Review article

From police to health adviser: the evolution of modern occupational health surveillance

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Abstract
(Gorman DF. From police to health adviser: the evolution of modern occupational health surveillance. *SPUMS J* 2003; 33: 134-139) Occupational health surveillance differs from healthcare-oriented surveys, and is an exercise in facilitated, informed risk management. In most situations, issues of condition importance and prevalence determine the survey composition and issues of predictive power should be the basis of survey type. This is usually not the case, as well illustrated by medical assessments of 'fitness' for diving. There is a need to introduce discretion into what has been inappropriately prescribed practice. There is also a need to emphasise functional capacity testing at the expense of medical examination and investigation.

Introduction

Occupational diving (diving) is a good model with which to demonstrate the principles of modern occupational health surveillance.

There is a difference between healthcare-oriented and occupational health surveillance. The former is usually predicated on the basis that early detection of and consequent intervention for disease will alter the outcome for the individual and/or society. This requires knowledge of the appropriate numbers needed to survey (NNS) and treat (NNT) and of numbers needed to harm (NNH) before the utility of a survey can be assessed. Failure to assess these numbers can result in harmful and or ineffective surveys; screening for breast cancer with mammography is an example of such a poor survey.[1]

Occupational health surveillance on the other hand is more responsive to duty-of-care responsibilities that arise from health and safety in employment legislation by the prohibition of discrimination on the basis of disability intrinsic to human rights-type legislation, and is highly influenced by privacy legislation. As a result, a health condition may be selected for survey for which there is no meaningful intervention. Generally, the process is highly dependent on selecting important and prevalent conditions, so that the survey will have high predictive power.[2]

Nevertheless, some health conditions may be included that do not exist at appropriate levels of prevalence. This highlights a difference between clinical and statistical significance. Some conditions may be unusual in such a (potential) worker cohort, but of great clinical importance, for instance epilepsy and diving, such that concerns about statistical validity are superseded by the need for detection. Some others need to be included for purposes of baseline data collection. An example of the latter is audiology, where many of those undergoing an initial medical assessment for diving had pre-existing hearing loss.[3]

The case for occupational health surveillance

When the New Zealand Department of Labour decided to introduce a standard medical assessment for all occupational divers,[4] many recreational diver instructors raised questions about the rationale for their inclusion. These questions well illustrate the generic argument about the utility of occupational health surveillance and will be addressed here in a question and answer format.

What evidence is there that assessing a person's fitness to dive affects the morbidity and mortality of recreational and occupational diving?

Notwithstanding the biological nonsense of a human being 'fit to dive', this question cannot be answered and to a large extent misses the point. The reason for the former is that no such data have been collected and, even if an attempt were made to do so, would be unlikely to confidently answer the question. Based on anecdotal data, my estimate is that the incidence of decompression illness (DCI) in Australian recreational divers is about 1/10,000 decompressions. My estimate of the fatality rate from any cause for this group would be about 1/100,000 hours of diving. It is clear that a study sufficiently powered to have an 80% likelihood of demonstrating a doubling of mortality after diving, in association with a subject disease of even high prevalence,

for instance asthma, would have to be based on more than one million hours of diving exposure.[2]

Some attempts have been made in this context; for example, asthma is said to double the risk of a lung injury after emergency ascent training from about 1:60,000 to 1:30,000 ascents,[5,6] but the statistical basis of this claim is not robust. It is also for this reason that a 'numeric wellness outcome' was used by Dr David Doolette and me to estimate the utility of decompression practice in South Australian tuna farm divers rather than the 'occurrence of DCI', which is after all an arbitrary threshold-based outcome category imposed on the spectrum of diver health status.[7]

The problem of answering any question about the utility of a health survey here to improve health outcomes after diving is also exaggerated by the following. First, the traditional, prescriptive approach to diving medical assessments has resulted in divers 'shopping around' for medical clearances and progressively greater withholding of key health information.[8] This is certainly my anecdotal experience with New Zealand occupational divers, where a change from such an approach to a more discretionary one has resulted in many long-time divers admitting to health problems that were both long-standing and previously undeclared. Second, the cause of more than 80% of all events that can or do lead to harm in any occupational setting is human error and/or violations of accepted practice, and not uncontrollable hazards and predisposing health problems.[9]

The Diving Incident Monitoring Study suggests that these conclusions can be extrapolated to diving,[10-12] and that study of the subject of diving accident causation would be better facilitated by consideration of the protection motivation theory than any survey of underlying health conditions.[13] This theory proposes that five factors predict preventive behaviour for health-at-risk issues: perceived susceptibility; perceived severity of the health consequences; perceived efficacy of taking the possible health action; perceived barriers to taking action; and self-efficacy expectancy of taking the action.

Most importantly, however, the question of the efficacy of occupational health surveillance in terms of influencing the morbidity and mortality of diving does miss the point, as such surveys should be an exercise of hazard identification, risk assessment and explanation, and of risk acceptance and/or rejection. That is, the primary obligation of occupational health surveillance is to facilitate informed choice by workers, employers, insurers and society.

What is the significance of duties of care intrinsic to health-in-employment legislation, of privacy legislation and of human rights legislation?

As implied above, such legislation is central to occupational health surveillance. A duty of care is intrinsic to health-in-employment legislation. Occupational diving is variably physically and psychologically demanding and occurs in an unpredictable, mobile, dense, irrespirable environment.[14] Although human error is primarily responsible for most diving incidents and accidents,[9] it is essential that a person's work-related health risks are known if they are to be managed adequately.[10-12] However, the issue here is how best to assess such risks and to what extent this can be done by a medical practitioner (doctor).

Privacy legislation is often cited as a reason against discretionary health surveillance, in that secondary risk takers, such as employers, government agencies, dive school instructors and insurers, are consequently excluded. This is false; privacy legislation simply requires that consent to inform other risk takers is obtained prior to the survey and that this consent be based on knowledge of the way in which the health data will be collected, analysed, stored and shared. Doctors need to develop the skill of information management.

For example, the requirement of a job may be that the workers need to be blood donors because of the remoteness of the work site. A potential worker is found to be HIV positive. The employer does not need to know such detail, and can make a decision about employment here if simply told that the potential worker is unsuitable for blood donation. It is my experience that too often doctors either breach their patient's or client's privacy by telling secondarily involved people and agencies 'everything', or prevent sensible decision making by telling them 'nothing'.

Human rights or disabled peoples legislation should have the greatest bearing on occupational health surveillance. That it does not is testimony to this 'gold mine' having yet to be discovered by the Australasian legal profession. To paraphrase, central to such legislation is the concept that someone cannot be denied employment on the basis of a disability unless that disability precludes them from being able to undertake the tasks required, and/or the person's health condition represents an unacceptable risk to them and/or those whom they are to work with, at work. All practicable, which does not mean convenient or cheap, steps should be taken to accommodate that disability.

It is clear, then, that any occupational health surveillance must be prefaced by a thorough knowledge of the functional requirements of the employment; that is, a functional rather than a strategic job description. It is also clear most jobs have not been so analysed and why a course to train doctors to assess diver fitness must be based on knowledge of the diving environment. On this basis, many standards of 'occupational fitness' are seen to be discriminatory.

For example, admission to one naval diver-training programme requires the candidate to complete a two-mile run in a set maximum time of 11 minutes. This is sexually discriminatory, as most women cannot satisfy this requirement and it is difficult to see how conventional naval

diving requires such running skills. By contrast, a standard based on having to be able to swim 400 metres using fins against a 1.5-knot current would satisfy any human rights legislation. Finally, while a functional orientation is essential, a medicalisation of the assessment is not. That is, whether or not a candidate can meet the functional requirements of a job are better assessed by functional capacity assessments (physical competency testing) than by facsimile testing in a doctor's rooms.[15]

Is there a difference between the health surveillance needs of different occupational diving groups (e.g., recreational diving instructors versus repair and construction divers)?

Although health professionals often assume the role, adoption of thresholds of acceptable risk at work is actually a societal responsibility.[16,17] In the case of diving, it is easiest to consider differential health survey thresholds and hence process by considering categories of private and public risk. The booted, helmeted construction diver has little of either because of duplicate systems, surface support, a standby diver and the absence of any dependent workers. By contrast, the free-swimming recreational diver instructor has much greater levels of both, as they have in real terms little equipment redundancy and are responsible for the health and safety of diving students and novices. Any differential standard, then, would be based on a requirement for a higher level of health reliability for those employed in the recreational diving industry. However, a common standard is preferable in most jurisdictions as divers usually are variously and not specifically employed.

In what role is the doctor engaged when undertaking an assessment of a recreational and an occupational diver's fitness for diving?

Doctors and their regulatory authorities are often unaware of the nature of their role when performing occupational health surveys.[18] Whereas the usual role in this context is that of undertaking an audit as a commissioned agent of a third party, such as an employer, government agency, insurer or diving school,[19] many doctors mistakenly believe that they have a doctor-patient relationship with the person being surveyed. This frequently leads to inappropriate advocacy behaviour; for example, both Sir John Scott and I, and a New Zealand coroner, considered this phenomenon to be a significant contributor to the dysfunction of the system used to assess medical 'fitness to fly' in pilots in New Zealand (see below).[16,17,20]

Careful attention is also needed to the semantics of any subsequent certification to ensure that the doctor's role is that of risk assessment and explanation and not that of risk acceptor. Given that an air-breathing mammal with negligible diving reflex such as *Homo sapiens* can never be literally 'fit to dive', for reasons of medico-legal prudence alone, certification should avoid such statements and conform instead to informed consent formats.[21]

Bad health surveillance

An analysis of bad health surveillance programmes is informative with respect to identifying the principles of effective health surveillance.

ROYAL AUSTRALIAN NAVY'S OBESITY SCREENING PROGRAMME

The Royal Australian Navy (RAN) had a long-standing obesity 'detection' programme, based on a variety of measures such as height, weight, skin-fold thickness, neck girth, body-mass index and even density.[22] The origins of the programme, which was expensive and produced many anomalies with respect to fitness, e.g., rugby front-row forwards, are uncertain. One anecdotal explanation was that the programme was a response to obese sailors not being able to escape from a stricken ship through small openings in the hull.

Assuming some veracity for this claim, this is a good example of 'medicalisation' of a functional issue.[15] At body temperature, human fat is fluid and consequently obese people are quite capable of negotiating small openings, much more so than those with broad skeletal and muscular shoulder girdles. The simple measure here would be an employment requirement to be able to pass through a standard opening, a process that does not require a doctor's assessment.

THE NEW ZEALAND CIVIL AVIATION AUTHORITY'S PROCESS OF ASSESSING PILOTS' FITNESS TO FLY

In the 1980s, the aviation industry in the United Kingdom and elsewhere recognised the hazards inherent in management-employee interactions and the "lethal combination of human error and a weak organizational structure".[23] In 1999, Noah (pg 242), stated

> "*Once the definition and identification of illness begin primarily to serve the needs of non-medical decision makers, such as insurer, regulatory agencies, and litigants, closer scrutiny of the diagnostic process is warranted.*"[24]

Sir John Scott and I undertook a random audit of the New Zealand Civil Aviation Authority pilot-medical files.[17] More than half of the files were flawed; most flaws were trivial but some errors certified pilots as 'fit to fly' when they should not have been so licensed. We thought that this unacceptably poor practice did not have its roots in doctor dishonesty or incompetence, but rather in system design with consequent funder capture. The system contained no systematically established external audit or rigid, mandatory confidential reporting to enhance safety through identification of problems involving individual pilots.

Not surprisingly, there had been an observable drift in practice, sustained by collegial reinforcement.[25] The pilots

funded the medical assessment system, and it quickly became responsive to their needs. Some doctors lost perspective of their primary obligation to the government and people of New Zealand. As cited briefly above, they saw their primary role as that of pilot advocacy.[16,17,20]

Concurrently, the New Zealand Medical Council's draft guidelines on 'certification' stated that a doctor's first responsibility was "to the patient".[18] This is wrong in law. Rather, in the context of certification, and particularly for a third party, such as the Department of Labour or an insurance company, it is clear that the legal responsibility of a medical practitioner is to that third party for whom they are acting as a commissioned agent.[19]

OCCUPATIONAL DIVERS IN NEW ZEALAND AND THE AUSTRALIAN AND NEW ZEALAND STANDARD AS/NZ 2299

An analysis of occupational diver assessments performed according to Australian and New Zealand Standard AS/NZ 2299 has shown a profile of low positive predictive values (PPV) and high negative predictive values (NPV), which would be far more useful in diagnosis than in health surveillance.[3,26] This observation is understandable given that this standard was based on a list of diseases considered to be either absolute or relative contraindications to diving. That is, the standard was designed to be diagnostic and not a survey of health risks at work.

In the analysis of the standard,[3] none of the questionnaire, examination and investigation items, alone or in combination, offered an acceptable balance of sensitivity and specificity. The data also 'suggested' that decisions regarding fitness to dive were not based so much on the questionnaire response, but more so on the free-text component.

It follows that if the AS/NZ 2299 questionnaire is to be used, then review of the yes/no responses, free-text clarification by the medical assessor and a subsequent clinical audit are critical components. It is also apparent that such an assessor cannot be naïve in the context of diving medicine. However, the real conclusion here is that any tool used to survey 'fitness for work' must be evaluated for consumer understanding and for both statistical reliability and reproducibility.[2] Few have been so in practice.

BREAST CANCER SCREENING BY MAMMOGRAPHY AND HIV SCREENING IN THE AUSTRALIAN MILITARY

Despite the claims of the related health-disease industry, breast cancer screening by mammography does not appear effective. The NNS to prevent a death is very high and the NNH, by way of surgery for benign masses, is low.[1] The reason for this is that in young women the incidence of benign masses is high, the incidence of malignant masses is low and the natural history of the latter is virulent. In this environment, the predictive power of almost any survey will be unacceptable.[2] The same situation of low prevalence and consequent poor predictive power explains the biopsychosocial harmfulness and low utility of the RAN's HIV screening programme. My assessment of this programme showed a positive predictive power of demonstrating infection with HIV in the first phase of the programme of only 6.7%.[2]

The evolution from prescribed to discretionary formats for occupational health surveillance

The traditional prescribed approach to determining 'occupational fitness' has actuarial roots. By prescribing thresholds of fitness and identifying those diseases considered contraindications to employment, actuaries are able to estimate risk and cost (premium). The approach was adopted by naval diving authorities,[22,27] and subsequently by Standards Australia,[26] given the appeal of an apparently consistent system and in response to increasing problems of diver morbidity and mortality. However, the sole strength of a prescribed approach is that the doctor undertaking the survey needs only to be able to interpret and administer the prescription; that is, they can be naïve.

By contrast, there are several weaknesses to such an approach. Firstly, the key risk taker is excluded from any involvement, which leads to both the shopping around behaviour and loss of veracity cited above.[8] Secondly, divers continue to dive despite medical contra-indications.[28] Thirdly, only a few health conditions, e.g., visual acuity and hearing, are able to be defined by prescription, whereas most, e.g., asthma, are not and sensible case definitions are elusive.[6]

It is not surprising, therefore, that our audit of AS/NZ 2299 has been shown to be of limited utility.[3,26] There is an inevitable need for centralised audit and for arbitration.

A discretionary approach to assessing 'occupational fitness' is to a large extent a response to the problems of prescriptions and to some degree is a predictable over-reaction. In this model of survey, the risks associated with the job for the person are identified and explained and any decision is left to the person concerned. The primary strength is that the key risk taker is central to the process, although there is a danger of excluding other risk takers as discussed above in the context of privacy legislation. The major weakness in administration is that only knowledgeable doctors can be used and the major flaw in application is that objective data usually do not exist so that most risk explanation is qualitative and not quantitative. For example, there is no diving-relevant test of cardiovascular fitness, and lung function tests are poorly predictive of risk for lung injury due to decompression barotrauma.[29]

The obvious solution is a 'halfway house', based on a kernel of community-determined, prohibited conditions. That is, a prescriptive element of conditions such as active exercise-induced asthma, epilepsy, insulin-dependent diabetes and ischaemic heart disease for divers is combined with a much larger penumbra of conditions for which discretion is exercised by the diver and secondary risk takers.

The process of modern occupational health surveillance

Modern health surveillance has three steps: the identification of relevant conditions for survey, the selection of survey tools and process and the audit of survey efficacy, with modification as necessary.

A condition here may refer to a disease, such as asthma, a treatment of such a disease, such as ß-blockade for hypertension, a state of aerobic fitness or even to an anthropometric measure. An example of the latter is the length of the thigh in a jet-fighter-pilot candidate in the context of ejection seats and the distance from the seat back to the rigid console. The key issues for selection are importance, which as discussed already is a literal and figurative functional outcome of human rights legislation, and prevalence, as demonstrated by some of the examples of poor health surveillance cited above.

I recommend the following four 'questions' are addressed to identify 'importance':

1 The effect that the condition will have on the person's ability to undertake the requisite tasks;
2 The effect that the work and work environment will have on the condition;
3 The effect that the condition will have on the 'safety' at work of the person and those with whom they work;
4 The effect that the condition will have on the likelihood of a work-related illness or injury.

Using asthma as an example shows that this condition is very important in the diving environment for several reasons. Impaired respiration will limit exercise tolerance and work performance. Many aspects of the diving environment will precipitate asthma. Asthma will increase the likelihood of drowning by impairing the diver's ability to swim ashore or back to the boat, etc; there are some weak data to this effect.[30] The safety of the diver's workmates, at least during rescues, will be compromised. The risk of pulmonary barotrauma may double, as cited above.[5,6] Similar to asthma, sickle cell disease and TB would also be selected as being important conditions in divers. However, as well demonstrated by the examples of breast cancer and HIV infection, predictive power is determined by prevalence,[2] such that in a developed European society only asthma would be selected from this group for inclusion in a survey of divers.

The selection of survey tools should be determined in the context of several factors. Unless the language of a questionnaire is tested against the subject population, it may not be intelligible to the consumers. This was my strong, anecdotal experience in developing the current questionnaire used for New Zealand occupational divers in lieu of AS/NZ 2299. It may also have a low PPV.[3,26] The yield of physical findings obtained in the absence of a suggestive history and that affect outcome of the survey is very low, and even lower for most investigations. Most relevant conditions are best tested functionally and are better not 'medicalised'.[15] Some of the key issues, for instance emotional coping skills, aquaphobia and claustrophobia in diver candidates, are impossible to test effectively in a doctor's rooms.

It is clear that a well-constructed questionnaire will be the ideal triage and that the undertaking of any physical examination and investigations should be predicated by some history suggestive of an important condition. It is too soon to assess the utility of the current New Zealand occupational diver health questionnaire. However, the recent audit of the initial assessment of these divers revealed only three independent predictors of certification outcome: a past history of asthma ($p < 0.0001$), abnormal cardiac auscultation ($p < 0.0005$) and abnormal respiratory function tests ($p < 0.0001$).[3]

Some tests do need inclusion for reasons of baseline, such as audiology given that many diver candidates were shown to have significant hearing loss before beginning their diving careers.[3] Medico-legal considerations may encourage some diver-employers to also insist on pre-employment X-rays of long bones and on psychometric testing. Unfortunately, as already stated, given the significance of cardio-respiratory fitness to survival in the ocean as a diver, there is no diving-relevant test of cardiovascular fitness and lung function tests are poorly predictive of risk for lung injury due to decompression barotrauma.[29]

Current international practice for occupational divers is to insist on annual assessment. There is no logic to this frequency and, although ageist,[31] an age-dependent frequency of assessment would be more sensible. Similarly, some tests do not require iteration; for example, the forced vital capacity, the only weakly predictive respiratory parameter for lung injury in divers,[29] does not change significantly after adolescence. The efficacy of substituting a questionnaire as a triage tool for the routine, full, annual AS/NZ 2299 [26] assessment for years 2 to 5 inclusive for every five-year cycle for New Zealand occupational divers will be tested later this year.

Summary

Occupational health surveillance is a demanding process of risk management and should conform to the principles of this discipline. Current practice generally falls well short of an acceptable standard. Diving has been used here to illustrate the modern principles of such surveys.

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