Ambiguity Aversion and the UK Government's Response to Swine Flu

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Introduction

In April 2009, an outbreak of the H1N1 swine flu virus captured the attention of the world. The UK government quickly claimed that the country was well prepared to respond to this potential global pandemic. Indeed, ever since (and even before) the 2002 H5N1 avian flu outbreak, the government had been laying the foundations for action. The Chief Medical Officer (CMO) for England, Sir Liam Donaldson, was deeply involved in the response, having himself published a 2002 policy document entitled, *Getting Ahead of the Curve: A Strategy for Combating Infectious Diseases* (Department of Health, 2002), and in 2007 the government published *A National Framework for Responding to an Influenza Pandemic* (Cabinet Office/Department of Health, 2007). The *Framework* was geared towards a worst case scenario, and planned for between 55,500 and 750,000 fatalities. It said that there should be a stockpile of antiviral medications sufficient to treat 50% of the population, and in the event of a pandemic, stated that the government should purchase sufficient vaccine to immunise everyone in the country and should establish a national pandemic flu service so that people can have antivirals authorised over the phone. The government's response to the 2009 outbreak was directly informed by the *Framework.*

The initial response focussed on containing the virus, principally so as to try to buy some time to better understand the virus before a treatment stage was initiated. Among the first people infected were schoolchildren, and the schools affected issued antiviral medications in many cases to all those in the same year as the infected pupil, and in some cases to the whole school. In several instances, schools closed for a week. On April 29th, two days after the first cases of swine flu were detected in the UK, the government announced plans to increase its stockpile of antivirals from levels sufficient to treat 50% of the population to levels sufficient to treat 80%, and people were advised to take these medications if they had come into contact with an infected person. Moreover, a mass public health media campaign was launched, and leaflets were sent to every household in the country advising on what swine flu is, and how to respond to it (e.g. to cover noses and mouths when sneezing and to undertake regular hand washing, captured under the slogan, "Catch it. Bin it. Kill it").

In May 2009, the government announced that it had in place advanced purchase agreements with pharmaceutical manufacturers to provide a flu vaccine for the entire UK population, which would be activated automatically in the event of the World Health Organization (WHO) classifying the outbreak as a pandemic (which it did in June 2009). In the July, the government, recognising that the spread of the virus could no longer be efficiently controlled, moved from a policy of containment to a treatment stage, during which it was hoped that the vaccine would form the central component. Also in July, the

National Flu Pandemic Service (NFPS) became live in England, and provided a website and call centres for those concerned that they had contracted the illness. Anyone who indicated relevant symptoms was given a unique reference number allowing them or someone acting on their behalf to collect antiviral medications without first visiting their general practitioner (GP), which relieved some of the pressure on primary care services.

As noted, the response was informed by the *Framework*, and the *Framework* was based upon a feared outbreak of avian flu. Swine flu ultimately proved much milder and less deadly that a worst case avian flu outbreak, which has led some to conclude that the government overreacted to the 2009 threat (*The Independent*, April 22nd 2010), insufficiently moderating its response as the nature of swine flu became clearer. One possible explanation for any 'excessive' response from the government is given by ambiguity aversion. That is to say that when it arrived, the behaviour of swine flu (its infectivity, severity etc.) was highly uncertain (or, synonymously, ambiguous), and as a consequence, the government attached disproportionate weight to the worst possible outcome of the threat. A dislike of uncertainty implies that people will pay a high price to avoid it, or, when uncertainty cannot be avoided, they adopt a pessimistic approach and overweight the slight possibility of the worst outcome happening. The latter is an explanation for why people are often attracted to the precautionary principle, particularly when the worst possible outcome is catastrophic.

This chapter is organised as follows. First, ambiguity aversion is described by means of a hypothetical thought experiment, and then the precautionary principle is defined. Following this definition, further details of, and suggested reasons for, the UK government's containment and treatment response to the 2009 swine flu pandemic are offered. The chapter finishes with a short conclusion.

Ambiguity Aversion

In economics, a distinction is made between risk and uncertainty. An event that is risky has a known probability of occurrence. For instance, if a die is rolled, the probability of a six is 0.116. When an event is uncertain (or, equivalently, ambiguous), however, the probability of an event occurring is not known, and will fall within a probability range. For instance, the probability of rain in London tomorrow might be somewhere between 0.05 and 0.15. Economic theory assumes that when people are faced with uncertain events they will behave as if well-specified probability distributions exist. If so, uncertain events reduce to risky events, and the same behavioural axioms underlie both types of scenario.

Economic theory of course allows for risk attitude. If someone is risk averse (say, in the case of insurance), they will pay a premium to avoid the risk, or if they are risk seeking (if they like gambling), they will pay to accept the risk. However, behavioural economists have observed that people will be willing to pay an additional premium, over and above that implied by risk aversion and outside the framework of standard economic theory, in order to avoid ambiguity. This can be best illustrated by Ellsberg's original

demonstration of this phenomenon, which he presented as a thought experiment at a dinner party fifty years ago (Ellsberg, 1961).

Ellsberg used money outcomes; in the table below his paradox has been adapted to a hypothetical influenza scenario. The example is not intended to be a representation of a realistic flu-related decision context. It is merely meant to illustrate the phenomenon of ambiguity aversion. Assume that there are three strains of the flu, A, B and C. The government knows that there is a 1/3 chance that strain A prevails. It also therefore knows that there is a 2/3 chance that either strain B or strain C prevails, but is uncertain of the exact chance of either of these strains. That is, there is a zero to 2/3 chance of B; likewise for C.

	Strain A 1/3	Strain B 2/3	Strain C
Strategy X	10,000	0	0
Strategy Y	0	10,000	0
Strategy X’	10,000	0	10,000
Strategy Y’	0	10,000	10,000

Assume that the government is considering implementing either Strategy X or Strategy Y in response to a flu outbreak. If X is followed, there is a 1/3 chance that 10,000 lives will be saved and a 2/3 chance that no lives will be saved. If Y is followed, there is an uncertain zero to two-thirds chance that 10,000 lives will be saved, and a 1/3 to certain chance that no lives will be saved.

Next assume that the government is considering X’ or Y’. For X’, there is a 1/3 to certain chance that 10,000 lives will be saved, and a zero to 2/3 chance that no lives will be saved. For Y’, there is a 2/3 chance that 10,000 lives will be saved, and a 1/3 chance that no lives will be saved.

Now, in the event of strain C, X and Y share a common outcome of no lives being saved. Therefore, according to the independence axiom of standard economic theory, strain C should be irrelevant when considering X or Y; likewise when considering X’ or Y’, where strain C gives a common outcome of saving 10,000 lives. If C is considered irrelevant in both choice contexts, then X is identical to X’ and Y is identical to Y’, and thus, in the choice between X and Y and X’ and Y’, the decision maker should choose X and X’ or Y and Y’ (or be indifferent in both choices). However, Ellsberg’s hypothesis implies that decision makers will lean towards X and Y’, an expectation that, in the context of money outcomes, has been confirmed empirically (e.g., Bernasconi and Loomes, 1992; Curley and Yates, 1989; Einhorn and Hogarth, 1986).

The reason for the Ellsberg paradox is that decision makers may not like the uncertainty embedded in Y and X’; that is to say, they are ambiguity averse, which can lead to systematic violations of standard economic theory. As noted in the previous section,

when events are uncertain, people may often adopt a form of pessimism, particularly when the magnitude of the associated threat is large, which leads them to lean towards the worst case scenario. This will in turn cause them to take action – arguably, sometimes too much action – to mitigate the uncertainty, and could lead them to adopt a strong version of the precautionary principle.

The Precautionary Principle

Henry and Henry (2002) maintain that the crucial concept underlying the precautionary principle is not the resolution of uncertainty, but uncertainty itself. That is to say that reaction to uncertainty drives the precautionary principle, with O'Riordan and Jordan (1995) stating that "…the principle of precaution…implies committing human activity to investments where the benefits of action cannot, at the time of expenditure, be justified by conclusive scientific evidence." Sunstein (2005) argues that a strong version of the precautionary principle is voiced when regulators are called to take steps to protect fully against all potential harms, a concept that he views as literally incoherent, because regulation itself introduces its own risks and thus the strong version is paralysing, because it forbids the very steps that it requires.

A weaker version of the precautionary principle contends that a lack of decisive evidence of harm should not offer grounds for refusing to act. This is, for Sunstein (2005), something to which no reasonable person could object. Given the uncertainty and the potentially catastrophic effects of the 2009 swine flu outbreak, a policy response that reflected some notion of the precautionary principle was necessary. That is, the government had to act to protect in the face of uncertainty, but was its actions too strong? In addressing this question, one has to consider the opportunity costs and unintended consequences of the response, such as the possibility of provoking unnecessary fear within the population in the short term and, conversely, causing widespread insensitivity to legitimate potential harms in the longer term (the 'cry wolf' effect). Further, if the response was too strong, was it because of an aversion to ambiguity? A consideration of these issues, among others, will occupy the rest of this chapter.

The Response

The strength of the government's initial and, until early 2010, continuing response to the swine flu pandemic has multiple causal factors. As mentioned in the introduction, Sir Liam Donaldson had for many years invested much effort in highlighting the threat of pandemics, and postponed his retirement to tackle the outbreak in the spring of 2009. In England, unlike Wales and Scotland, the CMO was used as the chief spokesperson during the outbreak, and his voice attracted much attention. Moreover, something akin to 'institutional memory' may have also played a role, in that Sir Liam's predecessors, Sir Donald Acheson and Sir Kenneth Calman, were publicly criticised in the *Phillips Report* (2000) for responding inadequately to the Bovine Spongiform Encephalopathy (BSE) / variant Creutzfeldt-Jakob Disease (vCJD) (i.e. mad cow's disease) scare in the 1980s and

1990s (see also Klein, 2000), and across broader government policy, more recent responses to, for example, foot and mouth disease in 2001, had been criticised severely (*The Guardian*, May 16th 2001).

More tellingly, perhaps, the initial information from Mexico (the first cases were confirmed in Mexico and the United States on April 23rd 2009) appeared to suggest that the virus was associated with rapid spread and high fatality. The quality of that data was later considered dubious (Hine, 2010), but nobody knew that at the time and it triggered an all out response from the UK government. Once the response had been set in motion, the government seemingly found it difficult to scale down its actions, perhaps indicating that once it had 'bought into' the threat and had started to apply the *Framework*, the actions became the 'default', and deviating from those proved sticky.

As noted, the *Framework* was a response to avian flu. In parallel, the modellers that the government relied on to predict the outcome of the 2009 outbreak relied on parameters that reflected more accurately the greater severity of the avian flu outbreak. More specifically, three groups of modellers heavily influenced the Scientific Advisory Group for Emergencies (SAGE), which was tasked with advising the government on the basis of the scientific evidence. SAGE, and thus the government, therefore adopted a worst case scenario. It has been suggested that policy makers may over-rely on modellers because they are 'credible' (i.e. mathematical and academic), and give concrete, easily understood, seemingly robust answers (Hine, 2010). Unfortunately, the emphasis on modelling may have somewhat blinded the decision makers to the contribution that those with other expertise could have made, including those experienced in dealing with previous pandemics and those who were dealing directly and practically with clinical cases who quickly saw that the virus was mild and associated with low mortality (Hine, 2010).

In addition to avian flu, fears provoked by previous pandemics had a significant influence on the government's response to swine flu. The 2002 avian flu outbreak, although infecting only 495 humans globally, had a mortality rate of 59% (*The Independent*, May 3rd 2010), and pandemics on a catastrophic scale in the more distant past still loomed large. For instance, the Asian flu and Hong Kong flu outbreaks in 1957 and 1968-69, respectively, had each killed 1-4 million people, and the mother (in terms of magnitude, not composition) of all pandemics, the Spanish flu outbreak in 1918-19, is estimated to have killed up to 40 million people (Hine, 2010), 3% of the world's population at that time.[1]

In addition to not wanting to be seen to repeat the mistakes of the past and relying on evidence that predicted the worst case scenario, the shadow of previous pandemics, the

[1] As an aside, the origins of the Spanish flu outbreak are debated, but it has been hypothesised that the virus gained a foothold among immuno-compromised soldiers in the hospital and army training complex near Etaples in northern France during the First World War (Oxford et al., 2007). Many of the soldiers had been weakened by gas used in the Somme battlefields, and the camp was overcrowded and under the flight path of flu-carrying geese and ducks. Moreover, there is photographic evidence of soldiers plucking geese and turkeys.

uncertainty and the potentially catastrophic outcome may therefore give reason for an element of ambiguity aversion and possible over-response from the government to the 2009 outbreak. However, to more confidently judge whether the response was indeed excessive requires us to delve a little further into its details.

The Containment Phase

Between April 27th and July 2nd 2009, the government focussed upon a containment strategy, the focal point of which centred on the use of antiviral medications. In order to increase the stockpile, two types of antivirals were bought: the primary stock, Tamiflu, and a secondary stock, Relenza, which was bought in case the virus became resistant to Tamiflu. Antivirals relieve the symptoms of flu by an average of one day if they are taken within the first 48 hours of the onset of symptoms. It is thus possible that they can prevent some people from developing more serious illness than they would in the absence of the drugs (Oxford *et al.*, 2007).[2] Moreover, if people act quickly and take antivirals within a day of the symptoms developing, there is a chance of reduced transmission (Ferguson *et al.*, 2006). The government therefore implemented a policy of recommending antiviral use by those who had come into contact with anyone infected with the virus, in the hope that this would slow the spread and thus give more time to learn about the virus' characteristics (and thus develop further measures to combat the virus effectively) before it had spread extensively throughout the population.

The English government adopted a 'treat all' approach with respect to antivirals, meaning that all those with swine flu symptoms were advised to take the medications. In the three devolved countries of the UK, only those considered most at risk from developing serious illness as a result of contracting the virus were recommended to take the drugs. However, as early as April 30th, it was noted that the virus appeared to be mild and self-limiting outside of Mexico (Hine, 2010), and by mid May the Health Protection Agency recommended that the use of antivirals be cut back, due to the observed side of effects of the medications (particularly in children), the large number of people who were not completing the courses of the drugs, and the risk of causing drug resistance (Hine, 2010). The English government did not change its policy until the beginning of July, and thus its actions regarding the use of antivirals, from a purely 'health' perspective, can quite reasonably be viewed as excessive (indeed, there is no evidence that the antiviral policy slowed the spread of the illness). However, in this case, any excessive reaction is perhaps less likely to have been motivated by ambiguity aversion (i.e. a focus upon the worst case scenario) *per se*; rather, the action was probably undertaken to show the general public that *something* was being done in response to the threat, and to show that everything possible had been done should the worst case scenario be realised.[3] Thus, the principle

[2] Although see Epstein (2011) for a critique of the purported effectiveness of antiviral medications.

[3] An aggressive response to the outbreak caused by anxiety of a public backlash should the worst happen is, in theory, fuelled by 'anticipated regret', a phenomenon that has a long history in the behavioural economics literature (Loomes and Sugden, 1982). That is, although the worst case was unlikely to happen, the repercussions for the government if it had happened and they had not done everything possible would have plausibly been very large, which led it to focus very heavily on this possible outcome. Like ambiguity aversion, anticipated regret can cause violations of standard economic theory.

motivation behind the treat all approach may well have been to maintain public confidence, to placate the 'worried well'.

Losing public confidence is a possible opportunity cost of *not* acting aggressively, but there are also opportunity costs of acting too aggressively that the government may have insufficiently considered.[4] As noted in the introduction, a mass media campaign was another part of the government's strategy, a campaign that included regular media briefings from the CMO that continued throughout the response. By July, the briefings included a 'reasonable worst case' scenario, an unfortunate turn of phrase as it was used by some to mean 'relatively likely to occur'. In fact, the reasonable worst case was a highly pessimistic scenario, possibly motivated by ambiguity aversion, but used principally for planning purposes. Initially, the reasonable worst case specified 65,000 deaths, intended for planning purposes,[5] but used by some of the media as a prediction. Sir Liam Donaldson later lamented this misuse, but the behaviour of the media should have been easy to predict. The sensationalist worst case scenario would be expected to sell most copy and maximise viewing numbers; as Ariely (2008) has pointed out, in press circles 'if it bleeds, it leads'.

It is not a good thing to incite fear unnecessarily. Anxiety has never been a foundation for rational action (Beck, 1992). Fear can spread much quicker than the virus itself, with people becoming fearful of the virus just because they observe a degree of fear in others. The fear was possibly compounded by stories that people construct from the visual images that the media present (e.g. the stressed yet determined mothers clinging to their antiviral medications as they steer their children away from school). All of this feeds the 'availability heuristic', where threats that people deem as relevant are those that are foremost in their consciousness', with other potential harms becoming barely visible to them. Policy makers as well as the general public are likely to suffer from the availability heuristic. People may then disproportionately focus on information that reinforces the conscious threat, and the escalating concern within the populace further compels governments to act in the strongest possible way, or face accusations of not doing enough.

Aside from the disutility felt from personal anxiety, fear can lead to attention and resources being directed away from interventions that are more health-enhancing and life-saving. It is perhaps instructive to note that normal seasonal flu kills 2,000-4,000 people in the UK; swine flu killed 457 people. Since swine flu very likely drove out the normal seasonal flu virus, the 2009 outbreak probably saved lives, although that is, of course, to speak with hindsight. Nonetheless, Hine (2010), in her independent review of the response to the swine flu outbreak, estimated that £1.2 billion was spent on the containment and treatment (discussed below) phases, equivalent to a little over 1% of the

[4] The consideration of opportunity costs is a key feature of economics. As far as I can gather, the official committees convened for the swine flu response included only one economist – the Chief Economist at the Department of Health, Barry McCormick.

[5] The reasonable worst case was revised down to 19,000 deaths in September 2009, and to 1,000 deaths in October. In total, 457 people died of swine flu in the UK. Most of these had underlying health problems, but there were some deaths among pregnant women.

annual National Health Service (NHS) budget, a not insubstantial amount of additional money to be found at the margin, particularly in a time of public sector spending constraint. This figure mainly appertains to the costs of pharmaceuticals and vaccines and did not factor in opportunity costs, but even taken at face value, if a part of this spending could have been avoided with a more measured response, it could have probably been used to significant effect elsewhere.

On the flipside of provoking short term fear is the danger of desensitising people to risk in the longer term, which may be more likely to occur if the policy is to emphasise initially the worst case scenario, but then to revise down the threat. That is, in the longer term, the government could face accusations of 'crying wolf', which may even occur in the short term as the number of threats that are not as catastrophic as originally feared multiplies over time (e.g. vCJD, SARS, avian flu, swine flu). There is some limited evidence that this occurred with respect to the swine flu outbreak, in that a telephone survey of a sample of the general public just a few weeks after the initial outbreak of the virus revealed that only 24% of respondents reported any anxiety with respect to swine flu, 68% believed the media had exaggerated the threat, and 72% reported no change in simple preventive measures, such as increased hand washing (Rubin *et al.*, 2009). A survey conducted in the United States reported similar findings (Holland Jones and Salathe, 2009).

The government's focus on the worst case scenario, and the potential unintended (but predictable) negative consequences of that strategy, can plausibly be explained by ambiguity aversion (among the other factors discussed earlier), but the excessive promoted use of antivirals was, it is contended here, consequent on a desire to maintain public trust. By July 2009, the government decided that it was no longer possible to efficiently contain the spread of the swine flu virus, and therefore moved on to a treatment phase.

The Treatment Phase

By July 2nd, after much delay, the government adopted a more targeted antiviral strategy, and then on July 23rd, the NFPS was launched in England, relieving some of the pressure on primary care services (the NPFS was closed on February 11th 2010, by which time it had undertaken 2.73 million assessments and prescribed 1.16 million courses of antivirals (Hine, 2010)). However, the stand-out feature of the treatment phase was the development and later use of a swine flu vaccine.

When WHO upgraded swine flu to phase 6 pandemic status on June 11th 2009,[6] the government had to make a decision on activating the advance vaccine purchase

[6] WHO has been criticised for its response by parliamentarians in a Council of Europe probe, who have questioned whether the pharmaceutical industry unduly influenced its decisions in relation to swine flu. WHO officials have denied these claims (*The Independent*, April 15th 2010), and the organisation has convened an independent committee to review the international response to swine flu, which is due to report in early 2011.

agreements that it had in place with two pharmaceutical companies, Glaxo SmithKline (GSK) and Baxter. Ministers had to choose between buying 30 million doses and 132 million doses of the vaccine, with the latter being sufficient to vaccinate the whole population effectively. The decision to purchase 132 million doses was confirmed on June 17th. This quantity of vaccine was ultimately not required. Due to the uncertainty at the time, the government ought to have been more forceful in negotiating break clauses in their contracts with the pharmaceutical manufacturers, a highly visible recommendation in the *Hine Review* (Hine, 2010). To their credit, Baxter agreed to a break clause; GSK did not. In July 2010, GSK issued the following statement: "A break clause that allows one country to exceed their allocation when supplies are limited and then pulls out later would not be ethical" (*The Guardian*, July 1st 2010). However, since the worst case scenario did not materialise, the UK's purchase did not presumably deny the populations of other countries needed vaccines. GSK's response is more likely to have been motivated by concerns for profit than for ethics. In future national emergencies (such as a 'worst case' viral outbreak), is it going too far to recommend that governments be instilled with powers to commandeer privately produced vaccines and medications at production prices? In such an eventually such action may well be in the health-related interests of everybody, including those who work in the commercial pharmaceutical sector.

Although the swine flu vaccine was available for use while the virus was still causing some disease, it took until October 21st before the vaccine had been developed and cleared to administer, almost six months since the first UK cases of illness had been recorded on April 27th. The process could not have been significantly quicker. However, it is likely that a worst case pandemic would largely be over within four months of the first cases being recorded (Ferguson *et al.*, 2006), and after that time much of the surviving population would probably have built up some natural immunity. The government anticipated that the virus could have peaked again in the winter of 2009/2010, but even without the benefit of hindsight, one can reasonably contend that a more moderate approach of purchasing sufficient vaccine to cover only those at high risk of susceptibility would have been a more appropriate decision.

Since the full quantity of vaccine purchased only became available gradually from late October onwards, the government announced that the high risk groups would indeed be targeted for vaccination first. These included those aged between six months and sixty-five years with low immunities or certain chronic illnesses, pregnant women, the non-healthy over sixty-fives, and frontline health care workers; in total, 13 million people. The government anticipated that 75% of these would get their vaccinations. In the event, only 5.5 million people in total vaccinated themselves against swine flu; 70% of front line health care workers did not go for vaccination (*The Independent*, April 22nd 2010). Although more people would no doubt have vaccinated themselves had the full threat been realised, the government would have been well advised of the likelihood that a significant percentage of the population would not have done so, quite apart from natural immunity rendering vaccination obsolete in many cases.

The government thus purchased sufficient vaccine for a worst case scenario, which appears to lend itself to ambiguity aversion (i.e. recognising that anything could happen, but nevertheless acting as if the worst would happen), but even if the worst case is certain to happen, a policy of purchasing vaccine for the whole population is questionable. By the time the vaccine is ready, the pandemic is likely to be over, many will have natural immunity, and a great number will not vaccinate themselves in any case. It would seem that, at most, a policy to vaccinate the high risk groups – 13 million people or 26 million doses if two vaccinations are required – will suffice, and even then contracts with manufacturers that better protect the public purse are advisable.

Conclusion

Many – perhaps most – of us are ambiguity averse, and more of us will be so when the worst case consequences are catastrophic. Pandemics provoke this 'dread factor'; we fear the worst, and will anchor on it. We will think of the opportunity costs of *not* acting, and be influenced by a 'what if' effect. Erring on the side of caution in such cases feeds into a basic human need for security. However, although Henry (2006) has stated that "uncertainty should not be inflated and invoked as an alibi for inaction", caution should be exercised when faced with acting in the face of uncertainty. That is to say that all of us, and particularly the policy makers among us, ought to recognize that in addition to the opportunity costs of not acting (e.g. the potential political costs, the possible loss of public confidence, the loss of life *if* the worst happens), there are opportunity costs of acting (e.g. provoking unnecessary fear, the repercussion from 'crying wolf', the lives and health lost by diverting resources away from other services) that should not be overlooked.

Clearly, the government had to act in the face of the swine flu pandemic, but did it act too much? The *Hine Review* concluded that given the initial uncertainties with respect to the behaviour of the virus, the development of resistance to antivirals, and the possibility of a more virulent second wave, there would inevitably be calls from some to assume the worst case scenario and resource the response accordingly (Hine, 2010). That is what happened. The response was tailored to fit the *Framework* rather than to the nature of the swine flu virus, and was thus arguably directed in part by some kind of 'sunk cost bias' or 'status quo bias', both of which compounded the ambiguity aversion. There was also an over-reliance on modellers who populated their trees with 'worst case' data, and insufficient consideration of other branches of expertise and of the experiences of those directly involved with clinical cases. Hine (2010) goes on to say that there was an alternative viable approach, which would have been for the government to take a view on the most likely outcome of the pandemic, while monitoring events closely and changing tack as necessary. Had this been done, it is the contention of this chapter that the government in England were sufficiently informed at the time to promote a more targeted use of antivirals much earlier than they did, and to buy far less vaccine when a decision on purchasing was required.

A more moderated approach may not have come at a political cost, because the government would still have been acting significantly (and arguably more appropriately), yet the response would have required considerably fewer resources. However, there seems to be a presumption in the *Hine Review* that the more aggressive approach still offered good value for money. This view appears to be based on the assumption that the severe threat is realised, but this will not do, because when assessing value for money, the less than certain chance that the severe threat will be realised has to be factored in. Fortunately, pandemics are quite rare, but unfortunately, this means that it is not possible to estimate accurately the chance that the severe threat will occur. This is partly why the government responded as if the severe threat would materialise. However, if an informed guess, on the basis of past experience, can be made on the chance of the severe threat being realised – say, 25% – then the government would need to respond four times to reap the benefits of tackling a severe threat once. Therefore, the cost side would have to be multiplied by four, and even then this would not account for the broader unintended consequences associated with fear, desensitisation etc. It is of course possible that a 'worst case' response to every pandemic does indeed represent a good use of resources, and it may in any case be the type of response that most policy makers and the general public want to see, but both of these considerations require more analysis and public discourse. A more sobering thought, however, is that even the most aggressive response might well be ineffective against the inevitable catastrophic pandemics that lie ahead.

References

Ariely D. 2008. Predictably *Irrational: The Hidden Forces that Shape Our Decisions.* Harper Collins, New York.

Beck U. 1992. *Risk Society: Towards a New Modernity.* Sage, London.

Bernasconi M, Loomes G. 1992. Failures of the reduction principle in an Ellsberg-type problem. *Theory and Decision* 32: 77-100.

Cabinet Office/Department of Health. 2007. *A National Framework for Responding to an Influenza Pandemic.* Department of Health, London.

Curley SP, Yates FJ. 1989. An empirical evaluation of descriptive models of ambiguity reactions in choice situations. *Journal of Mathematical Psychology* 33: 397-427.

Department of Health. 2002. *Getting Ahead of the Curve: A Strategy for Combating Infectious Diseases*. Department of Health, London.

Einhorn HJ, Hogarth RM. 1986. Decision making under ambiguity. *Journal of Business 59*: S225-S250.

Ellsberg D. 1961. Risk, ambiguity and the Savage axioms. *Quarterly Journal of Economics* 75: 643-669.

Epstein H. 2011. Flu warning: beware the drug companies! *The New York Review of Books*, 11th May.

Ferguson NM, Cummings DAT, Fraser, C, Cajka JC, Cooley PC, Burke DS. 2006. Strategies for mitigating an influenza pandemic. *Nature* 442: 448-452.

Henry C. 2006. *Decision-Making Under Scientific, Political and Economic Uncertainty.* Laboratoire d'Econometrie Cahier No. DDX-06-12. de l'Ecole Polytechnique, Paris.

Henry C, Henry M. 2002. *Formalization and Applications of the Precautionary Principle*. Laboratoire d'Econométrie Cahier No. 2002-008. l'Ecole Polytechnique, Paris.

Hine D. 2010. *An Independent Review of the UK Response to the 2009 Influenza Pandemic.* The Cabinet Office, London.

Holland Jones J, Salathe M. 2009. Early assessment of anxiety and behavioral response to novel swine-origin influenza A(H1N1). *PLoS One* 4: e8032.

Klein R. 2000. The politics of risk: the case of BSE. *BMJ* 321: 1091-1092.

Loomes GC, Sugden R. 1982. Regret theory: an alternative theory of rational choice under uncertainty. *Economic Journal* 92: 805-824.

O'Riordan T, Jordan A. 1995. The precautionary principle in contemporary environmental politics. *Environmental Values* 4: 191-212.

Oxford J, Lambkin-Williams R, Mann A. 2007. The threat of avian influenza H5N1: 'do we have the tools for the job?' *Antiviral Chemistry and Chemotherapy* 18: 71-74.

Phillips N (chairman). 2000. *The BSE Inquiry* Vol 1: *Findings and Conclusions*. Stationery Office, London.

Rubin GJ, Amlot R, Page L, Wessely S. 2009. Public perceptions, anxiety, and behaviour change in relation to the swine flu outbreak: cross sectional telephone survey. *BMJ* 339: b2651.

Sunstein CR. 2005. *Laws of Fear: Beyond the Precautionary Principle*. Cambridge University Press, Cambridge.

The Guardian. 2001. *A catalogue of failures that discredits the whole system: the must be an inquiry into the foot and mouth saga.* 16th May.

The Guardian. 2010. *Swine flu response was £1.2 billion well spent, review finds.* 1st July.

The Independent. 2010. *WHO flu experts reject charges of business influence in pandemic.* 15th April.

The Independent. 2010. *Governments accused of panicking over swine flu.* 22nd April.

The Independent. 2010: *A little knowledge: how research scientists were caught out by swine flu.* 3rd May.