Am J Cancer Res 2018;8(9):1887-1898
www.ajcr.us /ISSN:2156-6976/ajcr0083054

Original Article

Multidisciplinary team intervention associated with improved survival for patients with colorectal adenocarcinoma with liver or lung metastasis

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Received July 24, 2018; Accepted August 16, 2018; Epub September 1, 2018; Published September 15, 2018

Abstract: Background and Objectives: To investigate whether multidisciplinary team (MDT) intervention is associated with improved survival for patients with colorectal adenocarcinoma with liver or lung metastasis (CRA-LLM). Methods: We enrolled 161 consecutive patients with histologically confirmed CRA-LLM at Taipei Medical University-Wan Fang Hospital between January 2007 and December 2017. In total, 75 patients with CRA-LLM received MDT intervention, and 86 patients did not receive MDT intervention. To evaluate prognostic factors for overall death, we performed univariate and multivariate Cox regression analyses of the overall death rate in all patients. Overall survival rates were calculated using the Kaplan-Meier method, and Kaplan-Meier survival curves were compared using the log-rank test ($P < .001$). Results: A multivariate Cox regression analysis of the overall death rate in patients with CRA-LLM showed that age ≤ 65 years, systemic chemotherapy, curative-intent treatments, and MDT intervention are strong prognostic factors. The adjusted hazard ratio of death risk for age ≤ 65 years, systemic chemotherapy, curative-intent treatments, and MDT intervention were 0.60 (95% confidence interval [CI], 0.40-0.92; $P = .019$), 0.19 (95% CI, 0.12-0.32; $P = .001$), 0.25 (95% CI, 0.13-0.50; $P = .001$), and 0.40 (95% CI, 0.25-0.65; $P = .001$), respectively. The 3-year overall survival rates in patients with CRA-LLM receiving MDT intervention and not receiving MDT intervention were 48.75% and 24.21%, respectively. Conclusion: MDT intervention is associated with improved survival for patients with CRA-LLM.

Keywords: Colorectal adenocarcinoma, overall death, multidisciplinary teams, liver metastasis, lung metastasis

Introduction

In Taiwan, colorectal cancer (CRC) is the second leading cancer and the third leading cause of cancer deaths [1]. Globally, the regional incidence of CRC varies over 10-fold. Western countries and North America have the highest incidence, whereas Africa and south-central Asia have the lowest incidence [2]. These differences may be attributable to differences in dietary and environmental exposures and genetic susceptibility [3-6]. In Taiwan, 17.12% patients had an initial diagnosis of stage IV CRC, and approximately 38.87% of these patients had colorectal adenocarcinoma with liver or lung metastasis (CRA-LLM) [1].

Cancer care can be complex, and given the wide range and number of health care professionals involved, an enormous potential for poor coordination and miscommunication exists [7]. Multidisciplinary teams (MDTs) should improve coordination, communication, and decision-making among health care team members and patients and produce more positive outcomes [7]. The resection of limited metastatic sites could result in a higher overall survival rate [8, 9]. Therefore, surgery provides a curative option for selected patients who present with limited metastatic CRC [8, 9]. However, the resection rate of metastatic CRC in Taiwan was 61.13% in 2016 [1]. For patients with borderline resectable or initially unresectable but potentially resectable disease that is limited to the liver or lungs, downstaging with neoadjuvant chemotherapy (CT) may permit successful resection later [10, 11]. These patients must be managed by an MDT. MDT intervention could

improve monitoring of resection guidelines for CRC with liver or lung metastases based on the number of lesions, tumor size, and margins [12-14]. In addition, cancer navigators in MDTs can monitor clinical practice in patients with CRA-LLM and compliance with previously formed consensus in the colorectal tumor board and thus optimally cooperate with related cancer groups [15, 16].

Routine MDT intervention in patients with CRC has been controversial [7, 17]. Study has shown that optimal treatments exist for advanced CRC, especially stage IV, but not early stages [17]. A review article demonstrated that the effective MDT intervention in treatment of patients with cancer is scarce [7]. Therefore, we recruited patients with CRA-LLM who were recommended intensive therapy based on National Comprehensive Cancer Network (NCCN) guidelines. We investigated whether MDT intervention is associated with improved survival for patients with CRA-LLM.

Patients and methods

Study patients

We enrolled 161 consecutive patients who had histologically confirmed CRA-LLM at the Taipei Medical University-Wan Fang Hospital between January 2007 and December 2017. All enrolled patients were Taiwanese (Asian population). Colorectal surgeons confirmed that all the recruited patients had colorectal adenocarcinoma with lung or liver metastasis, and pathologic results confirmed presence of primary tumor without obstruction or imminent obstruction. The mean follow-up period was 84 months (standard deviation, 35 months). Clinical data (chest, abdominal, and pelvic computed tomography, magnetic resonance imaging, or positron emission tomography scan) were analyzed to evaluate the extent of lung or liver metastasis, including metastatic visceral organs, metastatic numbers, liver lobe metastatic status, largest metastatic tumor size, and secondary resectability after neoadjuvant CT. Rectal and colon adenocarcinomas were included. Neoadjuvant CT or systemic CT is indicated for CRA-LLM in our hospital [18, 19]. CT included standard fluorouracil (FU)-based regimens with or without contemporary regimens, such as irinotecan, oxaliplatin, bevacizumab, cetuximab, regorafenib, trifluridine-tipiracil, pembrolizumab, or nivolumab, depending on physicians' decision or patients' economic status. Crossovers of various regimens in systemic treatments were allowed. Our protocols were reviewed and approved by the institutional review board at our hospital (TMU-JIRB No. 201705066).

MDT intervention and follow-up

MDT intervention in patients with CRC has been executed in Taiwan according to the encouragement of Health Promotion Administration (HPA), Ministry of Health and Welfare since 2007. MDT intervention including a consensus regarding treatments for CRC was reached after discussion among the colorectal tumor board members. The members of the tumor board include medical oncologists, colorectal surgeons, radiation oncologists, diagnostic radiologists, pathologists, rehabilitation physicians, nuclear medicine physicians, professional nurses, and CRC navigators. The cancer navigators in MDTs monitor clinical practices in patients with CRC, ensure compliance with previously formed consensus in the colorectal tumor board, and reach optimal cooperation among related cancer groups [15, 16]. MDT intervention was not enforced but encouraged by the HPA and our hospital. Between January 2007 and December 2017, 75 patients with CRA-LLM received MDT intervention (MDT group), and 86 patients did not receive MDT intervention (non-MDT group). Secondary resectability after neoadjuvant CT was also allowed in our study.

Clinical staging of the disease was performed according to the seventh edition of the *American Joint Committee on Cancer Cancer Staging Manual, 7th edition*. After clinical imaging, all patients were enrolled in a surveillance program designed to detect disease status, including disease progression or death. Clinic visits were scheduled every 2 weeks during treatment followed by every 3 months for the first 2 years and subsequently at 6-month intervals for 3 years after treatment. At each visit during treatment, pelvic examination was performed, and the metastatic size, location, and numbers were determined through liver sonography, chest radiography, computed tomography scans, or positron emission tomography scan. Abdominal ultrasound or computed tomography was performed every 6 months after treatment. Colonoscopy was performed after 1

Table 1. Characteristics of patients with CRA-LLM receiving and not receiving MDT intervention

	No MDT (*N* = 86)	MDT (*N* = 75)	*P* value
	N (%)	*N* (%)	
Sex			.527
Men	43 (50.00)	42 (56.00)	
Women	43 (50.00)	33 (44.00)	
Age (years)			.635
≤ 65	44 (51.63)	42 (56.00)	
> 65	42 (48.37)	33 (44.00)	
Median	64	65	.945
Primary tumor location			.736
Rectum	30 (34.88)	23 (30.67)	
Colon	56 (65.12)	52 (69.33)	
Metastatic visceral organs			.054
Liver	73 (84.88)	54 (72.00)	
Lungs	13 (15.12)	21 (28.00)	
Both	8 (9.30)	7 (9.33)	
Metastatic numbers			.473
1	22 (25.58)	29 (38.67)	
2-3	21 (24.42)	18 (24.00)	
4-10	15 (17.44)	9 (12.00)	
11-20	8 (9.30)	5 (6.67)	
> 20	19 (22.09)	14 (18.67)	
Liver lobe metastatic status			.080
Unilateral lobe	32 (37.21)	39 (52.00)	
Bilateral lobes	54 (62.79)	37 (48.00)	
Largest metastatic tumor size			.014
≤ 5 cm	46 (53.49)	55 (73.33)	
> 5 cm	40 (46.51)	20 (26.67)	
Neoadjuvant CT			.080
No	77 (89.53)	59 (78.67)	
Yes	9 (10.47)	16 (21.33)	
Curative-intent treatments			.010
No	58 (67.44)	35 (46.67)	
Yes	28 (32.56)	40 (53.33)	
Regimens of CT			.773
FU based only	45 (52.36)	41 (54.67)	
FU + contemporary regimens	41 (47.64)	34 (45.33)	
Secondary resectability after neoadjuvant CT			.291
No	8 (88.89)	15 (93.75)	
Yes	1 (11.11)	1 (6.25)	
Systemic CT			.137
No	16 (18.60)	22 (29.33)	
Yes	70 (81.40)	53 (70.67)	

MDT, multidisciplinary team; CT, chemotherapy; FU, fluorouracil. Contemporary regimens: irinotecan, oxaliplatin, bevacizumab, cetuximab, regorafenib, trifluridine-tipiracil, pembrolizumab, or nivolumab. Crossovers of various contemporary regimens in systemic treatments were allowed.

and 3 years following treatment. If the patients did not return for follow-up at our outpatient department, we contacted them through telephone or email. Any symptom potentially related to disease progression was investigated through digital rectal examination, colonoscopy, and computed tomography or magnetic resonance imaging.

Statistical analysis

The primary endpoint of the study was confirmation of overall death. Patients lost to follow-up were censored from the time of final follow-up. The MDT group was compared with the non-MDT group. Continuous variables were expressed as medians (ranges) and compared using the Mann-Whitney *U* test or analysis of variance (2 or more independent groups), whereas categorical variables (percentages) were compared using the chi-squared test or Fisher exact test, when indicated. Multivariate analysis was performed using Cox regression analysis for long-term follow-up (different time, censored data), with only model variables having the highest or lowest ($P < .05$) univariate risk being included. Statistical significance was defined as $P < .05$, and results were described with a hazard ratio (HR) and 95% confidence interval (CI). All *P* values were 2-tailed. Significant independent predictors for overall death, comprising sex, age, primary tumor location, metastatic visceral organs, metastatic num-

Table 2. Univariate cox proportional hazard regression analysis of death risk among patients with CRA-LLM

	HR	95% CI	*P* value
MDT			
Yes (Ref.)	1.949	1.299-2.924	.001
No			
Neoadjuvant CT			
Yes (Ref.)	4.529	2.980-6.882	.001
No			
Treatment with curative intent			
Yes (Ref.)	6.385	4.007-10.178	.001
No			
Largest metastatic tumor size			
> 5 cm (Ref.)	0.373	0.253-0.550	.001
≤ 5 cm			
Liver lobe metastatic status			
Bilateral lobes (Ref.)	0.296	0.193-0.454	.001
Unilateral lobe			
Metastatic numbers (numbers > 20 as Ref.)			
1	0.17	0.093-0.311	.001
2-3	0.520	0.311-0.870	.013
4-10	0.703	0.396-1.249	.230
11-20	0.709	0.346-1.452	.347
Primary tumor location			
Colon (Ref.)	0.991	1.149-3.420	.964
Rectum			
Systemic CT			
Yes (Ref.)	3.675	1.785-7.562	.001
No			
Age			
> 65 (Ref.)	0.691	0.475-1.000	.050
≤ 65			
Regimens of CT			
FU + contemporary regimens (Ref.)	1.982	1.149-3.420	.014
FU based only			
Secondary resection after neoadjuvant CT	1.468	1.094-5.319	.037
Yes (Ref.)			
No			
Sex			
Women (Ref.)	1.103	0.758-1.604	.609
Men			
Metastatic visceral organs			
Lungs (Ref.)			
Liver	1.002	0.491-1.420	.594
Both	1.584	0.564-5.762	.508

MDT, multidisciplinary team; Ref., reference Group; CI, confidence interval; CT, chemotherapy. Contemporary regimens: irinotecan, oxaliplatin, bevacizumab, cetuximab, regorafenib, trifluridine-tipiracil, pembrolizumab, or nivolumab.

bers, liver lobe metastatic status, largest metastatic tumor size, neoadjuvant CT, curative-intent treatments, regimens of CT, secondary resectability after neoadjuvant CT, and systemic CT, were determined using a multivariate Cox regression analysis to determine the HR; the independent predictors were controlled using multivariate analysis in the study, and the endpoint was overall survival rate among the 2 groups. The overall survival rate was calculated through the Kaplan-Meier method. Kaplan-Meier survival curves were compared using the log-rank test. Statistical analyses were performed using SPSS, version 13.0, for Windows (SPSS Inc., Chicago, IL).

Results

Study participants

We enrolled 161 patients with CRA-LLM. The characteristics of the patients in the MDT and non-MDT groups are presented in **Table 1**. No significant difference was observed in sex, age, primary tumor location, metastatic visceral organs, metastatic numbers, liver lobe metastatic status, neoadjuvant CT, CT regimens, secondary resectability after neoadjuvant CT, and systemic CT between the 2 groups (**Table 1**).

Univariate and multivariate analysis

In the MDT group, largest metastatic tumor size > 5 cm was found in 26.67% of the patients compared with 46.51% in the non-MDT group. Moreover, curative-intent treatments were significantly

Table 3. Multivariate cox proportional hazard regression analysis of death risk among patients with CRA-LLM

	HR*	95% CI	*P* value
Neoadjuvant CT			
Yes (Ref.)	1.725	0.778-3.826	.180
No			
Sex			
Women (Ref.)	1.166	0.775-1.752	.461
Men			
Age			
> 65 (Ref.)	0.606	0.400-0.920	.019
≤ 65			
Regimens of CT			
FU + contemporary regimens (Ref.)	1.473	0.521-3.710	.849
FU based only			
Secondary resectability after neoadjuvant CT	1.313	0.752-5.698	.476
Yes (Ref.)			
No			
Metastatic numbers (numbers > 20 as Ref.)			
1	0.581	0.216-1.560	.281
2-3	0.848	0.467-1.537	.586
4-10	0.756	0.410-1.396	.372
11-20	0.893	0.426-1.874	.765
Liver lobe metastatic status			
Bilateral lobes (Ref.)	0.653	0.337-1.267	.207
Unilateral lobe			
Largest metastatic tumor size			
> 5 cm (Ref.)	1.218	0.767-1.934	.402
≤ 5 cm			
Treatment with curative intent			
No (Ref.)	0.252	0.128-0.496	.001
Yes			
MDT			
Yes (Ref.)	0.403	0.251-0.647	.001
No			
Systemic CT			
No (Ref.)	0.194	0.119-0.317	.001
Yes			

MDT, multidisciplinary team; Ref., reference group; CI, confidence interval; CT, chemotherapy. *All variables in **Table 1** were used in multivariate analysis. Contemporary regimens: irinotecan, oxaliplatin, bevacizumab, cetuximab, regorafenib, trifluridine-tipiracil, pembrolizumab, or nivolumab.

higher in the MDT group. Univariate Cox proportional hazard regression analyses of death risk among patients with CRA-LLM are presented in **Table 2**. In the univariate analysis, MDT intervention, age ≤ 65 years, neoadjuvant CT, curative-intent treatments, largest metastatic tumor size ≤ 5 cm, liver unilateral lobe metastasis, metastatic numbers 1-3, receiving systemic CT, using FU + contemporary regimens, and secondary resection after neoadjuvant CT reduced the death rate significantly among patients with CRA-LLM (**Table 2**). Moreover, no significant differences were observed in sex, metastatic liver, solitary or both lung and liver metastases, or primary colon or rectal adenocarcinoma. Metastatic number > 3 was not significant for death risk compared with metastatic number > 20. To examine prognostic factors for overall survival, we also performed a multivariate Cox regression analysis of the overall death rate in patients with CRA-LLM (**Table 3**). After including only model variables of overall death having the highest or lowest univariate risk, we observed that age ≤ 65 years, systemic CT, curative-intent treatments, and MDT intervention were better prognostic factors (**Table 3**). The adjusted HR of death risk for age ≤ 65 years, systemic CT, curative-intent treatments, and MDT intervention were 0.60 (95% CI, 0.40-0.92; *P* = .019), 0.19 (95% CI, 0.12-0.32; *P* = .001), 0.25 (95% CI, 0.13-0.50; *P* = .001), and 0.40 (95% CI, 0.25-0.65; *P* = .001), respectively.

Overall survival rates

The 1-year overall survival rates of the MDT and non-MDT groups were 74.52% and 53.45%, respectively (**Table 4**). Furthermore, the 3-year overall survival rates of the MDT and non-MDT groups were 48.75% and 24.21%, respectively. In addition, the overall survival rate was calcu-

Table 4. Survival rate of population in MDT and Non-MDT groups

	No MDT intervention (%)	MDT intervention (%)	*P* value
1-year overall survival	53.45	74.52	< .001
3-year overall survival	24.21	48.75	< .001

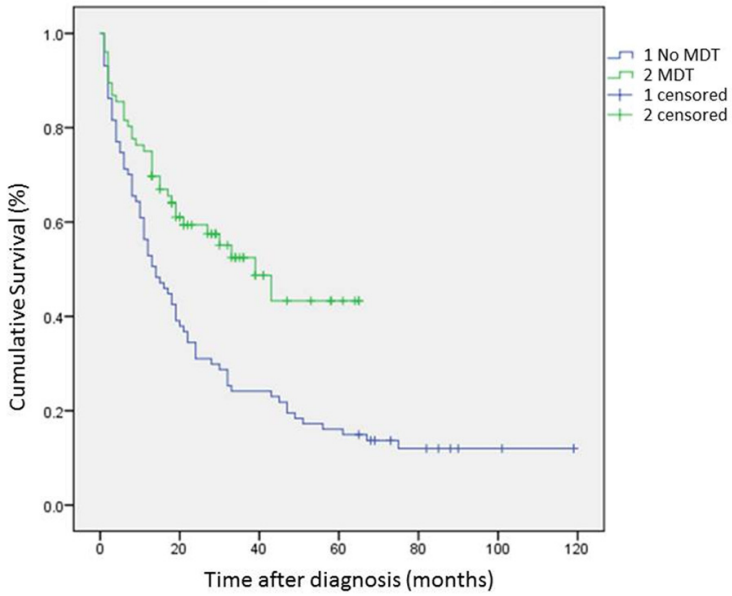

Figure 1. Kaplan-Meier curves for overall survival of patients with CRA-LLM receiving and not receiving MDT intervention. Note: *P* value of log-rank test is < .001.

lated using the Kaplan-Meier method, and Kaplan-Meier survival curves were compared using the log-rank test (**Figure 1**). As presented in the Figure, the 5-year overall survival rates of the MDT and non-MDT groups were 44.32% and 17.41%, respectively (log-rank test, $P < .001$). Kaplan-Meier curves for 5-year overall survival for patients with CRA-LLM with curative-intent treatments in the MDT and non-MDT groups were 64.57% and 41.31%, respectively (log-rank test, $P = .062$) (Figure S1).

Discussion

MDT intervention improved the diagnostic accuracy and overall survival of patients with CRC [13]. Moreover, it promoted communication and cooperation among different disciplines and ensured high-quality diagnosis, evidence-based decision-making, and optimal treatment planning [13]. However, a study showed that MDT intervention only benefits patients with advanced-stage CRC and delivers little demonstrable advantage to patients with early-stage CRC [20]. These results call into question the current belief that all new patients with CRC should be evaluated at an MDT meeting [20]. Furthermore, a review article demonstrated that effective MDT intervention is scarce [7] because ethnic cultural differences, historical enmities, hierarchical boundaries, and personality styles that are not conducive to harmonious exchange and respect of different viewpoints can make MDTs dysfunctional, and participation can be stressful [21]. The benefits to patients and health care professionals from MDTs might not be possible without substantial investment in team training [21]. No consolidative conclusions exist on the effectiveness of MDT intervention in overall survival, especially in CRA-LLM. The effectiveness of MDT intervention in patients with cancer or CRC remains debatable [7, 20].

Surgery provides a potentially curative option for selected patients who present with CRA-LLM [10, 11, 22]. As a result, secondary resectability after neoadjuvant CT is a crucial good prognostic factor in patients with CRA-LLM [10, 11, 14, 22]. In our study, secondary resectability was similar in the MDT and non-MDT groups. A resection rate of 8% was observed after neoadjuvant CT in our patients with initial CRA-LLM, and the positive outcome rates were lower than those of other studies [23, 24] because only 41.21% of the patients with CRA-LLM received contemporary regimens (**Table 1**). Secondary resectability after neoadjuvant CT reduced the death rate significantly in univariate analysis but not in multivariate analysis. The sample size of patients who underwent neoadjuvant CT was only 25. The small sample size could have led to statistical nonsignificance. However, these patients with CRA-LLM could be managed and monitored by an MDT [25]. The necessary cumulative dose or systemic CT and close follow-up are the strengths

of MDT intervention [25]. Moreover, sex, age, metastatic visceral organs, metastatic numbers, liver lobe metastatic status, largest metastatic tumor size, curative-intent treatments, regimens of CT, and systemic CT reported as prognostic factors were adjusted in our patients [26-34]. These possible confounding factors were considered as covariates in our univariate and multivariate analyses (**Tables 2** and **3**).

The majority of the patients with CRA-LLM cannot be cured, although a subset with limited liver or lung disease is potentially curable through surgery [10, 11, 22, 35, 36]. For other patients, treatment is palliative and generally consists of systemic CT [37]. For decades, FU was the sole active agent [37]. This has changed markedly since 2000, with the approval of FU and contemporary regimens like irinotecan; oxaliplatin; 3 humanized monoclonal antibodies, namely bevacizumab, cetuximab, and panitumumab; aflibercept; regorafenib; trifluridine-tipiracil; and tipiracil [37-41]. Most recently, the immune checkpoint inhibitors pembrolizumab and nivolumab have been approved for advanced microsatellite instability-high or deficient mismatch repair CRC that has progressed following conventional CT [42-44]. Systemic CT produces meaningful improvements in median overall survival [37]. These benefits are most pronounced with regimens containing irinotecan or oxaliplatin in combination with FU [45, 46]. Although these regimens have not been compared to determine the most effective supportive care individually, median survival is now routinely > 2 years, and 5-year survival with systemic CT alone is approximately 20% [37-41]. However, the most effective combination and sequence of contemporary agents are not established nor is the optimal duration of treatment. In our study, no statistical differences were observed between the MDT and non-MDT groups after combining contemporary agents (**Table 1**). In multivariate analysis, combined use of FU and contemporary agents was not an independent prognostic factor of death rate (**Table 3**).

With improvements in surgical techniques and postoperative intensive care, surgical mortality has decreased and influences survival outcomes of patients with CRA-LLM receiving neoadjuvant CT [47-49]. However, only 2 patients received secondary resection in our study. Therefore, the influence of improvements in surgical techniques and postoperative intensive care on survival outcomes is negligible. Moreover, no significant differences were observed in secondary resectability after neoadjuvant CT between the MDT and non-MDT groups (**Table 1**). As shown in **Table 1**, curative-intent treatment rates were 53.33% and 32.56% in the MDT and non-MDT groups, respectively. Thus, MDT intervention may result in more curative-intent treatments in patients with CRA-LLM in our study. Curative-intent treatments with more aggressive and optimal therapies in the MDT group of our study were proportional to those of previous studies [50-53]. Patients with largest metastatic tumor size > 5 cm were few in the MDT group, and largest metastatic tumor size > 5 cm was not an independent prognostic factor in overall death after all variables in **Table 1** were used in multivariate analysis (**Table 3**).

According to a multivariate Cox regression analysis of the overall death rate in patients with CRA-LLM (**Table 3**), we observed that age ≤ 65 years old, systemic CT, curative-intent treatments, and MDT intervention were independent prognostic factors (**Table 3**). Our findings showed that elderly patients with CRA-LLM had poor survival rates after treatment; these findings were similar to other studies [26, 54, 55]. Systemic CT lowered the death rate for patients with CRA-LLM compared with BSC in our study; these outcomes were also compatible with a previous study [56]. However, studies comparing overall survival outcomes using systemic CT and BSC in patients with CRA-LLM are few. In addition, multicollinearity might exist in curative-intent treatments and MDT intervention because treatment decisions differ, especially in patients with CRA-LLM after MDT intervention [51]. Therefore, we selected only patients with CRA-LLM who received curative-intent treatments, and we estimated the survival curve on the basis of whether they received MDT intervention. Kaplan-Meier curves for the 5-year overall survival rate for patients with CRA-LLM with curative-intent treatments of the MDT and non-MDT groups were 64.57% and 41.31%, respectively (log-rank test, P = .062) (Figure S1). The 5-year survival rate for patients with curative-intent treatments of the MDT group (n = 40) was > 20% higher than that of the non-MDT group (n = 28). The trend of the P value was nearly statistically significant, but the limitation was the sample size of patients with CRA-LLM receiving curative-intent treatments.

The 1-year overall survival rates of the MDT and non-MDT groups were 74.52% and 53.45%, respectively (**Table 4**). The 3-year overall survival rates of the MDT and non-MDT groups were 48.75% and 24.21%, respectively. As presented in the **Figure 1**, the 5-year overall survival rates of the MDT and non-MDT groups were 44.32% and 17.41%, respectively (log-rank test, $P < .001$). The Kaplan-Meier survival curves were focused toward the beginning of MDT intervention (**Figure 1**), which usually means the intervention is effective [57].

No clinical data exist that prove increased overall survival of patients with CRA-LLM after receiving MDT intervention. Our study is the largest study to evaluate the effect of MDT intervention in patients with CRA-LLM. This is also the first article to show independent improved prognostic factors such as age ≤ 65 years, systemic CT, curative-intent treatments, and MDT intervention in patients with CRA-LLM. Although some retrospective data or national cohort studies have shown patients with CRC receiving MDT intervention to have a lower mortality risk, no data specific to patients with CRA-LLM were available [17, 20]. We believe that MDT intervention promotes communication and cooperation among disciplines and ensures high-quality diagnosis, evidence-based decision-making, and optimal treatment planning in patients with CRA-LLM.

Our study had some limitations. First, a small sample size of neoadjuvant CT, secondary resection after neoadjuvant CT, and only 46.58% of patients with CRA-LLM received a combination of FU and contemporary regimens in our study. Second, intensive therapy was suggested in patients with CRA-LLM based on NCCN guidelines [58], but determining patients appropriate for intensive therapy was difficult, and well-trained MDTs were necessary [7, 21]. Putative benefits to patients and health care professionals from MDT intervention may not be possible without appropriate team training [21]. Third, wild-type and mutated *RAS* (*NRAS*, *KRAS*) oncogenes were not checked before 2014 in our institute. There were only 5 patients with mutated *KRAS* among the 12 patients whose oncogenes were checked.

Conclusions

Age ≤ 65 years, systemic CT, curative-intent treatments, and MDT intervention improved overall survival in patients with CRA-LLM. Thus, MDT intervention is associated with improved survival for patients with CRA-LLM.

Acknowledgements

Taipei Medical University (103TMU-WFH-07, and 104TMU-WFH-07, & TMU105-AE1-B26) and Wanfang Hospital funding 107-wf-swf-08. Our protocols were reviewed and approved by the Institutional Review Board of Taipei Medical University (TMU-JIRB No. 201705066).

Disclosure of conflict of interest

None.

Abbreviations

MDT, multidisciplinary team; CRA-LLM, colorectal adenocarcinoma with liver or lung metastasis; CT, chemotherapy; HR, hazard ratio; CRC, colorectal cancer; NCCN, National Comprehensive Cancer Network; FU, fluorouracil; HPA, Health Promotion Administration; CI, confidence interval.

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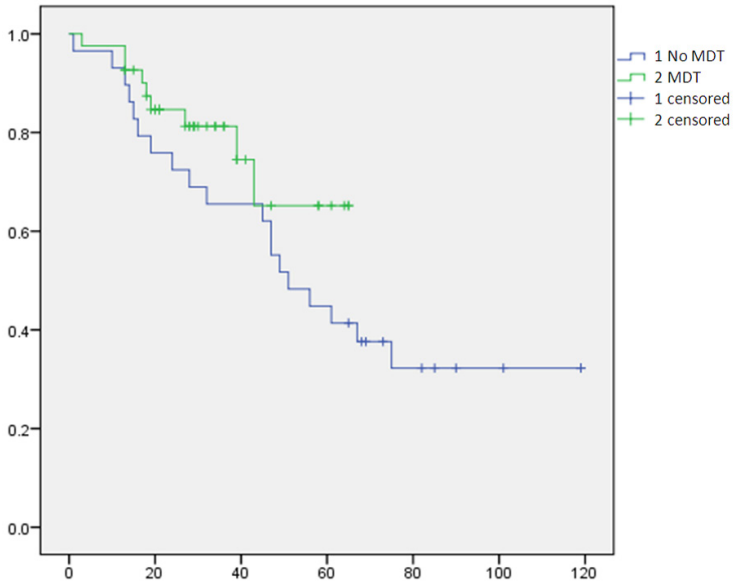

Figure S1. Kaplan-Meier curves for overall survival of patients with CRA-LLM receiving and not receiving MDT intervention with curative-intent treatments. Note: *P* value of log-rank test is .062.