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Clinicopathological Characteristics, Prognosis, and Survival Outcomes of Advanced Stage Gastric Cancer with Single- Site Metastasis: Nationwide Real-World Data from Qatar

L.A. Zar
Qatar University
A. Abdalhadi
AAbdalhadi@hamad.qa
Hamad Medical Corporation
M. S. Elkhatim
Hamad Medical Corporation
S. A. Abdelrahim
Hamad Medical Corporation
N. E. Omar
Hamad Medical Corporation
S. Abdo
Hamad Medical Corporation
A. Jama
Hamad Medical Corporation
R. Anil
Hamad Medical Corporation
W. Abdalla
Hamad Medical Corporation
A. Akram
Hamad Medical Corporation
M. Mostafa
Hamad Medical Corporation
E. Tubishat
Hamad Medical Corporation
S. Bujassoum
Hamad Medical Corporation
K. Rasul
Hamad Medical Corporation

A. Shablak
Hamad Medical Corporation

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Abstract

Introduction: Although recent studies have shown a steady decline in mortality over the past several decades, Gastric cancer (GC) remains the fifth major cause of cancer-related mortality. Several prognostic factors, both patient- and tumor-related have been investigated as predictors for survival in patients with stage 4 GC.

Aim: In this study, we aim to investigate whether the site of metastasis in patients newly diagnosed with stage 4 GC is a predictor for length of survival.

Methods: This is a retrospective cohort study of patients treated at the National Center for Cancer Care and Research, Doha, Qatar. The data was collected between January 2015 and December 2020. We generated three groups, each including patients with metastasis to a single site: liver, peritoneum, or retroperitoneal lymph nodes (RPLN). A Kaplan-Meier survival graph was used to illustrate the overall survival of patients in the three groups. Cox proportional-hazard model was used to investigate whether site of metastasis is a predictor for overall survival.

Results: A total of 134 patients with a median age of 52 (42 – 63) were diagnosed with stage IV GC. As for differentiation, around 67% had poorly differentiated GC. Of the 134 patients with Stage IV GC, 40 patients had single-site metastasis to either the liver, peritoneum, or RPLN. The Kaplan-Meier curve showed a statistically divergent increase in median overall survival (mOS) in patients with metastasis to the liver compared to peritoneum (20 vs 7, p = 0.03). Furthermore, patients with peritoneum-only metastasis had a 2.87-fold (95% UI 1.03 – 7.97, p = 0.043) increased mortality compared to liver-only metastasis. Patients with RPLN-only had similar survival compared to liver-only metastasis.

Conclusion: This study shows that patients with liver-only or RPLN-only metastasis have a better mOS compared to peritoneal. As our data is from a single center, further analysis of large cohorts is needed to validate the findings.

Introduction

The rates of Gastric cancer (GC) have been steadily declining over several decades, however, it remains the fifth leading cause of mortality among all cancers (1). The worldwide age-standardized rate of GC is 12.8% among males while in females the rate is lower (6.0%) based on a recent result from GLOBOCAN 2022(1). The incidence of GC is highest in eastern Asia (224.3 per 100,000) due to the high prevalence of drug-resistant *H. Pylori.* A recent systematic review of GC across 11 Arab countries found that Oman had the highest age-standardized incidence of GC (8.0 per 100,000), while Qatar had a lower incidence of GC the incidence was lower (5.2 per 100,000) (2). Stage IV GC, the most advanced form of the disease, is characterized by the spread of cancer cells beyond the stomach to distant organs, such as the liver, lungs, or peritoneum (3). There is limited data from the Arab world about the clinicopathological characteristics of GC, however a recent study done in Egypt of 70 patients with confirmed GC found that

the most of them were diagnosed at stage IV (55.7%) in whom the most common site of metastasis included peritoneum (53.8%), ascites (46.2%) and liver (23.1%) (4).

Several demographic and pathological factors play a role in the prognosis of stage IV GC. A retrospective study conducted in Japan showed that age > 70, CA19-9, and liver metastasis were strong prognostic indicators of overall survival (5) in patients with GC. Furthermore, multiple studies have shown that patients with limited metastatic lesions have a better disease outcome compared to those with extensive metastasis(6, 7). A more recent paper found that metastasis to a single organ had better median survival compared to multi-organ metastasis in GC (8).

However, despite these findings, there is limited evidence exploring whether the specific location of single-site metastasis—such as the liver, peritoneum, or lymph nodes—has a differential impact on survival outcomes in patients with stage IV GC. A retrospective population-based Swedish study found that patients with solitary bone or liver metastases experienced the worst median survival (~ 2 months), while peritoneal metastases were more frequently observed in younger patients (9). These findings point toward prognostic heterogeneity based on the metastatic site, yet the vast majority of such studies are derived from Western or East Asian populations. To date, there is a notable absence of data addressing this question in Middle Eastern populations, particularly in the Gulf region.

This study addresses this critical gap by analyzing nationwide, real-world data from Qatar to characterize the clinicopathological features and survival outcomes of patients with stage IV GC and single-site metastasis. Specifically, it investigates the prevalence of metastasis to the liver, peritoneum, and RPLN, and compares overall survival among these subgroups. In doing so, it aims to determine whether the site of solitary metastasis serves as a useful prognostic factor in this population. By providing data from a Middle Eastern context, this study contributes unique regional insights that may inform future diagnostic stratification and therapeutic strategies in the management of advanced GC.

Method

Study Design

This retrospective observational study was conducted at the National Center for Cancer Care and Research (NCCCR), the main tertiary oncology center in Doha, Qatar. The study protocol was approved by the Institutional Review Board (IRB) of Hamad Medical Corporation (MRC-01-24-522). In accordance with IRB guidelines, informed consent was waived due to the retrospective design of the study.

Data were collected for all adult patients (≥18 years) with a confirmed histological diagnosis of newly diagnosed stage IV GC between January 2015 and December 2020. Patient records were identified using the institutional electronic medical records (EMR) system. Trained research personnel extracted data using a standardized data collection form. Collected variables included patient demographics (age, sex, nationality), clinical characteristics (performance status, presenting symptoms), pathological features

(histological subtype, tumor location, HER2 status), and details of metastatic disease (site and number of metastases). Treatment details and survival outcomes were also recorded.

To ensure data accuracy, a random subset of records was independently reviewed by a second researcher. Any discrepancies were resolved through consensus with the clinical oncology team. All patient data were de-identified prior to analysis to maintain confidentiality.

Variable assessment

To assess the site of metastasis for each patient, we used diagnostic imaging modalities including contrast-enhanced computed tomography (CT) and positron emission tomography (PET) scans, performed at initial staging. Imaging findings were reviewed during multidisciplinary team (MDT) meetings, where consensus was reached on the presence and location of metastatic lesions. Only patients with confirmed de novo stage IV GC and metastasis confined to a single anatomical site were included in the final analysis. Patients with evidence of multiple metastatic sites were excluded during the data-cleaning phase.

The three most frequent solitary metastatic sites—liver-only, peritoneum-only, and RPLN-only—were designated as the primary exposure groups. The metastatic site was treated as a categorical variable in the analysis. The primary outcome was overall survival, defined as the time in months from the date of pathological diagnosis to the date of death or last follow-up.

Statistical Analysis

All analyses were conducted in Stata version 18 (10). Categorical variables were summarized using frequencies and percentages and compared using the Chi-square test or Fisher's exact test, as appropriate. Continuous variables were reported as medians with interquartile ranges (IQRs) and compared using the Kruskal–Wallis test due to non-normal distribution. We analyzed demographic variables such as age, gender, region, and comorbidities, alongside tumor markers including CA 19-9 and CEA levels in patients diagnosed with stage IV GC. Additionally, we evaluated histological characteristics, such as differentiation level, the presence of signet-ring cells, HER2/neu status, and expression levels of PD-L1 and MMR.

To address missing data, we used available case analysis, analyzing all non-missing values without imputation. For descriptive and inferential analyses, exact p-values were reported for both categorical and continuous variables. The language of statistical divergence was used in interpreting p-values rather than traditional notions of statistical significance (11). To evaluate whether the observed data diverged from a population model assuming no effect (the tested hypothesis), p-values were computed. A smaller p-value implies greater divergence of the study results from the tested hypothesis. Results with $p < 0.05$

were considered statistically divergent, indicating sufficient evidence to reject the tested hypothesis as a plausible explanation for the data.

We also reported point estimates and their 95% uncertainty intervals (95% UI) to assess both the precision and potential practical relevance of the findings (12). The uncertainty interval represents the range of tested hypotheses under which the observed result would be expected to lie within the central 95% of the predicted distribution.

A Kaplan–Meier survival analysis was conducted to compare survival duration among patients with single-site metastasis (liver-only, peritoneum-only, and retroperitoneal lymph node [RPLN]-only involvement). Differences between survival curves were evaluated using the log-rank test, with exact p-values reported. A Cox proportional hazards regression model was used to assess the association between metastatic site and overall survival. Both univariate and multivariable models were fitted, with the multivariable analysis adjusting for age and gender. Given the limited sample size (n = 40), the presence of imbalanced group sizes and rare events, we verified our result by applying the Firth penalized maximum likelihood correction.

Results

Patient characteristics

As shown in figure 1, a total of 134 patients diagnosed with de novo Stage 4 GC were included in this study, with a median age of 52 years (IQR: 42–63). The majority of patients were male (69.4%), while 30.6% were female. In terms of geographic distribution, 55.2% of patients were from Asia, 29.9% were from the MENA region, and 15% were from other regions (Table 1). Regarding comorbid conditions, 92.5% of patients had no history of cardiovascular disease (CVD), while 7.46% had a positive CVD history (Table 1).

The tumor marker levels varied among patients. The median CA19-9 level was 37.5 U/mL (IQR: 8.85–434.5), while the median carcinoembryonic antigen (CEA) level was 4.75 ng/mL (IQR: 1.9–24). The median programmed death-ligand 1 (PD-L1) expression was 5% (IQR: 0–20%). Mismatch repair (MMR) status was negative in 94.8% of patients, while only 5.13% had positive MMR status. Tumor differentiation was predominantly poor, observed in 67.2% of patients, while moderate to poor differentiation was noted in 1.7%. Signet-ring cell carcinoma was positive in 35.9% of cases. Human epidermal growth factor receptor 2 (HER2) status was negative in 83.6% of patients, with 16.4% testing positive.

The median overall survival for the cohort was 11 months (IQR: 8–15), with a mean survival time of 8.9 months (SD: 10.8). Regarding the location of the primary tumor, the most common sites were the body of the stomach (49.3%), followed by the antrum (21.6%), pylorus (2.99%), and other regions (26.1%). Metastasis was observed at multiple sites. The most common metastatic sites were the liver (48

patients), peritoneum (59 patients), RPLN (54 patients), and lung or pleural effusion (16 patients). Other metastatic sites included the adrenal glands, brain, omentum, and bone.

Table 1. Baseline Characteristics, Diagnostic Markers, and Survival Outcomes of Patients diagnosed with Stage IV Gastric Cancer

Variables		Total population means (N = 134)	Median (iqr)
Age		52.4 (13.7)	52 (42 – 63)
Gender	Male	93 (69.4%)	
	Female	41 (30.6%)	
Region	Asia	74 (55.2%)	
	MENA	40 (29.9%)	
	Other	20 (15%)	
CVD	No	124 (92.5%)	
	Yes	10 (7.46 %)	
HTN	No	95 (70.9%)	
	Yes	39 (26.1%)	
DM	No	97 (72.4%)	
	Yes	37 (27.6%)	
CA19-9		1264.4 (2976.2)	37.5 (8.85 – 434.5)
CEA		166.2 (916.7)	4.75 (1.9 – 24)
PD-L1		13.1 (19.2)	5 (0 – 20)
MMR	Negative	74 (94.8%)	
	Positive	4 (5.13%)	
Differentiation	Moderate	26 (22.4%)	
	Moderate to poor	2 (1.7%)	
	Poor	78 (67.2%)	
	N/A	10 (8.6%)	
Signet-ring	Negative	86 (64.2%)	
	Positive	48 (35.8%)	
HER2	Negative	107 (83.6%)	
	Positive	21 (16.4%)	
Overall median survival	Months, (95% UI)	11 (8 – 15)	

Malignant lesion site	Body	66 (49.3%)
	Pylorus	4 (2.99%)
	Antrum	29 (21.6%)
	Other	35 (26.1%)
Site of metastasis	Liver	48
	Peritoneum	59
	Omentum	31
	RPLN	54
	Lung/Pleural Effusion	16
	Bone	16
	Adrenal	5
	Ovary	7
	Brain	2

Single-site metastasis results

Only 40 patients were identified as having a single- site of metastasis distribute as follows; liver (n=16), peritoneum (n=15), and RPLN(n=9) (Figure 1). Table 2 compares the baseline characteristics of these patients. Patients with liver metastasis had a higher median age of 64.0 years (IQR: 54.5–68.0), while those with peritoneal metastasis were younger, with a median age of 46.0 years (IQR: 40.0–57.0). The RPLN group had a median age of 57.0 years (IQR: 43.0–73.0). The liver metastasis group had a higher proportion of males (94%), while the peritoneum and RPLN groups had a lower male prevalence (47% and 78%, respectively).

Among tumor markers, median CA19-9 levels were highest in the peritoneum group at 36.8 U/mL (IQR: 14.8–94.0), followed by the RPLN group at 32.0 U/mL (IQR: 23.0–7730.0) ($p = 0.32$), and liver group at 10.3 U/mL (IQR: 5.0–7683.0). Median CEA levels differed between the groups, showing statistical divergence ($p = 0.043$), with the highest levels in the liver metastasis group (13.5 ng/mL, IQR: 2.0–159.0), compared to the RPLN (2.6 ng/mL, IQR: 1.4–21.1) and peritoneum groups (1.6 ng/mL, IQR: 1.1–2.0).

Tumor differentiation was predominantly poor in all groups, with 64% of patients in the total population exhibiting poor differentiation. The RPLN group had the highest percentage of poor differentiation (71%), followed by the peritoneum group (73%) and liver group (50%) ($p = 0.40$). Signet-ring cell carcinoma was present in 32% of the total population, with the highest prevalence in the liver group (100%) and lower rates in the peritoneum (47%) and RPLN groups (44%) ($p = 0.002$). HER2 positivity was similar across

groups, with no statistically divergent differences (p = 0.18). PD-L1 positivity varied slightly, with the highest levels in the liver group (median 5%, IQR: 1.1–10.0) compared to the RPLN group (median 10%, IQR: 5.0–10.0) and the peritoneum group (median 2%, IQR: 0.0–3.0) (p = 0.10). MMR deficiency was rare across all groups, indicating non-divergence (p = 0.49). The liver metastasis group had the highest percentage of patients treated for cancer (29%), while the RPLN group had the highest percentage of untreated patients (56%) (p = 0.40). The most common location of primary gastric lesions was the body of the stomach (60%), with statistically non-divergent differences in location distribution across groups (p = 0.71).

Table 2. Comparison of Characteristics of Patients with Liver-only, Peritoneum-only, and RPLN-only metastasis

		Total	Liver	Peritoneum	RPLN	p-value
		N=40	N=16	N=15	N=9	
Age	Median (iqr)	57.0 (43.5-66.0)	64.0 (54.5-68.0)	46.0 (40.0-57.0)	57.0 (43.0-73.0)	0.074
Gender	Male	29 (72%)	15 (94%)	7 (47%)	7 (78%)	0.012
	Female	11 (28%)	1 (6%)	8 (53%)	2 (22%)	
Region	Asian	19 (48%)	8 (50%)	8 (53%)	3 (33%)	0.36
	Arab	16 (40%)	8 (50%)	5 (33%)	3 (33%)	
	Others	5 (13%)	0 (0%)	2 (14%)	3 (33%)	
CVD	No	35 (88%)	14 (88%)	12 (80%)	9 (100%)	0.36
	Yes	5 (12%)	2 (12%)	3 (20%)	0 (0%)	
HTN	No	26 (65%)	11 (69%)	10 (67%)	5 (56%)	0.79
	Yes	14 (35%)	5 (31%)	5 (33%)	4 (44%)	
DM	No	26 (65%)	9 (56%)	11 (73%)	6 (67%)	0.60
	Yes	14 (35%)	7 (44%)	4 (27%)	3 (33%)	
COPD/asthma	No	35 (88%)	14 (88%)	14 (93%)	7 (78%)	0.54
	Yes	5 (12%)	2 (12%)	1 (7%)	2 (22%)	
CA19-9	Median (iqr)	23.0 (10.3-393.0)	10.3 (5.0-7683.0)	36.8 (14.8-94.0)	32.0 (23.0-7730.0)	0.32
CEA	Median (iqr)	2.1 (1.4-13.5)	13.5 (2.0-159.0)	1.6 (1.1-2.0)	2.6 (1.4-21.1)	0.043
Differentiation	moderate	10 (28%)	6 (43%)	2 (13%)	2 (29%)	0.29
	poor	23 (64%)	7 (50%)	11 (73%)	5 (71%)	0.25
	N/A	3 (8%)	1 (7%)	2 (13%)	0 (0%)	
Signet-ring	No	27 (68%)	16 (100%)	7 (47%)	4 (44%)	0.002
	Yes	13 (32%)	0 (0%)	8 (53%)	5 (56%)	
HER2	No	31 (79%)	11 (69%)	11 (79%)	9 (100%)	0.18
	Yes	8 (21%)	5 (31%)	3 (21%)	0 (0%)	
PDL1 +ve	Median (iqr)	4.0 (1.6-10.0)	5.0 (1.1-10.0)	2.0 (0.0-3.0)	10.0 (5.0-10.0)	0.10

MMR	No	20 (91%)	7 (100%)	9 (90%)	4 (80%)	0.49
	Yes	2 (9%)	0 (0%)	1 (10%)	1 (20%)	
Treated	No	14 (37%)	4 (29%)	5 (33%)	5 (56%)	0.40
	Yes	24 (63%)	10 (71%)	10 (67%)	4 (44%)	
Location of primary lesion	Lower gastric	11 (28%)	4 (25%)	5 (33%)	2 (22%)	0.81
	Middle gastric	18 (45%)	6 (38%)	9 (60%)	3 (33%)	0.33
	Upper gastric	10 (25%)	5 (31%)	1 (7%)	4 (44%)	0.089

Survival Analysis Results

Kaplan–Meier analysis demonstrated a median overall survival (OS) of 20.7 months in patients with liver-only metastasis, compared to 7.0 months in those with peritoneum-only metastasis and 18.0 months in those with RPLN-only metastasis (Figure 2).

In univariate Cox regression analysis, peritoneum-only metastasis showed statistical divergence compared to liver-only metastasis (HR = 2.87, 95% UI: 1.03–7.97, p = 0.04), (Table 3). In contrast, RPLN-only metastasis did not demonstrate statistical divergence (HR = 1.07, 95% UI: 0.32–3.64, p = 0.90). After adjusting for age and gender, the association between peritoneum-only metastasis and reduced survival was not statistically divergent (adjusted HR = 2.9, 95% UI: 0.67–12.69, p = 0.15), and RPLN-only metastasis remained non-divergent (adjusted HR = 1.22, 95% UI: 0.35–4.19, p = 0.75). The wide uncertainty intervals, particularly in the multivariable analysis, reflect a high degree of imprecision, likely due to small subgroup sizes. Intervals that include the null value (HR = 1.0) suggest that the observed effects are also compatible with minimal or no difference in survival (Table 3).

In the Firth-penalized Cox regression model, the site of metastasis was associated with differential overall survival (Table 4). Using liver metastasis as the reference category, patients with peritoneal metastasis demonstrated an increased risk of death (HR = 2.81, 95% UI: 1.05–7.85, p = 0.04). In contrast, patients with RPLN metastasis did not exhibit a statistically divergent difference in hazard compared to those with liver metastases (HR = 1.14, 95% UI: 0.32–3.51, p = 0.83). These results suggest that peritoneal metastasis may be associated with a worse prognosis relative to liver involvement, while RPLN metastasis appears to confer a similar risk profile.

Table 3. Univariate and Multivariable Cox-proportional regression analysis comparing single-site metastasis

Site	Univariate HR (95% UI)*	p-value	Multivariable HR (95%UI)	p-value
Peritoneum	2.87 (1.03 – 7.97)	0.04	2.9 (0.67–12.69)	0.15
RPLN	1.07 (0.32 – 3.64)	0.90	1.22 (0.35–4.19)	0.75

*****Compared to liver metastasis

Table 4. Firth-penalized Cox-proportional regression analysis comparing single-site metastasis

Site	HR (95% UI) *	p-value
Peritoneum	2.81 (1.05 – 7.85)	0.04
RPLN	1.14 (0.32 – 3.51)	0.83
*Compared to liver metastasis		

Discussion

To the best of our knowledge, this is the first study from the MENA region to examine the clinicopathological characteristics, prognosis, and survival outcomes of advanced-stage gastric cancer with single-site metastasis using real-world data from Qatar. Unlike previous studies, our cohort includes a diverse population comprising individuals from Asian, Middle Eastern Arab, and African backgrounds, offering broader regional insight into metastatic patterns and outcomes. In this study, we analyzed the prognostic outcomes of patients diagnosed with stage IV GC, with a specific focus on those who had single-site of metastasis. Based on our data, liver, peritoneum, and RPLN were the most common sites of metastasis. In the overall sample of patients with GC, the most common site of metastasis was the peritoneum. This is consistent with recent results from a nationwide cancer registry in the Netherlands, which found that 58% of patients with gastric cancer–related peritoneal metastasis had isolated peritoneal involvement (13). In comparison, a 2016 population-based study from Sweden found liver metastasis to be the most common site followed by peritoneum and lung (9). The reason for this variation may be due to the difference in patient demographic including race, age distribution, and genetic factors (14–17).

The liver-only metastasis group had a higher prevalence of male patients, and older median age compared to those with peritoneum or RPLN metastasis. This is consistent with a previous study suggesting that liver-only metastasis in GC patients tends to occur in older populations (18). Additionally, our results show that liver-only metastasis is associated with a favorable prognosis compared to RPLN and peritoneum-only metastasis. Furthermore, studies have shown that GC patients with liver-only metastasis who undergo gastrectomy and/or hepatectomy have further improvement in overall survival (19, 20). However, only two patients in our cohort received surgical intervention, highlighting a potential underutilization of surgery in this subgroup. Future clinical practice should consider selecting appropriate patients with liver-only metastasis for surgical management to potentially enhance survival outcomes.

Our results are consistent with studies utilizing data from the Surveillance, Epidemiology, and End Results (SEER) database, which included patients with metastatic GC, found that patients with liver or lung metastasis exhibited better survival(21). However, a more recent study conducted by Wang et al. using the SEER database found that liver metastasis was an adverse prognostic factor for OS. Additionally, their multivariable Cox proportional hazard ration revealed that patients with liver metastasis had a much worse survival compared to lung-only(22). Although we did not compare liver-only metastasis to other sites such as lung, we found that liver-only metastasis had better OS in the overall population. A more recent 2024 retrospective study based on SEER database found liver metastasis to be the most common single organ metastasis, and bone metastasis leading to the worst OS (23). Within our sample, we found that peritonea-only metastasis had the worst OS compared to both liver-only and RPLN-only metastasis. In a Dutch registry (2015–2020), patients with isolated peritoneal metastases had a median OS of only 4.4 months, nearly identical to those with isolated non-peritoneal metastases (4.6 months), with an adjusted HR ≈ 0.94 ($p = 0.185$) (13). A systematic review found that the median OS for gastric peritoneal metastases ranged from 2–9 months(24). Furthermore, our study shows that patients with signet-ring cell positive are at a higher risk of peritoneal metastasis which is consistent with previous studies (9, 19, 25).

Additionally, our results suggest that tumor markers such as CA19-9, CEA, and PD-L1 expression vary depending on the site of metastasis. Specifically, CA19-9 levels were higher in patients with RPLN-only and peritoneum-only metastasis compared to liver-only metastasis (26). Previous studies have shown it to be strongly associated with lymph-node, peritoneal ,and serosal involvement (27, 28). Elevated tumor markers predict peritoneal disease. In a series of advanced GC patients, 80.6% of those with CA125 ≥ 35 U/mL had peritoneal metastasis, and high CA125 was associated with shorter survival (29). Recent studies have shown that combining CEA, CA19-9, and CA72-4 may help in improving the prognostic value compared with using a single tumor marker (30). Notably, a recent study found that nearly one-third of HER2-negative primary tumors converted to HER2-low in metastatic lesions, particularly in metachronous liver and lung metastases (31). This evolution has important clinical implications, as it could expand eligibility for HER2-targeted antibody-drug conjugate (ADC) therapies, such as trastuzumab deruxtecan, which have shown efficacy in HER2-low expressing tumors. Therefore, re-evaluating HER2

status in metastatic lesions, especially in non-peritoneal sites like the liver, is crucial when considering systemic treatment strategies.

Our study has several limitations, including the retrospective nature of the data and the small sample size, particularly in subgroup analyses. These factors may introduce bias and limit the generalizability of our findings. Nevertheless, the study offers several notable strengths. Importantly, despite the limited sample size (N = 40), we observed a statistically divergent association between peritoneum-only metastasis and worse overall survival compared to liver-only metastasis in both Kaplan-Meier and univariate Cox regression analyses. However, multivariable models had wider uncertainty intervals, reflecting reduced statistical power and the need for cautious interpretation. Further large cohort studies are needed to examine how combined molecular markers, and metastatic patterns influence prognosis in advanced-stage gastric cancer. In addition, future research should explore how metastatic patterns can inform a more individualized, patient-centered approach to treatment selection.

Abbreviations

GC: Gastric cancer

OS: Overall survival

mOS: Median overall survival

RPLN: Retroperitoneal lymph nodes

IRB: Institutional Review Board

NCCCR: National Center for Cancer Care and Research

HMC: Hamad Medical Corporation

CT: Computed tomography

PET: Positron emission tomography

MMR: Mismatch repair

PD-L1: Programmed death-ligand 1

HER2: Human epidermal growth factor receptor 2

CEA: Carcinoembryonic antigen

CA19-9: Carbohydrate antigen 19-9

Declarations

Data Availability statement

The datasets generated and/or analysed during the current study are not publicly available due to ethical and institutional restrictions related to patient confidentiality but are available from the corresponding author on reasonable request.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Funding Statement

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Author Contribution Statement (CRediT)

Conceptualization was carried out by A.S., A.A., K.R., and S.B. Methodology development and formal analysis were performed by L.A.Z., A.S., and N.E.O. Data curation and investigation were handled by M.S.E., S.A.A., M.M., E.T., A.A., A.S., and K.R. Visualization was prepared by L.A.Z., A.S., and N.E.O. Resources and project administration were provided by A.S., K.R., S.B., W.A., R.A., A.J., and M.M. Supervision of the study was conducted by S.A., M.S.E., S.A.A., A.J., R.A., W.A., A.A., and M.M. The original draft of the manuscript was written by L.A.Z., A.A., A.S., and N.E.O., and all authors contributed to the review and editing of the final manuscript. All authors read and approved the final version of the manuscript.

Ethics and Informed Consent Statement

The study protocol was approved by the Institutional Review Board (IRB) of Hamad Medical Corporation (MRC-01-24-522). The study was conducted in accordance with the principles of the Declaration of Helsinki. In accordance with IRB guidelines, informed consent was waived due to the retrospective design of the study.

Consent for publication

Not applicable.

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Figures

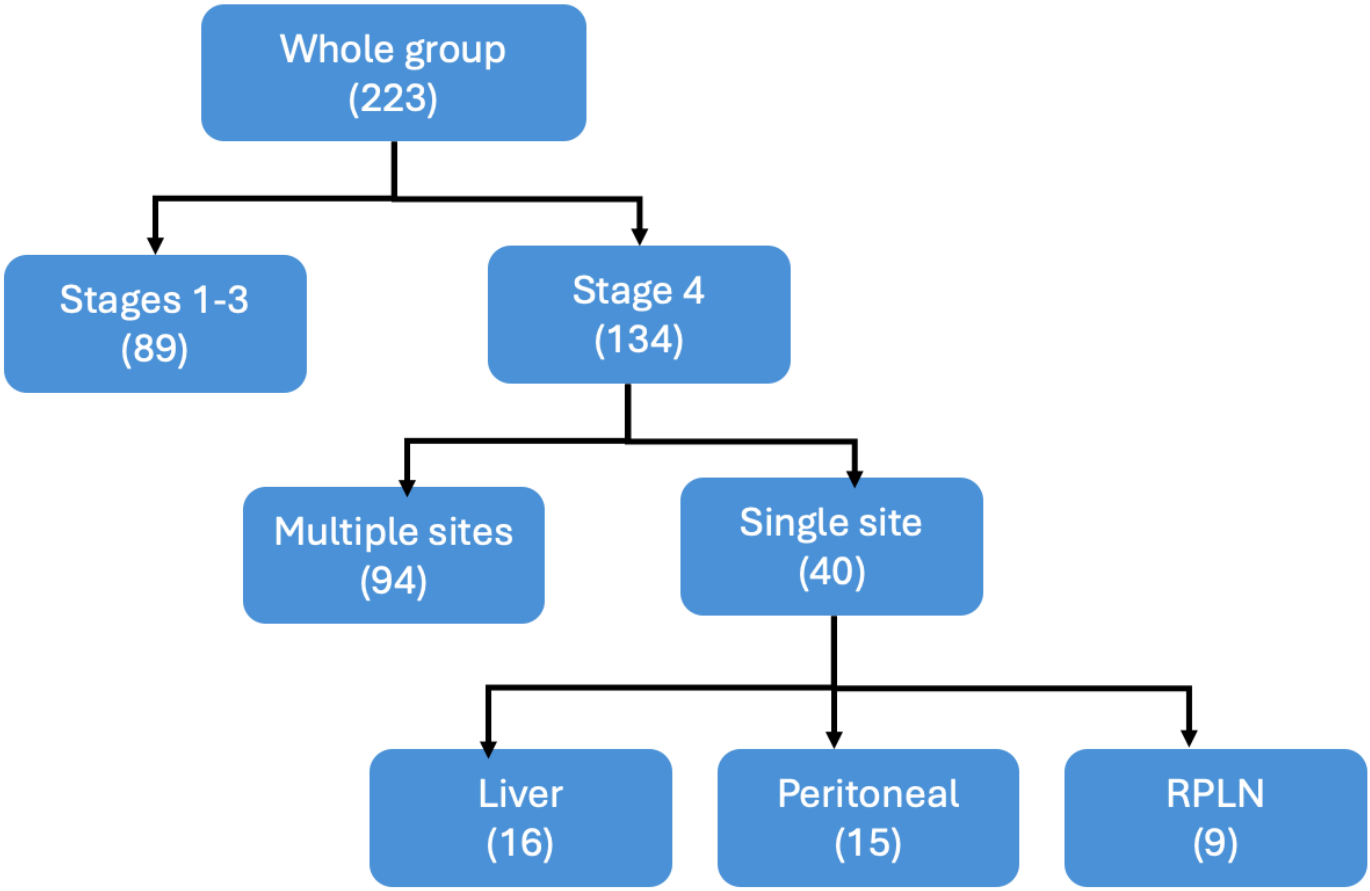
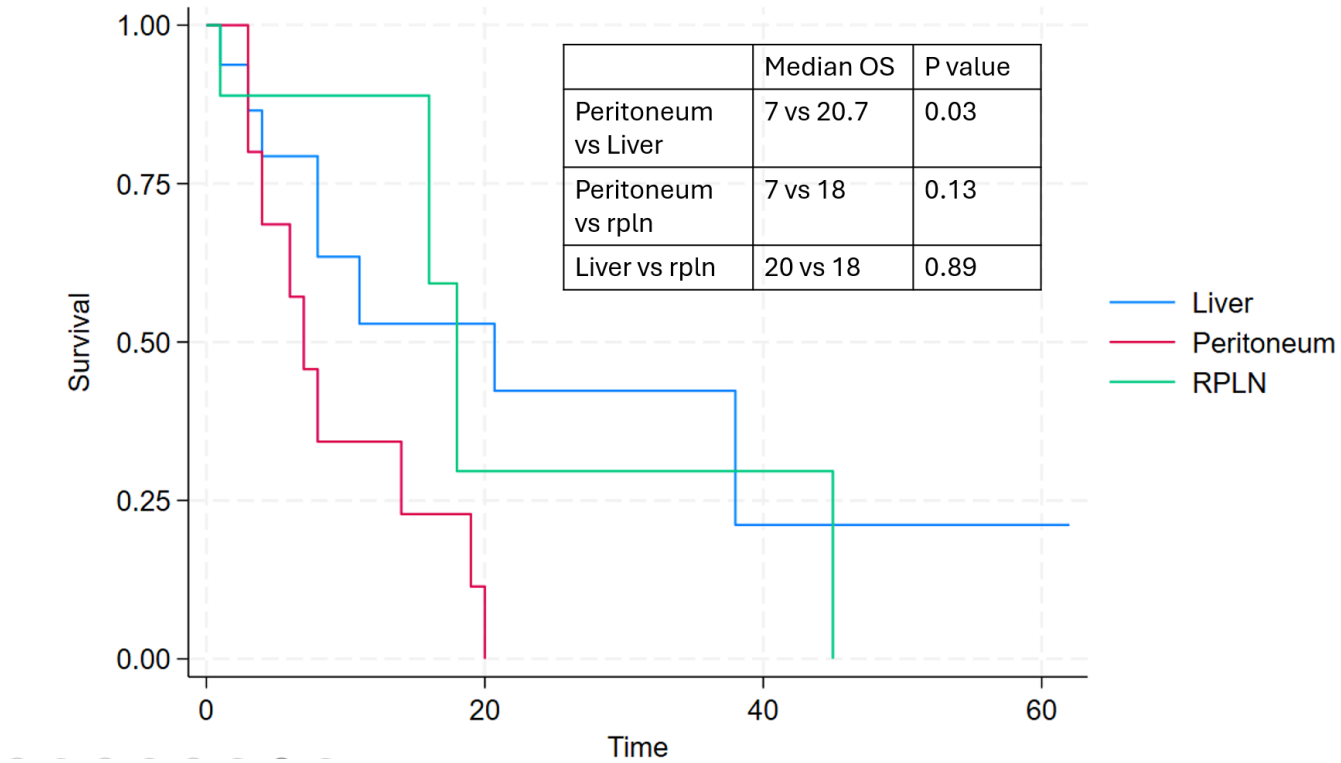


Figure 1

A flow diagram demonstrating patient selection and group allocation



	Median OS	P value
Peritoneum vs Liver	7 vs 20.7	0.03
Peritoneum vs rpln	7 vs 18	0.13
Liver vs rpln	20 vs 18	0.89

Figure 2

Kaplan-Meier survival graph shows the overall survival (OS) in the three single-site of metastases groups of patients with stage IV GC