NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY

SUBMARINE BASE, GROTON, CONN.

REPORT NUMBER 977

COLD WEATHER FIELD STUDY OF MARINE CORPS EMERGENCY MEDICAL TREATMENT

by

Kevin LAXAR, William ROGERS, and George MOELLER

Naval Medical Research and Development Command
Research Work Unit ZF51.524.013-1037

Released by:

W. C. MILROY, CAPT, MC, USN
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SUMMARY PAGE

THE PROBLEM

To determine the extent and sources of impairment in emergency medical treatment and evacuation due to cold weather field conditions.

FINDINGS

Under extreme cold weather field conditions, aspects of emergency medical treatment were seriously impaired. Reasons for this impairment were loss of manual dexterity due to cold, limitations in the corpsman's protective clothing, inadequacies identified in the field medical kit, and unsuitable means of medical evacuation. A corpsman's previous medical training and experience in cold weather field conditions was related to better performance of emergency medical treatment.

APPLICATION

Cold weather medical training and experience under field conditions were shown to be beneficial in the administration of emergency medical treatment. Recommendations are made for continued field training, improved gloves and trousers for corpsmen, improved supplies in the field medical kit, alternate procedures for use in the cold, and a dedicated vehicle for medical evacuation.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Naval Medical Research and Development Command Work Unit ZF51.524.013-1037 -- Human factors analysis of emergency cold weather medical treatment. The present report is Number 2 of this Work Unit. It was submitted for review on 24 February 1982, approved for publication on 19 April 1982, and designated as NAVSUBMEDRSCHLAB Report No. 977. The previous report in this series is NSMRL Report No. 939 dated August 1980.

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ABSTRACT

To assess the extent and sources of impairment due to cold weather field conditions, times to complete an emergency medical treatment scenario (EMTS) and a standardized test of manual dexterity were measured for 21 Navy corpsmen and Marines. These studies were conducted at the U.S. Marine Corps Mountain Warfare Training Center, Pickel Meadow, Bridgeport, California, in January and February, 1980. The environmental testing conditions ranged from a snowstorm with temperatures near 22°F (-5.6°C) to clear weather around 47°F (8.3°C). Results showed that performance under the milder conditions was not seriously affected, but under the most severe cold conditions performance on the EMTS was substantially impaired. ~~It was also shown that~~ practice significantly improves medical treatment performance, and that even a small amount of practice is beneficial. ~~In addition,~~ better performance was found to be related to previous cold weather medical training and experience. These findings, and the comments of the subjects, have led to suggestions for continued field training, and for improved handwear and trousers with padded knees for corpsmen.

Some inadequacies in the field medical kit were identified as causes of a decrement in medical treatment performance under cold weather field conditions. Recommendations were made for improved adhesive tape, more easily opened sterile plastic packages, and an alternate method of fastening splints.

Observations were made of various means of medical evacuation, with a concluding recommendation for the development of a dedicated medically-equipped vehicle suitable for use in deep snow.

COLD WEATHER FIELD STUDY OF MARINE CORPS EMERGENCY MEDICAL TREATMENT

The effect of exposure to extremely cold temperatures on manual performance has been well documented (Fox, 1967; Horvath & Freedman, 1947; Teichner, 1957; Vaughn, Higgins, & Funkhouser, 1968). Of particular interest to the U.S. Marine Corps has been the performance decrement in emergency medical treatment due to cold weather conditions (Dean & Laxar, 1980; Problems of medical evacuation in cold weather, 1977). In an attempt to assess some of the factors related to this performance deficit, a study was conducted by Rogers, Laxar, and Moeller (1980) involving a simulated emergency medical treatment scenario (EMTS). Eighteen volunteers performed the scenario, with a life-size manikin as the "patient," under room temperature and cold chamber (0°F(-18°C)) conditions. The adequacy of the standard field medical kit (U.S. Navy Individual Surgical Instrument and Supply Set, 6545-00-927-4960), normally carried in the field by Navy hospital corpsmen, was also assessed.

That study showed that cold conditions can seriously impair field medical treatment. While practice improved the performance during the early stages of the study, the treatment scenario took 24% longer to complete in the cold than at room temperature. The decrement in the cold was attributed to reduction in arm and hand dexterity, as evidenced by a high correlation between the time to perform the treatment scenario and the time to perform the button-turning subtest of the Minnesota Rate of Manipulation Test (MRM), a widely-used test of manual dexterity. In addition, a number of inadequacies in the field medical kit for use in the cold were noted.

To further study the general problem of emergency cold weather medical treatment and evacuation, a field study was conducted and observations made during Marine Corps cold weather training exercises. These were done, as part of a Naval Submarine Medical Research Laboratory program investigating cold weather medicine, at the Marine Corps Mountain Warfare Training Center, Pickel Meadow, Bridgeport, California, during January and February, 1980. A modified version of the EMTS used in the cold chamber study mentioned above was administered as were the MRM and questionnaires regarding cold weather training and experience. The field medical kit was evaluated under field conditions and observations were made regarding medical evacuation capabilities.

METHOD

Subjects

Twenty-one male volunteers who were undergoing cold weather training exercises with their respective active duty units served as subjects. Fifteen were Navy hospital corpsmen assigned to the Marine Corps Fleet Marine Force (FMF) and six were Marine Corps personnel, five enlisted men and one officer. The subjects ranged in age from 18 to 32 years, with a median age of 21. Their time in the military ranged from approximately eight months to over four years, with a median of 2 years 7 months. All had at least the minimum cold weather survival and hygiene indoctrination immediately prior to going to the field. Table 1 shows each subject's rank and/or rate, and the conditions under which he was tested. All tests were conducted with subjects dressed in their standard cold weather uniforms and insulated rubber boots.

Table 1

Subjects' Rank/Rate and Field Test Conditions

S#	Rank/ Rate	Test Conditions: Gauze/ Adhesive	Environmental: Room Temp	Environmental: 40-50°F ($4.4 \rightarrow 10$°C)	Environmental: 30-40°F ($-1.1 \rightarrow 4.4$°C)	Environmental: 20-30°F ($-6.7 \rightarrow -1.1$°C)	Environmental: 22°F (-5.6°C) Snowstorm
1	HA	G	X				X*
2	HN	G	X				X*
3	HN	A	X				X*
4	HN	A	X				X*
5	HA	G	X			X*	
6	HM3	A	X			X*	
7	HA	A				X*	
8	PFC	G				X*	
9	1st LT	A			X		
10	L/Cpl	A			X		
11	L/Cpl	A			X		
12	L/Cpl	G			X*		
13	HM3	A			X*		
14	HM2	G			X*		
15	HM2	A			X*		
16	CPL	A		X			
17	HM3	G		X			
18	HA	G		X*			
19	HA	A		X*			
20	HN	A		X*			
21	HM2	G		X*			

* Used in the ANOVA which compared the four outdoor environmental conditions.

Tasks

The EMTS was devised with the help of experienced hospital corpsmen and cold weather medical experts to simulate the emergency medical treatment a Navy corpsman might be required to perform under cold weather field conditions. The scenario, developed to test performance rather than diagnostic or decision making abilities, was slightly modified from the version used in the cold chamber study (Rogers, et al., 1980) and consisted of the following nine subtasks: 1) unrolling and unzipping an extreme cold weather sleeping bag (Type II), later to be used as the patient's evacuation bag, and setting it up with sticks placed vertically in the snow for use as a temporary windbreak; 2) removing a pressure bandage (field dressing) from the field medical kit and unfolding it in preparation for application; 3) wrapping and tying the pressure bandage around a simulated leg wound; 4) removing a wire mesh splint from the kit and unrolling it; 5) shaping the splint and placing it under a simulated fractured arm; 6) removing either a roll of adhesive tape or a package of gauze bandage, cutting three pieces, and securing the splint to the arm with them; 7) spreading out the sleeping bag alongside and partly beneath the patient; 8) placing the patient into the bag and zipping it closed; and 9) filling out a standard U.S. Field Medical Card (DD Form 1380) on the casualty's injuries and treatment.

Only items from the standard field medical kit were used in the scenario (see Rogers, et al., 1980, for a list of the kit's contents). USMC volunteers, wearing appropriate cold weather clothing including insulated rubber boots, served as the "patients." They were instructed to lie passively on a foam plastic pad placed on the snow while the corpsman "treated" their injuries.

Procedure

Virtually all the corpsmen from the three Companies and the Battalion Aid Station, plus six Marine Corps volunteers, all of whom were undergoing field training at the time of the study, were tested in the present experiment. The trainees had for the most part been flown in from a warm sea level climate and had spent one or two days at the altitude of the base camp, approximately 6000 feet (1829 m) above sea level. Before going to the field, six men were tested indoors at the base camp, without gloves, to obtain some baseline measurements. All subjects were then tested outdoors under prevailing field conditions after having been in the field two to five days, at altitudes ranging from approximately 7000 to 8000 feet (2134-2438 meters). Men from the different companies were tested on successive days under widely varying weather conditions (see Table 1).[2] All outdoor testing, however, was done with a heavy cover of snow on the ground.

The testing was conducted as follows. Four to six subjects were tested during a given session. The group was given a brief description of the purpose and nature of the study, and consent forms and pre-test questionnaires (see Appendix A) were administered. An experimenter described and demonstrated the procedure to be followed for each of the subtasks of the EMTS and for the MRM. The subjects were instructed to perform each subtask in the prescribed order to the best of their ability and as rapidly as possible. One trial of the EMTS was followed by three trials of the MRM. This procedure was followed for three replications, separated by the time it took for another subject to complete his trial. Times for each trial were reported to the subject and motivation was generally high. At the conclusion of the session, subjects were asked to fill out post-test questionnaires.

For the EMTS, subjects wore standard issue leather glove-shells with wool inserts. The MRM was always performed bare-handed and subjects were given time to rewarm their hands by donning their gloves between trials.

The investigating team consisted of two experimenters and two assistants, and the subjects alternated their trials between experimenters. Using a clipboard and a stopwatch, the experimenters manually recorded cumulative times for each EMTS subtask and each MRM trial on a data sheet. The assistants would replenish and repack supplies in the medical kit and roll up the sleeping bags between trials.

So far as possible, subjects were assigned alternately to use adhesive tape and gauze bandage to secure the wire mesh splint. This was done to test the relative effectiveness of these methods since in the Rogers et al. study (1980), adhesive tape had proven to be unmanageable in the cold.

RESULTS

The time taken to perform each EMTS subtask, the total time to perform the EMTS, and the mean of the three trials on the MRM were calculated for each replication of each subject.

To compare EMTS performance indoors without gloves with performance outdoors with gloves, a t test was computed using the mean of three trials of total EMTS time for both the six subjects tested indoors and the 15 subjects tested only outdoors. This difference was significant, $t = 2.28$, $p < .05$. Most subsequent analyses were made among subjects exposed to various weather conditions wearing gloves.

To get an estimate of the practice effect, an analysis of variance (ANOVA) was computed for total EMTS time for the three trials for 21 subjects tested outdoors. Performance on the task changed significantly over trials, $F(2, 40) = 28.60$, $p < .001$. This is shown in Figure 1. A Newman-Keuls test showed that Trials 2 and 3 were significantly faster than Trial 1 ($p < .01$), but Trials 2 and 3 did not differ from each other.

Twelve subjects used adhesive tape to secure the splint and nine used the gauze bandage, tying it with knots. The mean total EMTS time for the adhesive group was 455 sec (s.d. = 88) and for the gauze group 471 sec (s.d. = 91). A t test calculated for these means showed the difference was not significant, $t(19) = 0.511$. Therefore, no distinction was made on this basis in the other analyses. While there was no difference between the times for these methods, an important qualitative difference was noted and will be discussed below.

The conditions under which the tests were given outdoors varied from a heavy snowstorm, with temperatures around 22°F (-5.6°C) and with a 20 kt wind, to a calm sunny day with a temperature

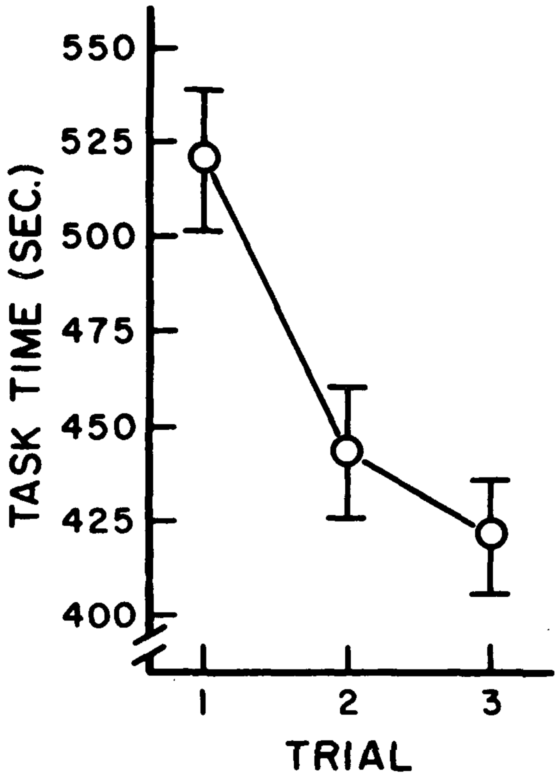

Figure 1. Mean total EMTS time (±1 standard error) by trial, outdoors (n=21).

near 47 F (8.3 C). While the mean times for the EMTS task were relatively uniform across most of the varied outdoor conditions, it can be seen in Figure 2 that the times obtained under the cold snowstorm conditions were substantially longer. Sixteen subjects were chosen from the 21 so that four groups were matched as closely as possible with respect to cold weather training, experience, and use of adhesive vs. gauze on the splint task. The subjects, 14 corpsmen and two Marines, were divided into groups of four on the basis of the temperature range in which they performed their tasks as shown in Table 1. One group had been tested under temperatures of 40° to 50°F (4.4° to 10°C), another group in the 30° to 40°F (-1.1° to 4.4°C) range, a third group in the 20° to 30°F (-6.7° to -1.1°C) range, and a fourth group in the 22°F (-5.6°C) snowstorm. A mixed design ANOVA was computed with the four environmental conditions as a between-subjects factor and the three trials as a within-subjects factor. The trials effect was significant, $F(2, 24) = 23.67$, $p < .001$, but the environmental condition was not, $F(3, 12) = 2.47$. An interaction was found between trial and condition, $F(6, 24) = 2.73$, $p < .05$. All four groups improved substantially from Trial 1 to Trial 2 (77 seconds faster). The groups tested in the two warmer conditions continued to improve on Trial 3, but those tested in the two colder conditions were slightly slower on Trial 3 than on Trial 2.

Further examination of the slower EMTS performance for the group tested in the snowstorm was possible, since those four subjects were among those who had been tested earlier under the indoor condition. A repeated measures ANOVA was computed for the indoor vs. the snowstorm condition, by trials, for those four subjects. The environmental effect was significant, $F(1, 3) = 21.95$, $p < .05$. Subjects took 117 seconds (29%) longer to perform the EMTS task in the cold snowstorm than they previously had indoors. Once again, trials was significant, $F(2, 6) = 10.98$, $p < .01$, but the interaction between environmental condition and trial was not. A corresponding ANOVA for the MRM task yielded no significant effects. Since the snowstorm conditions and the results obtained were substantially different from those of the other groups, data from these subjects were excluded from further analysis and will be discussed separately below.

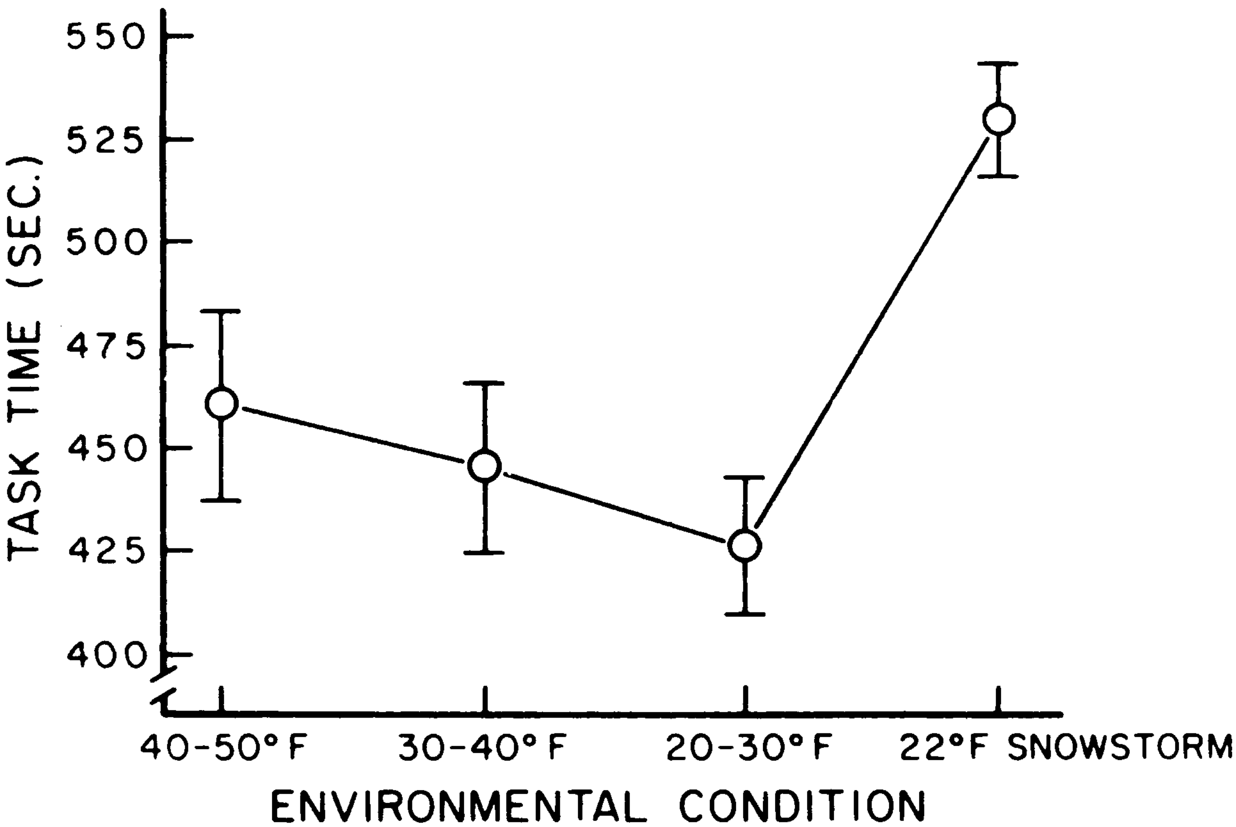

Figure 2. Mean total EMTS time (± 1 standard error) by condition (n=21).

Table 2.

Correlation Matrix of Times to Complete EMTS Subtasks, Total EMTS Time, and MRM Times[a].

	Task	1	2	3	4	5	6	7	8	9	10
1	Set up wind break	-----									
2	Open & prepare bandage	-.090	-----								
3	Apply bandage to leg	.090	.090	-----							
4	Open wire mesh splint	.445	-.065	.141	-----						
5	Shape & place splint	.248	-.052	.233	.088	-----					
6	Secure splint to arm	.358	.035	.215	.141	.177	-----				
7	Prepare evacuation bag	.032	-.022	.408	-.063	.416	.303	-----			
8	Put patient in bag	-.141	.075	.335	-.141	.119	.106	.262	-----		
9	Fill out medical card	.418	.078	.278	.125	.530*	.388	.297	.065	-----	
10	Total EMTS	.420	.236	.594*	.203	.466	.726*	.500*	.451	.729**	-----
11	MRM	-.050	.519*	-.049	.020	.039	.270	.119	.040	.039	.223

[a] Correlations were computed using 51 scores, 3 trials for each of the 17 subjects. For determining significance levels, *df* = 15.

*$p < .05$

**$p < .01$

For the remaining 17 subjects tested in outdoor conditions, a significant trial effect was found for total EMTS time and MRM time. In both cases, Trials 2 and 3 were faster than Trial 1, and Trial 3 was the same as or faster than Trial 2.

A correlation matrix computed for the three trials of each subtask, total EMTS time, and MRM time is presented in Table 2. In contrast to the data from the similar study conducted in the cold chamber, the correlations were generally low and non-significant. The two highest correlations were between total EMTS time and securing the splint, and between total EMTS time and filling out the medical card. These two subtasks were those which contributed most of the total EMTS time. Only preparing the pressure bandage (Task 2) correlated significantly with MRM time. Examination of scatter plots made of the individual correlations showed that none of the findings were due to errant data from a few subjects.

Total EMTS and MRM performances were examined for the group of 17 subjects in light of their rank or rate, their previous cold weather training or experience, and their previous cold weather medical training and experience. The subjects were divided into three subgroups for this analysis: six Marines, most of whom had cold weather training but no medical experience, five Hospitalmen (HM) or Hospital Apprentices (HA), two with some cold weather experience but none with previous training in cold weather medicine; and six second or third class Hospital Corpsmen (HN2 and HM3, respectively), the majority of whom had both cold weather medical training and experience.

The mean total EMTS and MRM times are given for these subgroups in Table 3. Since the number of subjects in each subgroup is small, any results from the following analyses must be considered as tentative and merely suggestive. A weighted means ANOVA showed that the difference was significant among the three groups for total EMTS time, $F(2, 14) = 4.52$, $p < .05$. Using Tukey's procedure, it was found that the HM2/HM3's were significantly different from the Marines ($p < .05$), and that the HA/HN's did not differ significantly from either group. No differences were found in a similar analysis of MRM times.

Table 3

Mean Total EMTS Time and MRM Time (sec) by Rank/Rate

Subgroup	n	Total EMTS	MRM
Marines	6	479	40.1
HA/HN	5	471	40.0
HM2/HM3	6	392	37.6

To further examine this difference in EMTS performance between the groups that differ the most in cold weather medical experience, a mixed design ANOVA was computed using Marines vs. HM2/HM3 as the between-group variable. Within-group variables were the nine EMTS subtasks and the three trials of each. A summary of this analysis is presented in Table 4, the results confirming earlier analyses. There was a significant difference between groups, and the trial effect was significant, as was the task x trial interaction (see Table 4). The subtasks, which varied widely in their mean times to complete, of course, showed a

Table 4

Analysis of Variance:

EMTS Subtasks

Source	df	MS	F
Group (G)	1	7569.0	9.78*
$Error_b$	10	774.3	
Subtask (S)	8	58248.6	116.74**
G x S	8	1894.0	3.80**
$Error_{bw1}$	80	499.0	
Trial (T)	2	2790.2	11.02**
G x T	2	46.4	0.183
$Error_{bw2}$	20	253.3	
S x T	16	378.2	2.02*
G x S x T	16	193.1	1.03
$Error_{bw1w2}$	160	187.4	

*$p < .05$

**$p < .01$

significant effect.

Of interest was the only remaining significant interaction, that of subgroup x subtask. This indicates that while performance between the two subgroups did not differ substantially over trials, the subgroups differed in the speed at which they performed some of the tasks but not the others.

The mean times for the two subgroups to complete each subtask were therefore compared, with the corpsmen faster than the Marines in each case. Separate subgroup x trial ANOVAs were computed for the four subtasks which showed at least a moderate difference between the subgroup means. There were no significant effects for the first task, setting up the windbreak. Task 2, preparing the pressure bandage, and Task 7, splinting the arm, both produced significant between-group differences, $F(1, 10) = 5.01$ and 9.81, respectively, $p < .05$, but no trial effect or subgroup x trial interaction. Task 10, filling out the medical card, showed only a marginal difference between the two groups, $F(1, 10) = 4.95$, $.05 < p < .10$. The trial effect was significant, however, $F(2, 20) = 10.79$, $p < .01$, as was the group x trial interaction, $F(2, 20) = 3.83$, $p < .05$. Examination of the means for each trial showed that the Marines improved significantly from trial to trial on the medical card subtask, yet never reached the speed of the HM2/HM3's, whose performance improved very little over trials.

DISCUSSION

As with most field studies, it was not possible to carefully control many important variables. In the present study, environmental conditions were not as severe as desired, there was considerable variability in the training and experience of the subjects, and the number of subjects was rather small. With a larger and more homogeneous group of subjects and more widely varying environmental conditions, more definitive results might have been obtained.

In the cold chamber study (Rogers, et al., 1980), the EMTS task and the MRM showed significant performance differences between room temperature and 0°F (-18°C) conditions. In this field study, the EMTS showed differences only between the two most extreme conditions, indoors and the snowstorm condition at 22°F (-5.6°C). The wind chill factor for 20 kts made this condition equivalent to -7°F (-22°C). Under more moderate environmental conditions, performance was not appreciably different from that under room temperature conditions. Apparently the leather glove shells with wool inserts, as worn in all outdoor EMTS trials, afforded adequate protection in all but the most severe conditions encountered. The trials conducted indoors without gloves were significantly faster than the outdoor ones, indicating that the combination of gloves and snow cover were a distinct hindrance in performing the EMTS.

It was somewhat surprising that the MRM showed no difference between the two extreme conditions. Although practice on this task under indoor conditions would have tended to reduce the difference found between the subsequent test outdoors, it was expected from the cold chamber study and previous research (Teichner, 1957; Dusek, 1957) that the cold would have out-weighed this effect, just as it seemed to do on the EMTS.

Apparently the subjects were able to rewarm their hands adequately between trials from the approximately 40 sec bare-handed exposure while performing the MRM task outdoors. In the chamber study, the temperature was over 20°F (11°C) colder than the outdoor conditions and adequate rewarming of the hands was generally not possible.

As in the cold chamber study, a practice effect was found with both the EMTS and MRM tasks, with the greatest improvement being shown between the first and second trial. Improvement in performance after the first of only three opportunities to perform the task in the cold means that even a little experience in performance under adverse conditions can be beneficial. Clearly improvement with such limited practice comes from learning how to approach a task rather than from attainment of a high level of skill.

The sources of variability encountered in this field study probably contributed to the lack of subtask correlations with other subtasks or with MRM time. In addition to those sources noted above, on some trials, a soft, deep snow cover did not impair performance on tasks involving manual dexterity, but hindered gross body movements, such as walking around the patient or placing him in the evacuation bag. Sometimes the corpsman would sink up to his thighs in the snow. Hard-packed surfaces caused no such problems, but on the other hand made it difficult to place sticks in the snow for the windbreak. Some patients' boots were so large that they would fit in the evacuation bag only with great difficulty, and occasionally the zippers on the bags would jam, thus adding more time.

An important finding from this field study was that performance on the EMTS task was related to the amount of the subjects' cold weather medical training and experience. The more experienced corpsmen performed significantly better than the inexperienced Marines. The less experienced corpsmen performed somewhere between the two. All subjects, however, performed equally well on the MRM, a task that was equally unfamiliar to all. This finding would indicate that there were no basic differences among groups regarding manual performance under field conditions, although the possibility exists that the MRM was simply insensitive within the range of environmental conditions encountered. It is interesting to note that the two subtasks which showed the greatest (and significant) differences between the experienced corpsmen and the Marines are both closely related to previous medical training: opening and preparing the pressure bandage, and splinting a fractured arm. It is concluded that medical training and experience in cold weather conditions has a beneficial effect on later performance, and it is recommended that such training be afforded these personnel.

Evaluation of the medical kit in the field yielded similar conclusions to those obtained in the cold chamber. One of the more evident problems was the inadequacy of the adhesive tape. Some rolls of tape were impossible to unroll, not just in the cold, but at any temperature. It is suggested that the corpsman determine the adequacy of each new roll of tape he draws from stock. Once unrolled, the tape rarely adhered, either to itself or to anything else, due to the cold or the snow. Splints secured by this means, therefore, were grossly inadequate, and would frequently become dislodged while the patient was being placed in the evacuation bag. Splints secured with the gauze bandage, however, were highly satisfactory and remained in position well. There was no difference between the two methods in the time it took to secure the splint.

The post-test questionnaires uncovered some additional problems with the materials in the medical kit. Of the 19 subjects who completed the forms, 10 (six of them Marines) thought the supplies were adequate. Of those who considered the supplies inadequate, most mentioned the problems with the adhesive tape. Others reported the difficulty encountered in opening the plastic packages of bandages, and some suggested the use of an alternate type of splint, since the wire mesh was difficult to manipulate. Only five men thought that their performances were slowed specifically by the cold, citing splinting the arm and filling out the medical card as the tasks most affected. Two-thirds of the subjects indicated that they were hampered by the bulkiness of the clothing, mostly in relation to the gloves. Manipulating the scissors with gloved hands proved particularly difficult, and it has been suggested previously (Rogers, et al., 1980) that scissors with oversize handles be provided. Two-thirds of the subjects also reported that they experienced discomfort in performing the EMTS, especially cold hands, faces, and knees. Their comments strongly suggested the need for more modern gloves, with minimum bulk for good manual dexterity, high insulation value, and waterproof outer shells. Another frequent suggestion was to provide the corpsmen with trousers with waterproof insulated kneepads, as much of their emergency medical treatment is done crouching or kneeling in the snow. In response to an open request for comment on the tasks, several subjects mentioned the inadequacy of adhesive tape for fastening splints, and the benefits of medical training under actual cold weather field conditions.

Several medical evacuations occurred at MCMWTC during the three weeks the research team was there. In confirmation of earlier interviews with experienced USMC personnel and published reports (Problems of medical evacuation in cold weather, 1977), it was observed that the most readily available means at the time was employed to transport the casualty from the field to the camp's branch dispensary, a typically lengthy procedure. To remove the casualty from the most inaccessible locations, the achkio fiberglass sled was used, but this required six men on snowshoes to haul it, a slow and exhausting method. Once to a road or an accessible area clear of heavy vegetation, motorized but medically unequipped means of evacuation were employed. Depending upon snow and road conditions, and vehicle proximity, tracked vehicles, large trucks, four-wheel-drive pickup trucks, or Gamma Goats (M-792) might be used. The tracked vehicle, M-116, had the greatest through-the-snow capability of the standard vehicles and was often used for medical evacuations, as it could accommodate one or two achkios plus attendants. Operators reported, however, that the M-116's were not designed for deep, soft snow conditions, in which they sink down and become immobile due to their heavy weight for the size of their tracks. All these vehicles had unheated carrying compartments, rough ride characteristics, high noise levels, and little or no interior illumination. Only infrequently would the base ambulance, a well equipped four-wheel-drive vehicle, be sent further than the paved and plowed roads of the immediate base camp area. Base personnel stated that a dedicated medically equipped vehicle with wide snow tracks would be highly desirable.

CONCLUSIONS

This field study has documented that cold weather conditions are detrimental to the Hospital Corpsman's emergency medical treatment. The combined effects of snow storms, wind, and deep snow cover substantially impaired his medical treatment performance while causing him discomfort and placing him and any casualty victims at increased risk. Personal items recommended to improve his cold weather performance are improved hand wear and trousers with waterproof insulated kneepads. The field medical kit could be improved for cold weather use by providing adhesive tape that is effective in cold and wet conditions, a more suitable substitute for the wire mesh splint, scissors with larger openings in the handles, and sealed sterile packages for such items as bandages that can be easily opened in slippery, wet, or subfreezing conditions. Medical training, practice, and experience under cold weather conditions are helpful to the corpsman in performing his duties.

For medical evacuations from remote confined areas over the snow, the standard achkio is currently used, with four men in body harnesses in front pulling on ropes for propulsion, and two similarly harnessed men at the rear for steering and braking. It is suggested that consideration be given to developing a modification to the achkio to have step-type running surfaces or perhaps spring loaded devices which would engage the snow and prevent rearward motion when being pulled uphill. This would eliminate some of the effort of those pulling the achkio. Similarly, handbrakes could be devised to slow downhill progress, perhaps mounted on long rigid pulling bars or handles rather than ropes. These modifications may affort better control of the achkio and perhaps reduce the number of personnel required to move it.

Finally, it is recommended that a dedicated medically equipped vehicle be developed especially for deep snow conditions. This should have a heated, well-lighted, and acoustically insulated compartment for the patients and the medical attendants, and have more comfortable ride characteristics than present vehicles.

ACKNOWLEDGEMENTS

The authors wish to express their appreciation to the officers and men of the Marine Corps Mountain Warfare Training Center and of the units which were undergoing training there for their assistance and cooperation in the conduct of this study, and also to Mr. Douglas Wray, HM3 John Davis, and HM3 Jeanne Mitchell, of the Naval Submarine Medical Research Laboratory, for their assistance in collecting field data.

FOOTNOTE

Portions of this research were presented at the Convention of the American Psychological Association, Montreal, September 1980.

[2] Marine Corps cold weather training exercise requirements precluded assignment of personnel to weather conditions (days) at random.

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To assess the extent and sources of impairment due to cold weather field conditions, times to complete an emergency medical treatment scenario (EMTS) and a standardized test of manual dexterity were measured for 21 Navy corpsmen and Marines. These studies were conducted at the U.S. Marine Corps Mountain Warfare Training Center, Pickel Meadow, Bridgeport, California, in January and February, 1980. The environmental testing conditions ranged from a snowstorm with temperatures near 22°F (-5.6°C) to clear weather around 47°F (8.3°C). Results showed that performance under the milder conditions was not seriously

Item 20--cont'd

affected, but under the most severe cold conditions performance on the EMTS was substantially impaired. It was also shown that practice significantly improves medical treatment performance, and that even a small amount of practice is beneficial. In addition, better performance was found to be related to previous cold weather medical training and experience. These findings, and the comments of the subjects, have led to suggestions for continued field training, and for improved handwear and trousers with padded knees for corpsmen.

Some inadequacies in the field medical kit were identified as causes of a decrement in medical treatment performance under cold weather field conditions. Recommendations were made for improved adhesive tape, more easily opened sterile plastic packages, and an alternate method of fastening splints.

Observations were made of various means of medical evacuation, with a concluding recommendation for the development of a dedicated medically equipped vehicle suitable for use in deep snow.