Policy Statement

Radiofrequency ablation and percutaneous ethanol injection of primary, inoperable (e.g., due to location of lesion[s] and/or comorbid conditions), hepatocellular carcinoma may be considered medically necessary under either of the following conditions:

- As a primary treatment of hepatocellular carcinoma (HCC) for patients meeting the Milan criteria (a single tumor of less than or equal to 5 cm or up to 3 nodules less than 3 cm)
- As a bridge to transplant*, where the intent is to prevent further tumor growth and to maintain a patient’s candidacy for liver transplant

Radiofrequency ablation and percutaneous ethanol injection as a primary treatment of inoperable hepatic metastases may be considered medically necessary under either of the following conditions:

- Metastases are of colorectal origin and meet the Milan criteria (a single tumor of less than or equal to 5 cm or up to 3 nodules less than 3 cm)
- Metastases are of neuroendocrine in origin and systemic therapy (e.g., Octreotide therapy) has failed to control symptoms

Radiofrequency ablation and percutaneous ethanol injection of primary, inoperable, hepatocellular carcinoma is considered investigational under either of the following conditions:

- When there are more than 3 nodules or when not all sites of tumor foci can be adequately treated
- When used to downstage (downsize) hepatocellular carcinoma HCC in patients being considered for liver transplant

Radiofrequency ablation of primary, operable hepatocellular carcinoma is considered investigational.

Radiofrequency ablation and percutaneous ethanol injection for hepatic metastasis is considered investigational for the treatment of either of the following:

- Hepatic metastases from colorectal cancer or neuroendocrine tumors that do not meet the criteria above
- Hepatic metastases from other types of cancer except colorectal cancer or neuroendocrine tumors

*Note: Criteria for ablative therapies as a bridge to transplantation are generally consistent with the United Network for Organ Sharing (UNOS) policy on Organ Distribution: Liver Transplant Candidates with Hepatocellular Carcinoma (HCC); Section 3.6.4.4 (11/9/2010).

Policy Guidelines

Neuroendocrine Tumors

Neuroendocrine tumors (NETs) may be referred to by their anatomical location (e.g., pulmonary neuroendocrine tumor, gastroenteropancreatic neuroendocrine tumor). Neuroendocrine tumors include the following:

- Carcinoid tumors
- Islet cell tumors (or pancreatic endocrine tumors)
- Neuroendocrine unknown primary
- Adrenal gland tumors
- Pheochromocytoma/paraganglioma
- Poorly differentiated (high grade or anaplastic)/small cell
Multiple endocrine neoplasia, Type 1 (also known as MEN-1 syndrome or Wermer's syndrome)

Multiple endocrine neoplasia, Type 2a or b (also known as pheochromocytoma and amyloid producing medullary thyroid carcinoma, PTC syndrome, or Sipple syndrome)

Symptomatic disease from neuroendocrine tumors may include hot, red flushing of the face, severe and debilitating diarrhea, asthma attacks, palpitations, low blood pressure, fatigue, dizziness, and weakness. Extreme symptoms may include heart disease, bronchial constriction, and bowel obstruction.

Systemic therapies for neuroendocrine tumors vary depending on the location and characteristics. Therapies may include, but are not limited to: octreotide, interferon, cytotoxic chemotherapy, angiogenesis inhibitors, and epidermal growth factor inhibitors.

**Coding**

The following CPT codes describe radiofrequency ablation specific to liver tumors:

- **47370**: Laparoscopy, surgical, ablation of 1 or more liver tumor(s); radiofrequency
- **47380**: Ablation, open, of 1 or more liver tumor(s); radiofrequency
- **47382**: Ablation, 1 or more liver tumor(s), percutaneous, radiofrequency

CPT code **76940** would be used to describe the ultrasound guidance for, and monitoring of, parenchymal tissue ablation.

**Description**

Radiofrequency ablation (RFA) is a procedure in which a probe is inserted into the center of a tumor and heated locally by a high-frequency, alternating current that flows from electrodes. The local heat treats the tissue adjacent to the probe, resulting in a 3- to 5-cm sphere of dead tissue. The cells killed by RFA are not removed but are gradually replaced by fibrosis and scar tissue. If there is local recurrence, it occurs at the edge of the treated tissue and, in some cases, is retreated. RFA may be performed percutaneously, laparoscopically, or as an open procedure.

**Related Policies**

- Cryosurgical Ablation of Primary or Metastatic Liver Tumors
- Radioembolization for Primary and Metastatic Tumors of the Liver
- Radiofrequency Ablation of Miscellaneous Solid Tumors Excluding Liver Tumors
- Transcatheter Arterial Chemoembolization to Treat Primary or Metastatic Liver Malignancies

**Benefit Application**

Benefit determinations should be based in all cases on the applicable contract language. To the extent there are any conflicts between these guidelines and the contract language, the contract language will control. Please refer to the member's contract benefits in effect at the time of service to determine coverage or non-coverage of these services as it applies to an individual member.

Some state or federal mandates [e.g., Federal Employee Program (FEP)] prohibits plans from denying Food and Drug Administration (FDA)-approved technologies as investigational. In these instances, plans may have to consider the coverage eligibility of FDA-approved technologies on the basis of medical necessity alone.
Regulatory Status

RFA devices have been cleared for marketing by the U.S. Food and Drug Administration through the 510(k) process. Food and Drug Administration product code GEI.

Rationale

Background
Hepatic and Neuroendocrine Tumors
Hepatic tumors can arise as primary liver cancer (hepatocellular cancer) or by metastasis to the liver from other tissues. Local therapy for hepatic metastasis may be indicated when there is no extrahepatic disease, which rarely occurs for patients with primary cancers other than colorectal carcinoma or certain neuroendocrine malignancies. At present, surgical resection with adequate margins or liver transplantation constitutes the only treatments available with demonstrated curative potential. However, most hepatic tumors are unresectable at diagnosis, due either to their anatomic location, size, number of lesions, or underlying liver reserve. Patients may also have comorbid conditions and do not qualify for surgical resection.

Neuroendocrine tumors are tumors of cells that possess secretory granules and originate from the neuroectoderm. Neuroendocrine cells have roles both in the endocrine system and in the nervous system. They produce and secrete a variety of regulatory hormones, or neuropeptides, which include neurotransmitters and growth factors. Overproduction of the specific neuropeptides produced by the cancerous cells causes various symptoms, depending on the hormone produced. They are rare, with an incidence of 2 to 4 per 100,000 per year. Treatment of liver metastases is undertaken to prolong survival and to reduce endocrine-related symptoms and hepatic mass-related symptoms.

Radiofrequency Ablation
Radiofrequency ablation (RFA) has been investigated as a treatment for unresectable hepatic tumors, both as primary treatment and as a bridge to liver transplant. In the latter setting, RFA is being tested to determine whether it can reduce the incidence of tumor progression in patients awaiting transplantation and thus maintain patients’ candidacy for liver ablation, transhepatic arterial chemoembolization, microwave coagulation, percutaneous ethanol injection, and radioembolization (yttrium-90 microspheres).

Note that RFA of extrahepatic tumors is addressed separately in Blue Shield of California Medical Policy: Radiofrequency Ablation of Miscellaneous Solid Tumors Excluding Liver Tumors.

Literature Review
Assessment of efficacy for therapeutic intervention involves a determination of whether the intervention improves health outcomes. The optimal study design for this purpose is a randomized controlled trial (RCT) that includes clinically relevant measures of health outcomes. Intermediate (or surrogate) outcome measures may also be adequate if there is an established link between the intermediate outcome and true health outcomes. Nonrandomized comparative studies and uncontrolled studies can sometimes provide useful information on health outcomes but are prone to biases such as noncomparability of treatment groups, placebo effect, and variable natural history of the condition.

Radiofrequency Ablation as a Treatment of Primary, Operable Hepatocellular Carcinoma
The evidence on radiofrequency ablation (RFA) as a treatment of resectable, hepatocellular carcinoma (HCC) includes randomized controlled trials (RCTs), meta-analyses, an analysis from a multicenter database, and an RCT that combined RFA with transhepatic arterial chemoembolization (TACE).
Systematic Reviews

In 2016, Lan et al published a network meta-analysis comparing different interventional treatments for early-stage HCC. Patients in these studies met the Milan criteria, with a single tumor of 5 cm or less or up to 3 nodules less than 3 cm. Over two-thirds of the studies limited tumor size to 3 cm or less. A total of 21 RCTs with 2691 patients were included that compared 6 different treatments: TACE, RFA, percutaneous ethanol injection (PEI), hepatic resection, TACE plus RFA, and RFA plus PEI. The studies were rated at a low-to-moderate risk of bias, lack of blinding being the most substantial limitation. The primary outcome measures were overall survival (OS) at 1, 3, and 5 years posttreatment, and the treatments were rank-ordered using both direct and indirect comparisons. The combination of RFA plus TACE led to the highest OS rates at 1, 3, and 5 years. RFA alone ranked fifth out of the 6 treatments and had a superior rank only to PEI. In matched comparison of RFA and surgical resection, RFA led to OS rates that were statistically lower than those of resection at 3 years but did not differ significantly from resection at 1 or 5 years. Interpretation of this network meta-analysis is limited by the heterogeneous patient populations. For example, a 2010 study included patients with recurrent tumors, while another included patients who had inoperable tumors. Additionally, one of the studies, with the most direct comparison with TACE plus RFA, has been withdrawn.

In a 2013 Cochrane review, Weis et al compared studies of RFA for HCC with other interventions. Moderate-quality evidence demonstrated hepatic resection had survival outcomes superior to those for RFA; however, resection might have greater rates of complications, and longer hospital stays. Other systematic reviews and meta-analyses have also found superior survival with hepatic resection but higher rates of complications than RFA. This finding reinforces the use of RFA only for unresectable HCC.

Randomized Controlled Trials

In 2016, Liu et al published an RCT that compared surgical resection with TACE plus RFA for HCC. A total of 200 patients within the Milan criteria were included in the trial and followed for 5 years. Tumor sizes ranged from 0.6 to 5.0 cm, with a median of 3.0 cm in the surgical resection group and 2.8 cm in the TACE plus RFA group. OS (p=0.007) and recurrence-free survival (p=0.026) were significantly longer in the surgical resection group (see Table 1). Local tumor progression occurred in 1 patient in the surgical resection group and in 18 in the TACE plus RFA group (p<0.001). There were no significant differences in recurrence or OS between the groups for HCC lesions 3.0 cm or smaller, but there were significant benefits for surgery in recurrence (p=0.032) and OS (p=0.012) in patients with lesions larger than 3 cm. Tumor size was an independent prognostic factor for recurrence-free survival (hazard ratio [HR], 1.76; p=0.006) along with hepatitis B DNA (HBV-DNA) and platelet count. HBV-DNA was a significant risk factor for OS. Complications were higher in the surgical resection group (23.0%) than in the TACE plus RFA group (11.0%; p=0.24). It could not be determined from this trial whether RFA alone is as effective as surgical resection for these small tumors.

Table 1. Percent Survival Following Surgical Resection or TACE Plus RFA for Resectable HCC

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>1 Year, %</th>
<th>2 Years, %</th>
<th>3 Years, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surgical resection</td>
<td>97.0</td>
<td>83.7</td>
<td>61.9</td>
</tr>
<tr>
<td>TACE plus RFA</td>
<td>96.0</td>
<td>67.2</td>
<td>45.7</td>
</tr>
<tr>
<td>Recurrence-free survival</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surgical resection</td>
<td>94.0</td>
<td>68.2</td>
<td>48.4</td>
</tr>
<tr>
<td>TACE plus RFA</td>
<td>83.0</td>
<td>44.9</td>
<td>35.5</td>
</tr>
</tbody>
</table>

HCC: hepatocellular carcinoma; RFA: radiofrequency ablation; TACE: transcatheter arterial chemoembolization.

Observational Studies

In 2017, Kutlu et al compared outcomes for RFA, resection, or transplantation in patients from the Surveillance, Epidemiology, and End Results database. A total of 1894 patients treated between 2004 and 2013 with HCC tumors measuring up to 50 mm met study criteria. Outcomes from the 3 treatment arms were compared for lesions 20 mm or smaller, 21 to 30 mm, 31 to 35
mm, or 31 to 50 mm in order to identify the upper limit of lesion size appropriate for RFA. Transplantation resulted in significant improvements in OS compared with RFA for all tumor sizes (p<0.001; see Table 2). In tumors up to 30 mm, there were no significant differences in OS between RFA and resection. However, OS was significantly lower with RFA compared with resection for tumors measuring 31 to 35 mm (adjusted HR=1.90; 95% confidence interval [CI], 1.07 to 3.38; p=0.028) or 31 to 50 mm (HR=1.69; 95% CI, 1.24 to 2.31; p=0.001). The study found that even a small increase in lesion size over 30 mm decreased OS compared with resection or transplantation.

Table 2. Mean Percent Overall Survival in Months by Treatment and Lesion Size

<table>
<thead>
<tr>
<th>Lesion Size</th>
<th>RFA (95% CI), %</th>
<th>Resection (95% CI), %</th>
<th>Transplantation (95% CI), %</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤20 mm</td>
<td>60.47 (50.12 to 70.82)</td>
<td>69.81 (62.81 to 76.80)</td>
<td>80.78 (75.72 to 85.85)</td>
</tr>
<tr>
<td>21 to 30 mm</td>
<td>60.92 (54.11 to 67.73)</td>
<td>69.71 (63.55 to 75.86)</td>
<td>77.28 (71.04 to 83.54)</td>
</tr>
<tr>
<td>31 to 35 mm</td>
<td>47.31 (40.02 to 54.60)</td>
<td>62.34 (56.10 to 68.58)</td>
<td>76.66 (71.04 to 83.67)</td>
</tr>
<tr>
<td>31 to 50 mm</td>
<td>48.87 (43.49 to 54.25)</td>
<td>65.44 (60.77 to 70.50)</td>
<td>76.74 (70.91 to 82.57)</td>
</tr>
</tbody>
</table>

CI: confidence interval; RFA: radiofrequency ablation.

Section Summary: Radiofrequency Ablation as a Treatment of Primary, Operable Hepatocellular Carcinoma

The evidence on RFA as a primary treatment of primary, operable HCC includes RCTs, meta-analyses of these RCTs, and a database analysis. Results from these studies have suggested that RFA alone or RFA plus TACE could be as effective as resection for small HCC tumors, although the exact cutoff size has not been established. The studies reviewed have suggested that RFA is inferior to hepatic resection for tumors of 5 cm or less but could lead to OS rates similar to those for resection of tumors less than 3 cm. In a network meta-analysis, TACE plus RFA was found to be more effective than surgery, TACE, or RFA alone. This network meta-analysis did not evaluate efficacy based on lesion size. Additionally, the results of this analysis were based on indirect comparisons with heterogeneous populations and should be confirmed in a prospective randomized trial. Further study in a multicenter RCT would permit greater certainty whether RFA, with or without TACE, is as effective as surgical resection in treating HCC tumors 30 mm or smaller.

Radiofrequency Ablation as a Primary Treatment of Inoperable Hepatocellular Carcinoma

The evidence on the use of RFA as a primary treatment option for inoperable HCC includes RCTs comparing RFA with other nonsurgical interventions, RFA as an adjunct to chemotherapy, and systematic reviews of the RCTs.

Systematic Reviews

A 2003 TEC Assessment addressed RFA in the treatment of unresectable primary or metastatic liver tumors.13 Since that report, many systematic reviews and meta-analyses have been published on RFA for HCC. Some are discussed below.

Majumdar et al (2017) published a Cochrane review and network meta-analysis of the management of early and very early-stage HCC.14 Reviewers included 14 RCTs (total N=2533 patients) of nonsurgical treatments compared with each other, sham, or no intervention in patients with unresectable HCC. The quality of the evidence was rated as low or very low for all outcomes. Follow-up ranged from 6 to 37 months. Compared with RFA, mortality was higher for percutaneous acetic acid injection (HR=1.8; 95% CI, 1.1 to 2.8; 1 trial; N=125) and PEI (HR=1.49; 95% CI, 1.2 to 1.9; 5 trials; n=882). No trials reported health-related quality of life.

In 2013, Shen et al reported on a systematic review of 4 RCTs and quasi-RCTs (total N=766 patients), comparing RFA to PEI for treatment of HCC nodules up to 3 cm.15 OS was significantly longer for RFA than for PEI at 3 years (HR=0.66; 95% CI, 0.48 to 0.90; p=0.009), and local recurrence risk was lower with RFA (HR=0.38; 95% CI, 0.15 to 0.96; p=0.040). However, there was no difference in distant intrahepatic recurrence, and RFA resulted in more complications.
Tiong and Maddern (2011) conducted a systematic review of the literature from 2000 to 2010 and a meta-analysis of survival and disease recurrence after RFA for HCC. Studies reporting on patients with HCC who were treated with RFA, either in comparison to or in combination with other interventions (e.g., surgery, PEI), were eligible for inclusion. Outcomes data collected were OS, disease-free survival (DFS), and disease recurrence rates. Only RCTs, quasi-RCTs, and nonrandomized comparative studies with more than 12 months of follow-up were included. Forty-three articles, including 12 RCTs, were selected for review. Most articles reported on the use of RFA for unresectable HCC, often in combination with other treatments (e.g., PEI, TACE, surgery). Meta-analysis of 5 RCTs showed that RFA was better than PEI, with higher OS and DFS rates. Data on RFA compared with microwave ablation were inconclusive. Reviewers concluded that RFA could achieve good clinical outcomes for unresectable HCC.

In a 2013 meta-analysis comparing RFA with cryoablation for HCC, Huang et al evaluated 3 prospective studies and 1 retrospective study. Included in the studies were 180 RFA and 253 cryoablation patients. RFA was significantly superior to cryoablation in complication rates (OR=2.80; 95% CI, 1.54 to 5.09), local recurrence rates (OR=4.02; 95% CI, 1.93 to 8.39), and local tumor recurrence rates (OR=1.96, 95% CI, 1.12 to 3.42). However, mortality rates did not differ significantly (OR=2.21; 95% CI, 0.45 to 10.8) between groups.

Randomized Controlled Trials
In 2016, Giorgio et al reported on an RCT comparing RFA plus chemotherapy to chemotherapy alone in 99 patients with unresectable HCC invading the portal vein. The HCC nodules ranged in size from 2.1 to 6.5 cm. The primary outcome was OS at 3 years. OS rates at 1, 2, and 3 years were 60%, 35%, and 26% in the combined therapy group and 37% and 0% at 1 and 2 years in the chemotherapy-alone arm (HR=2.87; 95% CI, 1.61 to 5.39), respectively.

Section Summary: Radiofrequency Ablation as a Primary Treatment of Inoperable Hepatocellular Carcinoma
Randomized and nonrandomized trials have compared RFA with alternative treatments for HCC in individuals who do not qualify for surgery. RCT evidence has established that RFA is more effective than PEI in this population, and some evidence has suggested that RFA may be better than cryoablation. The evidence comparing RFA with TACE is limited, and no conclusions can be drawn. RFA has also been shown to improve survival in patients with unresectable HCC as an adjunct to chemotherapy. Overall, the evidence supports the use of RFA in patients who are inoperable.

Radiofrequency Ablation for Patients with Inoperable Hepatocellular Carcinoma Awaiting Liver Transplant
In 2002, the United Network for Organ Sharing (UNOS) introduced a new liver allocation system—Model for End-stage Liver Disease (MELD)—for adults awaiting a liver transplant, relevant parts of which were updated in 2015 and 2016. In considering how to allocate the scarce donor organs, UNOS sought to balance the risk of death on the waiting list against the risk of recurrence after transplant. Under UNOS criteria, patients with T1 lesions (1 nodule ≤1.9 cm) are considered at low risk of death on the waiting list, while those with T3 lesions (1 nodule >5.0 cm, or 2 or 3 nodules at least 1 >3.0 cm) are at high risk of posttransplant recurrence. Patients with T2 tumors (1 nodule ≥2.0 cm and ≤5.0 cm, or 2 or 3 nodules ≥1 cm and ≤3.0 cm) have an increased risk of dying while on the waiting list compared with those with T1 lesions and an acceptable risk of posttransplant tumor recurrence. Therefore, UNOS criteria prioritize T2 HCC by allocating additional points equivalent to a MELD score predicting a 15% probability of death within 3 months. The definition of T2 lesions is also referred to as the Milan criteria, in reference to a key 1996 study that examined recurrence rates of HCC by size of the initial tumor. Note that liver transplantation for those with T3 HCC is not prohibited, but these patients do not receive priority on the waiting list. All patients with HCC awaiting transplantation are reassessed at 3-month intervals. Those whose tumors have progressed and are no longer T2 tumors lose additional allocation points.
The UNOS allocation system incentivizes use of locoregional therapies in 2 different settings: (1) to prevent the progress of T2 tumors while on the waiting list and (2) to downsize T3 tumors to T2 status to meet the UNOS criteria for additional allocation points.

These two indications are discussed further here. It should be noted that the UNOS policy addresses the role of locoregional therapy in the pretransplant setting as follows:

“Any OPTN [Organ Procurement and Transplantation Network] Class 5 or biopsy-proven HCC lesion that was automatically approved upon initial application or extension and has subsequently undergone loco-regional treatment. OPTN Class 5T nodules qualify for continued priority points predicated on the pre-treatment classification of the nodule(s) and are defined as:

Past loco-regional treatment for HCC (OPTN Class 5 lesion or biopsy proven prior to ablation). Evidence of persistent/recurrent HCC such as nodular or crescentic extra-zonal or intra-zonal enhancing tissue on late arterial imaging (relative to hepatic parenchyma) may be present.”

OPTN guidelines also indicate “candidates whose tumors have been ablated after previously meeting the criteria for additional MELD/PELD [Pediatric End-Stage Liver Disease] points (OPTN Class 5T) will continue to receive additional MELD/PELD points (equivalent to a 10-percentage point increase in candidate mortality) every 3 months without RRB [regional review board] review, even if the estimated size of residual viable tumor falls below stage T2 criteria.”

Candidates with HCC not meeting transplant criteria, “including those with downsized tumors whose original or presenting tumor was greater than a stage T2, must be referred to the applicable RRB for prospective review in order to receive additional priority.”

Pomfret et al (2010) summarized findings and recommendations from a national conference on outcomes of liver transplantation for patients with HCC. The workgroup on locoregional therapy found compelling evidence that pretransplant locoregional therapy decreases waitlist dropout, especially for patients who wait more than 3 to 6 months for a transplant. The group noted that “there is a paucity of data comparing RFA with transarterial therapies for the treatment of HCC prior to liver transplant and most single-center trials have a mixture of [locoregional therapies] included in the study population” and that, while early studies have suggested a high rate of tumor seeding with percutaneous RFA, it is rare in larger series from experienced centers. The workgroup considering evidence to support the expansion of MELD criteria for patients with HCC reported wide regional variation in the risk of death for patients without HCC. The “MELD score of the non-HCC patients was quite low in some regions. Posttransplant survival in HCC patients ranged from 25% in regions with few non-HCC patients with high MELD scores to greater than 70% in regions in which there was a greater need for liver transplant (higher MELD scores) in the non-HCC population.” The workgroup observed that there is extreme variability of the time to transplantation of patients with HCC in the United States, suggesting that management of patients on the waitlist and outcomes may vary. Additionally, “[c]oncern has been raised that short times to liver transplant may lead to an increase in posttransplant recurrence because the tumor biology [aggressiveness] has not had enough time to be expressed. The lack of national data on recurrence rates limits one’s ability to study this national experiment of nature based on the divergent waiting times for transplantation for HCC.” There was a consensus for the development of a calculated continuous HCC priority score for ranking HCC candidates on the list that would incorporate the calculated MELD score, α-fetoprotein, tumor size, and rate of tumor growth. Only candidates with at least stage T2 tumors would receive additional HCC priority points. Pomfret et al also discussed pretransplant locoregional therapy to allow patients to maintain transplant candidacy and to downstage tumors to meet MELD criteria.

Radiofrequency Ablation to Prevent Tumor Progression
Several prior studies have reported dropout rates of waitlisted patients treated with locoregional therapy. However, lacking controlled data, it is difficult to assess the contributions of
locoregional therapy to time on the waiting list. Additionally, in 2002, as previously discussed, UNOS revised its liver allocation policy, such that wait times for patients with HCC meeting the Milan criteria have now declined. Given these limitations, the following case series and cohort studies have been reported.

In 2017, Lee et al reported a 10-year intention-to-treat analysis of RFA to prevent progression and reduce the chance of posttransplant HCC.22 Patients were included in this analysis if they had cirrhosis with treatment-naive HCC, were on the transplant waiting list, and had RFA as a stand-alone treatment. Only tumors that could safely be treated with a 5-mm margin received RFA. Of 1016 patients who had HCC and were on the transplant waiting list, 121 were treated with RFA and were included in this analysis. Patients returned for follow-up with imaging every 3 to 6 months. The outcomes of interest were dropout rate from the waitlist, posttransplant recurrence, and OS at 10 years. The mean time on the waiting list was 10.2 months (range, 0.3-38 months). At the end of follow-up, 89 (73.6%) patients had undergone a liver transplant, 16 (13.2%) were delisted, 14 (11.6%) died, and 2 (1.7%) remained on the waitlist. The number of patients delisted due to tumor was 9 (7.4%). Intention-to-treat analysis of all patients estimated 8-year OS at 60.0% and disease-specific survival at 89.5%.

Mazzaferro et al (2004) reported on 50 patients with HCC who underwent RFA while awaiting transplantation; no patient had to be removed from the waiting list due to tumor progression over a mean wait time of 9.5 months.23 The median tumor size was 3 cm, and 80% of patients met the Milan criteria. Similarly, Lu et al (2005) reported on 52 patients who underwent RFA as a bridge to transplantation, 42 of whom met the Milan criteria.24 After a mean of 12 months, 5.8% had dropped off the waiting list due to tumor progression.

Porrett et al (2006) retrospectively compared 31 patients treated with RFA with 33 untreated controls.25 Study end points included patient survival and DFS, tumor recurrence, explant tumor viability, and the ability of magnetic resonance imaging to detect viable tumor after therapy. Both cohorts had similar demographic, radiographic, and pathologic characteristics, although untreated patients waited longer for transplantation (119 [untreated] days vs 54 [RFA] days after MELD assignment; p=0.05). Only 20% of treated tumors demonstrated complete ablation (necrosis) as defined by histologic examination of the entire lesion. Only 55% of lesions with histologic viable tumor were detected by magnetic resonance imaging after pretransplant therapy. After 36 months of follow-up, there was no difference between the treated and the untreated groups in OS (84% vs 91%), DFS (74% vs 85%), cancer recurrence (23% vs 12%), or mortality from cancer recurrence (57% vs 25%), all respectively (p>0.1). The authors concluded that viable tumor frequently persists after pretransplant locoregional therapy, and neoadjuvant treatment does not appear to improve posttransplant outcomes in the current MELD era.

Radiofrequency Ablation to Downgrade Hepatocellular Carcinoma

Yao et al (2008) analyzed longer term outcomes data on HCC downstaging in a cohort of 61 patients with tumor stage exceeding T2 criteria enrolled between 2002 and 2007.26 Eligibility criteria for downstaging included the following: (1) 1 lesion larger than 5 cm and up to 8 cm; (2) 2 to 3 lesions with at least 1 lesion larger than 3 cm and not exceeding 5 cm, with total tumor diameter up to 8 cm; or (3) 4 to 5 lesions with none larger than 3 cm, with total tumor diameter up to 8 cm. TACE and laparoscopic RFA (LRFA) either alone or in combination were the main methods used the following: 11 patients received laparoscopic RFA alone, 14 received TACE and laparoscopic RFA, and 9 received TACE and percutaneous RFA. A minimum observation period of 3 months after downstaging was required before liver transplant. Tumor downstaging was successful in 43 patients (70.5%). Thirty-five (57.4%) patients received a liver transplant, including 2 with live-donor liver transplantation. Treatment failure was observed in 18 (29.5%) patients, primarily due to tumor progression. In the explant of 35 patients who underwent a transplant, 13 had complete tumor necrosis, 17 met T2 criteria, and 5 exceeded T2 criteria. The Kaplan-Meier intention-to-treat survival rates at 1 and 4 years after downstaging were 87.5% and 69.3%, respectively. The 1- and 4-year posttransplantation survival rates were 96.2% and 92.1%, respectively. No patient had HCC recurrence after a median posttransplantation follow-up of 25
months. The only factor predicting treatment failure was pretreatment α-fetoprotein level greater than 1000 ng/mL. From this small series, the authors concluded that successful downstaging could be achieved with excellent posttransplant outcomes.

Yao et al (2005) also reported on a case series of 30 patients with HCC who underwent locoregional therapy specifically to downstage tumors to meet the University of California San Francisco (UCSF) criteria (see below for brief discussion of the UCSF criteria). Eligibility for locoregional therapy seeking to downstage patients included either (1) 1 nodule between 5 and 8 cm in diameter; (2) 2 or 3 nodules with at least 1 between 3 and 5 cm in diameter, with a sum of diameters no greater than 8 cm; or (3) 4 or 5 nodules all 3 cm or less, with a sum of diameters less than 8 cm. Among the 30 patients, 21 (70%) met the criteria for locoregional therapy and 16 of them were successfully downstaged and underwent transplantation. No tumors recurred at a median follow-up of 16 months. The authors concluded that downsizing could be successfully achieved in most patients, but that data on tumor recurrence required longer follow-up.

**Radiofrequency Ablation to Reduce Risk of Recurrence**

An additional indication for locoregional therapies has focused on their use to reduce the incidence of recurrence posttransplant. If the incidence of recurrence can be reduced, then advocates have argued that the UNOS allocation criteria should not discriminate against patients with larger tumors. Some patients with T3 lesions are cured with a liver transplant, although most experience tumor recurrence. For example, in the seminal 1996 study, the 4-year relapse-free survival (RFS) was 92% in those who met the Milan criteria compared with 59% in those who did not; additional studies have confirmed this difference in the RFS rate. However, other institutions have reported similar outcomes with expanded criteria. For example, Yao et al (2002) reported similar RFS rates after transplant in patients with T2 tumors and a subset of those with T3 tumors. This T3 subset was defined as a single lesion 6.5 cm or less or 3 or fewer lesions with none greater than 3 cm and with a sum of tumor diameters of 8 cm or less. These expanded criteria are known as the UCSF criteria.

The question is whether locoregional therapies (including both RFA and chemoembolization) decrease the recurrence rate in patients meeting the UCSF criteria. The authors also compared the RFS rates of those who did and did not receive locoregional therapy. For those with T2 lesions, recurrence rates were similar whether or not the patient received locoregional therapy. However, for T3 lesions (including both T3A and T3B), the 5-year RFS rate was 85.9% for those who received locoregional therapy compared with 51.4% for those who did not. When data for T2 and T3 lesions were pooled, the 5-year RFS rate was 93.8% for those who received locoregional therapy and 80.6% for those who did not. The authors concluded that preoperative locoregional therapy might confer a survival benefit in those with T2 or T3 lesions.

The authors noted several limitations to the study, including the retrospective nature of the data and the marginal statistical significance of the improved survival, given the small numbers of patients in each subgroup. For example, only 19 patients were in the T3A (i.e., UCSF expanded criteria) subgroup. Additionally, no protocol specified which type of locoregional therapy to offer different patients. These therapies are only offered to patients with adequate liver reserve; such patients may have an improved outcome regardless of the preoperative management. In the 2017 study by Lee et al (described above), of 89 patients with HCC who received RFA before liver transplant, 5 (5.6%) had HCC recurrence.

**Section Summary: Radiofrequency Ablation for Patients with Inoperable Hepatocellular Carcinoma Awaiting Liver Transplant**

The evidence on the use of RFA for HCC in patients awaiting transplant consists of case series and uncontrolled trials. There is sufficient evidence to conclude that locoregional therapy with RFA or alternatives decreases the dropout rate from the transplant list. This is especially true if patients wait more than 3 to 6 months for a transplant. Therefore, outcomes are improved for this group.
For other uses of RFA in the transplant, such as to downstage tumors for eligibility for transplant, and/or to prevent disease recurrence, the evidence is insufficient to make conclusions.

**Radiofrequency Ablation for Inoperable Hepatic Metastases of Colorectal Origin**

More than half of patients with colorectal cancer (CRC) will develop liver metastases, generally with a poor prognosis. A median survival of 21 months has been observed in patients with a single CRC liver metastasis; those with several unilobar lesions have a median survival of 15 months; and those with disseminated metastases have a median survival of less than 1 year. A number of first-line systemic chemotherapy regimens have been used to treat metastatic CRC, with a 2-year survival rate of 25% for those treated with 5-fluorouracil or 5-fluorouracil plus leucovorin. With the introduction of newer agents (e.g., irinotecan, oxaliplatin) and targeted drugs (e.g., cetuximab, bevacizumab), 2-year survival rates have increased to between 30% and 39% with marked improvement in OS. Because the liver is often the only site of metastases from CRC, locoregional therapies have been investigated. Surgical resection is considered the criterion standard for treatment of CRC liver metastases, with 5-year actuarial survival rates that historically range from 28% to 38% but may reach 58% in appropriately selected, resectable patients without widely disseminated disease. However, only 10% to 25% of patients with CRC metastases are eligible for surgical resection because of the extent and location of the lesions within the liver or because of the presence of comorbid conditions or disseminated disease. Unresectable cases or cases for whom surgery is contraindicated typically are treated with systemic chemotherapy, with poor results and considerable adverse effects. Alternatively, RFA has been proposed to treat metastatic CRC in the liver.

**Systematic Reviews**

In a 2014 Health Technology Assessment, Loveman et al found insufficient evidence to draw conclusions on the clinical effectiveness of ablative therapies, including RFA, for liver metastases.

In 2012, Weng et al reported a meta-analysis comparing RFA with liver resection for the treatment of CRC liver metastases. One prospective study and 12 retrospective studies were included in the analysis. OS at 3 and 5 years was significantly longer after liver resection than after RFA (relative risk [RR], 1.377; 95% CI, 1.246 to 1.522 vs RR=1.474; 95% CI, 1.284 to 1.692, respectively). DFS was also significantly longer after liver resection than after RFA at 3 and 5 years (RR=1.735; 95% CI, 1.483 to 2.029; RR=2.227 vs 95% CI, 1.823 to 2.720, respectively). While postoperative morbidity with liver resection was significantly higher than with RFA (RR=2.495; 95% CI, 1.881 to 3.308), mortality did not differ significantly between treatments. Liver resection also produced significantly better outcomes than RFA when data were analyzed in 3 subgroups: tumors less than 3 cm, solitary tumor, and open or laparoscopic approach. However, hospital stays were significantly shorter (9.2 days vs 3.9 days, p<0.01) and rates of complications lower (18.3% vs 3.9%, p<0.01) with RFA than liver resection. Interpretation of the meta-analysis is limited by the retrospective nature of most studies.

A 2011 systematic review by Pathak et al assessed the long-term outcome and complication rates of various ablative therapies used in the management of colorectal liver metastases. The literature search was from 1994 to 2010, and study inclusion criteria were a minimum of 1-year follow-up and more than 10 patients. In all, 226 studies were identified, 75 meeting inclusion criteria. Most studies were single-arm, single-center, retrospective, and prospective. There was wide variability in patient groups, adjuvant therapies, and management approaches within individual studies. Several studies combined results for colorectal and non-colorectal metastases, often reporting combined outcomes. End points were not reported uniformly, with varying definitions of survival time, recurrence time, and complication rates. Cryotherapy (26 studies) had local recurrence rates ranging from 12% to 39%, with mean 1-, 3-, and 5-year survival rates of 84%, 37%, and 17%, respectively. Major complication rates ranged from 7% to 66%. Microwave ablation (13 studies) had local recurrence rates ranging from 5% to 13%, with mean 1-, 3-, and 5-year survival rates of 73%, 30%, and 16%, respectively, and a major
complication rates ranging from 3% to 16%. RFA (36 studies) had local recurrence rates ranging from 10% to 31%, with a mean 1-, 3-, and 5-year survival of 85%, 36%, and 24% respectively, with major complication rates ranging from 0% to 33%. Reviewers concluded that ablative therapies offer significantly improved survival compared with palliative chemotherapy alone, with 5-year survival rates ranging from 17% to 24%, and that complication rates of commonly used techniques are low.

A 2010 review by Guenette and Dupuy summarized the literature on the use of RFA for colorectal hepatic metastases. Approximately 17 studies with more than 50 patients treated with RFA for colorectal hepatic metastases reported survival. Average tumor size, reported in 15 studies, ranged from 2.1 to 4.2 cm. Five-year OS, reported in 12 studies, ranged from 2% to 55.3% (mean, 24.5%). The largest study series (Lencioni et al, 2004) included in the review consisted of 423 patients, with average tumor size of 2.7 cm, 4 or fewer metastases, each 5 cm or less at greatest dimension, and no extrahepatic disease. OS rates in that study at 1, 3, and 5 years were 86%, 47%, and 24% respectively. Guenette and Dupuy concluded that 5-year survival rates following RFA were similar to those following resection but that long-term data associated with RFA and colorectal hepatic metastases were sparse, randomized trials had failed recruitment, and patients with the resectable disease should undergo resection if possible. However, given the efficacy of RFA compared with chemotherapy alone, they noted that RFA should be considered as a primary treatment option for patients with unresectable disease.

**Randomized Controlled Trials**

In 2012 and 2017, Ruers et al published the results of a multicenter RCT that compared RFA plus systemic treatment with systemic treatment alone for unresectable colorectal liver metastases. This RCT, originally designed as a phase 3 study, was completed as a phase 2 study due to slow accrual (N=119 patients). To be included in the trial, patients had to have nonresectable liver metastases with fewer than 10 nodes and without extrahepatic disease. In the experimental arm, RFA, with or without additional resection, was given in combination with systemic therapy. The primary end point was a 30-month survival higher than 38% in the experimental arm with intention-to-treat analysis. At 3 years, OS did not differ significantly between groups (see Table 3). However, there was a significant improvement in progression-free survival (HR=0.74; 95% CI, 0.42 to 0.95; p=0.025), which corresponded to a difference in progression-free survival at 3 years from 10.6% in the systemic therapy arm to 27.6% in the combined treatment arm. At a median follow-up of 9.7 years, 39 (65%) of 60 patients in the combined treatment arm had died compared with 53 (89.8%) of 59 in the systemic treatment arm (HR=0.58; 95% CI, 0.38 to 0.88; p=0.01).

**Table 3. Percent Overall Survival at 3, 5, and 8 Years**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>3 Years (95% CI), %</th>
<th>5 Years (95% CI), %</th>
<th>8 Years (95% CI), %</th>
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<tr>
<td>Combined treatment</td>
<td>56.9 (43.3 to 68.5)</td>
<td>43.1 (30.3 to 55.3)</td>
<td>35.9 (23.8 to 48.2)</td>
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<tr>
<td>Systemic alone</td>
<td>55.2 (41.6 to 66.9)</td>
<td>30.3 (19.0 to 42.4)</td>
<td>8.9 (3.3 to 18.1)</td>
</tr>
</tbody>
</table>

CI: confidence interval.

**Nonrandomized Comparative Studies**

Nonrandomized studies have compared RFA with resection or systemic chemotherapy in patients with localized CRC metastases and no evidence of additional metastatic disease. For example, in 2016, Hof et al compared outcomes from RFA or hepatic resection in patients with hepatic metastases from CRC. There were 431 patients included from an institutional database. All patients underwent locoregional treatment for hepatic metastases from CRC. Initial treatment was either hepatic resection (n=261), open RFA (n=26), percutaneous RFA (n=75), or a combination of resection plus RFA (n=69). Mean follow-up was 38.6 months. The overall recurrence rate was 83.5% (152/182) in patients treated with RFA compared with 66.6% (201/302) in patients treated with hepatic resection (p<0.001). The 5-year OS estimate by Kaplan-Meier analysis was 51.9% for RFA and 53.0% for hepatic resection (p=0.98).
Abdalla et al (2004) examined recurrence and survival rates for clinically similar patients treated with hepatic resection only (n=190), resection plus RFA (n=101), RFA only (n=57), open laparotomy with biopsy or systemic chemotherapy alone (n=70). In the key relevant comparison, RFA vs chemotherapy in chemotherapy-naive patients with nonresectable CRC metastases (median, 1 lesion per patient; range, 1-8; median tumor size, 2.5 cm), OS at 4 years was 22% in the RFA group and 10% in the chemotherapy group (p=0.005). Median survival was estimated at 25 months in the RFA group and 17 months in the chemotherapy group (p not reported). Recurrence at a median follow-up of 21 months was 44% in the RFA group and 11% in the resection-only group (p<0.001), although the proportion of patients with distant recurrence as a component of failure was similar (41% resection vs 40% RFA, p=NS).

In another trial, a 2007 consecutive series of well-defined, previously untreated patients (N=201) without extrahepatic disease underwent laparotomy to determine therapeutic approach. Three groups were identified: those amenable to hepatic resection (n=117); those for whom resection plus local ablation were indicated (RFA, n=27; cryoablation, n=18); and those deemed unresectable and unsuitable for local ablation (n=39) who received systemic chemotherapy. Median OS was 61 months (95% CI, 41 to 81 months) in resected patients (median, 1 tumor per patient; range, 1-9; median diameter, 3.8 cm), 31 months (95% CI, 20 to 42 months) in locally ablated patients (median, 4 tumors per patient; range, 1-19; median diameter, 3 cm per lesion), and 26 months (95% CI, 17 to 35 months) in the chemotherapy patients (median, 4 tumors per patient; range, 1-17; median diameter, 4 cm per lesion; p=0.052, ablated vs chemotherapy). Results from 2 validated quality of life instruments (EuroQol-5D, EORTC QLQ C-30) showed that patients treated with local ablation returned to baseline values within 3 months, whereas those treated with chemotherapy remained significantly lower (i.e., worse quality of life) than baseline over 12 months posttreatment (p<0.05).

In 2011, Van Tilborg et al reported long-term results in 100 patients with unresectable colorectal liver metastases who underwent a total of 126 RFA sessions (237 lesions). Lesion size ranged from 0.2 to 8.3 cm (mean, 2.4 cm). Mean follow-up was 29 months (range, 6-93 months). Major complications (including abscess, hemorrhage, grounding pad burns, and diaphragm perforation) occurred in 8 patients. Factors that determined procedural success included lesion size and the number and location of the lesions. Local tumor site recurrence was 5.6% for tumors less than 3 cm, 19.5% for tumors 3 to 5 cm, and 41.2% for those greater than 5 cm. Centrally located lesions recurred more often than peripheral (21.4% vs 6.5%, respectively; p=0.009). Mean survival from the time of RFA was 56 months (95% CI, 45 to 67 months).

Section Summary: Radiofrequency Ablation for Inoperable Hepatic Metastases of Colorectal Origin
There are no RCTs comparing RFA with alternative treatments for patients with unresectable colorectal liver metastases. However, an RCT of RFA combined with chemotherapy found improved survival at 8 years compared with chemotherapy alone. Additionally, prospective studies have demonstrated that OS following RFA is at least equivalent and likely better than that obtained with currently accepted systemic chemotherapy in well-matched patients with unresectable hepatic metastatic CRC who do not have extrahepatic disease. Results from a number of uncontrolled case series have also suggested RFA of hepatic CRC metastases produces long-term survival that is at least equivalent and likely superior to systemic chemotherapy, based on historical outcomes. Evidence from a comparative study has suggested RFA has fewer deleterious effects on quality of life than chemotherapy and that RFA patients recover quality of life significantly faster than chemotherapy recipients. Patients treated with RFA in different series may have a better prognosis than those who undergo chemotherapy, meaning that patient selection bias may at least partially explain the better outcomes observed following RFA.

Radiofrequency Ablation for Inoperable Hepatic Metastases of Neuroendocrine Origin
A systematic review of RFA as a treatment for unresectable metastases from neuroendocrine tumors was published in 2015. Seven unique studies (total N=301 patients); all retrospective
case series from a single institution, were included. The most common tumor type was carcinoid (59%), followed by nonfunctional pancreatic tumors (21%) and functional pancreatic tumors (13%). There were 2 peri-procedural deaths (rate, 0.7%), and the overall rate of complications was 10%, including hemorrhage, abscess, visceral perforation, bile leak, biliopleural fistula, transient liver insufficiency, pneumothorax, grounding pad burn, urinary retention, pneumonia, pleural effusion. Improvement in symptoms was reported in 92% (117/127) of symptomatic patients, with a median duration of relief ranging from 14 to 27 months. There was a high degree of variability in the length of follow-up and surveillance, and a wide range of local recurrence rates, from less than 5% to 50%. The reported 5-year survival rates ranged from 57% to 80%.

**Case Series**

Berber and Siperstein (2008) analyzed a large series of liver tumors treated with RFA. 47 Of 1032 tumors assessed, 295 were neuroendocrine tumor metastases. The mean number of lesions treated was 5.6 (range, 1-16 lesions) and mean lesion size was 2.3 cm (range, 0.5-10.0 cm). Local recurrence rates were lower in patients with neuroendocrine tumors than in patients with other tumor types: neuroendocrine tumors (19/295 [6%]), colorectal metastases (161/480 [24%]), non-colorectal, non-neuroendocrine metastases (28/126 [22%]), and HCC (23/131 [18%]). In patients with neuroendocrine tumors, 58% of the recurrences were evident at 1 year and 100% at 2 years vs 83% at 1 year and 97% at 2 years for colorectal metastases. Seven of the 8 neuroendocrine tumors were eligible for repeat RFA. Symptom control and survival were not reported.

Mazzaglia et al (2007) reported on a series collected over 10 years for 63 patients with neuroendocrine metastases treated with 80 sessions of RFA. 48 Tumor types were 36 carcinoid, 18 pancreatic islet cell, and 9 medullary thyroid cancer. Indications for study enrollment were liver metastases from neuroendocrine tumors, enlarging liver lesions, worsening of symptoms, and/or failure to respond to other treatment modalities and the predominance of liver disease; patients with additional minor extrahepatic disease were not excluded. RFA was performed 1.6 years (range, 0.1-7.8 years) after diagnosis of liver metastases. Fourteen patients had repeat sessions for disease progression. The mean number of lesions treated at the first RFA session was 6, and the mean tumor size was 2.3 cm. One week after surgery, 92% of patients had at least partial symptom relief, and 70% had complete relief. Symptom control lasted 11 months. Median survival times were 11 years post-diagnosis of the primary tumor, 5.5 years post-diagnosis of the neuroendocrine hepatic metastases, and 3.9 years after the first RFA treatment.

Elias et al (2009) reported on 16 patients who underwent a 1-step combination of hepatectomy plus RFA for the treatment of gastroenteropancreatic endocrine tumors. 49 A mean of 15 liver tumors per patient was surgically removed, and a mean of 12 was ablated using RFA. Three-year OS and DFS rates were similar to those observed in the authors' preliminary series of 47 patients who had hepatectomy with a median of 7 liver tumors per patient.

**Section Summary: Radiofrequency Ablation for Inoperable Hepatic Metastases of Neuroendocrine Origin**

The evidence on RFA for patients with inoperable liver metastases of neuroendocrine origin consists of case series and a systematic review of case series. Most reports of RFA treatment for neuroendocrine liver metastases include small numbers of patients or subsets of patients in reports of more than 1 ablative method or very small subsets of larger case series of patients with various diagnoses. The available evidence indicates that durable tumor and symptom control of neuroendocrine liver metastases can be achieved by RFA in individuals whose symptoms are not controlled by systemic therapy.

**Radiofrequency Ablation for Hepatic Metastases not of colorectal or Neuroendocrine Origin**

**Breast Cancer**

A number of case series have reported on the use of RFA to treat breast cancer liver metastases. In 2014, Veltri et al analyzed 45 women treated with RFA for 87 breast cancer liver metastases (mean size, 23 mm). 50 Complete ablation was seen on initial follow-up in 90% of tumors, but
tumors recurred in 19.7% within 8 months. RFA did not impact OS rates, which at 1 year was 90% and at 3 years was 44%.

In a retrospective review, Meloni et al (2009) assessed local control and intermediate- and long-term survival in 52 patients. Inclusion criteria were fewer than 5 tumors, maximum tumor diameter of 5 cm, and disease confined to the liver or stable with medical therapy. Complete tumor necrosis was achieved in 97% of tumors. Median time to follow-up from diagnosis of liver metastasis and from RFA was 37.2 and 19.1 months, respectively. Local tumor progression occurred in 25% of patients, and new intrahepatic metastases developed in 53%. Median OS, from the time of first liver metastasis diagnosis, was 42 months, and 5-year survival was 32%.

Patients with tumors 2.5 cm in diameter or larger had a worse prognosis than those with smaller tumors. The authors found these survival rates comparable to those reported in the literature for surgery or laser ablation. In another series (2009) of 43 breast cancer patients with 111 liver metastases, tumor ablation was achieved in 107 (96%) metastases. During follow-up, local tumor progression was observed in 15 metastases. Estimated median OS was 58.6 months. Survival was significantly lower among patients with extrahepatic disease, except skeletal metastases.

A series of 19 patients was reported by Lawes et al (2006). Eight patients had disease confined to the liver, with 11 also having stable extrahepatic disease. At the time of reporting, 7 patients, with disease confined to the liver at presentation, were alive, as were 6 patients with extrahepatic disease (median follow-up after RFA, 15 months; range, 0-77 months). Survival at 30 months was 41.6%. RFA failed to control hepatic disease in 3 patients.

Sarcoma
Jones et al (2010) evaluated RFA in a series of patients with sarcoma. Thirteen gastrointestinal stromal tumor (GIST) patients and 12 with other histologic subtypes received RFA for metastatic disease in the liver. 12 responded to the first RFA procedure and 1 patient achieved stable disease. Two gastrointestinal stromal tumor patients received RFA on 2 occasions for separate lesions within the liver, and both responded to the second RFA procedure. Of the other subtypes, 7 patients underwent RFA to liver lesions, 5 of whom responded to RFA, 1 patient progressed, and another was not assessable at the time of analysis. RFA was well-tolerated in this series of sarcoma patients. RFA may have a role in patients with gastrointestinal stromal tumor who have progression in a single metastasis but stable disease elsewhere. The authors advised conducting larger studies to define the role of this technique in this patient population.

A case series of 66 patients who underwent hepatic resection (n=35), resection and RFA (n=18), or RFA alone (n=13) was reported by Pawlik et al (2006). After a median follow-up of 35.8 months, 44 patients had recurrence (intrahepatic only, n=16; extrahepatic only, n=11; both, n=17). The 1-, 3-, and 5-year OS rates were 91.5%, 65.4%, and 27.1%, respectively.

Section Summary: Radiofrequency Ablation for Hepatic Metastases Not of Colorectal or Neuroendocrine Origin
For cancers other than CRC or neuroendocrine tumors, small case series are not sufficient to determine whether RFA improves outcomes.

Summary of Evidence
Primary, Operable Hepatocellular Carcinoma
For individuals who have primary, operable HCC who receive RFA, the evidence includes RCTs, meta-analyses of these RCTs, and a database analysis. Relevant outcomes are OS, disease-specific survival, change in disease status, and morbid events. Results from these studies have suggested that RFA alone or RFA plus transcatheter arterial chemoembolization may be as effective as resection for small resectable HCC tumors, although the exact size cutoff has not been established. The studies reviewed have suggested that RFA is inferior to hepatic resection for tumors of 50 mm or less in size but may lead to OS rates similar to resection of tumors less than 3 cm. Further study in a multicenter RCT would permit greater certainty whether RFA, with or
without transhepatic arterial chemoembolization, is as effective as surgical resection in treating HCC tumors 30 mm or smaller. The evidence is insufficient to determine the effects of the technology RFA on health outcomes.

**Inoperable Hepatocellular Carcinoma**

For individuals who have inoperable HCC who receive RFA, the evidence includes randomized trials and several systematic reviews and meta-analyses. Relevant outcomes are OS, disease-specific survival, change in disease status, and morbid events. Surgical resection of HCC, compared with RFA, has shown superior survival, supporting the use of RFA for unresectable HCC and for those who are not candidates for surgical resection. Response rates have demonstrated that, in patients with small foci of HCC (≤3 lesions), RFA appears to be better than ethanol injection in achieving complete ablation and preventing local recurrence. Three-year survival rates of 80% have been reported. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

**Inoperable Hepatocellular Carcinoma Awaiting Liver Transplant**

For individuals who have inoperable HCC awaiting liver transplant who receive RFA, the evidence includes small case series. Relevant outcomes are OS, disease-specific survival, and change in disease status. A number of approaches are used in this patient population, including RFA and other locoregional therapies, particularly transarterial chemoembolization. Locoregional therapy has reduced the dropout rate of patients with HCC awaiting a liver transplant. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

**Inoperable Hepatic Metastases of Colorectal Origin**

For individuals who have inoperable hepatic metastases of colorectal origin who receive RFA, the evidence includes an RCT, systematic reviews and meta-analyses, prospective cohort series, and retrospective case series. Relevant outcomes are OS, disease-specific survival, symptoms, change in disease status, morbid events, quality of life, and treatment-related morbidity. There are no RCTs comparing RFA with alternative treatments for patients with unresectable colorectal liver metastases. However, an RCT assessing RFA combined with chemotherapy found improved survival at 8 years compared with chemotherapy alone. In addition, prospective studies have demonstrated that OS following RFA is at least equivalent to and likely better than that for currently accepted systemic chemotherapy in well-matched patients with unresectable hepatic metastatic colorectal cancer who do not have extrahepatic disease. Results from a number of uncontrolled case series also have suggested RFA of hepatic colorectal cancer metastases produces long-term survival that is at minimum equivalent to but likely superior to historical outcomes achieved with systemic chemotherapy. Evidence from a comparative study has indicated RFA has fewer deleterious effects on quality of life than chemotherapy and that RFA patients recover quality of life significantly faster than chemotherapy recipients. It should be noted that patients treated with RFA in different series might have had better prognoses than those who had chemotherapy, suggesting patient selection bias might at least partially explain the better outcomes observed following RFA. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

**Inoperable Hepatic Metastases of Neuroendocrine Origin**

For individuals who have inoperable hepatic metastases of neuroendocrine origin who receive RFA, the evidence includes case series and a systematic review of case series. Relevant outcomes are OS, disease-specific survival, symptoms, change in disease status, morbid events, quality of life, and treatment-related morbidity. Most reports of RFA treatment for neuroendocrine liver metastases have assessed small numbers of patients or subsets of patients in reports of more than 1 ablative method or very small subsets of larger case series of patients with various diagnoses. The available evidence indicates that durable tumor and symptom control of neuroendocrine liver metastases can be achieved using RFA in individuals whose symptoms are not controlled by systemic therapy. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.
**Hepatic Metastases Not of Colorectal or Neuroendocrine Origin**

For individuals who have hepatic metastases not of colorectal or neuroendocrine origin who receive RFA, the evidence includes small case series. Relevant outcomes are OS, disease-specific survival, symptoms, change in disease status, morbid events, quality of life, and treatment-related morbidity. The evidence is insufficient to determine the effects of the technology RFA on health outcomes.

**Supplemental Information**

**Practice Guidelines and Position Statements**

**Society of Interventional Radiology**

The Society of Interventional Radiology published a position statement on percutaneous radiofrequency ablation for the treatment of liver tumors in 2009.56 The Society indicated that “percutaneous RF ablation of hepatic tumors is a safe and effective treatment for selected patients with HCC [hepatocellular carcinoma] and colorectal carcinoma metastases” and that the current literature does not support any recommendations for or against the use of radiofrequency ablation in other diseases.

**National Comprehensive Cancer Network**

Several National Comprehensive Cancer Network (NCCN) guidelines are relevant to this review. NCCN guidelines on hepatobiliary cancers (v.2.2017) state that “ablation alone may be curative in treating tumors ≤ 3 cm. In well-selected patients with small, properly located tumors, ablation should be considered as definitive treatment in the context of a multidisciplinary review. Lesions 3 to 5 cm may be treated to prolong survival using arterially directed therapies, alone or with combination of an arterially directed therapy and ablation as long as the tumor is accessible for ablation” (category 2A).57

The guidelines on colon cancer metastatic to the liver (v.2.2017) state that “Ablative techniques may be considered alone or in conjunction with resection. All original sites of disease need to be amenable to ablation or resection.” (category 2A).58

NCCN guidelines for neuroendocrine tumors (v.3.2017) state that “…ablative therapies such as radiofrequency ablation (RFA) or cryoaablation may be considered if near-complete treatment of tumor burden can be achieved (category 2B). For unresectable liver metastases, … (arterial embolization, chemoembolization, or radioembolization [category 2B]) is recommended.”59

**U.S. Preventive Services Task Force Recommendations**

Not applicable.

**Medicare National Coverage**

There is no national coverage determination. In the absence of a national coverage determination, coverage decisions are left to the discretion of local Medicare carriers.

**Ongoing and Unpublished Clinical Trials**

Some currently unpublished trials that might influence this review are listed in Table 4.

**Table 4. Summary of Key Trials**

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<thead>
<tr>
<th>NCT No.</th>
<th>Trial Name</th>
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### References


### Documentation for Clinical Review

**Please provide the following documentation (if/when requested):**
- History and physical and/or consultation notes including:
  - Clinical indications/justification of procedure
  - Eastern Cooperative Oncology Group functional status (if applicable)
  - Previous treatment(s), duration, and response(s)
  - Treatment plan
  - Tumor type and description (i.e., resectable or unresectable, primary or metastatic, tumor burden [e.g., liver dominant])
- Pertinent radiological imaging results (i.e., abdominal CT and/or MRI and/or PET)
- Pathology report including tumor node metastasis (TNM) classification
- Current serum chemistry, liver function tests, and tumor marker results

### Post service
- Procedure report(s)

### Coding

This Policy relates only to the services or supplies described herein. Benefits may vary according to product design; therefore, contract language should be reviewed before applying the terms of the Policy. Inclusion or exclusion of a procedure, diagnosis or device code(s) does not constitute or imply member coverage or provider reimbursement.

**MN/IE**

The following services may be considered medically necessary in certain instances and investigational in others. Services may be considered medically necessary when policy criteria...
are met. Services may be considered investigational when the policy criteria are not met or when the code describes application of a product in the position statement that is investigational.

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<th>Type</th>
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<td>Ultrasound guidance for, and monitoring of, parenchymal tissue ablation</td>
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| ICD-10 Diagnosis | All Diagnoses                             |

**Policy History**

This section provides a chronological history of the activities, updates and changes that have occurred with this Medical Policy.

<table>
<thead>
<tr>
<th>Effective Date</th>
<th>Action</th>
<th>Reason</th>
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<tbody>
<tr>
<td>06/26/2009</td>
<td>Policy Revision Policy Name Change</td>
<td>Medical Policy Committee</td>
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<td></td>
<td>Combined policies for Transcatheter Arterial Chemoembolization to Treat Primary or Metastatic Liver Malignancies, Cryoablation of Liver Tumors and Radiofrequency Ablation of Hepatic Tumors</td>
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<td>03/25/2011</td>
<td>Administrative Review</td>
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<td>01/06/2012</td>
<td>Policy revision with position change</td>
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<td>05/02/2014</td>
<td>Coding Update</td>
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<td>02/27/2015</td>
<td>Policy title change from Locoregional Treatment of Primary and Metastatic Hepatic Tumors</td>
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<td>Policy revision without position change</td>
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**Definitions of Decision Determinations**

**Medically Necessary:** A treatment, procedure, or drug is medically necessary only when it has been established as safe and effective for the particular symptoms or diagnosis, is not investigational or experimental, is not being provided primarily for the convenience of the patient or the provider, and is provided at the most appropriate level to treat the condition.
Investigational/Experimental: A treatment, procedure, or drug is investigational when it has not been recognized as safe and effective for use in treating the particular condition in accordance with generally accepted professional medical standards. This includes services where approval by the federal or state governmental is required prior to use, but has not yet been granted.

Split Evaluation: Blue Shield of California/Blue Shield of California Life & Health Insurance Company (Blue Shield) policy review can result in a split evaluation, where a treatment, procedure, or drug will be considered to be investigational for certain indications or conditions, but will be deemed safe and effective for other indications or conditions, and therefore potentially medically necessary in those instances.

Prior Authorization Requirements (as applicable to your plan)

Within five days before the actual date of service, the provider must confirm with Blue Shield that the member's health plan coverage is still in effect. Blue Shield reserves the right to revoke an authorization prior to services being rendered based on cancellation of the member's eligibility. Final determination of benefits will be made after review of the claim for limitations or exclusions.

Questions regarding the applicability of this policy should be directed to the Prior Authorization Department. Please call (800) 541-6652 or visit the provider portal at www.blueshieldca.com/provider.

Disclaimer: This medical policy is a guide in evaluating the medical necessity of a particular service or treatment. Blue Shield of California may consider published peer-reviewed scientific literature, national guidelines, and local standards of practice in developing its medical policy. Federal and state law, as well as contract language, including definitions and specific contract provisions/exclusions, take precedence over medical policy and must be considered first in determining covered services. Member contracts may differ in their benefits. Blue Shield reserves the right to review and update policies as appropriate.