A LONGITUDINAL STUDY OF RAYNAUD'S PHENOMENON IN CHAIN SAW OPERATORS

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ABSTRACT

A two-part interrelated presentation is given. Part I (presented by Dr. Taylor). A chain saw operator group (44 to 46 chain saw operators working 4½ to 5½ hours per day, 5 days per week) was surveyed at six annual intervals over a 5-year period (December 1969 to January 1975). During this interval, the percent prevalence of vibration white finger (VWF) was reduced from 85% to 73% in the exposed group (control group prevalence rate 6% in 1970) following introduction and 4 years' use of anti-vibration (A/V) type chain saws. Apparently the use of the A/V saw significantly contributed to the reduction of VWF prevalence. Part II (presented by Mr. Keighley). A chronological history and background of chain saw use in the United Kingdom is presented: the use of standard chain saws and the evolution and final use of the modern A/V chain saw.

PART I

INTRODUCTION

Since the first description of white fingers in pneumatic tool workers by Loriga [1,2] in Italy in 1911, there have been many accounts of Raynaud's phenomenon in industry: from quarries in the 1920's, foundries in the 1930's, hand-grinding shops in the 1940's, and rock mines in the 1950's. The following classification defines Raynaud's phenomenon as a secondary cause of white finger to be distinguished from primary Raynaud's disease. The secondary cause in this paper is trauma due to vibration.

CLASSIFICATION OF WHITE FINGER

Primary: Raynaud's Disease—Constitutional white finger

Secondary: Raynaud's Phenomenon

1. Connective tissue disease
   - a. Scleroderma
   - b. Systemic lupus erythematosus
   - c. Rheumatoid arthritis
   - d. Dermatomyositis
   - e. Polyarteritis nodosa
   - f. Mixed connective tissue disease
2. Trauma
   - a. Direct to extremities
     - i Following injury, fracture, or operation
     - ii Of occupational origin (vibration)
     - iii Frostbite and immersion syndrome
   - b. To proximal vessels by compression
     - i Thoracic outlet syndrome (cervical rib, scalenus anterior muscle)
     - ii Costoclavicular and hyperabduction syndromes
3. Occlusive vascular disease
   - a. Thromboangiitis obliterans
   - b. Arteriosclerosis
   - c. Embolism
   - d. Thrombosis
4. Dysglobulinaemia (cold haemagglutination syndrome)
   - a. Cryoglobulinaemia
   - b. Macroglobulinaemia
5. Intoxication
   - a. Acroosteolysis
   - b. Ergot
   - c. Nicotine
6. Neurogenic
   - a. Poliomyelitis
   - b. Syringomyelia
   - c. Hemiplegia

Throughout the 1960's in Britain and elsewhere, evidence was accumulating that a new tool, now used universally in timber operations—the power-driven chain saw, was giving rise to Raynaud's phenomenon.

This was first reported by Grounds[3] in 1964 who studied 22 "timber fellers" using chain saws in Tasmania. In this series, 20 men (91%) showed signs of white finger but none believed it necessary to give up his job. As the use of chain saws spread, reports from other countries, e.g., Japan,[4] Sweden,[5] Australia,[6] and New Zealand,[7] described essentially the same condition: after 2 to 4 years of saw operation, a proportion of the sawyers began to develop a condition in which, first, tingling and numbness were noted followed by blanching, usually of one finger tip. After 8 to 10 years' constant use of chain saws (usually 5 to 6 hours per day, 5 days per week), all fingers on both hands were involved.

The use of chain saws in forestry in Britain, initially confined to felling and cross-cutting, was increased with the introduction of chain saw snedding (debranching) in 1967. The saw usage time thus showed a steady increase from 1½ to 2 hours per day (late 1950's and early in the 1960's) to 6½ to 7½ hours in 1968-70 in Sweden[8] and 5 to 5½ hours in Britain (Keighley 1970, personal communication).

In 1968, an investigation of the prevalence of Raynaud's phenomenon among Forestry Commission employees was carried out by a questionnaire given to a random sample of the employees.[9] Following this investigation, which showed that the prevalence was highest in those areas where chain saws had been in use for the longest periods, the Forestry Commission offered facilities for medical examination of saw users at one of their largest felling centers, Thetford Chase, Norfolk. This population, which includes some of the men with the longest exposure to chain saw vibration in the United Kingdom, has now been examined six times at yearly intervals. This paper presents the results of these investigations.

POPULATION FOR STUDY

In the first survey in December 1969, all of the 50 sawyers, using the saw at least 5 years, agreed to take part in the study. They were age-matched with men in the same environment who had never been exposed to vibration, either from chain saws or from hand-held vibratory tools. This control group, however, was subsequently reexamined, and those men whose occupational history indicated exposure to any form of vibration, e.g., drivers of excavators, heavy tractors, and peeling machines, were rejected. This left only 48 in the control group. In January 1971, a similar study with 56 sawyers and controls was undertaken as part of a wider survey covering several industries where vibration-induced white finger (VWF) was known or thought to be present. Four subsequent surveys in January 1972, 1973, 1974, and 1975 dealt solely with sawyers already examined in the earlier surveys. The age distribution (at the time of the 1975 survey) of 44 men seen throughout the six surveys was:

Age, years	*Number*
20-29	0
30-39	9
40-49	14
50-59	16
60+	5

VIBRATION CHARACTERISTICS

From 1961 to June 1970, the Thetford chain saw operators were handling saws with high acceleration values on both the front and rear handles (200 to 400 meters/second^2). Prior to June 1970, the saws had no vibration damping on the upper and lower handles.

Anti-vibration (A/V) saws, conforming to limits established by the Forestry Commission (less than 60 meters/second^2 on either handle) were then gradually introduced throughout the year from June to December, and by the end of 1970, all sawyers in this study were on A/V saws. Thus, by the January 1972 survey, the sawyers had at least 1 year on A/V saws, and by the sixth survey in January 1975, the A/V saws were used for at least 4 years.

METHOD

In all six surveys, the same examiner (W. T.) took a full occupational history and graded the VWF signs and symptoms (stage assessment) according to the criteria shown below. In addition, sensory tests (depth sense aesthesiometer and two-point discrimination) were also made, the results of which have been incorporated in the final analyses. These same tests were conducted by Dr. P. L. Pelmear of Guest, Keene & Nettlefold, Dr. M. Griffin of the University of Southampton, Dr. R. M. Oliver and Dr. J. G. Fife, Civil Service Medical Branch.

Stages	*Clinical signs and symptoms*
0	Base line. No signs or symptoms.
0_{TN}	Tingling and numbness.
1	Blanching of one tip or one finger.
2	Blanching and sensory loss of one or more fingers. Noticed at work first and at home.
3	Blanching and sensory loss of all fingers, bilateral. Interference with work, home, and social activities and restriction of hobbies.
4	Signs and symptoms of such severity, vibration-induced white finger no longer tolerated; occupation changed.

PREVALENCE OF VWF IN CHAIN SAW OPERATORS

The mean saw usage time and the distribution by stage of VWF for the same population over the six

prospective surveys from 1969 to 1975 are shown in Table 1.

Table 1. Relationship of time saw used, stage of VWF, and prevalence (%) of VWF for 46 chain saw operators

Number of sawyers	Mean age, yr.	Mean saw usage time, yr.	Year of survey	Stage of VWF, number of cases					Prevalence of VWF, %
				0	1	2	3	1+2+3	
46	42.6	6.4	1970	7	4	17	18	39	85
46	43.6	7.4	1971	7	2	14	23	39	85
46	44.6	8.4	1972	6	5	15	20	40	87
44*	45.3	9.5	1973	7	10	15	12	37	84
46	46.6	10.4	1974	11	8	22	5	35	76
44	48.6	11.4	1975	12	8	21	3	32	73

*Two sawyers absent on sick leave.

In 1970-72 when the study group used the older-type saw that vibrated, the prevalence of VWF was 85%, 85%, and 87% respectively. With the introduction of A/V saws, the prevalence in 1973 was 84%, in 1974, 76%, and in 1975, 73%. Reduction is not significant, but there is a decreasing trend in VWF with A/V saw treatment.

The prevalence rates for a control group, age and sex matched, working in the same environment but without vibration was 6.0% in 1970 and 6.6% in 1971.

CLINICAL ASSESSMENT FROM VWF HISTORY

From the detailed occupational health history taken from the 46 sawyers seen on all five surveys (with the exception of two not available in 1973 because of sickness), and from the 44 seen in 1975, a clinical assessment was made on each individual using the following criteria:

1. Improved (I): if subject was reduced by one or more stages.
2. No change (NC): if subject remained in same stage.
3. Deteriorated (D): if subject had to be increased by one or more stages.

A stage shift was judged by an increase or decrease in number of blanching attacks, by the severity of the attacks, whether they occurred in summer as well as winter, and by the amount of social and hobby interference.

Between December 1969 and January 1971, 3 sawyers improved, 32 showed no change, and 11 deteriorated. This may not represent a significant overall deterioration for the group ($P>0.05$).

At the 1972 survey, after at least 1 year of A/V saw use, 11 sawyers improved, 23 showed no change, and 12 deteriorated compared with their stage in 1971. This again does not represent a significant departure from an overall "no change" situation ($P>0.05$), but it is a reversal of the trend in the previous year. By 1973, after at least 2 years of A/V saw use, 18 sawyers showed improvement, 25 showed no change, and only 1 had deteriorated compared with the 1971 assessment. This represents a significant overall improvement ($P<0.001$). At the 1974 survey, the fifth annual survey, after 3 years of A/V saw usage, 29 of the 46 sawyers examined had improved by one or more stages (4 had improved two stages), 17 showed no change, and none had deteriorated, compared with the 1971 assessment. Again this represents a significant overall improvement ($P<0.001$). At the 1975 survey, after 4 years of A/V saw use, 33 of the 44 sawyers examined had improved by one or more stages (8 had improved two stages), 11 showed no change, and none had deteriorated, compared with the 1971 assessment. Again this represents a significant overall improvement ($P<0.001$).

The results of the assessments following the introduction of A/V saws are summarized in Table 2.

Table 2. Assessment of progress (stage) of vibration white finger (VWF) in individual chain saw operators after introduction of anti-vibration saws*

Number of sawyers	Year of survey	Assessment of VWF, number of cases		
		Deterioration by one or more stages	No change in stage	Improvement by one or more stages
46	1971	11	32	3
46	1972	12	23	11
44†	1973	1	25	18
46	1974	0	17	29
44	1975	0	11	33

*Survey years 1972-1975 are compared with 1971 assessment.

†Two sawyers of the designated group were absent through illness.

SENSORY TESTS

By means of the depth sense aesthesiometer and the two-point discrimination tests, the 44 subjects examined were classified as normal (NC), or with reduced sensitivity (−ve), or with increased sensitivity (+ve). When the 1975 values are compared with those for 1972, 18 (41%) showed reduced sensitivity, 25 (57%) were classified as normal, and 1 (2%) had increased sensitivity.

SUMMARY AND CONCLUSIONS

1. A chain saw operator group (44 to 46 workers) from the Forest of Thetford Chase, Norfolk, England, exposed to chain saw hand-arm vibration for 4½ to 5½ hours per day, 5 days per week

(mean vibration exposure 11.4 years) was surveyed at six annual intervals over a 5-year period.

2. When first examined in December 1969, the prevalence of VWF in this group was 85%. At this initial examination, mean saw usage time was 6.4 years. Throughout 1970 new A/V saws were introduced so that by the 1972 survey all 46 sawyers were using A/V saws with vibration characteristics within vibration limits set by the Forestry Commission. When this population was examined in January 1975, the sixth annual survey, 44 of the original 46 sawyers were still in Forestry Commission employment and thus had 4 years of A/V saw use. During the interval the percent prevalences of VWF were 1970, 85%; 1971, 85%; 1972, 87%; 1973, 84%; 1974, 76%; and 1975, 73%. The prevalence rate for a control group of forestry workers in the same environment but without exposure to vibration was 6.0% in December 1969 and 6.6% in January 1971.
3. From a detailed occupational health history, a clinical assessment of the severity of VWF was made. Of the 44 sawyers that remained for reexamination in 1975, 11 indicated no change and 33 had improved compared with their VWF state in 1971. Of the 33 showing improvement, 8 had improved by two stages. Thus, after 4 years of A/V saws, there is a significant overall improvement in VWF ($P<0.001$).
4. The epidemiological data obtained from this prospective survey over a 5-year period indicated that the vibration characteristics of the old-type, untreated saws were excessive. The improvement in VWF following 4 years' use of anti-vibration saws is encouraging. Further monitoring of VWF will be required to show whether these saw improvements are safer over a chain sawyer's working lifetime.
5. Analyses of the sensory tests (Depth Sense Aesthesiometer and Two-Point Discrimination) made on 44 chain saw operators in 1972 and thereafter annually indicate (comparing 1972 and 1975 values) a "no change" situation in 25 sawyers (57%), deterioration in 18 sawyers (41%), and improvement in one sawyer (2%). These results suggest that there is increasing damage to the nerve endings in the superficial dermal plexus. Further research work is required to establish the validity of sensory tests particularly in studies of vibration-exposed populations. A history of clumsiness due to loss of touch sensitivity in the fingers and a loss of sensitivity to temperature have been noted in chain saw operators whose VWF assessment has reached Stage 3. In the future, sensory tests may therefore prove more valuable than assessment of VWF by stages since loss of sensation to pinprick and light touch often precedes trophic skin changes or even Stage 3 assessments.
6. In the course of these 5 years of annual surveys for VWF, all new chain saw operators have also been tested. No new case of VWF has been reported among the new employees who have used only A/V saws. Routine monitoring of this population will, in the future, prove if the present vibration on our A/V saws is within safe limits.

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PART II

To follow Professor Taylor's presentation is extremely difficult. I'm going to content myself with looking at this from the management point of view and in particular from that of the Forestry Commission in the United Kingdom.

We began our forestry activity in a big way from 1919 onwards. By the mid-50's, we had relatively few chain saws. The trees were generally small enough to be cut economically with ax only, or with a bow-saw and ax. It wasn't until the late 50's that a reasonable number of chain saws began to appear; most of these were what we'd phrase "work-around." In other words, they did not belong to the Forestry Commission directly.

Around the mid-60's, work study people began looking at a new process in Sweden, which we called the debranching or snedding (or limbing, as they called it) process. It involved chain saws. The idea was that the whole process of felling, debranching, and crosscutting, when necessary, would be done by the chain saw operator, and the ax would literally disappear from the forest. During 1965-66 as we looked at this, I became involved at headquarters in two part-time capacities: I had responsibility for the

training of forest workers and also for the safety of the Forest Commission staff.

We were aware there had been some white finger indications in Sweden, and perhaps if we had acted on that, we might not have taken up this method. However, the importers of Swedish saws into Britain were occasionally going around the country, often using Forest Commission locations, and giving demonstrations of their latest products. A lot of our men were beginning to use this limbing operation. That settled it. If we were going to have it spread anyway, the quicker we taught it properly, the better. So, in 1967-68, we introduced this full process.

I've said so much about this because it concerns the question of the hours per day, which seems to be very important. From our own data (and we've also got some data from Finland and for our type of European conditions), typical chain saw usage was 2 hours or so a day, if all you did was fell and perhaps crosscut with a saw. Even if the sawyer had a partner with him who was using the ax only, he himself still used an ax a good deal of the day on debranching. Once the chain saw was used on the whole process, our work figure is 4½ to 5½ hours in the most intensive work situation, which is basically fell-debranch, fell-debranch, leaving the whole pole for extraction. Finland's figure was 2 hours a day for felling for over 600 men that we have checked, and 5.1 hours per day when they included limbing. Clearly there was a correlation between these usage times in Scandinavian countries and those in the United Kingdom.

The next part of the problem was that big saws were used for felling and crosscutting only. For debranching only, a small saw is needed, one provided with a short guide-bar on the saw, because you must never catch the guide-bar on a stone on the ground. (No quicker way of wrecking a chainsaw than doing that.) So, to have short guide-bars, we need light saws, as light as possible. We, therefore, went to saws from Scandinavia designed for this particular use, and a number of the models were changed between 1967 and 1970.

In the spring of 1970, we told all our engineering colleagues not to order conventional saws, but to buy certain saws that we knew were anti-vibration. By July 1970, there were enough saws being imported that we could say with certainty, we're not going to face another winter with the old-type saws for a thousand men working full time in this work. Management was instructed to buy enough of the A/V saws to give every regular operator one before the end of October 1970. And we were able, in fact, to do this. We then set a date by which all other saws would be phased out.

By October 31, 1970, these thousand men used only A/V saws in their work. The time of use was about 3 hours in the more work-intensive situation in the steep country with the cable cranes where, for example, they fell, debranch, cover up the saw-log, put down the saw, measure the saw-log, and record it on the log and perhaps in a notebook. Then they go a few meters, and after felling a few trees, stack a number of 3-meter limbs into a stack suitable for a skyline winch. There are a lot of interruptions when compared with intensive fell-debranch, fell-debranch.

We chose Thetford forest for the survey because this was an area where the system was fell-debranch, fell-debranch, all day, leaving other machines to bring out the poles. We also chose Thetford because it has pines. Throughout the country, 75% of the crop is spruce, and with spruce there is the problem in thinning, particularly when one tree is not able to fall through the other trees very easily. Plus the very dense and stiff branching. And so they have a hang-up problem, with more interruptions during work. But at Thetford, there are pines and these come down straight. We knew this was, without a doubt, the most intensive work area for the chain saw, and it was an area with enough men to make a worthwhile population from a statistical point of view.

At the time the decisions were being made to go ahead, we wanted a check on this. After asking our Department of Health who knew about hand-arm vibration, I found the only place was the University of Dundee, and there, in 1967, I met Dr. Taylor. From that point on, Thetford was to be the main survey area with additional surveys going on at less-used areas.

At Thetford, there were always spare saws in the workshops. All men were trained to sharpen and generally maintain their own saws, but they were also told if there was anything doubtful about their saw in any way they couldn't directly deal with, send it to the workshop. There's always a spare one on the shelf of the same make. Things like rubber bushings, etc., were particularly looked at by the maintenance people. Since 1972, the saws have been changed every 10 months. At certain times of the year, boxes are packed with the old saws, waiting for an auction sale. We have picked saws from there, at random, and had them vibration tested. Basically, we found that even if the bar and chain were not in good condition, what really mattered was whether or not they'd tuned the saw correctly. If the saw is not correctly tuned, there is more vibration. And as soon as we found this out, of course, fairly early during testing, we emphasized this in refresher training; supervisors were also trained to check for this point.

I'll conclude by referring you to the histogram part of Figure 1. It will be noted that the early saws, before 1967, were saws like the Danarm DD8F—a saw that when you crudely tested it, hanging it in a sort of bicycle-frame handle and suspending the engine by springs, you could bring the vibration amplitude down. We did, in fact, do this following the Swedish method. We found that the vibration amplitude dropped to 25%.

I think that you can see from Figure 1 that there's been a significant reduction in vibration by using A/V saws. How does that fit into a standard we

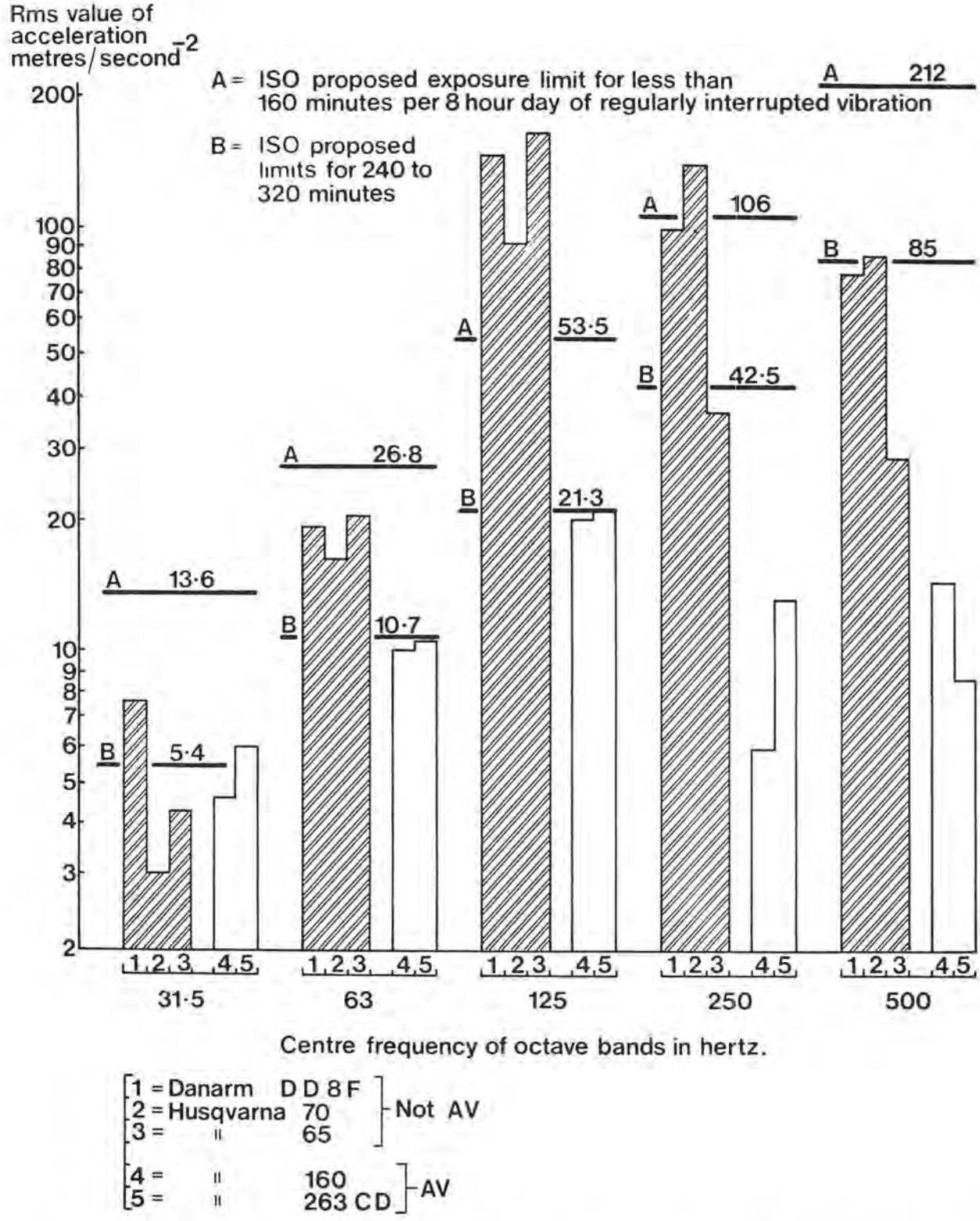

Figure 1. Hand-arm vibration — chain saws; measurement of acceleration when crosscutting timber at the manufacturers' recommended speed of maximum power.

know about? We have our own British standard which is just for saws. The figure has, however, inserted two of the ISO proposed lines (Figure 1, A and B), and you can see how the A/V saws appear to meet these criteria.

QUESTIONS, ANSWERS, AND COMMENTARY

Comment (I. Lidstrom, Swedish National Board of Occupational Safety and Health): I think the most interesting fact of your presentation, Dr. Taylor, is that you have performed a prospective study that we seldom find in the medical literature. It is very difficult to carry through, but it gives us data that we can't get in any other way.

Question (D. Wasserman, NIOSH): Professor, Taylor, I wonder if you would address the problem of the latent interval and what the differences are and whether this is a fixed period of time or whether it's variable?

Answer (W. Taylor): I hope I didn't convey the impression that the latent interval was constant other than in this group's statistical population data, because we have a biological spread here, as in all other areas. And the only thing we have evidence of is that one of the factors will be the original size of that digital artery. We find that in large hands we usually have large arteries. We've drawn a graph using Kitchener's data; this gives us a very good straight line correlation between the amount of energy and the latent interval—the greater the amount of energy coming in, the shorter the interval. All the results indicate that. But I must emphasize again you can't, as in noise, say when this chap is going to pass through the latent interval. In the case of Thetford, the figure is 2.8 years. There are the other points you have to worry about, namely, exposure time and energy. Other figures for the latent interval for chain sawyers that we get in the literature are 5 to 6 years. And this would also fall in with the data, because this, I think, is generally not the intense work schedule that they have at Thetford.

Question (D. Wasserman): I have another question, sir. This concerns the longitudinal study you performed. Did you or did you not set a minimum time on the job before looking at the medical records of the people on the job? Or did you start from the first day on the job?

Answer (W. Taylor): That raises the great issue of medical records. In the control of vibration in men, I don't think we're ahead, as you are in this country; we have no medical records! Mr. Keighley has the most excellent medical records of absenteeism, but this gives us no medical guidance whatsoever! So I go into a study, completely raw, without any medical records. And what I'm getting is a retrospective look at these gentlemen. Not only with regard to VWF. We're talking about all other things—backache is one of the big ones, and accidents are another. But I take your point. I think in your case here, in this country, it would be a great idea to go in with a neutral man into a population; if you back right up with your medical records and your compensation records, then this might tie it all together. And it would certainly confirm a lot of the subjective data. Because in doing it my way, I've got to rely on this worker's memory. I follow him up next year to see what he's up to and if he told me the truth the year before, but this is a very unscientific way of doing it. I have no means of thoroughly checking up. I can get an idea of the chain sawyer's length of service from Mr. Keighley's records. I can get some idea of exposure time from his saw petrol consumption. But then he puts me off by saying he uses fuel to wash his chain saw. That bothers me.

Question (J. Guignard, Naval Aerospace Medical Research Laboratory): Two questions for Dr. Taylor about hand and finger anaesthesiometry. In some work that I've been associated with, done by the University of Dayton for NIOSH on whole-body vibration, we devised a very simple anaesthesiometer in which the subjects were asked to feel a series of graded slots, rather than a continuously variable one. We got into difficulty with this, however, and the responses of the subjects are rather equivocal, apparently because they're not quite sure what they're being asked to judge, when you take their hand and guide it onto the slot. Do you have any views on the best way to design such a device? I have a supplementary question. In a paper that came out, about 5 years ago in London (I think, published by Alice Stewart), it was put forward that if you do get a dimunution of tactile sensitivity on anaesthesiometry testing, this may not be due to any change in function at neuronal or receptor level, but rather be due to some thickening or change in plasticity of the skin. Therefore, in a sense, this change may be an artifact in testing. I wonder what your theories of possible causes of any loss of sensitivity you may measure?

Answer (W. Taylor): Yes, these are two good questions. The first one is that we've also tried the spikes and the dips and the little circles, and so on, and we find greater variation than we do on the two simple tests I have indicated. The spread is even greater. And you're absolutely right. Both those tests are very insensitive indeed; how to refine them, is what we're doing at the moment in the United Kingdom. We're wondering how to proceed from here, but we tend to go on with that method because there is, as in audiometry, a training element in it, and now that these workers are getting better, we're getting very consistent results from Thetford. But then we're talking about 44, whereas a statistician wants about 400. So we'll have to develop this. You are absolutely right.

The second question is a great source of difficulty in this department of health, particularly with me. Dr. Stewart maintains white finger is due to callous formation subcutaneously. And it's the pressure outside the vessel that is causing the constriction. Now,

we have a most beautiful way of disproving this, because we've done finger diameters, finger circumferences, throughout the whole of that big series. In forestry, we don't get the same deformation of the finger or the joints as we do in grinding. Whenever there's a force factor involved, fingers appear to grow dorsal pads, and up comes the callous. Now, if we do a sensory test on those, we do not find that this follows the increase in finger circumference. I'm prepared to believe that she's right up to a point, and the only way that we're going to get any evidence is to get the postmortem material and just look at the organs, the end organs—the sense organs, the preceptors themselves. I think you're absolutely right. This is an element of both. We're both thinking along the same lines. It would be a very convenient method in the field. We can't submit all our VWF cases in the United Kingdom to a huge experimental setup. That's not feasible. Not only am I asking for an objective test, I'm asking for a simple one, and that makes the proposition even more difficult.

Question (D. Leonida, Peoria School of Medicine): How would you differentiate VWF gangrenous hands from a case of acracyanosis?

Answer (W. Taylor): For example, we've taken a worker to a physician, we've thoroughly examined him, and found an extreme gangrenous condition. And we cannot find anything other than occupational vibration to explain the conditions of his hands. We have to guess at this stage that that man was normal before he began. And this brings me back to the prospective data again. Unless we know what that man's condition was before we have him, we cannot assume any medical information. All we know is all the tests, including the rheumatoid tests, and X-rays, are normal. And this man has normal blood pressure. We think, therefore, that here is a straight history with no medical complications and that what we saw is due to vibration. Still not an accurate scientific statement, but the best we can do under the circumstances.

I would be asking you, Dr. Leonida, if you could tell me what more could I do?

Answer (D. Leonida): Well, it depends on your followup. Different investigators or different workers have different schemes of how to pursue this matter, e.g., whether they would approach it strictly from a diagnostic point of view, starting with the history, and then progress with physical examination.

Comment (W. Taylor): No. I didn't say that. We're doing both things simultaneously. We're doing a complete medical examination with the second medical man doing the occupational health history. All the series that you've seen have had a good medical exam. Otherwise we wouldn't know where we were with the differential diagnosis.

Question (D. Leonida): But on the history, what prior history do you have of occupational experience in this individual?

Answer (W. Taylor): We take a full occupational history, including any previbration exposure. We've got to take the man's word for that, but with any prehistory of vibration, we eliminate the individual from these surveys you've seen in our presentation. We wouldn't be able to compound the two, and so he is just automatically excluded.

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