

Ten years on: what do we know about the Gulf War syndrome?

Simon Wessely and the King's College Gulf War Research Unit

Simon Wessely

Professor of Epidemiology and Liaison Psychiatry, Guy's, King's and St Thomas' School of Medicine, London

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The Gulf War and its aftermath

We have just passed the tenth anniversary of Operation Desert Storm, the start of the Persian Gulf War. The facts are clear. Iraq occupied Kuwait on 2 August 1990. Shortly after Coalition Forces, led by the United States, began a military deployment known as Operation Desert Shield. On 17 January 1991 an active air campaign began against Iraq, Operation Desert Storm, and on 24 February a ground war began, lasting only four days. It was a resounding military success. Iraqi forces were beaten in the field and expelled from Kuwait.

Not only was the campaign a military success, it was also a medical success. Traditionally, fighting in hostile environments such as the desert has been associated with morbidity and mortality, often substantial, from causes not related to enemy action such as heat stroke, dehydration and infectious disease. Yet during the Gulf campaign there is no evidence for any deaths from those sources among American or British personnel¹.

Gulf War syndrome

Now, ten years later, few will remember the genuine medical achievements of the campaign, and instead most people when asked about the Gulf War and health, will answer 'Ah yes, that's where Gulf War syndrome began'.

It was shortly after the cessation of hostilities that reports started to emerge from the US of clusters of unusual illnesses occurring amongst Gulf War veterans. Claims were made that previously fit veterans had developed unusual diseases, illnesses and symptoms. Reports emerged also of children with birth defects being born to Gulf War veterans. Meanwhile, formal epidemiological research was at last commissioned (see below), but by the time these studies had started to report, Gulf War syndrome had captured the public imagination.

In this paper we review the published evidence on the nature and extent of illnesses associated with service in the Gulf War, and offer a tentative explanation for Gulf War syndromes.

The evidence so far

Case series

The first co-ordinated response to the problem was to invite any veteran with health problems to come forward for detailed medical evaluation. This began in the United States, and was then repeated in the United Kingdom with the establishment of the Medical Assessment Programme (MAP). Over 200,000 US and 2,000 UK veterans have now attended these programmes. Studies of these groups have not suggested any unusual pattern of illness – instead the largest diagnostic category has symptoms and syndromes such as chronic fatigue, pain and others without an adequate medical explanation^{2–4}. No new diseases have come to light, nor has any dramatic increase in other known but unusual conditions been documented.

Epidemiological studies

The most comprehensive analyses have been made of the mortality of both the US and UK Gulf cohorts. The results show that, contrary to media reports, there has been no increase in mortality in either cohort^{5,6} other than an increase in accidental death (US and UK) or suicide (US only), as observed in the aftermath of other conflicts. Likewise, hospitalisations have not increased either⁷.

The first epidemiological study of Gulf-related illness was a questionnaire-based study of a random sample of Gulf veterans and appropriate military controls from the state of Iowa⁸. This showed increased rates of symptom reporting in the Gulf cohort. Symptom defined conditions such as chronic fatigue syndrome, depression, post-traumatic stress disorder and others were all elevated.

In our UK study we compared a random sample of 4,246 UK Gulf War veterans, drawn from all three Armed Services and including both serving and non-serving, with non-deployed personnel ('Era'), but also with an active duty control group – namely members of the UK armed forces who had served in Bosnia from the start of the UN Peacekeeping Mission (1992–1997)⁹.

UK Gulf veterans were between two and three

times more likely to report every one of the fifty symptoms that were inquired about. Whatever the symptom, the rate was at least twice as high in the Gulf cohort as in either the non-deployed cohort or the Bosnia cohort. The Gulf veterans experienced more symptoms, endorsed more conditions and felt worse than either the non-deployed cohort or those deployed to Bosnia, but were still physically functioning well as a group⁹.

Other epidemiologically based samples from Hawaii, Pennsylvania¹⁰, Boston¹¹, active service USAAF personnel¹², the SeaBees¹³ and the large Veterans Administration study¹⁴ all show similar findings.

Significantly, all these studies are limited by the use of self-report measures. Self-reported symptoms are not, of course, a good guide to findings on clinical examination¹⁵. Somatic symptoms in the community are exceedingly common and often persistent, yet fewer than 1 in 5 are found to have a discrete physical explanation¹⁶.

Is there a Gulf War syndrome?

The term 'Gulf War syndrome' (GWS) has acquired remarkable media and popular salience, but is there any such thing? A syndrome implies a unique constellation of signs and/or symptoms. For there to be a Gulf War syndrome, there should be evidence of such a unique constellation, which should only be found in the context of the Gulf conflict¹⁷.

Haley and colleagues were the first to argue in favour of a unique Gulf War syndrome¹⁸, using factor analysis. However, his data came from a single naval reserve construction battalion, had a 41% response rate (of whom 70% reported serious health problems since the Gulf War) and a sample size of 249. There was no control group, military or non-military. Many commentators have pointed out this makes it difficult to establish whether or not the proposed new syndrome is indeed linked to Gulf service¹⁹. A further problem is that any population in which there is a normal distribution of symptoms will yield factors when these are entered into a factor analysis – what is needed is hypothesis driven studies.

Since then studies that use epidemiologically defined subjects and appropriate controls have generally not found evidence of a Gulf War syndrome. For example, in our study we did indeed find evidence to support a particular factor structure to symptoms in the Gulf cohort, but this was not significantly different from the factor structure in the Bosnia or Era controls. The Gulf group had experienced more symptoms at greater intensity, but there was no difference in the way these symptoms could be organised²⁰. Three controlled US studies drew similar conclusions^{12,21,22}.

The balance of evidence is currently against there being a distinct Gulf War syndrome. Yet irrespective of the emerging professional consensus, Gulf War syndrome is established as a popular, media and social reality anyway. Investigating how and why this concept developed is important, but the answers will not come from statistics, but social sciences.

The position elsewhere

So far we have considered the position solely from a US/UK perspective. But many countries participated in the Coalition Forces, and we are now starting to hear from them as well.

The first non-US country to publish a detailed examination of its Gulf veterans was Canada²³. The results were remarkably consistent with what had already been reported from the US, and would be reported from the UK.

Each country's experience has also given examples of natural variations and experiments, which will, in time, prove informative. For example, Canada sent three vessels to the Gulf – two used pyridostigmine prophylaxis, and one did not. Yet rates of illness were identical between the three ships²³. Likewise, Danish Gulf veterans also have elevated rates of symptomatic ill health²⁴, yet nearly all were only involved in peace-keeping duties after the end of hostilities and received neither pyridostigmine prophylaxis nor vaccinations against biological agents.

The largest enigma remains the French. The pattern of Forces protection used by the French differed from that of both the Americans and the British. The French authorities have consistently denied that any health problems have emerged in their Gulf forces, and there have been few media reports of similar stories in France, although this has been changing in the last few months²⁵. No systematic study has been undertaken – and one should recall official denials of any problem in the UK prior to the publication of systematic studies. Furthermore, the cultural pattern of illnesses in the Francophone world differs from that in the English speaking and Scandinavian world. Illness entities such as chronic fatigue syndrome or multiple chemical sensitivity are hardly acknowledged or recognised.

The evidence: summary

Gulf service has affected the symptomatic health of large numbers of those who took part in the campaign. At the same time, no firm evidence has emerged to date of either distinct biomedical abnormalities or premature mortality.

Is it that some veterans have been significantly affected, whilst the rest have not? It seems not. There are certainly small numbers of veterans, often with a high media profile, who have developed substantial disability. But on a population basis we need to note the larger numbers of veterans who have experienced small changes in their health.

The explanations

Hypothesis 1: Gulf War illness is the result of biological hazards in the Gulf

The most popular explanation among the media and, we suspect, the general public is that the cause of Gulf War syndrome lies in the particular hazards of that conflict. Most attention has been given to the measures taken to protect the combatants from the threat of chemical and biological warfare

(CBW). These included immunisations against biological weapons such as plague and anthrax, and pyridostigmine tablets to protect against exposure to anticholinesterase-based nerve agents such as sarin. Other hazards included exposure to depleted uranium or to the smoke from the oil fires ignited by the retreating Iraqi forces.

Evidence is conflicting. A small group of US Gulf veterans was definitely exposed to depleted uranium in the form of shrapnel fragments, and is being intensively monitored. Some subtle changes have been seen in neuropsychological and neuroendocrine function²⁶. No evidence relevant to the vast majority of those deployed has been presented to date.

Smoke from the burning oil wells received much publicity at the end of the land war, and was closely monitored on the spot. Environmental monitoring studies concluded that, in general, most toxins were below accepted lower limits, but there was an increase in the level of fine particulate, not unusual for a desert region²⁷. Levels of polycyclic aromatic hydrocarbon biomarkers were actually lower in Gulf veterans exposed to the oil fires than in controls who had remained in Germany²⁸.

Pyridostigmine bromide (PB), a reversible inhibitor of acetylcholinesterase, was used as a pretreatment for possible exposure to nerve gas. Although side effects were frequently reported during its use in the Gulf campaign (and elsewhere), they were short lived. No acute toxicity was observed²⁹. This is important, since long-term organophosphorus toxicity, which is certainly a hazard, has only been clearly documented in the aftermath of acute toxicity³⁰. The Canadian experience (see above) also argues against a prominent role for PB. PB has been used in civilian practice for the diagnosis of growth hormone disorders and the treatment of myasthenia gravis for many years, and in higher doses than used by the armed forces, without apparent adverse effect. It has even been used as a treatment for the fatigue associated with post polio syndrome³¹, and although later studies questioned its efficacy, it was safe and well tolerated³². The extensive cumulative experience with PB in civilian neurological practice argues against an important role for PB *per se* in Gulf-related illness^{33,34}.

Thus the evidence does not support an important role for PB administration, but with two caveats. An elegant mouse experiment has suggested that PB, which normally does not penetrate the blood-brain barrier, may do so under stressful conditions³⁵, but this was not confirmed in guinea pigs³⁶. Second, hazard may have resulted from interactions with other agents. A study of chickens confirmed the safety of pyridostigmine, permethrin and DEET (the latter two being a pesticide and insect repellent, respectively) individually, but reported neurotoxicity when given in combination, albeit in high dosage³⁷, whilst rats given similar combinations have slower locomotion rates³⁸. On the other hand, vaccines and PB did not prove toxic to guinea pigs³⁹.

Perhaps host variation may explain differences in individual susceptibility. It is plausible that polymorphisms in the enzyme detoxification pathways for organophosphate compounds are related to symptoms⁴⁰, but whereas one study reports such an association⁴¹, another does not⁴² but instead finds low levels of the detoxification enzyme itself (PON). Such pathways are also

probably not involved in PB metabolism³⁰. Studies of the King's cohort should clarify this issue.

The role of pesticides, and in particular organophosphate pesticides, has also been much discussed. Large quantities of pesticides in various forms were used by all the combatants to reduce the risk of infectious disease. In general, there is no disputing the acute toxic effects of organophosphates on the human nervous system, but there remains considerable uncertainty and controversy about the effects of low level chronic exposure^{30,33,43-45}.

In the US, but not in the UK, much attention was given to the possibility that troops had been exposed to low levels of the nerve agent sarin following the probable accidental destruction of an Iraqi arms dump at Khamisiyah. Little evidence has been found that those possibly exposed to the plume had any difference in postwar illness⁴⁶. A recent animal study failed to show any adverse effects from low dose sarin⁴⁷.

Some of the most suggestive evidence comes from studies of the possible effects of the vaccination programme used to protect the armed forces against the threat from biological weapons. The US programme involved immunisation against anthrax and botulism, whilst the UK chose to protect its armed forces against plague and anthrax, with the additional use of pertussis vaccine as adjuvant to speed up the response to anthrax⁴⁸. We found a relationship between receiving both multiple vaccinations in general, and those against CBW agents in particular, and the persistence of symptoms, despite controlling for obvious confounders. The finding that multiple vaccinations in other contexts, including deployment to Bosnia, were not associated with any increased experience of symptoms suggests some interaction between multiple vaccination and active service deployment to the Gulf^{9,49}. These data are compatible with the hypothesis that Gulf War related illness may be associated with a T-helper cell-2 shift in immune responsiveness⁵⁰. The final test of the hypothesis will come with the results of direct measures of immunological function currently being analysed at King's.

There are also some general objections to the first hypothesis³³. Some studies have found that certain symptom patterns are related to certain self-reported exposures^{51,52}, but others have not^{9,8,13,53}. The time latency between the war and onset of symptoms is also unusual if symptoms were related to war exposure⁵³.

In summary, there is evidence to suggest that **some of the new hazards to which the armed forces were exposed during the Gulf War may be associated with unexpected side effects, and perhaps later ill health. On the other hand, some claims need replication, and others remain implausible.** Hypothesis 1, therefore, is supported, but not for every claim and instance.

Hypothesis 2: Gulf War illness is a modern manifestation of post-conflict ill health

Our first argument, that the cause of the Gulf War health effect lies in the unique nature of modern warfare, would be substantially

weakened if it could be shown that similar clinical syndromes have arisen after other conflicts which did not involve the particular hazards of the Gulf War.

That similar syndromes have been found after other conflicts has been most clearly argued by Craig Hyams and colleagues in a seminal paper⁵⁴. Interpretable medical records and accounts really only commence from the middle of the 19th century, but from then onwards the literature does contain clinical descriptions of ex-servicemen (and it is always men) with conditions that do show considerable similarities to the Gulf narratives. These conditions have received many different labels – soldier's heart, later termed effort syndrome, owes its provenance to the Crimean and American Civil War. Shellshock and neurasthenia dominate the writings of the First World War, whilst Agent Orange syndrome and post-traumatic stress disorder emerge after Vietnam.

Hyams' argument rests entirely on a reading of secondary sources, but we have begun the task of assembling primary sources as well. Already we have located clinical case histories from the Crimean War and Indian Mutiny⁵⁵ which begin the theme of chronic, unexplained symptoms, and we are assembling more detailed analyses of medical records from the Boer War, and the First and Second World Wars.

The second hypothesis is that sending young men to war invariably results in some casualties that cannot be explained on a solely physical injury basis, and that the symptoms experienced are similar to those experienced by Gulf War veterans.

The implication is that this reflects the psychological cost of warfare on the combatants. Yet the Gulf War was not a particularly 'stressful' conflict in the traditional sense. The active ground war only lasted a few days. Casualties amongst the Coalition Forces were exceptionally light. It would be historically wrong to extrapolate from the prolonged privation, fear and danger of, for example, the Western Front or the Italian Campaign of the Second World War, to the Gulf War.

But it would be equally wrong to claim that Gulf veterans were not exposed to stress or fear of any sort. Most particularly, the real threat posed by chemical and biological weapons should not be underestimated^{56,57}. Such weapons 'engender fear out of all proportion to their threat'⁵⁸ – they are as much, if not more, weapons of psychological as of physical warfare⁵⁹. Even in training, up to 20% of those who took part in exercises using simulated exposure to irritant gases showed moderate to severe psychological anxiety⁶⁰.

Iraq possessed such weapons, and had used them during the Iran-Iraq war and against Kurdish civilians. It was anticipated that they would be used in the forthcoming campaign. Countermeasures were untested, and probably insufficient. Effective measures, such as wearing the full nuclear-biological-chemical (NBC) suits, were exceptionally uncomfortable and induced a state of partial sensory deprivation. Surveys during Desert Shield of US forces confirmed that the threat of CBW was the commonest expressed fear of the coming conflict. The ground war may have only taken a few days, but the deployment itself lasted over many months. During Desert Storm there were several thousand documented chemical alarm alerts.

Subsequently the consensus of opinion is that none were true positives, and that Iraq did not use its CBW arsenal. But at the time each alert had to be assumed to be genuine. Thus even if traditional military stressors were not a prominent feature of the active campaign, a well-founded and realistic anxiety about the threat of dread weapons could still be important. Believing oneself to have been subject to chemical attack has been frequently found to be associated with the development of symptoms^{9,61}, sometimes strongly^{11,18}, even though evidence is against such an attack actually having taken place.

In conclusion **Hypothesis 2**, like Hypothesis 1, can also be supported. **There have been similar syndromes before.** There were genuine sources of anxiety during Desert Shield and Desert Storm, chiefly around the threat of chemical and biological warfare, and **believing that one was exposed to such weapons is associated with later ill health.**

Hypothesis 3: Gulf War syndrome can be found in people who have never been to the Gulf or served in the armed forces

Our first argument was that either some hazard of Gulf War service alone (Hypothesis 1) or war service in general (Hypothesis 2) is linked to subsequent ill health. But may the features of Gulf War illness actually have nothing to do with warfare at all?

This seems a surprising proposition. However, patients with multiple unexplained symptoms, all of them reported in the narratives of Gulf veterans, are also encountered in civilian medical practice and literature. In the popular literature first person accounts and patient-orientated literature (in the media and the Internet) exist with considerable similarities to those of some Gulf veterans. One finds such material under diverse headings such as 'ME', total allergy syndrome, electrical hypersensitivity, dental amalgam disease, silicon breast implant disease, hypoglycaemia, chronic Lyme disease, sick building syndrome and many more.

Turning to the professional literature, studies are now reporting that the rates of various symptom-defined conditions originally described in the civilian population are also elevated in the Gulf cohorts. Chief amongst these are chronic fatigue syndrome (CFS)⁶² and multiple chemical sensitivity (MCS)^{63,64}. These syndromes, which also include fibromyalgia, irritable bowel syndrome (IBS) and others, overlap not only with each other⁶⁵, but also with Gulf War illness.

That symptom-based conditions overlap with Gulf War illness is not surprising, given that the epidemiological studies confirm that Gulf veterans experience an increased reporting of each and every one of the symptoms that make up the case definitions of all these syndromes found in civilian practice. This does not mean, however, that CFS/IBS/MCS and the others are all the same, or that Gulf War illness is the same either. It does mean that they all overlap, that discrete boundaries cannot be drawn between them (or alternatively that we have no idea where these boundaries are). It also means that any explanation of Gulf War

illness must explain how similar conditions can be found in non-deployed military personnel and in civilians.

Hypothesis 3 therefore can also be supported. **Illnesses identical to the complaints reported by Gulf veterans are found in civilians who have never served in the armed forces, let alone taken part in the Gulf War.**

Attributions and explanations

It seems therefore that each of our three hypotheses, which appeared at first reading to be mutually exclusive, can be supported. But none of these will help us describe another aspect of Gulf War illness – the shape it took and the controversies it generated. In this section we look at the social and cultural aspects of Gulf War illness. Our starting point is that, for whatever reason, Gulf War veterans began to experience unusual symptoms on their return from the conflict. How did these disparate symptoms come together as a new syndrome? Why did it take the shape it did? What labels and explanations were advanced by the veterans, and also the media and many others, for these symptoms? We now suggest that these can be understood not only in terms of human biology, toxicology and psychology, but also in terms of the sociology of illness, and the particular position of the veteran in modern society.

The military: from effort syndrome to Gulf War syndrome

Everyone in distress needs some way of explaining it. Indeed research confirms that in the clinical setting patients prefer a firm, albeit inaccurate, label for their symptoms as opposed to an honest expression of uncertainty⁶⁶. The ways people explain their symptoms can come from many sources. Sometimes doctors can provide such an explanation, often they cannot¹⁶.

Some of the labels applied to unexplained illnesses in the Armed Services are related to the particular nature of the recent conflict. Hence soldier's heart arose because of the contemporary concern that the straps securing the heavy backpacks worn by the Unionist soldiers in the American Civil War were compressing the muscles, arteries and nerves in the region of the heart. The epidemic of 'rheumatic' conditions documented after the Boer War was a response to the presumed health dangers of sleeping out in wet conditions on the High Veldt. Shellshock took its name from the presumed effects of concussion caused by the passage of the shell, let alone its actual detonation. The exploding shell remains the predominant image of the First World War, and epitomised both then and now the particular trauma and anxiety of that conflict – for the first time the main cause of death was the unseen enemy.

Another popular term was neurasthenia. As originally described in civilian life, neurasthenia was a condition affecting successful people, usually men, and was a response to the stresses and strains of contemporary life. Overwork, exhaustion, long hours, the new demands of capitalism and so on were the kind of explanations that dominated the early (but not late) literature – it was an illness of successful men, 'captains of

industry'. Hence when it emerged that army captains on the Western Front were developing similar unexplained conditions associated with extreme exhaustion, it was not difficult to translate the civilian neurasthenia concept into the military context. Sir Frederick Mott⁶⁷, one of the most influential medical figures of the period, wrote that 'neurasthenia ... was more likely to be acquired in officers of a sound mental constitution than men of the ranks, because in the former the prolonged stress of responsibility which, in the officer worn out by the prolonged stress of war and want of sleep, causes anxiety lest he should fail in his critical duties'.

After Vietnam came two new syndromes, one ostensibly psychological, the other somatic: post-traumatic stress disorder (PTSD) and Agent Orange syndrome⁶⁸, a forerunner of Gulf War syndrome.

So the labels given to previous post-conflict syndromes can be seen to derive from the specifics of that particular campaign, but also from the general health beliefs of the time. We have already listed the main health concerns of the Gulf campaign – depleted uranium, vaccinations, pollution, chemical warfare and so on. How do these map onto wider civilian health concerns?

The civilian perspective

In a previous time, ill health and misfortune was commonly interpreted in terms of demonic possession, spirits and satanic influence. Such explanations have now lost their cultural resonance in the developed world. To a large extent these have been replaced by explanations based on environmental hazards and threats.

It is evident that the range and scope of symptoms, illnesses and conditions blamed on the environment has increased over the course of the last decade or so. There are many social, historical and cultural reasons why this should be – reflecting increasing global concern about the effects of chemicals, radiation, and infectious diseases, and the collective memories of recent health disasters. The generation that fought the Gulf War was born in a world already sensitised by 'Silent Spring' and the thalidomide tragedy, and came to maturity to a background of the AIDS epidemic, mad cow disease, and numerous well-publicised environmental tragedies such as Chernobyl, Seveso and Bhopal. It is a moot point indeed if our environment really is more threatening than it was – the food, water and air of any given post industrial revolution city of the 19th century do not bear comparison with their modern counterparts^{69,70} – but we are certainly more aware of these dangers than our predecessors were.

It is the role of environmental attribution that provides a link between the otherwise varied new illnesses and health hazards that figure so prominently in the media, such as dental amalgam disease, electromagnetic radiation, ME, organophosphate toxicity, candida, sick building syndrome, multiple chemical sensitivity and so on. Although the postulated pathophysiological mechanisms are many and varied, all are associated with the presence of multiple unexplained symptoms, and all are in one way or another blamed on some unwelcome external

environmental hazard, such as chemicals, pollution, viruses, radiation and so on. Alternatively, it is a substance introduced into our bodies from outside, such as silicon breast implants or dental amalgam. The idea that our attempts to reduce the hazards of, for example, infections, can also cause unexpected side effects (our Hypothesis 1) has its echoes in the frequently bitter anti-vaccination movement⁷¹. Likewise, the frequently advanced argument that the Gulf War was the ‘most high tech war ever’ (which certainly seems to be the case), and that although this reduced the hazards of previous ‘low tech’ conflict, it replaced it with a new set of risks, is directly echoed in the civilian literature on ‘techno stress’, and thought by many to lie behind the epidemic of syndromes such as repetitive strain injury, VDU complaints and others that often follow the introduction of new technologies into the workplace^{72–74}.

Thus in civilian life we argue that what unites these disparate conditions is not only the clinical evidence of multiple unexplained symptomatology, but also the cognitive schema linking them with ideas of environmental hazard and toxicity.

One result of this heightened environmental awareness has been a gradual transformation of popular models of illness and disease. In place of the demons and spirits comes the belief that we as a society are oppressed by mystery gases, viruses and toxins, all of which are invisible, and some of which are as elusive as the demons of old. One can see this in the changing pattern of attributions given by patients with unexplained symptoms⁷⁵. Guy’s Poisons Unit, for example, reported that it is only in the last two decades that they have started to see patients with multiple symptoms attributed to environmental poisoning⁷⁶.

Many scientists now profess themselves baffled by the public anxieties expressed over the possible adverse effects of pesticides, not to mention genetically modified foods and cell phones⁷⁷ – but these make sense when seen in the light of the last paragraph. At the turn of the 19th century science and technology held great hopes for the future – the introduction of chemicals into food was to be welcomed as it promised greater, and not lesser, food safety, and chemical was not the term of abuse it has now become. Science is not a force for evil, nor have we become a nation of Luddites, but both science and technology are seen in more ambiguous terms than previously.

Our views of our environment have altered. There is heightened anxiety of the public and mass media over the safety of the environment, and suspicions about the food we eat, the water we drink and the air we breathe. As Barsky points out, ‘the world seems generally filled with peril, jammed with other health hazards in addition to disease ... nothing in our environment can be trusted, no matter how comfortable or familiar’⁷⁸. Activism to combat environmental pollution and toxic waste is a new social movement⁷⁹. There is even an epidemic of the word ‘risk’ in the scientific, and most particularly epidemiological, journals⁸⁰.

There is a complex relationship between environmental concerns and symptoms. There is no doubt that being exposed to environmental hazards, such as chemicals, leads to increased fears and concerns⁸¹. This increase occurs whether or not the exposure is real or perceived. These fears in turn lead to

increased symptom reporting, perhaps via activation of the stress response. The strength of a subject’s opinions on environmental matters was associated with symptom reporting in those exposed to a hazardous waste site but also in those who were not^{82,83}. Those who described themselves as ‘very worried’ about local environmental conditions were ten times more likely to complain of headaches than those not so concerned⁸⁴. Finally, people who experience more symptoms, for whatever reason, may have an increased level of concern about their environment as they look for explanations for their ill health. The consequence is a vicious circle linking exposure (whether real or perceived), beliefs and symptoms.

Reproductive fears

At the same time as fears over health surfaced, so did fears about reproductive health. Numerous emotional media stories emerged of veterans fathering children with severe birth defects. It was impossible not to be moved by these individual tragedies, and impossible not to understand and sympathise why the parents of children so afflicted should search for explanations, and generally find these in the father’s military service. These fears remain prominent – a common response we have encountered amongst the veterans who have completed our qualitative survey is the intention to delay having children until these issues are resolved. Fortunately there is no evidence of any increased risk at present⁸⁵. But the longer families delay fertility, the greater the chance that such a risk will develop.

Reproductive fears are one area in which there is a lack of historical continuity. These fears are largely absent from the voluminous records and narratives of the First World War. There is a single report of Australian veterans returning from the Pacific in the Second World War expressing these fears, blamed on the malaria prophylaxis they had taken, but fears about reproduction first surface as a major issue in veterans’ health during the Vietnam era, as part of the Agent Orange controversy. We suspect that it was the cumulative and widespread knowledge of the medical effects of radiation post-Hiroshima and the thalidomide tragedy that triggered this change. Now such fears frequently accompany many environmental accidents and exposures.

The soldier becomes a civilian again

The situation of the soldier returning from war, especially if accompanied by rapid separation from service, is a complex one. On joining up, individuals join military society and become part of a group where their loss of autonomy is offset by a feeling of belonging and a clearly defined role within the organisation. Deployment to war is a unique experience of shared adversity, when the reality of military service cannot be avoided and where individual fears are shared and managed by group membership.

Following combat everything is changed. Readjustment to routine soldiering occurs and the process of assimilation and accommodation of the experience of war continues. Some may experience guilt or shame at acts of commission or omission.

Pride and a feeling of achievement may be felt whilst others may become angry and accusatory at those whom they see as letting them down in time of threat. The search for meaning may continue for years.

Leaving the service may be desired for many reasons. These include the simple end of their engagement; but also both being unable to equal the combat experience or desiring never to have to repeat it. Once 'separated', modern servicemen and women will return to a risk averse society where individual rights, not duties or obligations, count – the obverse of military society. A realistic knowledge of military experience by civilian society has become less with the end of national conflicts or national service – fewer and fewer civilians will have any contact with the military. Contemporary understanding of military service is more likely to be driven by Hollywood's depictions than personal experience. Films which portray the veteran as victim are common, a situation abhorrent to most servicemen and women. A few will, however, construe their experience in this way, encouraged by the media.

Military and veteran culture also reflects the general changing relationship between the individual and society. One sign of this is the loss of Crown Indemnity by the Ministry of Defence, and the subsequent avalanche of litigation against the military authorities. However, it is simplistic, and probably erroneous, to assume that the rise in symptoms amongst Gulf veterans is related to the rise in litigation. Instead, it is more likely that litigation arises as a consequence, rather than a cause, of these concerns. Furthermore, there is little difference in the health complaints and concerns of US versus UK veterans¹⁴, but whereas UK veterans can, and are, litigating against the military, their American counterparts are statute barred from any similar activity.

We do not subscribe to simplistic notions of war, stress and post-traumatic stress, but neither do we see war as of no psychological or social significance. We suggest that nearly everyone is changed by exposure to combat, for better or worse. In the words of one Second World War veteran '... everything since (war) has just been a footnote'.

Distrust, conspiracy and confidence

The importance of public confidence and political (mis)judgement in shaping health concerns may be illustrated by one US/UK comparison. In the US there has been concern and controversy over the role of the probable accidental discharge of sarin gas at the Khamisayah arms dump, but this has not been a major issue in the UK. What has been a major issue is the role of exposure to organophosphate pesticides. One reason may be that both issues were accompanied by misinformation. In Great Britain it was originally denied that any organophosphate pesticides had been used – a clear mistake. This was corrected, but the result was to focus attention on this particular risk, and fuel the cries of 'cover up'. Something similar transpired with regard to Khamisayah in the US.

Indeed the initial actions of the UK authorities were less than optimal for maintaining the confidence and trust of the armed

forces and the populace. First, records that now would give crucial information, such as vaccination records, were destroyed. We do not generally subscribe to the conspiracy theories, and instead see this as a low level decision to get rid of unnecessary paperwork that was no longer of interest. But it fuelled an avalanche of conspiracy theories and claims.

Second, when concerns first began to surface in the UK, there was an attitude, expressed in Parliament, that this was a 'storm in a teacup', and hints that those complaining really should be able to 'pull themselves together', and that this would not happen to troops that were properly led and trained. This was not expressed in so many words, but the meaning was clear.

Third, there was a delay in commissioning research that might allay fears. Control of the research agenda was then given to the scientists in the form of the Medical Research Council. One can understand the logic of this decision, but the result was that the opportunity to use research as part of the risk management (and essentially political) process was reduced. Clemenceau's famous dictum was that war is too important to be left to the generals. Nowadays one might add that research is too important to be left to the scientists alone.

The results of all these events was a serious lack of trust of governmental and military authorities. Given that risk communication and management is critically dependent upon a trust between the community that feels exposed and those responsible for managing that risk⁸⁶, we believe these misjudgements were integral to the further development and shaping of 'Gulf War syndrome' after the conflict.

Another major participant in the story of Gulf War syndrome has been the media, which have reflected, but also shaped, public concern. Public concern and media coverage go hand in hand – the Gulf War syndrome was a 'good story' because it touched on so many contemporary issues of general public concern. Public concerns and media coverage are consistent with each other, even if neither necessarily reflects an 'objective' appraisal or reality⁸⁷. It is, however, true that the news media are more likely to report negative, trust destroying stories than ones that enhance trust⁸⁶.

Conclusions

What can we say, and what will we never know?

Ten years on, there are some established findings. There is a Gulf health effect, and it is not trivial. It is not due to selection bias. It is not post-traumatic stress disorder in its classic sense. There is no evidence of an increase in well-defined disease categories, and nothing to suggest that mortality has increased other than from suicide or accidental death.

More information will be available in the coming months. Key epidemiological studies, such as those conducted by the Veterans Administration in the US and by Manchester University in this country, will report. The experience of other countries will become clearer. Numerous clinical and animal studies will report, and we anticipate a flood of reports on neuropsychological, neurological, immunological and other

investigations of Gulf veterans. If these are based on well-defined and preferably epidemiologically based samples, the interpretation of these results will be far easier.

We can also make some informed speculations. Given that the health effect is not restricted to a small number of individuals, but is seen across the population, then the exposure or exposures must likewise be distributed across the population. For that reason exposures that seem only to have affected small numbers of veterans are unlikely candidates. More plausible are exposures that affected the majority of those in the war theatre. The medical countermeasures used to reduce the risk from chemical and biological weapons are thus more plausible candidates than depleted uranium fragments, which only affected a small number.

Likewise, psychosocial factors that might be of relevance are more likely to be general rather than specific. Combat stress disorders leading to post-traumatic stress are unlikely to have affected more than a small proportion of veterans, but the anxiety engendered by the threat of chemical warfare could have influenced virtually everyone in the theatre. Likewise, few veterans will not have been exposed to the media interest and speculation that began soon after their return.

We must also face reality. Much will never be known for certain. This is the tenth anniversary of the Gulf conflict. The chances of finding new evidence on exposures during the conflict become increasingly unlikely. The possibilities of further direct aetiological research diminish with each year.

The future

It might be argued that each military deployment is unique in its historical and military context, and so it is. But the story of Gulf War syndrome may not be a 'one off'. Already newspaper reports have appeared concerning, for example, the 'horrendous range of symptoms' now experienced by Canadian UN peacekeepers in Croatia⁸⁸ and Dutch peacekeepers in Cambodia^{89,90}. Similar reports have emerged in the German and Belgian press concerning their soldiers in Kosovo. Concerns include exposure to depleted uranium munitions, contaminated sandbags⁹¹ or to pollutants released from the destruction of factories during the NATO bombing campaign against Serbia.

The current uncertainty over the chronic health effects of low level exposure to chemical and nuclear materials will continue, as will public anxiety. The potential effects of low level chemical and radiation exposure are a longstanding controversy⁹². It is unlikely that these complex scientific and political issues will be resolved in the near term. Nor is it likely that research studies conducted after well-publicised disasters will convincingly answer basic scientific questions because of the difficulties of eliminating research biases in highly charged circumstances^{82,93,94}. Because health officials cannot provide blanket assurances that such exposures are associated with no, as opposed to low, risk, distrust of medical experts and government officials will continue⁹⁵. As a result, numerous unconfirmed and controversial hypotheses about the effects of low level exposures will continue to flourish.

Gulf War syndrome: the post-modern illness

In a provocative article Muir Gray⁹⁶ describes the features of what he calls 'post-modern medicine' – a distrust of science, a readiness to resort to litigation, a greater attention to risk and better access to information (of whatever quality). He also points out, as have many commentators, how consumer and patient values have already replaced paternalistic and professional values, and where doctors used to lead, they now follow. The monolithic role of the doctor has been challenged by 'lay experts' whose ability to influence public debate and policy increases just as that of the doctor or scientist diminishes – the 'lay expert' may be the survivor of a disaster or the sufferer from a disease⁹⁷. The Gulf War veteran has fulfilled both roles.

The shape of the Gulf War syndrome had been determined in the popular and political imaginations long before scientists or doctors had anything to say on the matter. Previously in this century popular syndromes often resulted from the combination of charismatic doctors and a receptive public. Gulf War syndrome, we suggest, developed without the assistance of science or medicine. Populist and occasionally maverick scientists have emerged into the limelight of Gulf War syndrome, and have played roles in subsequent events, but Gulf War syndrome may be the first truly post-modern illness in that it developed from the congruence of veterans' experiences and narratives, veterans' disquiet and distrust, and a powerful media agenda. Medical professionals and scientists generally have reacted to events, and not shaped them.

We speculate that the story of Gulf War ill health began with the experiences of veterans reporting symptoms. These may have been triggered as an unexpected reaction to measures taken to protect the armed forces against modern warfare, reinforced by the social and psychological pressures and changes that war brings to all it touches. These narratives were taken up by powerful media, and shaped into a particular syndrome under the influence of popular views of health, disease and illness. Further impetus came from the actions, or inactions, of government, and only recently by the activities of doctors and scientists. How the story will end remains to be seen.

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References

- 1 Hyams K, Hanson K, Wignall F, Escamilla J, Oldfield E. The impact of infectious diseases on the health of US troops deployed to the Persian Gulf during Operations Desert Shield and Desert Storm. *Clin Infect Dis* 1995;20:1497–04.
- 2 Joseph S. A comprehensive clinical evaluation of 20,000 Persian Gulf War veterans. *Mil Med* 1997;162:149–56.
- 3 Roy M, Koslowe P, Kroenke K, Magruder C. Signs, symptoms and ill-defined conditions in Persian Gulf war veterans: Findings from the Comprehensive Clinical Evaluation Program. *Psychosom Med* 1998;60:663–8.
- 4 Coker W, Bhatt B, Blatchley N, Graham J. Clinical findings for the first 1000 Gulf war veterans in the Ministry of Defence's medical assessment programme. *Br Med J* 1999;318:290–4.
- 5 Kang H, Bullman T. Mortality among US veterans of the Persian Gulf War. *N Engl J Med* 1996;335:1498–1504.
- 6 MacFarlane G, Thomas E, Cherry N. Mortality amongst United Kingdom Gulf War veterans. *Lancet* 2000;356:17–21.
- 7 Gray G, Coate B, Anderson C, Kang HK, et al. The postwar hospitalization experience of US veterans of the Persian Gulf War. *N Engl J Med* 1996;335:1505–13.
- 8 The Iowa Persian Gulf Study Group. Self-reported illness and health status among Persian Gulf War veterans: a population-based study. *JAMA* 1997;277:238–45.
- 9 Unwin C, Blatchley N, Coker W, Ferry S, et al. The health of United Kingdom Servicemen who served in the Persian Gulf War. *Lancet* 1999;353:169–78.
- 10 Stretch R, Bliese P, Marlowe D, Wright K, et al. Physical health symptomatology of Gulf War-era service personnel from the States of Pennsylvania and Hawaii. *Mil Med* 1995;160:131–6.
- 11 Proctor S, Heeren T, White R, Wolfe J, et al. Health status of Persian Gulf War veterans: self-reported symptoms, environmental exposures, and the effect of stress. *Int J Epidemiol* 1998;27:1000–10.
- 12 Fukuda K, Nisenbaum R, Stewart G, Thompson WW, et al. Chronic multisymptom illness affecting air force veterans of the gulf war. *JAMA* 1998;280:981–8.
- 13 Gray GC, Kaiser KS, Hawksworth AW, Hall FW, Barrett-Connor E. Increased postwar symptoms and psychological morbidity among US Navy Gulf War veterans. *Am J Trop Med Hyg* 1999;60:758–66.
- 14 Kang HK, Mahan CM, Murphy FM. Illnesses among United States veterans of the Gulf War: a population-based survey of 30,000 veterans. *J Occup Environ Med* 2000;42:491.
- 15 McCauley L, Joos S, Lasarev M, Storzbach D, Bourdette D. Gulf war unexplained illnesses: persistence and unexplained nature of self-reported symptoms. *Environmental Research* 1999;81:215–23.
- 16 Kroenke K, Mangelsdorff A. Common symptoms in ambulatory care: incidence, evaluation, therapy and outcome. *Am J Med* 1989;86:262–6.
- 17 Wegman D, Woods N, Bailar J. Invited commentary: how would we know a Gulf War syndrome if we saw one? *Am J Epidemiol* 1998;146:704–11.
- 18 Haley R, Kurt T, Hom J. Is there a Gulf War syndrome? Searching for syndromes by factor analysis of symptoms. *JAMA* 1997;277:215–22.
- 19 Landrigan P. Illness in Gulf War veterans: causes and consequences. *JAMA* 1997;277:259–61.
- 20 Ismail K, Everitt B, Blatchley N, Hull L, et al. Is there a Gulf war syndrome? *Lancet* 1999;353:179–82.
- 21 Knoke J, Smith TC, Gray G, Kaiser KS, Hawksworth AW. Factor analysis of self reported symptoms: Does it identify a Gulf War Syndrome? *Am J Epidemiol* 2000;152:379–88.
- 22 Doebbeling B, Clarke W, Watson D, Torner JC, et al. Is there a Persian Gulf War Syndrome? Evidence from a large population-based survey of veterans and nondeployed controls. *Am J Med* 2000;108:695–704.
- 23 Anon. *Health study of Canadian Forces Personnel involved in the 1991 conflict in the Persian Gulf*. Ottawa: Goss Gilroy Inc., 1998.
- 24 Ishoy T, Suadicani P, Guldager B, Appleyard M, et al. State of health after deployment in the Persian Gulf: The Danish Gulf War Study. *Danish Med Bull* 1999;46:416–19.
- 25 Anon. French army wary of first Gulf War syndrome charge. Reuters 2000 May 29.
- 26 McDiarmid M, Keogh J, Hooper F, McPhaul K, et al. Health effects of depleted uranium on exposed gulf war veterans. *Environmental Research* 2000;82:168–80.
- 27 United States Army Environmental Hygiene Agency. Biological Surveillance Initiative. Appendix F of Final Report Kuwait Oil Fire Health Risk Assessment, 5 May – 3 December 1991. Aberdeen Proving Ground, Md: US Army Environmental Hygiene Agency, 1994.
- 28 Poirier M, Weston A, Schoket B, Shamkhani H, et al. Polycyclic aromatic hydrocarbon biomarkers of internal exposure in US Army soldiers serving in Kuwait in 1991. *Polycyclic Aromatic Compounds* 1999;17:197–208.
- 29 Keeler J, Hurst C, Dunn M. Pyridostigmine used as a nerve agent pretreatment under wartime conditions. *JAMA* 1991;266:693–5.
- 30 Fulco C, Liverman C, Sox H (eds). *Gulf War and health: Volume 1. Depleted uranium, sarin, pyridostigmine bromide, vaccines*. Washington DC: Institute of Medicine, 2000.
- 31 Trojan D, Cashman N. An open trial of pyridostigmine in post poliomyelitis syndrome. *Can J Neurol Sci* 1995;22:223–7.
- 32 Trojan DA, Collet JP, Shapiro S, Jubelt B, et al. A multicenter, randomized, double-blinded trial of pyridostigmine in postpolio syndrome. *Neurology* 1999;53:1225–33.
- 33 Anon. *Presidential Advisory Committee on Gulf War Veterans' Illnesses: Final Report*. Washington DC: US Government Printing Office, 1997.
- 34 Ablers J, Berent S. Controversies in neurotoxicology. *Neuro Clin* 2000;18:741–63.
- 35 Friedman A, Kaufer D, Shemer J, Hendler I, et al. Pyridostigmine brain penetration under stress enhances neuronal excitability and induces early immediate transcriptional response. *Nat Med* 1996;2:1382–5.
- 36 Grauer E, Alkalia D, Kapon J, Cohen G, Ravey L. Stress does not enable pyridostigmine bromide to inhibit brain cholinesterase after parental administration. *Toxicol Appl Pharmacol* 2000;164:301–4.
- 37 Abou-Donia M, Wilmarth K, Jensen K, Oehme F, Kurt T. Neurotoxicity resulting from coexposure to pyridostigmine bromide, DEET, and permethrin: implications of Gulf War chemical exposures. *J Toxicol Environ Health* 1996;48:35–56.
- 38 Hoy J, Cornell J, Karlix J, Tebbett I, van Haaren F. Repeated coadministrations of pyridostigmine bromide, DEET, and permethrin alter locomotor behavior of rats. *Vet Human Toxicol* 2000;42:72–76.
- 39 Griffiths G, Hornby R, Stevens D, Scott L, Upshall D. Biological consequences of multiple vaccines and pyridostigmine pretreatment in the guinea pig. *J Appl Toxicol* 2000;in press.
- 40 Furlong C. PON1 status and neurologic symptom complexes in gulf war veterans. *Genome Res* 2000;10:153–5.
- 41 Haley R, Billecke S, la Du B. Association of low PON1 Type Q (type A) arylesterase activity with neurologic symptom complexes in Gulf War veterans. *Toxicol Appl Pharmacol* 1999;157:227–33.
- 42 Mackness B, Durrington P, Mackness M. Low paraoxonase in Persian Gulf War veterans self reporting Gulf War Syndrome. *Biochem Biophys Res Comm* 2000;276:725–33.
- 43 Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment. *Organophosphates*. London: Department of Health, 1999.
- 44 United States General Accounting Office. Gulf War illnesses: improved monitoring of clinical progress and reexamination of research emphasis are needed. Washington DC: United States General Accounting Office, 1997.
- 45 Joint Working Group of the Royal Colleges of Physicians and Royal College of Psychiatrists. *Organophosphate sheep dip: clinical aspects of long-term low-dose exposure*. Salisbury, Wiltshire: Royal College of Physicians, 1998.
- 46 Gray G, Smith T, Knoke J, Heller J. The postwar hospitalization experience of Gulf War veterans possibly exposed to chemical munitions destruction at Khamsiyah, Iraq. *Am J Epidemiol* 1999;150:532–40.
- 47 Pearce P, Crofts H, Muggleton N, Ridout D, Scott E. The effects of

- acutely administered low dose sarin on cognitive behaviour and the electroencephalogram in the common marmoset. *J Psychopharmacol* 1999;13:128–35.
- 48 Ministry of Defence. *British chemical warfare defence during the Gulf conflict (1990–1991)*. London: www.mod.uk/policy/gulfwar/index.htm, 2000.
- 49 Hotopf M, David A, Hull L, Ismail K, *et al*. The role of vaccinations as risk factors for ill-health in veterans of the Persian Gulf War. *Br Med J* 2000;320:1363–7.
- 50 Rook G, Zumla A. Gulf war syndrome: is it due to a systemic shift in cytokine balance towards a Th2 profile? *Lancet* 1997;349:1831–3.
- 51 Haley R, Kurt T. Self-reported exposure to neurotoxic chemical combinations in the Gulf War: a cross-sectional epidemiologic survey. *JAMA* 1997;277:231–7.
- 52 Wolfe J, Proctor S, Duncan Davis J, Borgos M, Friedman M. Health symptoms reported by Persian Gulf War veterans two years after return. *Am J Indust Med* 1998;33:104–13.
- 53 Kroenke K, Koslowe P, Roy M. Symptoms in 18,495 Persian Gulf War Veterans. *J Occup Environ Med* 1998;40:520–528.
- 54 Hyams K, Wignall F, Roswell R. War syndromes and their evaluation: from the US Civil War to the Persian Gulf War. *Ann Intern Med* 1996;125:398–405.
- 55 Jones E, Wessely S. Chronic fatigue syndrome after the Crimean War and the Indian Mutiny. *Br Med J* 1999;319:1645–7.
- 56 Stokes J, Banderet L. Psychological aspects of chemical defense and warfare. *Mil Psychol* 1997;9:395–415.
- 57 Betts R. The new threat of mass destruction. *Foreign Affairs* 1998; 77:26–41.
- 58 O'Brien L, Payne RG. Prevention and management of panic in personnel facing a chemical threat. *J R Army Med Corps* 1993;139:41–5.
- 59 Holloway H, Norwood A, Fullerton C, Engel C, Ursano R. The threat of biological weapons: prophylaxis and mitigation of psychological and social consequences. *JAMA* 1997;278:425–7.
- 60 Fullerton C, Ursano R. Behavioral and psychological responses to chemical and biological warfare. *Mil Med* 1990;155:54–9.
- 61 Nisenbaum R, Barrett DH, Reyes M, Reeves WC. Deployment stressors and a chronic multisymptom illness among Gulf War veterans. *J Nerv Ment Dis* 2000;188:259–66.
- 62 Kipen HM, Hallman W, Natelson BH. Prevalence of chronic fatigue and chemical sensitivities in Gulf Registry veterans. *Arch Environ Health* 1999;54:313.
- 63 Black D, Doebbeling B, Voelker M, Clarke WR, *et al*. Multiple chemical sensitivity syndrome: symptom prevalence and risk factors in a military population. *Arch Intern Med* 2000;160:1169–76.
- 64 Reid S, Hotopf M, Hull L, Ismail K, *et al*. Multiple chemical sensitivity and chronic fatigue syndrome in UK Gulf War veterans. *Am J Epidemiol* 2001;in press.
- 65 Wessely S, Nimnuan C, Sharpe M. Functional somatic syndromes: one or many? *Lancet* 1999;354:936–9.
- 66 Thomas K. The consultation and the therapeutic illusion. *Br Med J* 1978;i:1327–8.
- 67 Mott F. *War neuroses and shell shock*. London: Hodder & Stoughton, 1919.
- 68 Hall W. The logic of a controversy: the case of Agent Orange in Australia. *Soc Sci Med* 1989;29:537–44.
- 69 Shorter E. Multiple chemical sensitivity: pseudodisease in historical perspective. *Scand J Work Environ Health* 1997;23(Suppl 3):35–42.
- 70 Dalrymple T. *Mass listeria: the meaning of health scares*. London: Andre Deutsch, 1998.
- 71 Jefferson T. Real or perceived adverse effects of vaccines and the media – a tale of our times. *J Epidemiol Community Health* 2000;54:402–3.
- 72 Berg M, Arnetz B, Liden S, Eneroth P, Kallner A. Techno-stress: a psychophysiology study of employees with VDU-associated skin complaints. *J Occup Med* 1992;34:698–700.
- 73 Smith M, Carayon P. Work organization, stress and cumulative trauma disorders. In: Moon S, Sauter S (eds). *Beyond biomechanics: psychosocial aspects of musculoskeletal disorders in office work*. London: Taylor & Francis, 1996: 23–44.
- 74 Arnetz B, Wiholm C. Technological stress: psychophysiological symptoms in modern offices. *J Psychosom Res* 1997;43:35–42.
- 75 Stewart D. The changing faces of somatization. *Psychosomatics* 1990;31:153–8.
- 76 Hutchesson E, Volans G. Unsubstantiated complaints of being poisoned: psychopathology of patients referred to the National Poisons unit. *Br J Psychiatry* 1989;154:34–40.
- 77 Burke D. The recent excitement over genetically modified food. In: Bennett P, Calman K (eds). *Risk communication and public health*. Oxford: Oxford Medical Publications, 1999: 140–51.
- 78 Barsky A. *Worried sick: our troubled quest for wellness*. Toronto: Little, Brown & Co, 1988.
- 79 Matterson-Allen S, Brown P. Public reaction to toxic waste contamination: analysis of a social movement. *Int J Health Serv* 1990;20:484–500.
- 80 Skolbekken J. The risk epidemic in medical journals. *Soc Sci Med* 1995;40:291–305.
- 81 Bowler R, Mergler D, Huel G, Cone J. Psychological, psychosocial and psychophysiological sequelae to a community affected by a railroad disaster. *J Traumatic Stress* 1994;7:601–24.
- 82 Roht L, Vernon S, Weir F, Pier S, *et al*. Community exposure to hazardous waste disposal sites: assessing reporting bias. *Am J Epidemiol* 1985;122:418–33.
- 83 Lipscomb JA, Satin KP, Neutra RR. Reported symptom prevalence rates from comparison populations in community-based environmental studies. *Arch Environ Health* 1992;47:263–9.
- 84 Shusterman D, Lipscomb J, Neutra R, Satin K. Symptom prevalence and odor-worry interaction near hazardous waste sites. *Environ Health Perspect* 1991;94:25–30.
- 85 Cowan D, Gray G, DeFraitres R. Birth defects among children of Persian Gulf War veterans. *N Engl J Med* 1997;337:1175–76.
- 86 Slovic P. Trust, emotion, sex, politics, and science: surveying the risk assessment battlefield. *Risk Analysis* 1999;19:689–702.
- 87 Funkhouser G. The issues of the sixties: an exploratory study in the dynamics of public opinion. *Public Opinion Quarterly* 1973;37:62–75.
- 88 Gilmour B. Hazardous duty. *Edmonton Journal* 1999 Sept 9.
- 89 Soetekouw P, De Vries M, Preijers F, Van Crevel R, *et al*. Persistent symptoms in former UNTAC soldiers are not associated with shifted cytokine balance. *Eur J Clin Invest* 1999;29:960–3.
- 90 De Vries M, Soetekouw PM, Bleijenberg G, Van Der Meer J. Fatigue in Cambodia veterans. *Q J Med* 2000;93:283–9.
- 91 Kondro W. Soldiers claim ill health after contact with contaminated soil in Croatia. *Lancet* 1999;354:494.
- 92 Birchard K. Experts still arguing over radiation doses. *Lancet* 1999;354:400.
- 93 Neutra R. Epidemiology for and with a distrustful community. *Environ Health Perspect* 1985;62:393–7.
- 94 David A, Wessely S. The legend of Camelford: medical consequences of a water pollution accident. *J Psychosom Res* 1995;39:1–10.
- 95 Prince-Embury S, Rooney J. Psychological symptoms of residents in the aftermath of the Three-Mile island nuclear accident in the aftermath of technological disaster. *J Soc Psychol* 1988;128:779–90.
- 96 Gray J. Postmodern medicine. *Lancet* 1999;354:1550–3.
- 97 Bury M. Postmodernity and health. In: Scambler G, Higgs P (eds). *Modernity and health*. London: Routledge, 1998: 1–28.

Address for correspondence:**Professor Simon Wessely,****Guy's, King's and St Thomas' School of Medicine,****103 Denmark Hill, London SE5 8AF.****E-mail: s.wessely@iop.kcl.ac.uk**