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An Evidence-based Treatment Algorithm for Colorectal Polyp Cancers: Results from the Scottish Screen-detected Polyp Cancer Study (SSPoCS)

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Abbreviations:

SBoSP	Scottish Bowel Screening Programme
SIGN	Scottish Intercollegiate Guidelines Network
NICE	National Institute for Health and Care Excellence
ACPGBI	Association of Coloproctologists of Great Britain and Ireland
MDT	Multidisciplinary team
gFOBt	guaiac-based faecal occult blood test
SSRG	Scottish Surgical Research Group
BMI	Body mass index
OR	Odds ratio
CI	Confidence interval
NHS	National Health Service
CT	Computed tomography
NORCCAG	Northern Colorectal Cancer Audit Group Study
EMR	Endoscopic Mucosal Resection

Word count: 3785

ABSTRACT

Objectives

Colorectal polyp cancers present clinicians with a treatment dilemma. Decisions of whether to offer segmental resection or endoscopic surveillance are often taken without reference to good quality evidence. The aim of this study was to develop a treatment algorithm for patients with screen-detected polyp cancers.

Design

This national cohort study included all patients with a polyp cancer identified through the Scottish Bowel Screening Programme (SBoSP) between 2000 and 2012. Multivariate regression analysis was used to assess the impact of clinical, endoscopic and pathological variables on the rate of adverse events (residual tumour in patients undergoing segmental resection or cancer-related death or disease recurrence in any patient). These data were used to develop a clinically relevant treatment algorithm.

Results

485 patients with polyp cancers were included. 186/485 (38%) underwent segmental resection and residual tumour was identified in 41/186 (22%). The only factor associated with an increased risk of residual tumour in the bowel wall was incomplete excision of the original polyp (OR 5.61, p=0.001) while only lymphovascular invasion was associated with an increased risk of lymph node metastases (OR 5.95, p=0.002). When patients undergoing segmental resection or endoscopic

surveillance were considered together, the risk of adverse events was significantly higher in patients with incomplete excision (OR 10.23, $p<0.001$) or lymphovascular invasion (OR 2.65, $p=0.023$).

Conclusions

A policy of surveillance is adequate for the majority of patients with screen-detected colorectal polyp cancers. Consideration of segmental resection should be reserved for those with incomplete excision or evidence of lymphovascular invasion.

Abstract word count = 249

SUMMARY 'BOX'

What is already known about this subject?

- Population bowel screening programmes lead to large numbers of colonoscopies being carried out in asymptomatic patients.
- As a result, the inadvertent discovery of cancer within an excised colorectal polyp has become increasingly common.
- The dilemma facing clinicians is whether to offer patients segmental resection or endoscopic surveillance.
- Current guidelines for polyp cancer management are based on poor quality evidence.

What are the new findings?

- The long-term survival of patients with polyp cancers is excellent, regardless of management strategy.
- Over three quarters of patients who undergo segmental resection have no evidence of residual tumour when their specimens are examined.
- Incomplete excision and evidence of lymphovascular invasion are the only independent predictors of residual tumour, disease recurrence and cancer-related death.
- Treatment decisions must be tailored to avoid unnecessary surgery.

How might it impact on clinical practice in the foreseeable future?

- A new treatment algorithm for colorectal polyp cancers is proposed.

INTRODUCTION

Colorectal cancer is the third most common cancer in the Western world, responsible for over 16,000 deaths annually in the United Kingdom alone [1]. There is now robust evidence that population screening can reduce cancer-related mortality by detecting and treating disease at an early stage[2 3]. Indeed, an analysis of the first million tests carried out in the English National Bowel Cancer Screening Programme reported that 10% of the cancers detected were evident only as a focus of malignancy within an excised colorectal polyp [4]. The diagnosis of these early malignant lesions, termed 'polyp cancers', is likely to become increasingly common as population screening programmes become established around the world [5].

The management of polyp cancers is difficult because of the possibility that residual tumour cells remain within the bowel wall or loco-regional lymph nodes following endoscopic polypectomy. The endoscopist is usually unaware that the polyp being excised contains a focus of cancer and the subsequent histological diagnosis is therefore unexpected. The dilemma then is whether such patients can be managed with surveillance alone or whether operative intervention is required. A segmental resection serves to clear the patient of the risk of residual tumour but carries inherent morbidity and mortality. Given that a proportion of patients undergoing resection have no evidence of residual disease when their specimens are examined [6-8], it could be argued that such patients are being exposed to unnecessary risk.

To assist decision-making, several guidelines for the management of colorectal polyp cancers exist, including those published by the Scottish Intercollegiate Guidelines Network (SIGN) [9] and the

National Institute for Health and Care Excellence (NICE) [10]. However, the underlying evidence base is poor and the resultant recommendations are necessarily pragmatic. Much of the literature to date has focused on whether individual pathological features can predict the risk of residual disease in patients undergoing surgery and knowledge regarding the long term outcomes of those surveyed endoscopically is lacking [7 11 12].

It is clear from a recent position statement by the Association of Coloproctologists of Great Britain and Ireland (ACPGBI) that the management of polyp cancers currently presents the colorectal multidisciplinary team (MDT) with a considerable challenge [13]. To address this topic, the present study sought to establish the incidence, management strategies and outcomes for all polyp cancers diagnosed through population screening in Scotland. The primary aim was to develop an evidence-based treatment algorithm for patients with screen-detected colorectal polyp cancers.

PATIENTS & METHODS

The Scottish Bowel Screening Programme

Population screening in Scotland was piloted from April 2000 before a phased national roll out was commenced in June 2007. By December 2009 all NHS Health Boards in the country were participating. The programme dictates that all men and women aged 50 to 74 are invited to complete a guaiac-based faecal occult blood test (gFOBt) every 2 years. Those with positive test results are referred to their local hospital for assessment and investigation with colonoscopy [14].

Patient involvement

The study was conducted by the Scottish Surgical Research Group (SSRG), a trainee-led research collaborative, in conjunction with the Scottish Bowel Screening Programme (SBoSP). Outcome measures were chosen for their ability to influence how patients could make more informed treatment decisions. The study design was endorsed by professional and lay members of the SBoSP steering committee.

Inclusion and exclusion criteria

For the purposes of this study, a polyp cancer was defined as a colorectal polyp where primary excision was carried out endoscopically and where there was subsequent histological evidence of neoplastic cells having invaded through the muscularis mucosae into the submucosa. Cases were identified by interrogating the SBoSP database, a prospectively maintained database containing information on all patients who have participated in screening. All polyp cancers diagnosed since the start of the pilot programme on 01 April 2000 until 31 December 2012 were included. To

ensure reliability of data, the original endoscopy and histopathology reports of each potential case were reviewed on an individual basis and the following exclusion criteria applied; (1) specimens that were a biopsy of an invasive carcinoma, (2) polyps with high grade dysplasia only, (3) cases with a synchronous invasive cancer elsewhere in the colorectum, (4) cases with insufficient data to confirm the diagnosis. Finally, for included cases, medical records were retrieved from local health boards and clinical, endoscopic, radiological and pathological data recorded using a standardised proforma.

Primary outcome

The primary outcome was the number of adverse events. An adverse event was defined as any of the following; (1) evidence of tumour in the resected specimen of patients undergoing segmental resection, (2) cancer-related death in any patient, regardless of management strategy, (3) local or systemic disease recurrence in any patient, regardless of management strategy. Information on date and cause of death was obtained from the national cancer registration system and cross-checked with that received by the Registrar General (Scotland). Death records were considered complete up to 31 December 2012, which served as the censor date. Overall, cancer-specific and recurrence-free survival was measured from the date of the screening colonoscopy until the date of death or confirmed disease recurrence.

Clinico-pathological variables

Endoscopic variables recorded included polyp location, polyp morphology and polypectomy technique used during the initial colonoscopy. Pathological variables were recorded from contemporary laboratory reports and included details of whether the specimen had been reviewed

centrally by an independent panel of screening programme pathologists. Variables recorded included polyp size, differentiation and the presence of lymphatic and/or venous invasion (termed lymphovascular invasion). If the invasive margin could be reliably assessed pathologically and was free of tumour (regardless of distance), it was regarded as 'completely excised'. If the margin could not be assessed or if there was evidence of tumour extending to the diathermy edge, it was regarded as 'incompletely excised'. Where documented, the margin clearance in millimetres (mm) was also recorded. Pathological assessment of the depth of submucosal (sm) invasion according to the Haggitt [15] and Kikuchi [16] systems were included where documented. The Haggit levels of invasion in pedunculated polyps are defined as follows. Level 1: carcinoma invading into the submucosa but limited to the head of the polyp; Level 2: carcinoma invading to the level of the neck; Level 3: carcinoma invading any part of the stalk; Level 4: carcinoma invading into the submucosa below the level of the stalk but above the muscularis propria. The Kikuchi classification relates to sessile polyps and is defined as follows. An sm1 tumour invades into the upper third of the submucosa, an sm2 tumour invades into the middle third and an sm3 tumour invades into the lower third of the submucosa.

Demographic data included age, sex, body mass index (BMI) and comorbidity profile. The latter was assessed using the Charlson Comorbidity Index, a validated method for quantifying the burden of comorbidity[17]. Surgical outcomes in patients undergoing segmental resection (right hemicolectomy, left hemicolectomy, sigmoid colectomy, anterior resection, subtotal colectomy) or transanal excision microsurgery (TEMS) included length of stay and 30 day rates of mortality and morbidity. Post-operative complications were classified according to Clavien-Dindo criteria and graded as 'minor' (grade I/II) or 'major' (grade III/IV) [18].

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Statistical analysis

Grouping of variables was carried out using previously published or clinically relevant thresholds. Categorical variables were compared using Chi-square tests and binary logistic regression with calculation of odds ratios (OR) and 95% confidence intervals (CI). Continuous variables were compared using appropriate parametric and non-parametric tests. Multivariate analyses of associations with adverse events were carried out using a binary logistic regression model. *P* values <0.05 were considered statistically significant. Statistical analyses were performed using SPSS software (Version 19.0, IBM SPSS Inc., Chicago, IL).

Ethical review

Ethical approval was sought and obtained from the NHS Scotland Caldicott Guardian who confirmed that the study fulfilled the criteria of a clinical audit, obviating the requirement for further ethical committee approval.

RESULTS

The total number of invitations sent, screening colonoscopies carried out and number of cancers diagnosed through national screening in Scotland are shown in Figure 1. Since the programme began there have been 3202 bowel cancers identified. Interrogation of the SBoSP database originally identified 772 cases as possible polyp cancers. After examining medical records, 287 cases were excluded (143 were a biopsy only, 90 had no evidence of invasive malignancy, 10 had synchronous cancers, 35 had insufficient data and 9 were excluded for other reasons e.g. polyps not detected through screening) and 485 cases were included. Polyp cancers therefore comprised 15% (485/3202) of all screen-detected cancers with an annual incidence of 11 per 100,000 patients screened.

The summary characteristics of the 485 included cases are shown in Table 1. The vast majority of polyp cancers were located in the left colon (75%) or rectum (18%) with the morphology pedunculated in 58% and sessile in 31%. According to the original colonoscopy report, 71% of polyps were removed intact and 21% were excised piecemeal. The focus of tumour was considered incompletely excised in 39% (tumour extended to the diathermy edge in 27%; margin not assessable in 12%). The polyp specimen underwent central pathological review in 110/485 (23%) of cases (Table 1).

Table 1. Summary characteristics of the included patients.

Variable		**485 (%)**
Age	≤ 70 years	351 (72)
	> 70 years	134 (28)
Sex	Female	162 (33)
	Male	323 (67)
BMI	Normal (<25 kg/m^2)	74 (15)
	Overweight (25-30 kg/m^2)	147 (30)
	Obese (≥30 kg/m^2)	88 (18)
	missing	176 (36)
Charlson Comorbidity Index	0-2 (fit)	251 (52)
	≥3 (unfit)	186 (38)
	missing	48 (10)
Polyp location	Right colon	28 (6)
	Left colon	363 (75)
	Rectum	88 (18)
	Not recorded	6 (1)
Polyp size	< 10mm	101 (21)
	≥ 10mm	326 (67)
	Not recorded	58 (12)
Polyp morphology	Pedunculated	283 (58)
	Sessile	149 (31)
	Not recorded	53 (11)
Polypectomy technique ¥	Intact	345 (71)
	Piecemeal	103 (21)
	Not recorded	37 (8)
Polyp differentiation	Well/moderate	337 (70)
	Poor	45 (9)
	Not recorded	103 (21)
Lymphovascular invasion	Absent/not recorded	400 (82)
	Present	85 (18)
Completeness of excision	Complete †	296 (61)
	Incomplete (tumour to diathermy edge)	133 (27)
	Incomplete (not assessable)	56 (12)
Margin clearance	>1mm	178 (37)
	≤1mm	251 (52)
	Not assessable	56 (12)
Kikuchi level	Sm1	10 (2)
	Sm 2	18 (4)
	Sm 3	7 (1)
	Not recorded	450 (93)
Haggit level	Level 1/2	47 (10)
	Level 3/4	30 (6)
	Not recorded	408 (84)

* Chi-square test
¥ According to screening colonoscopy report
†Complete excision is defined as a pathologically assessable margin that is free of tumour

The strategies employed in the management of the patients with polyp cancers are summarised in Figure 2. There was documentation that the initial treatment decision was taken by a colorectal MDT in the majority of cases (74%). Over three quarters of patients (76%) were staged with a computed tomography (CT) scan (data not shown). Of note, there was a change from the intended treatment plan in a number of patients. The reasons for this were often not apparent from case note review but, where documented, included patient preference (n=10), fitness for surgery (n=2) and failed attempts at endoscopic re-resection (n=5). The final management strategy was a segmental resection in 186/485 (38%) and endoscopic surveillance in 299/485 (62%). Of the patients who underwent segmental resection, 186/485 (22%) had evidence of tumour in their resected specimens and 299/485 (78%) did not (Figure 2).

The operations performed, surgical outcomes and final pathology of the 186 patients who underwent segmental resection are shown in Table 2. Pathological examination of the resected bowel revealed evidence of residual tumour in 41/186 (22%) specimens. There was evidence of lymph node metastases in a total of 15/186 (8%) (Table 2).

Factors associated with the presence of residual disease in the bowel wall or lymph nodes in patients undergoing segmental resection are shown in Table 3. Following resection, the only factor associated with an increased risk of residual disease in the bowel wall was pathological evidence of incomplete excision (OR 5.61, p=0.001). The only factor that significantly increased the risk of lymph node metastases was evidence of lymphovascular invasion in the original polyp (OR 5.95, p=0.002) (Table 3).

Table 2. Operations, surgical outcomes and final pathology of the 186 patients who underwent segmental resection of a screen-detected polyp cancer.

Type of operation		**186 (%)**
Right hemicolectomy		15 (8)
Left hemicolectomy		18 (10)
Sigmoid colectomy		42 (23)
Anterior resection		90 (48)
Subtotal colectomy		5 (3)
Abdominoperineal resection		3 (2)
TEMS		7 (4)
Unknown		6 (3)
Operative Outcomes		
Length of stay (days) median (range)		7 (1-152)
Mortality*		0 (0)
Morbidity*		60 (32)
Major morbidity†		21 (11)
Anastomotic leak		7 (3.8)
Final Pathology		
Residual tumour		41 (22)
Residual tumour location	Luminal only	26 (14)
	Nodal only	3 (2)
	Luminal and nodal	12 (6)
T stage Ω	1	168 (90)
	2	11 (6)
	3	5 (3)
	4	2 (1)
N stage	0	171 (92)
	1	12 (6)
	2	3 (2)
Differentiation	Well	4 (10)
	Moderate	22 (53)
	Poor	5 (12)
	Not recorded	10 (24)
EMVI	No	35 (85)
	Yes	6 (15)
Number of nodes examined	Median (range)	9 (1-51)

* 30 day rate † Clavien-Dindo grade 3 or 4
Ω Patients with no evidence of residual disease in the resected bowel were designated as pT1 for staging purposes
EMVI; Extra-mural venous invasion
TEMS; transanal excision microsurgery

Long term outcomes are summarised in Figure 2. The median length of follow up was 50 months (minimum 16 months). Death records were complete up to 31 December 2014. The five-year overall, cancer-specific and recurrence-free survival of the cohort was 90%, 98% and 92% respectively. There was no difference in overall (p=0.78, log rank test) or cancer-specific (p=0.07, log rank test) survival between patients managed by segmental resection or endoscopic surveillance. Patients managed by segmental resection had a higher rate of systemic recurrence compared to those managed with endoscopic surveillance (6.5% versus 2.7%, X^2 value = 4.13, df = 1, p=0.042) although the rates of local recurrence were similar (2.2% versus 1.3%, X^2 value = 0.467, df = 1, p=0.49). Overall, the recurrence-free survival was significantly shorter in patients managed by segmental resection (median time to recurrence 45 months versus 53 months, p=0.008, log rank test) (data not shown).

Table 3. Factors associated with the presence of residual disease in the bowel wall or lymph nodes of the 186 patients who underwent segmental resection of screen-detected polyp cancers.

Variable		Residual disease in bowel wall				Residual disease in lymph nodes			
		N (%)	O.R.	95% C.I.	p value*	N (%)	O.R.	95% C.I.	p value*
Age	≤ 70 years	31 (24)				14 (10)			
	> 70 years	7 (17)	0.76	0.31-1.87	0.55	1 (2)	0.23	0.03-1.83	0.17
Sex	Female	11 (18)				6 (10)			
	Male	27 (21)	1.22	0.56-2.65	0.63	9 (7)	0.69	0.24-2.04	0.51
BMI	< 25 kg/m^2	4 (14)				1 (3)			
	> 25 kg/m^2	16 (19)	1.52	0.46-4.97	0.49	7 (9)	2.61	0.31-22.21	0.38
Charlson Comorbidity Index	0-2 (fit)	21 (20)				5 (6)			
	≥3 (unfit)	17 (24)	1.28	0.62-2.65	0.50	8 (11)	2.13	0.71-6.43	0.18
Polyp location	Colon	31 (20)				13 (9)			
	Rectum	7 (21)	1.01	0.40-2.54	0.98	2 (6)	0.67	0.14-3.11	0.61
Polyp size	< 10mm	8 (25)				2 (6)			
	≥ 10mm	27 (21)	0.79	0.32-1.95	0.60	11 (9)	1.39	0.29-6.59	0.68
Polyp morphology	Pedunculated	17 (18)				8 (8)			
	Sessile	16 (24)	1.47	0.68-3.17	0.33	7 (11)	1.29	0.44-3.75	0.64
Polyp differentiation	Well/mod	24 (19)				10 (8)			
	Poor	2 (9)	0.41	0.09-1.86	0.25	3 (13)	1.76	0.44-6.94	0.42
Lymphovascular invasion	Absent/not recorded	31 (23)				5 (4)			
	Present	7 (13)	0.50	0.21-1.22	0.13	10 (19)	5.95	1.93-18.39	0.002
Completeness of excision	Complete†	5 (7)				5 (7)			
	Incomplete	33 (29)	5.61	2.08-15.17	0.001	10 (9)	1.32	0.43-4.03	0.63
Margin clearance	>1mm	2 (7)				1 (4)			
	≤1mm / not assessable	36 (23)	3.84	0.87-16.94	0.08	14 (9)	2.63	0.33-20.80	0.36

OR; Odds ratio, CI; Confidence interval
* Binary logistic regression analysis
†Complete excision is defined as a pathologically assessable margin that is free of tumour

To investigate which variables were most relevant to surgical decision-making, we analysed their impact on the risk of adverse events. On multivariate logistic regression analysis, the factors independently associated with an increased risk of adverse events were pathological evidence of incomplete excision (OR 10.23, 95% CI 4.24-24.64, p<0.001) and the presence of lymphovascular invasion (OR 2.65, 95% CI 1.14-6.15, p=0.023) (Table 4).

Table 4. Multivariate analysis of risk factors associated with adverse events in all patients with screen-detected polyp cancers (binary logistic regression analysis). An adverse event is defined as (1) evidence of tumour in the resected specimen of patients undergoing segmental resection, (2) cancer-related death in any patient, (3) local or systemic disease recurrence in any patient.

Risk factor		**Adverse events**			
		N (%)	**O.R.**	**95% CI**	**p value***
Age	> 70 years	15 (11)	0.98	0.93 – 1.05	0.65
Sex	Male	43 (13)	1.06	0.45 – 2.47	0.90
Charlson Comorbidity Index	≥3 (unfit)	26 (14)	1.61	0.72 – 3.62	0.25
Polyp location	Rectum	12 (14)	0.60	0.22 – 1.65	0.32
Polyp size	≥ 10mm	44 (14)	1.72	0.62 – 4.71	0.30
Polyp morphology	Sessile	24 (16)	1.19	0.53 – 2.67	0.67
Polyp differentiation	Poor	6 (13)	1.78	0.49 – 6.43	0.38
Lymphovascular invasion	Present	16 (19)	2.65	1.14 – 6.15	0.023
Completeness of excision	Incomplete†	46 (24)	10.23	4.24 – 24.64	<0.001

OR; Odds ratio, CI; Confidence interval
*Multivariate binary logistic regression analysis
†Defined as pathological evidence of tumour extending to the diathermy edge or a margin that is not assessable

Using this data, we developed a treatment algorithm for patients with colorectal polyp cancers (Figure 3). This advocates that patients with completely excised polyp cancers without evidence of lymphovascular invasion are in a ‘low risk’ category (5% risk of adverse events) and can be followed up accordingly. Patients with completely excised polyp cancers but evidence of lymphovascular invasion are in a ‘medium risk’ category and should be considered for segmental resection (10% risk of adverse events). Finally, patients with incompletely excised polyp cancers are in a ‘high risk’ category and should be considered for segmental resection on the basis of a 24% risk of adverse events (Figure 3).

DISCUSSION

To our knowledge, the present study is the largest to have examined the treatment strategies and outcomes of patients with colorectal polyp cancers. By including every case identified since national screening began in Scotland over 15 years ago, we have been able to accurately define the incidence of screen-detected polyp cancers and provide an overview of current practice.

As screening programmes detect increasing numbers of polyp cancers, it is crucial that their management is based on good quality evidence. With this in mind, we sought to answer several key questions related to treatment decisions. The first was whether patients diagnosed with a focus of malignancy within an excised polyp should be offered segmental resection or endoscopic surveillance. When making this decision, the patient and clinician must balance the morbidity of surgery against the risk of residual disease if a surveillance strategy is followed. In our series, 78% of the segmental resections demonstrated no evidence of residual tumour and could, in retrospect, be considered to have been unnecessary. Our figures are similar to those reported by Gill and co-workers from a study of malignant colorectal polyps in the North of England. In the 71 patients who underwent surgery, there was no evidence of residual tumour in 82% [6]. However, despite this apparent over-treatment, it must be remembered that a small number of patients did have residual tumour, including metastases to the regional lymph nodes in 8%. An ideal predictive model would therefore identify those patients most likely to benefit from resection while preventing an excess of unnecessary operations. Previous studies have reported an array of 'high risk' pathological features, including polyp size[19], location[20], lymphovascular invasion [12], poor differentiation[21], tumour budding [22], close or involved margins [12 22], sessile

morphology [23] and depth of submucosal invasion. The latter, in particular, is widely regarded as an important determinant of the likelihood of lymph node metastases and can be assessed in a number of different ways. One option is to use the ordinal grading systems such as those described by Kikuchi [16] and Haggitt [15]. It should be emphasized, however, that these systems cannot be applied if the polypectomy specimen is too superficial to contain any muscularis propria; as should be the case after safe endoscopic excision of colonic or extraperitoneal rectal polyps. An alternative option is to employ a quantitative measurement of the breadth and depth of submucosal invasion in micrometres (μm). Using this technique, Ueno and colleagues [22] were able to predict which patients with early invasive cancers were likely to have lymph node metastases. While this method may have merit, such measurements are yet to be incorporated into standard pathological reporting of colorectal polyps in the United Kingdom and thus cannot yet play a role in polyp cancer decision-making.

In fact, our data suggest that histopathological confirmation of complete excision is enough to confidently predict a low likelihood of residual disease in the bowel lumen. We found that patients with completely excised polyp cancers had a <10% risk of residual disease compared to >30% in those where the margin was either involved or not assessable. Interestingly, extending the margin clearance to at least 1mm, as suggested by several international guidelines, did not improve risk stratification. Similar results were observed in the Northern Colorectal Cancer Audit Group Study (NORCCAG) where the authors reported that any clear margin was adequate, even as small as 0.1mm [6]. The caveat to these observations is that a small number of patients with completely excised lesions will have occult lymph node metastases at the time of their polypectomy. Clearly such patients would be best served by segmental resection but identifying

them is difficult. The only predictor of lymph node involvement in our series was the presence of lymphovascular invasion in the resected polyp. This is in line with findings from a pooled analysis of thirty one smaller studies, where the authors reported vascular invasion as the only factor associated with a higher rate of lymph node metastases [12]. Although the association between lymphovascular invasion and nodal metastases is intuitive, it is worthy of attention for several reasons. First, lymphovascular invasion appeared to be an important risk factor in patients managed both operatively and conservatively. Given that there is evidence that the use of 'elastica' staining can increase the detection of venous invasion in colorectal cancers [24], the question must now be asked whether adopting such a policy would translate into improved risk stratification.

The present study sought to report the long term outcomes of patients with polyp cancers and the most striking result was how few patients succumbed to their disease. Regardless of the type of treatment received, only 6% of patients developed tumour recurrence and less than 2% died of their disease. Decisions about how intensively to follow-up polyp cancers are for individual health authorities but our data suggests that endoscopic surveillance has a low diagnostic yield. One option, therefore, would be to simply apply existing British Society of Gastroenterology (BSG) adenoma surveillance guidelines [25].

In addition to the treatment algorithm we have proposed, this study has highlighted a number of simple points of practice that have the potential to improve polyp cancer management. Treatment decisions are reliant on the quality of the initial endoscopy and subsequent pathological examination and having an intact specimen with an invasive margin that can be accurately

assessed is key. The endoscopist should make every effort to achieve this and to this end we would support the wider use of advanced endoscopic techniques such as Endoscopic Mucosal Resection (EMR)[26 27]. In addition, although a cancer diagnosis may not be unexpected, we would encourage a policy of tattooing all suspicious polyps; without which attempts at endoscopic surveillance or re-excision are difficult [28]. Finally, we would advocate a policy of didactic reporting for all colorectal polyp cancers.

The main limitation to the present study was its retrospective nature. Treatment decisions had already been taken and the reasons behind them could often only be surmised. However, the data was derived from every health board in the country and we believe it to be a true representation of current practice. Our results are also limited by the fact that information on certain pathological risk factors was not available. However, we would emphasize that this study was conducted primarily to develop a clinically useful treatment algorithm and with this in mind, we only included variables that were and are described on contemporary pathology reports. In the future we plan to conduct a central pathological review of all available polyp cancer specimens. This will give opportunity to examine additional risk factors, such a quantitative measurements of submucosal invasion[22], tumour budding[22], mismatch repair status[29] and peritumoural inflammatory cell response[30] that may be of equal or greater value in predicting outcomes. Finally, our study was confined to polyps detected through population screening and it may be that the tumour biology of symptomatic lesions is different[31]. To address this, we are in the process of developing a national database of both incidental and screen-detected polyp cancers.

In conclusion, we have provided a treatment algorithm for patients with screen-detected colorectal polyp cancers. A policy of surveillance appears to be adequate for the majority of patients and consideration of segmental resection should be reserved for those with incomplete excision or evidence of lymphovascular invasion. To reduce uncertainty with these decisions, every effort should be made to obtain a single, intact resection specimen at the time of polypectomy.

Figure Legends

Figure 1. Summary data from the Scottish Bowel Screening Programme (SBoSP) showing the number of invitations sent, screening colonoscopies carried out and the number of non-polyp and polyp cancers diagnosed. The steep increase in 2007 reflects the end of the pilot programme and the start of the phased national rollout.

Figure 2. Management strategies and outcomes of screen-detected polyp cancers in Scotland. An adverse event is defined as (1) residual tumour in the specimen following segmental resection, (2) cancer death or (3) local or systemic disease recurrence.

Figure 3. The SSPoCS system: a proposed treatment algorithm for the management of patients with colorectal polyp cancers. The assessments of risk are based on the chance of adverse events, regardless of the management strategy chosen.

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Contributorship

RJCS and FAC proposed the project to the Scottish Surgical Research Group, a trainee-led research collaborative. GR was responsible for the relevant ethical approvals and liased with the Scottish Bowel Screening Programme. CHR coordinated data collection in the North of Scotland Deanery, NTV in the South-West of Scotland , DM in the West of Scotland and MW in the East of Scotland. All other authors extracted, collected and assimilated data from their relevant geographical area. The data was analysed by CHR and NTV. CHR wrote the manuscript which was revised and edited by RJCS, FAC, NTV, DM, MW, GR, and CDM. All other authors provided advice, intellectual input and approved the final manuscript.

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