BlueCross BlueShield Federal Employee Program.

FEP Medical Policy Manual

FEP 7.01.133 Microwave Tumor Ablation

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Related Policies:

7.01.75 - Cryosurgical Ablation of Primary or Metastatic Liver Tumors
7.01.91 - Radiofrequency Ablation of Primary or Metastatic Liver Tumors
7.01.92 - Cryoablation of Tumors Located in the Kidney, Lung, Breast, Pancreas, or Bone
7.01.95 - Radiofrequency Ablation of Miscellaneous Solid Tumors Excluding Liver Tumors
8.01.11 - Transcatheter Arterial Chemoembolization to Treat Primary or Metastatic Liver Malignancies
8.01.43 - Radioembolization for Primary and Metastatic Tumors of the Liver

Microwave Tumor Ablation

Description

Description

Microwave ablation (MWA) is a technique to destroy tumors and soft tissue using microwave energy to create thermal coagulation and localized tissue necrosis. Microwave ablation is used to treat tumors not amenable to resection and to treat patients ineligible for surgery due to age, comorbidities, or poor general health. Microwave ablation may be performed as an open procedure, laparoscopically, percutaneously, or thoracoscopically under image guidance (eg, ultrasound, computed tomography, magnetic resonance imaging) with sedation, or local or general anesthesia. This technique is also referred to as microwave coagulation therapy.

OBJECTIVE

The objective of this evidence review is to determine whether the use of microwave ablation improves the net health outcome in individuals with unresectable primary or metastatic solid tumors.

POLICY STATEMENT

Microwave ablation of primary or metastatic hepatic tumors may be considered **medically necessary** under the following conditions:

- The tumor is unresectable due to location of lesion[s] and/or comorbid conditions.
- A single tumor of ≤5 cm or up to 3 nodules ≤3 cm each.

Microwave ablation of primary or metastatic lung tumors may be considered **medically necessary** under the following conditions:

- The tumor is unresectable due to location of lesion and/or comorbid conditions.
- A single tumor of ≤3 cm.

Microwave ablation of more than a single primary or metastatic tumor in the lung is considered **investigational**.

Microwave ablation of primary or metastatic tumors other than liver or lung is considered **investigational**.

POLICY GUIDELINES

None

BENEFIT APPLICATION

Experimental or investigational procedures, treatments, drugs, or devices are not covered (See General Exclusion Section of brochure).

FDA REGULATORY STATUS

Multiple MWA devices have been cleared for marketing by the U.S. Food and Drug Administration (FDA) through the 510(k) process. These devices are indicated for soft tissue ablation, including partial or complete ablation of nonresectable liver tumors. Some devices are specifically cleared for use in open surgical ablation, percutaneous ablation, or laparoscopic procedures. Table 1 is a summary of selected MWA devices cleared by the FDA.

The FDA used determinations of substantial equivalence to existing radiofrequency and MWA devices to clear these devices. FDA product code: NEY.

This evidence review does not address MWA for the treatment of splenomegaly or ulcers, for cardiac applications, or as a surgical coagulation tool.

Table 1. Selected Microwave Ablation Devices Cleared by FDA

Device	Indication	Manufacturer	Date Cleared	510(k) No.
MedWaves Microwave Coagulation/Ablation System	General surgery use in open procedures for the coagulation and ablation of soft tissues	MedWaves Incorporated	12/2007	K070356
Acculis Accu2i pMTA Microwave Tissue Ablation Applicator Acculis Accu2i pMTA Applicator and SulisV^{pMTA} Generator	Intraoperative coagulation of soft tissue Software addition	Microsoulis Holdings, Ltd	8/2010 11/2012	K094021 K122762

MicroThermX Microwave Ablation System	Coagulation (ablation) of soft tissue; may be used in open surgical as well as percutaneous ablation procedures	BSD Medical Corporation	8/2010	K100786
Emprint™ Ablation System Emprint™ Ablation System Emprint™ SX Ablation Platform with Thermosphere™ Technology Emprint™ Ablation Platform with Thermosphere™ Technology and Emprint™ SX Ablation Platform with Thermosphere™ Technology	Percutaneous, laparoscopic, and intraoperative coagulation (ablation) of soft tissue, including partial or complete ablation of non-resectable liver tumors Same with design modification of device antenna for percutaneous use 3-D navigation feature assists in the placement of antenna using real-time image guidance during intraoperative and laparoscopic ablation procedures Antenna modification and update to instructions for use	Medtronic	4/2014 12/2016 9/2017 2/2020	K133821 K163105 K171358 K193232
Certus 140 2.45 GHz Ablation System and Accessories Certus 140™ 2.45 GHz Ablation System and Accessories CertuSurg^{GT} Surgical Tool Certus 140™ 2.45 GHz Ablation System and Accessories Certus 140 2.45GHz Ablation System	Ablation (coagulation) of soft tissue Ablation (coagulation) of soft tissue in percutaneous, open surgical and in conjunction with laparoscopic surgical settings Surgical coagulation (including Planar Coagulation) in open surgical settings Same indication with probe redesign Ablation (coagulation) of soft tissue in percutaneous, open surgical and in conjunction with laparoscopic surgical settings, including the partial or complete ablation of non-resectable liver tumors	Johnson & Johnson	10/2010 01/2012 7/2013 5/2016 10/2018	K100744 K113237 K130399 K160936 K173756
NEUWAVE Flex Microwave Ablation System (FLEX)	Ablation (coagulation) of soft tissue; design evolution of Certus 140 2.45GHz Ablation System (K160936)	Johnson & Johnson	3/2017	K163118
Solero Microwave Tissue Ablation (MTA) System and Accessories	Ablation of soft tissue during open procedures	Angiodynamics, Inc.	5/2017	K162449
Microwave Ablation System	Coagulation (ablation) of soft tissue	Surgnova Healthcare Technologies (Zhejiang) Co., Ltd	7/2019	K183153
NEUWAVE Microwave Ablation System and Accessories	Ablation (coagulation) of soft tissue in percutaneous, open surgical and in conjunction with laparoscopic surgical settings, including the partial or complete ablation of non-resectable liver tumors; not intended for use in cardiac procedures	Johnson & Johnson	11/2020	K200081

FDA: U.S. Food and Drug Administration.

RATIONALE

Summary of Evidence

For individuals who have an unresectable primary or metastatic hepatic tumor who receive microwave ablation (MWA), the evidence includes randomized controlled trials (RCTs), comparative observational studies, and systematic reviews comparing MWA to radiofrequency ablation (RFA) and to surgical resection. Relevant outcomes are overall survival (OS), disease-specific survival, symptoms, quality of life (QOL), and treatment-related mortality and morbidity. The body of evidence indicates that MWA is an effective option in patients for whom resection is not an option. Although studies

had methodological limitations, results consistently showed that that MWA and RFA had similar survival outcomes with up to 5 years of follow-up in patients with a single tumor <5 cm or up to 3 nodules <3 cm each. In a meta-analysis of observational studies, patients receiving MWA had higher local recurrence rates and lower survival than those who received resection, but the patient populations were not limited to those who had unresectable tumors. Microwave ablation was associated with lower complications, intraoperative blood loss, and hospital length of stay. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have an unresectable primary or metastatic lung tumor who receive MWA, the evidence includes a single RCT, retrospective observational studies, and systematic reviews of these studies. Relevant outcomes are OS, disease-specific survival, symptoms, QOL, and treatment-related mortality and morbidity. The body of evidence indicates that MWA is an effective option in patients for whom resection is not an option. In the RCT, direct comparison of MWA and RFA in patients with primary or metastatic lung cancer (mean tumor size, 1.90 cm [0.89] at baseline) found similar mortality rates up to 12 months of follow-up. In the first of 3 systematic reviews that included 12 retrospective observational studies, local recurrence rates were similar for MWA and RFA at a range of 9 to 47 months of follow-up. In the second systematic review with a meta-analysis, there was lower OS with MWA compared to RFA, but studies were not directly comparable due to clinical and methodological heterogeneity. However, the authors concluded that percutaneous RFA and MWA were both effective with a high safety profile. In the third systematic review using a network meta-analysis, the weighted average OS rates for MWA were 82.5%, 54.6%, 35.7%, 29.6%, and 16.6% at 1, 2, 3, 4, and 5 years, respectively. Limitations of the body of evidence included a lack of controlled studies and heterogeneity across studies. The RCT did not report results by tumor size or the number of metastases. The observational studies included in the systematic reviews did not report sufficient information to assess the effectiveness or safety of MWA in subgroups based on the presence of multiple tumors or total tumor burden. Therefore, conclusions about the evidence sufficiency can only be made about patients with single tumors. For this population, the evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have an unresectable primary or metastatic renal tumor who receive MWA, the evidence includes a single RCT that compared MWA to partial nephrectomy, retrospective reviews, systematic reviews, and meta-analyses of the retrospective reviews (with or without the single RCT) and case series. Relevant outcomes are OS, disease-specific survival, symptoms, QOL, and treatment-related mortality and morbidity. In the RCT, overall local recurrence-free survival at 3 years was 91.3% for MWA and 96.0% for partial nephrectomy (p=.54). This positive outcome should be replicated in additional RCTs. There are also no controlled studies comparing MWA to other ablation techniques in patients with renal tumors. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have unresectable primary or metastatic solid tumors other than hepatic, lung, or renal who receive MWA, the evidence includes systematic reviews and case series. Relevant outcomes are OS, disease-specific survival, symptoms, QOL, and treatment-related mortality and morbidity. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

SUPPLEMENTAL INFORMATION

Practice Guidelines and Position Statements

Guidelines or position statements will be considered for inclusion in 'Supplemental Information' if they were issued by, or jointly by, a US professional society, an international society with US representation, or National Institute for Health and Care Excellence (NICE). Priority will be given to guidelines that are informed by a systematic review, include strength of evidence ratings, and include a description of management of conflict of interest.

American College of Chest Physicians

The American College of Chest Physicians (2013) evidence-based guidelines on the treatment of NSCLC noted that the role of ablative therapies in the treatment of high-risk patients with stage I NSCLC is evolving.[109,] The guidelines deal mostly with radiofrequency ablation.

American Urological Association

The American Urological Association (2021) updated its guidelines on renal mass and localized renal cancer, which note that both RFA and cryoablation may be offered as options for patients who elect thermal ablation (Conditional Recommendation; Evidence Level: Grade C).[110,] Thermal ablation can be considered as an alternate approach in the management of T1a solid renal masses <3 cm. In these patients, a percutaneous technique is preferred (Moderate Recommendation; Evidence Level: Grade C). The guidelines do not specifically address MWA.

National Comprehensive Cancer Network

The National Comprehensive Cancer Network (NCCN) guidelines on hepatocellularcarcinoma (HCC) (v.1.2023) list MWA (along with radiofrequency ablation, cryoablation, and percutaneous alcohol injection) as a treatment option for HCC tumors in patients who are not candidates for potential curative treatments (eg, resection and transplantation) and do not have large-volume extrahepatic disease.[111,] Ablation should only be considered when tumors are accessible by percutaneous, laparoscopic, or open approaches. The guidelines indicate " Ablation alone may be curative in treating tumors less than or equal to 3 cm [...] Lesions 3 to 5 cm may be treated to prolong survival using arterially directed therapies, or with combination of an arterially directed therapy and ablation as long as tumor location is accessible for ablation."

The guidelines on non-small cell lung cancer (NSCLC) (v.3.2023) state that image-guided thermal ablation therapies such as cryotherapy, microwave, or radiofrequency may be an option for select medically inoperable patients not receiving stereotactic ablative radiotherapy or definitive radiotherapy.[112,] Image-guided thermal ablation therapy is considered an option for the management of NSCLC lesions <3 cm. Ablation for NSCLC lesions >3 cm has been associated with higher rates of local recurrence and complications.

Guidelines on small-cell lung cancer (v.3.2023) state, "stereotactic ablative radiotherapy is an option for certain patients with medically inoperable stage I to IIA small-cell lung cancer."[113,]

The Network guidelines on neuroendocrine tumors (v.1.2023) state that cytoreductive surgery or ablative therapies (eg, radiofrequency, cryotherapy, microwave) may be considered in patients with progressive hepatic-predominant metastatic disease to reduce tumor bulk and relieve symptoms of hormone hypersecretion (category 2B). Additionally, although prospective data for ablative therapy interventions are limited, the guideline notes that "percutaneous thermal ablation, often using microwave energy, can be considered for oligometastatic liver disease, generally up to 4 lesions each smaller than 3 cm.[114,]

The guidelines on kidney cancer (v.1.2024) state that thermal ablation techniques (MWA, RFA and cryotherapy) may be an option for T1 renal lesions, particularly for masses <3 cm.[115,]

The guidelines on breast cancer (v.4.2023) do not address thermal ablation techniques such as MWA.[116,]

Thyroid cancer guidelines from NCCN (v.4.2023) recommend ablation techniques such as cryoablation or RFA as an option for metastatic disease in select patients.[117,] There is not specific mention of MWA.

National Institute for Health and Care Excellence

The National Institute for Health and Care Excellence (2016) updated its guidance on MWA for treatment of metastases in the liver.[118,] The revised guidance states:

- Current evidence on MWA for treating liver metastases raises no major safety concerns and the evidence on efficacy is adequate in terms of tumor ablation. Therefore this procedure may be used provided that standard arrangements are in place for clinical governance, consent, and audit.
- Patient selection should be carried out by a hepatobiliary cancer multidisciplinary team.
- Further research would be useful for guiding the selection of patients for this procedure. This should document the site and type of the primary tumor being treated, the intention of treatment (palliative or curative), imaging techniques used to assess the efficacy of the procedure, long-term outcomes, and survival.

The Institute (2007) also published guidance on MWA for HCC.[119,] This guidance indicated: "Current evidence on the safety and efficacy of MWA of hepatocellular carcinoma appears adequate to support the use of this procedure....” The guidance also stated there are no major concerns about the efficacy of MWA, but noted that limited, long-term survival data are available.

The Institute (2022) has published guidance on MWA for lung tumors as well.[120,] This guidance indicated that, "Evidence on the safety of microwave ablation for treating primary lung cancer and metastases in the lung is adequate but shows it can cause infrequent serious complications. Evidence on its efficacy shows it reduces tumour size. But the evidence on improvement in survival, long-term outcomes and quality of life is limited in quantity and quality. Therefore, this procedure should only be used with special arrangements for clinical governance, consent, and audit or research." The guidance encourages further research.

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.

REFERENCES

1. Chinnaratha MA, Chuang MY, Fraser RJ, et al. Percutaneous thermal ablation for primary hepatocellular carcinoma: A systematic review and meta-analysis. J Gastroenterol Hepatol. Feb 2016; 31(2): 294-301. PMID 26114968
2. Bertot LC, Sato M, Tateishi R, et al. Mortality and complication rates of percutaneous ablative techniques for the treatment of liver tumors: a systematic review. Eur Radiol. Dec 2011; 21(12): 2584-96. PMID 21858539
3. Ong SL, Gravante G, Metcalfe MS, et al. Efficacy and safety of microwave ablation for primary and secondary liver malignancies: a systematic review. Eur J Gastroenterol Hepatol. Jun 2009; 21(6): 599-605. PMID 19282763
4. Glassberg MB, Ghosh S, Clymer JW, et al. Microwave ablation compared with hepatic resection for the treatment of hepatocellular carcinoma and liver metastases: a systematic review and meta-analysis. World J Surg Oncol. Jun 10 2019; 17(1): 98. PMID 31182102
5. Cui R, Yu J, Kuang M, et al. Microwave ablation versus other interventions for hepatocellular carcinoma: A systematic review and meta-analysis. J Cancer Res Ther. 2020; 16(2): 379-386. PMID 32474527
6. Dou Z, Lu F, Ren L, et al. Efficacy and safety of microwave ablation and radiofrequency ablation in the treatment of hepatocellular carcinoma: A systematic review and meta-analysis. Medicine (Baltimore). Jul 29 2022; 101(30): e29321. PMID 35905207
7. Seki T, Wakabayashi M, Nakagawa T, et al. Percutaneous microwave coagulation therapy for patients with small hepatocellular carcinoma: comparison with percutaneous ethanol injection therapy. Cancer. Apr 15 1999; 85(8): 1694-702. PMID 10223562
8. Shibata T, Iimuro Y, Yamamoto Y, et al. Small hepatocellular carcinoma: comparison of radio-frequency ablation and percutaneous microwave coagulation therapy. Radiology. May 2002; 223(2): 331-7. PMID 11997534
9. Xu HX, Xie XY, Lu MD, et al. Ultrasound-guided percutaneous thermal ablation of hepatocellular carcinoma using microwave and radiofrequency ablation. Clin Radiol. Jan 2004; 59(1): 53-61. PMID 14697375
10. Lu MD, Xu HX, Xie XY, et al. Percutaneous microwave and radiofrequency ablation for hepatocellular carcinoma: a retrospective comparative study. J Gastroenterol. Nov 2005; 40(11): 1054-60. PMID 16322950
11. Tanaka K, Shimada H, Nagano Y, et al. Outcome after hepatic resection versus combined resection and microwave ablation for multiple bilobar colorectal metastases to the liver. Surgery. Feb 2006; 139(2): 263-73. PMID 16455336
12. Wang ZL, Liang P, Dong BW, et al. Prognostic factors and recurrence of small hepatocellular carcinoma after hepatic resection or microwave ablation: a retrospective study. J Gastrointest Surg. Feb 2008; 12(2): 327-37. PMID 17943391
13. Ohmoto K, Yoshioka N, Tomiyama Y, et al. Comparison of therapeutic effects between radiofrequency ablation and percutaneous microwave coagulation therapy for small hepatocellular carcinomas. J Gastroenterol Hepatol. Feb 2009; 24(2): 223-7. PMID 18823439
14. Yin XY, Xie XY, Lu MD, et al. Percutaneous thermal ablation of medium and large hepatocellular carcinoma: long-term outcome and prognostic factors. Cancer. May 01 2009; 115(9): 1914-23. PMID 19241423
15. Kuang M, Xie XY, Huang C, et al. Long-term outcome of percutaneous ablation in very early-stage hepatocellular carcinoma. J Gastrointest Surg. Dec 2011; 15(12): 2165-71. PMID 21972056
16. Imura S, Shimada M, Utsunomiya T, et al. Ultrasound-guided microwave coagulation assists anatomical hepatic resection. Surg Today. Jan 2012; 42(1): 35-40. PMID 22075665
17. Qian GJ, Wang N, Shen Q, et al. Efficacy of microwave versus radiofrequency ablation for treatment of small hepatocellular carcinoma: experimental and clinical studies. Eur Radiol. Sep 2012; 22(9): 1983-90. PMID 22544225
18. Chinnaratha MA, Sathananthan D, Pateria P, Tse E, MacQuillan G, Wigg AJ. Predictors of hepatocellular carcinoma recurrence post thermal ablation. J Gastroenterol Hepatol. 2013;28(Suppl. 2):66-67.
19. Ding J, Jing X, Liu J, et al. Comparison of two different thermal techniques for the treatment of hepatocellular carcinoma. Eur J Radiol. Sep 2013; 82(9): 1379-84. PMID 23726122
20. Stttner S, Jones RP, Yip VS, et al. Microwave ablation with or without resection for colorectal liver metastases. Eur J Surg Oncol. Aug 2013; 39(8): 844-9. PMID 23769976
21. Takami Y, Ryu T, Wada Y, et al. Evaluation of intraoperative microwave coagulo-necrotic therapy (MCN) for hepatocellular carcinoma: a single center experience of 719 consecutive cases. J Hepatobiliary Pancreat Sci. Mar 2013; 20(3): 332-41. PMID 22710886
22. Zhang L, Wang N, Shen Q, et al. Therapeutic efficacy of percutaneous radiofrequency ablation versus microwave ablation for hepatocellular carcinoma. PLoS One. 2013; 8(10): e76119. PMID 24146824
23. Abdelaziz A, Elbaz T, Shousha HI, et al. Efficacy and survival analysis of percutaneous radiofrequency versus microwave ablation for hepatocellular carcinoma: an Egyptian multidisciplinary clinic experience. Surg Endosc. Dec 2014; 28(12): 3429-34. PMID 24935203
24. Shi J, Sun Q, Wang Y, et al. Comparison of microwave ablation and surgical resection for treatment of hepatocellular carcinomas conforming to Milan criteria. J Gastroenterol Hepatol. 2014; 29(7): 1500-7. PMID 24628534
25. Tan K, DU X, Yin J, et al. Microwave tissue coagulation technique in anatomical liver resection. Biomed Rep. Mar 2014; 2(2): 177-182. PMID 24649092
26. Zhang NN, Cheng XJ, Liu JY. Comparison of high-powered MWA and RFA in treating larger hepatocellular carcinoma. J Pract Oncol. 2014;29:349-356.

27. Abdelaziz AO, Nabeel MM, Elbaz TM, et al. Microwave ablation versus transarterial chemoembolization in large hepatocellular carcinoma: prospective analysis. Scand J Gastroenterol. Apr 2015; 50(4): 479-84. PMID 25592058
28. Vogl TJ, Farshid P, Naguib NN, et al. Ablation therapy of hepatocellular carcinoma: a comparative study between radiofrequency and microwave ablation. Abdom Imaging. Aug 2015; 40(6): 1829-37. PMID 25601438
29. Xu J, Zhao Y. Comparison of percutaneous microwave ablation and laparoscopic resection in the prognosis of liver cancer. Int J Clin Exp Pathol. 2015; 8(9): 11665-9. PMID 26617907
30. Potretzke TA, Ziemlewicz TJ, Hinshaw JL, et al. Microwave versus Radiofrequency Ablation Treatment for Hepatocellular Carcinoma: A Comparison of Efficacy at a Single Center. J Vasc Interv Radiol. May 2016; 27(5): 631-8. PMID 27017124
31. Zhang EL, Yang F, Wu ZB, et al. Therapeutic efficacy of percutaneous microwave coagulation versus liver resection for single hepatocellular carcinoma ≤3 cm with Child-Pugh A cirrhosis. Eur J Surg Oncol. May 2016; 42(5): 690-7. PMID 26995115
32. Li W, Zhou X, Huang Z, et al. Short-term and long-term outcomes of laparoscopic hepatectomy, microwave ablation, and open hepatectomy for small hepatocellular carcinoma: a 5-year experience in a single center. Hepatol Res. Jun 2017; 47(7): 650-657. PMID 27487979
33. Philips P, Scoggins CR, Rostas JK, et al. Safety and advantages of combined resection and microwave ablation in patients with bilobar hepatic malignancies. Int J Hyperthermia. Feb 2017; 33(1): 43-50. PMID 27405728
34. Ryu T, Takami Y, Wada Y, et al. Oncological outcomes after hepatic resection and/or surgical microwave ablation for liver metastasis from gastric cancer. Asian J Surg. Jan 2019; 42(1): 100-105. PMID 29254868
35. Song P, Sheng L, Sun Y, et al. The clinical utility and outcomes of microwave ablation for colorectal cancer liver metastases. Oncotarget. Aug 01 2017; 8(31): 51792-51799. PMID 28881688
36. Xu Y, Shen Q, Wang N, et al. Microwave ablation is as effective as radiofrequency ablation for very-early-stage hepatocellular carcinoma. Chin J Cancer. Jan 19 2017; 36(1): 14. PMID 28103953
37. Yu J, Yu XL, Han ZY, et al. Percutaneous cooled-probe microwave versus radiofrequency ablation in early-stage hepatocellular carcinoma: a phase III randomised controlled trial. Gut. Jun 2017; 66(6): 1172-1173. PMID 27884919
38. Zhang QB, Zhang XG, Jiang RD, et al. Microwave ablation versus hepatic resection for the treatment of hepatocellular carcinoma and oesophageal variceal bleeding in cirrhotic patients. Int J Hyperthermia. May 2017; 33(3): 255-262. PMID 27817240
39. Chen ZB, Qin F, Ye Z, et al. Microwave-assisted liver resection vs. clamp crushing liver resection in cirrhosis patients with hepatocellular carcinoma. Int J Hyperthermia. Dec 2018; 34(8): 1359-1366. PMID 29353503
40. Chong CCN, Lee KF, Chu CM, et al. Microwave ablation provides better survival than liver resection for hepatocellular carcinoma in patients with borderline liver function: application of ALBI score to patient selection. HPB (Oxford). Jun 2018; 20(6): 546-554. PMID 29352659
41. Chinnaratha MA, Sathananthan D, Pateria P, et al. High local recurrence of early-stage hepatocellular carcinoma after percutaneous thermal ablation in routine clinical practice. Eur J Gastroenterol Hepatol. Mar 2015; 27(3): 349-54. PMID 25563141
42. Cillo U, Noaro G, Vitale A, et al. Laparoscopic microwave ablation in patients with hepatocellular carcinoma: a prospective cohort study. HPB (Oxford). Nov 2014; 16(11): 979-86. PMID 24750429
43. Correa-Gallego C, Fong Y, Gonen M, et al. A retrospective comparison of microwave ablation vs. radiofrequency ablation for colorectal cancer hepatic metastases. Ann Surg Oncol. Dec 2014; 21(13): 4278-83. PMID 24889486
44. Di Vece F, Tombesi P, Ermili F, et al. Coagulation areas produced by cool-tip radiofrequency ablation and microwave ablation using a device to decrease back-heating effects: a prospective pilot study. Cardiovasc Intervent Radiol. Jun 2014; 37(3): 723-9. PMID 24196263
45. Hompes R, Fieuws S, Aerts R, et al. Results of single-probe microwave ablation of metastatic liver cancer. Eur J Surg Oncol. Aug 2010; 36(8): 725-30. PMID 20605397
46. Kamal A, Elmoety AAA, Rostom YAM, et al. Percutaneous radiofrequency versus microwave ablation for management of hepatocellular carcinoma: a randomized controlled trial. J Gastrointest Oncol. Jun 2019; 10(3): 562-571. PMID 31183208
47. Lee KF, Wong J, Hui JW, et al. Long-term outcomes of microwave versus radiofrequency ablation for hepatocellular carcinoma by surgical approach: A retrospective comparative study. Asian J Surg. Jul 2017; 40(4): 301-308. PMID 26922631
48. Liu Y, Li S, Wan X, et al. Efficacy and safety of thermal ablation in patients with liver metastases. Eur J Gastroenterol Hepatol. Apr 2013; 25(4): 442-6. PMID 23470267
49. Liu W, Zheng Y, He W, et al. Microwave vs radiofrequency ablation for hepatocellular carcinoma within the Milan criteria: a propensity score analysis. Aliment Pharmacol Ther. Sep 2018; 48(6): 671-681. PMID 30063081
50. Sakaguchi H, Seki S, Tsuji K, et al. Endoscopic thermal ablation therapies for hepatocellular carcinoma: a multi-center study. Hepatol Res. Jan 2009; 39(1): 47-52. PMID 18761680
51. Santambrogio R, Chiang J, Barabino M, et al. Comparison of Laparoscopic Microwave to Radiofrequency Ablation of Small Hepatocellular Carcinoma (≤3 cm). Ann Surg Oncol. Jan 2017; 24(1): 257-263. PMID 27581608
52. Sever I H, Sucu M, Biyikli E. Radiofrequency and Microwave Ablation in the Treatment of Hepatocellular Carcinoma. Iran J Radiol. 2018;15(3):e62396. doi: 10.5812/iranjradiol.62396.
53. Shady W, Petre EN, Do KG, et al. Percutaneous Microwave versus Radiofrequency Ablation of Colorectal Liver Metastases: Ablation with Clear Margins (A0) Provides the Best Local Tumor Control. J Vasc Interv Radiol. Feb 2018; 29(2): 268-275.e1. PMID 29203394
54. Simo KA, Sereika SE, Newton KN, et al. Laparoscopic-assisted microwave ablation for hepatocellular carcinoma: safety and efficacy in comparison with radiofrequency ablation. J Surg Oncol. Dec 2011; 104(7): 822-9. PMID 21520094
55. Sparchez Z, Mocan T, Hajjar NA, et al. Percutaneous ultrasound guided radiofrequency and microwave ablation in the treatment of hepatic metastases. A monocentric initial experience. Med Ultrason. Aug 31 2019; 21(3): 217-224. PMID 31476199
56. Tian W, Kuang M, Lv M, et al. A randomised comparative trial on liver tumors treated with ultrasound-guided percutaneous radiofrequency versus microwave ablation. Chin J Hepatobiliary Surg 2014;20:11922.
57. van Tilborg AA, Scheffer HJ, de Jong MC, et al. MWA Versus RFA for Perivascular and Peribiliary CRLM: A Retrospective Patient- and Lesion-Based Analysis of Two Historical Cohorts. Cardiovasc Intervent Radiol. Oct 2016; 39(10): 1438-46. PMID 27387188

58. Vietti Violi N, Duran R, Guiu B, et al. Efficacy of microwave ablation versus radiofrequency ablation for the treatment of hepatocellular carcinoma in patients with chronic liver disease: a randomised controlled phase 2 trial. Lancet Gastroenterol Hepatol. May 2018; 3(5): 317-325. PMID 29503247
59. Yang B, Li Y. A comparative study of laparoscopic microwave ablation with laparoscopic radiofrequency ablation for colorectal liver metastasis. J BUON. 2017; 22(3): 667-672. PMID 28730772
60. Chong CCN, Lee KF, Cheung SYS, et al. Prospective double-blinded randomized controlled trial of Microwave versus RadioFrequency Ablation for hepatocellular carcinoma (McRFA trial). HPB (Oxford). Aug 2020; 22(8): 1121-1127. PMID 32044268
61. Zaitoun MMA, Elsayed SB, Zaitoun NA, et al. Combined therapy with conventional trans-arterial chemoembolization (cTACE) and microwave ablation (MWA) for hepatocellular carcinoma 3- 5 cm. Int J Hyperthermia. 2021; 38(1): 248-256. PMID 33615957
62. Loveman E, Jones J, Clegg AJ, et al. The clinical effectiveness and cost-effectiveness of ablative therapies in the management of liver metastases: systematic review and economic evaluation. Health Technol Assess. Jan 2014; 18(7): vii-viii, 1-283. PMID 24484609
63. Bala MM, Riemsma RP, Wolff R, et al. Microwave coagulation for liver metastases. Cochrane Database Syst Rev. Oct 13 2013; (10): CD010163. PMID 24122576
64. Pathak S, Jones R, Tang JM, et al. Ablative therapies for colorectal liver metastases: a systematic review. Colorectal Dis. Sep 2011; 13(9): e252-65. PMID 21689362
65. Mimmo A, Pegoraro F, Rhaiem R, et al. Microwave Ablation for Colorectal Liver Metastases: A Systematic Review and Pooled Oncological Analyses. Cancers (Basel). Mar 03 2022; 14(5). PMID 35267612
66. Yuan Z, Wang Y, Zhang J, et al. A Meta-Analysis of Clinical Outcomes After Radiofrequency Ablation and Microwave Ablation for Lung Cancer and Pulmonary Metastases. J Am Coll Radiol. Mar 2019; 16(3): 302-314. PMID 30642784
67. Jiang B, Mcclure MA, Chen T, et al. Efficacy and safety of thermal ablation of lung malignancies: A Network meta-analysis. Ann Thorac Med. 2018; 13(4): 243-250. PMID 30416597
68. Nelson DB, Tam AL, Mitchell KG, et al. Local Recurrence After Microwave Ablation of Lung Malignancies: A Systematic Review. Ann Thorac Surg. Jun 2019; 107(6): 1876-1883. PMID 30508527
69. He W, Hu XD, Wu DF, et al. Ultrasonography-guided percutaneous microwave ablation of peripheral lung cancer. Clin Imaging. 2006; 30(4): 234-41. PMID 16814137
70. Wolf FJ, Grand DJ, Machan JT, et al. Microwave ablation of lung malignancies: effectiveness, CT findings, and safety in 50 patients. Radiology. Jun 2008; 247(3): 871-9. PMID 18372457
71. Vogl TJ, Naguib NN, Gruber-Rouh T, et al. Microwave ablation therapy: clinical utility in treatment of pulmonary metastases. Radiology. Nov 2011; 261(2): 643-51. PMID 22012906
72. Lu Q, Cao W, Huang L, et al. CT-guided percutaneous microwave ablation of pulmonary malignancies: Results in 69 cases. World J Surg Oncol. May 07 2012; 10: 80. PMID 22564777
73. Carrafiello G, Mangini M, Fontana F, et al. Microwave ablation of lung tumours: single-centre preliminary experience. Radiol Med. Jan 2014; 119(1): 75-82. PMID 24234180
74. Liu H, Steinke K. High-powered percutaneous microwave ablation of stage I medically inoperable non-small cell lung cancer: a preliminary study. J Med Imaging Radiat Oncol. Aug 2013; 57(4): 466-74. PMID 23870347
75. Vogl TJ, Worst TS, Naguib NN, et al. Factors influencing local tumor control in patients with neoplastic pulmonary nodules treated with microwave ablation: a risk-factor analysis. AJR Am J Roentgenol. Mar 2013; 200(3): 665-72. PMID 23436860
76. Wei Z, Ye X, Yang X, et al. Microwave ablation in combination with chemotherapy for the treatment of advanced non-small cell lung cancer. Cardiovasc Intervent Radiol. Feb 2015; 38(1): 135-42. PMID 24809754
77. Yang X, Ye X, Zheng A, et al. Percutaneous microwave ablation of stage I medically inoperable non-small cell lung cancer: clinical evaluation of 47 cases. J Surg Oncol. Nov 2014; 110(6): 758-63. PMID 24965604
78. Zheng A, Wang X, Yang X, et al. Major complications after lung microwave ablation: a single-center experience on 204 sessions. Ann Thorac Surg. Jul 2014; 98(1): 243-8. PMID 24793688
79. Acksteiner C, Steinke K. Percutaneous microwave ablation for early-stage non-small cell lung cancer (NSCLC) in the elderly: a promising outlook. J Med Imaging Radiat Oncol. Feb 2015; 59(1): 82-90. PMID 25335916
80. Wei Z, Ye X, Yang X, et al. Microwave ablation plus chemotherapy improved progression-free survival of advanced non-small cell lung cancer compared to chemotherapy alone. Med Oncol. Feb 2015; 32(2): 464. PMID 25572816
81. Egashira Y, Singh S, Bandula S, et al. Percutaneous High-Energy Microwave Ablation for the Treatment of Pulmonary Tumors: A Retrospective Single-Center Experience. J Vasc Interv Radiol. Apr 2016; 27(4): 474-9. PMID 26944360
82. Ko WC, Lee YF, Chen YC, et al. CT-guided percutaneous microwave ablation of pulmonary malignant tumors. J Thorac Dis. Oct 2016; 8(Suppl 9): S659-S665. PMID 28066666
83. Li B, Wang Z, Zhou K, et al. Safety and feasibility within 24 h of discharge in patents with inoperable malignant lung nodules after percutaneous microwave ablation. J Cancer Res Ther. Dec 2016; 12(Supplement): C171-C175. PMID 28230012
84. Macchi M, Belfiore MP, Floridi C, et al. Radiofrequency versus microwave ablation for treatment of the lung tumours: LUMIRA (lung microwave radiofrequency) randomized trial. Med Oncol. May 2017; 34(5): 96. PMID 28417355
85. Maxwell AW, Healey TT, Dupuy DE. Percutaneous Thermal Ablation for Small-Cell Lung Cancer: Initial Experience with Ten Tumors in Nine Patients. J Vasc Interv Radiol. Dec 2016; 27(12): 1815-1821. PMID 27776982
86. Vogl TJ, Eckert R, Naguib NN, et al. Thermal Ablation of Colorectal Lung Metastases: Retrospective Comparison Among Laser-Induced Thermotherapy, Radiofrequency Ablation, and Microwave Ablation. AJR Am J Roentgenol. Dec 2016; 207(6): 1340-1349. PMID 27680945
87. Zheng A, Ye X, Yang X, et al. Local Efficacy and Survival after Microwave Ablation of Lung Tumors: A Retrospective Study in 183 Patients. J Vasc Interv Radiol. Dec 2016; 27(12): 1806-1814. PMID 27789077

88. Healey TT, March BT, Baird G, et al. Microwave Ablation for Lung Neoplasms: A Retrospective Analysis of Long-Term Results. J Vasc Interv Radiol. Feb 2017; 28(2): 206-211. PMID 27993505
89. Nour-Eldin NA, Exner S, Al-Subhi M, et al. Ablation therapy of non-colorectal cancer lung metastases: retrospective analysis of tumour response post-laser-induced interstitial thermotherapy (LITT), radiofrequency ablation (RFA) and microwave ablation (MWA). Int J Hyperthermia. Nov 2017; 33(7): 820-829. PMID 28540791
90. Wei Z, Ye X, Yang X, et al. Advanced non small cell lung cancer: response to microwave ablation and EGFR Status. Eur Radiol. Apr 2017; 27(4): 1685-1694. PMID 27436020
91. Yang X, Ye X, Huang G, et al. Repeated percutaneous microwave ablation for local recurrence of inoperable Stage I nonsmall cell lung cancer. J Cancer Res Ther. 2017; 13(4): 683-688. PMID 28901314
92. Zhong L, Sun S, Shi J, et al. Clinical analysis on 113 patients with lung cancer treated by percutaneous CT-guided microwave ablation. J Thorac Dis. Mar 2017; 9(3): 590-597. PMID 28449467
93. Uhlig J, Strauss A, Rcker G, et al. Partial nephrectomy versus ablative techniques for small renal masses: a systematic review and network meta-analysis. Eur Radiol. Mar 2019; 29(3): 1293-1307. PMID 30255245
94. Guan W, Bai J, Liu J, et al. Microwave ablation versus partial nephrectomy for small renal tumors: intermediate-term results. J Surg Oncol. Sep 01 2012; 106(3): 316-21. PMID 22488716
95. Katsanos K, Mailli L, Krokidis M, et al. Systematic review and meta-analysis of thermal ablation versus surgical nephrectomy for small renal tumours. Cardiovasc Intervent Radiol. Apr 2014; 37(2): 427-37. PMID 24482030
96. Martin J, Athreya S. Meta-analysis of cryoablation versus microwave ablation for small renal masses: is there a difference in outcome?. Diagn Interv Radiol. 2013; 19(6): 501-7. PMID 24084196
97. McClure T, Lansing A, Ferko N, et al. A Comparison of Microwave Ablation and Cryoablation for the Treatment of Renal Cell Carcinoma: A Systematic Literature Review and Meta-analysis. Urology. Jun 17 2023. PMID 37331485
98. Guo J, Arellano RS. Percutaneous Microwave Ablation of Category T1a Renal Cell Carcinoma: Intermediate Results on Safety, Technical Feasibility, and Clinical Outcomes of 119 Tumors. AJR Am J Roentgenol. Jan 2021; 216(1): 117-124. PMID 32603227
99. Aarts BM, Prevoo W, Meier MAJ, et al. Percutaneous Microwave Ablation of Histologically Proven T1 Renal Cell Carcinoma. Cardiovasc Intervent Radiol. Jul 2020; 43(7): 1025-1033. PMID 32052093
100. Zhao Z, Wu F. Minimally-invasive thermal ablation of early-stage breast cancer: a systemic review. Eur J Surg Oncol. Dec 2010; 36(12): 1149-55. PMID 20889281
101. Zhou W, Zha X, Liu X, et al. US-guided percutaneous microwave coagulation of small breast cancers: a clinical study. Radiology. May 2012; 263(2): 364-73. PMID 22438362
102. Keane MG, Bramis K, Pereira SP, et al. Systematic review of novel ablative methods in locally advanced pancreatic cancer. World J Gastroenterol. Mar 07 2014; 20(9): 2267-78. PMID 24605026
103. Cui T, Jin C, Jiao D, et al. Safety and efficacy of microwave ablation for benign thyroid nodules and papillary thyroid microcarcinomas: A systematic review and meta-analysis. Eur J Radiol. Sep 2019; 118: 58-64. PMID 31439259
104. Wu X, Jiang Z, Liu J, et al. The efficacy and safety of microwave ablation versus conventional open surgery for the treatment of papillary thyroid microcarcinoma: a systematic review and meta-analysis. Gland Surg. Jun 2022; 11(6): 1003-1014. PMID 35800741
105. Li X, Fan W, Zhang L, et al. CT-guided percutaneous microwave ablation of adrenal malignant carcinoma: preliminary results. Cancer. Nov 15 2011; 117(22): 5182-8. PMID 21523760
106. Pusceddu C, Sotgia B, Fele RM, et al. Treatment of bone metastases with microwave thermal ablation. J Vasc Interv Radiol. Feb 2013; 24(2): 229-33. PMID 23200605
107. Yu MA, Liang P, Yu XL, et al. Sonography-guided percutaneous microwave ablation of intrahepatic primary cholangiocarcinoma. Eur J Radiol. Nov 2011; 80(2): 548-52. PMID 21300500
108. Egorov AV, Vasilyev IA, Musayev GH, et al. The role of microwave ablation in management of functioning pancreatic neuroendocrine tumors. Gland Surg. Dec 2019; 8(6): 766-772. PMID 32042685
109. Howington JA, Blum MG, Chang AC, et al. Treatment of stage I and II non-small cell lung cancer: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. May 2013; 143(5 Suppl): e278S-e313S. PMID 23649443
110. Campbell SC, Clark PE, Chang SS, et al. Renal Mass and Localized Renal Cancer: Evaluation, Management, and Follow-Up: AUA Guideline: Part I. J Urol. Aug 2021; 206(2): 199-208. PMID 34115547
111. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Hepatocellular Carcinoma. Version 1.2023. https://www.nccn.org/guidelines/guidelines-detail?category=1&id=1514. Accessed August 29, 2023.
112. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Non-Small Cell Lung Cancer. Version 3.2023. https://www.nccn.org/professionals/physician_gls/pdf/nscl.pdf. Accessed August 28, 2023.
113. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Small Cell Lung Cancer. Version 3.2023. https://www.nccn.org/professionals/physician_gls/pdf/sclc.pdf. Accessed August 26, 2023.
114. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Neuroendocrine and Adrenal Tumors. Version 1.2023. https://www.nccn.org/professionals/physician_gls/pdf/neuroendocrine.pdf. Accessed August 25, 2023.
115. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Kidney Cancer. Version 1.2024. https://www.nccn.org/professionals/physician_gls/pdf/kidney.pdf. Accessed August 27, 2023.
116. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Breast Cancer. Version 4.2023. https://www.nccn.org/professionals/physician_gls/pdf/breast.pdf. Accessed August 24, 2023.
117. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Thyroid Cancer. Version 4.2023. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.nccn.org/professionals/physician_gls/pdf/thyroid.pdf. Accessed August 23, 2023.

118. National Institute for Health and Care Excellence (NICE). Microwave ablation for treating liver metastases [IPG553]. 2016; https://www.nice.org.uk/guidance/ipg553. Accessed August 29, 2023.
119. National Institute for Health and Care Excellence (NICE). Microwave Ablation of Hepatocellular Carcinoma [IPG214]. 2007; https://www.nice.org.uk/guidance/ipg214. Accessed August 30, 2023.
120. National Institute for Health and Care Excellence (NICE). Microwave ablation for treating primary lung cancer and metastases in the lung [IPG469]. 2022; https://www.nice.org.uk/guidance/ipg469. Accessed August 28, 2023.

POLICY HISTORY - THIS POLICY WAS APPROVED BY THE FEP® PHARMACY AND MEDICAL POLICY COMMITTEE ACCORDING TO THE HISTORY BELOW:

Date	Action	Description
September 2012	New Policy	Investigational for all tumor types
March 2013	Replace policy	Policy updated with literature review; reference numbers 2, 12-13, 21-25, 32 & 36 added. Policy statement unchanged.
March 2014	Replace policy	Update Policy with literature review; references 10, 11, 20 & 34 were added. Policy statement is unchanged
March 2015	Replace policy	Policy updated with literature review through September 15, 2014, reference numbers 17-18, 29, and 31 added. Reference 46 updated. Policy statement unchanged.
June 2016	Replace policy	Policy updated with literature review through February 15, 2016; references 3, 8-9, and 25-26 added. Clinical input added. Policy statement unchanged
March 2018	Archive policy	Policy updated with literature review through July 20, 2017; no references added references 44 and 47 updated. Policy statement unchanged.
December 2020	Reactivate policy	Policy updated with literature review through September 28, 2020; references added. Policy statements changed to medically necessary for lung and liver tumors; statements for other tumor types unchanged.
December 2021	Replace policy	Policy updated with literature review through August 19, 2021; references added. Policy statements unchanged.
December 2022	Replace policy	Policy updated with literature review through August 30, 2022; references added. Policy statements unchanged.
December 2023	Replace policy	Policy updated with literature review through August 25, 2023; references added. Policy statements unchanged.