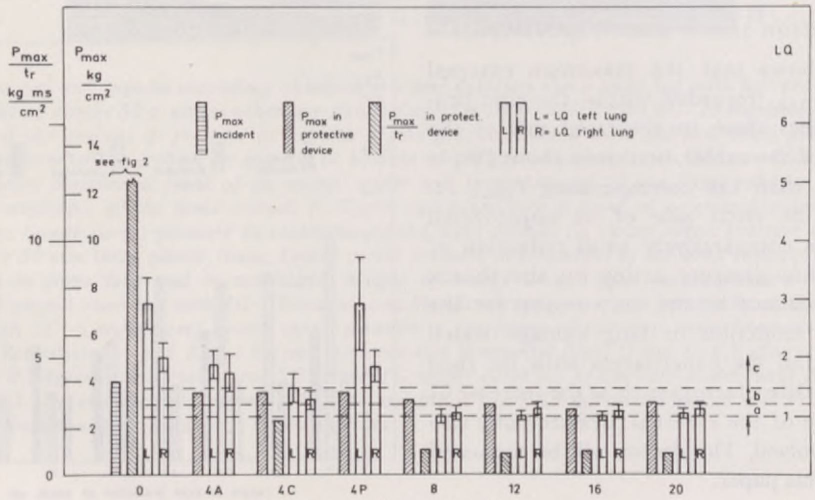

Figure 10. Mean values of external pressures and lung injuries obtained in the long duration shock wave tests with rigid protection of thorax. Weight of charge 50 g. Position of 4 cm protective device: A. anterior; C. central and P. posterior. Dashed horizontal lines indicate degree of lung injury: a. no or slight; b. moderate and c. severe injury.

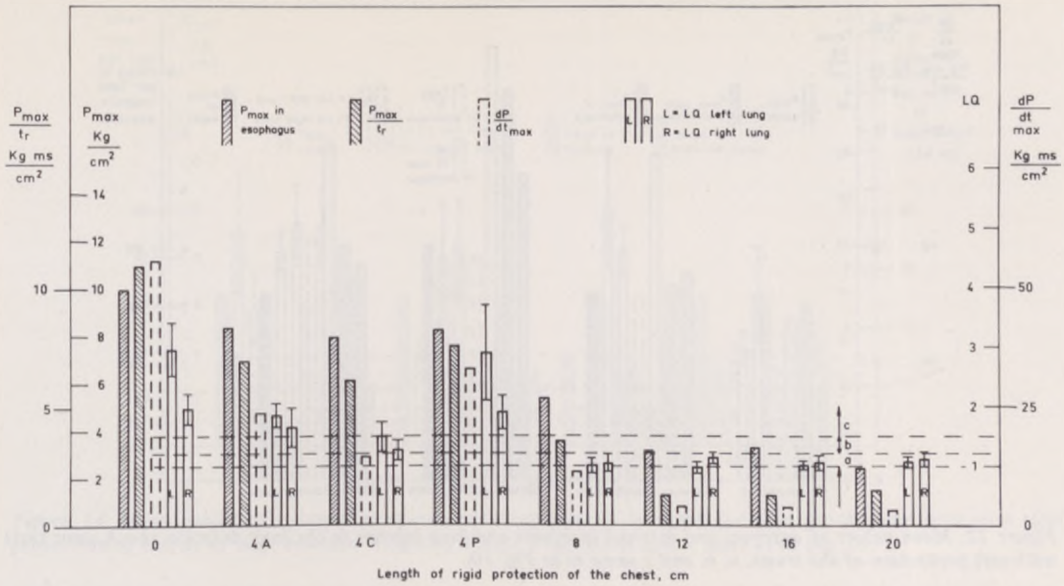

Figure 11. Mean values of esophageal pressures and lung injuries in the long duration shock wave tests with rigid protection of thorax. Weight of charge 50 g. A, C, P and a, b, c same as in Fig 10.

which the rise times are very short. The general tendency, however, seems to be that a protective device, which decreases the steepness of the pressure pulse in the thorax may have a good protective effect, even if the reduction of the maximum pressure is only insignificant.

In Figure 12 the results of the experiments with whole body soft protection are presented. The most striking feature is that soft protections of the kinds used in the present investigation offer no protection at all. On the contrary, the lung injuries are strongly aggravated in the protected animals as compared to the unprotected ones exposed to the same blast load. Most values of the parameters determined which are considered critical for the damage, are considerably increased as compared to the corresponding values obtained in unprotected animals and even more so, when compared to the values obtained in the experiments with rigid protection. For the kind of plastic foam used, a thicker protective layer (200 mm) caused more severe injuries than a thinner one (50 mm). All animals equipped with the thicker plastic foam protection died almost immediately after the exposure. These animals, however, had lower LQ values, probably due to the fact that they died so quickly that the lung hemorrhages ceased before having reached the maximum possible extent. This is indicated by the inclined and dotted lines at the top ends of the bars for the LQ values in Figure 12.

In Figure 13 the lung injuries (LQ values) sustained by animals with the various rigid and soft protective devices are compared. It is obvious from this figure that a rigid protection can be very effective in preventing the occurrence of lung damage from blast, while on the other hand a soft protection of the kind used in this investigation evidently increases the risk of such damage considerably. This is furthermore emphasized by the fact that more than 80 per cent of the animals protected by the soft material were killed by the blast wave and mostly died outright. A rigid protection located over the thorax and having a length of 8 cm or

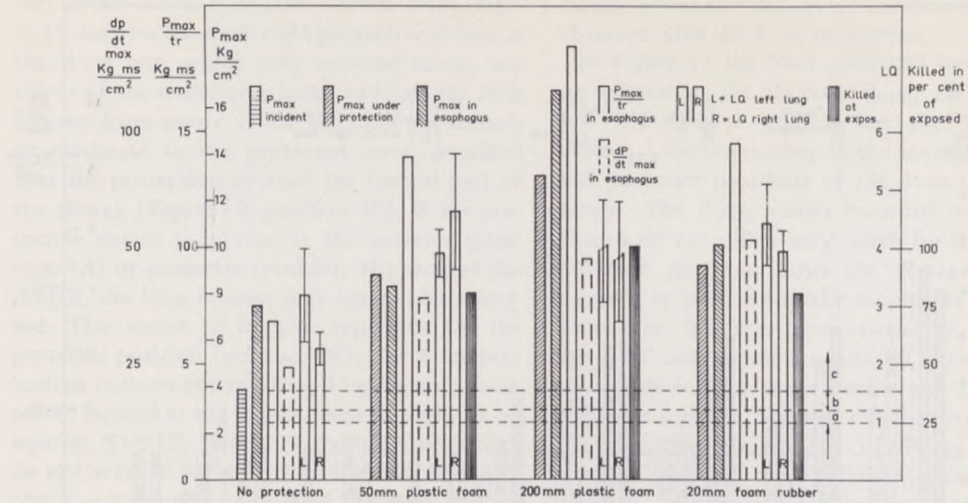

Figure 12. Mean values of external and internal pressures and lung injuries in the long duration shock wave tests with soft protection of the trunk. a, b, and c same as in Fig. 10.

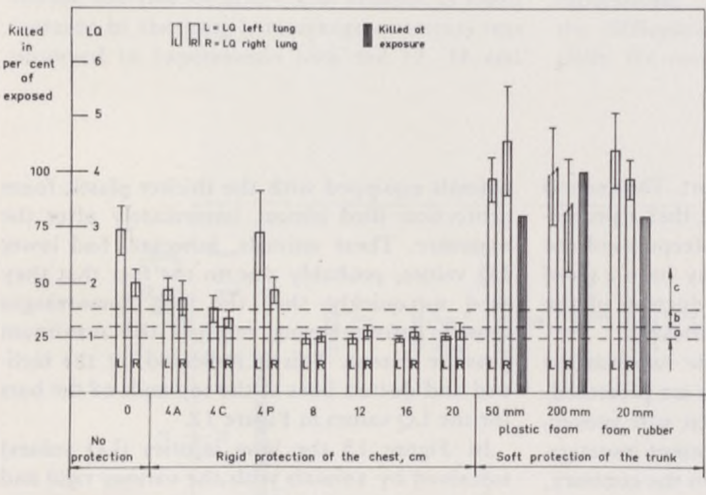

Figure 13. Comparison of the effects of rigid and soft protection in the long duration shock wave tests with large animals. Weight of charge 50 g. A, C, P and a, b, c same as in Fig. 10.

about one fifth of the body length of a rabbit can reduce an otherwise fatal blast exposure to a safe level.

Short duration shock wave experiments

Figure 14 shows the effects of rigid protection in experiments with large rabbits exposed to shock waves of short duration. In these experiments, the 4 cm protective device was insufficient to prevent the occurrence of severe blast injury. This protective device on the contrary seemed to increase the effect of the shock wave slightly, at least when placed over the anterior part of the thorax, which was the only position tested in the short duration experiments. As in the long duration experiments, a rigid protection 8 cm in length was much more effective, and the 12 cm protective device was found to be effective enough to prevent almost entirely

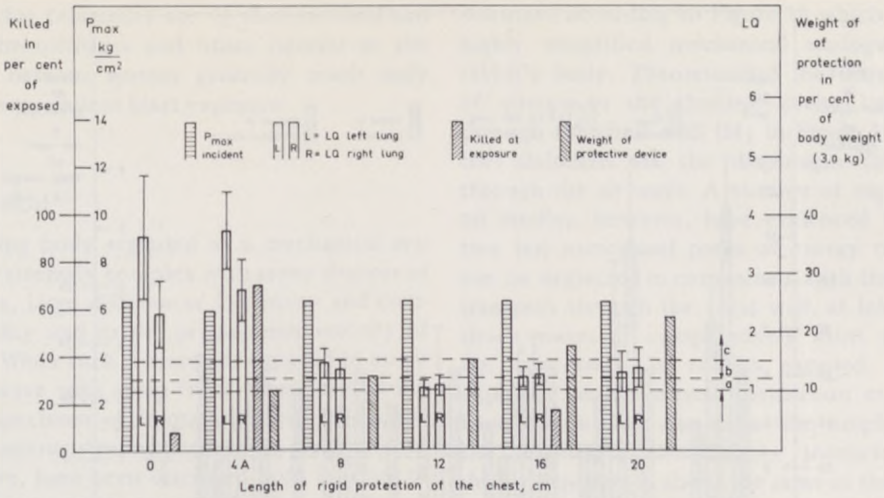

Figure 14. Mean values of external pressures and lung injuries in short duration shock wave tests with rigid protection of thorax of large animals. Weight of charge 8 kg. A and a, b, c same as in Fig. 10.

the occurrence of lung blast injuries. Also in the short duration experiments, the lung injuries sustained by animals equipped with a 16 or 20 cm protective device were slightly more pronounced than the injuries found in animals with the 12 cm protection.

Figure 14 also shows that less than 10 per cent of the unprotected animals died at the exposure, and that 70 per cent of the animals equipped with the 4 cm protective device died of their blast injuries. No animals with the 8, 12 or 20 cm protective device died, and only one out of 5 animals equipped with the 16 cm protection died at the exposure. Although it was not intended in this investigation to reduce the weight of the protective device to a minimum, it is evident that a rigid protection weighing only about 12 per cent of the body weight may reduce the effects of an otherwise fatal blast exposure to a probably safe level. A further increase in the length of the protective device and a corresponding increase of its weight to about 15 per cent of the body weight, almost completely eliminates the effects of the blast wave on the thorax, and prevents the occurrence of any visible lung damage.

Figure 15 shows the results of rigid protection in small rabbits exposed to short duration blast waves. The protective devices used for these experiments were exactly the same as those in the experiments with the large animals. This means that the protective devices which had been designed for the large animals, did not fit the small ones so well. This is probably the reason, why injuries could not be prevented to the same extent in these experiments. The greater susceptibility of smaller animals, which has been demonstrated by earlier investigators[38,39] and which is evidenced in the present investigation by the higher LQ values of the unprotected small animals, may have contributed to the more extensive lung injuries in these animals. Although the protective effect of the rigid devices was insufficient to prevent the occurrence of blast injuries completely, a considerable reduction of the lung injuries was achieved also in this case.

Abdominal and head injuries

Although the main objective of this investigation was to study the prevention of lung blast injuries all animals were also carefully inspected for occurrence of any abdominal and head injuries. These injuries are presented in Table 1. From this table it is evident that the abdominal injuries show a more irregular pattern than the lung injuries, and that there is no clear-cut

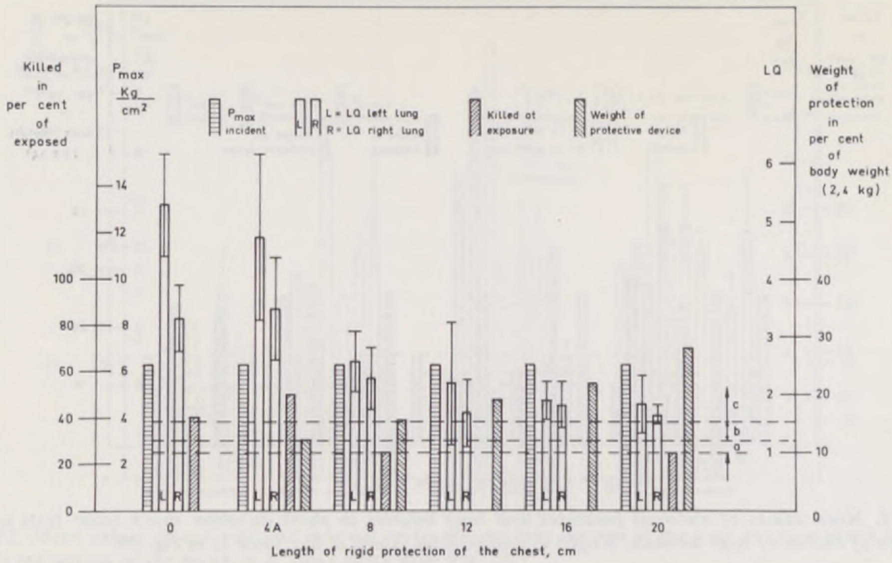

Figure 15. Mean values of external pressures and lung injuries in short duration shock wave tests with rigid protection of thorax of small animals. A and a, b, c same as in Fig. 10.

Table 1. Abdominal injuries in per cent of the total number of animals exposed. Mod = moderate; Sev = severe.

Rigid protection of thorax, length in cm	Large animals								Small animals							
	Intestines				Kidney, liver, spleen, etc				Intestines				Kidney, liver, spleen, etc			
	No	Slight	Mod	Sev	No	Slight	Mod	Sev	No	Slight	Mod	Sev	No	Slight	Mod	Sev
Unprotected	15	54	8	23	70	30	0	0	20	60	20	0	100	0	0	0
4 (anterior)	0	67	33	0	83	17	0	0	0	50	50	0	100	0	0	0
8	17	50	33	0	100	0	0	0	9	25	75	0	100	0	0	0
12	0	100	0	0	100	0	0	0	0	50	50	0	100	0	0	0
16	17	50	33	0	100	0	0	0	0	75	25	0	100	0	0	0
20	83	0	17	0	100	0	0	0	50	50	0	0	100	0	0	0

relationship between the degree of blast exposure and the severity of these injuries. As far as the abdominal injuries are concerned this is due among other things to the well known fact that abdominal blast injuries varies greatly due to the gas content in the intestinal tract.

Although the number of animals used is to small to draw any definite conclusions it can be inferred from the data in Table 1 that a certain protective effect was afforded also for the abdominal organs. Thus none of the animals equipped with protective devices 8 cm or longer sustained any injury of the liver or other parenchymatous abdominal organs, and only one suffered intestinal injuries which could be classified as severe. Of the animals equipped with the 20 cm protection, 83 per cent of the larger animals and 50 per cent of the smaller animals sustained no abdominal injury at all. These figures should be compared with the 15 per cent and 20 per cent, respectively, for the unprotected animals. From Figure 9 it is evident that the 16 and 20 cm protective devices caused a reduction of the peak pressures in the abdomen as compared with those in the unprotected animals.

Since the tympanic membrane is highly susceptible to damage by blast, ruptured ear drums were observed in practically all blast exposed animals in this investigation. No visible brain injuries were observed. It is known from earlier studies in our laboratory and by other investigators (for references see 6) that cerebral and spinal hemorrhages and other injuries to the central nervous system generally result only from a very violent blast exposure.

Discussion

The living body regarded as a mechanical system is extremely complex with many degrees of freedom, large differences in density and compressibility and in the propagation velocity of sound. When such a system is exposed to an air shock wave with steep front, vibrations with a broad spectrum of frequencies will be excited in the various structural elements. Such effects, therefore, have been discussed both in terms of wave propagation in continually distributed masses and of lumped parameter systems. During the last decade a number of theoretical and experimental investigations concerning the effects of blast load have been published[2,3,26,28], in which the thoraco-abdominal system has been considered as a lumped parameter system. The chest wall for instance has been assigned a certain effective lumped mass, and the lungs have been considered as nonlinear air springs.

The transmission of the mechanical energy of the air shock wave to the thoracic cavity in unprotected and in protected animals will be discussed according to Figure 16 which shows a highly simplified mechanical analogue of a rabbit's body. Theoretically, the transmission of energy to the thoracic cavity can occur through the chest wall (M_1 in Figure 16), from the abdomen via the diaphragm (M_2) and through the air ways. A number of experimental studies, however, have evidenced that the two last mentioned paths of energy transport can be neglected in comparison with the energy transport through the chest wall, at least when shock waves of comparatively short duration are concerned. In rabbits exposed to high explosive shock waves, Clemedson et coll.[28] have shown that the deflection amplitude of the diaphragm towards the thoracic cavity during exposure is about the same as that of the inward deflection of the chest wall. The velocity (v_2 in Figure 16) of the diaphragm, on the other hand, is only about one tenth of the velocity (v_1) of the chest wall. This means that the peak pressure in the thoracic cavity is attained long before any appreciable movement of the diaphragm has occurred. In a theoretical model of the response of the thoracic system to air shock waves discussed by Bowen et coll.[2] the possible effects of diaphragm motion and transfer of pressure through the trachea were taken into account, but in a later study[3] the effect of diaphragm motion was excluded.

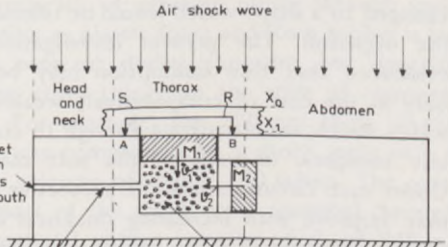

Figure 16. Mechanical analogue of a rabbit's body. Model composed of elements simulating parts of the body structure regarded to be of primary importance in the mechanical response to air blast load. M_1 piston simulating parts of the chest wall covering the lungs with a lumped, effective mass m_1; M_2. piston simulating the diaphragm and parts of the abdominal content forced into the thoracic cavity during exposure, with a lumped effective mass m_2; S. part of soft protection; R. rigid protection.

During exposure to severe blast, a considerable transient deformation of the thorax occurs. Thus, a decrease of the lateral width of the thorax of about 40 per cent has been recorded in rabbits exposed to air shock waves from spherical charges of 32 kg hexotol detonated in the open field (Jönsson 1967, unpublished experiments). This is in contrast to some earlier assumptions that the mechanical processes in a living body during air blast exposure seem to take place without any appreciable deformation of the body as a whole[1].

The large deformations of the thorax suggest that the chest does not react like a rigid mass but behaves more like a dynamic system when exposed to air shock wave load. This idea is also supported by the remarkably high peak pressures recorded in the thorax of rabbits[2,28]. The peak pressure may amount to several times the incident pressure acting on the chest wall.

Since also the present investigation supports the idea that the chest wall is the main way of transfer of shock wave energy to the intrathoracic structures, it seems justifiable to discuss the thoracic region as a lumped parameter system mainly based on the chest wall and the lungs. Furthermore, it can be assumed that the comparatively low frequency oscillations of the thorax associated with the large inward deflections of the chest wall and the corresponding compression of the lungs, are the main cause of the damage to the lungs and other intrathoracic organs. Any protective method, therefore, should aim at a reduction of these low frequency oscillations and the associated dangerous inward deflections of the chest wall.

Individual portable protective devices may reduce the effects of a shock wave either (1) by distribution of the acting forces to areas or parts of the body which are less susceptible to the damaging effects of the shock wave (A and B in figure 16) and/or to a supporting structure outside the organism (e.g. when lying on the ground), or (2) by changing the pressure-time pattern of the incident wave to a form which is more tolerable to the organism. The rigid protective devices used in this study belong to category (1) and the soft protective devices to category (2).

The essential effect of a rigid protection over the thorax is to prevent the incident shock wave from acting directly on the chest wall, and thereby to reduce or eliminate the dangerous inward deflection of the chest wall which is assumed to be the chief factor in the production of lung blast injury.

It has been demonstrated earlier in experiments[28] with rabbits equipped with rigid protective devices of the chest of the same basic construction as those used in this investigation that no significant inward deflection of the chest wall over the lungs is likely to occur during air blast load of the strength and duration tested. A significant outward movement of the chest wall was, however, recorded. Thus, a rigid protective device may not only prevent from the dangerous inward deflection of the chest wall, but may also provide for an expansion of the thoracic cavity. This expansion, which mainly will be caused by the motion of the abdominal contents towards the thorax, during exposure can be anticipated to lower the peak pressure in the lungs and thereby to reduce the resulting injury. Recalling what was mentioned earlier in this discussion it can be assumed, however, that an expansion of the protected thorax caused by the pressure acting on the abdomen, is not likely to influence the production of lung injuries significantly. It has been demonstrated earlier[34] that the resulting lung blast injury is remarkably dependent on certain characteristics of the incident shock wave in addition to its peak pressure and impulse. Such significant factors are for instance the steepness of the shock wave front and the time interval between two consequtive pressure pulses[34]. The effect of a change of the steepness of the shock front is demonstrated in the present investigation, especially in the experiments with the 4 cm rigid protective device. This protection caused no significant reduction of the peak pressure in the thorax, but the steepness of the leading part of the pressure pulse was diminished, and the lung damage as reflected by the LQ values was reduced from a probably fatal level to a moderate injury.

The general theory underlying the use of a soft, compressible material as individual protection against air shock waves is that such a material will disperse and dissipate the energy of the shock wave and thereby reduce the reflection pressure and the steepness of the pressure pulse significantly. Thus, the pressure-time pattern of the incident wave will be changed to a shape which would be tolerable to the organism. The present investigation has evidenced that this assumption may be true only in the case of comparatively weak shock waves which are not strong enough to completely compress or collapse the soft material. Under such circumstances the protective effect may improve with increasing thickness of the protective material. If the shock wave is strong enough to completely compress the plastic foam or foam rubber, these materials used as protective devices will produce an increased loading effect and will, therefore, be highly dangerous to the organism. This will be discussed further below.

The biophysical events occurring when a high explosive shock wave interferes with such a complex system as a living body is difficult or impossible to calculate, and the interposition of

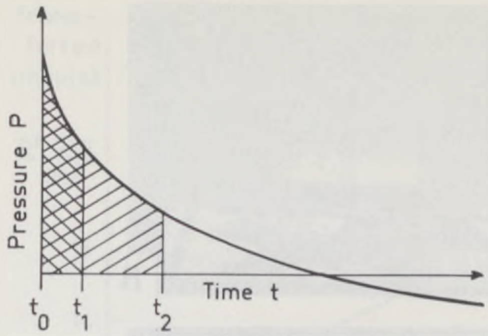

Figure 17. Idealized diagram of air blast load on a body. Crosshatched area corresponds to a partial impulse delivered to the chest of an animal during a critical period of time from the arrival of the shock wave at front of the animal to the occurrence of peak pressure in the thorax.

a soft material of the kind used in this investigation increases this difficulty even more. Therefore, no attempts will be made here to analyse this problem in detail. An idealized diagram of a pressure-time record is shown in Figure 17. The incident shock wave is assumed to be of sufficient strength to completely compress or collapse the soft protective material.

Figure 18 which is a sequence of high speed photographs, shows such a compression of a block made of 250 mm thick plastic foam by an air shock wave in connection with the short duration tests in the open field. The transmission velocity of pressure pulses through such materials as plastic foam and foam rubber is far from constant during exposure, but depends among other things on the state of compression. For example, the 200 mm thick plastic foam was compressed by a shock wave with a mean velocity of about 130 m/sec. The very first part of the shock wave travelled through the material with a velocity of about 240 m/sec. Thus the average velocity of propagation in the plastic foam was roughly about one third of the propagation velocity of the incident air shock waves used in this investigation.

Impulse considerations

On account of the very low velocity of wave propagation in the foam in comparison with the velocity in the air and of the high compressibility of the foam an impulse $I_2 = \int_{t_0}^{t_2} P(t)dt$, corresponding to $t = t_2$ in Figure 17, will be trapped in the foam and may be delivered to the chest of the rabbit in roughly the same time as an impulse $I_1 = \int_{t_0}^{t_1} P(t)dt$, corresponding to $t = t_1$ in Figure 17, is delivered to an unprotected animal. When $t_2 \gg t_1$, I_2 may be much larger than I_1, or, in other words, the time scale of the air shock wave has been shrunk by the foam. Since the force is equal to the first derivative of the impulse, and $I_2 > I_1$, then $\frac{d}{dt} I_2 > \frac{d}{dt} I_1$, which means a magnification of the forces generated during the period of interest. Figure 18 shows a partial impulse transmitted to a rigid surface which is uncovered (curve 1 in Figure 18) and covered (curve 2 in Figure 18) with a layer of 200 mm of plastic foam, respectively. A transmission time of 1 ms was chosen, because it has been domonstrated earlier[2,28] that peak pressures in the thorax of a rabbit occur about 1 ms after the arrival of the air shock wave to the chest wall. Consequently, it can be assumed that the partial impulse delivered during this period is strongly correlated to the structural damage in the thorax. This aspect of the question has also been discussed by Bowen et al.[3]. In Figure 19 it can be seen that about 2.5 times as large an impulse is transmitted to the covered as to the uncovered surface during the first millisecond of the transfer time. This trapping effect may also explain the somewhat surprising observation that a thick protective layer of plastic foam may be more dangerous to the organism than a thin layer. One possible explanation for this phenomenon is that a larger impulse is likely to be trapped in a thicker layer of plastic foam than in a thinner one. Rebound effects may also be involved. This possibility, however, will not be further discussed here.

Energy considerations

If energy considerations are applied, a potential energy equal to the work done by the air shock wave in compressing the soft material situated between the space coordinates X_0 and X_1 in Figure 16 will be stored in the foam. On

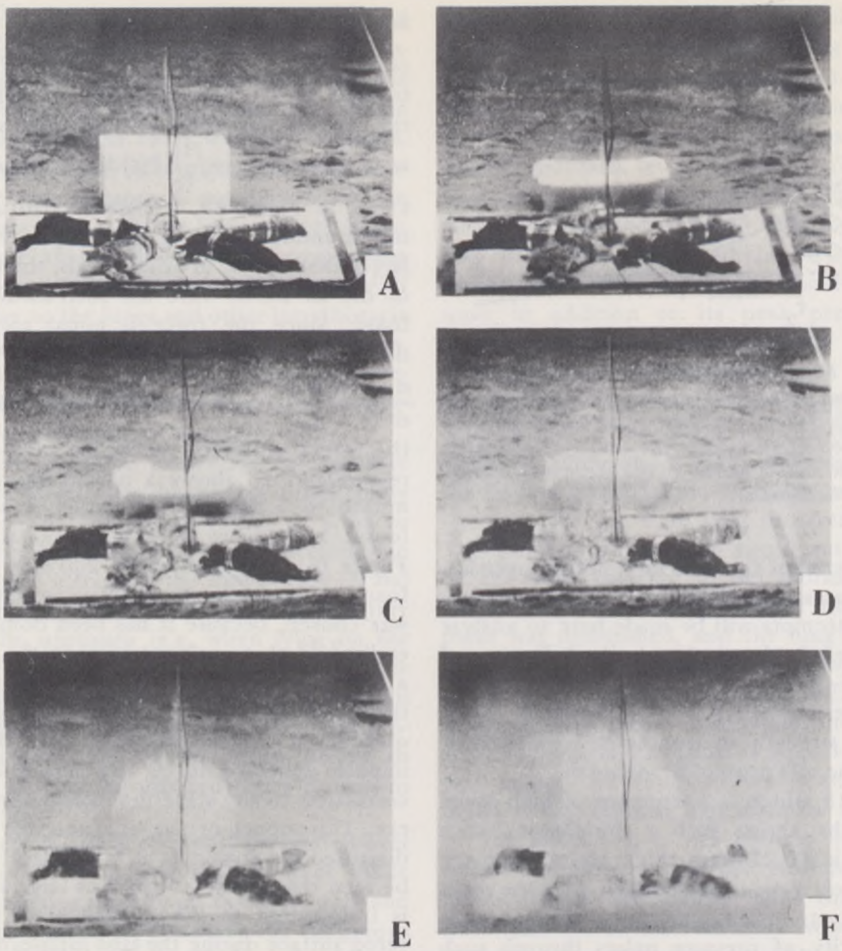

Figure 18. Sequence of pictures obtained with a high speed camera at about 3000 frames/sec showing the compression of a 250 mm thick block of plastic foam in connection with short duration shock wave tests of rigid protection of the thorax. A. before detonation of the 8 kg TNT charge; B—F. after detonation. It should be noted that the moment of maximum compression of the block may not have been recorded.

account of the low pulse velocity and the high compressibility of the foam, the potential energy stored in it may be much larger than the kinetic and potential energy stored in the shock wave occupying the corresponding space between the space coordinates X_0 and X_1 in free air. Also in this case, the time scale of the air shock wave can be considered to have been shrunk by the foam. From the aspects of shock wave load on the organism this means that the load corresponds to a shock wave of greater strength, and consequently the risk of structural damage is increased. If damping effects in the foam are neglected and furthermore if assuming that the energy stored in the foam is transmitted to a subject with a mass m_1, this can be expressed mathematically by the integral equation $A\int_{X_o}^{X_1} P dx = \frac{m_1 v_1^2}{2}$, in which the left side is equal to the potential energy stored in the foam and the right side is equal to the corresponding kinetic energy obtained by m_1. P is the effective pressure acting on the front surface of the foam in Figure 16, A

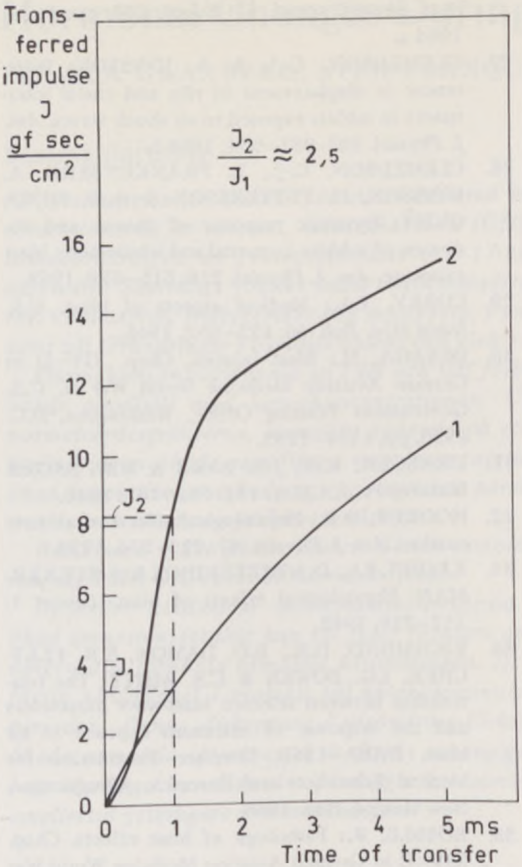

Figure 19. Transferred impulse values recorded in the shock tube at bottom of the groove. Curve 1: uncovered, and curve 2: covered with 200 mm thick plastic foam.

corresponds to the area of the piston or chest wall covering the lungs of a rabbit, X_0 and X_1 are space coordinates for the front surface of the foam in the normal and maximum compressed state respectively, m_1 is the mass of the piston or chest wall corresponding to the area A, and v_1 is the initial velocity of m_1. Provided the air shock wave is of enough strength to completely compress the foam, an increment of thickness will mean that more potential energy can be stored in the foam. This in turn may result in a higher initial velocity (v_1) of the chest wall (m_1) and a greater risk of damage to the lungs.

Finally, it may be mentioned that some investigations with protective systems composed of plastic foam and lead have given the same general results as foams only when tested on models.

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Hormonal Changes During Cold Diuresis

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Sammanfattning

På försökspersoner utsatta för standardiserad köldstress i klimatkammare studerades plasmakoncentrationerna av cortisol, tillväxthormon (GH) och thyroideastimulerande hormon (TSH) samt urinutsöndringen av 17-ketosteroider och 17-ketogena steroider, aldosteron, adrenalin och noradrenalin. Samtidigt följdes basal ämnesomsättning samt plasmakoncentrationerna av fria fettsyror, cholesterol, triglycerider och mjölksyra. Fynden relaterades till diures och hemokoncentration samt till förändringar i osmolal balans och elektrolytutsöndring.

Plasmakoncentrationerna av TSH och GH förblev inom normalvärdesgränserna. Cortisol i plasma ökade parallellt med hemokoncentrationen. Utsöndringen av 17-KS och 17-KGS ökade inom normalvärdesgränserna, sannolikt tydande på ett ökat perifert utnyttjande av cortisol. Aldosteronutsöndringen ökade signifikant men inom normalvärdesgränserna. En lineärt stigande, signifikant ökad katekolaminutsöndring registrerades, parallell med ökad BMR, stegrad plasmafosfatkoncentration och ökad urinfosfatutsöndring.

Resultaten tyder på att njurens ökade osmolala utsöndring under kyla ej är primärt beroende av vare sig TSH, GH, cortisol eller aldosteron.

Ej heller köldutlöst katekolaminstimulerad kärlsammandragning och värmeproduktion med ökad ämnesomsättning kan till fullo förklara den under hela köldperioden föreliggande diuresökningen och förhöjda osmolala utsöndringen. De sistnämnda parametrarna nådde maximum under första kölddygnet i motsats till katekolaminutsöndringen, vilken ökade successivt under försöksperioden. Denna diskrepans i utsöndringsförloppen tyder också på att diuresökningen och den ökade osmolala clearance ej är direkt avhängiga av den ökade katekolaminproduktionen. För att helt klarlägga huruvida det föreligger ett samband mellan katekolaminstegring och diures krävs emellertid ytterligare undersökningar.

Introduction

Hormonal responses to different forms of stress have for a long time attracted great interest. Changes in adrenocorticotrophic hormone (ACTH), cortisol, catecholamines, thyroid stimulating hormone (TSH) and growth hormone (GH) have been especially investigated. Acute exposure to cold is to be regarded as a special form of stress, and its influence on the endocrine secretion in man has been the object of several investigations.

The importance of the *adrenal cortex* during cold has long been established. Selye, who introduced the concept of stress, even proposed that adrenocortical hormones were responsible for the general adaptation syndrome including cold stress (Selye 1946). Publications concerning adrenocortical modifications by cold are, however, very conflicting. Increased, decreased, as well as unchanged plasma concentrations of cortisol and urinary excretion of cortisol metabolites have been shown (Bernhard, McMurrey, Ganong & Lenniham, 1956; Egdahl & Richards, 1956; Stein, Bader, Eliot & Bass, 1949; Staquet, 1961; Wilson, Hedner & Laurell, 1970).

An increased *catecholamine secretion* during stress has been well documented since Cannon's work during the thirties. Secretory increases during cold have been shown by several authors (Andersson, Brook, Gale & Hökfelt, 1964; Arnett & Watts, 1966; Botthby & Sandiford, 1922; Depocas, 1960; Chatonnet, Tanche & Guieu, 1961; Heroux, 1962; Hsieh & Carlson, 1957; Leduc, 1961; Morin, 1946; Ring, 1942; Shaeffer & Thibault, 1945; Sellers, Scott & Thomas, 1954; Tanche & Therminarias, 1967).

Growth hormone stimulation during cold was reported by Krulich & McCann, 1966, Pecile & Müller, 1968, and Machlin, Takahashi, Horino, Hertelendy, Gordon & Kipnis, 1968. A marked fall in growth hormone concentration was noted by Schalch & Reichlin, 1968. No variations during cold were, on the other hand, reported by Okada, Miyai, Iwatsubo & Kumahara, 1970, Golstein-Golaire, Vanhaelst, Bruno, Lectercg & Copinschi, 1970, Baum, Gale & Dillard, 1968 and Berg, Utiger, Schalch & Reichlin, 1966.

Several authors (Bard & Woods, 1960; Bauman & Turner, 1967; Knigge, 1960; Koch, Jobin & Fortier, 1966; Panda & Turner, 1967; Bottari, 1957; Itoh, Hiroshige, Koseki & Nakatsugawa, 1966; Stevens, D'Angelo, Paschkis, Cantarow & Sunderman, 1955) have shown or indirectly proposed increased *TSH secretion rate* during cold. Increased thyroid secretion without measurable changes in TSH was reported by Ermans & Camus, 1966, Berg et al., 1966, Odell, Vanslager & Bates, 1968, and Odell, Wilber & Utiger, 1967.

The experimental conditions in the investigations referred to above have varied both regarding the degree and duration of cold, and many of the conflicting results about hormonal responses during cold can be explained by experimental variations. An analysis of these parameters under standardized and easily reproducible conditions would therefore be desirable. The aim of this investigation was to study these hormonal changes parallel to diuresis, electrolyte excretion and osmolal balance in human subjects under strictly standardized conditions. The experimental arrangements used in the present series of investigations (Granberg, Lennquist & Wedin, 1971; Lennquist, 1971; Granberg, Lennquist, Löw & Werner, 1971) made it possible to evaluate more closely the nycthermal rhythmicity of hormonal secretion and electrolyte excretion. These experimental conditions also permitted differentiation between short- and long-term adaptation reactions to cold.

Our previous findings on cold induced diuresis and the excretion of calcium, sodium and phosphate (Granberg, Lennquist, Löw & Werner, 1971) made it of particular interest to study growth hormone, aldosterone and cortisol – hormones known to have effect on the parameters mentioned.

The linear, continuous increase in phosphate concentration in blood and urine during previous experiments was in sharp contrast to the instantaneous, pronounced increase in calcium and sodium excretion during the first hours of cold. This finding indicated that our experimental conditions also disclosed late adaptory effects. A generally increased metabolism seemed probable and motivated a concomitant analysis of catecholamines, thyroid stimulating hormone, basal metabolic rate, triglycerids and free fatty acids. In order to evaluate whether substrate utilization was adequate, plasma lactic acids and urinary keton bodies were analysed as well.

Material

The experiments were performed on nine healthy students, 8 men and 1 woman. Five subjects participated twice and the total number of experimental sessions was 14. The age range was between 22 and 30 years (mean 25 years). Body weight averaged 67.1 kg and body surface area 1.86 m^2.

Experimental conditions

The subjects spent 1–3 days without interruption in a climatic chamber at an air temperature of + 15 ± 0,5°C, a relative humidity between 39 and 44 per cent and a wind-speed at no point exceeding 0.3 m/sec. Clothing consisted of bathing trunks, socks and shoes. The supply of nutrients and fluid was standardized and adjusted to an ordinary daily intake as regards all elementary components. The fluid intake was altogether 1400 ml per day. Smoking was not allowed. To distinguish between the effects of cold from those caused by changed activity, a strictly standardized activity was executed, uniformly distributed over the 24 hour-experimental period and, after individual testing, adapted to correspond to the ordinary daily activity of the individual. The 24 hours were sub-divided into five periods, one 8 hour night period and four 4 hour day periods. Every experimental 24 hour-period started at 3 p m. In order to study the 24 hour rhythm and to make comparisons between the different periods, the day periods were made identical is so far each period started with measurements and samplings, immediately followed by meals, which were identical in all periods. Each period of cold exposure was preceded by a control period of 24 hours in a climatic chamber under exactly the same conditions, but at an air temperature of + 28°C.

The experimental conditions were the same as those used in climatic chamber experiments in our previous studies on cold induced diuresis (Granberg, Lennquist & Wedin, 1971; Lennquist, 1971; Granberg, Lennquist, Löw & Werner, 1971). For further description of the methods, see these works..

Analytical methods

Cortisol was determined fluorimetrically according to De Moor, as modified by Laurell (1961).

17-KS and 17-KGS was determined spectrophotometrically according to Appelby, Gibson, Norymberski & Stubbs 1955.

Aldosterone excretion was measured by the estimation of the 24 hour urinary excretion of 3-oxi-aldosterone, using a double labelling technique (Kliman & Peterson, 1960).

Growth hormone was determined by a double antibody radioimmunoassay technique as described by Cerasi, Dela Casa, Luft & Roovete (1966).

TSH was determined by radio-immunoassay technique described by Berson, Yalow, Glick & Roth (1964).

Basal metabolic rate was determined immediately on waking at 7 a m, after 8 hours rest in recumbent position and before rising. The expiratory air was collected during a period of 10 minutes in a Douglas bag. The air was analyzed for oxygen and carbon dioxide by the method described by Scholander, 1947.

Catecholamines where determined fluorimetrically using the procedure described by von Euler & Lishajko, 1961.

Cholesterol was determined colorimetrically by the method described by Block & Jarett, 1965.

Triglycerides were determined fluorimetrically by the method described by Kessler & Lederer, 1965.

Free fatty acids were determined according to the method of Dole, 1956 as modified by Trout, Ested & Friedberg, 1960.

Lactic acid from capillary blood was determined with the enzymatic method described by Jorfeldt, 1970.

Urinary keton bodies were tested according to the Labstix® method.

Stastistical methods

Common statistical methods (Snedecor & Cochran, 1967) were used. A Student's-t-test was used to determine the statistical significance. The following probability levels of significance were used:

$p > 0.05$	= not significant
p 0.01 –0.05	= probably significant
p 0.001–0.01	= significant
$p < 0.001$	= highly significant

Dispersion is generally given as standard deviation, when not otherwise stated.

Results

In the following presentation of the results, the hormonal changes have been visualized together with concomitant changes in electrolyte and body water homeostasis. For more detailed description of the latter parameters under these experimental conditions see previous reports (Granberg, Lennquist & Wedin, 1971; Lennquist, 1971; Granberg, Lennquist, Löw & Werner, 1971).

Cortisol concentrations in plasma, morning fasting values, increased continuously within normal limits, 10–30μg%, during the entire period of cold exposure. During the second and third nights of cold exposure, two subjects passed the upper normal limit, 10 μg%, for cortisol concentration in plasma during night. Cortisol rhythm for all subjects remained normal during the whole experiment (Fig. 1).

The excretion of *17-KS* increased from a mean value during the control period of 7 ± 1 μg/min to a mean value of the first day of cold of 12 ± 1 μg/min, a mean relative increase of 59 per cent, and then remained at this level (Fig. 2). The excretion of *17-KGS* increased during the corresponding time from 12 ± 3 μg/min to 17 ± 1 μg/min, a mean relative increase of 43 per cent (Fig. 2). Throughout the experiment, 17-KGS and 17-KS remained within normal limits for each subject, taking in consideration age, sex and weight.

Aldosterone excretion increased successively during the cold period. Basal excretion rates in normothermia, 6 ± 3 μg/24 hour, rose to 11 ± 3 μg/24 hour during the last day of the experiment ($p < 0.01$). The excretion was throughout within the normal range, 4–17 μg/24 hour (Fig. 3).

Plasma concentration of *growth hormone* and *thyroid stimulating hormone*, morning fasting samples, remained within the normal values,

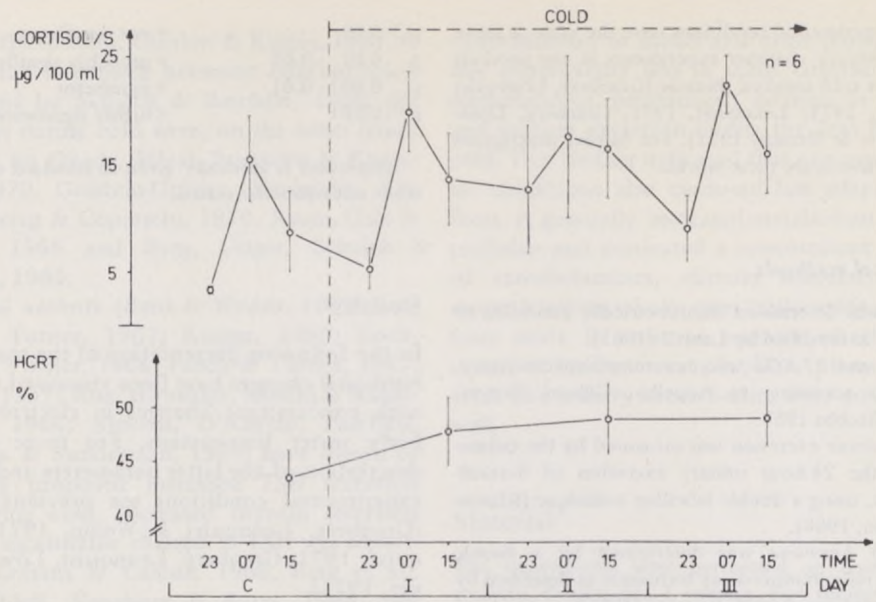

Fig. 1 Hematocrit (HCRT) and plasma concentration of cortisol. Mean values and standard-deviations for control period (C) and cold exposure (I–III).

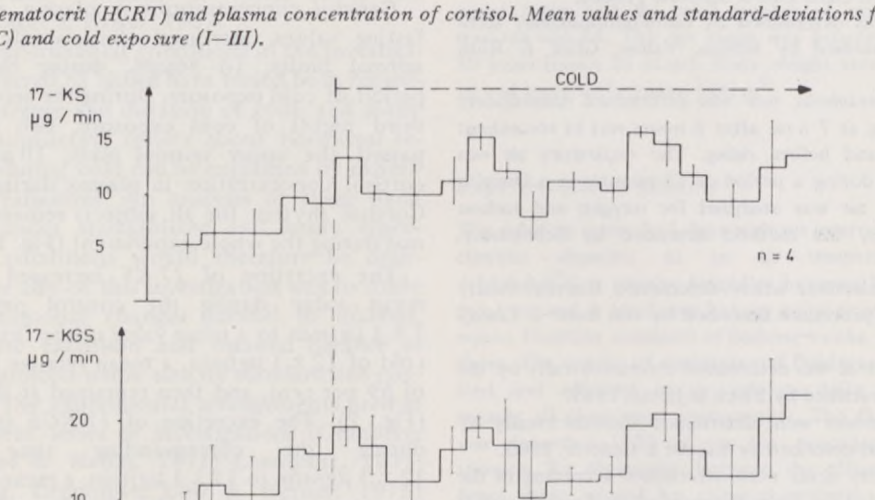

Fig. 2 Urine flow (V) and urinary excretion of 17 – KS and 17 –KGS. Mean values and standard-deviations for control period (C) and cold exposure (I–III).

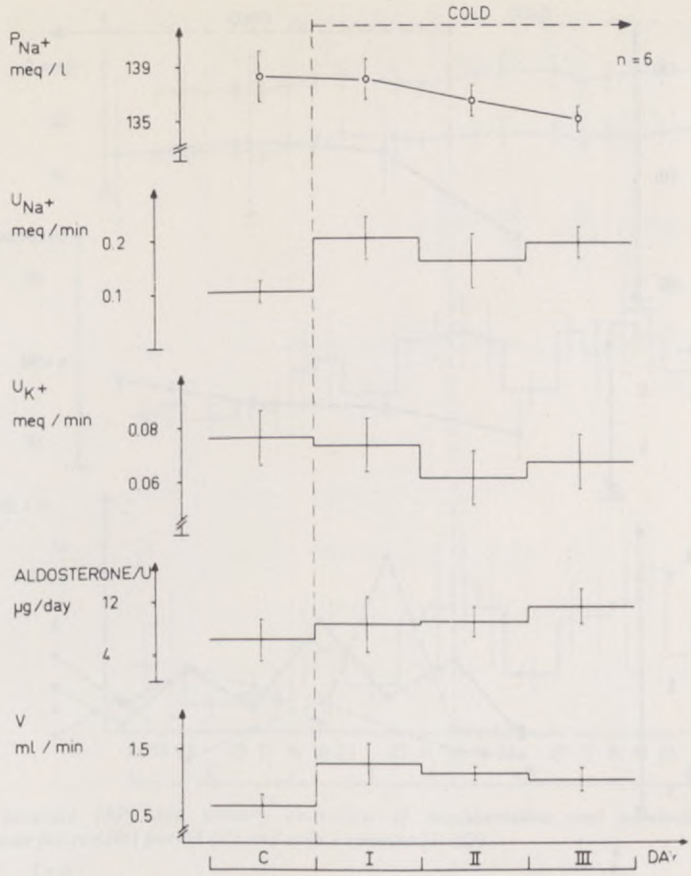

Fig. 3 Urine flow (V), urinary excretion of aldosterone, sodium and potassium and plasma sodium concentration. Mean values and standard-deviations for control period (C) and cold exposure (I—III).

< 12 mµg/ml and < 40 µU/ml, respectively, throughout the experiment (Fig. 4).

Table I also shows plasma concentrations of GH and TSH determined with short intervals immediately after the onset of cold in two subjects with a catheter inserted in the brachial vein.

Basal metabolic rate (BMR) increased from 99 ± 8 per cent during the control period to 115 ± 10, 117 ± 15 and 115 ± 20 per cent for the first, second and third days of cold, respectively.

Phosphate concentrations in plasma followed the same pattern (Fig. 4) and increased from a mean value of the control period of 4.8 ± 0.76 mg% to mean values of the first, second and third days of cold exposure of 4.6 ± 0.6, 5.0 ± 0.25 and 5.4 ± 0.23 mg% ($p < 0.05$), respectively.

The catecholamines increased continuously during the experiment. *Adrenaline* excretion increased successively from a basal mean value during the control period of 2.9 ± 1.2 ng/min to a mean value during the third day of cold of 8.6 ± 2.5 ng/min ($p <$'0.001). This meant daily mean relative increases of 168, 192 and 223 per cent, respectively (Fig. 5). *Noradrenaline excretion,* basal normothermic excretion 20.4 ± 4.7 ng/min, increased continuously throughout the experimental period, in the third day of cold to 45,4 ± 8.7 ng/min ($p < 0.001$). The mean relative increases were 91, 97 and

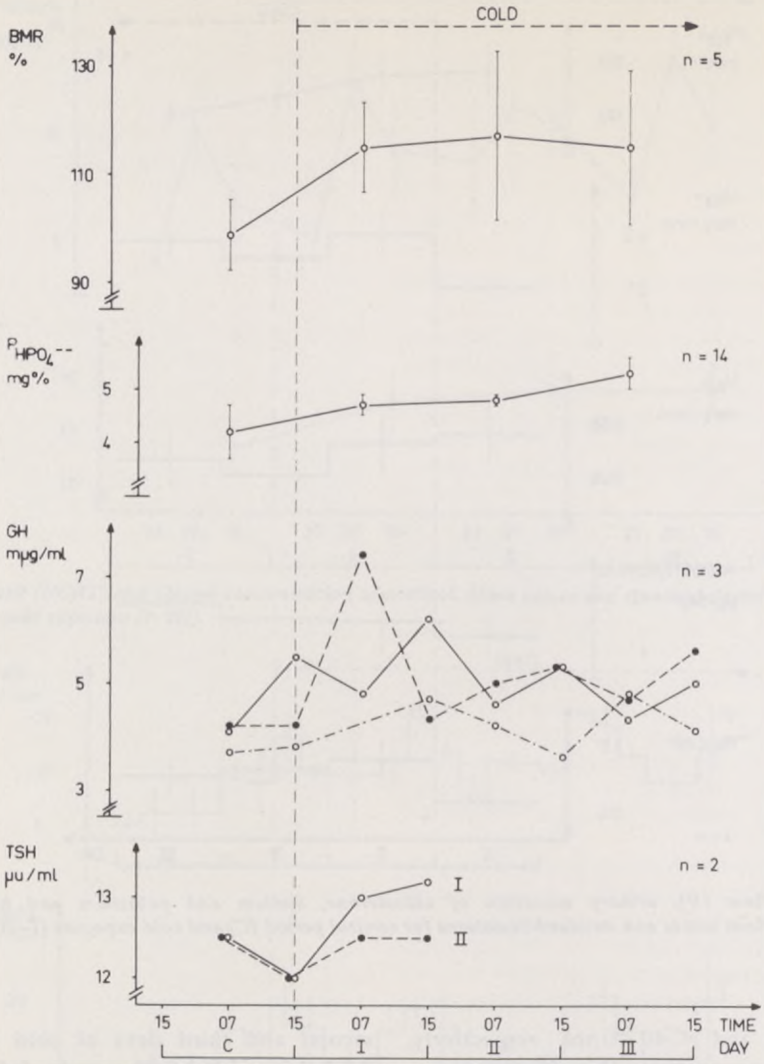

Fig. 4 Basal metabolic rate (BMR) and plasma concentrations of phosphate and growth hormone (GH). Mean values and standard-deviations for control period (C) and cold exposure (I—III). The figure also shows plasma concentrations of thyroid stimulating hormone (TSH) for two subjects during the first day of cold exposure.

126 per cent (Fig. 5). The excretion of noradrenaline reached already during the first day of cold exposure levels well above normal ranges.

Plasma concentrations of cholesterol, triglycerides and free fatty acids remained within the normal range and unchanged throughout the experiment (Fig. 6).

Plasma concentration of lactic acid, morning fasting values, increased from a mean value of the control period of 1.4 ± 0.26 mMol/l to mean values of the first second and third days of cold of 1.9 ± 0.12, 2.9 ± 0.67 and 2.5± 0.86 mMol/l, respectively.

Urinary keton bodies were not found during the experiment.

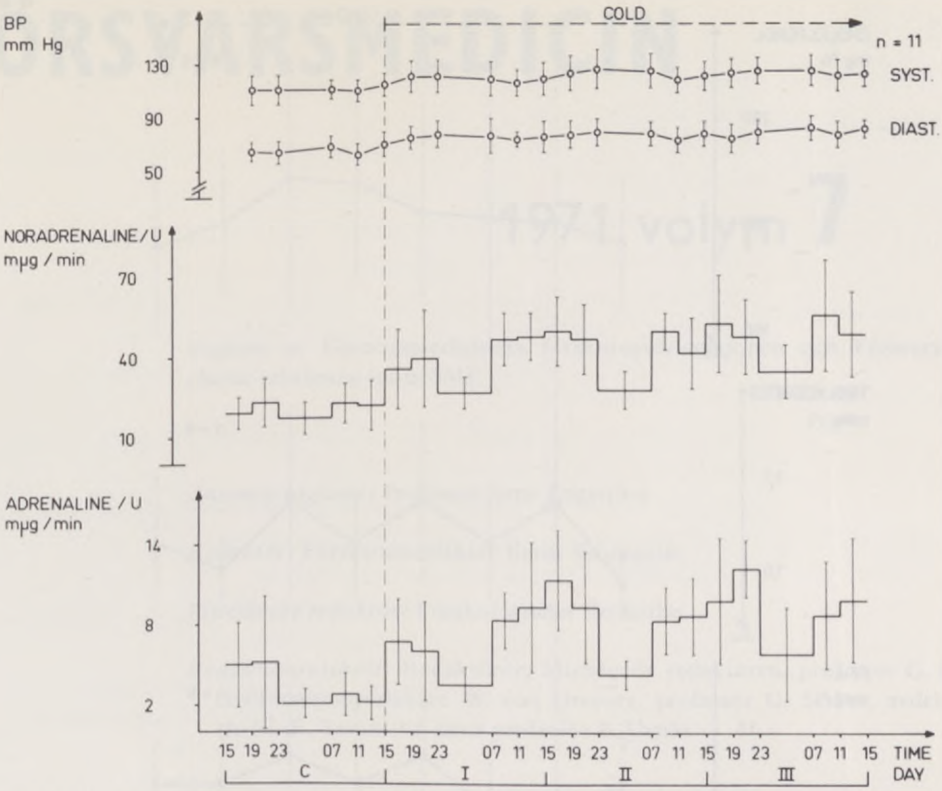

Fig. 5 Blood pressure (BP) and urinary excretion of noradrenaline and adrenaline. Mean values and standard-deviations for control period (C) and cold exposure (I–III).

Table I. Plasma concentrations of growth hormone (GH) and thyroid stimulation hormone (TSH) determined in two subjects (A and B) during the control period and with short intervals after the onset of cold.

Hormone	Subject	Control period	Minutes after the onset of cold					
			5	10	15	30	60	120
GH	A	3.4	4.1	2.9	2.5	3.4	3.2	3.3
ng/ml	B	3.3	2.7	2.9	2.4	3.5	3.7	3.4
TSH	A	17	17	15	16	19	18	9
mU/ml	B	10	12	10	13	19	11	11

Discussion

The exposure of unclothed normal subjects to a temperature of +15°C augmented the excretion of cortisol metabolites in urine. The normal rhythmicity with maximum values in the early morning and minimum values during the night was maintained. The slight increase in plasma cortisol concentration is fully explained by the concomitant decrease in plasma volume (Granberg, Lennquist & Wedin, 1971) resulting in hemoconcentration with relative increase of protein bound plasma cortisol. The excretory increase of cortisol metabolites in urine amounted in average to 4–7 mg/24 hour. A

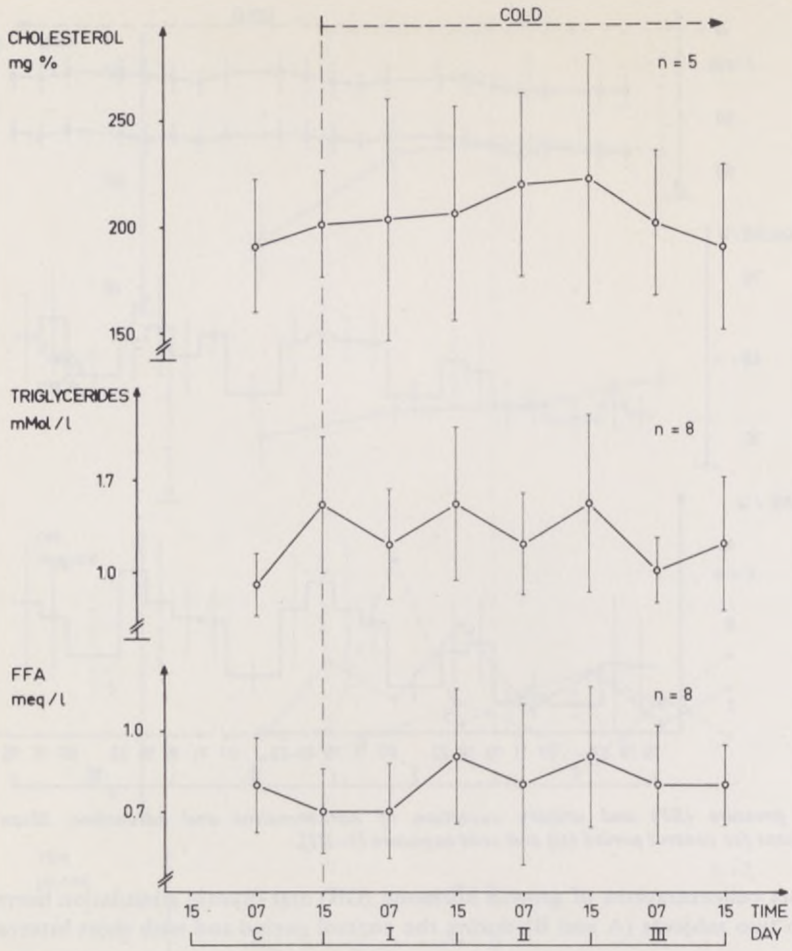

Fig. 6 Plasma concentrations of cholesterol, triglycerides and free fatty acids (FFA). Mean values and standard-deviations for control period (C) and cold exposure (I–III).

simple clearing of extracellular fluid through diuresis would only account for a few per cent of this increase, which for its major part most likely reflects elevated peripheral utilization of cortisol, effected by cold-induced, noradrenaline stimulated hypermetabolism.

The excretory increase of metabolites without elevated cortisol levels indicates a successive compensation for increased peripheral cortisol utilization in contrast to the sharp cortisol elevations normally seen during more severe and acute forms of stress such as hypoglycemia, severe cold and surgical trauma.

Aldosterone excretion, on the other hand, showed a significant, linear increase, which was completely correlated to the excretion of sodium and inversely correlated to plasma concentration of sodium and to plasma volume. This might indicate that the subjects reacted with a secondary aldosteronism to cold-induced sodium and volume depletion. However, it should be noted that the excretory values were throughout the experiment within the normal range. Aldosterone, of which the major site of action is on the distal convoluted tubules and collecting ducts, where sodium reabsorption is associated with increased potassium and hydrogen ion excretion, has been shown to have no

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Författarregister

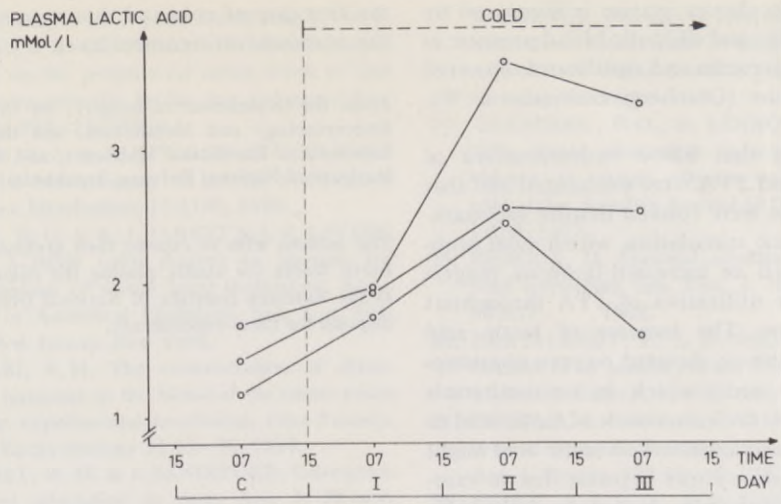

Fig. 7 Plasma concentrations of lactic acid for three subjects during control period (C) and cold exposure (I–III).

acute effects on calcium and magnesium excretion (Lemann, Piering & Lennon, 1970). In our experiment, no changes in potassium ion excretion was noted, and the parallel changes in sodium, calcium and magnesium excretion during diuresis suggest cold-induced changes in more proximal parts of the nephron. Thus, changed secretion of aldosterone or varied renal responsiveness to aldosterone as a cause of the excretory changes noted in our experiments does not seem probable.

The degree of cold in the present investigation did not induce marked changes in the concentrations of the pituitary hormones that were analyzed, growth hormone and thyroid stimulating hormone. This is valid during the early phase, while diuresis and electrolyte excretion were maximal, as well as for the later phases of cold exposure. Regarding TSH, this is in agreement with the works of Odell, Wilber and Utiger (1967), who found that subjects exposed to +13°C did not show any changes in TSH plasma concentrations despite an elevation of the metabolic rate indicated by increased BMR. On the basis of these serum analyses of GH and TSH, their respective secretion rates cannot be determined. The very slight increase during the first period of cold could actually indicate increased secretion rates for the two hormones, which, in analogy with the findings concerning the adrenal corticoid hormones, could indicate increased peripheral utilization of GH as well as TSH. The dynamics of the metabolic and concomitant circulatory changes, on the other hand, strongly indicate that noradrenaline and not GH and/or TSH is primarily responsible for the cold-induced changes. The marked increase in BMR, also noted during acute exposure to cold by several authors (Newburg & Spealman, 1943; Marmet & Grandjean, 1955; Anderssen, Løyning, Nelms, Wilson, Fox & Bolstad, 1960) most probably reflects catecholamine and not GH or TSH stimulated oxygen consumption. A support of this is the finding of Ring (1942) that rats exposed to cold maintain intact ability to increase BMR even after thyroidectomy. The increase of catecholamine excretion rate is parallel to the increase in BMR and the linear increase of phosphate – secondary effects of shivering and non-shivering calorigenesis. The discrepancy between the relatively moderate increase of adrenaline, excretion rates always within the normal range, and the massive secretion of noradrenaline, suggests increased production and release of noradrenaline from sympathetic nerve terminals rather than from the adrenals. The net effect of this catecholamine stimulation of the circulatory system is illustrated by elevated systolic and diastolic blood pressure as well as by bradycardia and significantly lowered skin temperature (Granberg, Lennquist & Wedin, 1971).

The finding that blood concentrations of triglycerides and FFA were unchanged and that no ketonbodies were formed despite the marked noradrenaline stimulation, which most probably had caused an increased lipolysis, suggest an appropriate utilization of FFA throughout the experiment. The increase of lactic acid occurred, despite an elevated oxygen consumption per time unit, which in normothermia would facilitate the conversion of lactic acid to pyruvate. The accumulation of lactic acid might depend on relative tissue hypoxia due to vasoconstriction peripherally, in its turn induced by noradrenaline.

General conclusions

In the present investigation, using cold as a stressor agent, an attempt was made to study the relationship between on the one hand the marked effects on plasma volume, diuresis and electrolyte excretion and on the other hand hormonal changes. GH, TSH, aldosterone and cortisol did not seem to be primarily involved in either the early or the late somatical response to cold.

Our findings suggest instead that the marked reduction of plasma volume occurring under these conditions (Granberg, Lennquist & Wedin, 1971) is best explained by a cold induced, noradrenaline mediated vasoconstriction. The diminution of the circulatory bed in its turn would evoke increased diuresis as well as an increased excretion of osmoles. However, this explanation may not be complete as throughout the experiment the excretion of osmoles remained greater than could be explained by clearing of plasma volume, redistribution of insensible water loss and by increased basal metabolic rate with endogenous production of osmoles due to the breakdown of stored energy.

It is noteworthy that the noradrenaline excretion continuously increased throughout the experiment, whereas the increased renal excretion of osmoles and water was maximal during the first day of cold and then returned towards the normothermic control level.

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Abstracts

GRANBERG, PER-OLA, STEN LENNQUIST, HANS LÖW & SIGBRITT WERNER: Changes in Calcium, Phosphate and Magnesium Homeostasis in Subjects under Standardized Cold Stress

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Changes in Calcium, Phosphate and Magnesium Homeostasis in Subjects under Standardized Cold Stress

In a previous work it was shown that cold induced diuresis in man is an osmotic diuresis, accompanied by a high osmolal clearance and negative free water clearance. It was also shown that the highly increased excretion of sodium under these conditions in an effect of a reduced tubular reabsorption of this ion, which, in contrast to the diuresis, occurs only when a sufficient amount of sodium is available and, consequently, is of no etiological significance for the increase in urine flow. The aim of this investigation was to study the excretion of calcium, phosphate and magnesium in human subjects under cold stress under the same standardized conditions as have been used in our earlier experiments.

Two types of experiments were performed: long-time experiments with the subjects staying several

Modifications dans l'homoeostasie du calcium, du phosphate et du magnésium chez les sujets soumis à des contraintes de froid uniformisées

C'est récemment montré que la diurèse déclenchée chez l'homme par le froid est une diurèse osmotique suivie d'une clearance osmotique élevée et d'une clearance d'eau libre négative. C'est aussi montré que la sécrétion fortement accrue de sodium sous ces conditions est un effet de la diminution de la réabsorption tubulaire de cet ion, laquelle, contrairement à l'accroissement de la diurèse, ne se manifeste que lorsqu'une quantité suffisante de sodium est accessible et ne joue par conséquent aucun rôle étiologique dans l'accroissement de la production d'urine. Le but de cet examen était l'étude de la sécrétion de calcium, de phosphate et de magnésium chez les sujets d'expérience exposés au froid sous les mêmes conditions que lors de nos examens précédents.

Deux types d'expériences ont

Veränderungen der Kalzium-, Phosphat- und Magnesiumhomöostasis bei Personen unter standardisierter Kältebelastung

Es ist kürzlich gewiest, daß die kälteinduzierte Diurese osmotischer Natur ist, begleitet von einer hohen osmotischen Clearance und negativer freier Wasserclearance. Weiter ist gewiest daß die stark erhöhte Natriumabsonderung unter diesen Verhältnissen ist eine Wirkung der herabgesetzten tubulösen Rückresorption dieses Ions, die im Gegensatz zur Erhöhung der Diurese nur dann auftritt, wenn eine genügende Menge Natrium vorhanden ist. Sie har folglich keine ætiologische Bedeutung für die Erhöhung der Urinerzeugung. Der Zweck dieser Untersuchung war, die Ausscheidung von Kalzium, Phosphat und Magnesium bei Versuchspersonen zu studieren, die Kältebelastungen unter den gleichen standardisierten Verhältnissen wie in den früheren Versuchen ausgesetzt worden sind.

days in a climativ chamber, and shorttime experiments on a hypothermic operating table in order to study the space in time between the onset of cold and the occurring of the different responses.

A significant increase in calcium excretion occurred immediately after the onset of cold, following the same pattern as the diuresis and the increased excretion of sodium and chlorides. Magnesium excretion followed calcium excretion in the climatic chamber experiments but showed no rise in short-time experiments. Phosphate excretion followed another pattern than calcium with a linear, successive increase regarding the daily mean values. As for magnesium, no rise in phosphate excretion was observed in the short time experiments.

Plasma concentration of phosphate increased significantly during cold. Plasma concentration of calcium increased to the same extant as could be expected by the simultaneous hemoconcentration. Plasma concentration of magnesium did not change.

From the determination of GFR from as well C_{Creat} as C_{In} it could be calculated that the increased excretion of calcium, which has not earlier been observed in human beings exposed to cold, was an effect of a reduced tubular reabsorption of this ion.

été pratiquées: expériences prolongées où le sujet a passé plusieurs jours dans une chambre climatisée, et expériences brèves sur table de cryothérapie en vue de reconnaître l'intervalle de temps écoulé entre le coup de froid et l'apparition des diverses réactions.

Un accroissement significatif de la sécrétion de calcium est apparu immédiatement après le déclenchement du coup de froid, suivant le mêmes modèle que l'augmentation de diurèse et l'augmentation de la sécrétion de sodium et de chlorures. La sécrétion de magnésium a suivi la sécrétion de calcium lors de l'essai en chambre climatisée mais n'a pas augmenté lors des expériences de courte durée. La sécrétion de phosphates a suivi un autre modèle que celle du calcium, avec accroissement linéaire progressif en ce qui concerne les valeurs moyennes de la journée. Comme pour le magnésium, aucune augmentation de la sécrétion n'a été constatée aux expériences de courte durée. Les phosphates du sérum ont augmenté par le froid de façon significative. Le calcium a augmenté dans le sérum dans la mesure à laquelle on pouvait s'attendre par suite de l'hémoconcentration simultanément apparue. Le magnésium n'a subi dans le sérum aucune modification. Par le calcul de GFR provenant tant de C_{Creat} que de C_{In}, il s'est révélé que cet accroissement de la sécrétion de calcium, qui n'avait pas été découverte antérieurement chez l'homme exposé au froid, est une suite de réabsorption tubulaire réduite de cet ion.

Zwei Arten von Versuchen wurden durchgeführt: Langzeitversuche, in welchen die Versuchspersonen mehrere Tage in einer Klimakammer verbrachten, und Kurzzeitversuche auf einem Kühloperationstisch, um zu studieren, in welcher Zeitspanne die Reaktion auf die Einschaltung der Kälte eintritt.

Eine markante Zunahme der Kalziumausscheidung ergab sich unmittelbar nach der Einschaltung der Kälte. Sie wies den gleichen Verlauf auf wie die Zunahme der Diurese und die vermehrte Ausscheidung von Natrium und Chloriden. Die Ausscheidung von Magnesium verlief bei den Klimakammerversuchen wie die von Kalzium, sie zeigte aber keine Zunahme bei den Kurzzeitversuchen. Die Absonderung von Phosphat nahm einen anderen Verlauf als die von Kalzium und wies eine geradlinige allmähliche Steigerung der Tagesmittelwerte auf. Ebenso wie bei Magnesium konnte bei den Kurzzeitversuchen keine Erhöhung der Absonderung festgestellt werden. Eine deutliche Zunahme von Phosphat im Serum konnte bei Kälte nachgewiesen werden. Kalzium im Serum stieg in dem Umfang an, wie als Folge der gleichzeitig auftretenden Hämokonzentration zu erwarten war. Der Magnesiumgehalt des Serums veränderte sich nicht. Durch Berechnung von GFR aus D_{Creat} und C_{In} ergab sich, daß die vermehrte Kalziumbesonderung, die bisher bei Menschen unter Kältebelastung nicht beobachtet worden war, eine Folge der verringerten tubulösen Rückresorption dieses Ions war.

CLEMEDSON CARL-JOHAN, LARS FRANKENBERG, ARNE JÖNSSON & ANNA-BRITT SUNDQVIST: Effects on Extra- and Intrathoracic Pressure Pattern and Lung Injuries of Rigid and Soft Protection of Thorax in Air Blast Exposed Rabbits

Försvarsmedicin (Stockholm), 7:172–190, 1971

Effects on Extra- and Intrathoracic Pressure Pattern and Lung Injuries of Rigid and Soft Protection of Thorax in Air Blast Exposed Rabbits

Anasthetized rabbits protected by rigid or soft protective devices were exposed to long duration air shock waves in a shock tube, or short duration air shock waves in the open field. The two types of rigid protective devices tested were made of steel and of lucite, respectively, and had been designed to protect the chest primarily. The two types of soft protective devices used were made of plastic foam and of foam rubber, respectively, and covered the whole trunk of the animal. Five different lengths of rigid protective device were tested, namely 4, 8, 12, 16 and 20 cm. The 8, 12, 16 and 20 cm protective devices were found to cause a considerable reduction of the peak pressure and of the rate of pressure rise in the thorax, and very effectively prevented from lung damage. An increment of the length of the protective device over 12 cm did not improve the protective effect against lung damage, but the 16 and 20 cm protective devices reduced the peak pressure and rate of pressure rise also in the abdomen, and thereby reduced the risk of abdominal injury. When located over the central part of the thorax, the 4 cm protective device, although it had no appreciable reducing effect on the peak pressure in the thorax, reduced the lung injuries from severe to moderate, probably due mainly to a decreasing effect on the rate of pressure rise.

Effets sur le cours de pression extra- et intra-thoracique et sur les lesions pulmonaires, de protections rigides et souples du thorax chez des lapins exposes a des jets d'air

Des lapins endormis à l'uréthane, abrités sous une protection corporelle rigide ou souple, ont été exposés à l'action d'ondes de choc d'air, de longue durée en tubes d'ondes de choc, et de courte durée à l'air libre. Les deux types de protection rigide testés étaient fabriqués l'un en acier, l'autre en plexiglas, et conçus pour protéger en premier lieu la poitrine. Les deux types de protection souple testés étaient l'un en plastique mousse, l'autre en caoutchouc mousse et protégeaient tant la poitrine que l'abdomen. La protection rigide a été testée en cinq longueurs, 4, 8 12, 16 et 20 cm. Les protections de 8, 12, 16 et 20 cm se sont révélées avoir pour résultat une sensible réduction de la pression maximale et de la raideur des poussées dans la poitrine et faisaient efficacement obstacle à l'apparition de lésions pulmonaires. L'allongement de la protection à plus de 12 cm n'améliorait pas l'effet en ce qui concerne les lésions pulmonaires mais les protections de 16 et de 20 cm réduisaient la pression maximale et la raideur des poussées également dans l'abdomen, y réduisant ainsi les risques de lésion. Lorsque la protection de 4 cm était placée sur la partie centrale de la poitrine, les lésions pulmonaires n'étaient plus que moyennes au lieu de graves, bien que l'effet réduisant la pression maximale sur la poitrine fût insignifiant. Dans ce cas, l'atténuation des lésions

Die Wirkungen steifer und weicher Brustpanzer auf durch Luftdruck-Stösse bei Kaninchen verursachte Lungenschäden

Urethan-betäubte Kaninchen, die durch Schutzpanzer aus steifen bzw. weichem Material geschützt waren, wurden in einer Detonationskammern langanhalten Luftdruckstössen und in freier Luft Stössen von kurzer Dauer ausgesetzt. Zwei Typen steifer Schutzpanzer wurden geprüft, die aus Stahl bzw. Plexiglas hergestellt und in erster Linie zum Schutze des Brustkorbes konstruiert worden waren. Die zwei Typen des Schutzpanzers aus weichem Material, die geprüft wurden, schützten sowohl den Brustkorb als auch den Bauch der Tiere und waren aus Schaumkunststoff bzw. Schaumgummi gefertigt. Fünf verschiedene Längen der steifen Schutzpanzer wurden geprüft, 4, 8, 12, 16 und 20 cm. Es zeigte sich, dass die Schutzpanzer in den Längen von 8, 12, 16 und 20 cm eine erhebliche Verminderung des Maximaldruckes und der Steilheit der Druckwellen im Brustkorb herbeiführten und dadurch die Entstehung von Lungenschäden effektiv verhinderten. Die Verlängerung der Schutzpanzer über 12 cm hinaus hatte keine Verbesserung des Schutzeffektes bezüglich der Lungenschäden zur Folge, dagegen erreichte man mit den Schutzpanzern von 16 und 20 cm Länge ausserdem eine Verminderung des Maximaldruckes und der Steilheit der Druckwellen in der Bauchhöhle und verringerte damit die Gefahr für Bauchschäden. Bei Anbringung der 4 cm

The soft protective devices tested were found to produce an increased loading effect, and to severly aggravate the lung injuries. The peak pressure as well as the rate of pressure rise in the thorax were considerably increased. In fact, the peak intrathoracic pressure increased up to 100 per cent as compared with the pressures in the thorax of unprotected animals. Experiments in the shock tube indicate that the impulses transferred to the chest of the animals during a period of time considered critical for the infliction of lung damage, may increase by a factor of 2 to 3.

pulmonaires était probablement due à une moindre raideur des poussées.

La protection souple s'est révélée entraîner un effet augmenté et non réduit de la contrainte; elle aggravait donc sérieusement les lésions pulmonaires. Tant la pression maximale que la raideur des poussées sur la poitrine augmentaient sensiblement. Nous pouvons mentionner que la pression maximale dans la poitrine croissait jusqu'à 100% comparativement aux témoins non protégés. Les expériences en tubes d'ondes de choc montrent que la poussée transmise à la poitrine des sujets d'expérience pendant un laps de temps considéré comme critique pour l'apparition de lésions pulmonaires, peut se voir multipliée par deux ou trois par la protection souple.

langen Schutzpanzer auf den zentralen Teilen des Brustkorbes erreichte man eine Verminderung der Lungenschäden von solchen schweren Grades auf solche mässigen Grades, trotz einer nur unbedeutenden Herabsetzung des Maximaldruckes im Brustkorb. In diesem Falle ist die Herabsetzung der Lungenschäden wahrscheinlich auf die geringere Steile der Druckwellen zurückzuführen.

Die Anwendung der weichen Schutzpanzer verursachte anstatt einer Verringerung eine Vergrösserung des Belastungseffektes und dadurch eine ernsthafte Erschwerung der Lungenschäden. Sowohl der Maximaldruck als auch die Steile der Druckwellen im Brustkorb steigerten sich erheblich. Es ist erwähnenswert, dass sich der Maximaldruck im Brustkorb, verglichen mit dem bei ungeschützten Versuchstieren gemessen, um ca. 100% steigerte. Versuche in der Detonationskammer zeigen, dass die Druckwelle, die während der für die Entstehung von Lungenschäden kritischen Zeit auf den Brustkorb der Versuchstiere übertragen wird, durch die Anbringung des weichen Schutzpanzers zwei- bis dreimal kräftiger werden kann.

PER-OLA GRANBERG, STEN LENNQUIST, HANS LÖW & SIGBRITT WERNER: Hormonal Changes During Cold Diuresis.

Försvarsmedicin (Stockholm), 7: 191–202, 1971

Hormonal Changes During Cold Diuresis

Experimental subjects were exposed to standardized cold stress in a climate chamber. Their plasma concentrations of cortisol, growth hormone (GH), thyroid-stimulating hormone (TSH) and urinary excretion of 17-ketosteroids and 17-ketogenic steroids, aldosterone, adrenaline and noradrenaline were studied. In con-

Modifications hormonales au cours de diurèse causée par le froid

Sur les sujets d'expérience soumis à des contraintes de froid uniformisées en chambre climatisée, on a étudié la concentration plasmatique de cortisol, d'hormones de croissance (HG) et d'hormones thyréotropes (HTS) ainsi que la sécrétion dans l'urine de 17 cétostéroïdes et de 17 stéroïdes cétogènes, aldostérone, adrénaline et

Hormonelle Veränderungen während der Kältestress

Das Plasma von Versuchspersonen, die man in einer Klimakammer einem Kältestress aussetzte, wurde auf seinen Gehalt an Kortisol, Wachstumshormon (STH) und thyreotropem Hormon (TSH) untersucht, ausserdem kontrollierte man die Harnausscheidung von 17-Ketosteroiden, 17-ketogenen Steroiden, Aldosteron, junction with this, their basic metabolic rate and plasma concentrations of free fatty acids, cholesterol, triglycerides and lactic acid were followed. The findings were related to diuresis and hemoconcentration as well as to the changes in osmolal balance and excretion of electrolytes.

The plasma concentrations of TSH and STH remained within the normal ranges. The concentration of cortisol in plasma increased proportionally with the hemoconcentration. Excretion of 17-KS and 17-KGS increased, remaining within the normal ranges, probably indicating increased peripheral utilization of cortisol. Excretion of aldosterone showed a significant increase within the normal range. A significant increase in the excretion of catecholamines was also noted, increasing proportionally with increase in BMR, plasma phosphate and urinary phosphate excretion.

The results indicate that the increased osmolal clearance during cold-induced diuresis is not primarily dependent on an increased secretion of TSH, GH, cortisol or aldosterone.

Nor can the vasoconstriction induced by the release of catecholamines and the generation of heat together with increased basal metabolic rate fully explain the diuresis and increased osmolal clearance. The last-mentioned parameters reached a maximum during the first 24 hours, as opposed to those for the excretion of catecholamines, which increased successively during the whole experiment. The discrepancy evident in the excretory products also indicates that the diuresis and increased osmolal clearance are not directly dependent on the increase in catecholamine secretion. However, further investigations are required to establish whether or not there is a correlation between the increase in catecholamines and diuresis.

noradrénaline. On a suivi simultanément le métabolisme basal et la concentration plasmatique d'acides gras libérés, de choléstérol, de triglycérides et d'acide lactique. Des constatations ont été mises en relation avec la diurèse et l'hémoconcentration sinsi qu'avec les altérations de l'équilibre osmotique et de la sécrétion d'electrolytes.

La concentration plasmatique d'hormones thyréotropes (HTS) et de corps (HG) est restée dans les limites normales. Le cortisol a augmenté dans le plasma parallèlement à l'hémoconcentration. La sécrétion de 17 CS et de 17 SCG a augmenté dans les limites normales, indiquant vraisemblablement un accroissement de la consommation périphérique de cortisol. La sécrétion d'aldostérone a augmenté de façon significative, mais en restant dans les limites normales. Un accroissement liniaire significatif de la sécrétion de catécholamine a été enregistré parallèlement à l'accroissement du m.b., à l'élévation du taux de concentration plasmatique des phosphates et à l'augmentation de la sécrétion de phosphates dans l'urine.

Les résultats indiquent que l'augmentation de la sécrétion osmotique du rein sous l'action du froid n'a pas pour cause primaire une augmentation de sécrétion d'hormones thyréotropes (HTS) ni d'HG, de cortisol ou d'aldostérone.

La contraction des vaisseaux et la production de chaleur accompagnées d'augmentation du métabolisme, encouragées par la catécholamine dégagée sous l'effet du froid, ne peuvent pas non plus expliquer entièrement l'augmentation de diurèse et la sécrétion osmotique surélevée qui se manifestent pendant toute la période d'exposition au froid. Ces derniers paramètres ont atteint leur sommet pendant la premier journée de froid, tandis que la sécrétion de catécholamine a augmenté pro-

Adrenalin und Noradrenalin. Gleichzeitig verfolgte man den Grundumsatz und den Blutspiegel der freien Fettsäuren von Cholesterin, Triglyzeriden und der Milchsäure. Die gefundenen Werte stellte man in Relation zur Diurese und Blutkonzentration sowie Veränderungen des osmotischen Gleichgewichtes und der Elektrolytausscheidung.

Die Blutkonzentrationen von TSH und STH hielten sich innerhalb der Normalwerte. Das Plasma-Kortisol stieg parallell mit der Blutkonzentration. Die Ausscheidung von 17-KS mit 17-KGS stieg innerhalb der Normgrenzen, dies deutet mit grösster Wahrscheinlichkeit auf eine gesteigerte perifere Ausnutzung des Kortisols. Die Aldosteronausscheidung stieg signifikativ, hielt sich aber innnerhalb der Normgrenzen. Man registrierte eine linear steigende, signifikativ gesteigerte Ausscheidung von Katecholaminen, parallell mit einer Steigerung des Grundumsatzes, einer erhöhten Konzentration der Plasmaphosphate und einer erhöhten Phosphatausscheidung im Urin.

Die Resultate deuten an, dass die gesteigerte osmotische Ausscheidung durch die Niere bei Kälteeinwirkung nicht in erster Hand von der erhöhten Sekretion von TSH, STH, Kortisol oder Aldosteron abhängt.

Auch können die durch Kälteeinwirkung ausgelöste und durch Katecholamine stimulierte Gefässkonstriktion und Wärmeproduktion mit erhöhtem Grundsatz die während der gesamten Kälteperiode vorliegende Diurese-Steigerung und erhöhte osmotische Ausscheidung nicht vollständig erklären. Letztgenannte Parameter erreichten ihren Höhepunkt während des ersten Kälte-Tages im Gegensatz zur Katecholamin-Ausscheidung, die während der ganzen Versuchsperiode successiv anstieg. Dieser Unterschied in den Ausscheidungsverläufen gressivement au cours de toute la période d'expérience. Cette divergence dans les processus de sécrétion indique aussi que la "clearance" osmotique accrue n'est pas directement dus à l'augmentation de la production de catécholamine. Pour éclaircir entièrement la question du rapport de l'augmentation de catécholamine et la diurèse, il faudra pratiquer encore d'autres expériences.

deutet auch darauf hin, dass die Diurese-Steigerung und die erhöhte osmotische "Clearance" nicht direkt von der gesteigerten Katecholamin-Produktion abhängig sind. Zur völligen Klarstellung der Frage, inwieweit ein Zusammenhang zwischen der Katecholaminsteigerung und der Diurese vorliegt, sind jedoch weitere Untersuchungen erforderlich.

MUREN ANDERS & LARS TROELL: Dykerimedicinska kongresser i Marseille och la Spezia

Försvarsmedicin (Stockholm), 7:205–215, 1971

Congresses on Underwater Medicine at Marseilles and La Spezia

International Congresses on Hyperbaric and Underwater Physiology are arranged at Marseilles every third year, and International Symposia on Underwater Medicine at La Spezia every fifth year. The Congress and Symposium which took place in June 1970 were both the third to be held and will next be arranged in 1973 and 1975 respectively.

Apart from the host countries, the USA was well represented at both Congresses and there were also delegates from most Western European countries and some countries in Eastern Europe, although not from the Soviet Union. Discussions comprised primarily matters relating to diving with heliox to extreme depths and problems connected with this. New aspects of treatment for decompression sickness were discussed. Conventional diving was also dealt with, breathing dynamics and problems connected with carbon dioxide being given particular attention. Regulation of temperature and protection against cold were also discussed, as well as problems relating to work under water. Treat-

Congres de medecine sous-marine a Marseille et la Spezia

Un congrès international de physiologie hyperbar et sous-marine est organisé à Marseille tous les trois ans, et un Symposium international sur la médecine sous-marine à la Spezia tous les cinq ans. Les deux derniers, qui sont tous deux tombés en juin 1970, étaient chacun le troisième de leur série; les prochains seront organisés respectivement en 1973 et 1975.

Outre les pays hôtes, les USA étaient bien représentés aux deux réunions où il se trouvait également des représentants de la plupart des pays de l'Europe de l'Ouest et de certains pays de l'Est, excepté toutefois l'URSS. Les discussions ont porté en premier lieu sur la plongée à grande profondeur avec Héliox et les problèmes qui s'y rattachent. De nouveaux aspects du traitement de la maladie des caissons ont été discutés. La plongée classique a été également discutée, l'attention se portant en particulier sur la dynamique de la respiration et sur les problèmes d'anhydride carbonique. Ont été encore discutés la régulation de la température et la protection contre le froid ainsi

Tauchermedizinische Kongresse in Marseille und La Spezia

Alle drei Jahre findet in Marseille ein internationaler Kongress über Hochdrucks- und Unterwasserphysiologie und alle fünf Jahre in La Spezia ein internationales Symposium über Unterwassermedizin statt. Die beiden letzten wurden im Juni 1970 abgehalten und waren die dritten in der Folge; die nächsten Veranstaltungen sollen im Jahre 1973 und 1975 stattfinden.

Ausser den veranstaltenden Ländern waren die USA auf beiden Kongressen neben Teilnehmern aus den meisten westeuropäischen Ländern und einigen Staaten des Ostblockes stark vertreten. Die Sowjetunion nahm jedoch an den Veranstaltungen nicht teil.

Die Themen behandelten in erster Hand das Tauchen in grosse Tiefen mit Heliox und damit zusammenhängende Probleme. Neue Geischtspunkte über die Behandlung der Druckfellerkrankung wurden erörtert, ebenso das herkömmliche Tauchen, wobei der Atmungsdynamik und dem Kohlendioxidproblem besondere Aufmerksamkeit gewidmet wurde. Weiterhin wurden die Temperaturregelung und der Kälment with hyperbaric oxygen was the subject of a number of contributions, mainly by the French delegates.

que diverse problèmes concernant le travail en plongée. Le traitement à l'oxygène hyperbar a été l'objet d'une série de rapports, surtout de la part des Français.

teschutz sowie mit der Arbeit unter Wasser zusammenhängende Probleme besprochen. Einige Vorträge, hauptsächlich von französischer Seite, hatten die Hochdrucksauerstoffbehandlung zum Gegenstand.

LUNDIN GERHARD: The 1971 drug list of Swedish Armed Forces

Försvarsmedicin (Stockholm), 7:217–227, 1971

The Armed Forces' Drug List 1971

A summary of the work behind the new drug equipment for the Swedish Defence Forces.

In 1968 a drug committee was appointed by the Central Military Pharmacy for the purpose of revising the present drug list of the Defence Forces and to work out "The Armed Forces' Drug List 1971". This investigation was limited to the drugs which were to be included from the Soldier's personal equipment up to the level of battalion.

The methodology for the selection of drugs is summarized. The drugs used by the Defence Forces should as much as possible conform with the commonly prescribed drugs. This was also an advantage, since to decrease costs, the drugs to a large extent were to be turned over through the Karolinska Hospital and the hospitals of the Defence Forces.

The major concern of the drug committee was to choose the medically most appropriate drug in each group. Other major aspects have been stability of drugs, necessary emergency supplies and at last the price of a drug.

Liste des medicaments de l'armee 1971

Résumé du travail relatif au nouvel équipement en médicaments de l'armée suèdoise.

En 1968 la Pharmacie Centrale de l'Armée nomma une commission des médicaments qui avait pour tâche de réviser la liste actuelle des médicaments employés par l'armée et de dresser la "Liste des médicaments de l'armée 1971". L'étude n'a porté que sur les médicaments devant faire partie de l'équipement personnel du soldat jusqu'au poste de secours du bataillon.

Nous résumons la méthode utilisée dans le choix médicaments. Les médicaments employés par l'armée devaient autant que possible correspondre aux médicaments prescrits communément. Ceci a un avantage certain permettant de réduire les frais, car les médicaments peuvent ainsi être échangés par l'intermédiaire de l'Hôpital Karolinska et les hôpitaux de l'armée.

Le premier souci de la commission des médicaments fut de choisir dans chaque groupe le médicament le plus indiqué du point de vue médical. Les autres points sont la stabilité des médicaments, les stock nécessaires pour les cas d'urgence et finalement le prix des médicaments.

Arzneimittelliste 1971 der Armee

Zusammenfassung der Arbeit, die für die Arzneimittelausrüstung der schwedischen Armee erforderlich war.

1968 ernannte die Zentral-Armeeapotheke einen Arzneimittelausschuss, dessen Aufgabe darin bestand, die gegenwärtige Arzneimittelliste der Armee zu revidieren und die Arzneimittelliste 1971 auszuarbeiten. Die Untersuchung beschränkte sich auf die Arzneimittel, die zur persönlichen Ausrüstung des Soldaten bis zur Ausrüstung der militärischen Einheiten bis hinauf zum Bataillon gehören sollten.

Die Kriterien, die für die Wahl der Arzneimittel massgebend waren, wurden zusammengefasst. Die von der Armee benützten Medikamente sollen soweit als möglich mit den häufig verschriebenen Arzneimitteln übereinstimmen. Dies ist ein unbedingter Vorteil, denn um die Kosten niedrig zu halten sollen die Medikamente zum grössten Teil durch das Karolinska Spital und die Armeespitäler zurückgenommen und ausgetauscht werden.

Das Hauptanliegen des Arzneimittel-Ausschusses war, in jeder Gruppe das vom medizinischen Gesichtspunkt bestgeeignete Medikament auszuwählen. Andere wichtige Punkte waren die Haltbarkeit der Arzneimittel, die erforderlichen Notfallvorräte und schliesslich der Preis des Medikamentes.

SKOGLUND, HANS GÖSTA: Stabsapotekare – en ny arbetsuppgift

Försvarsmedicin (Stockholm), 7:228–232, 1971

Staff Pharmacist - a new duty

In connection with a re-organisation, implemented in 1969, of the central and regional administrations of the Military Medical Service, a part-time appointment as Staff Pharmacist was created on the staffs of the six Military Commands. The duties of the appointment are to provide expert advice in pharmaceutical matters and to be in charge of the Pharmaceutical Service within the Military Command area - matters which are becoming increasingly important from the point of view of preparedness. More direct contact with the various units within the Military Command areas is also established in this way.

The Author is on the staff of the Southern Military Command at Kristianstad and gives an account of the experiences he gained during a year's work. The introduction gives detailes of the duties in the organisation when this is on a war footing in order that the scope and significance of peacetime duties may be made clear.

Pharmacien d'etat – une nouvelle tache

En liaison avec la réorganisation de la direction centrale et régionale des services de santé militaire, en 1969, un poste à mi-temps de pharmacien d'état-major a été créé pour chacun des six états-majors de région militaire avec mission d'apporter dans la région leur concours d'experts en produits pharmaceutiques et d'y répondre du service pharmaceutique – question de plus en plus importante au point de vue de la préparation de la défense du territoire. Par là est également obtenu un contact plus direct avec les différentes unités de la région militaire.

L'auteur est en service à l'état-major de la région militaire Sud à Kristianstad et relate ses espériences d'une année de travail. Il décrit en introduction les tâches de l'organisation de guerre pour expliquer l'ampleur et l'importance des tâches en temps de paix.

Stabsapotherker – eine neue dienststelle

Im Zuge der im Jahre 1969 durchgeführten Umorganisation der zentralen und regionalen Leitung Sanitätsdienstes wurde ein Halbtagsdienst als Stabsapotheker bei den Stäben der sechs Militärbereiche eingerichtet mit der Aufgabe, Sachverständiger in Arzneimittelfragen zu sein und den Arzneimitteldienst im Militärbereich zu versehen. Diese Fragen gewinnen für die Bereitschaft immer grössere Bedeutung. Ausserdem wird auch eine bessere Fühlungnahme mit den Verbänden im Militärbereich hergestellt.

Der beim Stab des Südlichen Militärbereiches eingesetzte Verfasser berichtet über seine Erfahrungen nach einer einjährigen Dienstzeit. Einleitend werden die Aufgaben im Kriegsfall dargestellt, um den Umfang und die Bedeutung der Friedensaufgaben zu erläutern.

Aktuell debatt

Försvarsmedicin 15.10.1971

Civilförsvaret i totalförsvaret

För drygt tjugu år sedan gav två svenska officerare, en överstelöjtnant och en kapten, gemensamt ut en bok om Nordens frihet, där de pläderade för en effektiv samordning av militära och civila försvarsförberedelser. En gradering mellan totalförsvarets olika grenar var varken möjlig eller nyttig. Alla måste fungera om systemet skall hålla.

Medan överstelöjtnanten och kaptenen vuxit upp till generaler har totalförsvarstanken trängt igenom. De här ovan refererade synpunkterna kan numera betraktas som självklarheter.

Däremot kan man möjligen diskutera vad bokens författare yttrade om funktionsuppdelningen. Det militära försvaret, menade de, skall sörja för det aktiva motståndet mot fienden, medan de övriga grenarna skall ge de väpnade styrkorna sitt stöd och dra försorg om folkets och landets förmåga att stå emot.

Ja, det må vara hänt – i vissa situationer!

Den av riksdagen fastställda formeln för totalförsvarets målsättning står visserligen fast: det är krigsmaktens uppgift att möta ett anfall och förhindra att svenskt territorium besätts, medan det är civilförsvarets uppgift att skydda befolkning och egendom mot skador av fientliga anfall och rädda överlevande vid sådana anfall.

Enkla och okomplicerade direktiv som ger krigsmakten inemot 7 miljarder om året och civilförsvaret 300 miljoner.

Vi som sysslar med de här frågorna till vardags börjar ändå så småningom förstå att gränserna för uppgifter och målsättning mellan systemets skilda delar självklart måste dras upp men att man inte kan ge avkall på enheten. Det vore beklagligt om man i riksdagskorridorerna skulle hänge sig åt uppfattningen att militären skall svara för det här och civilförsvaret för det där. I vissa situationer kan rollerna bli ombytta.

De mycket långsiktiga frågorna beträffande civilförsvarets framtid har ingående analyserats vid den i våras genomförda perspektivplaneringen som spänner över femton år. Den i höst redovisade femåriga programplanen återger civilförsvarsstyrelsens funderingar beträffande den närmaste perioden. Materialet utgörs enkelt uttryckt av en granskning av vad man har och en lista på vad man behöver.

Dagens civilförsvar är till sina huvuddrag uppbyggt mot bakgrunden av 50-talets syn på det framtida krigets karaktär. Studier under 60-talet föranledde vissa omprövningar och justeringar, men någon fullständig översyn av grunderna för planeringen gjordes inte. Civilförsvaret har i stort sett fått nöja sig med att förverkliga intentionerna bakom 1959 års riksdagsbeslut.

Resultatet är – åtminstone ytligt sett – ganska imponerande. Man har skapat nära 4,5 miljoner skyddsrumsplatser. Man har en väl genomförd utrymningsplanering. 86 procent av personalbehovet är täckt i det lokala civilförsvaret – 90 procent i det regionala – och 77 procent i verkskyddet. Man har anskaffat 90 procent av materielen. Hälften av de planerade moderna ledningscentralerna är byggda.

Plus etcetera. Det kan konstateras att det svenska civilförsvaret är av god klass mätt med internationella mått.

Men det är med bristerna som med våra svenska gråstenshällar – man behöver inte gräva så värst djupt för att stöta på dem.

Skyddsrumsprogrammet till exempel.

Källarskyddsrummen under kriget har för länge sen spelat ut sin roll och vi har fått de så kallade normalskyddsrummen – bunkerkonstruktioner i källarnivå. Ett stort antal skyddsplatser, som sagt, och antalet växer med 250 000 varje år.

Men det räcker inte. Sedan 1956 har inga sådana skyddsrum byggts i de fjorton största städernas innerområden. Tvärtom har ett antal tidigare byggda skyddsrum raderats bort i bebyggelsesaneringen. En- och tvåvåningars flerfamiljshus saknar skyddsrum helt och hållet, liksom alla småhus. I själva verket måste skyddet i de största städerna liksom i stora delar av landsorten betraktas som dåligt eller rentav som obefintligt.

Redan för fem år sedan föreslog civilförsvarsstyrelsen åtgärder beträffande innerområdena. Förslaget tillstyrktes två år senare av en departementsutredning, men ännu har inget beslut fattats. Under flera år har man därmed förlorat omkring 2 500 skyddsrumsplatser i månaden i de områden där de bäst skulle behövas.

En annan av huvudpunkterna i civilförsvarsprogrammet gäller skyddsmaskerna.

Låt vara att vi ännu 25 år efter Hiroshima vägrar att inrangera kärnvapnen bland de konventionella stridsmedlen. Egendomligare är att de *kemiska* stridsmedlen betraktas som mindre konventionella än kanoner trots att de med stor framgång användes redan för drygt femtio år sedan och har kommit till användning under både 30- och 60-talet. Kanske influeras beredskapen av den konservativa etiketteringen. I alla händelser föreligger här en besvärande skillnad mellan krigsmaktens och befolkningsskyddets förberedelser, som civilförsvaret är ytterst angeläget att få eliminerad.

Det nya som har hänt är att statsmakterna nu har fått möjligheter till en samordning som avser alternativt utnyttjande av totalförsvarets resurser för att nå hög effekt. Samordningen avser också att fördela uppgifterna och resurserna så att de totala behoven kan tillgodoses på bästa sätt.

I civilförsvarets resonemang ingår åtskilliga önskemål beträffande krigsmakten. Det gäller exempelvis information och utbildning av krigsmaktens personal i fred i civilt räddningsarbete, det gäller ansvaret för bomb-, projektil- och minröjning, det gäller alarmeringsfrågan, där civilförsvaret anser att det militära systemet rimligen måste anpassas till de civila behoven, och det gäller frågan om ytterligare överföringar av värnpliktig personal till civilförsvaret.

Kring offentliggörandet av programplanen har det antytts att civilförsvarsstyrelsen nu går till attack: mot skattebetalare och politiker och militära försvarsfilosofer.

Regeringen hade begärt analys av två kostnadsramar — 118 och 138 mkr/år — men civilförsvarsstyrelsen klämmer till med en egen ram på 154 miljoner och konstaterar att med den kan man ha de nödvändiga anskaffningarna och åtgärderna genomförda i slutet av 80-talet, medan programmet i nästa ram förskjuts till mitten av 90-talet och man med den lägsta ramen åker ett par årtionden in i 2000-talet — beträffande vissa detaljer utan att någonsin nå målet. . .

Trots att civilförsvarets kostnader ju kan betraktas som marginellt obetydliga i jämförelse med krigsmaktens och trots att kommentatorerna hittills överlag tycks anse att organisationen måste få vad den behöver för att funktionerna skall säkras, har det alltså ibland skymtat fram en glimt av kontroversintresse. Civilförsvaret går till anfall mot krigsmaktens miljarder?

Det är naturligtvis inte så.

Det är bara det att den gängse målsättningen börjar kännas alltför officiellt knapphändig och traditionellt innehållslös. Civilförsvaret har en funktion att fylla på alla nivåer. Som fredsbevarande — i det konventionella kriget — i kemiskt och nukleärt krig. Den funktionen har inte bara psykologiska aspekter och innebär inte bara upprätthållande av motståndsvilja och stöd åt krigsmakten utan kan karakteriseras som ett komplex av både krigsavhållande, försvars- och överlevandeeffekter. I många situationer kanske inte så siffermässigt imponerande, mätt under fred, men ändå någonting som aldrig kan bli helt betydelselöst eftersom det är fråga om människoliv.

Ivar I:son Österström

Dykerimedicinska kongresser i Marseille och la Spezia

ANDERS MUREN & LARS TROELL

Sammanfattning

International congress on hyperbaric and underwater physiology anordnas i Marseille vart tredje år och International symposium on underwater medicine i la Spezia vart femte år. De båda senaste, som inföll i juni 1970, var de tredje i raden, och de nästa skall anordnas 1973 respektive 1975.

Förutom världänderna var USA väl representerat på båda kongresserna, men deltagare fanns även från flertalet västeuropeiska länder och från vissa öststater, dock ej Sovjet. Förhandlingarna omfattade i första hand dykning till extrema djup med heliox och därmed sammanhängande problem. Nya aspekter på behandling av tryckfallssjuka diskuterades. Även konventionell dykning behandlades, varvid andningsdynamik och koldioxidproblem ägnades särskild uppmärksamhet. Vidare diskuterades temperaturreglering och köldskydd samt problem i samband med arbete under vatten. Hyperbar syrgasbehandling var föremål för en rad anföranden, huvudsakligen från franskt håll.

Journées internationales d'hyperbarie et de physiologie subaquatique

International Congress on Hyperbaric and Underwater Physiology

Marseille 8–11 juni 1970

Kongressen som anordnats av Faculté de Médecine de Marseille var den tredje i raden. Den senast föregående var 1967 och det uppgavs att den nästa skulle hållas i Marseille 1973. Förhandlingarna pågick i Centre National de la Recherche Scientifique lokaler med 20 minuters föredrag på engelska eller franska. Några 100 delegater från 18 länder var samlade, varav flertalet från USA och Frankrike. Flera av föredragen upptog två eller flera författare, medan endast föredragshållaren har angivits i följande referat.

SESSION I. Les grandes profondeurs (ordf: J.A. Kylstra).

J. Chouteau (Frankrike) redogjorde för anoxiproblemen vid dykning till extrema djup med getter. Vid normal pO_2 på 0.2 ata i helium uppträdde anoxi-symptom vid 50–60 ata. Vid ökning av pO_2 till nivån 0.4 ata hade han kunnat öka djupet till mer än 100 ata, men vid försök som nyligen utförts framträdde EEG-förändringar vid 111 ata. Vid extrema tryck synes således marginalerna för det tolerabla syretrycket minska och han diskuterade möjligheten att gränserna för hypoxi och hyperoxi går ihop vid ett visst kritiskt tryck. En rad tänkbara förklaringar till dessa fenomen diskuterades men någon tillfredsställande lösning hade han ännu icke kommit fram till.

X. Fructus (Frankrike) lämnade en exposé över verksamheten vid COMEX under de senaste två åren omfattande projekten Ludion, Physealis, Pre-Hydra och Janus. Han uppehöll sig särskilt vid HPNS (high pressure nervous syndrom) som synes uppträda med heliox redan på 250–350 m djup. Detta syndrom, som karakteriseras av bl a motoriska rubbningar och EEG-förändringar skiljer sig markant från den djupnarkos som man ser vid luftdykning. Han hoppades det skulle vara möjligt att "push back the HPNS barrier" bl a genom att göra längre uppehåll på mindre djup. Han ansåg det möjligt att nå åtminstone 400 m, och refererade i sammanhanget till den nyligen utförda dykningen till 1500 fot i Alverstoke (se nedan Bennett), men påpekade samtidigt den stora skillnaden mellan dykning i torr kammare och i kallt vatten.

R.W. Brauer (USA) talade också om problemen i samband med HPNS eller "high pressure hyperexatability syndrom" som han föredrog att kalla det. Vid sina ap-försök hade han funnit att symptomen uppträdde redan vid 30 ata med tremor och sedan övergick i konvulsioner på området 60–80 ata. Motsvarande symptom uppträdde vid dykning med hydrox men på ung 10 ata större djup än med heliox.

E.H. Lanphier (USA) redogjorde för det nya kammarkomplexet vid State University of New York, Buffalo. Tryckkapaciteten blir 170 ata och i den liggande kammaren 2x5 m kan, genom två halvcirkulära plexiglasväggar, avdelas en vattenfylld del som är lätt åtkomlig och väl överskådlig från manöverplatsen i den torra delen.

K.W. Miller (England) hade gjort försök på möss med tryck ned till 200 ata varvid såväl tremor som krampgränsen hade bestämts vid användande av olika gaser, helium, neon och kväve. Han ansåg sig ha funnit en kritisk gräns vid ung 120 ata för dessa djur.

J.C. Rostain (Frankrike) redogjorde för de försök som gjorts på Papio-apor med hydrox till 700 m i COMEX regi. Temperaturen hade hållits vid 30° C och gassammansättningen hade kontrollerats kontinuerligt. Vidare hade såväl EKG som EEG registrerats under hela försöket. Kompressionen påbörjades med heliox till 100–200 m, sedan övergick man till hydrox. Kompressionshastigheten 100–200 m/tim, i vissa fall 40 m/tim. Man höll pO_2 i början vid 300 mb men ökade sedan till 400 mb. HPNS-krisen syntes sätta in först på djup 600–700 m.

P.B. Bennet (England) presenterade den 1500 fots mättnadsdykning med människa som utfördes vid Alverstoke i mars 1970. Redogörelsen följdes av en film över dykningen vilken gav en god uppfattning om såväl metodik som resultat. Två civila amatördykare, ålder 21 och 27 år, användes som försökspersoner. Vid denna dykning i torr kammare som inalles varade 15 1/2 dygn skedde kompressionen långsamt och med 1 dygns uppehåll på 600, 1000 och 1300 fot. Av de 24 timmarna på varje nivå åtgick 8 timmar till att utföra en rad test. Avsikten med de långa uppehållen var annars att möjliggöra tillvänjning till djupet vilket bl a märktes på normaliseringen av EEG:t.

F ö gjordes under kompressionen 1 timmes uppehåll på 1100, 1200 och 1400 fot. Vistelsen på 1500 fot var 10 timmar. Dykarnas subjektiva tillstånd var gott frånsett korta episoder med tremor och lätt nausea. Under dekompressionen uppträdde emellertid hos den ene vestibularissymptom på ungefär 1200 fot vilket föranledde rekompression till 1537 fot. Efter kort uppehåll på denna nivå påbörjades åter dekompression i en något långsammare takt än ursprungligen avsett. Dekompressionen pågick under följande vecka i det närmaste linjärt med en tryckminskning på 10 fot/tim. Under sista 2 dygnen skedde dekompression i långsammare takt delvis föranledd av att den ene dykaren då fick bends i ett knä.

I samband med denna rekorddykning utfördes ett oerhört stort antal prov av olika slag. Förutom gasanalyser samt blod- och urinanalyser var såväl EKG som EEG kopplat under hela dykningen och projicerade på ett stort oscilloskop så att man genast kunde se om större förändringar uppträdde. Dykarna fick utföra en rad psykomotoriska test (aritmetik, ball-bearing m fl), och de fick även utföra arbete på en cykelergometer placerad inne i kammaren. Endast en del av det stora materialet var ännu bearbetat, men tydligen förekom inga påtagliga avvikelser från det normala. Det som Bennett uppehöll sig mest vid var EEG:t. Vid direkt inspektion syntes inga avvikelser från det normala men då registreringen var direkt kopplad till en frekvens-analysator (av japanskt fabrikat) framkom, särskilt hos den ene dykaren, klara avvikelser då det gällde theta-vågornas frekvens. En ökad förekomst framträdde särskilt under kompressionen, men en klar återgång mot det normala skedde under de dygns långa uppehåll som nämnts ovan.

V. Conti (Frankrike) hade gjort särskilda undersökningar på fosfo-kalcium metabolismen hos dykare som deltagit i COMEX projekt Ludion och Janus och ansåg sig ha säkra hållpunkter för att denna är rubbad i samband med mättnadsdykningar på 200–300 m djup.

J.M. Canty (USA) som tillhör Lanphier's grupp redogjorde för en rad snillrika tekniska lösningar vid konstruktion av det nya kammarkomplexet vid Buffalo. Han nämnde i samband med detta att dr Lundgren, Sverige är engagerad i projekteringen av en liknande kammare för Oceanic Institute på Hawaii.

J.A. Kylstra (USA) avstod, av okänd anledning, från det annonserade anförandet från sitt eget specialområde (Tolerance to hydralic compression in mammals) och talade i stället om termoreglering hos dykare. Han påpekade vikten av att skilja på värmeledningsförmåga och specifik värme hos gaser, ett förhållande som gör att man kan förlora mer värme via luftvägarna genom att andas luft än heliox.

R.C. Bornmann (USA) redogjorde för excursionsdykning i samband med mättnadsdykning med heliox. Från mättnadsdykningsnivå kan man således dyka till visst större djup under viss tid och återgå direkt. Han presenterade även tabeller som angav de säkra gränserna vid mättnadsdykning ned till 600 fot.

Bornmann nämnde inget om läget beträffande Sealab III i sitt anförande, men vid senare förfrågan angav han att Sealab III med säkerhet icke kommer att genomföras såsom tidigare planerats. Däremot har man börjat planera ett Sealab IV, men några närmare detaljer om tid, djup etc angavs inte.

Diskussionen efter denna session handlade huvudsakligen om HPNS och problem i samband med detta syndrom. Bühlmann berörde den stresseffekt i samband med dykning som ger sig uttryck i ökad utsöndring katekolaminer och även i hyperventilering som i sig sänker kramptröskeln. Han ifrågasatte om HPNS eller He-tremorn kan vara en kombination av dessa två saker. Flera, bl a Brauer, opponerade sig emot denna hypotes. *Schaefer* menade att nedbrytningsprodukterna av adrenalin-noradrenalin möjligen kan framkalla symptom. Det forcerande av "He-vallen" som 1500 fot dykningen i Alverstoke inneburit förbryllade en del och *Naquet* (neurologisk expert vid COMEX-försöken) frågade Bennett ingående om förändringen i theta-vågornas frekvens. *Chouteau* och *Fructus* införde problemen med hypoxi—hyperoxi i sammanhanget. *Brauer* berörde cerebellums och extra-pyramidala systemets engagemang i samband med syndromet.

Någon närmare klarhet i mekanismen för HPNS kom man således icke fram till. Däremot synes de flesta vara överens om att en acklimatisering kan ske, och att man på denna väg har en viss möjlighet att "push back the barrier".

På kvällen efter denna första session var kongressdeltagarna inbjudna till COMEX varvid denna firmas nya anläggningar demonstrerades av dess chef *H. Delauze* och av dr *X. Fructus*. I den stora kammarhallen inleddes just en mättnadsdykning till 70 m med heliox i samband med visningen, därvid användes en talomvandlare för helium som tillverkats av franska IBM. Såvitt man kunde bedöma vid avlyssning åstadkoms en betydande förbättring av talet. Av intresse för övrigt var att den stora hydrosfären med 5 m diameter (bekostad av CNEXO) nu var färdigställd och man kunde genom fönstren se den nedsänkta klockan placerad inuti sfären delvis nersänkt i det "mikrohav" som fyllde sfären till hälften. En detalj som ännu inte var klar var det isolerande lager av ungefär 10 cm tjocklek som skulle läggas utanpå hela hydrosfären.

SESSION II. Le CO_2 et les problèmes du confinement (ordf: A.A. Bühlmann).

K.E. Schaefer (USA) gav en översikt över effekten av ökad pCO_2 i inandningsluften, särskilt avseende långtidsexposition. Han refererade till arbeten av Behnke och Curtis som utsatte försökspersoner för 5 resp 3 % CO_2 under flera dygn utan uppenbara förändringar. Även lägre koncentrationer ger emellertid adaptiva förändringar vid lång tids exposition, vilket han visat i en serie med 1.5 % CO_2 under 40 dygn där försökspersonerna visade en förändring i kalium-natrium omsättningen samt en ändrad kalciumutsöndring. Efter 20 dygn inträffade en kraftig ökning av CO_2-utsöndringen i urinen. Vidare ökade fysiologiska dead space med 50—100 %.

Beträffande den akuta effekten av CO_2 har Schaefer, såsom andra forskare, funnit en klar skillnad på individer med hög CO_2-tolerans typ "low ventilatory rate" (hög tidal volume) kontra de CO_2-sensitiva "high ventilatory rate". Den CO_2-toleranta kategorin finner man särskilt bland tränade dykare, och denna höga tolerans synes vara ett delsymptom av allmänt ökad stressberedskap. Detta har han kunnat visa genom de betydligt minskade svar i form av blodtrycksfall vid injektion av mekolyl som dessa personer uppvisat. Av särskilt intresse var att Schaefer nämnde att CO_2 synes ha större effekt under förhöjt omgivande tryck än vid normalt tryck.

B. Broussolle (Frankrike) lämnade en intressant redogörelse för ergometri i torr kammare med luft på 1, 4 och 7 ata. Såväl dykare som icke dykare hade använts och bestämningar på alveolära pCO_2 hade gjorts vid arbete på upp till 110 watt. Det visade sig att pCO_2 hos dykarna steg till värden över 60 mm Hg (i ett fall 68.4 mm) medan icke dykarna låg på 50 mm eller lägre.

P. Varène (Frankrike) talade om ergometri med max arbete 300 watt vid 1, 2 och 3 ata med pulsbestämning. Ingen skillnad i maxpulsen (ung 200) vid de olika trycken.

G. Uhlig (Västtyskland) redogjorde för projekt Helgoland och visade en film som gav en god uppfattning om konstruktion av det undervattenslaboratorium som Drägerwerk byggt för ändamålet. Mättnadsdykning utfördes på 23 m djup under sammanlagt 22 dygn med tre team sommaren 1969. Dykarna, som huvudsakligen var marinbiologer, utförde arbete i vatten under 1 1/2–3 timmar varje dag. Andningsmediet var luft eller nitrox med O_2-halt 15–25 %, CO_2 0.2–0.3 %. Dekompressionstiden var 24 timmar. Det angavs att sömnbehovet var ökat under vistelsen på botten (9–10 timmar).

A. Muren (Sverige) redogjorde för de försök som gjordes inom svenska marinen för 2–3 år sedan rörande den ojämna fördelningen av CO_2 i dykarhjälmen vilka ledde fram till konstruktion av luftavledningskanalen LUAK som visat sig innebära en klar förbättring av hjälmens ventilation.

Det kan nämnas att särskilt amerikanarna visade stort intresse för denna modifikation och önskemål framställdes att erhålla specifikationer på konstruktionen. Sådana har sedan lämnats, och enligt uppgift i september –70 överväger en amerikansk firma som levererar hjälmar till bl a US Navy att utrusta dessa med LUAK under beteckningen "Swedish Navy Exhaust".

SESSION III. Physiologie et physiopathologie hyperbares (ordf: E.Y. Lanphier).

J.S.P. Rawlins (USA) var ej närvarande själv men hans översikt om köldskydd hos dykare framfördes. Han hävdade att det finns en stor individuell variabilitet beträffande "thermal stress", och att det finns en lång rad problem inom detta område som ännu är olösta. Vad beror t ex köldkollaps inom några sekunder på och hur allvarlig är köldnarkos? Även lokaliserad köld kan ge kollaps. Upp till 1/3 av totala värmeförlusten kan ske via luftvägarna och en direkt skada på luftvägarna genom kylan är även tänkbar. Vikten av rätt metod för uppvärmning efter nedkylning markerades. I US Navy används flushing med upp till 2 gallon/min med vatten av 110^{o} F tills kärnans temperatur börjar stiga.

P.J. Smit (Sydafrika) talade om pulsfrekvens och EKG-förändringar vid fri dykning. Ofta fann man bradycardieffekt i början. Extracystolier relativt vanliga.

J.N. Miller (England) visade med hjälp av vackra diagram och modeller hur man kan beräkna de andningsdynamiska begränsningarna vid olika gaser och tryck samt hur dessa kan läggas till grund för konstruktion av andningsapparater. En begränsning hos lungorna då det gäller expiratoriskt tryck är den kollapsibla delen av bronchialträdet (3:e–4:e generation broncher). Ett expiratoriskt tryck på 35–40 cm vatten kan uthärdas 10 min eller mer om man andas i övre delen av vitalkapaciteten, men som ett rimligt riktvärde anger han 5–10 cm vatten.

C.W. Sem-Jacobsen (Norge) höll två skilda anföranden. Det ena handlade om metodik att direkt registrera uppladdning och ursköljning av vätgas i hjärnsubstans på människa efter tillsats av 3 % vätgas till andningsluften. Materialet hade huvudsakligen erhållits från patienter som opererats för morbus Parkinson med stereotaktisk teknik. Speciella platinaelektroder av mycket fin kaliber infördes i olika delar av hjärnan och gav uttryck för genomblödningen vilken varierade avsevärt mellan olika lokalisationer och under olika förhållanden, exvis under CO_2-andning. Sem-Jacobsen ansåg att metodiken skulle kunna tillämpas på dykerimedicin för att direkt få uppgift om gasuppladdning och elimination från skilda vävnader.

Sem-Jacobsen fortsatte med en redogörelse för den s k "Vesla-Unit", en miniatyriserad EKG/EEG enhet, och resultaten av dess användning på dykare i öppen sjö, dels i Nordsjön dels i Mexicanska Golfen. Själva enheten är stor som två cigarrettpaket och innehåller förstärkare, batterier, skrivare för 4 kanaler och papper. Enheten hade ursprungligen konstruerats tillsammans med E. Kaiser i Köpenhamn för användning på piloter (en film över dessa studier visades senare). För användning på dykare hade en särskild tryckfast behållare tillverkats och elektroderna hade modifierats för att kunna ge störningsfria avledningar från hud omgiven av saltvatten. Detta hade tydligen varit det största problemet. De kurvor som visades från dykningar ned till 600 fot var av god kvalitet utan störningar med 1–2 EKG-avledningar och 2–3 EEG-avledningar. En rad förändringar på EKG:t demonstrerades, omfattande bradycardi samt extracystolier och arytmier vilket tydligen förekom relativt ofta. Även ett fall av övergående ventrikulär fibrillation demonstrerades; dykaren hade i detta fall fått ett plötsligt anfall av trötthet så han fick hjälpas in i klockan. Flertalet registreringar hade gjorts på områden 60–90 m djup (75 st) medan 5 registreringar gjorts på 120–180 m, tydligen Sea-lab dykare. Samtliga dessa senare visade normala EKG- och EEG-kurvor.

R. Pallotta (Italien) talade om möjligheterna för toxisk effekt av inerta gaser efter lång tids exposition vid höga tryck. Uttrycket "hyperbaric wear and tear" användes. Han hade inriktat sig på leverskada och hade studerat 20 professionella dykare med avseende på bl a hyperlipemi. Några övertygande resultat förelåg knappast.

SESSION IV. La maladie de la décompression (ordf: H.R. Schreiner).

G.C. Ricci (Italien) redogjorde under en timme för en lång rad fysiologiska och andra faktorer som kan tänkas inverka på uppkomsten av dekompressionssymptom. Bl a berördes muskelarbete, temperatur, stress, matvanor, fetma, rökning, kaffe, alkohol. Den föga givande översikten var i sin tur ett summariskt referat av ett 100-sidors manuskript som ev kan ha innehållit data av värde.

A.T.K. Cockett (USA) talade om värdet av behandling med dextran resp heparin vid tryckfallssjuka. På basis av ett stort material omfattande 200 hundar, 15 apor och 32 man fastslog han att dextran har en klart positiv effekt vid svåra dekompressionsfall. Bakgrunden skulle vara den uttalade hemokoncentration som inträffar vid tryckfallssjuka. Med 10 min dekompression av hundar efter 60 min på 50 m dog samtliga kontroller medan samtliga dextranbehandlade överlevde. Även heparin 2 mg/kg (hos människa 1 mg/kg) hade gynnsam effekt. Han rekommenderade både rekompression och dextran som rutinbehandling åtminstone vid svårare fall. Normalmolekylärt dextran användes då detta var billigare än rheomacrodex och ansågs ha ungefär samma effekt.

H.V. Hempleman (England) hade komprimerat råttor som dödats och snabbt dekomprimerats för att undersöka lokalisationen av gasbubblor i kärlsystemet. Det visade sig att inga bubblor fanns i pulmonalisvenerna utan ansamlade i aorta med störst förekomst i aortabågen. Konklusionen var att bubblorna som kommer från lungorna transporteras via arteriae bronchiales till aorta.

O.F. Ehm (Tyskland) redogjorde för ett dekompressionsfall med dödlig utgång efter 24 tim i chocktillstånd. Då fallet hade uppvisat omfattande blodkoagulation gjordes försök på kaniner med bestämning av trombocyter och protrombin efter dekompressionsdöd. En minskning i halten av dessa påvisades vilket ansågs tala för att intra-arteriell koagulation hade inträffat.

R.A. Morin (USA) som även tillhör Lanphier's grupp i Buffalo redogjorde för ytterligare en tekniskt avancerad utrustning vid det nya laboratoriet. Denna omfattade en människocentrifug för 7 G med möjlighet att applicera 0.5 ata övertryck i kapseln. I stället för betong som skydd var centrifugen omgiven av en cirkulär vattengrav. Denna avsågs användas som "oändlig" bana vid simstudier där manöver- och observationsenhet genom anslutning till centrifugen kunde följa simmare hela tiden.

Diskussionen rörde särskilt Cockett's anförande. Även om viss skepsis framfördes föreföll flertalet överens om värdet av dextran vid behandling av tryckfallssjuka. *Bühlmann* nämnde att han sedan länge med gott resultat använt plasma vid hypovolemisk chock, men ansåg att dextran borde göra samma nytta. *Perrimond-Trouchet* sa att man vid GERS redan för tio år sedan använt heparin med god effekt i två fall, men att de upphört med denna behandling efter varningar för blödningsrisken. Såväl *Hempleman* som *Fructus* varnade mot att låta dextranet ersätta rekompressionsbehandlingen. *Cockett* svarade att detta inte alls är meningen, utan dextran är ett värdefullt komplement, och för övrigt är det i många akuta fall lättare att få tag på dextran än på en rekompressionskammare. Frågan om dextranprofylax var även uppe till diskussion. *Miller* berörde de risker som rekompression kan innebära genom att bubblornas storlek reduceras så att de kan slinka vidare och fastna i vitala organ såsom hjärnan.

Som avslutning på denna session visade *K.E. Schaefer* en film av stort intresse. Den handlade om det världsrekord i fri dykning till 240 fot djup som utfördes av Croft nyligen under medicinsk ledning av Schaefer. Tidigare har gränsen för fri dykning ansetts ligga vid 30–40 m djup, d v s när totala lungvolymen har komprimerats till residualvolym. Sedan skulle man få tilltagande lungsqueeze. Nu har emellertid fenomenet "blood shift" introducerats vilket enligt Schaefer innebär att under den fria dykningen blod från benen förflyttas till thorax och på detta sätt förhindrar squeeze-effekten på lungorna. Croft själv anser att fri dykning till 90 m skulle vara möjlig. Det kan nämnas att Croft har en vitalkapacitet på drygt 7 lit och kan hålla andan i drygt 6 min. Totala tiden för rekorddykningen var endast 2 min 28 sek då han gick ned hastigt, hängande i en belastad släde som löpte på en lina, och sedan äntrade upp för egen kraft längs linan. Filmen illustrerade även de studier som gjorts i kammare med analys av andning och blodfördelning vid simulerad fri dykning.

SESSION V. Applications cliniques de l'hyperbarie (ordf: R.W. Brauer).

Från franskt håll lämnades ett antal rapporter om experimentella och kliniska erfarenheter av OHP (oxygen high pressure).

R. Benichoux angav god effekt på läkning av brännskador på råttor med kombination av OHP, THAM och penicillin.

P.H. Ohresser redogjorde för lungskador efter OHP där han påvisat förändringar av typ hyalina membraner.

F. Demard redogjorde för det kliniska materialet vid Centre Oxygenetherapie Hyperbare i Marseille där 8000 behandlingar genomförts. Vanligen behandlades 1 timme med 2–3 ata O_2 i 10–15 sessioner. Totalt 9 % komplikationer, flertalet i form av trumhinneskador.

R. Joly visade en film "L'oxygène hyperbare" som visade metodiken vid OHP-behandling.

P. Fructus jr. redogjorde för behandling av cornealtransplantat med syrgas lokalt applicerat genom ansiktsmask. Behandlingen ansågs motverka ödem och grumling av transplantatet.

M.W. Radomsky (Canada) redogjorde för en vacker experimentell undersökning över effekten av katjoner på syrets toxiska verkan såväl beträffande kramper som lungskador. Stora serier råttor hade exponerats för 6 ata O_2 under 60 min och olika doser kobolt, zink, mangan, magnesium, kalium och natrium hade givits. Det visade sig att Mg, Mn och Zn hade skyddande effekt. Mg mest uttalat då det gällde kramper men föga beträffande lungskador. Genom kombination av Mg och Mn kunde ett betydande skydd erhållas såväl mot kramper som lungskador. Preliminära försök med lithium hade givit mycket lovande resultat. Tänkbara mekanismer bakom dessa effekter diskuterades och man fick intrycket att här finns möjligen en framkomlig väg då det gäller det svåra området skydd mot syrgasförgiftning.

SESSION VI och VII.

Oxygene hyperbare et circulation cérébrale (ordf: K.E. Schaefer)
Hyperbarie et conservation des organes (ordf: P.G. Bennett).

Dessa två korta sessioner, där flera av de annonserade föredragen utgått, dominerades av franska inlägg. Dessa var endast till viss del av intresse ur dykerimedicinsk synpunkt.

J. Malmejac lämnade en översikt över cerebrala cirkulationen och inverkan av OHP på denna. Koldioxidens speciella effekt på cerebrala cirkulationen berördes även.

P. Joanny redogjorde för metabolismen i råtthjärna som inkuberats i tryckkammare med O_2 1–10 ata. En imponerande men svårsmält samling data presenterades.

Två rapporter, *du Cailar* och *Goulon* över kliniska erfarenheter av OHP framfördes. Behandlingar med 2–3 ata O_2 under 75–90 min hade använts upp till 3 ggr/dag med 10–20 seanser, i vissa fall ända upp till 50. Resultaten föreföll svåra att bedöma men det angavs att god effekt erhållits i upp till 50 % på ett ganska blandat patientmaterial.

M. Noirclerc presenterade en teknik för konservering av intakta hundlungor i OHP 3 ata för transplantationsändamål. Genom långsam perfusion (100 ml/tim) kunde de hållas viabla i upp till 24 tim, men de uppvisade då elektronmikroskopiska förändringar.

H. Dalmas kunde konservera hundlever i upp till 24 tim vid 2–3 ata och perfusion med bloddextran under förutsättning att temperaturen hölls nere vid 4° C. Om temperaturen steg minskade funktionen snabbt.

R.W. Brauer (USA) redogjorde för en metod utarbetad på början av 50-talet för perfusion av råttlever under tryck 2 ata. Dess funktionsduglighet, som bedömdes genom analys av producerad galla, var intakt under många timmar om plasma användes som perfusionslösning.

Third international symposium on underwater medicine

La Spezia 19–21 juni 1970

De tidigare symposierna har hållits på ön Ustica utanför Sicilien, det senaste 1965. Det nämndes att en tidrymd på 5 år mellan symposierna ansågs lämpligt ur den synpunkt att nya problem och nya resultat då borde hunnit komma fram. Årets symposium var förlagt till Italiens främsta flottbas och förhandlingarna pågick vid Circolo Marina i nära anslutning till flottbasen. President för symposiet var amiral F Baslini. Drygt 60 delegater från 12 länder var samlade. Många av dessa hade även deltagit i kongressen i Marseille en vecka tidigare, och även vissa av anförandena var desamma som framfördes i Marseille. I dessa fall kommer i redogörelsen nedan endast att hänvisas till referaten från Marseille.

Symposiet var uppdelat i åtta sessioner vilka behandlade de olika ämnesområden som föredragits vid förberedande konferensen i Rom 1968. Föredragen var i huvudsak begränsade till tio minuter.

SESSION I

A. Scano (Italien) inledde med en redogörelse över den komparativa fysiopatologin hos rymdmänniskan och dykaren. Han uppehöll sig vid såväl parallellerna som skillnaderna mellan dessa två verksamhetsområden och underströk vikten av att så långt möjligt integrera de medicinska kunskaperna inom dessa två områden. Han underströk att adaptation och acklimatisering till den främmande miljön är av stor vikt.

M. Milani-Comparetti (Italien) talade om genetiska problem i samband med djupdykning. Man vet från experimentellt arbete att extrema tryck kan utlösa genetiska förändringar. Man vet dock f n föga om vilka konsekvenser på lång sikt dykning på de djup som är aktuella för människan kan ha. Man bör dock uppmärksamma flera faktorer i dykarens miljö: det höga trycket, hyperoxi, hypoxi, den artificiella atmosfären etc. Man får också räkna med stora individuella skillnader då det gäller känsligheten för dessa faktorer. Han ansåg att kvinnor under första stadiet av graviditet bör vara särskilt försiktiga. Han efterlyste vidare noggranna studier på däggdjur och särskilt primater.

SESSION II

J. Chouteau (Frankrike) talade om faktorer som begränsar djupet vid mättnadsdykning. Problemen var till stor del desamma som behandlades i Marseille, nämligen svårigheten att balansera mellan hypoxi och hyperoxi vid extrema djup. Studierna var till större delen baserade på försök med getter som utsätts för tryck ned till 111 ata med He/O_2, 21 ata med N_2/O_2 och 16 ata med Ar/O_2. Med normalt pO_2 fick han EEG-förändringar vid 15 ata med nitrox, och trots en ökning av pO_2 till 0.5–0.8 ata avled ett djur i anoxi vid 111 ata med heliox. Han lämnade en särskild redogörelse för de försök på kanin med hydrox till 29 ata som gjordes vid GERS förra året, och som även han var engagerad i. Särskilt på basis av de EEG-förändringar som inträffade drog han konklusionen att hydrox inte är lämplig för mättnadsdykning, möjligen för kortvarig punkt-dykning.

G. Moretti (Italien) hade exponerat kaniner för 9 ata dels med luft, dels med heliox 80/20. De studerades tills de dog av lungskador, och som väntat inträdde den respiratoriska skadan tidigast hos de som uppehöll sig i luft. Däremot visade det sig att lungskadan utvecklades snabbare till dödlig utgång hos de som andades heliox.

P.B. Bennett (England) talade om möjligheterna att motverka inert gasnarkos. Försök hade utförts på råttor i nitrox till 8 ata och graden av narkospåverkan hade bedömts på basis av EEG:ets "visual evoked response" på "flash stimulus". Med utgångspunkt i de klassiska narkosteorierna var avsikten att påverka cellmembranens permeabilitet. Det visade sig också att vissa ytaktiva farmaka i katjonform (steatylamin, cetyl trimetyl ammonium och acetylsalicylsyra) motverkade narkosen. Anjoner hade ingen effekt.

G. Albano (Italien) talade om tryckfallssymptom från centrala nervsystemet och betydelsen av individuell konstitution, acklimatisering, grad av arbete och andningsgas. Han diskuterade de olika faktorerna med avseende på den hastighet med vilken CNS mättas och avmättas med inert gas. Utan att mekanismen klart framgick angavs att de som är tränade i hyperbar verksamhet har ökad resistens mot neurologiska komplikationer. Arbete under dykningen kan påskynda mättnaden med 50 %.

SESSION III

G. Moretti (Italien) redogjorde för 99 fall av tryckfallssjuka hos civila dykare vilka behandlats inom italienska marinen under de senaste 12 åren. US Navy standard rekompressionstabeller, vilka införts 1958, hade använts i flertalet fall. Symptomfrihet erhölls i samtliga fall med bends men endast i 63 % av fallen med neurologiska symptom. De nya syretabellerna enligt Workman-Goodman (tabell 5 och 6) hade även använts i ett antal fall och erfarenheterna av dessa var positiva.

G.C. Ricci (Italien) lämnade två översikter över problem i samband med fri dykning till stora djup. Han berörde den "blood shift" eller "attraction" av blod till bröstkorgen som sker vid fri dykning (ref. K.E. Schaefer i Marseille). För övrigt lämnade han en allmän översikt över en rad olika faktorer som inverkar på människans och de dykande däggdjurens förmåga på detta område.

P. Bennett (England) redogjorde för de fysiologiska metoder som använts vid 1500 fot dykningen vid Alverstoke (se referat Marseille) omfattande blodprov, urinprov, respiratoriska funktionsprov, EEG, EKG samt en rad psykomotoriska test. Han berörde även den heliumtalomvandlare som konstruerats av Gill vilken tydligen fungerade mycket väl. Han nämnde även att dykarna under 5 1/2 dygn befunnit sig på större djup än 1000 fot.

Galeatti (Frankrike) lämnade en överskådlig redogörelse för de olika delsymptomen inom high pressure nervous syndrom (HPNS) och uppehöll sig vid de principiella skillnaderna mellan HPNS och djupnarkos. Han ansåg att erfarenheterna vid COMEX stämmer väl med såväl Brauer's apförsök med hydrox som med Bennet's mättnadsdykning till 1500 fot. Problemen i samband med HPNS kan till stor del undvikas genom långsam kompression med mättnadspauser för adaptation. Han påpekade vidare den stora skillnaden mellan torr och våt dykning.

SESSION IV

D.W. Rennie (USA) talade om effekten av vistelse i vatten på hjärtats frekvens och slagvolym vid vila och arbete. Vid vistelse i vatten med temperatur under 34^{o}C låg pulsfrekvensen 20–25 % lägre än i luft såväl vid vila som vid medeltungt arbete. Först vid tungt arbete (syreförbrukning 3 lit/min) var pulsen densamma i vatten och luft. Såväl hjärtats minutvolym som utandningsluftens pO_2 och pCO_2 var oförändrade. Den perifera vasokonstriktion som utlöstes av kylan ansågs vara orsaken till bradycardin.

A. Muren (Sverige) talade om problem i samband med ergometri i våt kammare och redogjorde för den speciella ergometercykel för detta ändamål som konstruerats och sedan 2 år använts inom svenska marinen. De erhållna resultaten diskuterades i samband med den begränsning av arbetsförmågan som synes föreligga under dykning.

R.A. Morin (USA) redogjorde för den människocentrifug och cirkulära vattengrav som är under konstruktion vid laboratoriet i Buffalo. För övrigt hänvisas till referaten från Marseille.

J.N. Miller (USA) höll också samma anförande som i Marseille om respiratorisk begränsning av arbete under dykning.

SESSION V

R.J. Biersner (USA) hade utfört två olika psykologiska test på 20 professionella US Navydykare och på en motsvarande kontrollgrupp. Resultaten, som bl a skulle innebära att dykarna var mer benägna att ta risker, mer aggressiva och mindre människovänliga än kontrollerna utlöste ett antal protester från auditoriet.

C. Edmonds (Australien) presenterade (genom G. Bayliss) en studie över urval av dykare. Materialet omfattade 500 kandidater i ålder 16—30 år och en rad anatomiska, fysiologiska och psykologiska faktorer hade undersökts. Endast ett fåtal faktorer visade positiv korrelation till framgång inom området. Hög intelligens och låg neuroticism var viktiga personlighetsfaktorer. Av fysiologisk betydelse var maximala syreupptagningsförmågan och simhastigheten. Vidare erfarenhet i dykning och allmänt intresse för vattensport. Faktorer såsom ålder och respiratoriska funktioner hade inte visat sig spela någon avgörande roll.

D. Zannini (Italien) lämnade en redogörelse för värdet av psykologiska attitydundersökningar bland dykare.

X. Fructus (Frankrike) presenterade ett formulär för medicinsk-fysiologisk undersökning av dykare som tillämpats av CMAS och som tydligen använts i flera länder. Förslag till vissa ändringar diskuterades.

SESSION VI

C. Agarate (Frankrike) talade om respiratorisk värmeförlust vid djupdykning. Han nämnde att vid helioxandning på 280 m djup med 40 lit/min motsvarar värmeförlusten via andningsvägarna kroppens totala värmeproduktion. Vid COMEX pågår arbete att utveckla en anordning för uppvärmning av andningsgasen vilket, förutom motverkande av värmeförlusten, bör förbättra dykarens komfort.

J.K. Summitt (USA) redogjorde för bullerskador hos dykare och tryckkammarpersonal. Försök vid EDU har visat att hörselskador är vanliga. Detta gäller även hjälmdykare som undersökts i stor utsträckning. Olika former av hörselskador beskrivs, även en akut nedsättning som återgår viss tid efter avslutad dykning.

R.C. Bornmann (USA) talade om problem i samband med köldskydd och jämförde den torra och våta dräkten. Båda har sina nackdelar och önskemålet är en hel neoprendräkt som är tät och som kan fyllas med luft. Möljligheterna att använda koldioxid eller freon som isolerande gas berördes, men det påpekades att risken för kontamination är en betydande nackdel.

D. Prosperi (Frankrike) redogjorde för COMEX metoder att kontrollera atmosfären i tryckkammare. Separata analysatorer användes för syre och koldioxid (paramagnetisk resp infraröd) och för helium (katapherometer CALDOS III). Vidare användes gaskromatografi och masspektografi. Det nämndes även att analys av kväve innebär särskilda problem.

S. Picard (Frankrike) presenterade den heliumtalomvandlare som franska IBM framställt och som använts bl a av COMEX. Apparatens prestanda demonstrerades med ljudband. Det angavs att det korrigerade talet är begripligt i upp till 75 % för en otränad och upp till 95 % för en tränad. Apparaten är omställbar för olika gasblandningar och djup genom införande av olika elektroniska filter.

J. Parc (Frankrike) presenterade den metod för kontinuerlig dekompression som utvecklats vid GERS. Metoden anses vara mer fysiologisk än etappdekompression och kortare dekompressionstider erhålles. På basis av vissa givna förutsättningar kan dekompressionsprogrammet för viss dykning framräknas datamässigt och trycksänkningen styras automatiskt av datamaskiner.

SESSION VII

E.H. Lanphier (USA) lämnade samma redogörelse som i Marseille om den nya tryckkammaranläggningen till 170 ata vid laboratoriet i Buffalo.

R.C. Bornmann (USA) gav en översikt över nya mättnadsdykningsförsök inom US Navy. Deras deep diving system Mark II är klara för test och träning. Systemet skall installeras på två nya ubåts-bärgningsfartyg av katamarantyp. Ett lättare system Mark I som är luftburet har även utvecklats och prov med detta pågår. Prov pågår även med den nya halvslutna helioxapparaten Mark XI. Sammanlagt 2000 man/dygn mättnadsdykningsprov har genomförts på djup mellan 100 och 1000 fot. Särskilda tabeller för no-decompression excursion dives från mättnadsdjup har framtagits (Bornmann redogjorde för dessa i Marseille) och 1200 dykningar av denna typ har utförts.

G.C. Fasciani (Italien) lämnade en rapport om användningen av Trasylol Bayer, som är en proteinashämmare, för behandling av dysbarism. Enligt uppgift hade denna behandling god effekt vid smärttillstånd, särskilt ledsmärtor, som kvarstod efter rekompressionsbehandling.

SESSION VIII

B.E. Empleton (USA) redogjorde för arbeten att utveckla American National Standards for underwater Recreation. Dessa skulle omfatta renhetskrav på luften, utrustningens prestanda, rapportering av olyckor etc.

R.W. Smith (USA) gjorde en analys av olyckor som förekommit hos sportdykare såväl vid fri dykning som vid SCUBA dykning. Den mänskliga faktorn var klart dominerande och i de fall då ett olyckstillbud lett till en olycka hade minst 2 allvarliga fel begåtts. Ofta rörde det sig om uppenbara brister beträffande teoretiska eller praktiska kunskaper, oförsiktighet eller en felaktig bedömning av läget.

G. Tanzarella (Italien) framlade en rad förslag till nya bestämmelser rörande undervattensarbete. Det gällde särskilt åldersgränserna för olika former av dykning med exempelvis en nedre gräns på 18 år och en övre på 40–50 år beroende på kategori. Vidare max 50 m vid komprimerad luft och max 1 timme dekompression. De holländska lufttabellerna föreslogs som norm. Vid nitrox med högre syrehalt än luft skulle lufttabeller användas med beräkning av equivalentdjup. Med syrgasapparat skulle djupet vara högst 10 m.

Det kan nämnas att dessa förslag utlöste en hel del kritik varvid framgick att de flesta var mer restriktiva än föredragshållaren.

Förhandlingarna avslutades med visning av två filmer:

BENNET: *The record-breaking simulated human dive to 1500 feet* samt
BORNMANN: *The Aquanauts*

Under kongressen besöktes italienska flottans center för undervattens-fysiologi, *COMSUBIN*, jämte dykarskola med en kapacitet för 40 elever per kurs.

Någon verksamhet pågick inte vid detta tillfälle men den nya tryckkammaranläggningen demonstrerades. Denna hade levererats av firma Galeazzi (se nedan) och bestod av en torr tryckkammare för 200 m djup och 7 m^3 rymd med en anknuten våtkammare på 4.5 m^3 rymd för 300 m djup med underliggande våtkammare på 5 m^3 rymd. I utrustningen ingick, förutom TV-övervakning, möjligheter till EKG och EEG-undersökningar under tryck. Försök med mättnadsdykning hade icke utförts vid anläggningen.

I samband med detta besök demonstrerades även en polisen tillhörig räddningsstation för dykarolyckor som bl a var försedd med materiel för en rörlig räddningsgrupp och med en enmanskammare, transportabel på bil.

I samband med kongressen gjordes även besök vid de två ledande italienska firmor för konstruktion av tryckkammare och dykarutrustning.

1) Firma Ditta Roberto *Galeazzi*, Via Oldoini, 75, 19100 La Spezia. Firman som är Italiens äldsta i branschen, är ett familjeföretag som bl a levererat italienska marinens tryckkammaranläggning.

Vid besöket lämnades diverse uppgifter på olika anläggningar bestående av kammare och klocka, avsedda för dykning till 200, 300 och 500 m djup. Som exempel kan nämnas ett kammarkomplex för 500 m djup för helioxdykning med torrkammare, "igloo" och våtkammare (3 resp 3.5 m diameter) samt anslutbar klocka, som nyligen hade levererats till Peru.

2) Firma *Drass*, Ingenjör G Frigeni, Via Venezia 9, 24040-Zingonia (Bergamo) hade en omfattande konstruktionsverksamhet. Hittills hade firman levererat 96 kammare med tillhörande utrustningar till olika länder under de få år firman verkat. En stor anläggning under byggnad för firma Sub Sea Oil Services demonstrerades. Den bestod av två horisontella, med sluss förenade, 500 m kammare med 2 m höjd. Den ena av dessa var via en "igloo" anknuten till en våtkammare för 350 m djup med 6 m höjd. En rad kammaranläggningar för olika ändamål demonstrerades.

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Bokanmälan

R. FAVRE:
L'homme et les catastrophes
Förlag: S.P.E.I. (Paris), 1966, 376 sidor
Språk: Franska
Pris: 81:40 Skr

Författaren till det bokverk som här anmäles är fransk armékirurg med generals rang och professors titel. Boken handlar, som framgår av titeln, om katastrofmedicin och riktar sig till en bred läsekrets av såväl fackfolk av olika slag som till lekmän vilka på något sätt kan tänkas bli engagerade i katastrofarbete.

Genom denna höga målsättning – att rikta sig till läsare såväl med som utan förkunskaper – har boken blivit tämligen omfångsrik och fått karaktären av ett uppslagsverk. Till intrycket bidrar även förhållandet att varje kapitel avslutas med en förteckning över litteraturreferenser.

Bokens innehåll är som sagt katastrofmedicin med en viss tyngdpunkt lagd vid kirurgiska aspekter på ämnet. Inledningsvis görs en genomgång av olika typer av katastrofer innefattande översvämningskatastrofer, bränder, gruvolyckor, vulkanutbrott, jordbävningar m m alltså såväl naturkatastrofer som olyckor framkallade av mänsklig aktivitet av något slag. Kriget som katastrof beskrives medtagande såväl konventionellt krig som krig med ABC-vapen.

Ett kapitel ägnas åt patofysiologiska aspekter på katastrofmedicin. Här presenteras relativt ingående chockens patofysiologi och beskrives i detalj brännskador förorsakade av napalm, fosfor, elektricitet för att nämna några exempel.

Det är klart att kapitlen med mera fysiologisk inriktning – som t ex i fallet "Traumatisk chock" – skulle utformats annorlunda om de skrivits av en med ämnets teoretiska aspekter väl förtrogen forskare. I sådant fall skulle väl även litteraturreferenserna delvis vara av färskare datum. Man bör dock hålla i minnet att boken skrivits av en praktiskt erfaren kliniker och administratör för en läsekrets som behöver fysiologin mera som en allmän orientering. För den som vill fördjupa sig i fysiologin finns bättre böcker.

Katastrofmedicin i krig ges en utförlig belysning dels i ett eget kapitel och dels i de andra sammanhang som behandlas i boken där krigsaspekter har ett intresse. Ämnen av stor betydelse som författaren här tar upp och utförligt diskuterar är sorteringsproblematik ("Triage"), prioriteringar och den sänkta medicinska målsättningens problem vid masskador. Detta kapitel – Logistique et thérapeutique dans les grandes catastrophes – är i mitt tycke ett av bokens bäst skrivna och mest läsvärda.

Boken har som nämnts karaktär av uppslagsverk med ambitionen – som i mitt tycke uppnåtts – att vara såväl relativt fullständig som allsidig. Med denna omfattande utformning är väl boken sådan att den knappast kan rekommenderas att ingå i var mans bibliotek. Det är däremot min uppfattning att den kan vara till god hjälp för den som i tjänsten kommer i beröring med frågeställningar inom försvars- och katastrofmedicin. Den kan därför rekommenderas att ingå i ett katastrof- eller försvarsmedicinskt bibliotek.

Den har därför ett klart värde för var och en som vill tränga in i ett delproblem inom ämnesområdet katastrofmedicin. En hel del av stoffet är så behandlat att det går att använda i undervisningssammanhang.

Peter Westerholm

Försvarsmedicinska forskningsdelegationen tillkännager härmed att ansökan om

Anslag till försvarsmedicinsk forskning

av tillämpningskaraktär för budgetåret 1972/73 skall inges till totalförsvarsmyndighet senast den 1 januari 1972.

Totalförsvarsmyndighet är:

Överbefälhavaren
Ansökan inges till Försvarets sjukvårdsstyrelse, Fack,
104 40 Stockholm 14

Socialstyrelsen
105 30 Stockholm

Civilförsvarsstyrelsen
Fack, 162 10 Vällingby 1

Ansökan skall lämnas på särskilt formulär, som kan erhållas från Försvarets sjukvårdsstyrelse, tel 08/63 01 80, ankn 48, eller delegationen, tel 08/30 06 85.

TIDSKRIFT I MILITÄR HÄLSOVÅRD
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The 1971 Drug List of the Swedish Armed Forces

New instruction for the use of drugs in the Armed Forces

GERHARD LUNDIN[1]

Sammanfattning

I artikeln lämnas en redogörelse för arbetet bakom försvarets nya läkemedelskatalog omfattande läkemedelsutrustningen fr o m enskild soldat t o m bataljon. Förslaget till läkemedel har utarbetats av militärapotekets läkemedelskommitté, som tillsattes januari 1968.

Målsättningen för kommittén har varit att anpassa försvarsläkemedlen så nära de fredsmässigt använda läkemedlen som möjligt.

Urvalsmetodiken beskrives och föreslagna läkemedel presenteras.

History

The previous editions of "Instruction for the use of drugs in the Armed Forces" have been printed in 1942, 1944, 1951 and 1956. The two later editions have included also a number of "non-official military drugs" (the "official military drugs" are those included in the basic supply of the Armed Forces). With each year since 1956, the official drug equipment has been supplemented with a number of new drugs. In 1966, an abstract, based on therapeutic groups of the full line of drugs was printed. This particular list together with the fourth edition of Pharmaconomia Svecica, published by the Swedish Medical Society, has served as a temporary instruction pending the publication of the "1971 Drug List of the Swedish Armed Forces".

Purpose

The main purpose, in the compilation of the new instruction, has been to adapt the drugs used by the Armed Forces as much as possible to the normal civilian use. This aim is motivated by the following two reasons:

Primarily, the physician will, also during war, in his therapy be well acquainted with the drugs. Secondly, there are much less problems involved in the renewal o the emergency stocks of basic drugs.

The Drug Committee of the Central Military Pharmacy (abbreviated MALK) was established in January 1968 to revise the drug supply of the Armed Forces. The MALK Committee consists of representatives of the Central Military Pharmacy, one clinical pharmacologist – also secretary of the Karolinska Hospital drug committee, and one military physician.

The present paper is a report on the first part of the work by the committee, and includes the drug supply from the single soldier up to a battalion. This work was recently completed and the monographs of the drugs are presently being printed. During the fall of 1971 the next stage, comprising drug equipment for a brigade, will be started and with participation of further medical experts.

The proposed drug list will be confirmed by a special Drug Board of the Medical Board of the Armed Forces. This board has a large number of outside experts, representing a variety of

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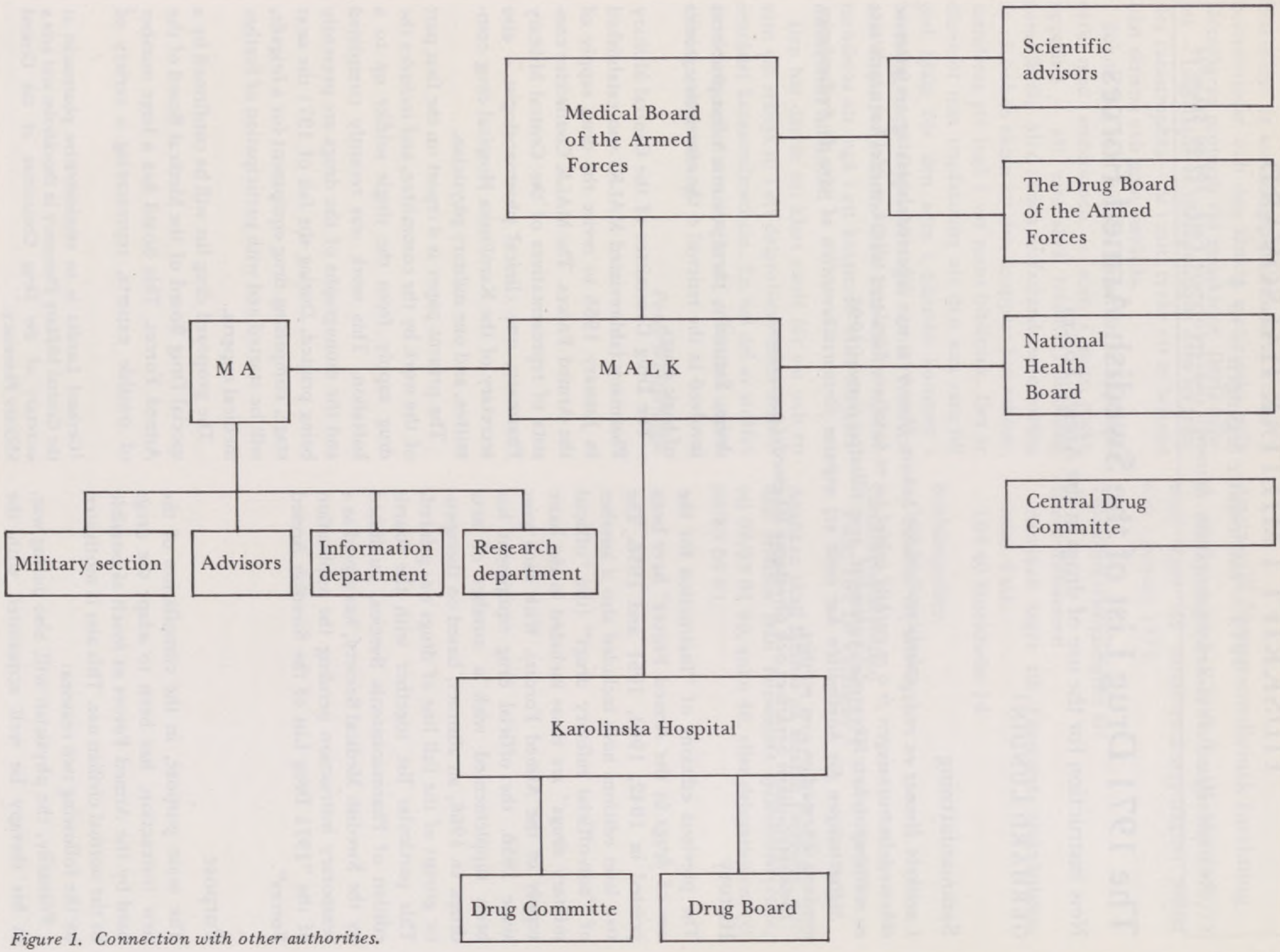

Figure 1. Connection with other authorities.

sciences and activities, available for further consultation.

Principles for selection

The basic principle for the selection of drugs has been to choose, for each indications, the *medically outstanding drug.* In this respect, documentation from the Drug Committee of the Karolinska Hospital has been of great value. The Central Military Pharmacy is the hospital pharmacy of the 2000 bed Karolinska Hospital, which also is the most important teaching hospital of Sweden.

In 1969, the Central Drug Committee of the National Board of Health was started. The purpose of this committee, which enlists the foremost drug experts in Sweden and has considerable resources, is to as objectively as possible evaluate drugs and publish the results. So far (september 1970), the following therapeutic groups have been discussed: diuretic drugs, vasodilator drugs, antacid drugs, anticolinergic drugs, antidiabetic drugs, sedative and hypnotic drugs and antihypertensive drugs.

In a number of cases where several drugs have been judged equally suitable, other factors have decided. One such important factor has been the *"drug tradition"* at the Karolinska Hospital or at the military infirmaries.

Previously, the statistic information on the use of different drugs involved a large amount of work, but in 1967 the Central Military Pharmacy initiated a program for transferring a number of routines from manual to data basis. As a by-product of this, statistic material became available on the consumption of drugs e.g. amount and value of different drugs as well as therapeutic group. The MALK committee could as a result of this follow the consumption of drugs by the Karolinska Hospital as well as by military hospitals. It was evident from the available material that the drug supply of the military hospitals sometimes differs from that of the Karolinska Hospital. This is undoubtedly due to that the former have a more homogenous patient material of policlinical character.

The *stability* of a drug has been another important factor in the selection of drugs. As long shelf life as possible is advantageous to minimize the number of renewals of emergency stocks.

The *drug package* should, if feasible, be adopted for use in the field. MALK has in general been concerned with suitable sizes of drug packages and has been involved in the design of new packages.

It is further preferable that the drug can be produced under *emergency conditions.*

Finally, if all other factors have been equal the *price* has been the decisive point.

Personal field kit

In the Swedish Armed Forces each soldier will be able, if necessary, to administer to himself a nerve gas antidote. Hence, each soldier is equipped with an autoinjector, which consist of a rear part with a spring and two forward parts with plastic ampoules and cannula. Each ampoule of 1,5 ml contains 150 mg obidoxim[1] (Toxogonin®) and 2 mg atropine sulphate. The kit further contains skin ointment, 10 halazone techniquettes for water purification and, when necessary, a mosquito preventive.

Medical kit for section commander, ambulance man and medical orderly

This kit is supplemented with a few simpler drugs like 2 x 6 aspirin – codeine tablets (aspirin 0,5 g, codeine 10 mg), 25 ml of benzalkonbenzocain-ointment and finally 3 x 10 quillaia lozenges (containing codeine 6 mg, ammonium chloride and tincture of quillaia). The ointment, containing a water-soluble ointment base (macrogol 400 et 300), is easily removed by washing. This kit is already included in the drug equipment of the Armed Forces.

The old kit contained coffein, noscapine and bismuth lozenges. However, in severe exhaustion coffein is not sufficiently stimulating and has consequently been deleted in the new proposal. Amphetamine cannot be included at this level for obvious reasons. Noscapine has been replaced with an expectorant (Quillaia). Attacks of diarrhoea should not be treated at this level whether due to infection or psycholo-

[1]INN or NFN nämes are used throughout.

gical reasons and bismuth is therefore now emitted.

Combat drug kit

A special kit has been developped for the treatment of cold, cough and pain in resistance nests and includes:

Aspirin – codeine tablets	3 x 6
Quillaia tablets	3 x 10
Noscapine tablets	2 x 10
Sedisonal® NAPA[x] tablets	2 x 20

[x] (Aprobarbital 56 mg, codeine 9 mg, paracetamol 0,2 g, aspirin 0,25 mg)

Sedisonal® NAPA has been chosen also on account of the barbiturate content, which is suitable for the treatment of insomnia due to pain.

Drug kit for medical orderly

The medical orderly should be able to treat wounds, pain, anxiety, infections in the respiratory tract and gastro-intestinal disorders. For the treatment of wounds the following drugs have been proposed: bensalkon-benzocain ointment, benzalkon solution 0,1 %, concentrated benzalkon solution 10 % and Nebocetin® spray (bacitracine and neomycine). Investigations are in progress on the possibility of replacing the benzalkon containing solutions with a thixotropic benzalkon gel. Pain will be treated with aspirin – codeine tablets and morphine ampoules 1 %. These latter ampoules will be of the same type as used for Toxoginin® and administered with a special plastic syringe adapter. Papaverine tablets are suggested as spasmolytic agent. Hexobarbital tablets are proposed as hypnotic. In cases of more severe anxiety morphine can be used. Quillaia tablets can be used for minor respiratory affections. Novalucol® (aluminium-magnesium carbonate) has replaced the earlier antacid sodium bicarbonate tablets. In cases of severe diarrhoea 30 mg opium tablets are available.

Figure 2. Case, containing the ampoules in the physician's hit.

Physicians Drug kit

The drug kit of the physician is intended primarily for emergency use. For sick calls the kit should be supplemented with aspirin, charcoal, quillaia, Novalucol®, Otrivin® (xylometazoline) spray and phenoxymethylpenicillin.

Apart from the indications treated also by the medical orderly, the physician should also treat acute cardiac failure, cardiac arrythmias, convulsions, hemorrhagic shock, anaphylactic shock, asthma, pulmonary oedema and fatigue.

For desinfection, Desetanol N (ethyl alcohol containing 0,1 % benzalkonchloride) will be used. Pain can be treated with aspirin-codeine, morphine ampines and morphine ampoules 1 %, pethidine ampoules 5 % (Meperidine®, Dolantine®). The morphine ampine is intended for wounded which, awaiting transport, themselves can administer the pain reliever. One analgesic (Sedyl® NAPA-aprobarbital 20 mg, codeine 5 mg, aspirin, paracetamol 0,25 g) and one hypnotic drug (Sedisonal® NAPA) with sedative effect have been included.

For the treatment of anxiety, the following drugs are available to the physician: hexobarbital tablets, Hypnofen ampoules (aprobarbital

0,1 g, barbital 0,1 g), promethazine ampoules 2,5 % and thiopental sodium ampoules 1 g. The indications for thiopental, which is a short-acting anaesthetic, are severe anxiety and pain-relief at intubation. Phenoxymethylpenicillin tablets are available as antibiotic and papaverine tablets 40 mg (compare the kit for medical orderly) and atropine tablets 0,5 mg as spasmolytic agents. Opium tablets 30 mg are to be used for severe diarrhoea. Acute cardiac failure can be treated with Cedilanid® (Lanatosid C) ampoules 0,2 mg/ml and morphine. The Hypnofen ampoules can further be used for convulsions and possibly for cardiac arrythmias. However, for reliable diagnosis of cardiac arrythmias an ECG is needed.

An α-receptor stimulating agent – metaraminol ampoules 1 % – is included but, when used for the treatment of hemorrhagic shock, must be administered at an early stage to preserve the volume of the circulating fluid. Anaphylactic shock and asthma can be treated with adrenaline, hydrocortison, calcium, promethazine and theophyllamine. Lasix® (furosemid) is included for use in acute pulmonary oedema and finally amphetamine tablets 50 mg to counteract physical and psychological fatigue.

A special case has been designed to contain all ampoules in the physician's kit. (Figure 2)

Drug equipment for battalion

At the battalion dressing-station the following medical procedure can be carried out:

first aid by physician;
free respiratory system;
tracheotomy;
treatment of hemmorrhage;
shock treatment (i.v.);
pain relief;
treatment of infections;
treatment of injuries due to nerve gases and blistering agents;
medical care for patients which can return to battle after 1–3 days of treatment (50 temporary beds);
sedation of psychical cases;
dental care;

In the selection of drugs for the battalion the committee has followed the indication groups based on the pharmacologic-clinical system used by Pharmaconomia Svecica. Corresponding system is also adopted by FASS (Pharmaceutic Drugs in Sweden).

Indication group 1 (Drugs for treatment of diseases of the respiratory tract).

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Adrenaline amp. 0,1 %	5 x 1 ml	1	Epinephrine (USP)
Ephedrine tabl. 20 mg	100	1	
Expigen® syrup (Pharmacia)	100 ml	24	Sorbimakrogoli (=Polysorbate BAN, USP) and amm. chloride
Hydrocortisone, watersoluble	100 mg	5	
Quillaia tabl.	50 x 10	6	Codeine phosphate 6 mg, amm. chloride and Quillaia tincture
Noscapine tabl. 25 mg	100	1	
Theophyllamin amp. 20 mg/ml	10 ml	10	Aminophyllinum (BP, DCF, Gall, USP)

Indication group 2 (Cardiovascular and diuretic drugs).

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Cedilanid® amp. 0,2 mg/ml (Sandoz)	6 x 2 ml	1	Lanatosidum C
Digoxin tabl. 0,25 mg	100	1	
Metaradrin amp. 1 %	3 x 1 ml	2	Metaraminoli bitartras (BAN, USP)
Glyceryl trinitrate 0,5 mg (ACO, Leo)	100	1	Resoriblettae glyceryli nitratis
Lasix® amp. 10 mg/ml (Hoechst)	5 x 2 ml	1	Furosemide

Note: Drugs for the treatment of hypertension appear first at the brigade level.

Indication group 3 (Parenteral nutrition, electrolytes, etc.)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
ACD-solution	100 ml in 500 ml plastic package (Fenwalsyst)	50	Anticoagulant acid citrate dextrose solution

Drug	*Package of*	*Number*	*Synonyms, Constitutents, etc.*
Macrodex® 6 % with 0,9 % sodium chloride (Pharmacia)	500 ml	42	100 ml = Dextran 70 (Pharmacia) 6 g, sod.chloride 0,9 g
Sodium chloride, isotonic	500 ml	10	Infundibile natrii chloridi isotonicum
Sodium bicarbonate, stock solution for injection 0,6 M	450 ml	3	Diluendum natrii bicarbonatis 5 %
Ringer-lactate – solution for injection	1000 ml	16	1000 ml = Na 130,4 mekv Ca 3,6 mekv K 4,0 mekv chloride 110,3 mekv lactate 27,7 mekv

Indication group 4 (Antiallergic drugs)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Calcium gluconate, amp. 10 %	5 x 10 ml	2	Calcii gluconas
Marziné® tabl. 50 mg (B.W. & Co)	10	10	Cyclizinii chloridum (BP, DCF, USP)
Promethazine amp. 2,5 %	10 x 2 ml	2	Promethazini hydrochloricum (BP, USP)
Promethazine tabl. 25 mg	100	5	

Note: 1. Marziné® is indicated for motion sickness. Compare also group 11. By the selection of drugs for motion sickness, the following requirements were evaluated:
Rapid onset, duration about 6 hrs, minimal central depressant action.

2. Promethazine appears also in group 11 and 16.

Indication group 5 (Drugs for gastrointestinal diseases)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Acetphenolisatin tabl. 5 mg	100	1	Diphésatine (DCF), oxyphenisatin acetate (USAN)
Atropine, injection 0,1 %	20 ml	50	
Atropine, tabl. 0,5 mg	100	1	
Egazil Duretter® tabl. 0,2 mg (Hässle)	100	3	Hyoscyamini sulfas (slow release)
Phthalylsulphathiazole tabl. 0,5 g	100	10	

Drug	*Package of*	*Number*	*Synonyms, Constituents etc.*
Rectal suppositories for haemorrhoids, pain relieving	10	3	Benzocaine 0,3 g zincoxide 0,5 g Peru Balsam 0,2 g
Charcoal tabl. 0,25 g	500	2	Adsorbent charcoal.
Novalucol® tabl. (Hässle)	100	3	Al-hydroxide/Mg-carb.
Opium tabl. 30 mg	20	5	
Papaverine tabl. 40 mg	100	3	
Relaxit® supp. (Pharmacia)	20	1	Na-bicarb., K-bitartr., Ca-silicate, etc.
Magnesium sulphate	100 g	1	

Note: Atropine injection also appears in group 17.

Indication group 6 (Drugs for hematologic disorders and malignant tumors)

Drugs in this indication group do not appear below brigade level (heparine, aminocaproic acid and tranexamic acid).

Indication group 7 (Chemotherapeutics)

Drug	*Package of*	*Number*	*Synonyms, Constituents etc.*
a. Sulfa drugs			
1. Sulfa drugs with short duration			
Sulfaisodimidine tabl. 0,5 g (Elkosin® CIBA)	50	4	Sulfisomidinum (DCF, NND) sulphasomidine (BP)
Sulfaisodimidine amp. 0,2 g/ml (Elkosin® CIBA)	5 x 5 ml	5	Sulfisomidinum (DCF, NND) sulphasomidine (BP)
2. Sulfa drugs with long duration			
Sulfadimethoxine tabl. 0,5 g (Madribon® Roche)	50	2	
3. Poorly absorbed sulfa drugs			
Phthalylsulphathiazole tabl. 0,5 g (Sulftalyl® Pharmacia)	100	5	
4. Combined sulfa drugs			
Sulfapral® tabl. (Astra)	100	1	Sulfamethizole 0.4 g sulfamethoxypyridazine 0,1 g
b. *Antibiotica*			
Phenoxymethylpenicillin tabl. 0,3 g (Penicillin V tabl.) 455.000 IE	100	5	
Buffered benzylpenicillin solution (Penicillin G sodium) 5 milj. IE dry powder	6	2	
Penicillin G sodium 1,0 MIE, procaine penicillin G 1,2 MIE (Gonocillin® amp., Leo) comb. pck.	5 x (I + II)	2	
Tetracycline tabl. 0,25 g	100	2	

Note: Gonocillin® was suggested for the treatment of gonorrhoea in accordance with the directions of the National Board of Health (MF 25/1963).

Indication group 8 (Antisera, immunglobulins, vaccines)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Diphteria and Tetanus vaccine, SBL	10 ml	5	Vaccinum diphtericum et tetanicum
	50 ml	1	

A separate study group is presently evaluating antisera and vaccines and their recommendations may necessitate changes.

Indication group 9 (Vitamins, etc.)

The multivitamine tablets will, during war, be included in the food rations.

Indication group 10 (Hormones, etc.)

At the batallion level, only water-soluble hydrocortisone 100 mg (Syn. Solu-Cortef® Upjohn, Solu-Glyc., Acto-cortin®) is included.

Indication group 11 (Sedatives, tranquilizers, drugs for psychiatric disorders)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Amphetamine tabl. 5 mg	20	3	
Diazepam tabl. 2 mg	100	1	
Hexobarbitone tabl. 0.25 g	10	4	Hexobarbitalum (DCF, NF)
Hypnofen amp.	5 x 2 ml	2	Allypropymalum (= aprobarbitalum DCF, NF), diemalum (=barbitalum DCF) ana 0,1 g
Marziné® Tabl. 50 mg (B.W. & Co)	10	10	Cyklizinii chloridum (BP, DCF, USP)
Meprobamate tabl. 0,4 g	100	1	
Amobarbitone tabl. 0,1 g	100	5	Amobarbitalum (DCF, USP), amylobarbitone (BP)
Promethazine amp. 2,5 %	10 x 2 ml	2	
Promethazine tabl. 25 mg	100	5	
Suxamethonium iodide 0,1 g (Celocurin® jodid Vitrum)	10 x 0,1 g	1	Suxamethoni jodidum (BP, DCF), succinylcholine (USP)
Pentothalsodium (Abbott)	5 x 1 g	2	Thiopentalum natricum (DCF, USP), thiopentone sodium (BP), penthiobarbital sodique (Gall)

Note: Marziné® appears also in indication group 4, Pentothalsodim indication group 12 and Promethazine in indication groups 4 and 16.

Indication group 12 (Analgesic and anesthetic drugs).

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Aspirin tabl. 0,5 g	50	3	Acidum acetylsalicylicum 0,5 g
Aspirin and codeine tabl.	600	1	Acidum acetylsalicylicum 0,5 g, codeini phosphas 10 mg
Anervan® Supp. (Kabi)	10	1	Ergotamin. tartr. 1 mg, chlorcyklizin. chlorid 20 mg, coffein. 0,1 g, meprobamat 0,2 g
Anervan® Drag. (Kabi)	20	1	Ergotamin. tartr. 0,5 mg, chlorcyklizin. chlorid. 10 mg, coffein. 50 mg, meprobamat 0,1 g
Lidocaine injection 2 %	20 ml	1	Lidocaine chloridum (USP)
Lidocaine ointment	35 g	2	Lignocaine Hydrochloride (BP, DCF)
Lidocaine-adrenaline injection 0,5 %	50 ml	5	
Morphine ampine 10 mg	1	50	
Morphine amp. (plastic) 1 %	10 x 1 ml	15	
Anaesthetic ether	100 g	2	Aether ad narcosin (Ph. Nord), anaesthetic ether (BP 58)
Sedisonal® NAPA tabl. (Leo)	50	4	Aprobarbital. 56 mg codeine 9 mg, paracetamol 0,2 g, aspirin 0,25 g, magn. ox. pond. 20 mg
Sedyl NAPA tabl. (Leo)	50	4	Aprobarbital 20 mg, codeine 5 mg, paracetamol 0,2 g, aspirin 0,25 g, magn. ox. pond. 20 mg
Tanderil® tabl. (Geigy)	100	1	Oxiphenbutazonum (BAN, NND), oxyphenbutazone
Pentothalsodium (Abbott)	5 x 1 g	2	
Trafuril® topical cream (CIBA)	50 ml	5	

Note: Pentothalsodium is also included in group 11, lidocaine ointment in group 16.

Indication group 13 (Drugs in obstetrics and gynecology)

At the brigade level Methergin® (=Methylergometrine maleas) amp. 0,2 g/ml is included for postabortal and postpartum use and reserpine and/or Nepresolin® (Dihydralazinum) amp. 25 mg for treatment of hypertension.

Indication group 14 (Drugs in otolaryngology)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Adrenaline solution 0,1 %	10 ml	1	Solutio adrenalini 0,1 %
Benzocaine lozenges	10		Benzocainum (BP, NF), aethylis aminobenzoas (Ph. Int.), ethoforme (DCF)
Histason® tabl.	25	1	N-hydroxiaethyl-promethazin.chlorid 15 mg, ephedrin. sulf. 10 mg
Jodopax® solution (Ferrosan)	25 ml	1	One jodophor, 5 %-solution of iodine
Chromic acid	5 g	1	Chromi trioxidum (Ph Nord), acidum chromicum (DAB 26, Helv 33)
Quillaia lozenges	50 x 10	2	Codeine phosph. 6 mg, amm. chloride 75 mg, tinct. Quilla. 75 mg, sacchar. 0,45 g, extr. glyc. sol. 60 mg, aetherol. anis. 5 mg, tolu balsam. 2 mg
Lidocaine solution 4 % (Surface anaesthesia)	100 ml	1	Lidocaini chloridum (USP) Lignocaini hydrochloride (BP, DCF)
Otrivin® spray (CIBA)	10 ml	20	Xylometazolini chloridum (BAN, DCF)
Sodium carbonate, anhydrous	20 g	1	Natrii carbonas technicus siccatus
Strepsils® lozenges	24 x 4	4	2,4-Dichlorphenylcarbinol 1,2 mg, 5-methyl-2-pentylphenol 0.6 mg, acid tartr. 30 mg, sacch., aroma, glycos liq. et color q.s.

Note: Histason® is indicated under allergic rhinitis.

Indication group 15 (Ophtalmologicals)

The following ophtalmological treatment can be adminstered:

Removal of foreign materials from the eye (gas, irritating liquids, particles) by irrigation.

Treatment of superficial, not infected wounds of the corneous tunic conjunctiva and eyelids.

Treatment of minor, acute and chronic conjunctival infections.

Treatment of stye.

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Bibrocathol eye ointment 5 %	10 ml	5	Oculentum bibrocatholi
Fluorescein eye drops 1 %	10 ml	1	Oculoguttae fluoresceini 1 %
Lidocaine eye drops 4 % (Xylocain®, Astra)	,4 ml	2	Lidocain.chlorid. anhydr. 40 mg., methylcellulose 6,5 mg, bensalkon. chlorid. 0,02 mg, aq. steril. q.s. ad 1 ml
Sodium chloride, isotonic	500 ml	10	Infundibile nahii chlorieli isotonicum
Zinc eye drops	10 ml	2	Oculoguttae zinci (Ph. Nord), oculoguttae zinci boricae (DAN 48)

Note: Sodium chloride appears also in group 3.

Indication group 16 (Drugs for dermatologic disorders)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Aluminum acetotartrate soultion 50 %	250 g	1	Solutio aluminii aceto tartratis 50 %
Amyceni conspergens	150 ml	2	Conspergens amyceni (acidum salicylicum 5 g, aethyli paraoxibenzoas 5 g, talcum 90 g)
Benzalconium benzocaine cream	25 ml	10	Unguentum benzalconi cum benzocaino
Handbalsam MA	100 g	2	(Aetherol, rosae artific 0,12 g, propyli paraoxibenzoas 0,15 g, spir. conc. 1,5 g, triaethanolaminum 1, 5 g, vaselinum 5 g, acid stear. 10 g, cetaceum 10 g, glycerinum 10 g, ol. arach. 10 g, aq. purif. ad 100 g)
Skin ointment	10 ml	10	Sebum protegens (acidum citricum 0,01 g, propyli gallas 0,006 g, vanillinum 0.024 g, spir. conc. 0.09 g, cera flava 24 g, sebum 38 g, ol. arach. ad 100 g)
Potassium permanganate	500 g	1	Kalii permanganas
Lidocaine ointment 5 %	35 g	2	Lidocaini chloridum (USP)
Nebocetin® dusting powder, spray (Lundbeck)	10 g	5	Neomycinum and bacitracinum (BP, DCF, USP)
Promethazine tabl. 25 mg	100 st	5	
Salicylic acid dusting powder	100 g	5	Conspergens talci salicylatum (ac.salicyl 3 g, amylum tritici 10 g, talcum ad 100 g)
Synalar® with chinoform ointment (ICI)	5 g	5	100 g: Fluocinolon, acetonid. 25 mg, clioquinol 3 g
Talc	100 g	1	
Tenutex® (Pharmacia)	25 ml	10	100 g: Chlorphenethan (DDT) 0,5 g, disulfiranum 2 g

Note: Promethazine is included in group 11, lidocaine in 12.

Indication group 17 (Antidotes)

Drug	*Package of*	*Number*	*Synonyms, Constituents, etc.*
Atropine injection 0,1 %	20 ml	50	
Autoinjector (Toxogonin® 150 mg, atropine sulphate 2 mg)		1	
Charcoal tabl. 0,25 g	500 st	2	Carbo medicinal. 0,25 g
Nalorphine amp. 10 mg/ml	5 x 1 ml	2	Nalorphini chloridum
Physostigmine tabl. 3 mg	25 st	1	Physostigmine salicylate (USP)
Pralidoxime tabl 0,5 g	12 st	1	Pralidoxime chloride

Note: Atropine injection and charcoal appear also in group 5.

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Stabsapotekare – en ny arbetsuppgift

HANS GÖSTA SKOGLUND[1]

Sammanfattning

I samband med en år 1969 verkställd omorganisation av den militära sjukvårdens centrala och regionala ledning tillkom deltidsbefattningen som stabsapotekare i de sex militärområdesstaberna med uppgift att vara expert i läkemedelsfrågor samt svara för läkemedelstjänsten inom militärområdet – frågor som ur beredskapssynpunkt får allt större betydelse. Härigenom uppnås även en mera direkt kontakt med de olika förbanden inom militärområdena.

Författaren tjänstgör vid Södra militärområdesstaben i Kristianstad och redovisar erfarenheter från ett års arbete. Inledningsvis redogörs för uppgifterna i krigsorganisationen för att klargöra fredsuppgifternas omfattning och betydelse.

Staff Pharmacist – a newly created post in Sweden

Following His Majesty's approval on the 13th June 1969 of the new regulations for the organisation of the central and regional command of the Medical Corps, the post of Staff Pharmacist was created in each of the 6 commands as from the 1st of July. This new appointment would be attached to the Command's Health and Medical Section under the command of the Senior Medical Officer.

The appointment will entail 7 hours per week for all commands except Upper Norrland where the period is limited to 3 hours on account of the close link with the Senior Staff of the Military Pharmacy in Boden which lies very near the command base. The emoluments for these services are 15,300 and 6,960 crowns per year respectively. The six commands have thus now in addition to the existing medical, odontological and vetinary expertise also acquired pharmaceutical specialists.

The appointment of these pharmaceutical advisers was preceded by several years of investigation. It was planned at first to create half time posts with one experimental full time staff appointment.

The proposal of the Supreme Commander of the Armed Forces which was finally implemented was that which I have already outlined. It was also proposed that the Staff Pharmacists should, similarly to certain appointments at the Military Pharmacy be accorded civilian-military status and thereby be included in the newly created Medical Defence Corps. This proposal has in principle been accepted by the Supreme Commander of the Armed Forces but at present it is not considered workable.

Duties in wartime

The duties in peacetime must be related to those in wartime – and I shall briefly penetrate these aspects.

The staff pharmacist acts as director of the supplies for the maintenance section (section 2) of the medical department. He is responsible for the operational (tactical) supply services and administrative duties within his sphere. It should be noted that this includes both medical supplies and pharmaceuticals. In addition blood, fluids and to a certain extent water supplies are included.

Within the operational sector, the pharmacist shall advise on matters within his jurisdiction and his suggestions will after discussion at the various levels become standing orders.

These recommendations will in particular concern the use of the resources with special reference to the military situation. Continual collaboration with the civilian authorities will be necessary and he must therefore participate in discussions of the regional medical department. It is thus evidient that one of the most

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important tasks for the appointee is to coordinate the activities of the military and civilian authorities.

The administrative and technical functions will be directed towards establishing adequate resources and also making the best and most advantageous use of the existing pharmaceutical service.

Duties in peacetime

The duties of the Staff Pharmacist lie within the four following spheres:

Preparation for war
Preparation for mobilisation
Formation and education of units
Administration

I have mentioned earlier that the wartime duties of the Staff Pharmacist, especially in connection with operational supplies, will be extensive and varied. In peacetime, the corresponding duties will comprise participation in the organisation of the wartime medical services and compilation of the command standing orders which will be enforced at the start of hostilities providing nothing untoward occurs. With the increasing importance of pharmaceuticals, the pharmacist with his expert knowledge will become an important link – a fact which was clearly recognised by the creation of these new appointments.

Even during peacetime continual collabration with the civilian authorities must be maintained in order to make best possible use of the national resources.

The Staff Pharmacist must also assist the Senior Med. Officer in the preparations for mobilisation – in particular the location of stores for medical supplies and drugs following the regulations laid down for the storage of drugs and dangerous substances and the safety requirements for narcotic drugs.

Formation organisation of units

Two important activities fall under this heading firstly, educational services and secondly, medical services in the unit. The Staff Pharmacist should assist in the professional training of doctors, dentists and pharmacists where such training concerns military matters. Similarly he should also plan lecture courses and practical demonstrations for the other medical personnel and arrange special training during unit manoeuvres excercises.

In peacetime, it is the responsibility of the pharmacist to check the drugs used for daily treatment in the medical unit, to see that the existing regulations are complied with and also to coordinate the inspections of the command hospitals (medical centres) by the pharmacists. Another important activity is to maintain regular contact with the doctors and nurses at the unit assisting with advice, directives and information on pharmaceutical matters.

Many duties and questions which were previously dealt with by the Central Military Pharmacy in Stockholm are now solved more simply regionally even though this decentralisation of offices cannot attain full effect until the staff pharmacist's hourly week is increased considerably.

Administration

The administrative duties of the staff pharmacist are essentially to ensure that military practice conforms with the existing regulations. The nature and extent of the duties are best illustrated by the following provisional orders issued by the Southern Military Command. The Staff Pharmacist –

- will be called upon to advise in matters concerning drugs and medical supplies. He must keep abreast with developments in pharmaceuticals and must assist in the planning of peacetime activities and in the preparations for mobilisation and war. It is particularly vital that he maintains contact in these activities with the civilian planning authorities.
- will be responsible for all technical aspects of drug use arising at the command administration and conduct inspections of the drug supply services in the military units within the Command.
- will be concerned in the formulation of directives and instructions dealing with drugs

in peacetime and during preparations for mobilisation and war. This will include such items as estimating demand, purchasing, storing, turn-over, discarding old stock and concealment (disposition) of stock within the command.

- assist in the review by the Commanding General and his staff of those aspects of the preparations for mobilisation and war concerned with drugs and medical supplies.
- ensure that central directives and instructions for drugs are compiled with at the Command Medical Units and where necessary modify these in accordance with the local military regulations for the command.
- coordinate the statutory quarterly inspections of the drugs in the commands, medical centres and hospitals.
- participate in the organisation of personnel connected with the handling of drugs within the command.
- participate in the training programmes for all those categories in the command receiving training or instruction on drugs. This will preferably take the form of lectures and practical demonstrations during manoeuvres.

After an initial training period, the experience gained will be used by the central administration to draw up general specifications for the post. The duties may vary from command to command depending on the number and type of units. At present a fairly extensive programme of instruction for medical personnel is taking place at Hässleholm in Southern Command – hence there will be a greater demand for lecture courses there than in other commands.

Personal Experiences

It is appropriate here after one year's service as staff pharmacist to reflect on some of my own experiences. A number of tasks have arisen which could easily have absorbed considerably more time than that available. There is a transparent need for pharmaceutical expertise and it has been a stimulating experience to tackle important problems which could not earlier have been dealt with at a regional level. Thus it has been expedient that these duties have combined well with those at the Military Pharmacy at Karlskrona – a combination of duties which has been very beneficial. The greater part of the time is devoted to "field-work" and since the time available for actual staff work is rather limited, this means that the time must be reckoned per month rather than per week – particularly as occasionally a tour within the command may take 2–3 days at a time.

In the following I have listed some of the many duties performed during the period:

1. Inspection of the medical and drug services at three units (accompanied by the senior medical officer, and senior dental officer).
2. Participation in the Commanding General's inspection of the plans for mobilisation of the unit.
3. Survey of rock strongholds for storage of certain materials and drugs.
4. Lectures in pharmacy for medical officers.
5. Lectures to nurses and dental nurses.
6. Lectures to stores personnel.
7. Present a paper at the unit Medical Officer's meeting.
8. Participation in the orientation of the section of Staff Command.
9. Participation in the inspection of the Southern Military Command by the Senior Medical Officer including lecture on pharmacy (drug services).
10. Visit to Western Command for negotiations on the sharing of storage centres.
11. Visit to units for organisation of drug supplies in the event of sudden attack.
12. Assisting during visits to Command Staff H.Q. by foreign visitors – lectures on pharmacy.
13. Participation in staff excercises.
14. Investigations on behalf of the Military Pharmacy in Stockholm.

The Staff Pharmacist may thus be regarded as a civilian employed expert in all matters concerning pharmaceuticals although the time allotted for such duties is limited. It is essential nevertheless that he is regarded as a member of the Staff and thereby automatically consulted in all matters where drugs may be involved. In addition he may himself introduce appropriate procedures and safeguards.

Duties which will in the future attain considerable importance will concern questions dealing with the handling and destruction of poisons and the problems of pollution and nature preservation.

The counterpart to the staff pharmacist may be found in several foreign defence organisations where even in peacetime he is responsible for all medical supplies – a development which is also conceivable in the Swedish Services.

The pharmacist has without doubt and important function in military staff work – and reflects the broadening attitudes of the pharmaceutical profession, characteristic of present day society.

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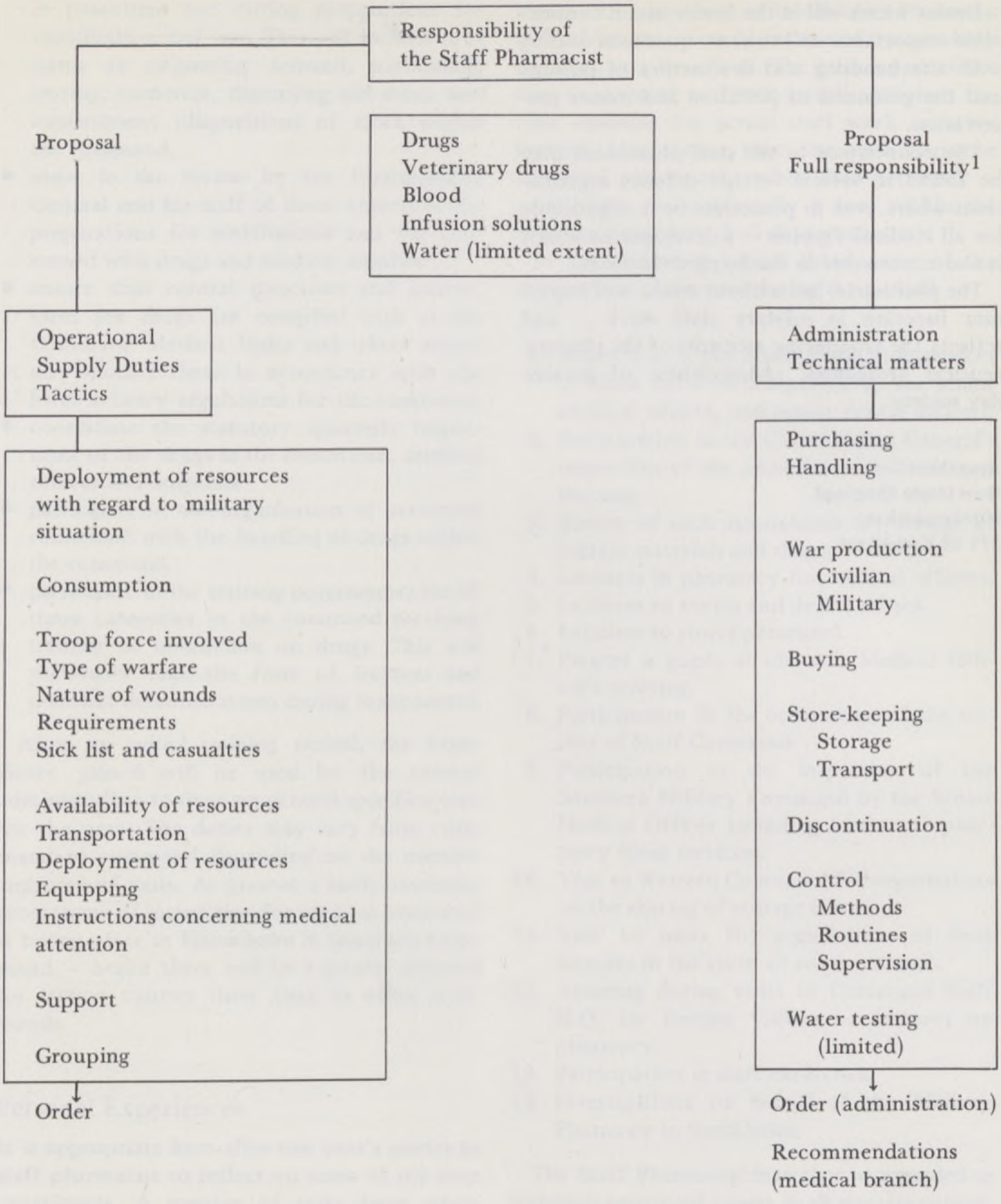

[1] Following the succession of authority

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