cones were unaccounted for and were assumed to have drifted farther downstream. Thus, 31% of the cones arrived at one destination and 23% at a second. The likelihood of this happening by chance is very small ($P < 0.0001$).

Comment

Pine cones ("emboli") dropped into the stream at the same point were carried by currents and eddies downstream and ended up at a range of destinations, some of which were reached more often than others. This process is similar to what happens when emboli are released into the bloodstream. Emboli arising from a point in the heart or the aortic arch will travel to a range of destinations. Some will be swept to other parts of the body—temporarily causing minute, harmless, and unrecognised ischaemia—but others, and those from the internal carotid artery, will arrive at the brain. On the basis of the Poohsticks experiment, it is not surprising that many of them are carried to the same destination, a small artery, causing repeated ischaemia with the same clinical features.

Contributors: Rose Turner dropped the pine cones into the water. Tim Rockall drew the chart. Tim Mant, Hilary Pritchard, Eleanor Farrell, and the nursing staff of Bright Ward, Guy's Hospital, made the observations. Marion Knight painted the cones. RK conceived the study, wrote the paper, and organised the travel arrangements to Pooh Bridge; he is also the guarantor.

Funding: None.

Competing interests: None declared.

Ethical approval: Not needed.

1 A A Milne. *The house at Pooh Corner*. London: Methuen, 1928.

Commentary: Modelling emboli with floating fir cones

Stephen E Greenwald

The study by Knight draws attention to the phenomenon that repeated transient ischaemic attacks often produce similar symptoms and proposes that if the emboli are shed from the same or nearby locations, they are likely to lodge finally in the same place, thus producing ischaemia in the same region of the brain.[1]

The cones used by Knight to simulate emboli did indeed come to rest in a limited number of locations, a result that is consistent with the hypothesis proposed. Statistical analysis suggests that this aggregation was unlikely to have occurred by chance.

The river Authie and the entrance to the mill stream provide a model of the aortic arch and origin of the left common carotid artery. Note the temporary occlusive lesion

The limitations of this appealing model prompt some questions and comments. Firstly, the flow in the river, although possibly laminar, as is blood flow in most arteries, is essentially steady, whereas flow in large arteries is pulsatile, giving rise to flow patterns that vary with time. How placid or vigorous was the flow in the river and did it undergo any low frequency oscillations? If oscillations did occur, the pattern of the pine cones' arrivals at particular points might change with time; if oscillations did not occur, the cones would probably have arrived randomly at the collection points. Secondly, the vascular system consists of a many branched network in three dimensions whereas, as pointed out by a colleague (C D Bertram), floating objects inhabit a two dimensional system that can contain closed eddies. A true "flow tracer" (that is, a massless object that faithfully follows streamlines) cannot enter such a closed eddy, but one with inertia, such as a pine cone, can be impelled across the boundary. Once inside, it may have insufficient inertia to escape. Sooner or later, most paths will jostle such an inertial object into a closed eddy and the stream may provide copious eddies. Thus in two dimensions (cones floating on a stream), there is a strong likelihood of collection. However, this mechanism would not operate in the vascular system.

Turbulent flow does occur in the aorta during systole, so one might suppose that emboli arising in or passing through the heart and ascending aorta would be randomly distributed owing to the chaotic nature of such flow. However, many chaotic systems are characterised by "strange attractors," as originally described by Lorenz,[2] so emboli arising from the same place could end up in proximity in spite of the chaotic nature of the flow.

I tried to improve on the experiment by visualising flow in the river Authie (in northern France) near to the inlet of a millstream. The geometry of this junction bears a noticeable resemblance, at least in two dimensions and in certain lights, to that of the aorta and the left common carotid. A boat manned by me and three

Institute of Cell and Molecular Science, Barts and The London School of Medicine and Dentistry, London E1 2AD

Stephen E Greenwald *professor of cardiovascular mechanics*

s.e.greenwald@qmul.ac.uk

BMJ: first published as 10.1136/bmj.329.7480.1433 on 16 December 2004. Downloaded from http://www.bmj.com/ on 20 April 2024 by guest. Protected by copyright.

companions (one canine) was positioned upstream of the junction, and we poured milk (UHT skimmed, Intermarché, Hesdin, Pas-de-Calais) in a thin stream from each side of the hull so that one stream tended to flow towards the river and the other towards the mill stream. The flow was largely laminar, and the streamlines remained remarkably coherent and showed little deviation during the course of the experiment (about 30 seconds). Photographs were taken but, disappointingly, navigational and other inexplicable stability problems rendered them unfit for publication. Fortunately this type of flow behaviour is well known on a larger scale from aerial views of the sediment carried by converging tributaries of rivers carrying glacial melt water, in which streamlines consisting of sediment from the two sources travel side by side for many miles without mixing.

The observation that prompted Knight's study is of considerable interest, and the hypothesis and experimental results are thought provoking. The possibility of predicting the likelihood of repeated transient ischaemic attacks suggests that more formal modelling of the system as well as numerical simulations of the shedding, transport, and capture of emboli would be a worthwhile enterprise both clinically and scientifically.

Competing interests: None declared.

1 Knight R. *The Poohsticks phenomenon. BMJ* 2004;329:1432-3.
2 Lorenz EN. Deterministic non-periodic flow. *J Atmospheric Sci* 1963;20:130-41.

Commentary: A Fee-Nom-in-Hum and an Expotition

Julie Morris

South Manchester NHS Trust, Wythenshawe Hospital, Manchester M23 9LT
Julie Morris *head of medical statistics*
julie_m@fs1.with.man.ac.uk

This paper by Knight[1] describes a great Expotition into the 100 Aker Wood to investigate the puzzle, "Isn't it funny how emboli race to the same place?" by throwing pine cones from My Bridge into the stream and tracking them, in a Big Adventure, to see where they would end up.

The study seems very interesting, and the results would make my friend Eeyore think, "That accounts for a Good Deal. It Explains Everything. No Wonder." But I am not sure I understand everything the Clever Dr Knight has described. For example, when was this Expotition carried out? "On Monday, when the sun is hot" or "On Tuesday, when it hails and snows"? This matters because the stream changes with the weather.

How many investigators came to the bridge? And how did they carry so many pine cones? Did they bring enough Provisions for such a Big Adventure? And did they sing,

"How sweet to be a cone
Floating in the stream
Every little cone
Always sings alone"?

It isn't surprising that some cones stopped in the same place. I assume there were Big Stones and Rox, and the cones went, Bump, Bump, Bump against these or other Cunning Traps.

As a Bear of Very Little Brain I asked my friend Owl, who always knows something about something, to calculate how likely it is that so many cones end up at the same place. He said that assuming there were only seven different places, A, B, C, D, E, F, and "other" (for the cones that were assumed to have drifted further downstream[1]), then the probability of getting 31 or more (out of 100) at just one place was much smaller than $P < 0.0001$ (assuming a binomial distribution and equal probabilities of getting to each of the seven places). I said to him, "I see, I see," but I didn't quite understand, as long words Bother Me.

The last point that worries me is: what happened to all those red pine cones? Did the investigators collect them all up? Or will I have to do it? I suppose I could use Christopher Robin's umbrella, and my friends Piglet and Eeyore could help. But, it reminds me of the Very Great Danger during the Terrible Flood. Anyway, perhaps the Woozle or Heffalump ate them?

Now I am Very Tired and I think I shall Stop There and eat my Provisions.

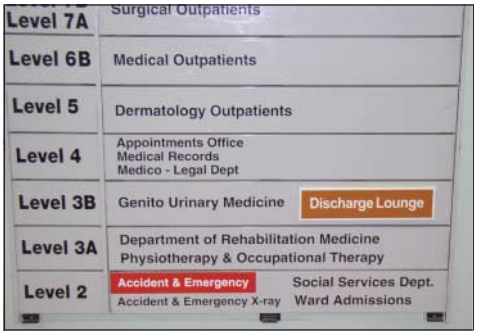
Winnie-the-Pooh.

With apologies to A A Milne. Extracts from *Winnie the Pooh*, by A A Milne, were quoted by permission of the trustees of the Pooh Properties.

Competing interests: Anything connected to Hunny.

1 Knight R. *The Poohsticks phenomenon. BMJ* 2004;329:1432-3.

A conflict of interest?



This sign is genuine. The title of the level 3B lounge in the outpatient block of the Royal Victoria Hospital, Belfast, is unfortunate, given its site.

James A Patterson, *specialist registrar* (jamesapatterson@hotmail.com), Adrian K Neill, *specialist registrar*, Keith Mulholland, *research fellow*, William D Wallace, *research fellow*, department of surgery, Queen's University Belfast, Belfast BT12 6BJ

BMJ: first published as 10.1136/bmj.329.7480.1433 on 16 December 2004. Downloaded from http://www.bmj.com/ on 20 April 2024 by guest. Protected by copyright.