Drinnan M¹, Clarkson B¹, Robson W¹, Harding C¹, Caffarel J¹, Pickard R¹, Griffiths C¹

1. Newcastle upon Tyne Hospitals NHS Trust

A NEW NOMOGRAM FOR THE PENILE CUFF STUDY

Hypothesis / aims of study

One in three of all men will seek medical help for lower urinary tract symptoms in later life. While a reduced free flow rate is often indicative of bladder outlet obstruction, it does not exclude the diagnosis of detrusor under-activity. A simultaneous measurement of bladder contractility can resolve the diagnosis, and the penile cuff test provides a noninvasive estimate of isometric bladder pressure [1]. A non-invasive pressure-flow nomogram derived from the wellused ICS nomogram for invasive cystometry has been proposed [2]. However, as with the ICS nomogram the classification is categorical - obstructed, not obstructed or diagnostically uncertain. Near the centre of the nomogram a small change in pressure or flow rate could potentially change the diagnosis markedly, and this seems intuitively undesirable. The aim of this study was to propose an improved nomogram for the penile cuff test based on statistical principles.

Study design, materials and methods

We recruited 144 men in two UK institutions. All had been referred for conventional cystometry according to ICS guidelines to clarify the urodynamic cause of lower urinary tract symptoms. They were classified as obstructed or not obstructed (equivocal/unobstructed) according to the provisional ICS nomogram. All men underwent a penile cuff test. According to the standard protocol, the operator measured peak flow rate (Qmax) and the highest cuff pressure required to interrupt flow (Pcuff.int). We then constructed the new nomogram using Gaussian statistics. Outcome data Finally, we present data from a study of 166 men who underwent TURP, and where good outcome was defined as a 50% reduction in subjective symptoms. Using the t-statistic as a pragmatic indicator of performance, we compare the classifications according to the original categorical nomogram with those of the new probability-based nomogram.

Results

From a Gaussian distribution in two variables, we calculated the probability that a patient with given measurements of Q_{max} and p_{cuff,int} belongs to the obstructed population, and to the not-obstructed population (figure 1).



Figure 1 The bivariate Gaussian distributions for (left) non-obstructed and (right) obstructed patients. In each case, shading shows the probability of belonging to that population.

By taking at each point the relative probability of belonging to the two populations, we constructed the new nomogram (figure 2).



Figure 2 The new nomogram, where shading shows the probability of being obstructed. The crossed lines are taken from the original categorical nomogram. Obstructed and not-obstructed patients are topleft and bottom-right respectively, with the other two quadrants being diagnostically uncertain NOTE: Resting abdominal and hydrostatic pressures give a cuff pressure of 50 cm H_2O even with no bladder contraction. We therefore have no measurements below 50 cm H_2O on which to base the nomogram, and have not shown this region.

Outcome data For comparison, the *obstructed*, *not-obstructed* and *uncertain* quadrants of the original categorical nomogram were assigned probabilities of 1.0, 0.0 and 0.5 respectively. Treating *good* and *poor* outcomes as two separate groups, the t-statistic shows how well the probabilities of obstruction suggested by each nomogram separate the *good* and *poor* outcome groups. Table 2 shows the relative performances; a higher value is better, and so the new nomogram performed slightly better by this criterion.

	t-statistic
Original nomogram	3.99
Probability-based nomogram	4.34

Table 2 The diagnostic performance of the two nomograms according to the t statistic; a higher value indicates better performance.

Interpretation of results

The new nomogram (figure 2) shows the properties to be expected, with a strong probability of obstruction for patients in the top-left (high pressure, low flow). The region of intermediate probability (shaded green in figure 2) is where the probabilities of belonging to the obstructed and non-obstructed populations are approximately equal. It is noteworthy that this region corresponds well with the line of separation taken from the original nomogram, and therefore reassuring that the two nomograms performed similarly.

Concluding message

We have proposed a way to make better use of the cuff test using a nomogram based on Gaussian statistics, and this can be implemented easily by computer. However, the original nomogram has the advantage of simplicity, and is perfectly acceptable where the facility to calculate statistics for the new nomogram is not available.

References

- 1. J Urology 2002; 167: 1344-47.
- 2. J Urology 2005; 174: 1323-26.

FUNDING:The TURP outcome study was funded by the UK charity Action Medical Research.HUMAN SUBJECTS:This study was approved by the Newcastle & North Tyneside LREC and followed theDeclaration of Helsinki Informed consent was obtained from the patients.