Outbreak Column 16: Cognitive errors in outbreak decision making

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Abstract

During outbreaks, decisions must be made without all the required information. People, including infection prevention and control teams (IPCTs), who have to make decisions during uncertainty use heuristics to fill the missing data gaps. Heuristics are mental model short cuts that by-and-large enable us to make good decisions quickly. However, these heuristics contain biases and effects that at times lead to cognitive (thinking) errors. These cognitive errors are not made to deliberately misrepresent any given situation; we are subject to heuristic biases when we are trying to perform optimally. The science of decision making is large; there are over 100 different biases recognised and described. Outbreak Column 16 discusses and relates these heuristics and biases to decision making during outbreak prevention, preparedness and management. Insights as to how we might recognise and avoid them are offered.

Keywords

Competencies, infection control, outbreak

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Introduction

The world of infection prevention and control (IPC) is populated by professionals whose goals for the working day can be summarised as: preventing, preparing for and managing outbreaks. In pursuit of these goals infection prevention and control teams (IPCTs) strive to achieve excellence. However, as Aristotle pointed out, merely wishing for excellence does not guarantee it will be achieved:

Excellence is never an accident. It is always the result of high intention, sincere effort, and intelligent execution; it represents the wise choice of many alternatives – choice, not chance, determines your destiny. Aristotle

As microbes are invisible to the naked eye, IPC professionals can never have all the required information needed for outbreak decision making. The World Health Organization (WHO) acknowledges that the decisions made during outbreaks are based on uncertainty (WHO, 2005). When there is uncertainty we are prone to decision-making errors because of the flawed mental models we regularly use, and because of the numerous biases and effects that are present in the way we present and receive information. As Aristotle would have it, we can, and sometimes do, pick the wrong choices. These flawed mental

models are not the result of any intended deception to downplay or inflate the importance of a situation – it is while trying to perform optimally that these errors manifest themselves and from which flawed decision-making can result (Kahneman et al., 1982).

In recent times health care has looked to other high-risk industries, like aviation, nuclear and construction, where there is increasing and sustained reliability in performance and few or reducing errors (Hales and Pronovost, 2006; de Korne et al., 2010). The tools from these industries that could prove useful for outbreak prevention, preparedness and management (outbreak PPM), include: situational awareness, crew resource management, human factors and high-reliability theory (Reason, 1990; Weick et al., 1999; Wright et al., 2004; Sundar et al., 2007). All of these merit greater scrutiny and deployment by IPC specialists. In this first of two papers, (Outbreak Column 16) there is a move

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away from organisms, transmission pathways and specific control measures to explore the cognitive errors and biases that could adversely affect the IPCT's outbreak decision making. Outbreak Column 16 will focus on cognitive errors *per se*, specifically the what, how and why we as IPCTs are prone to decision-making errors; and what we can do to increase our mindfulness of them and reduce their incidence. Outbreak Column 17 will focus on increasing IPCT reliability for outbreak PPM. To start, we give an introduction to some of the different types of cognitive errors and considerations as to how they are relevant to outbreak PPM.

Cognitive errors that lead to poor decision making

Adapting a definition written for anaesthetists, cognitive errors are thought-processing errors, or thinking mistakes, which can lead to incorrect outbreak PPM decision making (Stiegler et al., 2012). IPCTs are by no means the only professionals who have to make decisions during uncertainty. Everyone, including those who run governments, financial markets and fruit markets have to produce policies, sell and buy products without all the information they would wish. As a consequence the academic study behind how we make decisions, what influences us, and why decisions sometimes go wrong is extensive. The first question to consider is what happens when there is uncertainty – just how do we fill in the blanks? The answer is we use heuristics. Kahneman et al. (1982) describes heuristics as mental model short cuts that reduce complicated assessments to simple judgements; heuristics usually serve us well but are subject to inherent, but not always obvious, biases. One heuristic we use almost every day is to look out of a window to judge how warm it is outside. Such a judgement can be biased by the missing data on the effects of any cooling northerly breeze. Although we would accept the judgement of temperature without a thermometer as being imprecise, when it comes to important outbreak decisions such as: *have we considered all possible outbreak transmission pathways? Or, are we sure we have found all the cases?* we are perhaps less likely to believe the decisions to result from biased heuristics. Kahneman et al. (1982) detailed three categories of decision-making heuristics used to assess and predict values – all of which have implications for outbreak PPM. These are: 1) representativeness, 2) availability and 3) adjustment and anchoring, examples and explanations of all three are given below.

1. Representativeness

This is about how we judge A to be representative of population B (Kahneman et al., 1982). Randomised controlled trials are designed to negate representativeness biases and as far as possible ensure that when results indicate that any

given sample of, say, people (A), is representative of a whole population (B) – the result is true (Lewis and Warlow, 2004; Pannucci and Wilkins, 2010). For example, the sample size will be big enough and the duration of observations long enough to minimise a chance result or regression towards the mean (Morton and Torgerson, 2003). The population from which the sample is taken will be stratified and selected randomly so that the sample best represents the parent population and results can be generalised to it (Lewis and Warlow, 2004; Pannucci and Wilkins, 2010). However, published outbreak reports are studies that last for an arbitrary duration and comprise non-randomly selected, unstratified, non-power-sized populations. These outbreak reports use descriptive epidemiology to detail what happened and to whom. They produce a narrative that best fits the events. Even though statistics are used to estimate the likelihood of results arising from chance, the studies themselves are more prone to biases, and extrapolating findings from such papers is problematic (Cooper et al., 2007).

The IPCT never knows for sure in which direction an epidemic curve will move next. Often they have to consider whether or not to act when an individual infection outcome result has increased. The IPCT determines whether any given result is exhibiting natural or unnatural variation (Curran et al., 2002). If the result is considered to represent unnatural variation – something in the system being awry – and the IPCT have not acted immediately they will be judged (by hindsight bias) as having delayed an opportunity for action. The IPCT are in a no win situation here. The IPCT can hardly wait to see if an aberrant infection result will be 'righted' by regression to the mean before acting.

Football manager awards provide an example of how regression towards the mean can be (mis)interpreted. The *Manager of the month award* is given to football managers who have 'performed well' over a given month, but it is often termed 'a curse' (Pullein, 2005). This is because the award winners frequently experience a bad run of results after receiving the award. However, this change in result fortunes is most likely regression towards the mean; the managers' results being neither superior pre-award, nor in decline post-award. By chance alone short runs of independent 50:50 events (e.g. heads or tails, win or lose) periodically present results of HHHHHH or HHHTTT. Such results look unlikely to be due to chance, but are in fact as much a result of chance as HTHHTHT, which seem more normal. The IPCT might also be faced with several results in a row which are in fact due to chance. Statistical process control charts can help by distinguishing between natural and unnatural variation and by estimating the likelihood that any given result is due to chance or regression to the mean (Curran et al., 2002, 2008). But what is imperative to emphasise is this: infection results are merely a count of outcomes – the IPCT must qualitatively investigate and interpret them.

2. Availability heuristic

This heuristic is about lacking, not recalling or not acquiring information from all the past problems in order to deal with a current one (Kahneman et al., 1982). Decision making can be biased by being unable to recall or being unaware of all the possibilities; this is the What You See Is All There Is (WYSIATI) bias (Kahneman, 2011). This can result from a lack of searching, experience, forgetfulness or because an event available for recall, perhaps a recent and dramatic one, takes too dominant a position in our thoughts (salience effect) (Dobelli, 2013). As an example, the diagnoses of possible cases of viral haemorrhagic fever (VHF) in the UK appear to have increased markedly due to the prominence of the Ebola outbreak in the media. However, horrendous and out of control as the Ebola outbreak undoubtedly is (at the time of writing), the diagnosis in travellers returning to the UK needs to be seen in the context of overall travellers returning with fever. According to the WHO in 2012 there were an estimated 207 million cases of malaria and 627,000 deaths (most of the world's malaria deaths occur in Africa) (WHO, 2014(a)). The risk of acquiring malaria is widespread throughout many parts of Africa; the risk from Ebola is confined to those with exposure to blood and body fluids of an infected human or animal. In the past 10 years the incidence of malaria in persons arriving in the UK is approximately 15,000; at the time of writing the incidence from Ebola in the UK is one known repatriation. However, Ebola's dominant media position means that when considering the possible cause of fever in returning travellers people are being misled by another heuristic – negation of the base rate (Kahneman, 2011; Dobelli, 2013). As the WHO Director-General Dr Margaret Chan highlights (WHO 2014(b)), 'Rumours and panic are spreading faster than the virus.' The most likely diagnosis in any person returning from even Ebola affected areas of Africa with a fever is malaria – even if Ebola cannot be excluded; this is why it is important to follow the Viral Haemorrhagic Fevers Risk Assessment algorithm in assessing risk, and take the stated actions, which, if followed, are sufficient to negate transmission (Department of Health, 2014).

As another example of availability bias, before people saw black swans they believed, and were confident in the belief, that they did not exist (black swans were first identified after the discovery of Australia). This type of error, resulting in not knowing what you don't know, is called, not unsurprisingly, the 'black swan effect' (Dobelli, 2013). Other examples of the availability heuristic include: single cause fallacy and feature positive effect:

- *Single cause fallacy*: believing there is only one cause to a problem – a problem with outbreak management where there are often multiple different transmission pathways and reservoirs.
- *Feature positive effect*: a single feature's presence can have a profound effect on decision making (Dobelli, 2013). In outbreaks, positive findings, e.g. a finding that cases having a particular characteristic

are more likely to be identified and published than outbreaks which do not identify special features.

Consider the numbers in row A, and then separately in row B – what do they have in common? If possible time yourself for each set:

A: 123 829 236 723 452 253 529 286

B: 856 534 256 923 431 839 614 423

(Experiment published by: (Dobelli, 2013)).

The answer is the presence of number '2' in row A and the absence of number '7' in row B. It probably took you longer to find the absent 7 in row B, than what was *feature-positive* in row A. For IPCTs in pursuit of an outbreak source this can be summarised as: if it's there it will be found and it probably won't take long; but if the common feature is the absence of something it is likely to be missed or at least take a much longer time to find. Such heuristics can result in poor outbreak decision making by the IPCT due to assumptions or reliance on what has always been, what is known/believed, and what has been experienced as the only possible outbreak hypotheses. Much as we might not wish to believe it – we still think inside the box.

The availability heuristic can also manifest when actions that have no impact on outcome, are followed by a desired outcome and generate erroneous interpretations of outbreak events. Consider for example the following scenario: a bad result such as a higher than expected infection rate, is swiftly followed by IPCT interventions, which were then followed by a good infection result. This could easily be interpreted as IPCT actions remedying the procedure and preventing high infection rates from continuing. The temptation when there is a nice story that fits the data is to stop looking – when in fact we should continue looking for intelligence that could prove the nicely fitting hypothesis to be wrong. This is of course an example of the *post hoc ergo propter hoc* logic fallacy, after this therefore because of this (La Bossiere, 2013). The desire for a narrative that fits the *available* information is very persuasive; this heuristic is known as 'story bias' and is easier to fall foul of if it is accompanied by a WYSIATI bias (Kahneman, 2011).

The availability heuristic is also a problem for clinicians who should more often be the first to spot an outbreak. For IPCTs who practise outbreak PPM, outbreaks happen often and are experienced in lots of different settings. But for any given clinical setting outbreaks happen rarely or not at all. Clinicians in these fortunate clinical settings will be less prone to think 'outbreak' when an odd clinical picture arises because to them it has not happened before and therefore it is unavailable for them to recall. As a consequence it erroneously appears not to be happening before their very eyes. I have personally heard clinicians diagnose pregnancy-related diarrhoea that was Salmonellosis, and attribute a pyrexia of 40°C, caused by infusate-related bloodstream infection, to

Table 1. Differences in the possible size of the outbreak with different definitions.

Definition parameters				
Person	With	Place	Time	Outbreak size
All persons (patient, staff or family member)	Unexplained diarrhoea	With a link to the hospital	Since 1/6/2014	Cases 100
All patients or staff members	Diarrhoea and <i>Clostridium difficile</i> isolated from stools	The surgical wards 6,7,8,9	Since 1/9/2014	Cases 6
All patients	Diarrhoea and <i>C. difficile</i> type 007 isolated from stools	Ward 6	Since 1/9/2014	Cases 3

stress. As has been shown, without knowing or believing that *Legionella* is in the hospital water system, diagnoses of Legionnaire's disease will be missed (Goetz et al., 1998). Outbreak preparedness activity should therefore include IPCTs informing clinicians about the types of outbreaks that could arise in their particular clinical environment(s) (i.e. specific to their patient population and healthcare practice), how these outbreaks are likely to manifest and what they should do should such events arise. It must also be emphasised to clinicians that lack of personal experience of such an outbreak is no guarantee of continued future absence. The ingredients necessary for an outbreak are present in every ward every day (Curran, 2013a).

3. Adjustment and anchoring

This is the third type of heuristic which includes biases that result in a poor assessment of the size of problem or its solutions (Kahneman et al., 1982). This can happen when we fail to appropriately adjust for other variables, or because we are primed by a number. If we are primed by a high number, e.g., somebody tells us the price of a Rolls RoyceTM and then try to think of a price for a small car – our estimate is likely to be a lot higher than if we are primed with the price of something much less expensive to start with (Kahneman, 2011; Kahneman et al., 1982). This is akin to a numerical salience effect mentioned above (Dobelli, 2013). Other examples of adjustment and anchoring biases that can creep in to our decision making are the framing effect and observational-selection bias (Kahneman et al., 1982).

Framing effect. Depending on how a situation is framed different conclusions are drawn on its size and the implications thereof (Kahneman et al., 1982). In an outbreak situation, framing is produced firstly by the case definition used, which is based on a period of time, a place and person characteristics. Table 1 illustrates that depending on the frame (case definition) used, different interpretations of the size of the outbreak will be drawn. The precision with which the IPCT can frame the outbreak is itself dependent on the availability of samples for testing, the specificity with which the samples can be processed to distinguish

strains and how far back and how wide the IPCT considers it appropriate to draw the perimeter. Too narrow a definition will exclude cases and may result in ongoing transmission if the precautions are not instigated for the unidentified cases. Too wide a frame will result in the IPCT being unable to cope with the resultantly large (and unnecessary) investigations. The IPCT must modify the definition over time to present the most appropriate definition of cases.

Another frame used by IPCTs is in the presentation of data to others. The two Situation Background Assessment Recommendations (SBARs) in Table 2 both describe (frame) the same event. Consider how as a manager, perhaps without infection prevention experience, you would view the importance of the same Group A *Streptococcus* (GAS) incidents in the different SBAR frames.

Observational-selection bias. There are a variety of observational-selection biases which can result from both the measuring tools and/or interpretations of what has been measured (Bostrom, 2002). In particular, this bias can arise when we notice things that we have not noticed previously and wrongly assume that there has been an increase in the frequency rather than an increase in attention to the phenomena being observed (Bostrom, 2002). Think of something you have bought, a new car, dog or bicycle. Once you have your new toy you notice many other people also have the same make of car, dog or bicycle. Did something impact simultaneously on everyone's sub-conscious and they all went out for the same make or breed? No. It is observational-selection bias that is making you notice what you did not see before – there are and have been for some time lots of people who have made similar purchasing choices. In outbreaks or pseudo-outbreaks this could arise following a change to a more sensitive test, or a change in definitions used to diagnose an event or a workaround being introduced with unintended consequences (Curran, 2013b).

Summary of three main heuristics and application

Kahneman et al. (1982) describes three categories of heuristics of availability and anchoring, adjusting and

Table 2. Framing using Situation, Background Assessment Recommendations (SBAR) creating different interpretations of a Group A Streptococcus (GAS) outbreak.

	SBAR – Frame 1	SBAR – Frame 2
Situation	Recently there has been a small cluster of patients on ward X found to have GAS.	There is an outbreak of GAS on ward x that has affected 3 patients within the past 28 days.
Background	Ward X is an elderly care ward which from time to time sees patients with GAS.	Patients on ward X are particularly vulnerable to GAS infections because they are frail and have minor wounds which can easily become infected. Mortality associated with this pathogen in this population is up to 50%.
Assessment	The 3 affected patients are being treated and are nursed together in a 4 bedded area. There may be other cases in the near future – which is not unusual in this population.	The 3 patients have invasive GAS disease. They are being cohorted in a 4-bedded area and are responding to treatment. To confirm there are no other cases all patients with wounds are being screened. All healthcare workers (HCW) are being checked for sore throats or skin conditions as HCW have been implicated in previous outbreaks of GAS in such populations. Specific infection control measures against GAS are being implemented.
Recommendations	The IPCT will keep an eye on the ward.	As there can be 6 months between cases in the same outbreak, the IPCT will maintain close observations for further cases for 6 months from the diagnosis of the last case. Infection control precautions against GAS will need to continue for some time. The IPCT will report weekly until it is considered there is no risk of onward transmission.

Table 3. Select other biases and effects that can impede our outbreak decision making.

Action bias	In response to a situation humans feel compelled to do something, to take some actions – even when the best and most logical decision may be to do nothing.
Clustering illusion	Arises when patterns and clusters are identified as outbreaks that are in reality due to chance. From time to time patients with <i>Clostridium difficile</i> infection outbreak will cluster in time and place because of chance and not because of cross-infection.
Confirmation bias	People sometimes are so attached to their original hypothesis of an outbreak cause that they only recognise and utilise evidence that is supportive Stronger evidence that supports an alternative outbreak hypothesis is rejected and disregarded.
Feedback bias	Taking an absence of feedback as a positive sign. Ward staff might be given the instruction to call the IPCT if there are more cases; it would be unsafe to consider a lack of a contact as a confirmed sign that there are no more cases. Absence of news is not synonymous with good news – absence of news should be considered as outbreak neutral.
Halo effect	Some people can dazzle us such that we excuse them for anything, forgive them for everything and believe whatever they say to be true. Such people can send our moral compass as well as our decision making significantly off course.

(Kahneman et al., 1982; Reason, 1990; Dobelli, 2013).

representativeness. But this is by no means where the problem of bias in outbreak PPM ends. There appears to be no complete list of all heuristics, biases and effects which can lead IPCTs – for all their efforts – to poor decision making. Table 3 contains a select few others that IPCTs might like to

consider. It is easy to find at least 100 different biases that could affect outbreak PPM (Kahneman et al., 1982; Reason, 1990; Bostrom, 2002; Kahneman, 2011; Stiegler et al., 2012; Dobelli, 2013; La Bossiere, 2013). My interpretation is that there is considerable overlap and close connection

between several of them. Also, the procedure to identify a new and sufficiently different bias does not appear to be as precise as the procedure for classifying a new bacterium; there is no committee or novel sugar test which confirms identification. However, this does not negate the importance of the topic and its relevance to outbreak PPM, which was the purpose of this column. The size of the topic should not overwhelm our outbreak PPM decision making with doubt, but serve to demonstrate that this science is useful to IPCTs in that it shows us we need to be mindful that we are prone to such biases when we use heuristics and therefore IPCTs need to have back-up plans activated all the time.

Stiegler et al. (2012) went further in the application of cognitive errors to their specialty – anaesthesiology. They identified a cognitive error catalogue specific to anaesthesiology practice and used a modified Delphi method to confirm relevance. Of the more than 30 cognitive errors identified there were 14 considered important to anaesthesiology; this list of errors was reduced to nine that were looked for during simulated anaesthesiology emergencies. They found seven of these nine cognitive errors were observed in more than half of 32 observed simulated emergencies. The Stiegler et al. (2012) study shows that cognitive errors are likely to be relevant to other healthcare specialties, such as IPC, where during outbreaks multiple rapid decisions are required and heuristics are by necessity used.

Trust me I'm an infection control nurse....

There are another couple of effects that can be used to influence our behaviour and which are worth noting. The first is the 'because justification' (Dobelli, 2013). Apparently and somewhat illogically, if a request of minor inconvenience to ourselves includes a bogus reason, we are inclined to be unmindful and assume the request is rational and accede to it. This was ably demonstrated in an experiment where people were asked if someone could jump the queue at a photocopier with the words '... may I use the photocopier, because I have to make copies ...'. This bogus reason met with a 93% positive response rate (Langer et al., 1978)! When investigating how clinical procedures are performed it is important to be mindful of both the requests and responses – no matter how minor an inconvenience caused. The lesson is to always pay attention to what follows a 'because'.

One further effect is what Dobelli (2013) describes as the Twaddle Tendency. This he describes as: 'Reams of words used to disguise intellectual laziness, stupidity or underdeveloped ideas' (Dobelli, 2013). We have all met people who have a tendency to produce twaddle; however, our junior colleagues might not have done so. When faced with dialogue that is over-verbose, contains unnecessary clauses and lacks an actual answer we must be ready (and teach others to be ready) with polite responses that request

a translation into clarity. When Twaddle Tendency meets authority bias (exerting influence of rank on reasoning) the problem is less likely to be challenged. Having stated that these biases in heuristics arise when we are trying to be optimal, there will inevitably be people who will use these biases as a strategy to wrongly control people and situations – so an awareness of these for life in general is also useful.

Final thoughts

The purpose of this paper is to illustrate for IPCTs how their outbreak PPM decision making can be poor even when people are trying to do their best. As a consequence of the biases that result from the use of heuristics we can err in outbreak decision making. Outbreak Column 17 will discuss how we can use our colleagues, our procedures and develop our culture to be more open to the likelihood of personal errors and thereby more willing to accept and generally promote co-workers to question our stance in order to minimise the risk of outbreak PPM decision-making errors.

Kahneman et al. (1982) provide a useful last sentence on the matter when they summarise the rationale for this being a relevant topic: 'The "point" of bias research is, of course that where people have no good reason to act sub-optimally, [the study of] errors suggest that they just do not know any better.' After Outbreak Column 17, we will know better and hopefully also know what to do about it.

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