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STUDIES ON FLASH BURNS:

THE SCREENING EFFECT OF FABRIC AT A DISTANCE FROM ANIMALS

by

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ABSTRACT

A method of testing fabrics for their screening value against flash burns by interposing a fabric between a pig and ignited magnesium flash powder is presented. All fabrics offered some protection from flash burns. Of the fabrics tested, 8-1/2 oz. gray sateen affords the best protection and cotton tubing the least. The darker OG 8-1/2 oz. sateens were intermediate. A nylon-vinyl poncho material was a hazardous screen because of contact burns produced by its flaming.

INTRODUCTION

Methods of protection against flash burns have been studied previously in this laboratory. It has been shown that most fabrics offer some protection, the degree being a function of color, weight, moisture content, and separation from the skin (1, 2). This earlier work was done on small area burns from the carbon arc, and with the fabric either in contact with the skin or separated 0.5 mm. from the skin, as is usual in clothing assemblies. The present studies were designed to evaluate the protection afforded against large area flash burns by draping a fabric at a greater distance from the skin to simulate the possible effects of a shield, screen or tent. The experiment compared six fabrics. The calories of radiant heat delivered to the cloth or animal were not measured.

METHODS

Young Chester White pigs (3) weighing 8-12 Kg. were anesthetized with intraperitoneal doses of 70 mg/Kg. of Dial-urethane (Ciba). The hair of the area to be exposed was closely clipped and the skin gently cleansed. The pig was suspended by the skin of its back; this flattens the side and simulates a standing position. Hooves, head, and genitalia were protected with asbestos paper (Fig. 1). Both sides of every animal were exposed. A plan of random choice of test fabrics was made.

Magnesium flash powder has been used in this laboratory for producing large area flash burns (4). A 50 gm. charge of flash powder, which burned in 0.9 sec., was ignited by a high voltage spark in a Y-shaped tray to shape the flame. The fabric to be tested was hung loosely by two corners between the heat source and the animal at 5.0 cm. from the pig's skin and 10.0 cm. from the tray. In all cases the pig was 15.0 cm. from the heat source.

FIGURE 1

Diagrammatic Illustration of Experimental Plan

Distance A - B = 5 cm.

Distance B - C = 10 cm.

The grading system previously employed in this laboratory was used to assess the surface appearance of all burns 24 hours after infliction (5):

Grade	Gross Appearance
0	No Burn
1+	Erythema
2+	Patchy Coagulation
3+	Uniform Coagulation
4+	Steam Bleb
5+	Carbonization

Materials Tested:

Six fabrics supplied by the Quartermaster Corps, U. S. Army, were identified as:

1. Carded Sateen, gray, 8-1/2 oz.
2. OG Cotton Sateen, fire resistant, treated, 8-1/2 oz.
3. OG 107 Cotton Sateen, untreated, 8-1/2 oz.
4. Vinyl Coated Nylon (1.8 oz. nylon twill) new standard poncho OG 107.
5. Khaki Cotton Poplin, 5 oz.
6. Cotton Tubing.

Five replications were performed with each fabric and with bare skin.

In all cases of flaming an attempt was made to remove the burning fabric as rapidly as possible. In some instances this could not be done before a contact burn had been sustained. A color motion picture was made of representative explosions to evaluate spatter of magnesium and flame contact.

RESULTS

Due to the convexity of a pig's side the burns occurred as concentric ellipses, the most severe located in the center. Each grade of burn severity, expressed as a percentage of the total exposed area, is tabulated in Table I. These results are averaged in Table II and shown graphically in Fig. 2. Unprotected skin always sustained at least a 4+ burn and 7% of the exposed area

was charred. The most severe screened burn was only 3+, demonstrating a significant amount of protection from all fabrics. The 8-1/2 oz. gray sateen afforded by far the best protection, most of the exposed area being unburned and the most severe being a 1+ burn. The colored 8-1/2 oz. sateens fall into a second group of relatively good protection with only small areas of 2+ burns. The lighter fabrics and nylon poncho form the least protective group, all these allowing fairly large areas of 3+ burns.

Appendix I lists the observed behavior of the test fabrics when exposed to the flash. Some merely charred while others flamed. The flaming may be divided into two categories: slow burning and flash burning. The nylon-vinyl poncho melted, throwing balls of hot molten material in all directions, deposited a heavy coating of tars on the pig's skin, and produced clouds of a very acrid smoke.

On review of the color movie no flame contact was seen. Some spattering of magnesium particles did occur but these were not as numerous as the charred areas and steam blebs seen on bare skin.

Of the fabrics tested only the gray sateen appeared usable after exposure. The other fabrics either burned or were so weakened by the heat that the cloth shredded.

DISCUSSION

In assessing the protective value of a fabric against flash burns both its ability to screen from the flash and its flammability must be considered. Burning cloth was removed as rapidly as possible to minimize contact burns. Contact burning undoubtedly accounted for a large portion of the more severe burns behind the nylon-vinyl poncho. The broad spread of burns in this case suggests that, but for the flaming, protection would

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TABLE I

(SEVERITY OF EACH BURN) EXPRESSED AS PER CENT OF TOTAL EXPOSED AREA

Fabric	Pig No.	No Burn	1+			2+			3+			4+			5+
			Mild	Mod.	Sev.	Mild	Mod.	Sev.	Mild	Mod.	Sev.	Mild	Mod.	Sev.	
8-1/2 oz. Gray Carded Sateen	991	75		25											
	986		100												
	985	100													
	985	60	40												
	981	100													
OG Cotton Sateen Fire Resistant	990			100											
	990				90		10								
	989	100													
	987			95		5									
	986			100											
OG Cotton Sateen 8-1/2 oz. Untreated	989	100													
	987	100													
	995				75			25							
	994	50			50										
	983				90	10									
OG Nylon Twill Vinyl Imported	996				20		20				60				
	980				80		10		10						
	980	100													
	992	90			10										
	993	80			15					5					
5 oz. Cotton Khaki Poplin	992				50	50									
	991	50			25	25									
	983				35		35			30					
	982				70		30								
	981				10			20			70				
Cotton Tubing	995				50		20			30					
	997				60					40					
	982				100										
	987				50		50								
	993			10	20						70				
Bare Skin	996				10				20			35		35	10
	979							10		10				70	15
	979				5						10	35		35	10
	988										50			40	
	994					10					40			50	

TABLE II

AVERAGE SEVERITY AND PER CENT OF TOTAL EXPOSED AREA BURNED ON PIG

SKIN WHEN EXPOSED TO 50 GM. MAGNESIUM FLASH AT 15.0 CM.

Fabric	No Burn	1+	2+	3+	4+	5+
1. Gray Cotton Sateen, 8-1/2 oz.	67	33				
2. OG Cotton Sateen, Fire Re- sistant, 8-1/2 oz.	20	77	3			
3. OG Cotton Sateen, Untreated, 8-1/2 oz.	50	43	7			
4. Nylon Vinyl Poncho	54	25	6	15		
5. Cotton Khaki Poplin, 5 oz.	10	38	32	20		
6. Cotton Tubing		58	14	28		
7. Bare Skin		3	4	26	60	7

FLASH — SKIN DISTANCE 15.0 CM.
FLASH — FABRIC DISTANCE 10.0 CM.

FIGURE 2

approach that of the sateens. The slower burning fabrics do not seem as hazardous as evidenced by the small difference between the treated and untreated OG sateens.

If the nylon-vinyl poncho is placed in a category by itself because of its peculiar flaming characteristics, the remaining fabrics fall into two broad groups by weight, the 8-1/2 oz. sateens affording considerably more protection than the lighter cottons. These groups may be subdivided by color, the gray being the most protective.

Perkins, Pearse, and Kingsley in a study comparing burns on pig skin and human skin found that approximately the same caloric value required to produce a 2+ burn on pig skin would inflict a 2° burn on human skin (5). On the pig, by shielding with a loosely draped gray sateen, we have converted a 5+ burn to a 1+ burn. In terms of human protection this would change what would be a lethal or severely incapacitating burn to a 1° burn or one that would not even require treatment. On the basis of this study one of the non-flaming fabrics loosely draped over a pole or similar center support to allow separation from the skin would seem to be a reasonable method of affording a good degree of protection from flash burns. Flammable fabrics would be of limited value since contact burns might result.

SUMMARY AND CONCLUSIONS

1. A method for comparing the value of fabrics as shields against large area flash burns is described, and the results with six fabrics supplied by the Quartermaster Corps, U. S. Army, are presented.
2. Of the fabrics tested, 8-1/2 oz. gray sateen affords the best protection and cotton tubing the least.
3. Nylon-vinyl poncho is a poor fabric for this use due to its incendiary qualities.
4. The method of screening by draping a fabric so that it is separated from the skin offers a good degree of protection from large area flash burns.

APPENDIX I

OBSERVATIONS ON THE BEHAVIOR OF VARIOUS CLOTHS WHEN
EXPOSED TO 50 GM. MAGNESIUM FLASH AT 10 CM.1. 8-1/2 oz. Carded Sateen - Gray

In most instances this fabric was deeply browned on the exposed side, with only slight browning on the reverse side. In one case the cloth charred through and flamed slowly after a 20 - 30 second delay.

2. OG Cotton Sateen, 8-1/2 oz., Fire Resistant, Treated

Considerable smoke was produced by this fabric and in all instances marked charring occurred on the reverse side. Cloth shredded immediately on handling. However in no case did the cloth flame.

3. OG 107 Cotton Sateen, 8-1/2 oz., Untreated

Ignition of the fabric occurred immediately after the magnesium flash although the cloth itself did not flash. Burning proceeded with moderate rapidity.

4. OG 107 Nylon Twill, Vinyl Treated, - New Standard Poncho

This fabric flamed immediately in a flash-like flame, melted, and disintegrated completely. Particles of the molten cloth tended to fly out, some striking the animal.

5. Cotton Khaki Poplin, 5 oz.

An initial flash occurred with rather rapid and complete burning.

6. Cotton Tubing

This fabric tended to flash immediately and burned rather rapidly.

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