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ORIGINAL ARTICLE

Impact of a single-day multidisciplinary clinic on the management of patients with liver tumours

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ABSTRACT

Purpose

Multidisciplinary cancer clinics may improve patient care. We examined how a single-day multidisciplinary liver clinic (MDLC) affected care recommendations for patients compared with the recommendations provided before presentation to the MDLC.

Methods

We analyzed the demographic and clinicopathologic data of 343 patients assessed in the Johns Hopkins Liver Tumor Center from 2009 to 2012, comparing imaging and pathology interpretation, diagnosis, and management plan between the outside provider (OSP) and the MDLC.

Results

Most patients were white (n = 259, 76%); median age was 60 years; and 146 were women (43%). Outside providers referred 182 patients (53%); the rest were self-referred. Patients travelled median of 83.4 miles (interquartile range: 42.7–247 miles). Most had already undergone imaging (n = 338, 99%) and biopsy (n = 194, 57%) at the OSP, and a formal management plan had been formulated for about half (n = 168, 49%).

Alterations in the interpretation of imaging occurred for 49 patients (18%) and of biopsy for 14 patients (10%). Referral to the MDLC resulted in a change of diagnosis in 26 patients (8%), of management plan in 70 patients (42%), and of tumour resectability in 7 patients (5%). Roughly half the patients (n = 174, 51%) returned for a follow-up, and 154 of the returnees (89%) received treatment, primarily intraarterial therapy (n = 88, 57%), systemic chemotherapy (n = 60, 39%), or liver resection (n = 32, 21%). Enrollment in a clinical trial was proposed to 34 patients (10%), and 21 of the 34 (62%) were accrued.

Conclusions

Patient assessment by our multidisciplinary liver clinic had a significant impact on management, resulting in alterations to imaging and pathology interpretation, diagnosis, and management plan. The MDLC is an effective and convenient means of delivering expert opinion about the diagnosis and management of liver tumours.

KEY WORDS

Multidisciplinary care, single-day clinic, liver tumours, surgical oncology, interventional radiology

1. INTRODUCTION

In recent decades, few fields of medicine have advanced as much as oncology, and the advent of new diagnostic and treatment modalities has rendered the management of patients highly personalized and complex. State-of-the art care for the oncology patient now often requires the prompt cooperation of physicians from several specialties. In most hospitals, multidisciplinary care consists of separate clinic visits with various specialists in conjunction with a weekly tumour board discussion. One reason for the emphasis on this approach is the accumulating evidence that multidisciplinary care leads to more favourable patient outcomes[1–9]. In this regard, contemporary recommendations support the management of oncologic patients by a multidisciplinary team including surgical oncologists, medical oncologists,

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radiation oncologists, interventional radiologists, pathologists, and other specialties[10].

Most hospitals that deliver cancer care have weekly tumour boards, but fewer have actual single-day multidisciplinary clinics. From the patient's perspective, a single-day multidisciplinary clinic visit is less stressful and more convenient than multiple visits to physicians of different specialties and may lead to faster delivery of care and higher adherence to physicians' recommendations[1,10,11]. Multidisciplinary clinics can, however, be more resource-intense and might require providers to deviate from their normal clinic routine. Multidisciplinary cancer clinics have been adopted for patients with breast[1–3], gynecologic[12–14], pancreatic[4,5], lung[13,15], skin[16–18], head-and-neck[19,20], and prostate malignancies[6–9]. Multidisciplinary clinics have even been proposed for patients with specific types of metastases[21].

Primary and secondary malignancies of the liver may be particularly well suited to a single-day multidisciplinary clinic approach. Primary liver cancer is the 5th most common cancer in terms of mortality, with about 20,550 attributable deaths estimated in 2012, and its incidence is increasing. Treatment of primary and secondary malignancies has evolved to include systemic, intraarterial, and surgical options. In addition, patients with liver malignancies often have underlying steatosis, hepatitis, or cirrhosis. A single-day multidisciplinary clinic in which patients can be seen by various providers during one visit may therefore be of great benefit to patients with liver tumours.

Although outcomes of multidisciplinary clinics have been described for several cancer types[1–9,12–20], no study to date has documented the outcomes of a single-day liver multidisciplinary clinic. The multidisciplinary liver clinic (MDLC) at the Johns Hopkins Hospital (JHH) was established in 2009 so that patients with liver tumours could be evaluated by a range of specialists within the same visit day and site. We sought to evaluate the impact of a multidisciplinary liver tumour clinic on the diagnosis and treatment recommendations for patients with liver tumours.

2. METHODS

The Johns Hopkins Liver Tumor Center established the MDLC in 2009, aiming to evaluate patients with known or suspected tumours in the liver in the context of a single-day multidisciplinary clinic. Patient referrals are first screened by the clinical coordinator (SS) and then triaged by the clinical director (TMP). The coordinator obtains prior medical records, cross-sectional imaging, pathology slides and reports, and other pertinent information. Every effort is made to acquire existing imaging and pathology studies, which are submitted to JHH for formal radiology and pathology review. The multidisciplinary clinic involves mostly new, but also routine follow-up, patient consultations.

In advance of the clinic, each patient's medical information, imaging studies, and pathology are reviewed, and the case is discussed at a multidisciplinary conference consisting of the providers scheduled to see the patient on the given clinic day. The board regularly consists of a surgical oncologist, medical oncologist, radiation oncologist, radiologist, pathologist, interventional radiologist, hepatologist, and transplant surgeon. On the day of the clinic visit, routine laboratory exams and, if necessary, repeat cross-sectional imaging are obtained. Patients are seen by the clinical team and consensus recommendations are communicated to them the same day during the clinic visit. On a typical day, patients undergo any additional necessary imaging and laboratory studies from 07h00 to 09h00; the multidisciplinary tumour board conducts formal case reviews from 09h00 to 10h00; and patients are seen sequentially or together by physicians from the various disciplines from 10h00 to 13h00, during which time full details of the tumour board recommendations are discussed with the patients.

The records of 389 patients seen in the clinic from April 28, 2009, to February 21, 2012, were systematically reviewed. Of those 389 patients, 46 were excluded because they did not represent new consultations or because data from the outside hospital records were missing such that comparisons with the MDLC recommendations were not possible. Demographic information for the 343 included patients (including age, sex, race, and distance from JHH) was extracted from the records, as were data about evaluation and treatment of the patient both by the prior outside provider (OSP) and by the JHH MDLC. Clinically significant alterations in pathology or imaging interpretation, diagnosis, and management plan between the OSP and the MDLC were recorded. The outside recommendations were determined by review of records from the outside institution, including clinic and hospital notes. A clinically significant alteration was defined as one that could potentially alter the patient's diagnosis, management plan, or outcome. The impact of those alterations on clinical assessment and recommendations were assessed.

3. RESULTS

Of the 343 included patients, 197 were men (57.4%), and 146 were women (42.6%). Most patients ($n = 259$, 75.5%) were white; the rest were ethnically African American ($n = 37$, 10.8%), Asian ($n = 19$, 5.5%), or other ($n = 28$, 8.2%). Median patient age was 60 years [interquartile range (IQR): 52–70 years], and the median distance traveled was 83.4 miles [IQR: 42.7–247 miles (2 patients visited from Europe)]. Approximately half the patients were self-referred ($n = 161$, 46.9%); the rest were referred from an outside institution ($n = 182$, 53.1%). Six patients (1.7%) had a known history of liver cancer in the family, defined

as 1 or more first-degree relatives with a known diagnosis of liver cancer. Fifteen patients (4.4%) were positive for chronic hepatitis B, and 44 (12.8%) had chronic hepatitis C. Among patients for whom alcohol consumption was known, 13 (4.2%) were current heavy drinkers, and 35 (11.3%) were prior heavy drinkers. At presentation, 76 patients (22.2%) had cirrhosis, 18 (5.2%) had experienced at least 1 episode of moderate-to-severe ascites, and 8 (2.3%) had mild hepatic encephalopathy. The median time from OSP to being seen at JHH MDLC was 1.5 months (IQR: 1.1–3.6 months).

Almost all patients (n = 338, 98.5%) had undergone some form of cross-sectional imaging of the liver at the OSP before their presentation at the JHH MDLC (Table I). Imaging studies consisted of computed tomography (CT) in 296 patients (86.3%), magnetic resonance (MR) in 155 (45.2%), positron-emission tomography in 84 (24.5%), and other types in 26 (7.6%), including octreotide scintigraphy (n = 7), hepatobiliary iminodiacetic acid scan (n = 1), single-photon-emission CT (n = 1), MR cholangiopancreatography (n = 1), and ^{111}In-leucocyte imaging (n = 1).

Most patients did not undergo repeat imaging at the MDLC. However, repeat CT imaging was obtained in 61 patients (20.6%) within a median time interval of 1.9 months (IQR: 1.1–3.6 months), and repeat MR imaging was obtained in 29 (18.7%) within a median time interval of 1.1 months (IQR: 0.8–2.6 months). No patients underwent repeat positron-emission tomography or other imaging upon presentation to the MDLC. The most common reasons for repeat cross-sectional imaging were low-quality images or poor visualization of the hepatic mass or masses or vital structures. Of the 47 patients who did not undergo CT imaging at the outside institution, 11 (23.4%) underwent CT imaging at the liver clinic. Of the 188 patients who did not undergo MR imaging at the outside institution, 52 (27.7%) underwent MR imaging at the liver clinic. Fourteen patients (4.1%) underwent positron-emission tomography at the clinic.

Approximately half the patients (n = 194, 56.6%) had undergone a biopsy of the liver mass before their presentation at the MDLC (Table I). Biopsy slides for most of those patients (n = 137, 70.6%) were re-reviewed by the pathology department at the JHH MDLC. A new biopsy was performed at JHH for 9 of the patients (2.6%) attending the MDLC.

Most patients (n = 269, 78.4%) had been diagnosed with malignant liver disease at the OSP (Table I), most commonly hepatocellular carcinoma (n = 95, 35.3%), colorectal or neuroendocrine cancer metastasis (n = 47 and 39, 17.5% and 14.5% respectively), cholangiocarcinoma (n = 40, 14.9%), and other malignancies. Benign disease was diagnosed in 23 patients (6.7%) at the OSP, mostly hepatic adenoma (n = 7, 30.4%), focal nodular hyperplasia (n = 6, 26.1%), hemangioma (n = 6, 26.1%), and others. Two patients (0.6%) were found at the outside institution to have no abnormal findings, and 31 (9.0%), to have an indeterminate liver mass or diagnosis.

Patients seen at the MDLC had formal consultations with a median of 2 specialties (IQR: 2–3; Table II). Surgical oncology assessed 299 patients (87.2%); medical oncology, 215 (62.7%); interventional radiology, 161 (46.9%); hepatology, 75 (21.9%); transplant surgery, 9 (2.6%); and radiation oncology, 6 (1.7%). A modified Venn diagram depicts the interplay of the alterations in diagnosis, resectability, and treatment plan resulting from re-interpretation of imaging studies or pathology (Figure 1); Figure 2 presents 3 representative cases.

Among the 309 patients who came to the MDLC with a clinical diagnosis from the OSP, that diagnosis was altered in 26 (8.4%), with unknown or indeterminate diagnoses decreasing to 10 (2.9%) from 31 (9.0%). Of the diagnostic changes, 17 (65.4%) resulted from a change in imaging interpretation by the members of the MDLC; 1 (3.8%), from a change in pathology; 1 (3.8%), from a combination of pathology and imaging reinterpretation; 1 (3.8%), from a combination of negative screening for a primary tumour and pathology reinterpretation; and 6 (23.1%), because of clinical impression. Of the altered diagnoses, 6 (23.1%) changed from indeterminate to benign; 6 (23.1%), from indeterminate to malignant; 11 (42.3%), from one malignant diagnosis to another type of malignant diagnosis; 2 (7.7%), from malignant to benign; and 1 (3.8%), from one benign diagnosis to a another type of benign diagnosis.

Of the 267 patients whose outside cross-sectional imaging was re-reviewed at the JHH MDLC, 49 (18.4%) received an altered interpretation. The most common alteration was a change in diagnosis (n = 30, 61.2%). In 18 studies, an indeterminate diagnosis changed to a probable radiologic diagnosis. The change was from benign to malignant in 5 patients, from a malignant diagnosis to a different malignant diagnosis in 6 patients, and from a benign diagnosis to a different benign diagnosis in 1 patient. In 10 patients (20.4%), there was a change in the number of lesions; in 2 (4.1%), a change in the lesion location or locations; in 2 (4.1%), a change in determination of the primary lesion; and in 1 (2.0%), a change concerning patency of the portal vein. For several patients, multiple alterations pertained to single image, or a single change pertained to multiple imaging modalities.

Of the 137 patients whose outside pathology slides were re-reviewed at JHH, 14 (10.2%) received an altered pathology diagnosis. For 1 patient (7.1%), the pathology interpretation changed from one benign diagnosis to another benign diagnosis, and for 2 patients (14.3%), from one malignant diagnosis to a different malignant diagnosis. Among the alterations in biopsy reads, 1 diagnosis (7.1%) changed from adenoma to normal liver; 2 (14.3%), from malignant to indeterminate; and 3 (21.4%), from indeterminate

TABLE I Patient management and leading diagnosis at the outside provider and the multidisciplinary liver clinic

Variable	*Outside provider*		*Multidisciplinary liver clinic*	
	(n)	*(%)*	*(n)*	*(%)*
Cross-sectional imaging of the liver	338	98.5	139	40.5
Computed tomography	296	86.3	72[b]	21.0
Magnetic resonance imaging	155	45.2	81[b]	23.6
Positron-emission tomography	84	24.5	14[b]	4.1
Other imaging[a]	26	7.6	6[b]	1.8
Biopsy of liver lesion	194	56.6	146	42.6
New biopsy	194[c]	56.6	9	2.6
Review of prior biopsy by pathology	NA	NA	137	39.9
Indeterminate diagnosis	31	9.0	10	2.9
No specific patient management plan	180	52.5	4	0.6
Did not receive any treatment at the institution	224	65.3	189	55.1
Clinical trial enrollment recommendation	NA	NA	34	9.9
Diagnosis				
Benign	23	6.7	37	10.8
Focal nodular hyperplasia	7	2.0	13	3.8
Hepatic adenoma	6	1.7	7	2.0
Hemangioma	6	1.7	8	2.3
Other benign	4	1.2	9	2.6
Malignant	269	78.4	292	85.1
Hepatocellular carcinoma	95	27.7	102	29.7
Cholangiocarcinoma NOS	40	11.7	58	16.9
Gallbladder cancer	6	1.7	7	2.0
Metastases from				
Colorectal primary	47	13.7	51	14.9
Neuroendocrine primary	39	11.4	40	11.7
Breast primary	3	0.9	3	0.9
Lung primary	2	0.6	2	0.6
Other primary	22	6.4	21	6.1
Adenocarcinoma NOS	14	4.1	7	2.0
Other malignant	1	0.3	1	0.3
No abnormal findings	2	0.6	4	1.2
Indeterminate diagnosis	31	9.0	10	2.9
Unknown diagnosis	17	5.0	NA	NA

[a] Magnetic resonance cholangiopancreatography, octreotide scintigraphy, and single-photon-emission computed tomography, among others.

[b] Computed tomography (CT) imaging was repeated at the multidisciplinary liver clinic (MDLC) for 61 patients (20.6%) receiving CT imaging at the outside provider (OSP), with a median time interval of 1.9 months (interquartile range: 1.1–3.6). Magnetic resonance imaging (MRI) was repeated at the MDLC for 29 patients (18.7%) receiving MRI at the OSP, with a median time interval of 1.1 months (interquartile range: 0.8–2.6). No patients underwent repeat positron-emission tomography (PET) or other imaging at the MDLC. In addition, 5 CT, 2 MRI, and 2 PET studies ordered in the MDLC were performed at an OSP for various reasons (for example, insurance coverage).

[c] A biopsy ordered by the outside provider was performed at The Johns Hopkins Hospital for 2 patients (before they presented at the multidisciplinary liver clinic).

NOS = not otherwise specified.

to malignant. In 4 patients, the diagnosis changed from adenocarcinoma not otherwise specified to cholangiocarcinoma.

A management plan was known to have been formulated for 168 patients (49.0%) at their outside institution. After evaluation at the JHH MDLC, 70 of those patients (41.7%) received alterations to the recommended management plan. Resection was recommended for 4 patients who were initially deemed inoperable by the OSP, and a recommendation against resection was given to 5 patients, contrary to the outside recommendation. Three patients who were

TABLE II Outcome and alterations in patient care as a result of the multidisciplinary liver clinic (MDLC) visit[a]

Outcome	*Value*
Specialties directly involved in care of patient	
Specialties per patient (*n*)	
Median	2
Interquartile range	2–3
Patients assessed by [*n* (%)]	
≥2 Specialties	277 (80.8)
≥3 Specialties	127 (37.0)
Assessments per specialty [*n* (%)]	
Surgical oncology	299 (87.2)
Medical oncology	215 (62.7)
Interventional radiology	161 (46.9)
Gastroenterology or hepatology	75 (21.9)
Transplant surgery	9 (2.6)
Radiation oncology	6 (1.7)
Patient revisited the MDLC for a follow-up [*n* (%)]	174 (50.7)
Patient care delivered at JHH [*n* (%)]	154
Immuno-augmentative therapy	88 (57.1)
Systemic chemotherapy	60 (39.0)
Liver resection	32 (20.8)
Biliary stent placement	9 (5.8)
Thermal ablation of liver lesions	5 (3.2)
Radiation therapy	4 (2.6)
Orthotopic liver transplantation	3 (1.9)
Other treatment	4 (2.6)
Actual patient accrual in clinical trials [*n* (%)]	21 (13.7)
Duration of follow-up (months)	
Median	6.9
Interquartile range	3.2–13.8
Alterations [*n* (%)]	
Imaging interpretation	49 (18.4)
Pathology interpretation	14 (10.9)
Diagnosis	26 (8.4)
Management plan	70 (41.7)
Resectability of liver lesion	7 (5.2)

[a] No data on specific outside provider or MDLC imaging interpretation, pathology interpretation, diagnosis, and management plan were available for 76, 205, 34, and 175 patients respectively. Resectability was assessed only if clinically relevant (*n* = 134).
JHH = The Johns Hopkins Hospital.

previously denied transplantation were considered eligible. Two patients previously offered transplantation were not considered transplantable after review at the MDLC. For 8 patients, chemotherapy was added to the management plan, and for 3, a change in the type of chemotherapy was recommended. Intraarterial therapy was offered to 28 patients, and 4 patients were counselled not to undergo intraarterial therapy as recommended by the OSP. Plans for 5 patients were changed from no treatment or palliation to some form of treatment and, for 6 patients, from some form of treatment recommendation to no treatment or palliation.

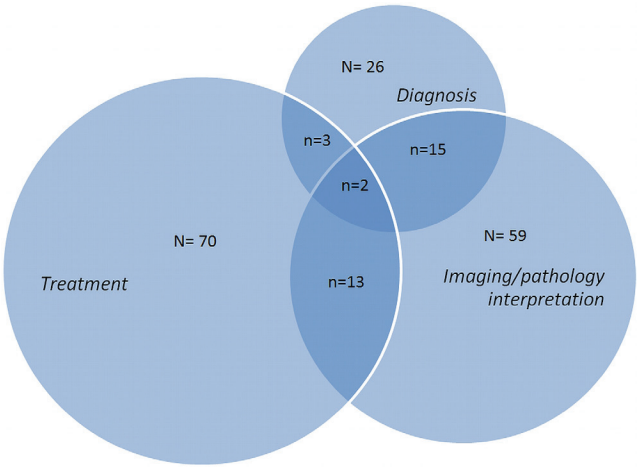
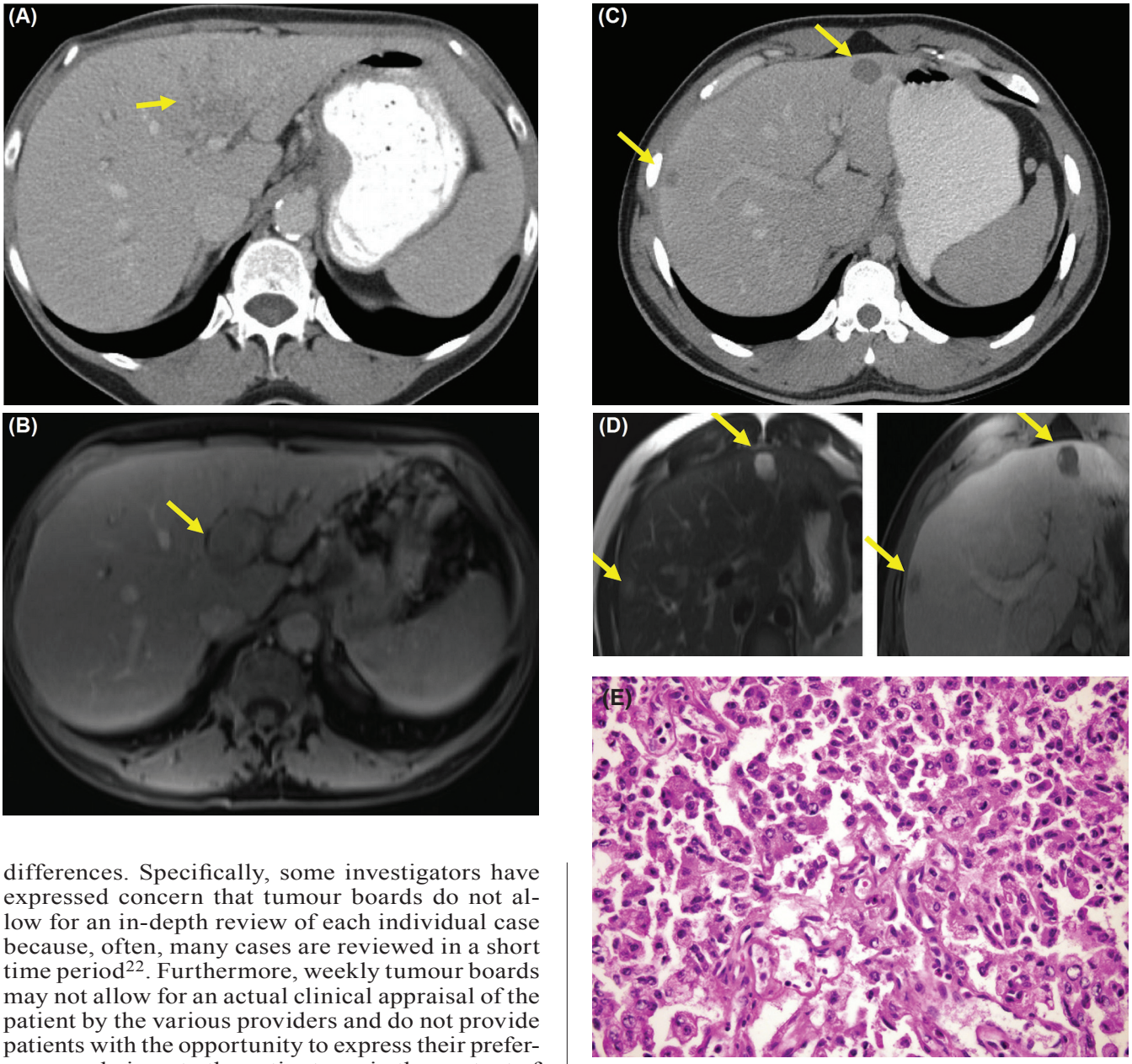


FIGURE 1 *A modified Venn diagram depicts the overlap of changes in treatment, imaging, or pathology (or a combination), and diagnosis. Imaging or pathology (or both) changed in 29 patients without changes in diagnosis or treatment; in 17 patients with a change in diagnosis; in 15 with a change in treatment; in 2 with a change in both diagnosis and treatment. In 6 patients, the diagnosis changed without a change in treatment, imaging, or pathology; in 47, treatment changed without such a change; and in 3, diagnosis and treatment both changed without a change in imaging or pathology. In 2 patients, resectability changed because of a change in imaging or pathology, and in 5, resectability changed without a change in imaging or pathology. Changes in imaging include only those recorded on official radiology reports.*

Approximately half the patients (*n* = 174, 50.7%) returned to JHH for a follow-up visit, and 154 (44.9%) received treatment at JHH (Table II). The treatment most commonly received at JHH was intraarterial therapy (*n* = 88, 57.1%). Patients also received chemotherapy (*n* = 60, 39.0%), liver resection (*n* = 32, 20.8%), thermal ablation (*n* = 5, 3.2%), radiation therapy (*n* = 4, 2.6%), orthotopic liver transplantation (*n* = 3, 1.9%), and biliary stent placement (*n* = 9, 5.8%). Clinical trial enrollment was recommended to 34 patients (9.9%) and, of those, 21 (61.8%) were enrolled. The median duration of follow-up was 6.9 months (IQR: 3.2–13.8 months).

4. DISCUSSION

The importance of coordinated multidisciplinary care has been increasingly emphasized for oncology patients with a wide array of cancers including breast, pancreatic, and prostatic[1–9]. Weekly tumour boards and single-day multidisciplinary clinics both allow a variety of providers to review and contribute to the care plan of patients with cancer, but these two approaches have some important



differences. Specifically, some investigators have expressed concern that tumour boards do not allow for an in-depth review of each individual case because, often, many cases are reviewed in a short time period[22]. Furthermore, weekly tumour boards may not allow for an actual clinical appraisal of the patient by the various providers and do not provide patients with the opportunity to express their preferences and views to the entire team in the context of multiple therapeutic options[23]. In contrast, during a single-day multidisciplinary clinic, the patient's information can be reviewed by a team of providers in "real time" and the providers can all interact with the patient. In turn, the patient can meet with the various teams in the course of the one day. Improved outcomes have been associated with the use of single-day multidisciplinary clinics for patients with breast and pancreatic cancer[3,4].

The present study is important because, to our knowledge, it is the first report the impact of a single-day multidisciplinary clinic for patients with liver tumours. Notably, we found that the OSP management plan was altered for 41.7% of the patients who visited the MDLC. In fact, a number of those alterations to the

FIGURE 2 *(A) Scan of a 56-year-old woman at an outside provider (OSP) was interpreted as perfusion changes (arrow), with no mass. (B) Review of images at the multidisciplinary liver clinic (MDLC) revealed a left portal vein tumour thrombus (arrow) consistent with infiltrative hepatocellular carcinoma with portal vein involvement. The patient subsequently underwent intraarterial therapy. (C) Scan of a 28-year-old man with newly diagnosed colon cancer at an OSP was interpreted as hepatic hemangiomas (arrows). (D) Review of images at the MDLC revealed T2-intense signal in the left hemi-liver lesion, with nodular enhancement compatible with hemangioma. The right liver lesion was consistent with metastatic disease, however. Patient subsequently underwent colon resection with simultaneous liver resection and received adjuvant systemic therapy. (E) Accurate diagnosis is vital in guiding therapy. This neuroendocrine neoplasm looks similar to a hepatocellular carcinoma. Careful histologic examination and special staining techniques are keys to correctly classifying this liver tumour.*

therapeutic plan were based on the clinical expertise of the providers, a re-review of pathology, or a reinterpretation of cross-sectional imaging.

Interpretation of the imaging obtained at an outside institution was changed for a significant number of patients (n = 49, 18.4%). Although some of the interpretation differences in the cross-sectional imaging included a change in tumour location or number, it is important to note that the diagnosis was actually changed in a subset of the patients (n = 30, 61.2%). It can be challenging to distinguish between benign and malignant liver disease and to identify and differentiate lesions in the setting of a steatotic ("fatty") or cirrhotic liver[24,25]. Heiken *et al.*[26] reported that 10%–20% of solid benign tumours may display atypical features that could be confused with hepatocellular carcinoma, cholangiocarcinoma, or hypervascular metastases. In addition, hepatocellular adenoma can often have a varied appearance, and certain subtypes such as infiltrative hepatocellular carcinoma can frequently be missed completely by inexperienced radiologists[27,28]. Although the causes are undoubtedly multifactorial, the interpretive changes reported in the present study are likely a result of having specialized radiologists whose primary focus is hepatobiliary disease review the images.

A change in the pathology interpretation of outside slides was also not infrequent (10.2%). Most commonly, the pathology diagnosis was changed because of a reinterpretation of the immunohistochemistry staining done at the outside institution. In a previous study, Bomeisl *et al.*[29] reported that a change in management was suggested for 2.6% of patients (n = 2) based on the results of a pathology second opinion, and that a major disagreement in the pathology findings arose for 9% (n = 7). In another study, Layfield *et al.*[30] reported a 16% overall rate of diagnosis disagreement in second-opinion reviews of outside cytology specimens, with the greatest number of cases coming from lung, thyroid, and liver.

Pathology reassessment may be particularly important for patients with liver tumours. Several investigators have reported on the difficulty of differentiating dysplastic nodules, hepatic adenoma, and hepatocellular carcinoma[31,32], and of separating primary liver cancers from metastatic disease[33]. The Association of Directors of Anatomic and Surgical Pathology recommend a second-opinion review of outside pathology specimens before initiation of treatment, including radiation, chemotherapy, or surgery[34]. Our data support the importance of having outside pathology re-reviewed before arriving at a final clinical diagnosis and initiating therapy.

By offering a single-day MDLC, we provide patients greater access to expertise, resources, and clinical trials. For example, for many patients, the change in their management plan was a result of the presence at the MDLC of providers with significant expertise in chemotherapy and intraarterial therapy[35–38]. For patients who had seen only an outside surgical provider, the change in the treatment recommendations might partly have arisen from a lack of sufficient expertise among the outside providers with respect to the administration of chemotherapy and intraarterial therapy for hepatobiliary tumours.

Besides the therapeutic benefits, a single-day multidisciplinary clinic offers a more patient-centered approach to delivering cancer care, which may also facilitate faster initiation of treatment[39]. Other authors have shown that patients prefer a one-stop clinic to a multiple-visit approach[39,40]. In addition, Frost *et al.*[41] reported that patients seen in a multidisciplinary clinic were significantly more satisfied than patients who did not receive multidisciplinary care. As health care increasingly shifts to a more patient-centred focus, we believe that demand for single-day multidisciplinary cancer clinics such as the MDLC will only increase.

Our study has several limitations, a major one being its retrospective single-institution nature. Although we were able to collect data on patients prospectively from the initiation of the clinic in 2009, we were not able to compare the MDLC patients with liver tumour patients treated at JHH before 2009. A comparison of the MDLC's findings and therapeutic recommendations compared with those for patients treated at JHH outside the confines of the clinic was not feasible. Specifically, after initiation of the multidisciplinary clinic, patients who were thought likely to benefit from a multimodality approach were preferentially triaged to the clinic. As a result of that selection bias, direct comparisons between the multidisciplinary and non-multidisciplinary patients would not be appropriate. However, a direct comparison was not necessary to meet the primary objective of the present study, which was to assess the relative "value added" of the MDLC.

Information on patient evaluation of, and satisfaction with, the multidisciplinary clinic was collected only from a subset of patients—all of whom "strongly agreed" that the multidisciplinary clinic was "better" than a more traditional clinic appointment during which the patient sees only one provider. More comprehensive patient satisfaction data are needed, and those data are currently being prospectively collected.

5. CONCLUSIONS

Our study notes a significant impact of a single-day MDLC on patient care. A change in imaging interpretation occurred in 18.4% of patients, and a change in pathology interpretation, in 10.2%. Patient assessment in the MDLC led to a change in management plan for 41.7% of patients, and of patients who were ultimately followed at our institution, 13.7% were enrolled in clinical trials. Although the foregoing changes might not be fully attributable to the multidisciplinary

format, a large benefit of the MDLC is its role as a central location for physicians to discuss information and to review new radiology and pathology interpretations. This "360 review" of all data, imaging, and records by a team of experts makes the MDLC is an important means of delivering expert opinion about the diagnosis and management of benign and malignant liver disease. Our institution's experience supports the feasibility and effectiveness of a single-day MDLC and demonstrates the impact of the clinic on patient care.

6. CONFLICT OF INTEREST DISCLOSURES

The authors have no financial conflicts of interest to declare.

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