

Occupational screening

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ABSTRACT: Medical screening of workers is one of the tools often used to assess suitability for work and to attempt to reduce worker ill-health. This article outlines the objectives of the screening process and the basic criteria to be followed in developing a quality programme. It describes the different types of medical examination used in this setting. Screening programmes should be related to hazards specific to the workplace as well as to the physical and mental requirements of the job. The guiding principle in the prevention of occupational disease should always be the control of hazardous exposure to prevent harmful effects occurring rather than early detection of harmful effects after they have occurred. The importance of being aware of and abiding by these principles is particularly applicable in the local context.

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Introduction

Diseases resulting from exposure to workplace agents are all potentially preventable. The prevention of occupational disease is based on three levels. Primary measures are aimed at preventing the occurrence of ill-health by eliminating or reducing worker exposure to occupational hazards. This includes the testing of certain chemicals prior to their use, the substitution of chemicals by less hazardous substances, control of hazardous exposure by various engineering measures, assessments of the hygiene of the workplace, worker placement and training, and the use of appropriate protective equipment¹.

At a secondary level, attempts are made to detect disease at an early stage before the onset of clinical signs and symptoms when the worker would not normally seek medical advice². At this stage, the progress of the disease may be slowed, halted or even reversed³. The tertiary level of prevention involves the appropriate treatment of any diagnosed medical condition to minimise the effects of disease or disability and suitable attempts at rehabilitating the worker to enable a return to productive employment.

Why screen?

Health surveillance is the systematic collection, analysis and dissemination of disease data on groups of workers to monitor for the early occurrence of disease. When the main purpose of health surveillance is to identify work-related disease at an early stage, it may be considered as a type of screening. In fact, occupational screening is the search for previously unrecognised diseases or physiologic conditions that are caused or influenced by work associated factors or which can influence work. Thus, screening has a role mainly in secondary prevention¹. Such programmes may yield benefits to workers both as individuals as well as a

group. Benefits to the individual include the identification of risk factors to health, the detection of non-occupational disease, evaluation of fitness for work, proper job placement, early identification of the disease being screened for, identification and assessment of over-exposure to workplace agents, and establishment of a baseline health record. The advantages at a group level include the identification of new hazards, the recognition of adverse effects occurring at levels previously considered not harmful, the determination of hazardous areas, and the adequacy or otherwise of existing engineering controls and work methods. Screening also permits the assessment of absence patterns, the projection of health resource needs and the planning of preventive programmes.

Screening is a commonly used procedure in most developed countries; figures published in the United States for example, show that up to 34% of the workforce have periodical health examinations⁴. Despite its potential value when clinically indicated, adequate and appropriate screening of workers is not always carried out. In addition, there may be substantial variance in the legal requirements pertaining to the use of screening in various countries. In a 1991 study of the member countries in the EC, legislation varied from one requiring mandatory surveillance of all workers irrespective of potential exposures as adopted by France and Portugal, to a state which solely required screening of workers exposed to substances covered by EC directives (Denmark and Holland), with the other countries adopting intermediate screening policies⁵.

Is screening required?

Apart from the specific statutory obligation on the employer to arrange for the pre-employment and periodic medical examination of certain types of workers (Table 1)⁶, there is also a general requirement to ensure the health, safety and welfare of all employees, to

Table 1 - List of persons where there is a specified statutory duty on the employer to provide pre-employment and periodical medical examinations

Persons under 18 years of age
Persons making use of the following machines:
• <i>Machines worked with the aid of mechanical power:</i>
1. Brick and tile presses
2. Machines used for opening or teasing in upholstery or bedding works
3. Carding machines in use in the wool trades
4. Corner staying machines
5. Dough brakes
6. Dough mixers
7. Warm pressure extruding machines
8. Gill boxes in use in the wool textile trades
9. Hydro-extractors, calenders, washing machines, garment presses used in laundries
10. Meat mincing machines
11. Milling machines in use in the metal trades
12. Pie and tart making machines
13. Power presses including hydraulic and pneumatic processes
14. Loose knife punching machines
15. Wire stretching machines
16. Semi-automatic wood turning lathes
• <i>Machines whether worked with the aid of mechanical power or not:</i>
17. Guillotine machines
18. Platen printing machines.

ascertain the hazards at work and to prevent occupational disease^{7,8}. The initial step which needs to be taken by an employer to prevent occupational disease is a risk assessment of the workplace. This should be performed by a competent person with the aim of identifying any prevailing hazards including whether any agents used or given off in a process or work activity are known to adversely affect health. It will also determine which workers are at a higher risk of developing specific adverse health effects as a consequence of their exposures. When the assessment has revealed a risk which cannot be eliminated or is not insignificant, the employer will have to consider the measures, which may include health surveillance, required to prevent ill-health. Two important work-related conditions are occupational skin disease and occupational asthma. Tables 2 and 3 give examples of commonly recognised agents or processes which can cause these conditions: their presence in the workplace should alert the employer or physician of the need to introduce some form of health surveillance.

The risk assessment also helps to define the objectives to be achieved by any subsequent screening of the targeted population. It is imperative that screening programmes do not divert attention and resources from reducing toxic exposures at the workplace⁹. The anticipated benefits of initiating a programme should be

Table 2 - Agents causing occupational dermatoses

Chemical Agents:

Acrylates	releasers	compounds
Asphalt	Formaldehyde	Paraffin
Azo dyes	resins	Phenols
Brine	Glutaraldehyde	Quinones
Cement	Hydrazine	Rubber
Chromates	Hydrofluoric acid	processing agents
Cobalt	Hypochlorites	Shampoos
Colophony	Isocyanates	Soluble oils
Cresols	Kerosene	Styrene
Cyanoacrylates	Lime	Synthetic coolants
Dimethacrylates	Methacrylates	Talc
Epoxy resins	Nickel	Thinners
Fibreglass	Organic solvents	White spirit
Flour	Organotin	
Formaldehyde		
Formaldehyde		

Mechanical agents:

Friction:	Calluses, abrasions, lichenification of skin, Koebner's phenomenon
Pressure:	Blisters, nail dystrophy
Vibration:	Vibration induced white finger, Raynaud's phenomenon

Physical agents:

Heat:	Burns, sweating
Cold:	Frostbite, Raynaud's phenomenon
Radiation:	Radiation dermatitis, skin cancer, photosensitivity reactions

Biological agents:

Plants:	Poison ivy, oak
Arthropods:	Lyme disease
Animals:	Orf
Microbiological:	Viruses: herpetic whitlow
	Bacteria: anthrax
	mycobacterium marinum
	Rickettsiae: Rocky mountain spotted fever
	Parasites: Plasmodium
	Helminthes: cutaneous larva migrans
	Fungi

taken into account, and they should never be introduced solely as a public relations exercise or as a 'perk' for employees: neither should they be introduced before careful appraisal of whether the clinical condition to be screened for and the tests to be used to assess the presence and extent of disease satisfy certain basic criteria.

Disease criteria

Wilson and Jungner have suggested that screening programmes should be aimed at detecting diseases of sufficient severity and/or prevalence¹⁰. This will depend on the degree of the effects which such disease may have both on the individual as well as on the general community. The natural history of the disease should be

Table 3 - Processes and agents known to cause occupational asthma

<i>Exposures arising during work involving:</i>	<i>Causative agents:</i>
Polyurethanes/plastics/rubber/epoxy resins/paints	Di and tri-isocyanates, acid anhydrides, ethanolamines, tetramines, diamines, azodicarbonamide, acrylates
Fluxes: electronics industry aluminium soldering	Colophony Aminoethyl ethanolamine
Dyeing	Reactive dyes
Metal refining and plating/hard metal/ stainless steel welding	Platinum, chrome and nickel salts, cobalt and vanadium
Pharmaceuticals	Antibiotics, sulphonamides, ispaghula powder, ipecacuanha, piperazine, cimetidine, biological enzymes
Plant derived material: grain workers/bakers coffee and castor bean processing/ soya beans/tea dust tobacco industry carpentry/saw mill	Grain dust and flour Green coffee, castor and soya beans, tea dust Tobacco leaf Hardwood dusts
Animal derived material: biomedical laboratories/educational establishments/breeders sea-food processors	Small laboratory animals, locusts cockroaches Crustaceans, fish and products arising from them Organic dusts
Farming/animal handling	
Food processing	Biological enzymes
Detergent manufacture	Biological enzymes
Chemical, electronics, photography	Diamines, ethanolamines, tetramines
Health care	Glutaraldehyde
Hair dressing	Persulphate salts, henna

or early adverse effects (from chemical, physical or biological agents). Screening tests must be simple, appropriate and readily applicable both to meet cost constraints and to match the level of skill of the practitioner who will administer them¹¹. The realisation of the objectives of the screening examination depend to a considerable degree on the selection of the appropriate tests that are acceptable to the workers¹², and whenever possible should be non-invasive, since lack of worker co-operation is one of the major difficulties encountered in such programmes¹³. For example, the use of urinalysis as part of a screening programme to monitor workers exposed to agents known to cause bladder cancer is much more acceptable than cystoscopy. It is usually considered essential that benefits should outweigh costs, although in certain situations (e.g. in nuclear physics) the use of the appropriate test, whatever the expense involved, may be influenced by the possibility of liability and subsequent compensation.

The tests to be used should be selective and aimed at the risk population as well as be effective in terms of reliability and validity. Reliability reflects the repeatability of the test whilst validity is a function of the test's specificity and sensitivity. Such tests should have a high rate of sensitivity (the proportion of those with the disease identified correctly) and specificity (the degree to which those without the disease are correctly identified). However, the positive predictive value (the proportion of those testing positive who actually have the disease) is often more useful clinically than sensitivity and specificity. These test criteria are not always followed. For example, low back radiography is not sensitive or specific, and does not prevent low back morbidity, yet it is still a commonly used test, with, for example, more than one million performed each year in the United States. If everything else is ignored, the radiation hazards of this practice are considerable¹⁴.

Types of occupational screening examinations

known and it should have a recognisable latent asymptomatic stage or early symptomatic stage. The disease should ideally be amenable to some form of treatment resulting in cure or in an improvement in the clinical condition. Treatment of the disease in the latent stage should result in a much greater improvement in the quality of life or life expectancy than if treated at a later stage⁹.

Test criteria

Consideration has to be given to the selection of a suitable screening technique (if one exists), which will detect either excess absorption (in the case of chemicals)

If the risk assessment suggests that surveillance may be required, the employer should then obtain advice on the type and frequency of any surveillance to be undertaken from a medical practitioner with appropriate expertise. Before taking responsibility for running a screening programme, the physician must be aware of the various ethical (voluntary and informed consent, amount and type of information to be passed on to the employer, confidentiality)¹⁵ and legal ramifications of worker screening particularly with regards to Maltese statutory requirements regarding worker examination and the notification of occupational diseases^{6, 16}. It is interesting though worrying to note that an examination

of the annual records of the Register of Notifiable Occupational Diseases in Malta by the authors strongly suggests that there is a gross under-reporting of these diseases (Table 4). This may be due to a lack of reporting of the condition by the employee, or to a lack of recognition by the physician of the occupational factors causing or exacerbating such conditions or to a lack of reporting of the recognised occupational disease by the physician. Failure of physician reporting is possibly the result of a lack of awareness of their legal obligations or of a lack of appreciation of the importance of reporting such occurrences. Apart from its statistical value, such reporting serves to draw attention to the prevailing situation at a particular workplace where workers are being excessively exposed to hazardous agents and highlights an urgent need to improve preventive measures to protect other workers who may be similarly exposed.

Table 4 - Number of Notifications of Occupational Disease 1990-96

1990	9
1991	3
1992	3
1993	7
1994	29
1995	3
1996	3

Screening methods utilised will depend on the disease which is being screened for and the degree of risk to health. They may include, either singly or in some form of combination, a number of procedures varying from completion of questionnaires, self-reporting of symptoms, physician evaluation, diagnostic tests, organ function assessments, biological monitoring (measurement of levels of absorbed environmental agents or their breakdown products in biological samples, e.g. blood lead) or biological effect monitoring (measurement of nonharmful biological markers of absorption e.g. pseudo cholinesterase levels).

Questionnaires aimed at eliciting symptoms associated with exposure to the hazardous agent of interest are a simple, inexpensive and commonly used screening method. It may be an effective and sensitive way of obtaining information on the possible presence of a pathological problem and is often one of the first indications of the need for further investigation. Physical examination is a relatively inexpensive procedure but may be of limited effectiveness when one considers that physical findings are usually a late manifestation of disease. Chest radiography is a relatively sensitive screening procedure for early pneumoconiotic changes but of doubtful use in other pulmonary conditions. Pulmonary function tests, which are often used as a screening procedure for non-malignant lung disorders, can be a reasonably sensitive test, although the results obtained may be influenced by factors unrelated to the workplace such as cigarette smoking or chronic obstructive airways disease. Biological monitoring attempts to measure the parameter most directly related to the hazardous exposure and gives an indication of the

degree of environmental exposure to a hazard, and reflects uptake by all the routes of entry. However it is limited to a small number of chemical agents, since toxicological data on most hazardous agents is inadequate. There may be considerable differences in the uptake and elimination rate of chemicals and their metabolites and in the persistence of induced metabolic changes and it is essential that the recommended sampling time is strictly observed since this will affect the validity of the results obtained. Once a decision has been taken on the most appropriate method or methods to be utilised, the proposed screening programme can be set up provided that worker acceptability and adequate resources to plan and implement the programme are forthcoming. Tables 5 and 6 give examples of the screening measures appropriate in workplaces where there is a risk of exposure of workers to agents or processes which may cause asthma or dermatitis.

Table 5 - Health surveillance of workers exposed to risk of developing occupational dermatosis

<i>Type of process/agent</i>	<i>Type of surveillance</i>
Handling of chemical agents	Regular skin inspection and symptom reporting by worker
Substances known to cause severe dermatitis	Regular skin inspection by trained person
Suspect cases Substances which may cause skin cancer	Referral to medical practitioner for regular examination and further investigations e.g. patch testing, blood testing, skin biopsy
Widespread skin complaints or complaints with no identifiable aetiology	Dermatological surveys

Various terms (pre-employment, periodic, post-sickness, post-incident, post-employment) are used for different types of screening examinations but this different nomenclature reflects mostly the timing in a person's working life in which they are performed and not any significant difference in the principal aim. Similarly, the nomenclature does not give any indication as to the form or content of the screening procedure which varies according to the clinical indication.

The American Medical Association's Council on Occupational Health states that preplacement examinations are made for the express purpose of detecting and recording the physical condition of the prospective worker and the assignment to a suitable job in which any disabilities will not affect his personal efficiency, safety and health, or the safety of others¹⁷. They help in identifying persons likely to be vulnerable to certain types of exposure or who have established disease that could be aggravated by work. The individual's risk of future serious health problems that would inhibit job performance or result in large economic expenditures for the company may also be

Table 6 - Health surveillance of workers having different risks of developing occupational asthma

<i>Degree of risk</i>	<i>Type of surveillance</i>
Suggestive evidence of hazard - low risk	Pre-employment examination particularly with regards to past or current history of asthma Self-reporting of suspicious symptoms
Well documented evidence of hazard, with possible exposure of workers - moderate risk	Pre-employment examination including baseline lung function tests Self-reporting of suspicious symptoms Annual questionnaire
Strong evidence of hazard - significant risk	Pre-employment examination, including baseline lung function tests Self-reporting of suspicious symptoms medical examination, including lung function tests, at 6 and 12 weeks post employment, and, in the absence of symptoms, annually thereafter. Post-sickness examination if worker was off work due to respiratory illness.

considered. Baseline data obtained at pre-placement examinations may subsequently make it possible to measure early adverse effects of exposure. Pre-placement examinations are performed either before a worker starts a new job or before a worker is relocated to a new post. Such examinations should not be considered as a complete evaluation of the health of the prospective worker. In fact, the routine examination of all workers prior to employment is neither necessary nor desirable, and is only recommended for workers in specific circumstances (Table 7).

Table 7. Situations where preplacement examinations are indicated

- in the case of all new employees or employees transferred to a workplace in which the work carried out may be hazardous to the worker himself if certain medical criteria are not met
- in the case of workers exposed to hazardous environments, e.g. diving, work at heights
- in work which entails a significant hazard not only to the worker but also to third parties, e.g. transport workers
- in work which requires a high degree of physical and mental preparedness, e.g. firefighters
- if statutorily required, e.g. under 18 years(7)

Periodic examinations, performed at varying intervals during employment should be carried out for all workers where pre-placement examinations are recommended. In certain occupations, this may be a legal obligation. Their aim is to identify employees suffering from asymptomatic or early work-related disease who may then be recommended for a change of job prior to the onset of serious disease. These individuals may benefit from either reducing or removing the hazardous exposure (e.g. through a change of job) or from appropriate medical treatment¹⁸. Clinical or biological evidence of excess exposure indicates ineffective preventive measures and emphasises the need to identify the deficiencies so as to take appropriate corrective measures. Any such data may be correlated with environmental exposure levels which can then be useful in establishing or revising threshold limit values¹². They can also serve as opportunities to encourage safe methods of work and positive attitudes towards personal habits and hygiene.

Post-sickness absence examinations are used to ensure the fitness of an employee who is about to resume work with a view to assess the suitability of the match between the job and the employee. There is little use in subjecting all employees returning to work after illness to a medical examination, but these type of assessments can be of substantial benefit in certain situations (Table 8).

Table 8 - Situations where post-sickness examinations are recommended

- absence from work following accidents or injuries, whether at work or not
- absence from work of more than four weeks
- absences from work related to vertigo, loss of consciousness, and to cardiovascular, neurological, psychiatric, infectious or malignant disease

Post-employment examinations may be desirable for persons at risk of contracting diseases with long latent periods (e.g. skin cancer). Such surveillance may help in providing a fuller assessment of the effects of a particular hazard, especially if good exposure data is available. Unfortunately this type of examination is usually difficult to arrange.

When and how often?

The timing of screening tests should reflect the natural history of the disease processes. For example, chest X-rays performed in the first decade for persons exposed to asbestos will pick up very few abnormalities. Adequate attention has also to be given to any 'window period' in which a negative test result will not accurately reflect the state of health of the individual.

The frequency of screening depends on several factors including length of pre-clinical detection period, level and frequency of exposure and worker turnover rate. If a screening programme is considered necessary, it should be ongoing. One time programmes reach only a proportion of the population exposed in time and detect only those who have the condition sought at a particular time, not those who will develop it later¹⁴.

Interpretation of results

The normal values for screening test results and the predictive value of the test should not be assumed to be the same as those for the rest of the community. This is because the predictive value of the test depends on the specificity of the test and the prevalence of the disease. The work force is also different from the community both in demographic characteristics as well as in "the healthy worker effect", (the natural selection of healthy persons to work). Interpretation of such results may also be complicated by the presence of confounders such as alcohol and tobacco use and insensitivity of screening tests¹¹.

Personnel must be suitably trained not only to conduct the screening test but also to correctly interpret the ensuing results at both individual and group levels. A National Institute of Occupational Safety and Health (NIOSH) study reviewing routine chest X-ray films taken over several years revealed that physicians specially trained to read chest X-rays for occupational disease (B readers) found several cases of simple silicosis which had been missed by others¹⁹. However this does not mean that inconsistencies in radiographic reporting by trained readers does not occur^{20,21}.

The importance of suitable systems which record the information or results generated by a screening programme can hardly be overemphasised. In Malta this is also a legal requirement⁶. Their absence will result in an inability to perform an adequate audit of the programme. Epidemiological analysis of such programmes is useful in assessing the efficacy of programmes as a whole at individual worksites and in ensuring the absence of known unwanted sequelae. It may also be invaluable in detecting unexpected consequences of certain occupations. The periodic reassessment of an ongoing programme to ensure consistency with evolving knowledge and to modify existing practice as work conditions improve, is essential.

Courses of action

Abnormalities of screening results indicate the need for remedial action. Monitoring an individual's exposure is of little value unless this leads to action that improves working conditions²². Decisions should be made prior to the initiation of a programme as to the degree of abnormality of the test result that will result in action being taken and what action will be considered appropriate at varying degrees of abnormality.

In some cases screening may be useless with regards to early disease detection or survival enhancement for certain populations at risk, such as persons exposed to agents causing lung cancer. The most commonly used lung cancer screening techniques (chest X-rays and sputum cytology) have a low sensitivity (detectability rates of 45 to 50% and 10 to 20%, respectively). Although this results in earlier diagnosis when compared with discovery of lung cancer outside screening programmes, there is no corresponding increase in long term survival and thus screening for this disease is not considered valuable²³. However, in situations where no treatment is possible worker surveillance may still be useful in ensuring the adequacy of primary preventive

measures.

Screening programmes should include planning for the care of participating workers who demonstrate abnormal screening results, as well as arrangements for offering alternative employment or retirement on medical grounds. This planning is required prior to the initiation of any screening programme and should also include consideration of the provision of ancillary services not directed at clinical cure, such as education and counselling services, aimed not only at those at high risk but also at their families and communities.

Asymptomatic workers who may have suffered a hazardous exposure often ask for screening services²⁴, despite the fact that no valid test exists. In fact workers who feel ill or are worried about their health are more likely to consent to participate in screening programmes than others who feel well^{25,26}. Although such responses may be understandable they are usually inappropriate. The routine use of a battery of tests or individual tests chosen without a firm reason increases the possibility of at least one result being abnormal by statistical chance alone which will then require further investigation with corresponding increases in cost and inconvenience. Workers having true or false positive laboratory results may also encounter problems in continuing in their job or in finding alternative employment, in spite of the irrelevance of the test result to the job risks or to the ability to perform the job.

Conclusion

In the last decade occupational screening has received more scrutiny primarily because of the interest and problems associated with genetic screening and also because of the introduction of drugs testing at the workplace. Locally, many of the larger enterprises do have some form of screening programmes, usually consisting of an initial pre-employment medical examination and some tests of organ function. Even so, there are doubts with regards to both the efficacy of such interventions and to whether they are ever repeated in the course of the employee's working life or when a worker is relocated. This state of affairs with regards to pre-employment examinations does not usually extend to the smaller concerns where, at best, the applicant is simply asked to provide a medical certificate attesting as to his/her fitness for work, often with the physician concerned having little knowledge of the particular work environment and health risks of the proposed job.

Although preventive programmes in industry do not compete for resources with preventive or therapeutic programmes in the community, they do compete amongst themselves and with other priorities of industry. Poor or inappropriate screening will result in a waste of resources, may unfairly eliminate some workers from gainful employment and may divert attention from other methods of prevention. There is a need for the continuous assessment of screening recommendations and improvement in screening approaches to avoid the risk that both employees and employers become disillusioned with preventive measures. There is a sore need of education of both workers and employers as to the benefits and limitations of screening programmes. This has to be complemented with an increased awareness and observance of the legal duties of all those

who are involved in these programmes if such strategies aimed at promoting worker health are to have a reasonable chance of success. Finally, one must keep in mind that screening and monitoring in themselves prevent nothing; only the appropriate intervention in response to results of these tests can prevent²⁷.

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