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Significant risk factors in elective colorectal surgery

R D Kingston MB ChB FRCS FRCSEd
Consultant Surgeon

J Jeacock MSc
Clinical Trials Analyst

S Walsh RGN
Research Sister

F Keeling RGN
Research Sister

C Robinson BSc
Data Manager

Department of Clinical Studies, Trafford General Hospital, Manchester

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A prospective study of 618 patients undergoing elective colorectal surgery performed in a district general hospital over a 10-year period is reported. Multivariate analysis has been used in an attempt to identify risk factors.

The risk of wound infection was increased if septicaemia, respiratory sepsis or faecal contamination was present, if the surgeon was a consultant and if the patient had suffered a haemorrhage. There was an increased risk of serious complications if the patient was male and of poor physical status. Operative mortality was significantly associated with poor physical status, respiratory sepsis and intra-abdominal abscess.

Only three risk factors could be identified preoperatively: patient gender, physical status and seniority of surgeon. However, procedures low in the pelvis are more difficult and in this study group are also associated with a higher risk of wound infection. The majority of these procedures are performed by consultants. In addition, this study group has proportionally more female patients of poor physical status who are selectively being operated on by the consultant, seemingly indicating the 'consultant' as a risk factor.

Despite a reduction in postoperative septic complications, elective colorectal surgery is still associated with morbidity and mortality rates which vary from one specialist centre to another *(1–5)*. A number of factors have been identified by univariate analysis as being significantly associated with increased morbidity or mortality. Because of lack of numbers few studies have sought to identify risk factors by using multivariate analysis. It is possible that by identifying strongly significant factors a further reduction in morbidity and mortality may be possible by appropriate management adjustments.

Correspondence to: Mr R D Kingston, Department of Clinical Studies, Trafford General Hospital, Davyhulme, Manchester M41 5SL

Patients and methods

All patients undergoing elective colorectal surgery by the three general surgical teams at Trafford General Hospital between 1983 and 1992 have been entered into the study. All patients, except those with a history of allergy to penicillins or cephalosporins have received prophylactic antibiotics. The majority received a bolus intravenous injection at the time of anaesthetic induction, most commonly cefuroxime 1.5 g and metronidazole 0.5 g. During the 9 years, three antibiotic regimens have been evaluated against the effectiveness of a single intravenous bolus of cefuroxime and metronidazole.

Before surgery, all patients were interviewed by one of two clinical research nurses. Information relating to patient identification, disease history, and investigations were recorded. Postoperatively, the operative, pathological and clinical recovery details were recorded. Wounds were inspected daily and observations recorded. Wound swabs, sputum, urine and blood were sent to the microbiology unit for culture and sensitivity as clinically indicated. All patients were supervised by the clinical research nurses until discharged. At the time of discharge all patients were requested to inform the nurses of any septic or non-septic complication after discharge. Further specimens were collected at home as indicated.

Specimens were transported to the laboratory as soon as

possible after collection. Pus, urine, sputum and faeces were collected into sterile universals, swabs into Transwab® for aerobes and anaerobes and blood cultures into bottles. Cultures were carried out both aerobically and anaerobically. Blood cultures were processed by BACTEC® N.R. 370 (Bectan–Dickenson). Pathogenic organisms were identified by conventional bacteriological methods and antibiotic sensitivities carried out using a modified Stokes' method. A wound infection is defined as a purulent discharge from a wound (abdominal or perineal) and a major wound infection as a purulent discharge associated with pain and/or pyrexia and positive bacteriology. A chest infection was said to be present if the patient had purulent sputum with positive bacteriology and/or infective change on chest radiograph. Urinary infection was defined as the presence of increased leucocytes seen on microscopy and/or a urinary culture greater than 10 organisms per litre. A positive blood culture was defined as the presence of bacteraemia.

Faecal contamination was estimated by the surgeon to be none, minor or major spillage. Faecal fistula was said to be present when a faecal discharge was noted through the wound or other site.

The Karnofsky performance status of the patient was defined according to the Eastern Co-operative Oncology Group criteria:

Status 0: Fully active, predisease status.
Status 1: Ambulatory, capable of light work.
Status 2: Capable of self-care, not able to work.
Status 3: In bed 50% of time, limited self-care.
Status 4: Completely bedridden, incapable of self-care.

A patient was classified as having haemorrhaged if significant blood loss occurred which required > 2 units of blood at operation or needed to return to theatre to control bleeding within 24 h of surgery.

Data were collected on standard computer forms by the two research nurses, input directly to a microcomputer using a database package (D Base IV) and, after validation by the Data Manager, data were transferred to the mainframe computer at Manchester University. Logistic regression analysis was then performed using SPSS (Statistical Package for the Social Sciences).

Results

Data from 618 patients were available for multivariate analysis. Table I shows the frequency distribution of 11 factors which were suitable for inclusion as independent variables in a stepwise logistic regression analysis. Three separate analyses were performed using different criteria for the dependent variable.

The first analysis was designed to identify significant factors associated with wound infection, the second to examine factors associated with the occurrence of serious complications and the third the risk factors associated with operative mortality. The dependent variables and the number of patients in each category for these three analyses are detailed in Table II.

Table I. Frequency distributions of independent variables

		N
Total number of patients		618
Patient sex:	Male	310
	Female	308
Age:	Median	68
	Range	13–93
Physical status	0	197
	1	241
	2	131
	3	43
	4	6
Surgeon:	Consultant	471
	Reg/Sen Reg/Other	147
Faecal contamination:	None	448
	Severe/minimal	170
Duration of operation:	< 90 min	381
	> 90 min	237
Abscess:	No	602
	Yes	16
Septicaemia:	No	601
	Yes	17
Respiratory sepsis:	No	557
	Yes	61
Urinary tract infection:	No	468
	Yes	150
Haemorrhage:	No	600
	Yes	18

Table II. Dependent variables

Analyses	*Dependent variable*	*N*
1	Wound infection (minor or major)	105
	vs	
	No wound infection	513
2	Patient had either chest infection, septicaemia or abscess	83
	No serious complication	535
3	Operative mortality (ie patient survived less than 30 days)	39
	No operative mortality	579

Analysis 1: wound infection

Five variables were included as significant (ie P for inclusion < 0.05) and the coefficient β and standard errors associated with these variables are detailed in Table III. Summarising, the risk of wound infection was increased if septicaemia, respiratory sepsis or faecal contamination was present, if the surgeon was a consultant and if the patient had suffered a haemorrhage at operation. (Global $\chi^2 = 61.6$, df = 5, $P < 0.0001$.)

Analysis 2: serious complication

The factors identified as important in this analysis are shown in Table IV. Only two factors were significant; the sex of the patient and the physical status at admission. There was an increased risk of a serious complication if

Table III. Significant factors—wound infection

Variable	*β*	*SE*	*P*
Septicaemia	−1.8296	0.5348	0.0006
Surgeon	−1.3105	0.3891	0.0008
Respiratory sepsis	−1.1394	0.3126	0.0003
Faecal contamination	0.6326	0.2378	0.0078
Haemorrhage	−1.2841	0.5106	0.0119
Constant	6.6381	1.5990	

SE = Standard error

Table IV. Significant factors—serious complications

Variable	*β*	*SE of β*	*P to include*
Patient sex	−0.8366	0.2563	0.0073
Physical status	0.4059	0.1267	0.0015
Constant	−1.1286	0.3662	

SE = Standard error

Table V. Significant factors—operative mortality

Variable	*β*	*SE*	*P to include*
Abscess	−2.7497	0.5991	< 0.0001
Respiratory sepsis	−1.9307	0.4121	< 0.0001
Physical status	0.8457	0.1837	< 0.0001
Haemorrhage	−1.9894	0.6516	0.006
Faecal contamination	0.7588	0.3821	0.049
Constant	8.4374	1.8786	

SE = Standard error

the patient was male and of poor physical status. (Global $\chi^2 = 17.32$, df = 2, $P = 0.0002$.)

Analysis 3: operative mortality

All independent variables could be included in this analysis and significant factors are summarised in Table V. The factors are shown in order of importance to the regression model. (Global $\chi^2 = 76.1$, df = 5, $P < 0.0001$.)

Discussion

Multivariate analysis reveals only three risk factors that could be identified preoperatively: patient gender, their physical status and the seniority of the surgeon. Procedures low in the pelvis are more difficult and often more time consuming. Analysis reveals a significantly higher wound infection rate when the procedure is below the peritoneal reflection; 50 (23%) compared with 27 (12%) above the peritoneal reflection and 10 (16%) for other procedures (Table VI). The majority of these procedures are performed by consultants ($\chi^2 = 58.2$, df = 2, $P < 0.0001$). In addition, this study group has proportionally more female patients of poor physical status ($\chi^2 = 28.7$, df = 2, $P < 0.0001$) (Table VI) and more of these are selectively being operated on by the consultant when compared with the other surgeons.

Table VI. Factors related to seniority of the surgeon

	Consultant	*Other surgeon*	*P*
Peritoneal reflection			
Above	135 (62%)	83 (38%)	$\chi^2 = 9.08$
Below	197 (92%)	17 (8%)	df = 2
Other	52 (84%)	10 (16%)	$P = 0.01$
Physical status			
0 Male	91	25	
0 Female	71	10	NS
1 Male	100	34	
1 Female	76	31	NS
2, 3, 4 Male	37	23	$\chi^2 = 6.58$
2, 3, 4 Female	96	23	df = 1
			$P = 0.01$

NS = Not significant

These three factors explain why the 'consultant' is associated with a higher risk.

In the past, we have reported *(6)* the association of poor physical status with operative mortality and cancer survival in patients with colorectal cancer. Our results would suggest that it is this group of patients, so often reported at CEPOD meetings, that merit attention if we wish to improve our serious complication and operative mortality rates. A more careful and prolonged preoperative assessment to identify bleeding tendencies, underlying chest and other chronic problems and nutritional deficiencies may help minimise complications and death. Sepsis caused by intra-abdominal abscess, respiratory infection, faecal peritoneal soiling together with haemorrhage are the principal factors associated with wound sepsis and death. These factors may well be associated with poor nutrition and physical status.

References

1 Lau WY, Chu KW, Poon GP, Ho KK. Prophylactic antibiotics in elective colo-rectal surgery. *Br J Surg* 1988; **75**: 782–5.

2 Rowe-Jones DC, Peel ALG, Kingston RD, Shaw JFL, Teasdale C, Cole DS. Single dose cefotaxime plus metronidazole versus three dose cefuroxime plus metronidazole as prophylaxis against wound infection in colo-rectal surgery: multicentre prospective randomised study. *Br Med J* 1990; **300**: 18–22.

3 Brown SCW, Abraham JS, Walsh S, Sykes PA. Risk factors and operative mortality in surgery for colorectal cancer. *Ann R Coll Surg Engl* 1991; **73**: 269–72.

4 Fielding LP, Stewart-Brown S, Blesovsky L. Anastomotic integrity after operation for large bowel cancer: a multicentre study. *Br Med J* 1980; **281**: 411–14.

5 Canivet JL, Damas-P, Desaive-C. Operative mortality following surgery for colo-rectal cancer. *Br J Surg* 1989; **76**: 745–7.

6 Kingston RD, Walsh S, Jeacock J. Curative resection: the major determinant of survival in patients with large bowel cancer. *J R Coll Surg Edinb* 1991; **36**: 298–302.

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