Errors in radiotherapy can have serious, even fatal, results. We are all well trained, intelligent people, yet still errors and near misses occur. We double check all our clinical calculations, yet still errors creep through. This article describes some errors and the underlying thought process that contributed to them.

The International Atomic Energy Agency (IAEA)\(^1\) has published a very informative summary of 92 errors that were brought to its attention. The cause of each of these errors is described and both the initiating event and the contributing factors are briefly discussed. Some were caused by technical failure, some were due to misunderstandings and some were due to carelessness.

The phenomenon of ‘automaticity’ played a role in many accidents. Automaticity occurs when someone performs a complex series of actions that they know so well that they do not consciously think about the details; driving a car is an example. Air crews and health workers often use checklists and a verbal ‘challenge and response’ system to verify instrument settings. Tofts\(^2\) has discussed problems when automaticity takes over when a familiar checklist becomes a litany. An air accident occurred when the crew went through a landing checklist which included ‘undercarriage down’, but neglected to lower the undercarriage.\(^3\)

A team of radiographers may go through about 40 checklists each day, and errors will occur very infrequently. Consequently a false sense of security can be engendered. This mental process is similar to the radiotherapy error described above. The common ground between the trick and the error is that in both cases the participant assumes they know the true situation (the coin is in the hand, the correct patient is on the couch) and marshal their thoughts accordingly.

Errors that were caused by technical failures can be instructive. Software and hardware components go through exhaustive checks. A linac control system will check to see if a photon beam is selected, in which case the target and flattening filter will be placed in the beam line; if an electron beam is selected a scattering foil may be used. A serious accident occurred\(^1\) with a mixed mode (photon and electron) accelerator when the operator rapidly changed from setting photon to electron modes and back again; the control software became confused and treated a patient in a hybrid state, with the target out of the beam line but with the higher electron fluence that would have been used for a photon beam.

This erroneous machine configuration could only happen if a very unusual series of actions were performed by the operator. This situation would not have happened if the software had been designed to wait until the operator had finished entering set-up data. The integrity of all the entered data would be checked and only then would the appropriate components be moved into place. The author is reminded of the use of sleight of hand by magicians; swift, deft hand movements can make the ball appear under an unexpected cup by misdirecting the observer. The linac operator’s swift movements effectively confused the control software.

A treatment planning system related error occurred as follows: the planning system had a facility to allow the user to add up to four beam shaping blocks. The clinicians wanted to use a fifth block (figure 2). The immediate solution that was adopted was to only digitise the central block. However, a physicist subsequently decided that all five blocks could be digitised by treating them as a single block. When a second physicist used this method he digitised the blocks in a different way; the block creation algorithm was sensitive to the clockwise/anticlockwise sense in which the points were digitised. As a result the dose algorithm treated the shielded component as open. This caused a dose error of 100% (figure 3).

The quest for blame for this accident must be spread between the physicist who used the program in a way for which it was not designed, the introduction of a new treatment system without a sufficient check and the lack of experimental confirmation. However, the joker in the pack was the importance of the clockwise/anticlockwise sense in which blocks were digitised. The program was only sensitive to the sense in which points were digitised in this particular case, so software tests did not pick this up. The final test is done by the treatment radiographers, who must ask themselves whether the monitor units look sensible.

The author has no right to gloat on these issues. When I started working in treatment planning I changed a pen in the pen plotter, and plotted an isodose distribution. I used one of the printed parameters in the monitor unit calculation, as was normal practice. However, the ink from the new pen spread out to make the digit ‘0’ look like the digit ‘8’. This error was not picked up in the second check, and inde-
dependent monitor unit checks had not then been introduced at our centre. Only when the plan was taken to the machine did the alarm bells ring; an experienced therapy radiographer saw the unusually high monitor units and refused to treat the patient. So I am very thankful to the vigilance of my colleague; were it not for her the patient would have been overdosed and I would have made a contribution to the IAEA report.¹⁷

Accidents and near misses can happen and the causes can be subtle, especially as treatment techniques become more complicated. ‘Defence in Depth’ recognises that errors will be made, so second checks, experimental confirmation and clear documentation are most important.

Anyone who has been fooled by a stage magician’s mis-

direction and sleight of hand must be vigilant about becoming blasé; automaticity may open a chink through which an error passes. And anyone who wants to know about stage magic and performance should read Dancy.⁴

References