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## Predictors of Multivisceral Resection in Patients with Locally Advanced Colorectal Cancer

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### Abstract

**Background**—Practice guidelines recommend en bloc multivisceral resection (MVR) for all involved organs in patients with locally advanced adherent colorectal cancer (LAACRC) to reduce local recurrence and improve survival. We found that MVR was performed in one-third of eligible American patients in the Surveillance, Epidemiology and End Results cancer registry but that study could not identify factors amenable to quality improvement. This study was conducted to examine rates, and predictors of MVR among Canadian patients with LAACRC.

**Methods**—Rates of MVR were examined by observational study. Eligible patients were aged 20–74 years who had surgery for nonmetastatic LAACRC from July 1997 to December 2000. Patient, tumor, surgeon, and hospital characteristics were extracted from medical records. Summary statistics were compared by type of surgery (MVR, partial MVR, standard resection). To identify factors associated with MVR we analyzed operative notes and transcripts from interviews with general surgeons using standard qualitative methods.

**Results**—Factors associated with MVR included fewer years in practice, preoperative treatment planning, involvement of surgical consultants, and access to diagnostic imaging and systems to enable preoperative multidisciplinary planning. Judgments regarding the nature of peritumoral adhesions, resectability, and personal technical skill may mediate decision-making. Many surgeons would prefer to refer patients than undertake complicated, lengthy cases.

**Conclusion**—Further research is required to validate these findings in larger studies and among patients undergoing surgery for conditions other than LAACRC, and evaluate strategies to improve rates of MVR through enhanced individual awareness and system capacity.

### Keywords

Colorectal neoplasms; Multivisceral resection; Decision-making; Practice guideline adherence; Continuing education; Quality improvement

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Colorectal cancer (CRC) is the third-most common cancer in North America and the second-leading cause of cancer-related mortality.<sup>1,2</sup> In up to 15% of cases, the primary tumor is adherent to adjacent organs as a result of direct malignant invasion or peritumoral inflammatory reaction. Intraoperative assessment of adhesions as malignant or benign is often inaccurate.<sup>3</sup>

<sup>4</sup> Previous investigations have documented higher local recurrence rates and inferior overall survival among CRC patients in which the tumor was transected as a result of separation from adherent structures compared with patients receiving en bloc multivisceral resection (MVR).<sup>5–10</sup> Thus, current guidelines put forth by the National Cancer Institute and the American Society of Colon and Rectal Surgeons recommend that management of locally advanced adherent colorectal cancer (LAACRC) include en bloc MVR of all involved organs.<sup>11–13</sup> Studies suggest that MVR may be underutilized in patients with LAACRC.<sup>5,14</sup> We recently found that MVR was performed by surgeons in only one-third of eligible patients in the Surveillance, Epidemiology and End Results (SEER) cancer registry.<sup>14</sup> However, this study could not elucidate the factors influencing use of this procedure by surgeons, data which are critical to designing interventions that could improve rates of MVR in eligible patients.

There is a large body of research investigating physician compliance with guideline recommendations, which can be influenced by multiple factors including patient issues (age, comorbidity, expressed preferences), tumor features (stage, location), physician characteristics (age, specialty, setting of care, knowledge, attitude), and elements of the health care institution or system that either enable or prevent appropriate practice.<sup>15–17</sup> Since the decision to perform MVR is often made intraoperatively, individual surgeon decision-making may also be an important determinant of operative strategy. Few studies have examined factors that influence surgical decision-making.<sup>18,19</sup> Yule<sup>20</sup> reviewed the surgical and psychological literature on surgeons' intraoperative nontechnical skills and proposed that mental readiness, situation awareness, anticipation, risk assessment, and decision-making were distinct, important cognitive elements of surgical practice (Table 1). The purpose of this study was to examine rates of MVR for LAACRC in Canada, and identify factors that influence performance of MVR, information that is essential for quality improvement planning.

## METHODS

### Approach

In the absence of a national population-based cancer registry, Canadian rates of MVR in patients with LAACRC were examined with a retrospective observational study involving cohorts from two provinces that could identify and provide medical records for eligible cases. To assess factors influencing MVR performance an exploratory approach was used involving qualitative analysis of operative notes from cases in the cohort study, and transcripts from interviews with surgeons not involved in cases from the cohort study. Ethical approval for this study was granted by the Research Ethics Boards at Sunnybrook Health Sciences Centre, Mount Sinai Hospital, Eastern Health, and Memorial University of Newfoundland.

### Data Sources

**Cohort Study**—Ontario patients were identified by staff at the Ontario Familial Colorectal Cancer Registry (OFCCR). The OFCCR is one of six population-based registries comprising the Cooperative Familial Registry for Colorectal Studies, directed by the National Cancer Institute.<sup>21</sup> Starting in July 1997, the OFCCR has approached all patients from Ontario, Canada diagnosed with suspected familial CRC, and a 25% random sample of patients with sporadic CRC. In Newfoundland and Labrador, all incident cases of patients diagnosed with CRC from January 1, 1999 to December 31, 2000 had been retrospectively ascertained. Two investigators with access to this data (DW, VC) identified cases for this study. Eligible patients were aged 20 to 74, and had surgery for primary nonmetastatic LAACRC between July 1, 1997 and December 31, 2000, the time period common to both sources for which operative notes were available. Nonmetastatic LAACRC was further confirmed by two investigators (AG, AJS) who examined the operative and pathology reports. Patients were excluded if it could not be

determined whether the patient received MVR, or if the operative note was dictated more than two weeks after the operation, as this can result in incomplete or inaccurate notes.<sup>22,23</sup>

**Qualitative Study**—General surgeons known to operate on colorectal cancer patients but not associated with cases in the cohort study were selected from a publicly available list maintained by the College of Physicians and Surgeons of Ontario to represent different regions, years in practice, and settings (academic, community). They were invited by regular mail to take part in a single telephone interview. The initial sampling target was 20 interviews. In qualitative research, detailed information from representative rather than a large number of cases is needed, sample size is determined concurrent with data collection and data analysis, and sampling is deemed sufficient when no further unique themes emerge from successive interviews.<sup>24</sup>

### Data Collection

**Cohort Study**—A data extraction sheet for both patient and surgeon information was developed and pilot-tested on ten records. Variables included patient (age, sex), tumor (location, nodal status), surgeon (age, years in practice), and hospital characteristics (academic, cancer center status), and surgical factors (date of operation, emergent or elective, date of dictation, dictation by primary surgeon or other staff, and type of operation characterized as MVR, partial MVR or standard resection). A partial MVR was defined as a case where the principles of MVR were followed for part of the operation but not including all involved organs or structures. Surgeon characteristics were obtained from publicly available databases of physician licensing bodies.

**Qualitative Study**—Operative notes were anonymized by a research associate (NF) in preparation for analysis so that both investigators performing qualitative analysis were blinded to patient, surgeon, and hospital identifiers. A semistructured interview guide was developed and pilot-tested with one general surgeon. Several open-ended questions asked surgeons about their usual surgical approach in cases of LAACRC to assess knowledge of MVR, application of decision-making concepts in the Yule framework,<sup>20</sup> impact of other non-decision-making factors influencing this practice, and to solicit recommendations for improving management of patients with LAACRC. The critical incident technique of questioning was also used.<sup>25</sup> This method involves asking the participants to describe specific cases to better understand the reasons for their behavior. Interviews were conducted by a single investigator (AG) between March 7, 2007 and April 12, 2007. Each was audiorecorded, then transcribed verbatim by an external professional.

### Data Analysis

**Cohort Study**—Descriptive characteristics were calculated on all study variables, and compared between the two provinces (Ontario and Newfoundland) and across the types of surgery (MVR, partial MVR, standard resection) using one-way analysis of variance for continuous variables and the Fisher's exact test for categorical variables.

**Qualitative Study**—Unique themes within operative notes and interview transcripts were identified in an inductive manner using standard methods for qualitative analysis.<sup>25,26</sup> This involved familiarization (repeated reading to identify relevant information), indexing with codes reflecting relevant concepts (knowledge, attitudes, beliefs, elements of decision-making, surgical practice, institutional or system factors), charting (comparing themes by tabulation), and interpretation. To improve the reliability of these findings two investigators independently conducted qualitative analysis (AG, ARG), then met to compare findings and resolve differences through discussion.

## RESULTS

### Sample Description

The eligible study population (Table 2) consisted of 50 patients, 37 Ontario patients treated at 28 hospitals (O1–O37) and 13 from Newfoundland treated at six hospitals (N1–N13). Overall, 75% of the operative notes were dictated on the day of surgery and 95% were dictated within one week. The operative note was dictated by the primary surgeon in 29 cases (58.0%). The ability to determine whether MVR was performed was not significantly related to either the practitioner performing the dictation ( $P = 0.14$ ), or the time interval between the surgery and the dictation ( $P = 0.59$ ), confirming that the determination of study outcomes were not related to the attributes of the operative note. A total of 20 interviews (S01–S20) were completed with surgeons from seven geographic regions representing academic (8) and community (12) practices. Years in practice were comparable among surgeons interviewed and those whose operative notes were examined (median 11.5 years, interquartile range 6–22 years,  $P = 0.93$ ).

### Factors Associated with MVR

MVR was not performed in 14 (28.0%) patients. It was fully and partially performed (some but not all adherent organs) in 24 (48.0%) and 12 (24.0%) patients, respectively. There was no significant difference in the performance of MVR between the two provinces ( $P = 0.49$ ). Patient age and sex were not significantly associated with receipt of MVR (Table 3). A significant inverse association was seen between number of years in practice and MVR, while trends were noted toward a positive association between MVR and academic centers, and intraoperative consultation from another surgical discipline. Six themes emerged from qualitative analysis of operative notes and interview transcripts. These are described here with representative quotes.

**Mental Readiness**—Preoperative awareness of possible adherence appeared to be associated with MVR. Surgeons who performed MVR dictated findings from preoperative imaging suggestive of this.

*[CT scan showed] advanced cecal growth infiltrating the anterior abdominal wall in the right iliac fossa, the retroperitoneum in the right iliac fossa (N10)*

Surgeons who did not perform MVR either did not have such information available to them, did not dictate these details, or discussed alternate diagnoses.

*The preoperative investigations were inconclusive...I felt that the diagnosis was that of previous appendicitis with fibrotic resolution (O33)*

Surgeons explained that, with advance knowledge enabled by imaging, they were better able to arrange for intraoperative assistance, or decide whether to refer patients elsewhere for either neoadjuvant treatment or surgery by a team more experienced in managing LAACRC.

*We had gynecologists and urologists ready to go (S17)*

*If I'm concerned about margin, I'll treat the patient with preoperative chemoradiation (S13)*

*I might refer the patient to somebody more experienced (S03)*

**Situation Awareness (Anticipation)**—Surgeons dictated similar laparotomy procedures regardless of MVR performance. Interviewed surgeons said that laparotomy identified problems and established the complexity of the required operation, thus informing decisions about whether to proceed with surgery or refer the patient.

*I don't make the final decision as to operative approach until I get in there (S19)*

*We're happy to refer to somebody who's making it their specialty (S07)*

**Assessing Risk**—Surgeons who performed MVR were more likely to obtain intraoperative consultation from other surgical disciplines for both assessment and resection of the tumor.

*We then asked [gynecologist] and [urologist] to come and assess this (O32)*

Among patients who did not receive MVR, assessment of the extent of the tumor was sometimes performed post hoc, after the principles of en bloc MVR were already violated.

*...inflammatory mass had to be cracked off bluntly from the bladder...and we were horrified to think this may actually be a carcinoma...biopsies were sent (O24)*

**Decision-making**—When MVR was performed, surgeons clearly described their awareness of the need for, and intent to perform en bloc MVR.

*It was clear that the tumor would have to be taken out en bloc with the spleen (O26)*

*GIA50 was used to [resect] jejunum adherent to the tumor...keeping a distinct macroscopically normal cuff tissue in all planes around the tumor (N9)*

When uncertain over whether adhesions were benign or malignant, surgeons who performed MVR assumed a worst-case scenario of malignant invasion and performed an en bloc resection.

*We were not sure whether it was being invaded by tumor...we decided to resect some small bowel to keep it in one piece with the rest of the tumor (O36)*

Among surgeons who did not perform MVR, it was assumed that adhesions between the tumor and adjacent organs were benign, and thus could be divided without violating tumor margins.

*...did not appear to be invading, [adhesions] were taken down easily with blunt dissection (O2)*

*The tumor was adherent to the duodenum which was separated using combination of blunt and sharp dissection...my own feeling is that this might be a curative surgery (N11)*

During interviews all surgeons revealed knowledge of the need for en bloc resection. If, upon commencing surgery, they could not achieve negative margins or the extent of invasion was greater than expected, most surgeons would refer patients for neoadjuvant treatment (for rectal cancer), or to a specialist surgeon for resection, rather than compromise surgical planes.

*It's best not to compromise oncologic planes and leave that for the next operation (S10)*

*It's not frequent enough to make it a priority so I just send it to [a colleague] (S02)*

**Judgment**—Within operative notes individual judgment seemed to influence whether patients received MVR. This was confirmed during interviews, and best exemplified by the statement that “resectability is like beauty, it's in the eye of the beholder” (S03). For example, in relation to mental readiness, surgeons preoperatively considered whether to obtain imaging, or whether to proceed with a case based on imaging.

*If I have time or concern I might get a CT scan or an ultrasound (S18)*

*Do I feel comfortable or do I actually think the patient should go elsewhere (S10)*

In the context of situation awareness and risk assessment, surgeons determined whether they felt capable of performing the operation without assistance from other surgical specialties.

*For pancreas it depends, if it was just a little bit of the tail I may do it myself (S02)*

As part of decision-making, several surgeons equated aborting the surgical resection with failure.

*Backing out is somehow an admission of failure even if it is the correct thing to do (S17)*

**Capacity**—During interviews surgeons said that logistic issues (referral of patients to another site for diagnostic testing, waiting time for diagnostic testing or results, accuracy of diagnostic interpretation, and availability of onsite consultant surgeons) were sometimes barriers to preoperative and intraoperative decision-making. Interview participants were asked to describe resources or strategies needed to support the performance of MVR. Two quality improvement strategies were recommended. First, many surgeons highlighted the need for multidisciplinary communication and teamwork to improve preoperative patient care planning by fostering a “*culture within the surgical group that allows consultation*” (S12). Some thought it was “*important to have tumor boards so that patients can be discussed preoperatively*” (S11). Second, several surgeons said that more specialist surgeons at tertiary care centers were required to manage the increasing volume of cases being referred rather than managed in the community, and to offer remote intraoperative consultation for unavoidable, unexpected cases.

*I would rather send the patient to where they're [going to] get better care than I can offer but it's hard to get appointments for people. If there was a little bit more manpower in the tertiary care centre, people with specific expertise in colorectal who can provide some kind of consulting service, it might help sort out cases into what's appropriate to keep at home and what's better served in the tertiary centre (S15)*

## DISCUSSION

This study was carried out to identify possible factors that influence the use of en bloc MVR in patients with LAACRC. Overall, the principles of en bloc MVR were similarly violated in more than 50% of eligible LAACRC patients in two Canadian provinces. Newer physicians were significantly more likely to perform MVR than older physicians. Patient factors such as age and comorbidity were not predictive of MVR performance. In contrast, our SEER-based study found that one-third of eligible patients undergoing surgery during a time period similar to this cohort study received MVR, and this was associated with younger patient age and geographic region.<sup>14</sup> No other studies have examined predictors of MVR, but it is known that age bias can influence receipt of recommended therapy for other types of cancer, as can surgeon factors such as years in practice, teaching status, and cancer volume.<sup>27–30</sup> This research is inconsistent with the findings of our cohort study, but more detailed information of greater relevance to ongoing quality improvement can be gleaned from qualitative analysis of both operative notes and interview transcripts.

Several elements of surgical decision-making appeared to differ between surgeons who did and did not perform en bloc MVR including mental readiness, risk assessment, and intraoperative decision-making. Both mental readiness (preoperative treatment planning) and risk assessment (intraoperative consultation/assistance) were challenged by capacity issues, for example, some hospitals did not have onsite imaging technology. To enhance mental readiness through preoperative decision-making, surgeons underscored the importance of tumor boards, or multidisciplinary cancer conferences (MCCs). These are regularly scheduled multidisciplinary meetings to prospectively review individual cancer patients and formulate appropriate management plans.<sup>31</sup> Several observational studies suggest that MCCs can improve compliance with guideline recommendations and patient care outcomes.<sup>32–36</sup> We explored the benefits of an MCC linking surgeons at six hospitals by videoconference.<sup>37</sup> Participating surgeons said that sharing of clinical experience improved decision-making for complex cancer cases, and through exposure to decision-making for more cases than they

would see in their own practices, clinical expertise was developed that could be applied to future cases.

Whether identified preoperatively or intraoperatively, many surgeons indicated a preference for referring LAACRC patients to specialists at tertiary care centers due to little experience with, or desire to engage in these complex, lengthy operations, and suggested the need for greater human and technologic infrastructure. First, they expressed concern over difficulties in arranging appointments for LAACRC patients with specialist surgeons who may be overwhelmed with the volume of referrals. Second, access to specialist surgeons could remotely provide just-in-time intraoperative consultation when unexpected or emergent cases arose, thereby alleviating the need for referral in some cases. Participants of an exploratory study of telehealth delivery of medical care in remote regions of Quebec, Canada also emphasized the need for dedicated human and technologic resources, and health professional remuneration in order to integrate such activities into regular practice.<sup>38</sup> Further research is required to examine referral patterns for MVR, and evaluate the effectiveness of technology for enabling intraoperative communication between community and academic centers.

Perhaps more importantly, this study identified that individual surgeon judgment was influential in the care received by patients with LAACRC because it seemed to mediate all elements of surgical decision-making. Judgments were made about resectability according to tumor characteristics and personal views on surgical success. During interviews surgeons said they would utilize MVR if adhesion or invasion were uncertain, but operative notes demonstrated that judgments about the nature of adhesions were frequently the reason for MVR not being performed. Furthermore, judgments on personal technical ability influenced whether a patient was referred for neoadjuvant care or to specialist surgeons, and may also predict whether a surgeon arranges for intraoperative support from other specialties, a factor associated with the use of MVR. Surgical judgment, largely based on personal assessments about technical ability, knowledge, and experience, may not be amenable to modification using traditional continuing education approaches due to the limited time and capacity of physicians for reflective practice without external triggers or guidance.<sup>39,40</sup> To promote greater awareness of personal MVR practice, a more promising intervention may be audit and feedback. A Cochrane review of 118 trials found that audit and feedback can improve clinical practice when individuals are able to compare their own performance with that of peers, and data is provided periodically on an ongoing basis and is delivered verbally or by senior colleagues.<sup>41</sup> Further research is required to determine whether audit and feedback is an effective approach for improving MVR in patients with LAACRC.

This study had several limitations. Operative notes may be incomplete sources of information on decision-making because they are meant to capture the technical details of surgery and only contain details that the physician chooses to dictate. Regardless, we were able to extract detailed information from operative notes on all elements of surgical decision-making proposed by Yule.<sup>20</sup> Interview findings may be influenced by small sample size and volunteer bias, wherein participating surgeons are those most compliant with recommended practice. However, surgeons interviewed were diverse with respect to jurisdiction, practice setting, and experience, and provided very similar responses. Analysis of operative notes was also based on a small sample size, but patients were sampled in a population-based manner. Despite the care taken to mitigate these limitations, decision-making factors or capacity issues found to influence MVR practice may not apply to other jurisdictions. However, these concepts can now form the hypothesis in larger, more descriptive studies, both in Canada and elsewhere. In particular, we found that situation awareness and anticipation were joint cognitive intraoperative processes, and that individual judgment mediated the entire continuum of nontechnical surgical skills proposed by Yule, as did organizational and system capacity.<sup>20</sup>

In summary, we identified factors that appear to contribute to low rates of MVR among patients with LAACRC, including surgical decision-making (preoperative planning and readiness, intraoperative assessment of the need for MVR, and choice of surgical approach, all mediated by judgment about resectability and personal skill) and capacity issues (access to diagnostic imaging, availability of surgical specialties in both community and academic settings, systems to enable preoperative multidisciplinary planning). Further research is required to examine the effectiveness of tumor boards, and audit and feedback on improving rates of MVR in patients with LAACRC. Further research is also required to examine whether these key elements of surgical decision-making apply to conditions other than LAACRC.

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**TABLE 1**Analytic framework of nontechnical surgical skills<sup>20</sup>

Concept	Definition	Example
Mental readiness	Any form of preparation prior to surgery	Review of patient file, diagnostic test results, or referral notes
Situation awareness	Initial intraoperative assessment	Overall abdominal examination
Anticipation	Problem identification	Potential adherence or invasion noted
Risk assessment	Confirm extent of problem	Further visual, manual, surgical, pathologic or consultant assessment
Decision-making	Use of a cognitive process to select an appropriate course of action	Reasoning for decision to proceed with MVR or alternate procedure

**TABLE 2**

## Characteristics of study population

Characteristic	Ontario	Newfoundland and Labrador	<i>P</i> value
Median age, years	61	68	0.10
Sex, male	54.1%	46.2%	0.75
Emergency surgery	13.5%	7.7%	1.00
Tumor site			0.41
Right (proximal to splenic flexure)	43.2%	61.5%	
Left (distal to splenic flexure)	32.4%	30.8%	
Rectosigmoid/rectum	24.3%	7.7%	
Treatment facility			
Academic centre	43.2%	38.5%	1.00
Cancer centre	37.8%	0.0%	0.022
Median physician years in practice	14	13	0.83
Type of surgery			
MVR	46.0%	53.9%	0.49
Partial MVR	21.6%	30.8%	
Standard resection	32.4%	15.4%	

**TABLE 3**

Population characteristics by type of surgical procedure

	Standard resection or partial MVR (n = 26)	MVR (n = 24)	P value
Patient age, mean, years	61.7	60.8	0.74
Sex, male	50.0%	54.2%	0.79
Emergency surgery	15.4%	8.3%	0.67
Treatment at cancer centre	30.0%	35.3%	1.00*
Treatment at academic centre	30.8%	54.2%	0.15
Physician years in practice, mean	16.6	11.0	0.039
Intraoperative consult	7.7%	20.8%	0.24

\* Only on Ontario patients (no designated cancer centers in the Newfoundland cohort).