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Risk, perception and sport – the doctor as policeman?

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Risk, safety, medicals - diving, fitness to dive, review article

Abstract

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Introduction: The pre-diving medical examination might be approached from the point of view of a barrier to be policed, or a risk assessment exercise. Whilst the examiner as policeman is the model that has been popular in the past, many diving physicians no longer feel this is an appropriate role.
Review: This article explores the concepts of risk assessment in the context of the diving medical examination. While risk is a fixed value and potentially quantifiable, risk perception is both personal and variable. Risk may be communicated using relative risk, absolute risk, numbers needed to harm or probability. Which presentation of risk is appropriate will vary with circumstance. Using an inappropriate measure may result in miscommunication and an inappropriate response. The theoretical models of risk homeostasis and cognitive mapping are discussed in relation to scuba activity, and the influence of safety measures on actual risk are explored.
Conclusion: Risk perception and actual risk are often difficult to reconcile. Individuals are likely to assess risk in remarkably different ways, and it is very difficult to ensure risk is communicated in both a truthful and meaningful way. For any medical assessment that requires risk communication (and this certainly includes a pre-dive medical), great care must be taken. Whilst the role of the medical examiner as policeman removes the need to communicate risk accurately, this may no longer be appropriate.

Introduction

Diving, whatever form it may take, carries risk to health. Some of these risks are appreciated through 'common sense' (you can't breathe underwater), while others are more obscure and require specific education and/or training to appreciate (decompression illness). The aim of this paper is to introduce some general concepts concerning risk and risk perception, particularly in relation to the physician as part of the risk assessment process in sports activity. This paper was presented at the opening of the SPUMS ASM in 2003. That meeting was concerned specifically with the role of the physician in the risk assessment of sports divers.

Risk and risk perception are large fields of investigation. The following is nothing more than a brief introduction to what is becoming a complex area. Interested readers are referred to two of a number of good general summaries of the field.[1,2]

Specifically, the aims are to put the concepts of risk assessment in the context of the diving medical examination, define precisely what is meant by 'risk' and 'risk perception', discuss the concept of relative risk perception in the context of sporting activity and to explore how these concepts apply to recreational scuba diving. Finally, the question central to the 2003 ASM will be introduced. What is the role for the physician in this context? Are we acting as policeman or risk assessor during a routine 'fitness to dive' medical?

Risk

The term 'risk' derives from the Latin *'riskare'* meaning to navigate around a rock or cliff. The link with the sea is quite apt for our purposes. In English, 'risk' has been defined by the Royal Society as "*the chance (probability) of the occurrence of a particular adverse event or hazard*".[3]

Thus, for most purposes at least, risk can be defined as the subgroup of possible events that would be perceived as adverse. We can express risk quantitatively in a number of equivalent forms, as probabilities with values between 0 (no risk) and 1 (certainty of event), percentages between 0% (no risk) and 100% (certainty) or frequencies (10 times out of 100). Much of medical statistics in both epidemiology and clinical research is designed to produce estimates of risk values, and a full appreciation of risk theory is not possible without some understanding of both probability theory and statistical analysis. Indeed, proponents of the evidence-based paradigm for the practice of medicine would suggest that rational medical practice is not possible in the absence of such an understanding.[4]

In practice, such concepts are not difficult to master, and the interested reader is referred to the excellent publication by Sackett and colleagues.[5]

Risk perception

The perception of risk is a rather different and inexact concept. Risk perception may be formally defined as the subjective assessment of risk, and perceptions will vary between individuals and even in the same individual over time. Risk perception is therefore both personal and variable.[6] Not surprisingly perhaps, the perception of risk is poorly correlated with actual risk, and highly dependent on the way in which information is presented to the individual. Risk perception is not logical. It is very difficult for the human mind to accept that, after a run of six consecutive red numbers on a roulette wheel, the chance of a further red number is no different than the chance of the first. We all instinctively feel that a black number is 'due'.

A few examples may serve to illustrate these concepts. During 2003, a rogue sniper was infamously active in the Washington DC area. Several individuals were shot whilst in public places such as petrol stations and shopping mall car parks. There was understandably widespread concern for the safety of residents, and many individuals were reported as driving long distances to avoid exposure in such places in the Washington area. One author calculated that during this time there was a 1 in 517,422 chance (p = 0.00002) of being shot by the sniper, while the risk of death through a motor vehicle crash over the average extra miles travelled was likely to be appreciably higher.[7]

In Sydney, over approximately the last three years, there have been plans promulgated to site Australia's next nuclear facility at the same site as our present facility, in the southern Sydney suburb of Lucas Heights. Apart from any other potential concerns about the wisdom of this plan, numerous local residents are opposed to it on the basis of what is calculated to be a negligible increase in the risk of cancer from environmental radiation. A number of these residents are smokers. Their risk of cancer is many orders of magnitude greater than that due to any possible environmental exposure from the facility proposed. Rather than their residential address, they should be concerned with their personal habits, but their perception of the relative risk is very different.

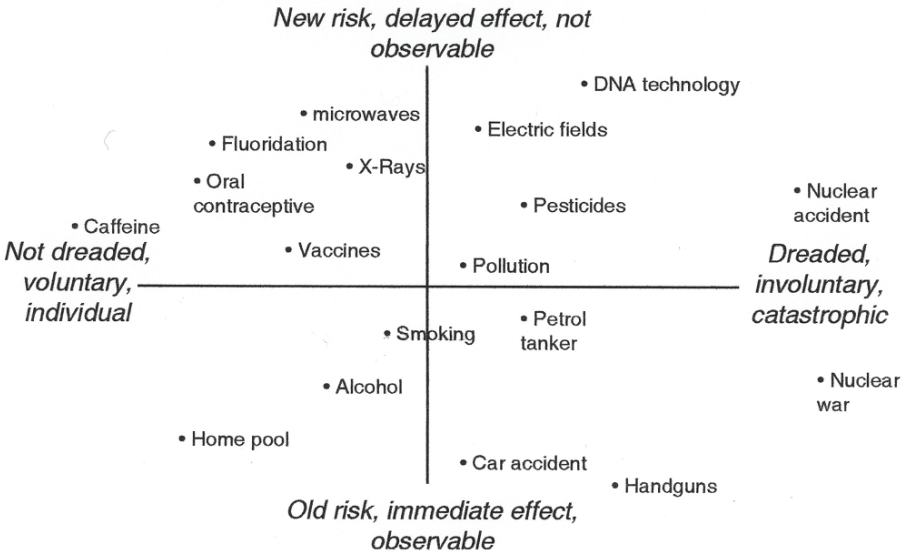
Finally, in the USA during the early 1980s, a rash of teenage suicides was reported that seemed to be associated with playing the interactive fantasy game 'Dungeons and Dragons'. In total, 131 players were claimed to have committed suicide over this period and there were wild theories expounded concerning the sinister nature of this hobby activity. One author went so far as to suggest,

> *"[Dungeons and Dragons] is essentially a feeding program for occultism and witchcraft. For Christians, the first scriptural problem is the fact that Dungeons and Dragons violates the commandment of I Ths. 5:22 "Abstain from all appearance of evil." Much of the trappings, art, figurines, and writing within D&D certainly appears evil - to say the least of it."* [8]

Parents were urged to keep their children away from the dangerous influence of known players, or they would be at grave risk of succumbing to subliminal messages urging them to take their own lives. In fact, one author has calculated that at this time, there were approximately 4,000,000 teenage players active worldwide. With an overall teenage suicide rate an unacceptable 1 in 10,000 teenagers each year, one might have expected to see 400 suicides in this group. The number of players who died (131) seemed more likely to suggest a protective effect of playing rather than a risk.[9]

Risk perception has little to do with rational interpretation

Figure 1. A cognitive map of some perceived risks[11]



of true risk and a lot to do with our view of the world, with our suspicion of those elements of science and society with which we are unfamiliar.

A number of schemes have been advanced to help us understand the way we all appreciate risk. Adams points out that we can divide risk into three categories – direct, practical risk, e.g., drowning; scientific risk, e.g., the risk of suffering DCI; and virtual, as yet unquantifiable risk, e.g., the chance of suffering a cerebral arterial gas embolism when diving following a past history of insertion of a chest drain.[10] Examining which type of risk we are dealing with may improve our ability to correctly interpret any perception we have.

Cutter has described a cognitive-mapping approach to help interpretation of relative risk perception by society.[1] Through a questionnaire sampling process, she has described a scheme for representing relative risk across four different categories (Figure 1). The further a particular risk is placed from the centre of the cross, the greater the risk. She suggests such a scheme may assist in deciding which risks most require addressing at any moment in time.

In the example given in Figure 1, the well-known risks associated with smoking have been judged as substantially less 'risky' than a home pool, or even water fluoridation. While it is not clear how useful such a construct will prove, it does at least give some insight into the particular risk perception of the individuals responding. It might be instructive for such a cognitive map of potential risks to be constructed among a sample of divers questioned about a variety of diving-associated risks. Such a map could conceivably be of use when planning a dive safety intervention.

Communication of risk in medical statistics

There are four common ways in which risk is communicated in medical scientific reports: relative risk (RR), absolute risk (AR), numbers needed to harm (NNH) and probability values (p). Each has value in communicating true risk of a particular outcome, good or bad, but can adversely affect the reader's perception of the true risk if not presented clearly. The consequences of the 1995 report of the UK Committee on Safety in Medicines illustrate the potential dangers.[12]

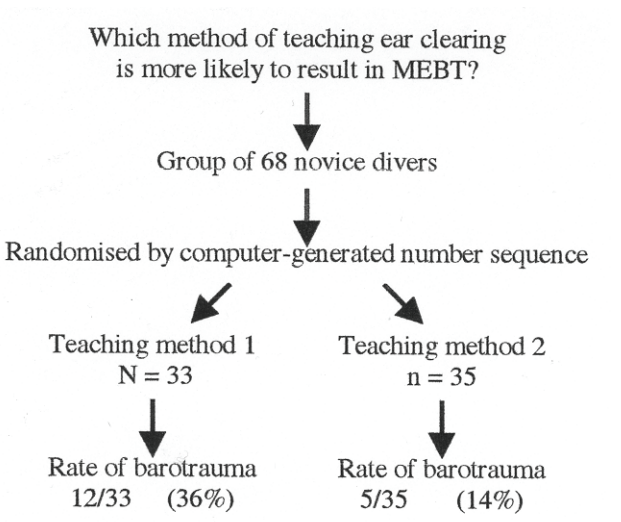
The Committee reported, accurately, that there was a 100% RR increase of significant thromboembolic disease associated with the use of the 3rd generation oral contraceptive, as compared to the 2nd generation.[13] Following a flurry of concern, many women abandoned the preparation, resulting in an estimated 8,000 extra abortions in the UK, and an unknown number of unwanted pregnancies. The AR increase was from 3 to 6 deep vein thromboses for each 1,000,000 users per year, equivalent to a NNH with the new preparation of 333,333 before one additional clot was caused. It is highly unlikely that more harm could be caused by continuing the use of the oral contraceptive pill than was caused by ceasing it. In this case, poor but accurate risk communication probably harmed the community.[12]

Consider the example in Figure 2. Let us construct a thought experiment whereby we test the hypothesis that different methods of teaching ear-clearing techniques to novice divers result in different risks of middle ear barotrauma (MEBt). We gather a sample of novice divers and randomise them to one of two methods, then measure the proportion that display MEBt.

There is a different risk of MEBt depending upon the method of ear clearing to which the individual is randomised. We might variously describe the lower risk associated with method 2 as a *relative* risk reduction of 39%, an *absolute* risk reduction of 22%, or that we would need to train five novices to avoid one episode of barotrauma (100/22). Whether this difference is important *in practice* is a matter for interpretation – let us agree for the sake of this presentation that it is. If we were selling method 2 it is likely we would prefer to use the RR reduction, and this is common practice in drug company advertising. A more rational approach might be to consider the costs of methods 1 and 2 and the severity of the outcome, before interpreting the fact that we would need to train five students to avoid one single case of MEBt.

Whether or not this difference is statistically important, otherwise known as 'significant', is similarly open to interpretation. In the example here, the risk this difference is due to random chance using a Chi-squared test for significance is 1 in 14, or 7% (p = 0.07). In general, we have abrogated our responsibility to make this latter

Figure 2.
A thought experiment concerned with the incidence of middle ear barotrauma (MEBt) associated with two different methods of teaching ear-clearing techniques



interpretation by almost universally accepting that a chance of less that 1 in 20 is 'statistically significant'– that is, when $p < 0.05$. By that convention, therefore, this experiment shows a non-significant reduction in the risk of MEBt when using teaching method 2.

This finding could be communicated to a dive training organisation, or a single prospective diver in a number of ways from: 'there is no significant difference in the chance of MEBt between the two methods' to 'there is about 40% less chance of having MEBt with method 2'. How the risk is perceived and communicated by people like dive medical examiners is likely to influence decisions profoundly, and for this reason we need to understand risk assessment and understand how to communicate it to both our patients and commercial clients.

Whenever presenting risk assessments, it is always best to be clear and unambiguous. It is useful to recall that in 1990, when asked about the wisdom of eating British beef, Sir Kenneth Calman, the Chief Medical Officer of the UK replied "*Beef is absolutely safe to eat*". By 1996, he was moved to add "*The term safe did not mean there was no risk*".[14]

Risk, benefit and homeostasis

Consider a man driving along a slippery, wet road in the pre-dawn gloom. These are challenging driving conditions and we might expect the driver would proceed with caution. The curve approaching is sharp and taking this turn at speed would be associated with some risk of a crash. Being both a reasonable man and an experienced driver, our subject is naturally inclined to take it slowly and reduce this risk as far as possible. There are many reasons to do so, apart from the fear of injury. Such an accident might injure others, e.g., pedestrians, or perhaps he has a baby on board, and will prove costly for repairs.

Nevertheless, there may be competing benefits attached to taking the curve more rapidly – he may be trying to get to an important appointment on time, want to impress his beautiful female passenger, or perhaps the sheer enjoyment of driving 'on the edge' is benefit enough. Our actions, including therapeutic decisions, are always driven by the attempt to balance risks and benefits to maximise utility.[10]

Substantially reducing the risk of all our actions across the spectrum of human activity would make for a world most would find intolerably restricting. It is unlikely any of us would be permitted to scuba dive. Evans has suggested, somewhat frivolously, that

> "*All drivers I have questioned admit that they would drive more carefully if their vehicles contained high explosives set to detonate on impact; dramatically increasing the harm from a minor crash can clearly reduce the probability of a minor crash*".[15]

Even this type of drastic constraint may not achieve the desired result, however. The principle of risk homeostasis, also referred to as 'risk compensation' or 'offsetting behaviour', suggests that most of us tend to react to safety measures by decreasing the safety of our behaviour in order to return the overall level of risk to much the same level that existed prior to the safety measure. Under this theory, we each drive to our own personal level of risk, and adjust our actual behaviour according to our perception of the risk during a particular journey.[10, 16,17]

There is some evidence for this principle in action. The death rate from motor vehicle crash (MVC) leading to head injury is the same in the USA today as it was in 1926. While the distance travelled by car per person each year has increased by a factor of 10, so has the distance needed to travel for each such fatal crash.[17] Figure 3 illustrates the risk of serious injury from road traffic crashes following the 1967 decision to change the side on which Swedes drive.[17] Prior to the change there was a 'baseline' risk. Following this radical change in the road rules, drivers perceived an increased risk and modified their driving behaviour. This actually reduced the risk of injury for the two years following the change. Gradually, however, drivers perceived the reduction in risk, further modified their driving behaviour and returned the risk to the original baseline level. Risk homeostasis was restored. Similar examples have been the introduction of compulsory seat belts in the UK and bicycle helmets in Victoria.[18]

Opponents of risk homeostasis theory suggest it is nothing more than an excuse to do nothing about safety, and the theory has been strongly criticised at several levels.[19] It is suggested that individuals are notoriously bad at risk assessment, that poor outcomes (e.g., crashes) are not sufficiently frequent occurrences for the individual to make an accurate risk assessment, and that there is very little supportive research with reliable methodology. Certainly, there are a number of studies that suggest long-lasting changes in risk on introduction of similar safety measures.[20, 21] The debate rages on.

If, however, risk homeostasis is operating in a particular environment, the question arises as to how we might re-set

Figure 3.
Risk homeostasis. The risk of serious injury on Swedish roads following the decision to change the side on which people were obliged to drive. The risk of serious injury reduced, then returned to pre-change baseline after two years (adapted from ref 17)

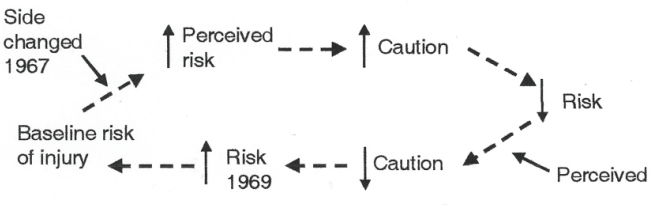


Table 1.
Injury rates for various sports. Number of injuries for each 100 player events and percent serious injury

Rugby football[23]	10.6	
Snowboarding[24]	4.0	(56%)
Soccer[25,26]	2.1	(1%)
American football[27]	1.4	(15%)
Skiing[24]	1.0	
Scuba[28]	0.01/100 tank fills	

the homeostatic mechanism in order to achieve a desired goal. The traditional approach is to punish unsafe behaviour (via the police) but some authors suggest it may be more productive to reward safe behaviour instead. The experience recently in California of offering free licence renewals to those with 'clean' licences has been associated with a 58% reduction in MVCs in the first two years.[17] Similar results have been reported from Norway and Sweden.

Risk and scuba diving

In 1997 Pedersen reported on the risk perception of a group of 444 men and women in relation to a number of potentially risky activities.[22] Interestingly for a diving readership, this group rated snow skiing as the least risky activity, followed by scuba diving, bungee jumping, rock climbing, motor cycle racing, hang gliding, cliff jumping and skydiving. Among this group, self-rated likelihood of participation was inversely related to the perceived risk. A short table of reported actual risks of injury is given in Table 1.

Experienced scuba divers would likely agree that, given appropriate instruction and training, this activity is relatively low risk when conducted at modest depth with standard equipment. Many would also accept that among the scuba diving community there are those who have set their 'risk homeostat' at a very high level. Like many activities, the risk lies not only with the nature of the activity, but the behaviour of the individual concerned.

This 'risk seeking' proportion of the population is estimated at between 10 and 20% and their behaviour has been studied in a number of ways.[29] Witte described various strategies to deal with young male drivers who attempted to 'beat' trains across level crossings in mid-west USA. She described a dysfunctional response to the threat appraisal of this activity. When an individual is requested to ask themself the questions "Is being hit by a train serious?" and "Am I likely to be hit by a train?", a typical reported response was likely to be "Being hit by a train is serious, but I can avoid the possibility by obeying the rules". For the high-risk group, the response was typically "Being hit by a train is serious, but I can beat the train because I am a great driver and have fast reflexes". Every successful crossing is a positive reinforcement of this view and further amplifies this behaviour until the almost inevitable, fatal crash.

Experienced scuba divers can probably relate these findings to a number of divers they know. Many factors have been suggested in the clinical literature to increase the risk of scuba misadventure, and it is not the purpose of this article to discuss these factors. It is interesting to note, however, what the insurance industry feels about risk and diving.

> *"The host factors that represent most risk...are poor fitness, overweight, chronic diseases, structural abnormalities of the heart and lungs and risk factors for CAD* (coronary arterial disease)*...These plus inexperience, irresponsible behavior or technical diving should alert the underwriter (to) excess risk for fatal accidents."*[30]

Conclusions

Risk perception and actual risk are often difficult to reconcile. Individuals are likely to assess risk in remarkably different ways, and it is very difficult to ensure risk is communicated in both a truthful and meaningful way.

For any medical assessment that requires risk communication, and this certainly includes a pre-dive medical, great care must be taken. The process of risk communication may be summarised in a way analogous to the practice of any evidence-based medicine as summarised in Table 2.

The role of the medical examiner as policeman removes the need to communicate risk accurately, but the easiest ways are not always the most useful.[31] To quote Adams:

> "*Attempts to criminalise self-risk are likely to be worse than useless; they are likely to redistribute the burden of risk in ways that harm innocent third parties*".[10]

Table 2.
Comparing the characteristics of good risk communication with good evidence-based medicine (EBM)

Communicating risk	Practice of EBM
Ensure both parties agree on exposure and absolute measures	Explicit questioning and use of ARR and NNH
Indicate uncertainty	Confidence limits
Give risks of alternatives	Explicit comparators
Consider all relevant outcomes	Explicit clinical outcomes
Who benefits and who pays in the event of injury or death	Cost utility, benefit and effectiveness

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