

# Evaluation of individual surgical performance using V-POSSUM risk adjusted mortality rates

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## ABSTRACT

### Background

V-POSSUM is a risk adjusted scoring system for predicting 30-day mortality in patients undergoing vascular surgery. It can assess surgical performance by comparing predicted with observed deaths. The aim of this analysis was to assess trends in surgical performance over time using risk adjusted 30 day mortality as the primary outcome.

### Methods

Major vascular surgery procedures (n=454) were prospectively scored for V-POSSUM between 1995-2006. Procedures were divided into 11 consecutive time bands. Observed and predicted deaths were compared using the logistic regression equation derived for V-POSSUM.

### Results

The observed death rates decreased over time as did the predicted number of deaths calculated from the V-POSSUM scores. The overall predicted mortality rate was 17.2%, and that the rate varied with the 12 month period, with a high of 23.9% and a low of 9.2%. The downward trend in the predicted rate shows that the patient risk factors have changed over time and that the risk of dying has declined by almost 50%, (from 21.6% to 11.1%). There was a trend towards improved surgical performance over time with a drop in the observed to predicted ratios of deaths.

### Conclusion

Observed and predicted mortality changed over the study periods. There was a trend towards improved performance compared with the risk adjusted predicted mortality. V-POSSUM is a useful tool in the longitudinal assessment of performance in major vascular surgery.

## INTRODUCTION

Monitoring clinical performance is increasingly important and forms an essential part of the RACS Continuing Professional Development (CPD) Programme. Unadjusted mortality rates, although easy to obtain, do not take into account type of surgery, patient selection by the surgeon and patient co-morbidity. There is a clear need to adjust for variable casemix when calculating mortality rates.

The POSSUM risk-adjusted scoring system for predicting mortality in surgical patients was developed by Copeland et al in 1991. The system can be used to compare surgical outcomes, particularly 30-day mortality.

The aim of this study was to monitor the changes that have occurred in one individual surgeon's performance of vascular surgery, after appointment to a specialist post, by using V-POSSUM risk-adjusted 30-day mortality as the primary outcome. In particular, we look at nearly 10 years of data and review the results when data are aggregated over time and examine fluctuations in performance.

## METHODS

Data were collected prospectively by a single surgeon (DM), who was appointed to a specialist vascular surgery post in September 1995 in Birmingham, UK, in a large hospital serving a population of 450,000. Initially emergency vascular cover was shared between 3 surgeons, but by

2000 five vascular surgeons shared emergency cover. In February 2002, DM moved to Taranaki Base Hospital in New Plymouth, New Zealand. Base Hospital is a 210 bed district hospital serving a population of approximately 105,000. This post was a general surgery post with an interest in vascular surgery and an effective vascular emergency roster of 1 in 2.

The major vascular procedures between September 1995 and April 2006 were included in an uninterrupted consecutive series. All of the POSSUM data were collected by DM at the time of surgery (see figures 1 and 2).

VARIABLE	ONE	TWO	FOUR	EIGHT
Age (years)	<60	61-70	>71	
Cardiac status	Normal	Cardiac drugs or steroids	Oedema, warfarin, borderline cardiomegaly	Raised JVP, cardiomegaly
Respiratory status	Normal	Dyspnoea on exertion	Limiting dyspnoea (one night), Moderate COAD	Dyspnoea at rest (RR>30/min)
Systolic BP (mmHg)	110-130	131-170	>170	<90
Pulse (beats/min)	50-80	81-100	101-120	>120
Glasgow coma score	15	12-14	9-11	<9
Haemoglobin (g/100ml)	13-16	11.5-12.9	10.0-11.4	<10.0
White cell count (x10 <sup>12</sup> )	4-10	10.1-20.0	>20.0	>18.0
Urea (mmol/L)	<7.5	7.5-10.0	10.1-15.0	>15.0
Sodium (mmol/L)	>136	131-135	126-130	<126
Potassium (mmol/L)	3.5-5.0	3.2-3.4	2.9-3.1	<2.9
ECG	Normal		Atrial fibrillation (rate 60-90)	Any other abnormality

Figure 1: V-POSSUM Physiological Score (PS)

Variable	One	Two	Four	Eight
Operative severity	Minor	Intermediate	Major	Major+
Multiple procedures	1		2	>2
Total blood loss (mls)	<100	101-500	501-999	>1000
Peritoneal soiling	None	Minor (serous fluid)	Local pus	Free bowel content, pus or blood
Presence of malignancy	None	Primary only	Nodal metastases	Distant metastases
Mode of surgery	Elective		Emergency resuscitation of <2h possible, Operation <24h after admission	Emergency (immediate surgery <2h needed)

Figure 2: V-POSSUM Operative Severity Score (OSS)

Using the scores and regression equation for V-POSSUM, a predicted probability of death can be calculated and compared with the actual number of deaths within 30-days.

The regression equation for V-POSSUM is:

$$\ln(R/(1-R)) = (-8.0616 + (0.1552 \times PS) + (0.1238 \times OS))$$

Where R = mortality risk, PS = physiological score and OS = operative score<sup>3</sup>

The data were aggregated into 12 month periods (except for the last period that had 8 months). The ratios of observed deaths to expected deaths were used to report trends over the 11 time periods. A cusum chart, (cumulative result of observed minus expected deaths over time), was used to display individual results for all cases.

## RESULTS

A total of 454 major vascular procedures were performed (see figure 3). The number of procedures in each month ranged from 1 to 15 with a mean of 4.1 per month. There were 60 actual deaths or an overall rate of 13.2%. The number of deaths per month ranged from 0 to 3, with a mean of 0.55. There was no relationship between the number of procedures carried out per month and mortality, but there was a significant decline in the annual mortality rate as shown in figure 4, (P = 0.0002).

81	Elective aortic procedures
66	Emergency or acute aortic procedures
63	Carotid procedures
106	Intra-arterial bypasses
83	Miscellaneous revascularisation procedures such as extra-anatomic bypass and endarterectomy
29	Other procedures
26	Upper limb procedures

Figure 3: Operative procedures

12 month period	Number of cases	Deaths	Rate %	Predicted deaths	Predicted Rate %	Observed rate / Predicted rate *100
1	39	8	20.5%	7	17.9%	114.8
2	57	12	21.1%	12	20.7%	101.7
3	64	14	21.9%	15	23.9%	91.6
4	56	6	10.7%	9	16.8%	63.8
5	58	6	10.3%	10	17.4%	59.4
6	37	2	5.4%	4	11.4%	47.3
7	30	5	16.7%	6	19.1%	87.1
8	32	2	6.3%	6	17.3%	36.1
9	24	3	12.5%	3	12.0%	104.5
10	42	2	4.8%	5	11.5%	41.3
11	15	0	0.0%	1	9.2%	0.0
Total	454	60	13.2%	78	17.2%	76.8

Figure 4: Observed and predicted mortality rates by 12 month period

The overall predicted mortality rate calculated from V-POSSUM was 17.2%, and that the rate varied with the 12-month periods, with a high of 23.9% and a low of 9.2%. The downward trend in the predicted rate shows that the patient risk factors have changed over time and that the risk of dying has declined by almost 60%, (from 23.9% to 9.2%). The factors that changed were the physiological scores for blood pressure, pulse and cardiac status. There were also less multiple procedures and emergency resuscitations after the first three years. The overall changes in the individual scores resulted in the total physiological score declining from 26 to 21 (p = 0.007), but no significant change in the operative score, from 16 to 15 (see figure 5).

12 month period	Number of cases	Mean PS	Mean OSS
1	39	25.7	15.3
2	57	25.0	16.5
3	64	26.5	17.6
4	56	25.4	14.6
5	58	24.3	15.6
6	37	23.7	13.8
7	30	24.3	17.7
8	32	25.1	15.2
9	24	23.8	15.3
10	42	22.1	15.5
11	15	21.0	14.1
Total	454	24.6	15.7

Figure 5: Summary of Physiological and Operative Scores by 12 month period PS = Physiological Score, OSS = Operative Severity Score

Overall the mortality rate was 23.5% below the predicted rate from V-POSSUM, but this improved rate can only be seen from the 3rd period onwards, where the observed number of deaths was less than the predicted number. However, none of these differences are statistically significant (see figure 6).

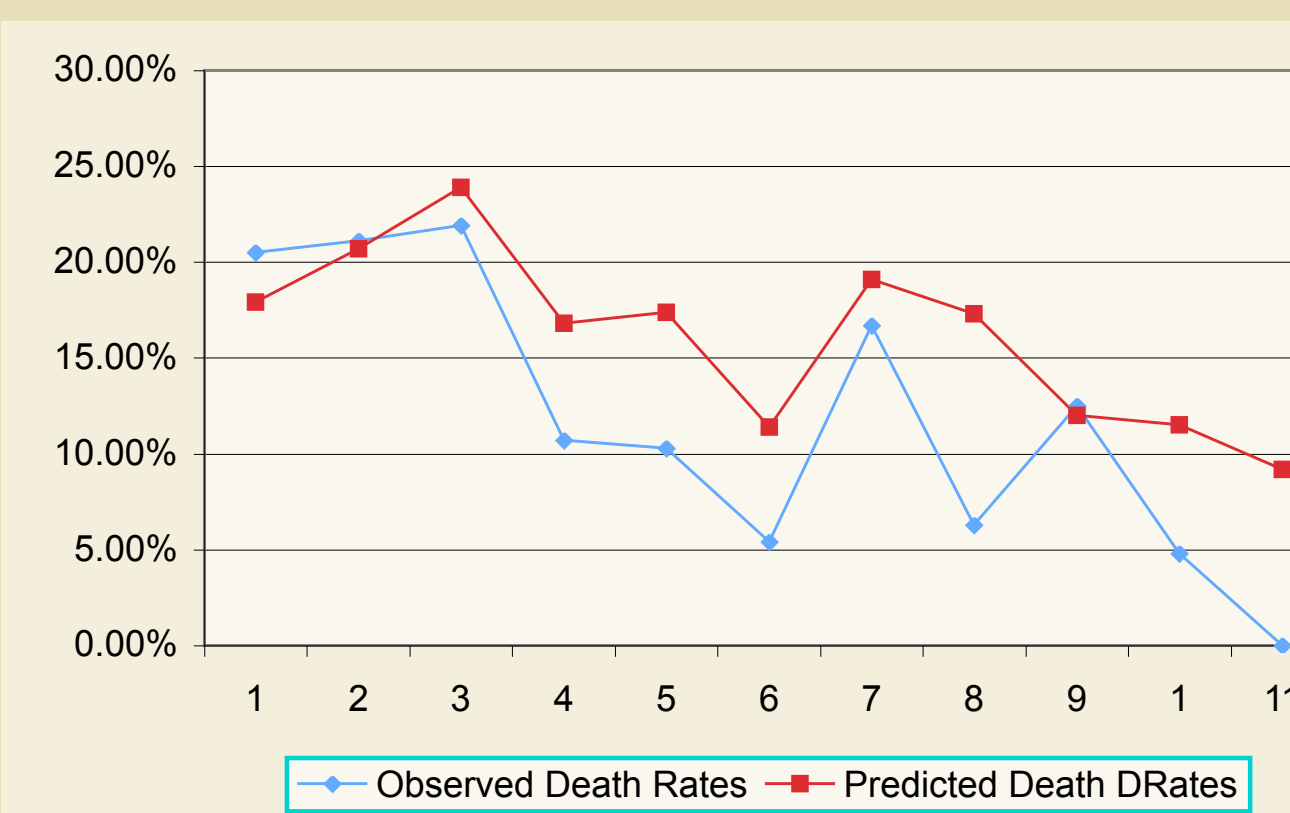


Figure 6: Observed death rates vs expected death rates

The improvement in the observed mortality was large, (21% to 5%), but after adjusting for the V-Possum scores, the improvement attributable to the surgeon was about 50%, (the observed over expected ratios averaged about 50% for periods 8 to 11).

The results can also be used to assess whether there is a learning curve. Figure 7 shows the cumulative observed minus predicted deaths based on V-POSSUM. Although the patterns are not completely clear, the plot suggests that there was an excess mortality of nearly 5 deaths by the 80th patient, and then there was a continuous improvement. Or it could be suggested that for the first 200 cases, the mortality rate was as predicted, and then improvement occurred. Either interpretation suggests that a possible significant change occurred after either 80 or 200 procedures.

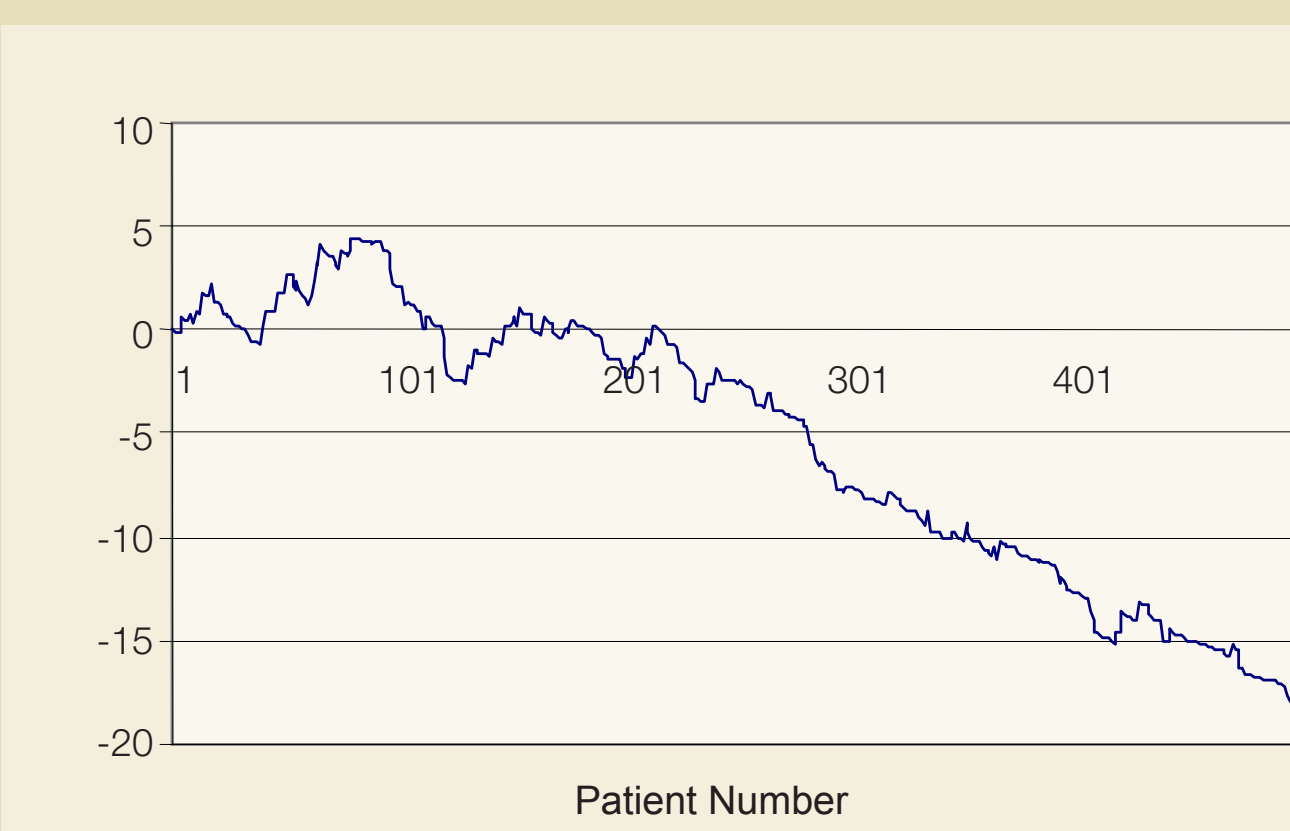


Figure 7: Cusum plot of observed minus expected deaths: 1995-2006.

## DISCUSSION

The V-POSSUM scores can adjust for changes in the casemix of the patient population which will alter the expected mortality. It enables performance data to be dynamic and track these changes in a way which crude mortality rates do not.

Evaluation of performance may become an increasingly important issue in the future with shorter training times and narrower breadth of training. Although V-POSSUM has been developed specifically for vascular surgery, there are other regression equations such as POSSUM and P-POSSUM which apply across general surgery.

One concern with POSSUM is that there are also 18 different parameters to score which may inhibit its use. A recently reported minimum dataset for vascular surgery (Vascular Biochemistry and Haematology Outcome Models, VBHOM) only uses information obtainable before operation and would be easier to collect routinely than V-POSSUM.

Although mortality is important, it is critical to remember that it is only one aspect of surgical performance. Morbidity, patient satisfaction and assessment of the surgical team through procedure specific outcomes are equally relevant.

Individual evaluation of surgical performance is straightforward and has many potential benefits for surgeons and the society. Although often cool to the concept, surgeons should embrace the development of evaluation tools such as V-POSSUM and use them for the mutual benefit of themselves and their patients.

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