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VIBRATION WHITE FINGER IN DOCKYARD WORKERS

T. P. OLIVER[1], R. J. PETHYBRIDGE[2] and K. P. S. LUMLEY[3]
H.M. Naval Base, Portsmouth[1], Institute of Naval Medicine Gosport[2] and H.M. Naval Base Devonport[3], United Kingdom

ABSTRACT

The incidence of vibration white finger (VWF) in caulkers and paint chippers in two Royal dockyards has been assessed by means of a questionnaire administered by a medical officer. Amongst the caulkers, 75% showed finger blanching compatible with Stage 1 or 2 VWF. These symptoms were exposure (years), not age dependent. The incidence in paint chippers was 18% and similarly dependent. The daily exposure of the caulker was far greater at 5.55 hours than that of the paint chipper at 2.45 hours. The non-dominant hand was most affected in caulkers and the dominant hand in paint chippers, the differences being statistically significant.

The vibration characteristics of these traditional tools which have been in use for many years have been measured. These vibration characteristics are outside the proposed British Standards for hand-arm vibration. It is suggested that a similar incidence will be found in other shipyards throughout the world where similar tools are used.

Vibration white finger (VWF) is the term used to describe Raynaud's phenomena of occupational origin. The term "Raynaud's phenomena" is used to describe attacks of cold induced blanching, numbness and cyanosis occurring in the extremities (i.e. fingers and toes) and is named after the French physician, Maurice Raynaud[6] who first described it. Air driven tools were first used in France in 1939. Loriga[4] first postulated the association between Raynaud's phenomena and occupations involving the use of such tools.

The causes of Raynaud's phenomena can be conveniently classified thus:

1. Primary – constitutional
2. Secondary – non-occupational (connective tissue disease, trauma – direct to extremities or proximal to extremities, occlusive vascular disease, dysglobulinaemie, intoxication, neurogenic)
3. Secondary – occupational (use of vibrating tools).

Hunter and co-workers[3], Agate and Druett[1], Magos and Okos[5], Taylor and Pelmear[7] are amongst the authors who have drawn attention to the incidence of the phenomena amongst caulker, rivetters and chippers. It is with the development of VWF in workers using air driven caulking guns and paint chippers that this paper is concerned.

The introduction of the all welded ship – as distinct from one in which the plates were held together by rivets – has led to the demise of the rivetter in the shipyard world and his replacement by the caulker. Although some of the more elderly dockyard caulkers started work as rivetters (or even rivet boys) most of their working life has been spent as iron caulkers.

The task of the caulker is to remove excess metal particularly where two metal plates have been welded together. For the purpose he uses an air driven gun whose hammer drives a cutting tool. The gun weighs about 10 kg, is held in one hand (which also operates the trigger) with the other hand holding the cutting tool in the gun (there being no locking device), and guiding it.

The paint chipping hammer is lighter – weighing 5.5 kg – and can be held one-handed, although two-handed operation to exert pressure is not uncommon.

Leather industrial gloves are normally worn by the operators of both types of tool, not only because of the rough nature of the task but because work is often in the open air in all weathers and to diminish the discomfort of the cold air exhausted from the tools.

Although the association between vibrating tools and the development of VWF was well known to the occupational physician in the Royal dockyards only one case of Raynaud's phenomena had, over the years, ever presented itself. The work of Taylor and Pelmear[7] who included in their survey a volunteer group of dockyard caulkers and paint chippers at Rosyth suggested that a full survey might reveal more than a few workers with VWF.

STUDY METHOD

The primary objective of this stydy was to quantify the extent of VWF in caulkers and paint chippers in the two largest British naval dockyards, and if necessary to make recommendations.

The method of study was by a personal medical interview, with a standard questionnaire based on that used by Taylor and Pelmear[7] for each caulker and paint chipper in the two dockyards. The questionnaire, besides noting basic identification data, date of birth and dominant hand, recorded occupational

TABLE 1
Stages of Raynaud's phenomena. After Taylor and Pelmear[7].

Stage	Symptoms	Handicap
0	No symptoms	
$0_T/0_N$	Intermittent tingling, numbness	No work, domestic, social interference
1	Blanching one/more finger tips	No work, domestic, social interference
2	Blanching of increased frequency/number of fingers affected, usually triggered by cold	Slight domestic, social interference but not with work
3	Extensive blanching, frequent episodes in summer and winter	Definite work, domestic, social interference
4	Extensive blanching affecting all digits summer and winter	Change of occupation required

history, medical history of significance in the context of Raynaud's phenomena, the presence or absence of tingling and numbness in the fingers, finger blanching and which hand(s) or digit(s) were affected, any triggering mechanism, social and occupational handicap and smoking habits.

The results were evaluated by the occupational physician conducting the interview and categorised according to the stages suggested by Taylor and Pelmear[7] as given in Table 1. The data from the questionnaire were then coded and analysed by computer.

RESULTS

An overall response rate of 97.6% was achieved for questionnaire completion.

The population

Figures 1 and 2 show the age distribution of the two populations – 80% of the caulkers are over 40 years of age and 50% over 50. The age of the paint

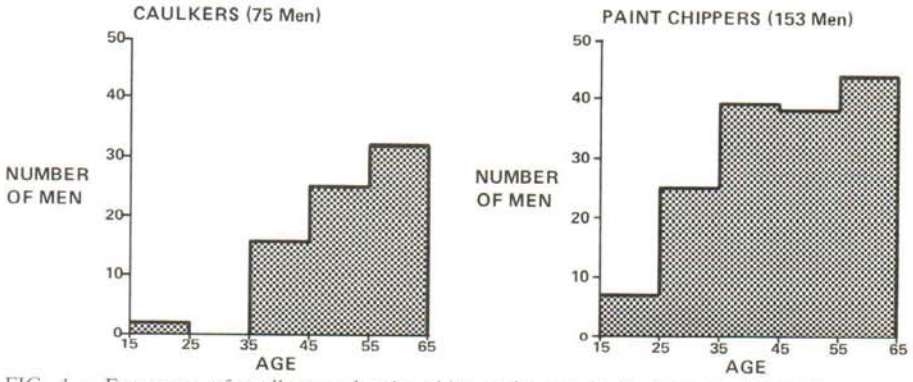

FIG. 1 – Frequency of caulkers and paint chippers by age in Portsmouth dockyard.

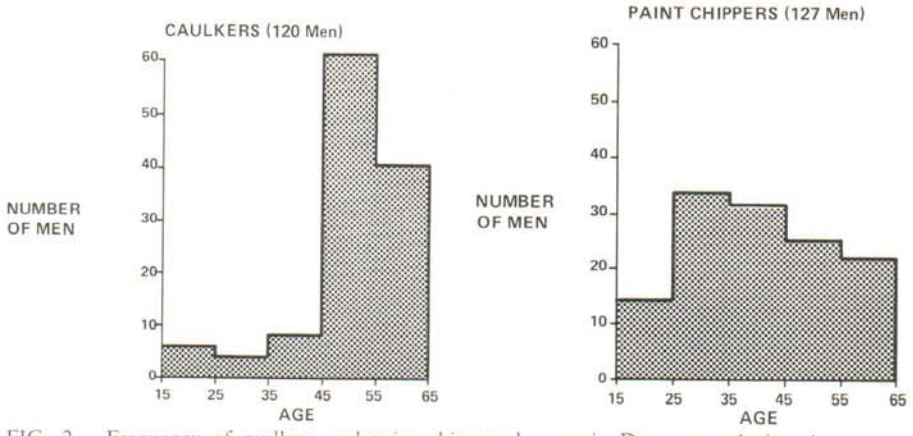

FIG. 2 – Frequency of caulkers and paint chippers by age in Devonport dockyard.

chippers is fairly uniform across the working age groups. Figures 3 and 4 show the number of years the men have been exposed to the vibrating tools. Nearly 90% of the Portsmouth caulkers and over 80% of Devonport caulkers have an exposure of 20 years or more. The paint chippers in both yards are heavily weighted towards far lower exposures. Over 60% of the Devonport chippers

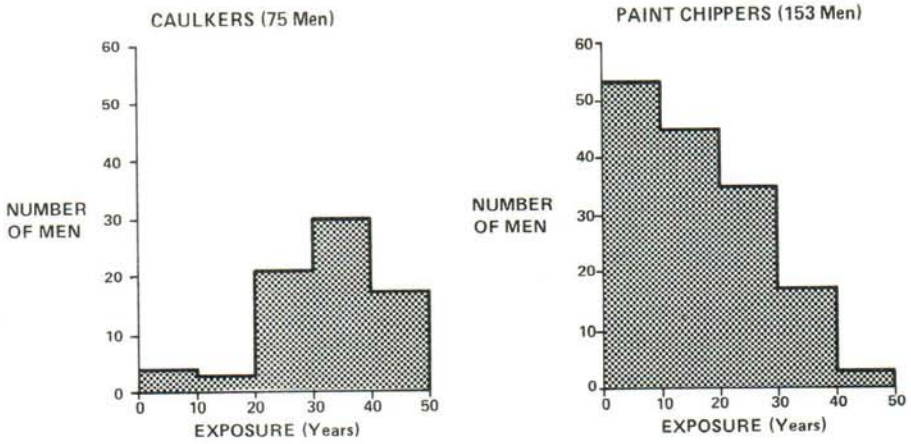

FIG. 3 – Frequency of caulkers and paint chippers by years of exposure in Portsmouth dockyard.

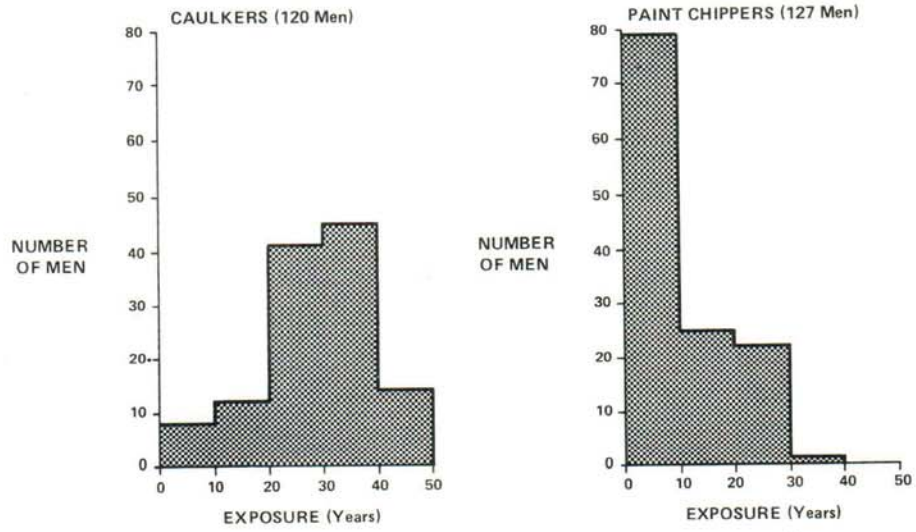

FIG. 4 – Frequency of caulkers and paint chippers by years of exposure in Devonport dockyard.

have less than 10 years exposure, but at Portsmouth this lower exposure level is encountered in only 35%.

The incidence of VWF

Table 2 shows the incidence of admitted vibration white finger for the two occupational groups in the two dockyards; 80% of all caulkers indicated they had symptoms of which 75% were classified as stage 1 or 2. Amongst the paint chippers over 70% had no symptoms.

TABLE 2
Dockyard caulkers and paint chippers by category of vibration white finger (%).

Dockyard group		N	Stage of white finger			
			0	$0_{T/N}$	1	2
Devonport	Caulkers	120	21	3	40	36
	Paint chippers	127	69	8	18	5
Portsmouth	Caulkers	75	18	7	42	33
	Paint chippers	153	77	11	10	2

Table 3 relates the percentage incidence of VWF stages 1 and 2 (i.e. those with other than minimal disability) to exposure time. In all exposure groupings, the caulkers have a worse experience than the paint chippers.

TABLE 3
Percentage admitting to vibration white finger categories 1 and 2 in relation to years of exposure.

Dockyard group		Years of exposure					All years
		Under 10	10–19	20–29	30–39	40 and over	
Devonport	Caulkers	(25)*	67	83	84	64	76
	Paint chippers	16	28	41	(100)	–	23
Portsmouth	Caulkers	(50)	(33)	76	77	82	75
	Paint chippers	6	16	14	18	(33)	12

*( ) indicates figure is based on less than 10 men

Figure 5 shows the incidence of stage 1 as compared with stages 1 and 2 in the caulkers only – the difference between the two plotted lines representing the category 2 element. The estimated exposure to actual vibration per day demonstrates the far greater average daily exposure of the tradesman caulker (6.0 hours in Devonport and 5.1 hours in Portsmouth) from the skilled labourer, paint chipper (2.3 hours in Devonport and 2.6 hours in Portsmouth).

Table 4 relates the percentage incidence of VWF in stages 1 and 2 to age. The incidence rises with age. Again, the caulkers have a worse experience.

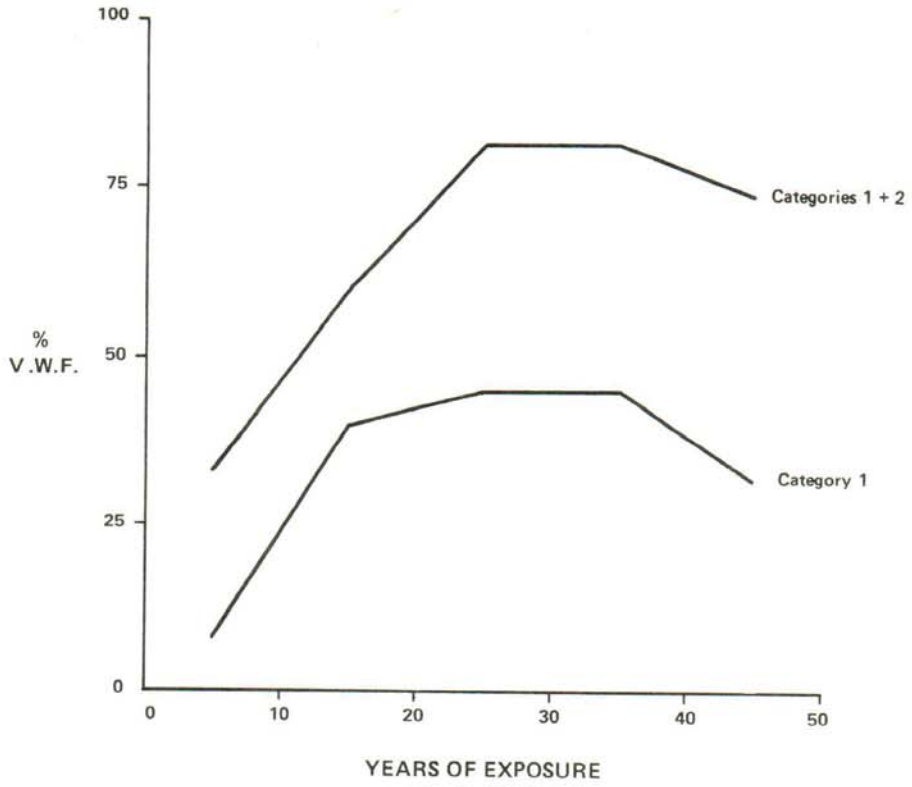

FIG. 5 – Relationship of vibration white finger to years of exposure among caulkers (Devonport and Portsmouth combined).

TABLE 4
Percentage admitting to vibration white finger categories 1 and 2 in relation to age.

Dockyard group		Age					All ages
		Under 25	25–34	34–44	45–54	55 and over	
Devonport	Caulkers	(17)*	(100)	(63)	80	78	76
	Paint chippers	14	9	28	36	27	23
Portsmouth	Caulkers	(0)	–	63	80	81	75
	Paint chippers	(14)	8	8	11	20	12

*( ) indicates figure is based on less than 10 men

Hands and fingers affected

Table 5 details the actual numbers of hands affected by blanching in the total population.

TABLE 5
Number of caulkers and paint chippers affected by finger blanching related to hands.

			Dominant hand					
			Portsmouth*			Devonport**		
			Yes	No	All	Yes	No	All
Non-dominant hand	Caulkers	Yes	29	23	52	54	26	80
		No	4	19	23	9	27	36
		All	33	42	75	63	53	116
	Paint chippers	Yes	8	2	10	14	2	16
		No	9	132	141	13	96	109
		All	17	134	151	27	98	125

*Excluded two ambidextrous paint chippers
**Excluded four ambidextrous caulkers and two paint chippers

When the results from the men admitting to finger blanching (i.e. those categorised as stage 1 or 2) are analysed in respect of their dominant hand, a very interesting but consistent picture emerges (Table 6). In the caulker, the non-dominant hand is more likely to be affected, 90% as against 65% for the dominant hand. The opposite is true of the paint chipper, where the non-dominant hand is less likely to be affected, 54% and the dominant hand more so – 91%. These differences are statistically significant at the 1% level.

TABLE 6
Percentages admitting to stage 1 and 2 VWF related to dominant hand.

Per cent of men with	Caulkers		Paint chippers	
	Portsmouth	Devonport	Portsmouth	Devonport
Right hand dominant	85	91	88	91
Admitting VWF	76	76	12	23
Blanching in dominant hand*	59	71	89	93
Blanching in non-dominant hand*	93	90	53	55

*expressed as % of those with VWF

In those men admitting to finger blanching the percentage incidence for each finger is given in Table 7. It is seen that the thumb is rarely affected. In both groups the 2nd and the 3rd fingers are most affected.

Smoking habits

The results obtained from the question on smoking habits are shown in Tables 8 and 9. They can best be described as equivocable.

TABLE 7
Fingers affected in those admitting to blanching as percentages of those with VWF.

Hand	Finger	Caulkers		Paint chippers	
		Portsmouth	Devonport	Portsmouth	Devonport
Dominant	0	11	5	5	0
	1	48	49	47	62
	2	55	58	63	83
	3	52	55	63	72
	4	50	54	11	48
Non-dominant	0	14	5	5	0
	1	68	55	21	45
	2	86	67	32	48
	3	86	74	26	52
	4	79	72	16	38

TABLE 8
Relative frequency distribution of men by smoking habits.

Dockyard group		N	Non-smokers	Ex-smokers	Smokers
Devonport	Caulkers	120	17	32	52
	Paint chippers	127	24	17	59
Portsmouth	Caulkers	75	13	33	53
	Paint chippers	153	13	18	69

TABLE 9
Percentage admitting to vibration white finger categories 1 and 2 in relation to smoking habits.

Dockyard group		Non-smokers	Ex-smokers	Smokers	All men
Devonport	Caulkers	65	79	77	76
	Paint chippers	13	18	28	23
Portsmouth	Caulkers	40	80	80	75
	Paint chippers	10	4	17	17

VIBRATION CHARACTERISTICS OF THE TOOLS

Recordings from the tools were made on a calibrated battery/mains operated Uher tape recorder, the input to which was fed by a frequency modulator/demodulator unit, coupled to a Bruel and Kjaer portable precision sound level meter type 2203 connected to an accelerometer type 4332. A calibration signal from a pistophone type 4220 was fed in before and after the recordings were made. The recordings were subsequently analysed through a Bruel and Kjaer Audio Frequency Spectrometer type 2114 and Level Recorder type 2305.

The analyses are plotted in Figure 6 and compared with the draft British Standard for hand-arm vibration[2]. It can be seen that in the lower frequencies the draft standard is more than marginally exceeded.

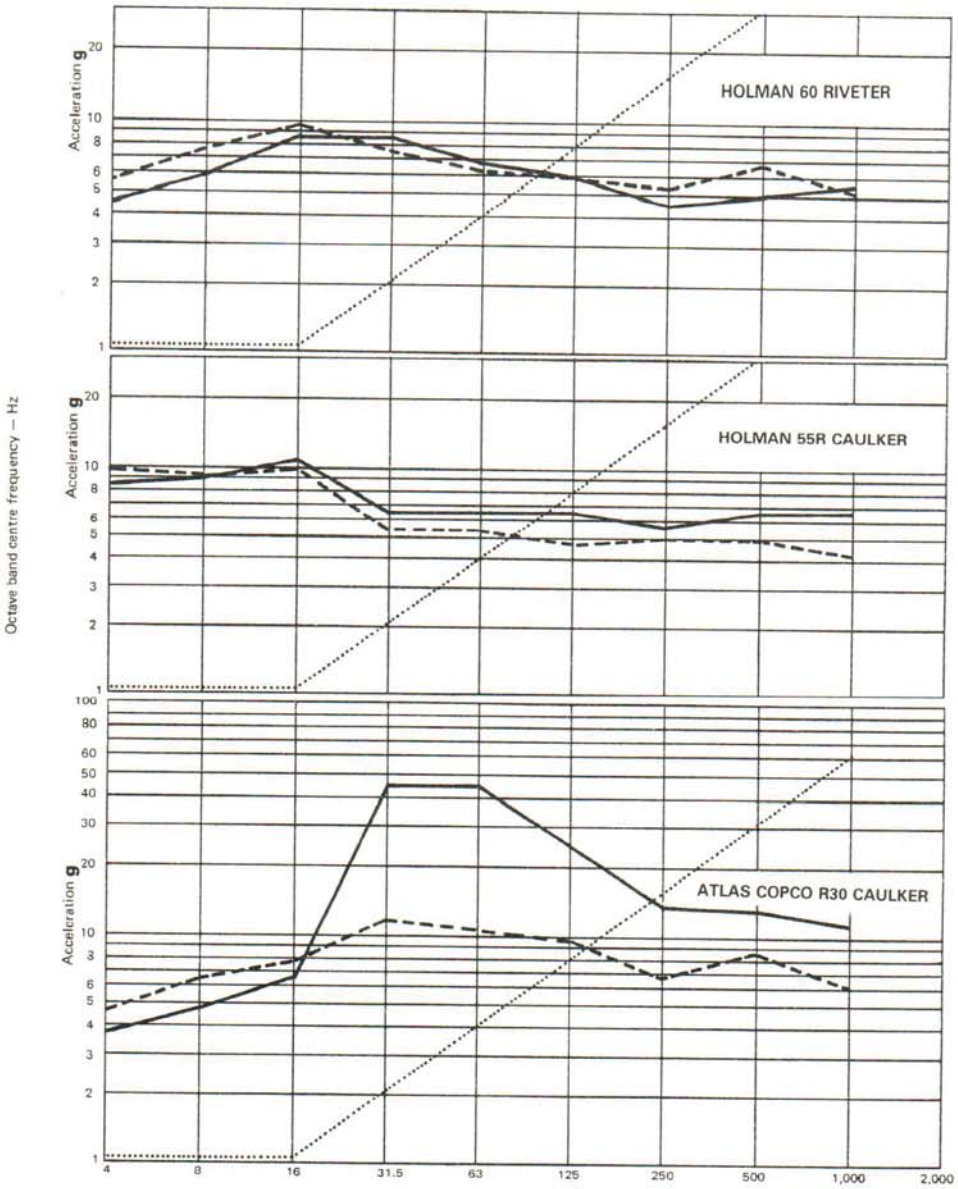

FIG. 6 – Vibration characteristics of three tools. Solid line shows transverse component, broken line shows longitudinal component and dotted line is DD43: 1975 Maximum.

DISCUSSION

The work pattern of the two occupational groups studied is dissimilar. The tradesman caulker does not undertake other work but stays in his trade. The chipper, a non-tradesman, has an irregular work pattern, undertakes other tasks like paint application and moves in and out of the job. The caulkers estimated 5.5 hours vibration exposure per day and the chippers 2.5 hours. These estimated daily exposures are, by the very nature of the two groups work patterns, far more reliable for caulkers than paint chippers.

The incidence in caulkers reached a plateau at age 40. The incidence in paint chippers continued to increase with further exposure. The development of VWF is related to length of exposure in both groups. The interyard differences among chippers is based on a small number of mildly affected positives. Some individuals appear non-susceptible whatever the exposure.

The incidence also rises with age. However, this is not an age dependent relationship, merely a reflection that the older workers – especially the caulkers – have an exposure which is age dependent. Exposure time per day has probably decreased over the last few years with introduction of a shorter working week. Except in awkward corners the caulker holds the gun in his dominant hand and the cutting tool in his non-dominant hand. The paint chipper holds the hammer in his dominant hand and may also exert pressure with his non-dominant hand.

These results suggest that the vibration characteristics of the cutting chisels held by caulkers are even more unfavourable than those of the gun, although the discarding of the glove on the cutting tool hand or the pressure exerted on gun or tool may play their part. The differences between the fingers affected probably reflect the normal grip used by most of the men, with possible variations due to adoption of a different one by some individuals. The tools used have not varied over the past 40 years, thus eliminating a possible variable. During this period rivetting has virtually disappeared in the dockyard context.

The unisex nature of the trade groups concerned and their common social class structure ensure that these statistical parameters are non-causative in this study. There appears to be no adverse effect from smoking.

CONCLUSION

Vibration white finger is very prevalent amongst caulkers and occurs in paint chippers. The natural incidence of Raynaud's phenomena in a male population would not, at a maximum, be expected to exceed 5%. The study figures exceed this by a large margin, this not only confirming its occurrence, but also the acceptance of a questionnaire alone as a suitable epidemiological tool in the context of VWF.

It must be concluded, therefore, that the currently used tools are potentially hazardous (doubly so, as they are also major producers of unacceptable noise). Their vibration characteristics have been shown to be outside the British Standard, which is at the very least partially vindicated.

It would seem reasonable to suppose that similar surveys conducted in other shipyards where these tools are used would probably demonstrate a similar incidence of VWF.

RECOMMENDATIONS

With a cause-effect relationship established, the next step for the occupational physician is to formulate his recommendations. The following have been made:

All the tools in question should be replaced as soon as possible by safer tools, i. e. those with acceptable vibration and noise characteristics, or alternative work arrangements providing any new tools introduced also satisfy the criteria as mentioned above and a medical monitoring system be set up for the employees identified as affected and those who might be affected.

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