CUSUM for monitoring competency: computer software is useful for bootstrapping and real-time CUSUM plotting

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Does Goldmann applanation tonometry performed by community optometrists reduce referrals? A pilot study

PRESS RELEASE

The recent publication of the NICE glaucoma guidelines (http://www.nice.org.uk/) has led to a large increase in new patient referrals from community optometrists to the Hospital Eye Service (HES) with possible glaucoma. Changes in population demographics mean that these numbers are likely to rise further in the coming years. As well as putting a strain on the HES capacity, this increase in potentially false-positive referrals has significant financial implications for PCTs and can cause unnecessary distress and anxiety to patients. The majority of these referrals, due solely to intraocular pressure (IOP) measurements of over 21, are made based on the results of non-contact tonometry (NCT), in contravention of the NICE guidelines which advises the use of Goldmann applananation tonometry (GAT).[1]

GAT in experienced hands is accepted as the gold standard in intraocular pressure measurement, and many non-contact tonometers have been shown to overestimate GAT measurements at higher IOPs.[2–4] Unfortunately, non-contact tonometers are frequently used in preference to GAT by optometrists for reasons including cost, ease of use and lack of need for anaesthetic eyedrops. We performed a pilot study with the help of four local optometry practices to determine how many NICE guideline referrals based solely on IOPs over 21 would be avoided if Goldmann applanation tonometry were offered to all patients. Every patient who had an IOP of 22–25 on NCT had this measurement repeated with GAT. If the IOP on GAT was 21 or under, referral was not indicated in the absence of any other suspicion of glaucoma. If the IOP was over 21 on Goldmann, referral was instigated as per NICE guidelines.

A total of 3295 patients were examined over a 5-month period. Seventy-three (2.22%) of these were found to have IOPs of 22–25 on NCT in the absence of any other signs of glaucoma. These 73 patients would normally therefore have been referred to the HES. Of these 73 patients, 46 (63%) were found to have IOPs of 21 or less when the measurements were repeated on GAT. These 46 patients therefore did not require referral to the HES. Only 27 of the 73 patients had IOPs over 21 confirmed on GAT and were thus referred, as per NICE guidelines. The use of Goldmann applanation tonometry by optometrists, prior to instigating a referral to the HES, has huge potential to reduce unnecessary referrals. This will benefit patients, PCTs and the HES.

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CUSUM for monitoring competency: computer software is useful for bootstrapping and real-time CUSUM plotting

We congratulate Salowi and colleagues on their study of the use of cumulative sum (CUSUM) to monitor competency in cataract extraction.[1] However, there are two modifications that could be used to make their system more responsive and reliable.

1. The authors use a CSUM chart that fluctuates on only one side of the zero line. Traditionally, CUSUM charts fluctuate on both sides of the zero line.[2 3] The consultant in their figure 1 performed 48 procedures and 43 were successful, while five were failures. The weight for a failure would be −1.791666, and for a success it would be +0.208333. Figure 1 depicts the traditional CUSUM graph with these data. Against this, the data from his trainee are also drawn. The trainee's CUSUM score keeps going further and further away from the zero line, suggesting that he has not reached the bottom of his learning curve. Once his learning is over, his mean CUSUM line will run parallel to the zero line.
2. The authors discuss in detail the arbitrary 'decision intervals' or 'control lines' that they have employed, based on a trade-off between the need to detect poor performance quickly and that to avoid a large number of false alarms.

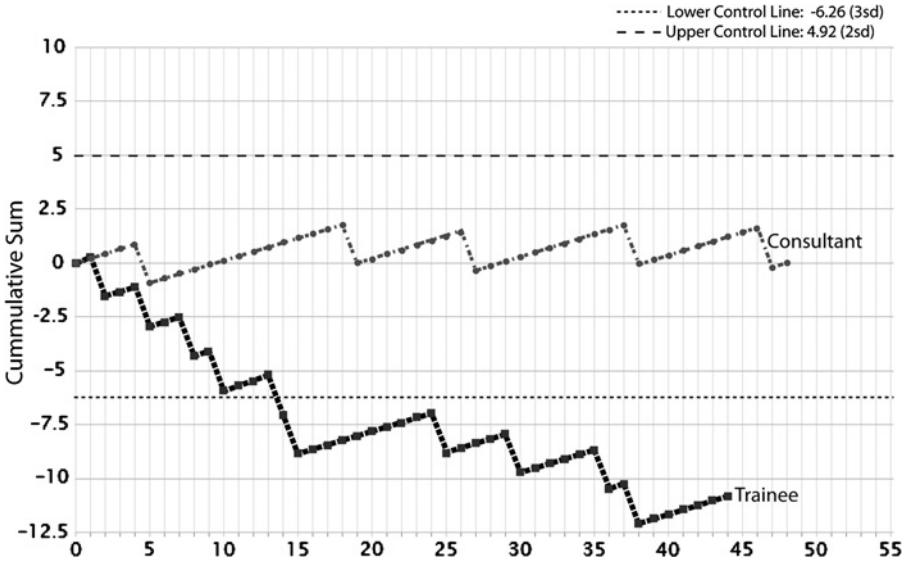

Figure 1 Standard reference cumulative sum (CUSUM) showing performance by a trainee and a consultant.

The decision lines need not be arbitrary. With the help of computers, bootstrapping techniques can be employed so that these lines are placed where they are statistically meaningful. As an illustration, in figure 1 with the consultant's performance, there were five failures and 43 successes. The five failures need not be evenly interspersed among the successes. The sequence of failures is purely a matter of chance, and two or even three failures may be clustered together. Bootstrapping allows random reordering of the failures and successes in a way that the overall numbers of success and failures are the same for each iteration. The computer can calculate the maximum and minimum score for each iteration. If 1000 iterations are performed, it is possible to calculate the mean of the highest scores (maximum score in the iteration), the mean of the lowest scores (minimum score in the iteration) and also the SD around the means. The upper decision line is the limit drawn with the mean upper score +2SD. The lower decision line is the mean lower score −2SD. If surgery is performed by a person of comparable competence as the consultant, their CUSUM score will lie within the two decision lines 95% of the time.

We have recently used CUSUM for a clinical trial, and for this we developed software that allows for easy bootstrapping, drawing of control lines and plotting of CUSUM score. This software is available free on the internet (http://jacob.puliyel.com/foresee/).

Figure 2 (in the original article by Salowi *et al*) can also be redrawn using the acceptable rate for posterior capsule rupture (PCR) of 5%. Here, the acceptable standard is one failure for 19 successes. For figure 3 (in the original article by Salowi *et al*) using the acceptable rate for impaired vision as 10% (using data reported by the authors from the Malaysian National Cataract Surgery Registry), there can be one failure for nine successes.

The software is interactive and allows CUSUM plotting in real time (meaning that it allows one to see how the CUSUM graph evolves, with each new success or failure). We hope that the free software available on the net will encourage more widespread use of CUSUM in various clinical situations.

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Competing interests The CUSUM software, available free on the internet, was developed by the authors in the context of a clinical trial.

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