Pulmonary Pitfalls: Problems of Lung Function Screening in Industry

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Curriculum vitae

Chris van Selm graduated from the University of Stellenbosch with BSc (Med) and MBChB in 1969. He obtained the Dip Mid (SA) in 1974 and thereafter spent many years in clinical practice. He was awarded the MFGP (SA) in 1980 and consequently the Diploma in Occupational Health from the University of the Witwatersrand in 1986. In 1984 he moved to Kearsney Hospital and in 1986 was transferred to Tongaat-Hulett Group Hospital as a Senior Medical Officer.

Summary

This article discusses the relevance of various ways in which lung function testing could be carried out. It illustrates, through patient studies, some pitfalls when assessing a patient, and the many personal, emotional economical and occupational aspects involved. It also gives guidelines regarding pre-employment examination, and the human, "holistic", clinical assessment of the doctor is emphasized over and against the accurate measurements of the machine.

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KEYWORDS:
Lung Volume Measurements; Occupational Diseases; Holistic Health; Socio-economic Factors.

Pulmonary function testing is gaining increasing validity in both physiological and pathological conditions, and in General Practice, an awareness of both the useful and simply operated Mini Peak Flow Meter, to the more sophisticated computerized Flow-Volume briefcase apparatus, is now well established. Integrated equipment is installed at large industrial clinics and in particular at the respiratory units of the various medical schools throughout RSA. Prior to the flow-volume curves used in inspiratory and expiratory movements, the expiratory component in volume-time curves (eg Vitallograph) was, and still is, an extremely useful and accurate measurement of pulmonary function.

While machines and print-outs are impressive to the patient, the old adage of accurate history and clinical examination cannot be over-emphasized, together with the use of other parameters, in establishing lung function assessment. Appropriate and accurate chest X-rays, sinus X-rays, and measurement of full blood counts, sputum analysis, and immunoglobulin fractions can assist in consolidating an often complex and difficult assessment. The problems surrounding lung function assays are directly related to effort as well, both by patient/subject and the instructor. It is vital therefore to recognise valid and effective measurements through maximum effort by the patient, and maximum encouragement by the instructor. We are particularly concerned about adequate and appropriate training of instructors (eg the occupational health nurse with qualified attendance of a pulmonary function screening course), and the General Practitioner in the consulting rooms who must take cognisance of the effect on the pulmonary functions test used - whether a peak flow meter or a larger unit.

With Pulmonary Function Testing, (PFT) it is imperative that the objectives be identified clearly to facilitate a complex assessment. Pulmonary function tests involve active and motivated participation by subject/patient, and in assessing the outcome, the tests are often confusing and can give no answers to existing problems or suspected abnormalities, with the result that inaccuracies of presentation can lead to unfair and incorrect conclusions, when timely prevention could be so important. Also, in determining compensation or disablement for patients who suffer irreversible lung

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damage, criteria for standards and recognition can be misleading. All this does *not* mean that there is no place for such measurements, but it does imply caution, and an awareness of both the physiology and pathology, and the recognition of variables in assessing a functional and valid measurement.

Depending on the availability of equipment, and the need for the capital investment, a briefcase type electronic unit can be purchased and

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Pulmonary function testing is gaining increasing validity

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used effectively with both inspiratory and expiratory components. These mini-computerized machines are programmed to be used with ease and can be portable, are reasonably accurate and available to almost any situation, be it clinical in the home, or at the factory workplace where surveillance of occupational exposure is commonplace and requires monitoring on a regular basis.

While some of the commercially available units are effective, others are unsuitable for a number of reasons.[7] The more sophisticated systems vary from the well tried and tested volume-time graphs (eg Vitallograph) to the integrated computerized system using flow-volumes.

What are the objectives?

a) Personal (Acute) Assessment

In a patient or subject with an acute illness or problem (eg acute toxic exposure) and who requires immediate assessment for baseline

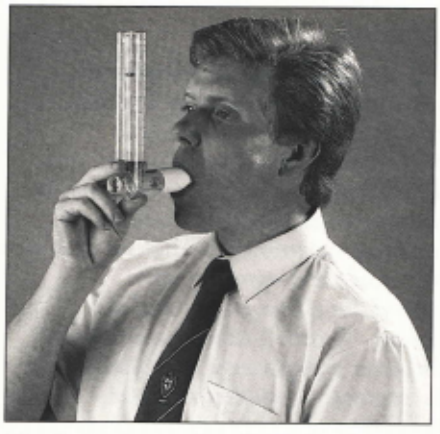

Fig 1. Using a Peak Flow Meter

monitoring (eg asthma), availability of lung function equipment is imperative for objective measurement. Simple expiratory flow rates by using a Peak Flow Meter (See Figure 1) is both cost-effective and useful, and the measurements can be charted (Figure 2). These small instruments may be used against charted nomograms for comparison. (Figure 3).

The larger systems are found in industry particularly in mining and other industries where occupational exposure to hazardous dusts and substances is a major component of surveillance programmes in occupational health clinics. (Figure 4).

While the importance in emphasizing accurate and appropriate pulmonary function testing should never be minimized, the objectives of this article are not to discuss the different systems in any detail, but rather to draw attention to the relevance of the various ways in which lung function testing may be carried out. Further reading in reference books is advisable,[1,2,3,4] for more information; and specific courses in occupational health is a strong recommendation to any practitioner who is involved in an industrial setting, particularly where exposure to hazardous substances and conditions are present.

Two examples illustrate the pitfalls that prevail in assessing a person or an acute condition:

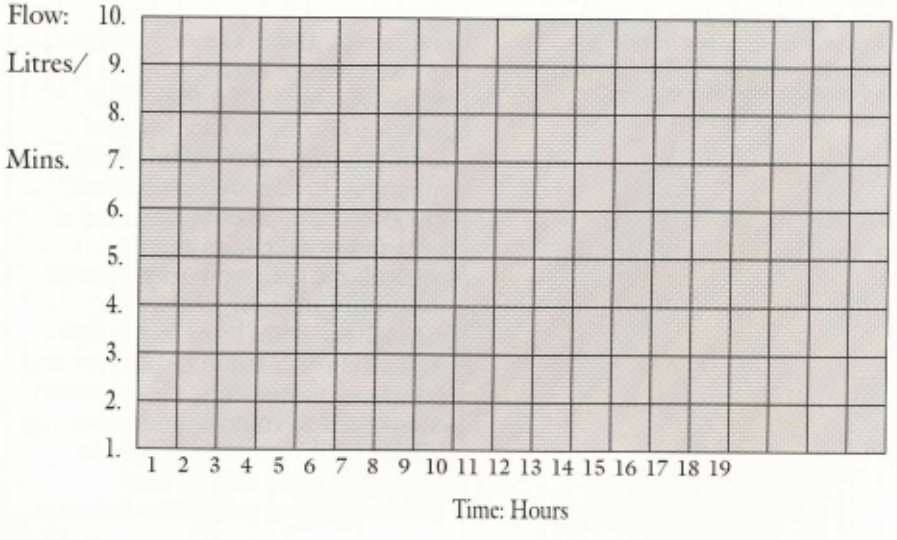

Figure 2

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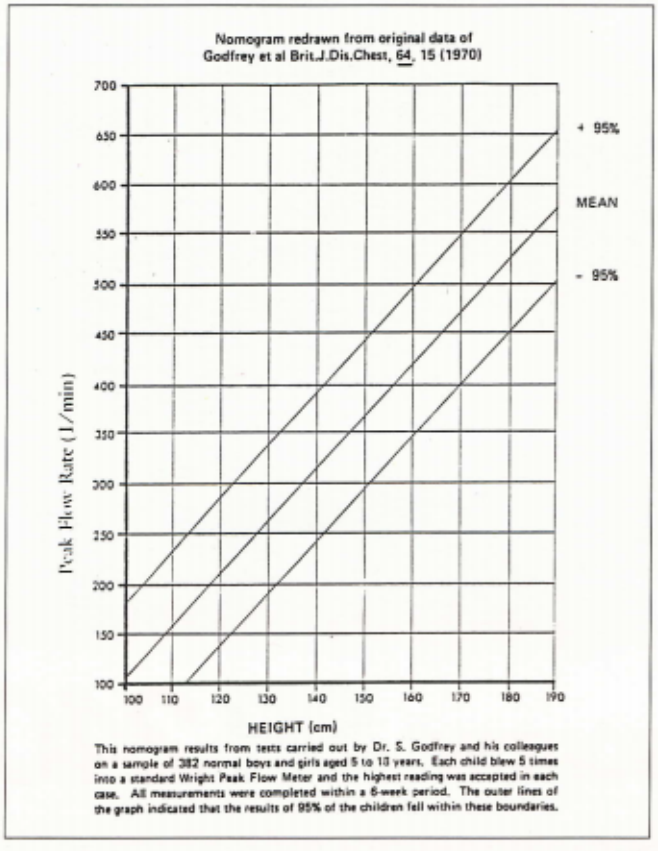

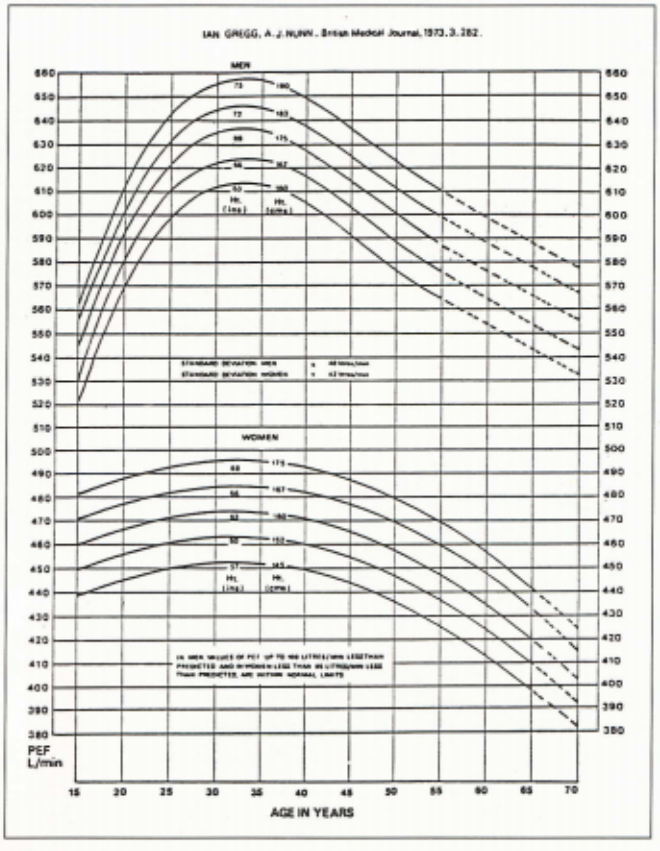

Figure 3

Patient 1

Male, aged 37 years, referred to our occupational health clinic for assessment because of chronic cough, dyspnoeic attacks and wheezing at night plus appetite loss and general malaise.

His occupational history was of limited exposure (if any) to hazardous dusts, he worked in the engineering section of a textile factory, there was no medical history of significance, and all investigations (eg chest X-ray, FBC, IgE, Heaf, etc) were normal. He is a smoker of an acknowledged 10-15 cigs/day. His PFT based on the expiratory component only, (because this is the most practical and effective measurement in a GP setting) was as follows:

	Actual (litres)	Predicted (lt)	%
Vital Capacity (V.C.)	4,92	5,42	91
Forced Vital Capacity (FVC)	5,42	5,42	100
Forced Expiratory Volume in one second (FEV_1)	4,48	4,36	103
FEV_1/FVC (Ratio expressed as percentage)	83%	80%	+3%

Assessment: Normal

Our dilemma is what to do with him: although his "tests" are normal, would his working environment be an added hazard if he had any "dusty" exposure? And then, by what measurement do we decide that any exposure is measurably significant?

Patient 2

Male, aged 36 years, no direct cotton dust exposure, but works as a fitter in a textile plant. Known history of PTB in 1976, carefully followed-up and monitored, with definite respiratory impairment on record over past 14 years.

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PFTs	Actual	Predicted	%
VC:	2,16	4,24	51
FVC	2,41	4,24	57
FEV_1	1,66	3,43	48
FEV_1/FVC	69%	81%	−12
Peak Expiratory Flow (PEF)	141	583	24

The problem is that the patient is under control, cured from his PTB, but with significant residual respiratory impairment (manifested by asthmatic wheeze and intermittent bronchitis). He is 36 years old, married with three children and no definite exposure to cotton dust. He works well and is happy in his job.

Do we disrupt his existence, recognising the poor pulmonary function? Bearing in mind his pensionable benefits are minimal in comparison to his job situation and trying to place him outside his present job is practically impossible in the present economic climate. While we all recognise his risk of exposure, his PFT levels, and his condition, what do we do?

(b) Personal Surveillance

Monitoring patients and their follow-up in the progress of routine surveillance, is part of the occupational health setting, and is particularly significant in exposure areas at the place of work. Pulmonary dysfunction therefore requires continued surveillance, (eg Asthma or COAD) and in high risk exposure areas (eg the mining industry with pneumoconiosis). Similarly, cotton dust exposure risk remains a significant hazard in the textile industry, and is continually monitored and assessed.

Patient 3

A welder, aged 37 years with exposure to welding fumes for ten years without adequate protection, presents at the outpatient department with dyspnoeic attacks. His investigations include chest X-rays, FBC, IgE and physical examination confirming an expiratory wheeze which is not causing distress. He also smokes, averaging 5-10 cigs/day.

PFTs	Actual	Predicted	%
VC:	2,69	3,18	85
FVC	2,89	3,18	91
FEV_1	2,32	2,98	78
FEV_1/FVC	80%	94%	-14
PEF	328	506	65%

The problem here is that his PFT's are still acceptable, the imminent dangers involved in welding fumes exposure over a period of 10 years, are very significant, but difficult to "measure" and comment on objectively. Employers with this type of reported comment usually react negatively, and resent or express dismay at placing the employee elsewhere or protecting him/her adequately, (protective equipment which is appropriate, is usually very costly.)

(c) Mass Screening in Industry

This occurs where ongoing screening in industry in which potential or real exposure to toxic or obnoxious gasses, dusts, particled waste, and other inhalants may be prevalent. Invariably, pulmonary exposure

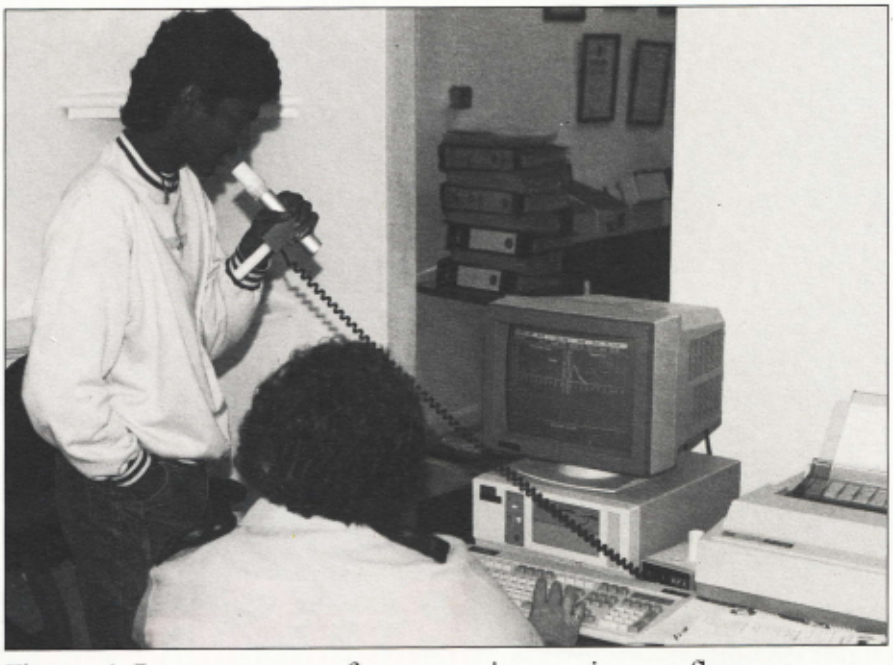

Figure 4. Larger systems for measuring expiratory flow rates are found in industry.

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means significant potential for harm, and although industry is making efforts to improve working conditions as a direct result of the MOSACT requirements (October, 1983), much needs to be reviewed in general on a continual basis.

Screening of a workforce in an industrial plant is based on initial pre-employment measurements, regular (usually annual) review measurements and across-shift measurements, where workers are measured before and after exposure. Concern lies in unrecognised, or ignored exposural hazards, as such exposure may cause irreversible harm to the lungs and airways with resultant permanent impairment or disability.

(d) Features of Pre-employment Examinations

The first critical feature of employment of appropriate personnel in industry with adequate health for the job situation, and the ability within

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Effective measurements are directly related to active, maximum effort by the patient and the instructor

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that industry to maintain a healthy environment as well, is accurate measurement. It is essential therefore to have available measurements in which the monitoring of such health standards would include appropriate screening procedures before contracts of employment can be negotiated.

The second feature of measuring PFTs in pre-employment examinations, is to establish the most effective and

Figure 5. Personnel Questionnaire
Pre-Employment/Pre-placemement Questionnaire

Department/Section:

Sex: Male | Female

Name:

Date of birth: | | | | | | (Day Month Year)

Occupation:

Job Specification: Key in scale eg Nil = 0, Light = 1, Moderate = 2, Heavy = 3.

A. Physical Requirements

- Climbing Stairs
- Climbing Ladders
- Hearing
- Lifting Equipment
- Standing
- Sitting
- Bending
- Vision
- Colour Distinction
- Co-Ordination

B. Special Requirements

- Use of Safety Glasses
- Use of Respirators
- Use of Hand Gloves
- Use of Safety Hat
- Use of Safety Boots/Shoes
- Use of Safety Belt
- Use of Ear Muffs
- Driving Vehicles
- Other (Specify)

C. Mechanical

- Action Repeating
- Physical Exertion

D. Working Environment

- Outside
- Inside
- High Temperatures
- Noise
- Humidity
- Vibration
- Heights
- Confined Spaces
- Abnormal Positions (Specify)

E. Working Conditions (NB Specify)

- Dust
- Gas
- Fumes
- Hazardous Substances

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accurate placement of an individual in a job situation in which he or she may possibly be exposed to potential or real hazards in a workplace, or placed in a position in which an already existent respiratory impairment would be affected or aggravated.

The third feature is to outline the baseline measurements of the applicant to establish a measurable comparison to monitor the situation

Inaccuracies can lead to unfair conclusions and often very sad disruptions in a patient's existence

in progressive medical follow-ups. Any deviation away from the norm would allow effective action to be taken to avoid further deterioration.

A fourth measure would be to make accurate details of any existing defective or pulmonary impairment for future reference, should any compensatory action be taken against the employer to effect claims against damages which may not necessarily have been caused or related to the employment of the individual.

Patient 4

Female, 19 years old for Pre-employment Medical (PEM). Her occupation would be a trainee in a textile plant with low risk of exposure on her Job Specification analysis. (This is a measure indicating the degree to which exposures may be relevant. (See Fig 5). No medical or occupational history of note.

PFTs	Actual	Predicted	%
VC:	2,54	3,91	65
FVC	2,71	3,91	69
FEV_1	2,47	3,53	70
FEV_1/FVC	91%	90,3%	+0,7
PEF	390	428	91%

Assessment: Applicant is completely acceptable and normal. The details illustrate the complex problems of establishing appropriate reference values to accommodate "constitutional" limitations of the VC and FVC.

Patient 5

Male, aged 26 years. Occupation: Trainee with high risk exposure on Job-Specification. No medical or occupational history of note.

PFTs	Actual	Predicted	%
VC:	6,53	5,03	130
FVC	6,72	5,03	134
FEV_1	5,92	4,09	145
FEV_1/FVC	88%	81%	+7%
PEF	809	576	140

Assessment: Completely Normal.

Criteria for acceptance of pre-employment or pre-placement medical examination

(based on our own assessments at the workplace).

(1) Acceptable history of respiratory function to evaluate risk in terms of placement, exposure, etc

(2) FEV_1 in Males > 1,00 litre below predicted value in Females > 0,80 litres below predicted value

(3) FEV_1 > 80% predicted

(4) FEV_1/FVC > 70% of predicted.

Criteria for surveillance of all employees on an annual basis, with particular emphasis on high risk exposure:

(1) A FEV_1 across shift (Δ FEV_1) of more than 0,5 litre (BOHS[8] recommend 0,2 litre).

(2) Byssinosis, Pneumoconiosis, Asbestosis, etc

(3) ? Smoking.

What to do?

Difficulties in deciding on the assessment of each individual employee are compounded by extraneous variables. Conflicting interests occur where employees are affected, compromised and even disabled. If Management accepts the medical assessment, the WCA Commissioner often challenges the decision, and vice versa.

A briefcase type electronic unit is very practical and effective

If on the other hand aggressive compensatory action is contemplated, the doctor finds himself compromised as Management feels his services are needed to be supportive, whereas the employee/patient feels victimized on biased decisions against him/her. Alternatively, if PFTs on an employee indicate trends which imply

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detriment to his/her health, Management is obliged to move him/her out of the working environment where occupational exposure has been identified as being hazardous. This can lead to unhappiness and resentment on the part of the employee who may feel that his/her potential for progress or unhappy placement, will jeopardize their future.

Practical difficulties in pulmonary function testing

(1) The most important criterion is the active and motivated participation in the testing programme by both instructor and subject alike. The practical implications of inaccurate measurements are obvious, and careful screening procedures require both appropriate decisions and ongoing surveillance.

(2) The instructor must be adequately trained to cope with the difficult practical problems in establishing normal levels at which PFTs can be measured. If the readings are inaccurate, criteria for invalidation should be introduced, and valid readings should comply within normal limits on repetition (eg 3 values within 5%).

(3) Appropriate reference values are essential. These are currently under serious review in the RSA,[6] and complex issues are being addressed.[7]

(4) Diagnostic dilemmas about what is normal, and when limits are acceptable, with confounding variables (like smoking) confusing the ability of the investigator to find acceptability for employment.

(5) What is "*At Risk*"? In terms of employment, placement, diagnosis, deterioration or exposure? This in itself is difficult to assess if a holistic view is taken of the worker, and the working environment, together with the enormous socio-economic problems facing so many people through unemployment.

(6) What is compensation, and when is it adequate? If we refer to further actual examples, we note some of the problems involved.

Patient 6

Male, aged 39 years. Occupational cotton dust exposure for 9 years. Medical history on record of chronic bronchitis and asthma attacks. Apparently denied consideration of any Byssinosis, to be reclassified a year later after Trade Union pressure to Grade 3 with retirement and compensation by WCA Commissioner @ R91,88 per month, on a 70% disability. Later increased to R217,00 per month since 1987.

Patient 7

Male, aged 51 years. Cotton dust exposure of 8 years. Graded Byssinosis in 1986 (Grade 2).

PFTs	Actual		Predicted	Percentage	
	Pre-shift	post-shift		Pre-shift	Post-shift
VC	2,16	2,23	3,82	57	58
FVC	2,43	2,14	3,82	64	56
FEV_1	1,53	1,37	3,02	51	54
FEV_1/FVC	63%	64%	74%	-8%	-15%
PEF	145	114	514	28	22

Assessment: Assessed by WCA Grade 2. A lump sum of R5 567,00 was paid in June 1989, with 20% disability. His employer provided a Pensionable Fund Scheme for his retirement as well.

Conclusion

In summarising some of these details, I would like to emphasise two aspects worth remembering:

1. People are not always measurable on machines - they are human.
2. Machines do not always tell you what you are looking for - clinical judgement remains the most important weapon a doctor can use.

Conflicting interests appear when employees are affected - the doctor should be fair to the Management as well as to the employee

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General Practitioners involved in industry will recognise the significance of trying to assist workers in their rightful plea for safe and healthy working conditions. Furthermore, these doctors must at all times, listen to their patients, and understand their methods of presentation, verbal and non-verbal