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ORIGINAL ARTICLE

Management of high and low risk malignant polyps: a population-wide analysis

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Abstract

Aim: The management of malignant polyps is a treatment dilemma in selecting between polypectomy and colorectal resection. To assist clinicians, guidelines have been developed by the Association of Coloproctology of Great Britain and Ireland (ACPGBI) to provide treatment recommendations.

Methods: This study compared management strategy based on the ACPGBI risk categorization for malignant polyps. Univariable and multivariable statistical analysis was undertaken to assess the factors predicting management strategy. A population-wide analysis was performed of 1646 malignant polyps and the factors that predicted their management strategy, from Queensland, Australia, from 2011 to 2019.

Results: Overall, 31.55% of patients with very low or low risk disease proceeded to resection. Of those with high or very high risk disease, 36.69% did not proceed to resection. In very low and low risk polyps, age ($P = 0.003$) and polyp location ($P < 0.001$) were significantly different between the colorectal resection group and the polypectomy alone group. In those with very high or high risk polyps age ($P < 0.001$), type of facility (public or private) for the colonoscopy ($P = 0.037$), right colonic polyps compared to left colonic polyps ($P = 0.015$) and rectal polyps ($P < 0.001$) and mismatch repair mutations present ($P = 0.027$) were predictive of resection in high risk disease using a multivariable model.

Conclusion: Over 30% of patients with very low and low risk malignant polyps proceeded to resection, against the advice of guidelines. Furthermore, over 35% of patients with very high or high risk malignant polyps did not proceed to resection. Education strategies may improve management decision choices. Furthermore, improvements in data collation will improve the understanding of management choices in the future.

KEYWORDS
colorectal cancer, colorectal surgery, malignant polyp, polypectomy

INTRODUCTION

Colorectal adenocarcinoma represents one of the most commonly diagnosed malignancies throughout the world [1]. This cancer commonly develops within adenomatous polyps following the adenoma–carcinoma sequence. Consequently, early in carcinogenesis, cancer may be restricted to being within a polyp—thus termed a malignant polyp. Malignant polyps are defined as any macroscopically complete

endoluminal resection of an adenoma that contains a focus of adenocarcinoma, which invades through the muscularis mucosae into the submucosa [2–4]. Furthermore, malignant cells must be seen to be invading into the submucosa (excluding intramucosal carcinoma), and those cancers invading beyond the submucosa (i.e., T2 or higher) are no longer considered malignant polyps [2, 4].

The management of malignant polyps poses a dilemma. Historically management was for all patients to undergo a colorectal resection ensuring complete excision of all draining nodes as well as the polypectomy site [4]. However, few patients had residual disease in the bowel wall or lymphovascular metastasis. It was, and is therefore, of interest to determine which patients were at risk of residual disease. A number of pathological factors have been described which increase the risk of either residual disease or metastatic disease to draining lymph nodes [5]. These have been summarized in various guidelines, including those of the Association of Coloproctology of Great Britain and Ireland (ACPGBI) [5].

The ACPGBI guidelines grade the risk of residual disease (either residual disease in the bowel wall or lymphatic disease) from very low to very high, in five categories. The factors which influence this grade are the status of the polypectomy resection margin, the depth of invasion assessed by either Haggitt or Kikuchi levels, the presence of poor tumour differentiation, mucinous differentiation in the tumour, the presence of tumour budding and any lymphovascular invasion [5]. The ACPGBI guidelines calculate the grade of risk by summing the presence of the above criteria, based on the individual risk contributed to the presence of residual or lymphatic disease (Table S1). In Grades 0 and 1 (very low or low) the guidelines recommend routine follow-up. In Grades 3 and 4 (high and very high risk), the guidelines recommend to err towards surgery or recommend surgery [5].

Whilst guidelines are important for assisting clinicians to make a recommendation for surgery, individual patient preferences and systemic risk factors need to be considered in treatment decisions. Thus, when confronted with the diagnosis of a malignant polyp, clinicians and patients must balance the risks of surgery against the likelihood of residual disease or metastatic spread.

It is of interest to know how patients with a malignant polyp are being managed. In Queensland, Australia, reporting of all malignancies to the Queensland Cancer Registry is mandated by law. These data are managed by the Cancer Alliance Queensland, which links the data from the Queensland Cancer Registry with over 60 other population level sources including hospital admissions, treatment, public and private pathology and mortality data into the Queensland Oncology Repository (QOR). By accessing this combined repository, a complete population-wide analysis of malignant polyps can be performed.

What does this paper add to the literature?

This study is one of the largest population-wide analyses of the management of malignant polyps. Furthermore, it is the only population-wide study assessing management choice based on risk categorization from the Association of Coloproctology of Great Britain and Ireland guidelines.

METHODS

This retrospective population-based cohort study was performed using data from the linked QOR. Ethical approval for this was given by the Brisbane Metro North Health Human Research Ethics Committee (HREC/17/QRBW/483). All data were initially screened on an encrypted database. Once screening and reviewing was completed, data were extracted and, in the process, de-identified.

Population

All Queensland, Australia, patients (population 5.2 million [6]) from January 2011 to October 2019 were considered for this study. A screening algorithm was developed to identify all patients diagnosed with a colorectal adenocarcinoma (ICD-10 codes C18, C19, C20) which excluded patients who were not diagnosed on colonoscopy (Australian Classification of Health Interventions ICD-10 codes 3209001, 3209300, 328401, 3208401, 3208700), flexible sigmoidoscopy (ICD-10 codes 3207501, 3207800, 3208100) or other endoluminal excision (e.g., ICD-10 code 3210500). Thus, all patients diagnosed with large or perforated tumours were excluded.

Each individual patient record was then manually examined to identify which patients had a malignant polyp (as defined above) compared with other more advanced disease. Those patients diagnosed with synchronous malignant polyps or other synchronous colorectal malignancy, prior history of colorectal malignancy, history of inflammatory bowel disease, history of familial or inherited polyposis syndromes and those who were post treatment with neoadjuvant chemotherapy and/or radiotherapy were excluded from this study.

Variables extracted

Following screening, all pathology reports were reviewed to extract necessary details to classify patients based on the ACPGBI risk of residual disease score (resection margins, Haggitt/Kikuchi level, tumour differentiation, presence of mucinous differentiation, tumour budding and lymphovascular invasion). Polyps were then categorized per the ACPGBI guidelines into very low, low, medium, high or very high risk of residual disease. These data were extracted along with other patient demographic and pathological data including age, gender, American Society of Anesthesiology (ASA) score, socioeconomic status (assigned according to the Australian Bureau of Statistics Socioeconomic Index for Areas, SEIFA) [7], residential location (grouped as major city, inner regional or rural, as per the Australian Geographical Classification [8]), location of where the procedure was undertaken, location of the polyp, the type of underlying polyp and whether a mismatch repair mutation was detected.

Using the SEIFA decile ranking system to assign socioeconomic status, patients from suburbs in deciles 1–2 were classed as 'Affluent', deciles 3–8 as 'Middle' and deciles 9–10 as 'Disadvantaged'. Patient comorbidities were also obtained using hospital admission data, from any admission 12 months prior to or after the diagnosis of a malignant polyp. The number of comorbidities a patient had were counted from a list: acquired immune deficiency syndrome, prior myocardial infarction, cancer (other than the malignant polyp), cerebrovascular disease, congestive heart failure, chronic obstructive pulmonary disease, dementia, diabetes, complications from diabetes, hemiplegia or paraplegia, liver disease, peptic ulcer disease, peripheral vascular disease, renal disease and rheumatoid/connective tissue disease. The location where the colonoscopy was performed was defined as either metropolitan or regional/rural [9]. Health facilities were considered to be metropolitan if they were located within the Hospital and Health Services of Brisbane Metro North, Brisbane Metro South, Gold Coast, Sunshine Coast or West Moreton. The management of patients following diagnosis with a malignant polyp was also documented—whether that be colonoscopy and surveillance, or colorectal resection.

Analysis

Comparison of patient characteristics between those who had polypectomy and surveillance alone (including those undergoing advanced endoscopic resection techniques such as endoscopic mucosal resection and endoscopic submucosal dissection) compared to polypectomy and colorectal resection was analysed using Student's *t* test and chi-squared tests as appropriate. Furthermore, subgroup analysis was performed analysing those with low risk disease (ACPGBI risk of residual disease rated as very low or low) and high risk disease (ACPGBI risk of residual disease rated as high or very high). Multivariable logistic regression models were additionally created to assess the significance of patient factors on the choice of management strategy. Statistical analysis was performed using Stata v17.0 (STATA). Statistical significance was defined as a P value <0.05.

RESULTS

The initial screening algorithms identified 18 303 patients (all colorectal adenocarcinomas diagnosed on colonoscopy or flexible sigmoidoscopy). Following manual examination of the records of these cases, 1646 patients with a malignant polyp were identified. The mean age at diagnosis was 66.5 years (range 15–96), with a median age of 67. Table 1 demonstrates how patients were managed based on their ACPGBI risk score. Using a chi-squared analysis, there was a significant difference in the rate of follow-up colorectal resection compared against the ACPGBI risk group ($P<0.001$). There were a number of missing pathological details, which may have influenced the ACPGBI score; the most frequently non-reported detail was tumour budding with 947 pathology reports not commenting on this feature. Furthermore, 770 pathology reports did not detail a Haggitt or Kikuchi level. There was a median of two missing histopathological features per pathology report. The mean number of missing pathological details decreased by an average of 0.4 missing features per year over the study period ($P = 0.008$).

TABLE 1 Management strategy as per the ACPGBI polyp risk profile

	Follow-up resection		
ACPGBI guideline score[a]	Yes (%)	No (%)	Total
0 (very low)	146 (31.88)	312 (68.12)	458
1 (low)	78 (33.05)	158 (66.95)	236
2 (medium)	43 (64.18)	24 (35.82)	67
3 (high)	42 (60.87)	27 (39.13)	69
4 (very high)	540 (66.18)	276 (33.82)	816
Total	849 (51.58)	797 (48.42)	1646

[a]ACPGBI, Association of ColoProctology of Great Britain and Ireland, risk of residual disease assessment from the ACPGBI malignant polyp guidelines [5].

To determine what factors may influence the rate of colorectal resection, patient and pathological factors were compared between those who had polypectomy alone versus polypectomy and a follow-up colorectal resection. This was first assessed for all patients (Table 2). A subgroup analysis was then performed for those with very low and low risk of residual disease (Table 3) and for those with high and very high risk disease (Table 4) as classified by the ACPGBI guidelines. A multivariable logistic regression model was created for the overall analysis (logistic regression model $P<0.001$), of the low risk polyp group ($P = 0.036$) and the high risk polyp group ($P<0.001$).

Using a chi-squared analysis, there were no significant differences in the management strategy based upon the year of diagnosis ($P = 0.15$). This remained not significant when performing a subgroup analysis for very low and low risk polyps ($P = 0.08$) and high and very high risk polyps ($P = 0.057$).

Patient age was significantly lower in those who proceeded to follow-up resection, both overall and in all subgroup analyses ($P<0.001$). Age remained significant when adjusting for other variables. Management strategy was significantly different depending on the polyp location in all analyses ($P<0.001$); however, in the adjusted model for low risk polyps, rectal polyp was only of borderline significance in predicting different management strategies ($P = 0.063$). The adjusted model did demonstrate, however, that left colonic polyps were, in all patients, significantly less likely to proceed to resection compared to right colonic disease ($P = 0.009$). In high risk disease, right colonic polyps proceeded to resection in 72.9% of cases, whereas rectal polyps proceeded to resection in only 49.28% of cases ($P<0.001$; Table 4). Also, in high risk disease there was a significant difference in management strategy based on both where the colonoscopy was performed ($P = 0.005$) and the patient's residence ($P = 0.001$); however, in the adjusted model both of these factors were no longer significant.

TABLE 2 Comparison between patients with malignant polyps and their subsequent management—all patients

Variable	Polypectomy alone (%) $n = 797$	Follow-up resection (%) $n = 849$	*P* value	Adjusted OR (95% CI)	*P* value
Age (mean) (95% CI)	68.80 (68.01–69.60)	64.43 (63.64–65.22)	**<0.001**	0.96 (0.94–0.97)	**<0.001**
ASA score			**<0.001**		
1	83 (36.89)	142 (63.11)		REF	
2	304 (46.55)	349 (53.45)		1.24 (0.75–2.02)	0.40
3	210 (59.49)	143 (40.51)		0.70 (0.39–1.24)	0.22
4	22 (70.97)	9 (29.03)		0.72 (0.21–2.53)	0.61
Comorbidity count			**<0.001**		
0	224 (54.5)	187 (45.5)		REF	
1	382 (43.41)	498 (56.59)		0.87 (0.50–1.51)	0.62
2+	191 (53.8)	164 (46.2)		1.06 (0.55–2.07)	0.86
Gender			**0.001**		
Male	520 (51.64)	487 (48.36)		REF	
Female	277 (43.35)	362 (56.65)		1.49 (1.04–2.15)	**0.031**
Type of facility for colonoscopy			**<0.001**		
Public	268 (57.51)	198 (42.49)		0.74 (0.47–1.16)	0.19
Private	517 (44.84)	636 (55.16)		REF	
Socioeconomic status			**0.025**		
Affluent	74 (39.78)	112 (60.22)		REF	
Middle	517 (48.82)	542 (51.18)		1.19 (0.70–2.01)	0.52
Disadvantaged	202 (51.79)	188 (48.21)		1.04 (0.54–2.00)	0.91
Residence of patient			**0.033**		
Major city	454 (45.9)	535 (54.1)		*REF*	
Inner regional	243 (52.83)	217 (47.17)		1.31 (0.76–2.26)	0.33
Remote	96 (51.61)	90 (48.39)		1.06 (0.48–2.31)	0.89
Location of colonoscopy			**0.005**		
Metropolitan	507 (46.01)	595 (53.99)		REF	
Regional/rural	290 (53.31)	254 (46.69)		0.68 (0.39–1.20)	0.18
Site of polyp			**<0.001**		
Right colon	111 (37.5)	185 (62.5)		REF	
Left colon	414 (46.83)	470 (53.17)		0.48 (0.28–0.83)	**0.009**
Rectum	267 (60.14)	177 (39.86)		0.31 (0.16–0.63)	**0.001**
Polyp type			0.37		
TA	207 (49.17)	214 (50.83)		0.80 (0.37–1.73)	0.57
TVA	435 (51.24)	414 (48.76)		1.02 (0.49–2.10)	0.96
VA	48 (50)	48 (50)		0.63 (0.25–1.57)	0.32
SSA	49 (42.61)	66 (57.39)		REF	
Mismatch repair			0.14		
Normal	345 (44.01)	439 (55.99)		REF	
Mutation present	33 (35.87)	59 (64.13)		1.00 (0.51–1.96)	0.99

Abbreviations: ASA, American Society of Anesthesiology score [10]; SSA, sessile serrated adenoma/lesion; TA, tubular adenoma; TVA, tubulovillous adenoma; VA, villous adenoma.

Bold values indicate all the results that are statistical significant.

DISCUSSION

This study assessed the contemporary management of malignant polyps and specifically how management decisions varied based on risk as assessed by the ACPGBI guidelines. This study is one of the few population-wide analyses of the management of malignant polyps [4, 11–14], with only four known previous population-wide analyses being completed since 1985 [4]. It also represents one of the largest cohorts of malignant polyps reported [11, 12, 14–25], with the majority of other investigations on the management of

TABLE 3 Comparison between patients with malignant polyps and their subsequent management—very low and low risk of residual disease

Variable	Polypectomy alone (%) $n = 470$	Follow-up resection (%) $n = 224$	*P* value	Adjusted OR (95% CI)	*P* value
Age (mean) (95% CI)	68.02 (66.96–69.08)	64.87 (63.33–66.41)	**<0.001**	0.95 (0.92–0.98)	**0.001**
ASA score			0.15		
1	51 (61.45)	32 (38.55)		REF	
2	187 (67.03)	92 (32.97)		1.85 (0.71–4.80)	0.21
3	111 (74.5)	38 (25.5)		0.83 (0.26–2.62)	0.75
4	11 (78.57)	3 (21.43)		1.62 (0.06–42.29)	0.77
Comorbidity count			0.053		
0	112 (73.2)	41 (26.8)		REF	
1	246 (63.9)	139 (36.1)		0.79 (0.25–2.59)	0.71
2+	112 (71.79)	44 (28.21)		0.72 (0.19–2.78)	0.63
Gender			0.143		
Male	304 (69.72)	132 (30.28)		REF	
Female	166 (64.34)	92 (35.66)		1.41 (0.70–2.81)	0.34
Type of facility for colonoscopy			0.60		
Public	142 (69.61)	62 (30.39)		1.98 (0.88–4.46)	0.10
Private	323 (67.57)	155 (32.43)		REF	
Socioeconomic status			0.43		
Affluent	41 (61.19)	26 (38.81)		REF	
Middle	320 (68.09)	150 (31.91)		0.56 (0.21–1.55)	0.27
Disadvantaged	107 (69.93)	46 (30.07)		0.38 (0.11–1.34)	0.13
Residence of patient			0.32		
Major city	284 (68.11)	133 (31.89)		REF	
Inner regional	134 (70.16)	57 (29.84)		1.63 (0.55–4.81)	0.37
Remote	50 (60.98)	32 (39.02)		2.74 (0.62–12.17)	0.19
Location of colonoscopy			0.47		
Metropolitan	307 (68.68)	140 (31.32)		REF	
Regional/rural	163 (65.99)	84 (34.01)		0.84 (0.28–2.52)	0.75
Site of polyp			**<0.001**		
Right colon	66 (48.53)	70 (51.47)		REF	
Left colon	284 (70.65)	118 (29.35)		0.39 (0.15–1.00)	**0.049**
Rectum	118 (78.67)	32 (21.33)		0.25 (0.06–1.08)	0.063
Polyp type			**0.004**		
TA	110 (65.09)	59 (34.91)		1.38 (0.31–6.08)	0.67
TVA	282 (74.6)	96 (25.4)		1.18 (0.31–4.56)	0.81
VA	22 (56.41)	17 (43.59)		0.73 (0.11–4.71)	0.74
SSA	22 (55)	18 (45)		REF	
Mismatch repair			0.076		
Proficient	180 (64.98)	97 (35.02)		REF	
Deficient	14 (48.28)	15 (51.72)		2.52 (0.75–8.49)	0.14

Abbreviations: ASA, American Society of Anesthesiology score [10]; SSA, sessile serrated adenoma/lesion; TA, tubular adenoma; TVA, tubulovillous adenoma; VA, villous adenoma.

Bold values indicate all the results that are statistical significant.

malignant polyps having less than 1000 malignant polyps investigated [4]. There have only been two larger cohort studies [14, 16] published since 1985, and neither of these represented population-wide analyses of malignant polyps [4].

To date no other malignant polyp database has been interrogated to assess compliance with the ACPGBI guidelines [4]. It was noted that there was a large proportion of patients in either the low risk or very low risk of residual disease groups (32.28%) who proceeded to

TABLE 4 Comparison between patients with malignant polyps and their subsequent management—high and very high risk of residual disease

Variable	Polypectomy alone (%) $n = 303$	Follow-up resection (%) $n = 582$	*P* value	Adjusted OR (95% CI)	*P* value
Age (mean) (95% CI)	70.16 (68.92–71.41)	64.51 (63.57–65.47)	**<0.001**	0.94 (0.92–0.97)	**<0.001**
ASA score			**<0.001**		
1	31 (23.13)	103 (76.87)		REF	
2	107 (30.75)	241 (69.25)		1.52 (0.71–3.25)	0.29
3	94 (48.7)	99 (51.3)		0.65 (0.28–1.51)	0.32
4	10 (62.5)	6 (37.5)		0.47 (0.10–2.19)	0.34
Comorbidity count			**<0.001**		
0	105 (44.12)	133 (55.88)		REF	
1	127 (27)	338 (73)		0.98 (0.46–2.10)	0.96
2	73 (39.67)	111 (60.33)		1.27 (0.50–3.26)	0.61
Gender			**0.013**		
Male	197 (37.52)	328 (62.48)		REF	
Female	106 (29.44)	254 (70.56)		1.07 (0.62–1.83)	0.81
Type of facility for colonoscopy			**<0.001**		
Public	112 (47.06)	126 (52.94)		0.50 (0.26–0.96)	**0.037**
Private	184 (29.11)	448 (70.89)		REF	
Socioeconomic status			0.063		
Affluent	32 (28.32)	81 (71.68)		REF	
Middle	182 (33.15)	367 (66.85)		2.19 (1.04–4.62)	**0.039**
Disadvantaged	87 (40.28)	129 (59.72)		1.68 (0.65–4.34)	0.29
Residence of patient			**0.001**		
Major city	157 (29.46)	376 (70.54)		REF	
Inner regional	101 (41.22)	144 (58.78)		1.02 (0.47–2.19)	0.97
Remote	43 (43)	57 (57)		0.45 (0.15–1.30)	0.14
Location of colonoscopy			**0.001**		
Metropolitan	188 (30.57)	427 (69.43)		REF	
Regional/rural	115 (42.59)	155 (57.41)		0.69 (0.32–1.51)	0.35
Site of polyp			**<0.001**		
Right colon	42 (27.1)	113 (72.9)		REF	
Left colon	117 (26.83)	319 (73.17)		0.33 (0.13–0.81)	**0.015**
Rectum	141 (50.72)	137 (49.28)		0.09 (0.03–0.28)	**<0.001**
Polyp type			0.17		
TA	93 (38.59)	148 (61.41)		0.43 (0.15–1.26)	0.13
TVA	138 (32.39)	288 (67.61)		0.89 (0.32–2.45)	0.82
VA	24 (45.28)	29 (54.72)		0.58 (0.17–2.05)	0.40
SSA	26 (35.62)	47 (64.38)		REF	
Mismatch repair			0.60		
Proficient	152 (32.34)	318 (67.66)		REF	
Deficient	18 (29.03)	44 (70.97)		0.32 (0.12–0.88)	**0.027**

Abbreviations: ASA, American Society of Anesthesiology score [10]; SSA, sessile serrated adenoma/lesion; TA, tubular adenoma; TVA, tubulovillous adenoma; VA, villous adenoma.

Bold values indicate all the results that are statistical significant.

resection, despite the recommendations of the ACPGBI guidelines for observational follow-up. Likewise, there was also a large proportion (35.86%) of patients with high or very high risk of residual disease who did not have a resection.

The mean age at diagnosis was a significant predictor of those with low and very low risk disease proceeding to a resection, despite guidelines suggesting otherwise. This suggests that some clinicians may have recommended that young patients, for whom surgery was

not indicated in the guidelines, proceed to surgery simply due to their age and their anticipated life span.

There was a significant association between management strategy and location of the malignant polyp in both the low risk and the high risk groups. It is generally accepted that left sided and rectal resections pose a greater surgical risk to patients including being associated with increased risk of anastomotic leaks, stoma, sexual dysfunction and conversion from a laparoscopic to an open procedure [26]. Furthermore the long-term sequelae of rectal resection include long-term functional changes such as incontinence, impotence and low anterior resection syndrome [27]. These risks may be the reason that clinicians appear to be more likely to recommend observation in patients with left sided or rectal disease, even in high risk disease. Right sided colorectal resection is typically considered a less technically demanding procedure [28], and it could be considered that surgeons may be more inclined to offer resection for right sided disease when the clinical indications are not as compelling.

Furthermore, left colonic and rectal disease can be more easily surveilled with flexible sigmoidoscopy compared to colonoscopy for right sided malignant polyps, avoiding the increased risk from the procedure and also the requirement for mechanical bowel preparation [29]. These considerations may have contributed to clinicians appearing more likely to recommend observation in patients with left sided or rectal disease, even in high risk disease.

Colorectal resection is a major procedure, with significant short- and long-term risks [27]. Surgical morbidity and mortality are correlated with patient's comorbidities and thus the ability to tolerate major physiological stresses such as colorectal surgery [10]. The ASA score is a surrogate measure of the number and severity of patient comorbidities and can assist in estimating perioperative risk [10]. This study demonstrated that, in low risk polyps, the ASA score made no significant difference to management choice. This is logical in that clinicians are not likely to simply offer a resection to a patient with a malignant polyp because they are surgically low risk from a morbidity or mortality perspective. In the high risk polyp group, ASA differed significantly between the management strategies, however, only in the univariable analysis. ASA score was not significant in any of the multivariable analyses. Likewise, when analysing the raw count of the documented comorbidities, in the multivariable analysis there were no significant differences between the treatment groups. This is unexpected: it was hypothesized that, in the high risk polypectomy group, medically comorbid patients would be less likely to be offered surgery as the risk of surgery would have been higher than the risk of residual or metastatic disease in some patients. An explanation may be that hospital coding did not completely document relevant comorbidities for these patients. Evidence of incomplete capture of comorbidities using hospital admission and discharge coding data has been documented by other authors throughout the world [30, 31].

The location of the health facility where the colonoscopy was performed was of interest, whether it be in a metropolitan location or a regional/rural location. The definition of metropolitan area encompassed all but one of the tertiary referral hospitals and all of the quaternary hospitals within the state. Those with high risk disease and who had their colonoscopy performed in a regional/rural setting were significantly less likely to proceed to resection relative to those who had it performed in a metropolitan setting. However, this was only on univariable assessment; on multivariable modelling, location of the colonoscopy was no longer significant ($P = 0.35$; Table 4). This may reflect those living regionally, outside of a metropolitan area, having other variables that are the predictor of proceeding to resection rather than the location of where the colonoscopy was performed. However, it may also be the reflection of smaller numbers available to multivariable analysis due to missing pathology details. It may be that a study with higher statistical power or a study with fewer missing pathology details may find the location of colonoscopy a significant predictor of management strategy, with those in a regional/rural setting being less likely to proceed to resection. Regardless, there may be additional reasons why management strategy differs depending on patient location. These may include those living regionally having poorer access to health services, health services not being available close to patients' residence and patients not wishing to travel long distances for health services away from personal support networks. Additionally, if services were available close to home, there are likely to be fewer subspecialist colorectal surgeons in that area, which may mean less understanding, by those clinicians, of the ACPGBI or other similar guidelines. It is likely that improvements to clinician education, especially where access to subspecialty surgical services is limited, would improve patient care.

A limitation of this study is the number of missing pathology details documented. It was noted that budding and a Haggitt/Kikuchi level were the most underreported pathological features. Accurate assessment of the risk of residual or lymphatic metastatic disease is vital for clinicians to advise appropriate management strategies. This hampered the accurate assessment of the ACPGBI risk scoring, and probably resulted in the under-calling of the risk of the malignant potential of polyps with a large number of missing pathology details. It is noted that clinicians would have equally been unable to accurately assess these malignant polyps' risk of residual or metastatic disease, given that these pathology reports are the same reports delivered to clinicians. Additionally, the large number of missing pathology details influenced the ability to perform highly powered multivariable logistic regression modelling. This may have affected the overall power and ability to detect significant differences. It was demonstrated that the average number of missing pathological features decreased through the study period. A thorough assessment of missing pathological factors warrants a comprehensive quality assurance review, to identify whether there are any trends which could explain underreporting of histopathological features. The authors are now progressing with this review, with the results to be reported in the literature.

The comorbidity count used along with ASA scores are crude measures of patient perioperative surgical risk. It is likely, however,

that more nuanced measures of comorbidities would potentially provide a better appreciation of those who were offered surgery compared to those who had polypectomy and surveillance alone. Whilst the list of comorbidities collated in the QOR were aligned with the Charlson Comorbidity Index, they were not recorded in the QOR in a format which facilitated calculation of a Charlson Comorbidity Index. Lastly, whilst piecemeal excision of a malignant polyp is considered an indication for colorectal resection, this was not available to be assessed from the histopathological reporting. Without access to the original colonoscopy procedural reports, this detail could not be assessed.

Individual patient and surgeon discussions are the cornerstone of patient-centred clinical practice and these nuanced discussions are not accessible. Whilst guidelines provide clinical understanding of risks to individual patients, patient autonomy in the management of malignant polyps cannot be understated. Clinicians may consider a malignant polyp to be high risk, but this may not be the case from the patient's perspective. Furthermore, balancing this risk against the potentially long-term sequelae of colorectal resection, especially left sided and rectal resection, may mean patients with high risk disease do not consider a resection to be in their best interests, even when they are young with few comorbidities. Unfortunately, this level of detail is not available in current population-wide analyses on the management of malignant polyps.

CONCLUSION

The ACPGBI guidelines provide recommendations for the management of malignant polyps, dependent on a number of pathological criteria. This study found that 31.55% of patients ACPGBI defined as low or very low risk disease proceeded to resection, despite recommendations for observational follow-up. Additionally, 36.69% of patients with high or very high risk disease did not proceed to resection. Education campaigns to clinicians on when to consider elective colorectal resection may improve colorectal resection rates in those with high risk polyps, especially in regional areas, and increase observational follow-up rates in low and very low risk cases. Improvements in data collection, especially for comorbidity data, and multidisciplinary team discussions will help obtain a more comprehensive understanding on the management of malignant polyps in the future.

AUTHOR CONTRIBUTIONS

Research plan and conceptualisation: APZ, SEP, DAC, ADR; Data collection: APZ, SEP; Data analysis: APZ; Manuscript draft: APZ; Review and Editing: SEP, JDH, IB, DAC, ADR.

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Research data are not shared.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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