Nine centuries in a season

A spell of bad weather during June and July with wet wickets staunched the flow of runs somewhat in midsummer, when WG was forced to admit that he "was master of the situation no longer."[4] Nevertheless, with blue skies and firmer wickets in August the runs returned in abundance and he scored five more centuries. At the end of the summer he had accumulated 2346 runs with nine centuries, an astonishing performance for a portly, middle aged general practitioner whose career had been perceived by critics as being on the wane at the beginning of the season.

These exploits had excited the imagination and affection of all classes throughout England. To the Victorian public Dr W G Grace was as easily recognisable as the Queen or her prime ministers. For more than 30 years he had been a giant towering over his fellow sportsmen. The knighthood demanded by the press did not materialise, but in more practical terms a wave of testimonials throughout the country from the *Daily Telegraph*, the *Sportsman*, the MCC, and Gloucestershire County Cricket Club produced a gratifying total of £9073 8s 6d. It was indeed a generous gift for an amateur and allowed WG to return to his doctoring and his winter quarters well satisfied with the summer's work. In more ways than one 1895 had been a golden summer for this eminent Victorian.

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Probability of adverse events that have not yet occurred: a statistical reminder

Ernst Eypasch, Rolf Lefering, C K Kum, Hans Troidl

The probability of adverse and undesirable events during and after operations that have not yet occurred in a finite number of patients (*n*) can be estimated with Hanley's simple formula, which gives the upper limit of the 95% confidence interval of the probability of such an event: upper limit of 95% confidence interval = maximum risk = $3/n$ (for $n > 30$). Doctors and surgeons should keep this simple rule in mind when complication rates of zero are reported in the literature and when they have not (yet) experienced a disastrous complication in a procedure.

Just as aeroplanes should not crash, common bile ducts should not be cut and iliac vessels not be punctured during laparoscopic procedures. In reality, however, these things do happen.[1] With the boom in endoscopic surgery, surgeons are claiming to have zero mortality or even zero morbidity in their series of operations. A little reminder, not only for surgeons, may be necessary. If a certain adverse event or complication does not occur in a series, it does not mean that it will never happen. Experience and Murphy's law teach us that catastrophes do happen, and their probability can in fact be calculated by a simple rule of thumb.

In 1983 Hanley, a Canadian statistician, published the paper *If nothing goes wrong is everything alright?*[2] This paper deserves explanation and needs to be highlighted to surgeons in particular. The paper describes in detail the statistical implications if an event of interest fails to occur in a finite number of operations or subjects. Instead of assuming that a technique is safe because of zero numerators, we should look at confidence intervals between zero and a certain upper limit. Hanley gives a simple rule, which should be known by every practising surgeon, to calculate the upper limit of a 95% confidence interval.

Methods

THE FORMULA

Hanley wrote: "This rule of three states that if none of *n* patients showed the event about which we are concerned, we can be 95% confident that the chance of this event is at most 3 in *n* (i.e. $3/n$). In other words, the upper 95% confidence limit of a $0/n$ rate is approximately $3/n$."[2] The calculations are based on the following consideration. Given the risk of a certain event, the probability of this event not occurring is $(1 - \text{risk})$. The probability of this event not occurring in *n* independent observations (patients or operations) is then $(1 - \text{risk})^n$. The higher the risk, the lower the chance of not finding at least one occurrence of the event. One can therefore determine the maximum risk of an event, with a 5% error, that is compatible with *n* observations of non-occurrence:

$(1 - \text{maximum risk})^n = 0.05$, equal to
$1 - \text{maximum risk} = \sqrt[n]{0.05}$, equal to
$1 - \text{maximum risk} = (0.05)^{1/n}$.
For $n > 30$ this can be approximated by
$1 - \text{maximum risk} = 1 - (3/n)$, equal to
maximum risk = $3/n$.

This formula closely fits the upper limit of the 95% confidence interval.[2] Even when $n = 20$ the number based on the rule of three does not differ substantially from the exact value ($15\% \ v \ 14\%^2$).

Upper limits of 95% confidence intervals for occurrence of immediate intraoperative death from vascular injury in series of laparoscopic appendicectomies and cholecystectomies

Study	No of procedures	No of deaths due to injury	Upper limit of 95% confidence interval (rule of three)
Laparoscopic appendicectomy			
Hebebrand *et al*[5]	25	0	12/100
Attwood *et al*[6]	27	0	11/100
McAnena *et al*[7]	29	0	10/100
Frazee *et al*[8]	38	0	8/100
Kum *et al*[9]	57	0	5/100
Tate *et al*[7]	70	0	4/100
Pier *et al*[8]	653	0	4/1000
Total	842	0	1/1000
Laparoscopic cholecystectomy			
Peters et al[10]	100	0	3/100
Troidl *et al*[11]	400	0	8/1000
Cuschieri *et al*[13]	1236	0	2/1000
Southern Surgeons Club[15]	1518	0	2/1000
Larson *et al*[14]	1983	0	1/1000
Collet *et al*[12]	2955	0	1/1000
Total	8192	0	3/10000

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The event that most worries endoscopic surgeons is intraoperative vascular injury that leads to loss of a limb or death. We selected well known international reports of series of laparoscopic appendicectomies and cholecystectomies from the literature.[3-15] None of them reported a major vascular injury with subsequent loss of a limb or death. We applied Hanley's rule of three to the data in the papers to calculate the upper limit of a 95% confidence interval for such an adverse event. The table shows the results of these calculations.

Discussion

Several conclusions can be drawn from the table. It is obvious that a small series of any procedure can say hardly anything about the safety of the technique. Even though a major vascular injury with subsequent loss of a limb or death never occurred, the statistical analysis shows that, depending on the study selected, there was the threat that it might occur in four out of every 1000 procedures or even 12 out of every 100. This makes statements like "laparoscopic appendectomy is the method of choice"[3] premature or even irresponsible if they are based on single studies.

The non-occurrence of an adverse event in a surgical series does not mean that it cannot happen. It can, and the true rate of occurrence can be estimated from its 95% confidence interval. It is a good estimate of the worst case that is compatible with the observed data. The smaller the sample, the wider the confidence interval. This means that the upper limit of a confidence interval from a small sample is greater than that from a large sample, but this does not mean that the true probability of an adverse event occurring is larger in a small series.

Doctors and surgeons should keep this simple rule of three in mind when complication rates of zero are reported in the literature and when they have not (yet) experienced a disastrous complication in a procedure.

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New broom at the top? An interview with Anders Milton, the chairman of the World Medical Association's Council

Douglas Carnall

The week long annual assembly of the World Medical Association opens in Bali next week. The WMA has been through long years of internal conflict associated with the continuing membership of the South African Medical Association and wrangles over finance, and the question that observers of the assembly must address is: has the WMA finally turned a corner, or are there still questions over its relevance to ordinary doctors? Douglas Carnall talked to Anders Milton, the chairman of its council, about the work of the WMA and his vision of its future.

Dr Milton was born and brought up in Sweden and studied for a degree in economics before turning to medicine. He was appointed to the staff of the University Hospital at Uppsala as a nephrologist on completing his PhD. Four years ago he gave up his clinical work to became the full time secretary general of the Swedish Medical Association. He was elected chairman of the council of the WMA in April of this year.

Anders Milton, the WMA's new chairman of council

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DC: Why do doctors need the WMA?

AM: Doctors are all members of one of the classic professions. A profession is defined by two qualities: firstly, it defines its own area of work, and, secondly it has it own ethics. Medicine has had its own ethical guidelines since the time of Hippocrates, the basic rule being that you should not harm your patients—do good and not bad. However, during the second world war some doctors in some countries engaged in "scientific" research on or pure torture of both civilians in concentration camps and prisoners of war. After the second world war it was felt that this should not happen again, and a number of medical associations decided to form a world body that would define and promulgate medical ethics throughout the world, while ensuring that free medical associations would not let their members become part of an oppressive state apparatus. A doctor's first duty is to his or her patients, and he or