



Selection for local treatment and outcomes of surgical resection in patients with synchronous colorectal liver metastases: A nationwide population-based study

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ABSTRACT

Background: The aim of this study was to evaluate potential disparities in the probability of undergoing surgical treatment among patients with synchronous colorectal liver metastases (CRLM) and to investigate which non-tumour-related characteristics influenced postoperative outcomes.

Methods: This was a population-based study of all patients diagnosed with synchronous CRLM between 2015 and 2021 in the Netherlands. Data were retrieved from the Netherlands Cancer Registry (NCR) and data of patients who underwent surgical exploration were retrieved from the Dutch Hepato Biliary Audit (DHBA). The association between non-tumour-related factors, the chance of getting local treatment of CRLM and outcomes after resection were evaluated using multivariable logistic regression models.

Results: From the NCR, 14,047 patients with synchronous CRLM were included. Of these 2753 (20 %) patients underwent local treatment of CRLM. Non-tumour-related factors associated with a lower likelihood of local treatment of CRLM included age (OR 0.94 95 %CI 0.94–0.95) and female sex (OR 0.87, 95 %CI 0.78–0.97). Middle and high Socioeconomic status (SES) compared to low SES (respectively OR 1.35, 95 %CI 1.18–1.54 and OR 1.61, 95 %CI 1.41–1.84) and presentation in a hospital that performed liver surgery (OR 1.52, 95 %CI 1.26–1.84) were associated with a higher likelihood of getting local treatment. From the DHBA 2535 patients were included. Non-tumour-related factors associated with both major morbidity and mortality included age (OR 1.01 95 %CI 1.00–1.03 and OR 1.07, 95 %CI 1.02–1.11, respectively) and ASA-score ≥ 3 (OR 1.7, 95 %CI 1.34–2.29 and OR 2.88, 95 %CI 1.92–1.11) respectively.

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Conclusion: In addition to tumour-related factors, non-tumour-related factors, including age, male sex, SES and hospital of presentation, all contributed to the likelihood of getting local treatment for CRLM. As not all these factors influence postoperative outcomes, healthcare systems should also focus on eliminating barriers to accessing appropriate care.

1. Introduction

Colorectal cancer (CRC) is the third most common cause of cancer worldwide. Approximately 14–18 % of all patients with CRC presents with synchronous colorectal liver metastasis (CRLM) [1–4]. Surgical resection of CRLM improves the patient's overall survival and has curative potential. Only 20–30 % of patients diagnosed with synchronous CRLM undergo surgical resection for CRLM [4–6].

Previous studies conducted in the Netherlands have demonstrated significant hospital variation in managing patients with CRLM [7–11]. Also, a lack of agreement among hepatobiliary surgeons regarding resectability of CRLM has been reported [12,13]. This uncertainty is even more pronounced among non-hepatobiliary surgeons or medical oncologists [12,14]. Management of CRLM may, however, also be influenced by factors beyond resectability criteria.

Recently, more emphasis has been directed toward recognising the impact of non-tumour-related disparities in treating patients with CRLM. Population-based studies described the influence of sex, age, socioeconomic status (SES), race, healthcare insurance, and the hospital where the initial treatment occurred as determinants influencing the likelihood of CRLM patients undergoing surgical intervention [3, 15–19]. Disparities in healthcare access are concerning if they cannot be explained by disease-related factors, which directly affect surgical feasibility and outcomes, or by patient preferences. [20].

The aim of this study was to evaluate potential non-tumour-related factors influencing the probability of receiving local treatment (surgical resection and/or thermal ablation) among patients with synchronous CRLM in the Netherlands and their potential impact on treatment outcomes after liver resection for synchronous CRLM.

2. Methods

For this study, data analysis across two nationwide sources was necessary, including the Netherlands Cancer Registry (NCR) and the Dutch Hepato Biliary Audit (DHBA). These databases were used to address different aspects of this study. These datasets complement each other. While the NCR provided data on all patient and tumour characteristics for local treatment of synchronous CRLM, the DHBA provided more detailed data on treatment outcomes after liver surgery. Using both databases is crucial, as it allows for a more comprehensive analysis by combining patient selection data with detailed outcome data. According to Dutch law, no ethical approval was needed since all data was managed anonymously. The scientific committees of the NCR and DHBA approved the study protocol.

2.1. NCR

In the Netherlands, all newly diagnosed patients with malignancies have been registered in the NCR since 1989. The main notifications of the NCR are the Dutch Pathology Reporting System (PALGA) and the National Hospital Discharge Registry. Data is collected retrospectively. Trained personnel collect information from medical records in all Dutch hospitals. The dataset of the NCR includes patient and tumour characteristics and information on treatment at the time of diagnosis of the primary tumour. Information on metachronous metastases is not standard available in the NCR.

2.2. DHBA

The DHBA, established in 2013, is a nationwide Dutch audit that includes all patients who undergo surgical exploration for intended liver surgery and/or thermal ablation [21]. This audit has been mandatory since 2014, with reported data completeness of 97 % [22]. Data is collected retrospectively. In 2018, with the participation of radiologists, the DHBA became multidisciplinary. The funding and initiation of the DHBA have been described previously [21]. The DHBA is a clinical audit, mainly focusing on outcomes after liver surgery and thermal ablation; recently, outcomes after a decade of auditing with the DHBA have been published [23].

2.3. Patient selection

To assess which patients underwent local treatment, all patients diagnosed with synchronous CRLM between 2015 and 2021 were selected from the NCR. Local treatment was defined as either surgical resection of CRLM, thermal ablation of CRLM, or concomitant resection and ablation.

To assess postoperative outcomes, all patients with synchronous CRLM who underwent liver surgery between 2015 and 2021 were retrieved from the DHBA. For the DHBA database, patients with missing data on date of birth, type of tumour, and timing of metastases were excluded. Since thermal ablation alone was not obligatory to register before 2023, patients who were treated with thermal ablation alone were not included in the analyses of DHBA data. (Supplementary Fig. 1). Data was analysed in 2023–2024. Reporting these outcomes is mandatory for all participating hospitals. Hospitals can update data from the previous year until March of the following year to ensure accurate follow-up.

2.4. Outcomes

The main outcome of this study was the likelihood of receiving local treatment (yes/no) in patients with synchronous CRLM. Furthermore, short-term postoperative outcomes (i.e. major morbidity and 30-day mortality) after liver resection in patients with synchronous CRLM were investigated [24].

2.5. Definitions

In the NCR, synchronous CRLM were classified as liver metastases detected before the start of treatment or during surgical exploration of the primary tumour. In the DHBA, synchronous CRLM were defined as colorectal liver metastases diagnosed within 6 months of primary tumour diagnosis.

Major morbidity was defined as complication grade 3A or higher, graded according to the Clavien-Dindo classification [25]. Mortality was defined as death during initial hospitalisation or within 30 days after liver resection, both in and out of hospital.

Income was a proxy for SES using income data by postcode area from CBS, with 2019 as the reference year [25]. Income is defined as the median disposable household income after adjusting for the size and composition of the household and categorised into three groups.

2.6. Statistical analysis

Baseline characteristics were analysed, categorical variables

(presented as proportions) were compared using the chi-square test, and continuous variables (presented as median with interquartile ranges (IQR)) were compared using students' t-tests.

The association between patient and tumour characteristics and the likelihood of undergoing local treatment for synchronous CRLM was evaluated using multivariable multilevel logistic regression models, accounting for patients' dependency within hospitals. In this model, the hospital of diagnosis was entered as level.

Univariable and multivariable logistic regression models evaluated the association between patient and tumour characteristics and post-operative outcomes. All possible variables were included in the multivariable analysis if there was no restriction due to the number of degrees of freedom based on the number of events. If the degrees of freedom were exceeded, variables were only included with a P-value of <0.10 in univariable regression. In all models, multicollinearity was assessed with a variance inflation factor (VIF). Variables were considered multicollinear if VIF exceeded 2.5.

In this manuscript, P-values <0.05 were considered statistically significant. All analyses were performed with R version 4.1.0 (R Core Team (2021). (R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria).

3. Results

3.1. Baseline characteristics (NCR database)

This study included 14,047 patients with synchronous CRLM from the NCR, of whom 2753 (19.6 %) underwent local treatment. Of these 1675 (60.8 %) patients underwent liver resection, 671 (24.4 %) patients underwent combined liver resection and ablation, and 407 (14.8 %) patients underwent thermal ablation alone for CRLM. Patients who underwent local treatment were more often male (62 % vs. 57 %), and patients who underwent local treatment had more often higher SES scores (40 % vs 31 %). Patients who underwent local treatment were younger compared (median age 64 years (IQR 56–72) vs 71 years (IQR 62–79), $P < 0.001$) and had better performance status (performance status 0: 68 % versus 34 %, $P < 0.001$) (Table 1).

3.2. Patient selection local treatment (NCR database)

Older patients (OR 0.94, 95 % CI 0.94–0.95), and females (OR 0.87, 95 % CI 0.78–0.97) had a lower likelihood of receiving local treatment. Patients with middle and high SES compared to low SES (respectively OR 1.35, 95 % CI 1.18–1.54 and OR 1.61, 95 % CI 1.41–1.84) had a higher likelihood of local treatment for CRLM. Patients who were diagnosed in a hospital that performed liver surgery also had a higher likelihood of undergoing local treatment (OR 1.52, 95 % CI 1.26–1.84).

Tumour-related factors associated with a lower probability of local treatment included extrahepatic metastases (OR 0.10, 95 % CI 0.09–0.129) and a higher number of CRLM (2 CRLM OR 0.62 95 % CI 0.51–0.75 and > 2 CRLM OR 0.42 95 % CI 0.36–0.50). Patients with left-sided (OR 1.48, 95 % CI 1.30–1.67) or rectal CRC (OR 1.46, 95 % CI 1.28–1.67) were associated with a higher likelihood of receiving local treatment for CRLM compared to patients with right-sided tumours (Table 2).

3.3. Baseline characteristics (DHBA database)

In total, 2534 patients were included from the DHBA database. Patients included from the DHBA database who underwent liver resection were more frequently male (61 %). The cohort's median age was 65 years (IQR 57–73). Among all patients undergoing surgery, 22 % had an ASA score of 3 or higher, and 21 % had a Charlson comorbidity score of 2 or higher. All patients and tumour-specific characteristics are summarised in Supplementary Table 1.

Table 1

Baseline characteristics of patients with synchronous colorectal liver metastases diagnosed between 2015 and 2021 in the Netherlands, stratified by local treatment of CRLM. (NCR data).

Factor	Local treatment CRLM N = 2753	No local treatment CRLM N = 11,294	p-value
Non-tumour-related			
Sex			< 0.001
Male	1694 (62)	6424 (57)	
Female	1059 (38)	4870 (43)	
Age (median, IQR)	64 (56, 72)	71 (62, 79)	< 0.001
Performance status			< 0.001
0	1267 (68)	2228 (34)	
1	551 (29)	2619 (40)	
≥2	56 (3)	1780 (27)	
Unknown	879	4667	
Charlson Comorbidity index (CCI)			< 0.001
0	889 (65)	2030 (52)	
1	372 (27)	1190 (30)	
2	115 (8)	694 (18)	
Unknown	1377	7380	
SES (income)			< 0.001
Low	691 (25)	3783 (34)	
Middle	951 (35)	3942 (35)	
High	1075 (40)	3461 (31)	
Unknown	36	108	
Tumour-related			
Location primary tumour			< 0.001
Left-sided	1093 (40)	3673 (33)	
Right-sided	721 (26)	4341 (38)	
Rectal	920 (33)	2837 (25)	
Not otherwise specified/ Overlapping parts	19 (1)	443 (4)	
Pattern of metastasis			< 0.001
Liver only metastasis	2371 (86)	4754 (42)	
Multiple metastasis	382 (14)	6540 (58)	
Surgical treatment for primary colorectal tumour			< 0.001
No	359 (13)	9331 (83)	
Yes	2394 (87)	1963 (17)	
Local treatment			
Combined liver resection and ablation	671 (24)	–	
Liver resection	1675 (61)		
Only thermal liver ablation	407 (15)		
Number of CRLM			< 0.001
1	664 (33)	7989 (10)	
2	372 (18)	653 (8)	
≥2	788 (39)	1664 (21)	
Multiple (exact unknown)	214 (11)	4764 (60)	
Unknown	715	3415	
Metastasis			
Peritoneal	121 (4)	2181 (19)	< 0.001
Lung	167 (6)	3562 (32)	< 0.001

3.4. Short-term postoperative outcomes after liver surgery (DHBA database)

Major complications were observed in 12 % of patients undergoing surgery. Non-tumour-related factors associated with major morbidity included age (OR 1.01 95 % CI 1.00–1.03) and ASA score ≥3 compared to ASA score 1–2 (OR 1.76; 95 % CI 1.34–2.29). Tumour-related factors which correlated with major morbidity included rectal primary tumour (OR 0.58; 95 % CI 0.44–0.77), 4 or 5 CRLM (OR 1.46 95 % CI 1.05–1.94), diameter of largest CRLM >35 mm (OR 1.85 95 % CI 1.26–2.72), diameter of largest CRLM >50 mm (OR 2.92 95 % CI 2.04–4.022), and major liver resection (OR 1.95; 95 % CI 1.50–2.52) (Table 3).

Thirty-day mortality occurred in 2.4 % of patients undergoing surgery. Age (OR 1.07; 95 % CI 1.02–1.11) and ASA score ≥3 (OR 2.88; 95

Table 2

Multivariable multilevel regression analysis of the odds of receiving local treatment for CRLM between 2015 and 2021 in patients with synchronous colorectal liver metastases (NCR data).

characteristic	OR	95 % CI
Non-tumour-related		
Age	0.94	0.94–0.95
Sex		
Male	–	
Female	0.87	0.78–0.97
SES (income)		
Low	–	
Middle	1.35	1.18–1.54
High	1.61	1.41–1.84
Unknown	1.67	1.04–2.67
Year of diagnosis	0.96	0.93–0.99
Hospital of diagnosis performs liver surgery		
No	–	
Yes	1.52	1.26–1.84
Tumour-related		
Localisation of primary tumour		
Right-sided colon	–	
Left-sided colon	1.48	1.30–1.67
Rectal	1.46	1.28–1.67
Colon nno/nos	0.31	0.19–0.52
Liver-only metastases		
Yes	–	
No	0.10	0.09–0.12
Number of CRLM		
1	–	
2	0.62	0.51–0.75
>2	0.41	0.36–0.50
Multiple, unknown exact number	0.04	0.03–0.05
Unknown	0.20	0.17–0.24

%CI 1.35–6.11) were independently associated with 30-day mortality. Tumour-related factors associated with mortality included major liver resection (OR 3.10, 95 % CI 1.41–6.87) (Table 4).

Other non-tumour-related factors, such as sex, BMI, Charlson comorbidity, and the type of hospital (regional vs. tertiary referral) where the patient underwent surgery, were not significantly related to major complications or mortality (Tables 4 and 5).

4. Discussion

During the study time, one in five patients with synchronous CRLM underwent local treatment for CRLM. This study revealed that in addition to tumour-related factors, non-tumour-related factors also influenced the likelihood of receiving local treatment of CLRM. These factors include age, SES, sex, and the hospital at which the patient initially presented. While tumour-related factors significantly influenced post-operative outcomes in surgical patients, most non-tumour-related factors such as sex, Charlson Comorbidity Index, and BMI had no impact on these outcomes. Higher age and ASA scores were however associated with poorer postoperative outcomes.

Factors influencing receiving or not receiving local treatment could be categorised as justified and unjustified barriers. It's important to distinguish these factors since factors considered unjustified could reflect possible disparities in access to care. Tumour-related factors influencing treatment eligibility include the number and size of CRLM, presence of extrahepatic metastasis, and the need for major liver resection [26]. These factors reflect tumour biology and are critical determinants of local treatment feasibility. This study showed that major liver resection and maximum diameter of CRLM were independently associated with increased postoperative complications. In addition to tumour-related factors, non-tumour-related factors such as age could be a barrier [27]. While these factors may influence postoperative risk, they should not be absolute disqualifiers for treatment. Age alone does not necessarily correlate with physiological fitness. This study further showed patients with higher ASA scores had a higher likelihood

Table 3

Baseline characteristics of patients with synchronous colorectal liver metastases who underwent liver surgery between 2015 and 2021 in the Netherlands. (DHBA data).

Characteristic	N (%)
N = 2534	
Sex	
Male	1552 (61)
Female	982 (39)
Age (IQR)	65 (57–73)
BMI	25.2 (23–28)
Missing	27
ASA score ≥3	546 (22)
Missing	6
CCI ≥2	538 (21)
Surgery performed in a tertiary referral centre	1155 (46)
Location primary tumour	
Colon	1699 (67)
Rectal	835 (33)
Extrehepatic metastasis	295 (12)
Missing	43
Number of CRLM	
1–3	1603 (66)
4–5	409 (17)
>5	414 (17)
Missing	108
Diameter of largest CRLM in mm	
<20	709 (31)
20–34	764 (33)
35–49	424 (19)
≥50	387 (17)
Missing	250
Bilobar disease	
No	1022 (45)
Yes	1241 (54)
Missing	271
Liver disease	
No	1760 (69)
Cirrhosis	368 (15)
Other	84 (3.3)
Unknown	322 (13)
Preoperative chemotherapy	1091 (46)
Missing	155
Major liver resection	602 (24)
Liver resection alone	1848 (73)
Combined liver resection and ablation	686 (27)
Outcomes	
Major complications	297 (12)
30-day mortality	34 (1.4)

Table 4

Multivariable regression analysis to assess factors associated with mortality in patients who underwent liver resection for synchronous colorectal liver metastases between 2015 and 2021 in the Netherlands.

Characteristic	OR ¹	95 % CI ¹
Non-tumour-related factors		
Age	1.07	1.02–1.11
ASA score		
1–2	–	–
≥3	2.88	1.35–6.11
Tumour related factors		
Major liver resection		
No	–	–
Yes	3.10	1.41–6.87
Diameter of largest CRLM		
<20	–	–
20–34	1.12	0.35–3.82
35–49	1.83	0.56–6.34
≥50	2.74	0.92–9.27

of postoperative complications and mortality, which could, therefore, be deemed a justified barrier, reflecting the patient's overall health status and surgical risk rather than an arbitrary criterion.

Table 5

Multivariable regression analysis to assess factors associated with major morbidity in patients who underwent liver resection for synchronous colorectal liver metastases between 2015 and 2021 in the Netherlands (DHBA data).

Characteristic	OR	95 % CI
Non-tumour-related factors		
Sex		
Male	–	–
Female	0.92	0.72–1.18
Age in years		
	1.01	1.00–1.03
BMI		
	0.99	0.95–1.02
ASA score		
1–2	–	–
≥3	1.76	1.34–2.29
Charlson comorbidity index		
0–1	–	–
≥2	1.07	0.79–1.42
Type of hospital		
Regional	–	–
Tertiary referral centre	1.23	0.97–1.57
Tumour related factors		
Location primary tumour		
Colon	–	–
Rectal	0.58	0.44–0.77
Extrahepatic metastasis		
No	–	–
Yes	1.10	0.75–1.57
Number of CRLM		
1–3	–	–
4–5	1.43	1.05–1.94
>5	0.78	0.53–1.11
Unknown	0.94	0.59–1.47
Diameter of largest CRLM in mm		
<20	–	–
20–34	1.26	0.88–1.80
35–49	1.85	1.26–2.72
≥50	2.92	2.04–4.22
Bilobar CRLM		
No	–	–
Yes	0.87	0.68–1.13
Unknown	1.26	0.36–3.35
Liver disease		
No	–	–
Cirrhosis	1.20	0.85–1.66
Other	1.79	0.99–3.08
Unknown	0.70	0.45–1.04
Preoperative chemotherapy		
No	–	–
Yes	0.96	0.75–1.23
Major liver resection		
No	–	–
Yes	1.95	1.50–2.52

Several non-tumour-related factors should be regarded as unjustified barriers. Higher SES meant a higher likelihood of undergoing local treatment for CRLM. This was concordant with previous studies [28,29]. An interaction between lower SES and multimorbidity has been described before and could impact eligibility for local treatment [30–32]. Higher SES has been associated with greater health awareness and participation in screening programs, potentially leading to earlier diagnosis and more treatment options [33–35]. Therefore, it is possible that patients with lower SES scores presented later with subsequently fewer treatment options [36,37]. Studies conducted in the USA have reported that higher SES was associated with increased health-seeking behaviour, travelling longer distances and often visiting multiple hospitals [38,39]. However, a recent study with DHBA data did not observe differences in postoperative outcomes between different SES groups [40]. We would not expect travel distance is SES alone is associated with proximity to high-volume centers offering liver surgery since the Netherlands is small and densely populated, recently research showed most Dutch citizens live within 5 km from a hospital facility [41]. A strategy to increase patients' chances for treatment could involve enhancing their overall fitness and readiness for surgery. This can be

achieved through prehabilitation programs, which involve preparing patients for surgery through physical, nutritional, and psychological interventions [42,43]. These programmes could increase the number of patients deemed eligible for local treatment by prioritising patients from lower SES neighbourhoods or those with higher ASA scores who might have poorer baseline health. Furthermore, it is important to train healthcare professionals to align with the patient's health literacy level [44]. Healthcare systems should focus on ensuring equal access to surgical treatments and improving outcomes for all patients with CRLM.

Another potentially unjustifiable barrier factor was patients' sex. Female patients were less likely to undergo local treatment. This was concordant with other studies showing that female patients were less likely to receive surgical treatment for CRLM [16,45–47]. Several factors, such as tumour biology, clinical presentation, progression, and treatment response of CRC, differ between sexes [48–50]. However, this study showed that outcomes after surgery were comparable between sexes. A recent Dutch study on sex differences in treatment in patients with colorectal cancer described women more often receiving best supportive care only [51]. It has been described that compared to men, women attach more value to psychosocial support and have other preferences concerning health care [52]. More research is needed on specific preferences between sexes in CRLM surgery. However, in the meantime, healthcare professionals could be more aware of sex differences and enhance their ability to identify patients' preferences.

Unwarranted variation in practice was also observed in the likelihood of local treatment for CRLM, which is significantly influenced by the hospital where the patient initially presented. Patients primarily presenting at hospitals performing liver surgery were more likely to undergo local treatment. A previous study of NCR data, conducted between 2008 and 2012, already showed considerable inter-hospital variation in the proportion of patients undergoing liver resection, favouring patients diagnosed in hospitals where liver surgery was performed [53]. This trend has also been observed in recent studies focusing on resectability criteria, which have shown that specialists in dedicated liver centers are more likely to evaluate patients as eligible for local therapy for metastases than those in general hospitals [12,14,19, 54,55]. Several strategies could be proposed to reduce disparities in access to liver surgery. In the Netherlands, all treated patients with stage IV colorectal cancer are discussed in a multidisciplinary team (MDT) meeting at the treating hospital. It is essential to optimise multi-disciplinary team (MDT) meetings in hospitals that do not perform liver surgery. This can be achieved by mandatory MDTs of these hospitals with an expert liver surgeon through telemedicine or regular consultations. However, considerable variability among expert liver surgeons in assessing resectability highlights the complexity of defining treatment strategies for CRLM. This underscores the necessity of a nationwide expert panel rather than a single-surgeon approach, as introduced in a trial setting by the CAIRO 5 trial.[56] Future efforts should focus on reintroducing such a panel for regular treatment of these patients. The authors advocate that this panel should be available for consultation in every patient with CRLM. This could potentially increase more comprehensive evaluations and appropriate referrals, increasing the chances of patients with CRLM undergoing (local) treatment when indicated.

Several limitations of this study must be considered. Although the NCR and DHBA are complementary, and their combined use was essential for this study, they are distinct registries with slightly different definitions of synchronous disease. The NCR included all patients diagnosed with colorectal cancer and synchronous metastases, regardless of treatment type. In contrast, the DHBA only includes patients who underwent local treatment, providing detailed perioperative and surgical data but excluding non-surgical patients. This study only included patients with synchronous CRLM because the NCR does not routinely collect information on metachronous metastases. Timing of metastases is an important prognostic factor for patients with CRLM and could also influence patient selection. Furthermore, the DHBA uses a broader

definition of synchronous liver metastases; therefore, the DHBA included more patients who underwent liver surgery compared to the NCR. Furthermore, the NCR lacks data on comorbidities for all patients; even though comorbidities will influence patient selection for CRLM [57]. Furthermore, in the NCR, information about the burden of CRLMs was not available for all patients, such as the size and number of CRLMs. The DHBA lacked information about post-ablation outcomes. If these outcomes after thermal ablation alone could have been included, overall morbidity and mortality rates would have been expected similar or somewhat lower, as thermal ablation generally has equal or slightly better short-term outcome profile compared to surgery. The registration nature of both data sets lacks detailed information, for example, if a patient is discussed within the (specialised) MDT and why the MDT chose a specific treatment. This makes it challenging to capture the complex decision-making process of multidisciplinary teams. Treatment strategies, surgical techniques, and institutional experience may have evolved during this time, which could have influenced patient selection and outcomes.

In conclusion, this nationwide population-based study demonstrated several patient, tumour and hospital-related disparities in receiving local treatment of synchronous CRLM. Healthcare systems should focus on eliminating barriers to accessing proper care.

Author credit

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Conflict of interest

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Appendix A. Supplementary data

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