RISK SOLUTIONS

An introduction to risk and how risk concepts apply in the Housing Health and Safety Rating System

A training guide prepared for Bristol City Council

August 2005

Issue 1

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1 Introduction

Risk Solutions are a professional risk management consultancy. We have not been directly involved with the development of the Housing Health and Safety Rating System (HHSRS), but we are experienced at helping people understand the basic concepts behind risk assessment and risk management.

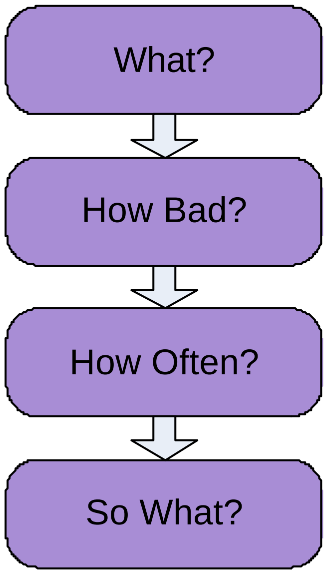
Bristol City Council asked us to prepare this guide as part of the support they offer on the HHSRS through their web site. Its purpose is to provide additional information on risk for those who are required to understand the HHSRS but who have had no previous experience of risk assessment. We start with some fundamental concepts and definitions and build up through a series of simple examples towards more complex examples based on the HHSRS scheme, to illustrate how the same principles are being applied throughout. We have also provided some practical hints and tips for potential assessors faced with having to make risk assessments as part of their job.

2 What is risk?

2.1 Risk events and measures

The idea of risk is quite simple and can be (and should be) explained in simple, everyday words. We can start with four key questions that should be asked about risk:

1. What is the thing that we are worried about?
2. How bad would the consequences be if it happened?
3. How often might it happen?
4. So what are we going to do about it?



But, if you start to look below the surface of these ideas things can get complex and there can be scope for confusion.

Risk has been described in many different ways and there is not yet a standard definition that is totally accepted. Examples of how risk is defined include:

"Risk can be defined as the combination of the probability of an event and its consequences." (ISO/IEC Guide 73:2002)

or

"Risk – the chance of something happening that will have an impact upon objectives. It is measured in terms of consequences and likelihood." (Australian/New Zealand Standard AS/NZS 4360:1995)

or

"Risk - defined as uncertainty of outcome (whether positive opportunity or negative threat). It is the combination of the chance of an event and its consequences." (Successful IT: Guidelines on Managing Risk, OGC)

However, if you read about 'risk' the word is often used to cover at least two different meanings which we shall refer to as the **risk event** meaning and the **risk measure** meaning.

A '**risk event**' is an event that (a) is a possible but not certain outcome of an activity and (b) is unwanted or has unwanted negative consequences.

A '**risk measure**' is associated with a risk event. It is a suitable combination (often the product) of a measure of likelihood and a measure of consequence.

Consider the following two pairs of sentences using the word 'risk':

What **risks** am I running when I go to the shops? One of the **risks** is that I might be run over by a bus.

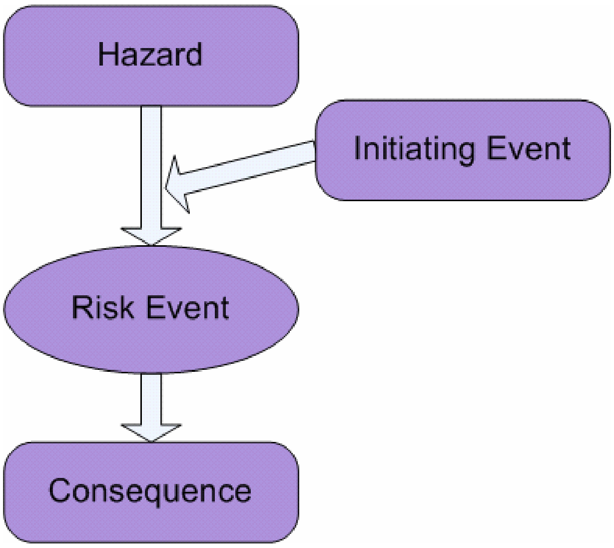
What is the **risk** that I might be run over by a bus when I go to the shops? The **risk** of being run over by a bus is 1 in 10,000 per journey.

The first pair of sentences is talking bout **risk events**. The second pair is talking about **risk measures**.

2.2 Hazard and consequence

A **Hazard** is the potential to cause risk events, and therefore adverse consequences. A hazard is usually a continuing state of affairs - for example the storage of flammable liquids or the presence of a faulty electrical socket.

A **Consequence** is an outcome that follows when a hazard is triggered by some initiating event – in other words when the risk event occurs. The relationship between these concepts is illustrated in the diagram.



This simple example may help to explain the difference between hazards, risks and consequences:

Consider a Tiger, this is a **Hazard**. The Tiger has the potential to cause risk events and possibly adverse consequences.

The **Risk** associated with the tiger depends on the conditions surrounding it.

For example,

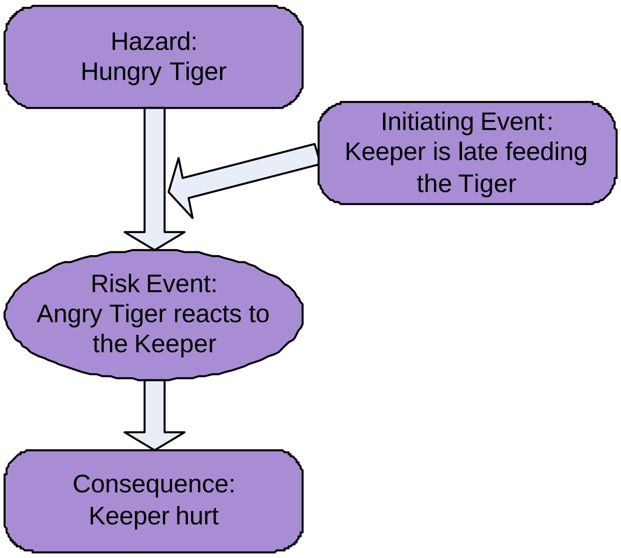
Caged Tiger = lower risk, the potential damage that the tiger is able to cause is reduced by it being in the cage.

Hungry Tiger = higher risk, the potential for adverse consequences is increased as the tiger is more likely to be agitated or angry.

The **Consequences** associated with the Tiger depend on the chain of events.

In this example, the consequence of feeding the tiger late is that the Keeper is hurt by the Tiger.

The example is a simple one and aims to introduce the idea of hazards, risks and consequences and the relationship between them. In the real world there can be more than one type of hazard or initiating event present that would lead to the same risk event, and more than one possible consequence.



2.3 Probability and frequency

2.3.1 Probability

Probability is a number between 0 and 1 that reflects the chance of an uncertain event occurring, with 1 corresponding to certainty and 0 to impossibility.

For example, consider the probability that a tossed coin will land head-side up. The two possible outcomes, heads or tails, have an equal chance of occurring (provided the coin is not biased in any way). We can say that the probability of the coin landing on heads is 1 in 2 or 0.5.

Another example of a simple probability is to consider the chances of rolling a three on a dice. There are six sides on a normal dice, each with a different number. Only one outcome corresponds to what you want – a three – so we can say the probability of rolling a three is 1 in 6 or 0.1666. We can calculate this probability as we assume all the events are equally likely to occur and all possible outcomes are known.

One of the most familiar examples of probability is the chance of winning on the National Lottery. The table below shows you the probability of matching one of the combinations of numbers that win a prize.

Winning Selections	**Probability**	
Jackpot: Match six main numbers	1 in 13,983,816	(approx. 0.00000007)
Match five main numbers plus the bonus ball	1 in 2,330,636	(approx. 0.0000004)
Match five main numbers	1 in 55,492	(approx. 0.000018)
Match four main numbers	1 in 1,033	(approx. 0.00097)
Match three main numbers	1 in 57	(approx. 0.018)

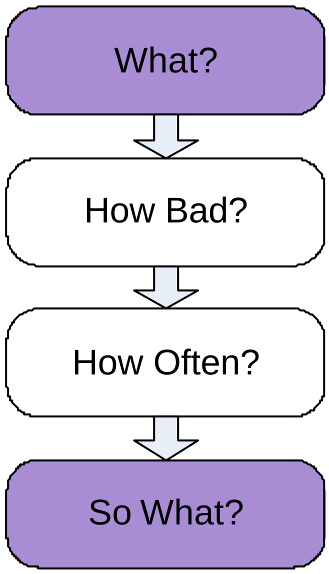
2.3.2 Frequency

An event that can occur with equal probability at any time, regardless of how often it has or has not occurred in the past, is characterised using a frequency. Frequencies are often quoted in units of per year, for example "3 per year" or "0.2 per year". Fractional frequencies are often expressed as "1 in n years", for example "0.2 per year" can be expressed as "1 in 5 years". This can often lead to misconceptions. A frequency of "1 in 5 years" ***does not*** mean that the event:

- Occurs regularly every 5 years, or
- Will not happen until 5 years have elapsed, or
- Will happen once and only once in any 5 year period

If a frequency of "1 in 5 years" is stated, all that you really know is that if you kept a watch for the next five years then on average you would expect the event to have happened once during that time, but of course it might not happen at all or it might happen more than once.

2.4 Likelihood and severity



Having identified what the risk is, we can move on to considering the next two questions:

How Bad? this relates to the severity of the consequences.

How Often? this relates to the probability or frequency with which the event will occur.

Severity can be rated against a number of different scales. What is important is that the scales chosen are relevant to the activity being assessed. For example, severity scales could be based on £££ lost, number of people hurt, cost of repairs that would have to be made afterwards, etc. It is also possible to assess a risk using more than one severity scale, if more than one type of consequence is to be expected.

Likelihood scales can be expressed using frequencies or probabilities, depending on the type of exposure – discrete or continuous.

If exposure to the hazard is 'discrete', this means that the risk event can only occur at discrete or specific times. For example, missing my train is a discrete outcome. The likelihood in this case would be expressed as a Probability (a value between 0 and 1).

If the exposure is 'Continuous' it can happen at any time. For example, the risk of having a car accident is continuous, throughout a journey per mile, per hour etc. For a continuous exposure we would use a frequency to express the likelihood.

Sometimes it is not possible (or necessary) to quantify the severity and likelihood using actual numerical values for the size of the consequence or the probability/frequency of the risk event. It might be sufficient to use a qualitative scale, as illustrated below:

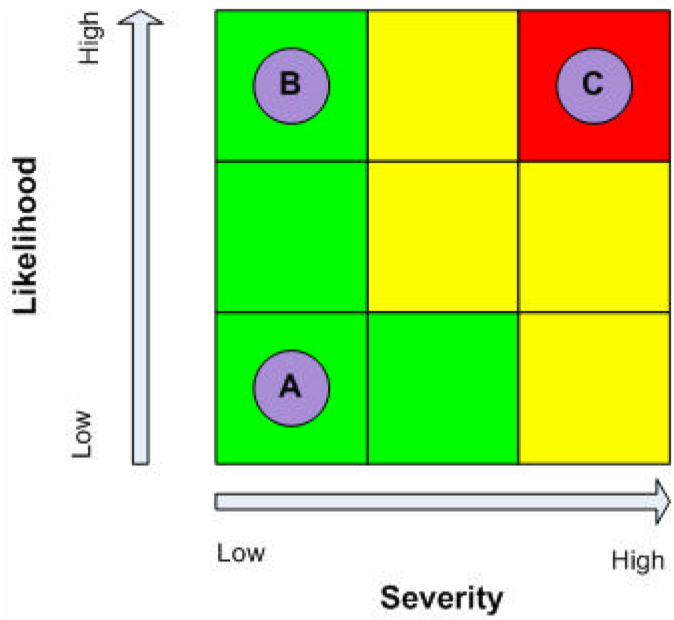
Qualitative measure of Likelihood	
Level	**Description**
1	Rare
2	Unlikely
3	Moderate
4	Likely
5	Almost certain

Qualitative measure of Severity	
Level	**Description**
1	Insignificant
2	Minor
3	Moderate
4	Major
5	Catastrophic

Source: adapted from Australian/New Zealand Risk Management Standard AS/NZS 4360:1995

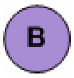
By rating each risk against scales of likelihood and severity we can start to identify priorities for risk reduction and control (to minimise the potential for harm). A simple way of showing these priorities is to plot the results on a matrix. The colours on the matrix relate to how bad we think the combination of likelihood and severity is. The colour scales have been allocated based on a traffic light system;

red = high risk,
yellow = medium risk,
and
green = low risk.

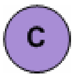


The matrix shown is a simple 3x3 example, but it is common for larger more complicated matrices to be used.

Event A has been given a low severity rating and a low likelihood rating.



Event B is considered to have a high likelihood of occurring but low severity consequences. An example of this type of situation may be a car rental company that expects to have a large number of low-cost accidents. The company may choose to absorb the losses associated with these accidents as the alternative risk control methods may be more expensive.



Event C has both high likelihood and high severity consequences. This event should be treated as a priority as it has the potential to cause the most harm.

The Tiger example suggested the idea that there may be several consequences associated with a single risk event. Each separate consequence will have a probability associated with it. The example below shows how a simple event can have differing degrees of severity.

Situation

Fire occurs in a home, at night, when all household members are asleep.

Possible Severity of Consequences

Low	Household are alerted by a smoke alarm and evacuate the house with no injuries.
Medium	Household are alerted by smell of smoke and evacuate the house. Several members experience breathing difficulties due to smoke inhalation.
High	Household are able to alert the Emergency Services but unable to escape, due to the fire and smoke. They are rescued by the Fire Brigade with some members suffering injuries.

The possible consequences of a fire described in the example above may appear dramatic, but they shown the differences in severity which could have a significant impact on the outcome. The likelihood of each possible consequence could also be assessed. It is reasonable to assume that in the majority of household fires, the occupants would be alerted by an alarm, the smell of smoke or other simple means. In these situations, the likelihood of them being injured by the fire could be considered to be low. Similarly, if the household members are trapped and require rescue by the emergency services, the likelihood of them being injured is much greater.

2.5 Likelihood in the HHSRS

Question: What does a Likelihood of 1 in 10 mean in the HHSRS?

Example: Steps and Stairs

Exposure to the hazard associated with steps and stairs is continuous, so we are talking about a frequency rather than a probability. What we mean is that there is a 1 in 10 chance that a fall on steps and stairs will happen……

- During the **12 months** following the assessment;
- That results in a measurable harm (illness, injury, death)
- Adding together all the steps and staircases in the property
- Assuming that the "most vulnerable age group" are using the stairs (e.g. over 65s) – NOT necessarily the current occupants

- Informed by average chance for all dwellings of this type and age (eg pre 1920s flat)

There are several alternative ways you can think about likelihood and what the figures actually mean. For example, the following statements are all referring to the same likelihood situation:

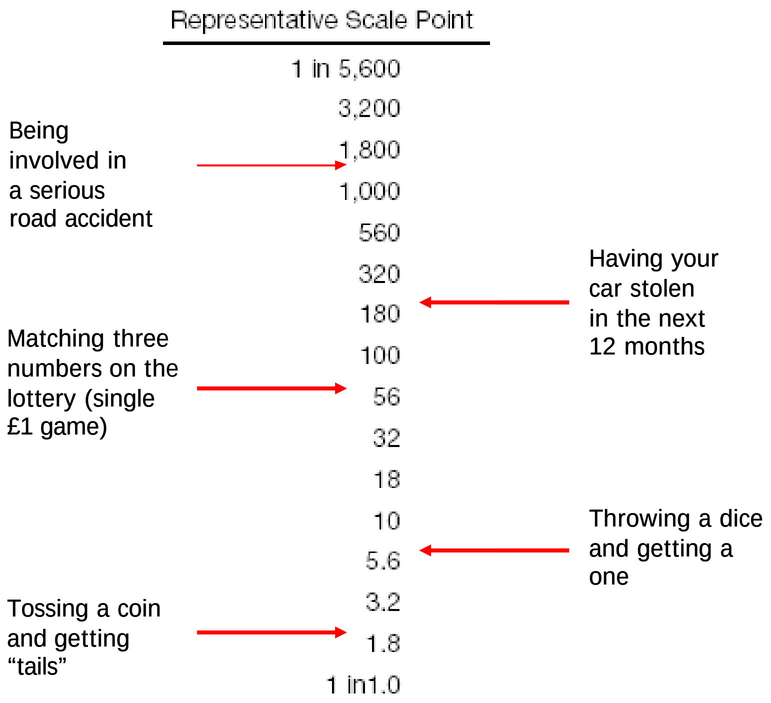
- 1 in 10 chance that a vulnerable person would fall on the stairs in this house in the next year, or

- 9 in 10 chance that they would NOT fall in the next year, or

- If I observe this house for 10 years, I would expect to see one person fall on average during that time, or

- If there were 10 identical houses in the street, and each house was occupied by the same vulnerable age group, I would expect to see someone fall in one of them during the next year.

The HHSRS uses a standard range of Likelihoods for the assessments; the representative scale points from the guidance are shown here.



It can be difficult to appreciate what, for example, a likelihood of 1 in 56 means. Relating it to an everyday probability may help, as shown by the red arrows on the illustration.

The table below shows the standard range of Likelihoods in the form of a percentage.

Likelihood		As a %	Likelihood		As a %
1 in	5600	0.018%	1 in	56	1.8%
	3200	0.031%		32	3.1%
	1800	0.056%		18	5.6%
	1000	0.100%		10	10.0%
	560	0.179%		5.6	17.9%
	320	0.313%		3.2	31.3%
	180	0.556%		1.8	55.6%
1 in	100	1.0%	1 in	1.0	100.0%

2.6 Severity in the HHSRS

We have said already that a risk event can have more than one consequence. The HHSRS scheme therefore asks for more than a single number measure of severity; it asks the assessor to estimate the spread of harm across four different levels of health and safety consequence, as follows:

1. **Extreme (Class I).** This is the most serious outcome, e.g. death or life threatening injuries such as 80% burns.
2. **Severe (Class II).** This includes for example a serious fracture.
3. **Serious (Class III).** This includes for example a mild heart attack.
4. **Moderate (Class IV).** This includes for example cuts and bruises, mild concussion.

In some cases the consequences of a risk event are clear cut. For example falling out of a window on the 90th floor would result in certain death, so the assessor would give a 100% spread of harm to Class 1 and 0% to the other three. But in most cases the consequences are not so clear cut, and the assessor would use his judgement to apportion a total of 100% across the four Classes. The HHSRS guidance documents give some background statistics on the average spread of harm experienced by the medical profession for different types of accident or ill health episode.

2.7 Combining likelihood and severity in the HHSRS

The likelihood and spread of harm numbers are combined in a simple calculation to give an HHSRS hazard score, as illustrated in the figure below:

Figure 1 – The HHSRS Formula

Class of Harm Weighting			Likelihood		Spread of Harm (%)		
I	10,000	X	$\frac{1}{L}$	X	O1	=	S1
II	1,000	X	$\frac{1}{L}$	X	O2	=	S2
III	300	X	$\frac{1}{L}$	X	O3	=	S3
IV	10	X	$\frac{1}{L}$	X	O4	=	S4
				Hazard Score = (S1 + S2 + S3 + S4)			

Where –
L = the Likelihood of an occurrence
O = the Outcome expressed as a percentage for each Class of Harm
S = the row product for each Class of Harm.

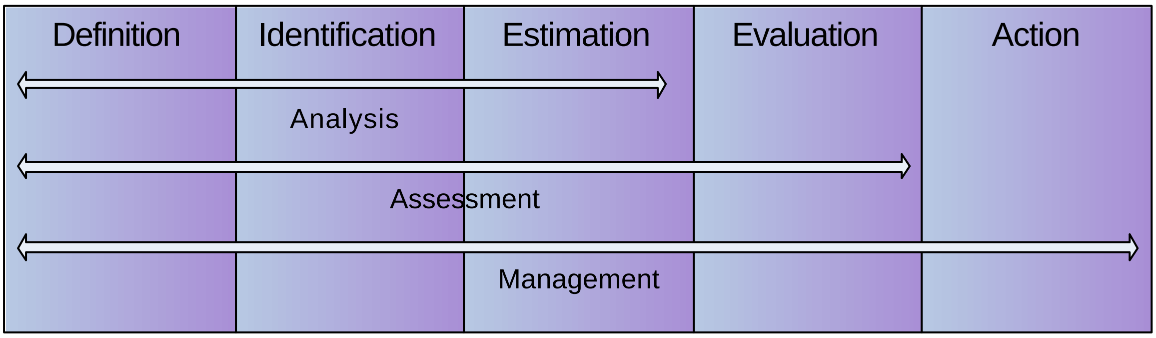
Source: HHSRS Guidance (Version 2)

This approach is more complicated than simply plotting a point on the risk matrix described in Section 2.4 above, but essentially it is just the same: combining a measure of likelihood together with a measure of severity to come up with an overall risk measure that can be used to inform future action.

3 Risk management

3.1 Basic stages of risk management

The basic stages of Risk Management are shown in the diagram below:



Risk Analysis, Risk Assessment and Risk Management are commonly used terms but it is important to understand what they mean and the type of activities they cover.

The initial stage is the **definition** of the risk problem that is to be managed. This involves defining the activity that gives rise to the risks, and often restricting the scope to a particular type of risk (for example the risks to the health and safety of the most vulnerable occupants of the particular dwelling being assessed using the HHSRS).

Identification involves the recognition of threats or hazards which could give rise to a risk event. The types of health and safety hazards that are considered under the HHSRS include the potential for falls, excessive temperatures, fires, noise etc. The full list of hazards covered by the rating system can be found in the ODPM guidance documents.

Estimation involves quantifying the likelihood that a risk event will translate into a reality, and if it occurs, how severe the outcomes are. This is not a precise science, but the accuracy of the estimates can be improved where good data is available. This stage quantifies the risk and is important as it enables issues to be prioritised. The HHSRS has provided statistics for the likelihood of the various risk events occurring based on the average age and type of property being assessed.

These first three steps make up what we call **Risk Analysis**. They tell us what and how big the risks are, but do not yet say what should be done about them.

When the **Evaluation** step is added to the process described above, we get **Risk Assessment**. In the Risk Analysis phase, the risks were defined, identified and estimated. By evaluating the risks we can assess how much of an impact they are likely to have and also develop priorities for action.

Risk Management combines the first four stages with **Action**, where the actions identified by the assessment process are carried out.

3.2 Risk tolerability

To be able to assign priorities, it is necessary to have defined a framework that sets out the **tolerability of risk**. By assigning a tolerability measure to each risk it is possible to highlight what needs to be done to control it. A three-point tolerability scale is often used, with 'traffic light' colour coding to assist with the prioritisation.

Intolerable Immediate measures must be taken to reduce the risk or the activity that gives rise to the risk should be stopped immediately.

Tolerable Risk reduction measures should be implemented, unless the costs of doing so are disproportionate.

Acceptable Risk reduction is probably not needed, although it may be prudent to continue to monitor the risk.

The HHSRS scheme has its own tolerability scale - the ten hazard bands from A through to J. These are analogous to the simpler three band scheme above (Intolerable; Tolerable; Acceptable) and to the Red, Amber and Green colours on the risk matrix described in Section 2.4.

Band	Hazard Score Range
A	5,000 or more
B	2,000 to 4,999
C	1,000 to 1,999
D	500 to 999
E	200 to 499
F	100 to 199
G	50 to 99
H	20 to 49
I	10 to 19
J	9 or less

Source: HHSRS Guidance (Version 2)

4 The business of making severity and likelihood judgements

Nobody can predict the future with certainty, so inevitably the business of assessing risk and making risk severity and risk likelihood judgements is down to the expert opinion of the risk assessor. There are some important pitfalls that you should be aware of in order to make your assessments as robust as possible. Psychologists have identified five main types of ‘biases’ when we exercise human judgement. These can be influenced by the assessor’s age, cultural background, and previous life experiences. The five biases are as follows:

1. **Anchoring.** This means the unwillingness to move far away from a particular answer, e.g. the tendency to always pick the middle number when given a choice of three. In the case of the HHSRS anchoring may be exhibited by assessors who feel unwilling to deviate far from the baseline likelihood values provided in the guidance for the different hazards.

2. **Conservatism.** This means the tendency to play safe, particularly when the assessor might feel “responsible” if an accident were to occur after they had finished their assessment. In the case of the HHSRS this might result in an assessor systematically producing high risk ratings for the houses that they look at compared to a colleague who does not suffer from the same feelings of responsibility.

3. **Forgetting base rates.** This means the tendency to react to the most recent experience you have had rather than taking into account the long term trend. In the case of the HHSRS a particular assessor might have some personal knowledge of a recent accident such as a fire, and therefore tend to increase the fire risk rating for other properties that they visit. The statistical data provided in the HHSRS is a good check against this.

4. **Poor information processing.** This means not using all the information available to come to a conclusion, and in the worst case simply ‘plucking a number from thin air’. Good training and a robust audit process is the key to guarding against this.

5. **Poor framing of the question.** This means asking the assessor to make a judgement in a way that naturally leads them to make one decision rather than another. For example, consider the following descriptions of a drug trial decision:

> There is an outbreak of a deadly disease in a village. Without any action, 600 people will die.
>
> Description 1: "If you use the existing drug then 400 people will die, but there is a new drug available that has a 1/3 chance that it would save all 600 and a 2/3 chance of it saving none of them".
>
> Description 2: "If you use the existing drug then you will save 200 people. There is also a new drug available, but if you use it there is a 2/3 chance that all 600 will die and a 1/3 chance that you will save them all."

In this example the average number of people saved is the same whether you choose the new drug or the existing drug, but the descriptions are written in such a way to exert some moral influence on the decision maker to lean towards picking either the new drug or the existing drug.