Protocol

Oncologic Applications of Photodynamic Therapy, Including Barrett Esophagus

(80106)

Medical Benefit		**Effective Date**: 01/01/18	**Next Review Date**: 05/23
Preauthorization	No	**Review Dates**: 09/07, 09/08, 09/09, 05/10, 05/11, 05/12, 05/13, 05/14, 05/15, 05/16, 05/17, 11/17, 05/18, 05/19, 05/20, 05/21, 05/22	

Preauthorization is not required.

The following protocol contains medical necessity criteria that apply for this service. The criteria are also applicable to services provided in the local Medicare Advantage operating area for those members, unless separate Medicare Advantage criteria are indicated. If the criteria are not met, reimbursement will be denied and the patient cannot be billed. Please note that payment for covered services is subject to eligibility and the limitations noted in the patient's contract at the time the services are rendered.

RELATED PROTOCOLS

Dermatologic Applications of Photodynamic Therapy

Endoscopic Radiofrequency Ablation or Cryoablation for Barrett Esophagus

Photodynamic Therapy for Choroidal Neovascularization

Populations	Interventions	Comparators	Outcomes
Individuals: • With obstructing esophageal cancer	Interventions of interest are: • Photodynamic therapy as palliation	Comparators of interest are: • Stenting • Laser therapy • Argon plasma coagulation	Relevant outcomes include: • Change in disease status • Symptoms • Quality of life • Treatment-related morbidity
Individuals: • With obstructing endobronchial lesions	Interventions of interest are: • Photodynamic therapy as palliation	Comparators of interest are: • Laser therapy • Brachytherapy • External-beam radiotherapy • Resection	Relevant outcomes include: • Change in disease status • Symptoms • Quality of life • Treatment-related morbidity
Individuals: • With early-stage non-small-cell lung cancer who are not candidates for surgery or radiotherapy	Interventions of interest are: • Photodynamic therapy	Comparators of interest are: • Radiofrequency ablation • Cryotherapy • Brachytherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Change in disease status • Quality of life • Treatment-related morbidity
Individuals: • With Barrett esophagus with high-grade dysplasia	Interventions of interest are: • Photodynamic therapy	Comparators of interest are: • Radiofrequency ablation • Surveillance • Esophagectomy • Cryotherapy	Relevant outcomes include: • Overall survival • Disease-specific survival • Change in disease status • Quality of life • Treatment-related morbidity

Populations	Interventions	Comparators	Outcomes
Individuals: • With unresectable cholangiocarcinoma	Interventions of interest are: • Photodynamic therapy plus stenting as palliation	Comparators of interest are: • Stenting alone	Relevant outcomes include: • Change in disease status • Symptoms • Quality of life • Treatment-related morbidity
Individuals: • With other malignancies	Interventions of interest are: • Photodynamic therapy	Comparators of interest are: • Standard of care	Relevant outcomes include: • Overall survival • Disease-specific survival • Change in disease status • Quality of life • Treatment-related morbidity

DESCRIPTION

Photodynamic therapy (PDT; also called phototherapy, photoradiotherapy, photosensitizing therapy, or photochemotherapy) is an ablative treatment that uses a photosensitizing agent to expose tumor cells to a light source of a specific wavelength for the purpose of damaging the cells. After administration of the photosensitizing agent, the target tissue is exposed to light using a variety of laser techniques. For example, a laser fiber may be placed through the channel of the endoscope, or a specialized modified diffuser may be placed via fluoroscopic guidance. Treatment for tumor cells occurs through selective retention of the photosensitizing agent and the selective delivery of light.

SUMMARY OF EVIDENCE

For individuals who have obstructing esophageal cancer who receive PDT as palliation, the evidence includes systematic reviews, randomized controlled trials (RCTs), and uncontrolled single-arm studies. Relevant outcomes are change in disease status, symptoms, quality of life, and treatment-related morbidity. A meta-analysis comparing PDT with neodymium-doped yttrium aluminum garnet laser suggested that improvements in dysphagia are similar, although estimates are imprecise. Compared with the neodymium-doped yttrium aluminum garnet laser, PDT is associated with a lower risk of perforation and a higher risk of adverse reactions to the light (e.g., photosensitivity). PDT plus argon plasma coagulation appears to prolong the time to recurrence of dysphagia as opposed to argon plasma coagulation alone. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have obstructing endobronchial lesions who receive PDT as palliation, the evidence includes RCTs and uncontrolled single-arm studies. Relevant outcomes are change in disease status, symptoms, quality of life, and treatment-related morbidity. Evidence from RCTs comparing PDT with neodymium-doped yttrium aluminum garnet laser has generally supported reductions in symptoms using PDT similar to those using a laser. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have early-stage non-small-cell lung cancer who are not candidates for surgery or radiotherapy who receive PDT, the evidence includes uncontrolled single-arm studies. Relevant outcomes are overall survival (OS), disease-specific survival, change in disease status, quality of life, and treatment-related morbidity. There are few patients with early-stage non-small-cell lung cancer who are not candidates for surgery or radiotherapy. While several treatment methods (e.g., laser, electrocautery, cryotherapy, brachytherapy) are available for this population, studies comparing the treatment methods are not available. Case series of PDT include be-

tween 21 and 95 patients and have reported complete response rates ranging from 72% to 100%. Given the small size of this potential population and the ineligibility for standard surgical treatment or radiotherapy, it is unlikely that stronger evidence will become available. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals with Barrett esophagus with high-grade dysplasia who receive PDT, the evidence includes 2 systematic reviews and 2 RCTs. Relevant outcomes are OS, disease-specific survival, change in disease status, quality of life, and treatment-related morbidity. One RCT compared PDT plus a proton pump inhibitor with a proton pump inhibitor alone and demonstrated higher response rates and lower risk of progression with cancer persisting during 5 years of follow-up for patients in the PDT plus proton pump inhibitor group. The results of the RCT also revealed that patients treated with PDT had significantly more complications, including a high rate of strictures. Another RCT compared PDT performed with different photosensitizers; results revealed that neither were valuable long-term treatments for dysplastic Barrett esophagus. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have unresectable cholangiocarcinoma who receive PDT plus stenting as palliation, the evidence includes systematic reviews, RCTs, and observational studies. Relevant outcomes are change in disease status, symptoms, quality of life, and treatment-related morbidity. Two small RCTs and several observational studies have found that PDT plus stenting is associated with the greater elimination of bile duct stenosis and improved survival benefit compared with stenting alone. One RCT comparing stenting plus chemotherapy and PDT with stenting plus chemotherapy without PDT reported longer progression-free survival, but not OS, with similar adverse event rates. Case series have suggested an improvement in the quality of life with PDT. The main complication of PDT in cholangiocarcinoma is cholangitis. Given the small size of this potential population, it is unlikely that stronger evidence will become available. The evidence is sufficient to determine that the technology results in an improvement in the net health outcome.

For individuals who have other malignancies (e.g., gynecologic, bladder, head and neck, brain, soft tissue) who receive PDT, the evidence includes controlled observational studies and uncontrolled single-arm studies. Relevant outcomes are OS, disease-specific survival, change in disease status, quality of life, and treatment-related morbidity. The published literature on PDT for these malignancies is generally comprised of small case series without comparator groups. The evidence is insufficient to determine that the technology results in an improvement in the net health outcome.

POLICY

One or more courses of photodynamic therapy may be considered **medically necessary** for the following oncologic applications:

- palliative treatment of obstructing esophageal cancer
- palliative treatment of obstructing endobronchial lesions
- treatment of early-stage non-small cell lung cancer in patients who are ineligible for surgery and radiotherapy
- treatment of high-grade dysplasia in Barrett esophagus
- palliative treatment of unresectable cholangiocarcinoma when used with stenting

Other oncologic applications of photodynamic therapy are **investigational** including, but not limited to, other malignancies and Barrett esophagus without associated high-grade dysplasia.

BACKGROUND

PHOTODYNAMIC THERAPY

Photodynamic therapy (PDT) has been investigated for use in a wide variety of tumors, including esophageal, lung, cholangiocarcinoma, prostate, bladder, breast, brain (administered intraoperatively), skin, and head and neck cancers. Barrett esophagus also has been treated with PDT.

Several photosensitizing agents have been used in PDT: porfimer sodium (Photofrin®), administered intravenously 48 hours before light exposure, and 5-aminolevulinic acid, administered orally 4 to 6 hours before the procedure. Aminolevulinic acid is metabolized to protoporphyrin IX, which is preferentially taken up by the mucosa. Clearance of porfimer occurs in a variety of normal tissues over 40 to 72 hours, but tumor cells retain porfimer for a longer period. Laser treatment of Barrett esophagus may be enhanced by the use of balloons containing a cylindrical diffusing fiber. The balloon compresses the mucosal folds of the esophagus, thus increasing the likelihood that the entire Barrett mucosa is exposed to light. All patients who receive porfimer become photosensitive and must avoid exposure of skin and eyes to direct sunlight or bright indoor light for 30 days.

REGULATORY STATUS

Labeled indications for porfimer sodium (Photofrin; Pinnacle Biologics)[1], as approved by the U.S. Food and Drug Administration (FDA), are as follows.

ESOPHAGEAL CANCER

- Palliation of patients with completely obstructing esophageal cancer, or of patients with partially obstructing esophageal cancer who, in the opinion of their physician, cannot be satisfactorily treated with neodymium-doped yttrium aluminum garnet laser therapy.

ENDOBRONCHIAL CANCER

- Reduction of obstruction and palliation of symptoms in patients with completely or partially obstructing endobronchial non-small-cell lung cancer
- Treatment of microinvasive endobronchial non-small-cell lung cancer in patients for whom surgery and radiotherapy are not indicated.

HIGH-GRADE DYSPLASIA IN BARRETT ESOPHAGUS

- Treatment of high-grade dysplasia in Barrett esophagus patients who do not undergo esophagectomy.

As of June 2018, oral 5-aminolevulinic acid has not received FDA approval as a photosensitizing agent for PDT. Topical 5-aminolevulinic acid, used for the treatment of actinic keratoses.

This protocol addresses only the non-dermatologic oncology applications of PDT and does not address its use in dermatologic applications, such as actinic keratosis and superficial basal cell cancer, or age-related macular degeneration. In addition, PDT should not be confused with extracorporeal photopheresis, which involves withdrawing blood from the patient, irradiating it with ultraviolet light, and then returning the blood to the patient. Extracorporeal photopheresis is addressed separately.

Services that are the subject of a clinical trial do not meet our Technology Assessment and Medically Necessary

Services Protocol criteria and are considered investigational. *For explanation of experimental and investigational, please refer to the Technology Assessment and Medically Necessary Services Protocol.*

It is expected that only appropriate and medically necessary services will be rendered. We reserve the right to conduct prepayment and postpayment reviews to assess the medical appropriateness of the above-referenced procedures. **Some of this protocol may not pertain to the patients you provide care to, as it may relate to products that are not available in your geographic area.**

REFERENCES

We are not responsible for the continuing viability of web site addresses that may be listed in any references below.

1. Pinnacle Biologics. Photofrin (porfimer sodium) Injection [prescribing information]. 2011; http://www.accessdata.fda.gov/drugsatfda_docs/label/2011/020451s020lbl.pdf. Accessed June 7, 2018.
2. Fayter D, Corbett M, Heirs M, et al. A systematic review of photodynamic therapy in the treatment of pre-cancerous skin conditions, Barrett's oesophagus and cancers of the biliary tract, brain, head and neck, lung, oesophagus and skin. Health Technol Assess. Jul 2010;14(37):1-288. PMID 20663420
3. Dai Y, Li C, Xie Y, et al. Interventions for dysphagia in oesophageal cancer. Cochrane Database Syst Rev. Oct 30 2014;(10):CD005048. PMID 25354795
4. Lightdale CJ, Heier SK, Marcon NE, et al. Photodynamic therapy with porfimer sodium versus thermal ablation therapy with Nd:YAG laser for palliation of esophageal cancer: a multicenter randomized trial. Gastrointest Endosc. Dec 1995;42(6):507-12. PMID 8674919
5. Heier SK, Rothman KA, Heier LM, et al. Photodynamic therapy for obstructing esophageal cancer: light dosimetry and randomized comparison with Nd:YAG laser therapy. Gastroenterology. Jul 1995;109(1):63-72. PMID 7541003
6. Rupinski M, Zagorowicz E, Regula J, et al. Randomized comparison of three palliative regimens including brachytherapy, photodynamic therapy, and APC in patients with malignant dysphagia (CONSORT 1a) (Revised II). Am J Gastroenterol. Sep 2011;106(9):1612-20. PMID 21670770
7. McCann P, Stafinski T, Wong C, et al. The safety and effectiveness of endoscopic and non-endoscopic approaches to the management of early esophageal cancer: a systematic review. Cancer Treat Rev. Feb 2011;37(1):11-62. PMID 20570442
8. Li LB, Xie JM, Zhang XN, et al. Retrospective study of photodynamic therapy vs. photodynamic therapy combined with chemotherapy and chemotherapy alone on advanced esophageal cancer. Photodiagnosis Photodyn Ther. Sep 2010;7(3):139-43. PMID 20728836
9. Akopov A, Rusanov A, Gerasin A, et al. Preoperative endobronchial photodynamic therapy improves resectability in initially irresectable (inoperable) locally advanced non small cell lung cancer. Photodiagnosis Photodyn Ther. Sep 2014;11(3):259-64. PMID 24704942
10. Diaz-Jimenez JP, Martinez-Ballarin JE, Llunell A, et al. Efficacy and safety of photodynamic therapy versus Nd-YAG laser resection in NSCLC with airway obstruction. Eur Respir J. Oct 1999;14(4):800-5. PMID 10573224
11. Kato H, Okunaka T, Shimatani H. Photodynamic therapy for early stage bronchogenic carcinoma. J Clin Laser Med Surg. Oct 1996;14(5):235-8. PMID 9612188
12. Endo C, Miyamoto A, Sakurada A, et al. Results of long-term follow-up of photodynamic therapy for roentgenographically occult bronchogenic squamous cell carcinoma. Chest. Aug 2009;136(2):369-375. PMID 19318660
13. Moghissi K, Dixon K, Thorpe JA, et al. Photodynamic therapy (PDT) in early central lung cancer: a treatment option for patients ineligible for surgical resection. Thorax. May 2007;62(5):391-5. PMID 17090572

14. Corti L, Toniolo L, Boso C, et al. Long-term survival of patients treated with photodynamic therapy for carcinoma in situ and early non-small-cell lung carcinoma. Lasers Surg Med. Jun 2007;39(5):394-402. PMID 17565719
15. Furukawa K, Kato H, Konaka C, et al. Locally recurrent central-type early stage lung cancer 1.0 cm in diameter after complete remission by photodynamic therapy. Chest. Nov 2005;128(5):3269-75. PMID 16306036
16. Cortese DA, Edell ES, Kinsey JH. Photodynamic therapy for early stage squamous cell carcinoma of the lung. Mayo Clin Proc. Jul 1997;72(7):595-602. PMID 9212759
17. Spechler SJ, Sharma P, Souza RF, et al. American Gastroenterological Association medical position statement on the management of Barrett's esophagus. Gastroenterology. Mar 2011;140(3):1084-91. PMID 21376940
18. Konda VJ, Waxman I. Endotherapy for Barrett's esophagus. Am J Gastroenterol. Jun 2012;107(6):827-33. PMID 22488078
19. Overholt BF, Wang KK, Burdick JS, et al. Five-year efficacy and safety of photodynamic therapy with Photofrin in Barrett's high-grade dysplasia. Gastrointest Endosc. Sep 2007;66(3):460-8. PMID 17643436
20. Dunn JM, Mackenzie GD, Banks MR, et al. A randomised controlled trial of ALA vs. Photofrin photodynamic therapy for high-grade dysplasia arising in Barrett's oesophagus. Lasers Med Sci. May 2013;28(3):707-15. PMID 22699800
21. Kohoutova D, Haidry R, Banks M, et al. Long-term outcomes of the randomized controlled trial comparing 5-aminolaevulinic acid and Photofrin photodynamic therapy for Barrett's oesophagus related neoplasia. Scand J Gastroenterol. May 2018;53(5):527-532. PMID 29161901
22. Gao F, Bai Y, Ma SR, et al. Systematic review: photodynamic therapy for unresectable cholangiocarcinoma. J Hepatobiliary Pancreat Sci. Mar 2010;17(2):125-31. PMID 19455276
23. Tomizawa Y, Tian J. Photodynamic therapy for unresectable cholangiocarcinoma. Dig Dis Sci. Feb 2012; 57(2):274-83. PMID 22057285
24. Lu Y, Liu L, Wu JC, et al. Efficacy and safety of photodynamic therapy for unresectable cholangiocarcinoma: A meta-analysis. Clin Res Hepatol Gastroenterol. Dec 2015;39(6):718-24. PMID 26070572
25. Ortner ME, Caca K, Berr F, et al. Successful photodynamic therapy for nonresectable cholangiocarcinoma: a randomized prospective study. Gastroenterology. Nov 2003;125(5):1355-63. PMID 14598251
26. Zoepf T, Jakobs R, Arnold JC, et al. Palliation of nonresectable bile duct cancer: improved survival after photodynamic therapy. Am J Gastroenterol. Nov 2005;100(11):2426-30. PMID 16279895
27. Hauge T, Hauge PW, Warloe T, et al. Randomised controlled trial of temoporfin photodynamic therapy plus chemotherapy in nonresectable biliary carcinoma--PCS Nordic study. Photodiagnosis Photodyn Ther. Mar 2016;13:330-333. PMID 26415549
28. Pereira SP, Aithal GP, Ragunath K, et al. Safety and long term efficacy of porfimer sodium photodynamic therapy in locally advanced biliary tract carcinoma. Photodiagnosis Photodyn Ther. Dec 2012;9(4):287-92. PMID 23200007
29. Shim CS, Cheon YK, Cha SW, et al. Prospective study of the effectiveness of percutaneous transhepatic photodynamic therapy for advanced bile duct cancer and the role of intraductal ultrasonography in response assessment. Endoscopy. May 2005;37(5):425-33. PMID 15844020
30. Harewood GC, Baron TH, Rumalla A, et al. Pilot study to assess patient outcomes following endoscopic application of photodynamic therapy for advanced cholangiocarcinoma. J Gastroenterol Hepatol. Mar 2005; 20(3):415-20. PMID 15740486
31. Berr F. Photodynamic therapy for cholangiocarcinoma. Semin Liver Dis. May 2004;24(2):177-87. PMID 15192790
32. Baron TH. Photodynamic therapy: standard of care for palliation of cholangiocarcinoma?. Clin Gastroenterol Hepatol. Mar 2008;6(3):266-7. PMID 18328433/
33. Godoy H, Vaddadi P, Cooper M, et al. Photodynamic therapy effectively palliates gynecologic malignancies. Eur J Gynaecol Oncol. 2013;34(4):300-2. PMID 24020133

34. Choi MC, Jung SG, Park H, et al. Fertility preservation via photodynamic therapy in young patients with early-stage uterine endometrial cancer: a long-term follow-up study. Int J Gynecol Cancer. May 2013;23(4):698-704. PMID 23478222
35. Choi MC, Jung SG, Park H, et al. Fertility preservation by photodynamic therapy combined with conization in young patients with early stage cervical cancer: a pilot study. Photodiagnosis Photodyn Ther. Sep 2014; 11(3): 420-5. PMID 24927981
36. Zhang W, Zhang A, Sun W, et al. Efficacy and safety of photodynamic therapy for cervical intraepithelial neoplasia and human papilloma virus infection: A systematic review and meta-analysis of randomized clinical trials. Medicine (Baltimore). May 2018;97(21):e10864. PMID 29794788
37. Tao XH, Guan Y, Shao D, et al. Efficacy and safety of photodynamic therapy for cervical intraepithelial neoplasia: a systemic review. Photodiagnosis Photodyn Ther. Jun 2014;11(2):104-12. PMID 24631593
38. Hillemanns P, Garcia F, Petry KU, et al. A randomized study of hexaminolevulinate photodynamic therapy in patients with cervical intraepithelial neoplasia 1/2. Am J Obstet Gynecol. Apr 2015;212(4):465.e1-7. PMID 25467012
39. Istomin YP, Lapzevich TP, Chalau VN, et al. Photodynamic therapy of cervical intraepithelial neoplasia grades II and III with Photolon. Photodiagnosis Photodyn Ther. Sep 2010;7(3):144-51. PMID 20728837
40. Soergel P, Dahl GF, Onsrud M, et al. Photodynamic therapy of cervical intraepithelial neoplasia 1-3 and human papilloma virus (HMV) infection with methylaminolevulinate and hexaminolevulinate--a double-blind, dose-finding study. Lasers Surg Med. Aug 2012;44(6):468-74. PMID 22693121
41. Winters U, Daayana S, Lear JT, et al. Clinical and immunologic results of a phase II trial of sequential imiquimod and photodynamic therapy for vulval intraepithelial neoplasia. Clin Cancer Res. Aug 15 2008; 14(16):5292-9. PMID 18698049
42. Zhang R, Wang L. Photodynamic therapy for treatment of usual-type vulvar intraepithelial neoplasia: a case report and literature review. J Int Med Res. Aug 2019;47(8):4019-4026. PMID 31364444
43. Bader MJ, Stepp H, Beyer W, et al. Photodynamic therapy of bladder cancer - a phase I study using hexaminolevulinate (HAL). Urol Oncol. Oct 2013;31(7):1178-83. PMID 22440147
44. Lee JY, Diaz RR, Cho KS, et al. Efficacy and safety of photodynamic therapy for recurrent, high grade non-muscle invasive bladder cancer refractory or intolerant to bacille Calmette-Guerin immunotherapy. J Urol. Oct 2013;190(4):1192-9. PMID 23648222
45. Gondivkar SM, Gadbail AR, Choudhary MG, et al. Photodynamic treatment outcomes of potentially-malignant lesions and malignancies of the head and neck region: A systematic review. J Investig Clin Dent. Feb 2018;9(1). PMID 28480637
46. de Visscher SA, Dijkstra PU, Tan IB, et al. mTHPC mediated photodynamic therapy (PDT) of squamous cell carcinoma in the head and neck: a systematic review. Oral Oncol. Mar 2013;49(3):192-210. PMID 23068024
47. Wildeman MA, Nyst HJ, Karakullukcu B, et al. Photodynamic therapy in the therapy for recurrent/persistent nasopharyngeal cancer. Head Neck Oncol. Dec 17 2009;1:40. PMID 20017928
48. Karakullukcu B, Stoker SD, Wildeman AP, et al. A matched cohort comparison of mTHPC-mediated photodynamic therapy and trans-oral surgery of early stage oral cavity squamous cell cancer. Eur Arch Otorhinolaryngol. Mar 2013;270(3):1093-7. PMID 22773192
49. Ahn PH, Quon H, O'Malley BW, et al. Toxicities and early outcomes in a phase 1 trial of photodynamic therapy for premalignant and early stage head and neck tumors. Oral Oncol. Apr 2016;55:37-42. PMID 26865261
50. Biel MA. Photodynamic therapy treatment of early oral and laryngeal cancers. Photochem Photobiol. Sep-Oct 2007;83(5):1063-8. PMID 17880501
51. Silbergleit AK, Somers ML, Schweitzer VG, et al. Vocal fold vibration after photofrin-mediated photodynamic therapy for treatment of early-stage laryngeal malignancies. J Voice. Nov 2013;27(6):762-4. PMID 24119638
52. Wildeman MA, Fles R, Herdini C, et al. Primary treatment results of Nasopharyngeal Carcinoma (NPC) in Yogyakarta, Indonesia. PLoS One. 2013;8(5):e63706. PMID 23675501

53. Durbec M, Cosmidis A, Fuchsmann C, et al. Efficacy and safety of photodynamic therapy with temoporfin in curative treatment of recurrent carcinoma of the oral cavity and oropharynx. Eur Arch Otorhinolaryngol. Mar 2013;270(4):1433-9. PMID 22927020
54. Rigual NR, Shafirstein G, Frustino J, et al. Adjuvant intraoperative photodynamic therapy in head and neck cancer. JAMA Otolaryngol Head Neck Surg. Jul 2013;139(7):706-11. PMID 23868427
55. Rigual NR, Thankappan K, Cooper M, et al. Photodynamic therapy for head and neck dysplasia and cancer. Arch Otolaryngol Head Neck Surg. Aug 2009;135(8):784-8. PMID 19687399
56. Schweitzer VG, Somers ML. PHOTOFRIN-mediated photodynamic therapy for treatment of early stage (Tis-T2N0M0) SqCCa of oral cavity and oropharynx. Lasers Surg Med. Jan 2010;42(1):1-8. PMID 20077493
57. Lambert A, Nees L, Nuyts S, et al. Photodynamic Therapy as an Alternative Therapeutic Tool in Functionally Inoperable Oral and Oropharyngeal Carcinoma: A Single Tertiary Center Retrospective Cohort Analysis. Front Oncol. 2021;11:626394. PMID 33747943
58. Muragaki Y, Akimoto J, Maruyama T, et al. Phase II clinical study on intraoperative photodynamic therapy with talaporfin sodium and semiconductor laser in patients with malignant brain tumors. J Neurosurg. Oct 2013;119(4):845-52. PMID 23952800
59. Aziz F, Telara S, Moseley H, et al. Photodynamic therapy adjuvant to surgery in metastatic carcinoma in brain. Photodiagnosis Photodyn Ther. Sep-Dec 2009;6(3-4):227-30. PMID 19932456
60. Nakamura T, Kusuzaki K, Matsubara T, et al. Long-term clinical outcome in patients with high-grade soft tissue sarcoma who were treated with surgical adjuvant therapy using acridine orange after intra-lesional or marginal resection. Photodiagnosis Photodyn Ther. Sep 2018;23:165-170. PMID 29885811
61. FNCLCC. The Free Dictionary by Farlex. https://acronyms.thefreedictionary.com/FNCLCC. Accessed May 21, 2019.
62. Matsubara T, Kusuzaki K, Matsumine A, et al. Can a less radical surgery using photodynamic therapy with acridine orange be equal to a wide-margin resection?. Clin Orthop Relat Res. Mar 2013;471(3):792-802. PMID 23008027
63. Matzi V, Maier A, Woltsche M, et al. Polyhematoporphyrin-mediated photodynamic therapy and decortication in palliation of malignant pleural mesothelioma: a clinical pilot study. Interact Cardiovasc Thorac Surg. Mar 2004;3(1):52-6. PMID 17670175
64. Lindenmann J, Matzi V, Neuboeck N, et al. Multimodal therapy of malignant pleural mesothelioma: is the replacement of radical surgery imminent?. Interact Cardiovasc Thorac Surg. Mar 2013;16(3):237-43. PMID 23171517
65. Friedberg JS, Simone CB, Culligan MJ, et al. Extended Pleurectomy-Decortication-Based Treatment for Advanced Stage Epithelial Mesothelioma Yielding a Median Survival of Nearly Three Years. Ann Thorac Surg. Mar 2017;103(3):912-919. PMID 27825687
66. Pereira S. Photodynamic therapy for pancreatic and biliary tract cancer: the United Kingdom experience. J Natl Compr Canc Netw. Oct 01 2012;10 Suppl 2:S48-51. PMID 23055216
67. Huggett MT, Jermyn M, Gillams A, et al. Phase I/II study of verteporfin photodynamic therapy in locally advanced pancreatic cancer. Br J Cancer. Apr 02 2014;110(7):1698-704. PMID 24569464
68. Bahng S, Yoo BC, Paik SW, et al. Photodynamic therapy for bile duct invasion of hepatocellular carcinoma. Photochem Photobiol Sci. Mar 2013;12(3):439-45. PMID 23175171
69. Vohra F, Al-Kheraif AA, Qadri T, et al. Efficacy of photodynamic therapy in the management of oral premalignant lesions. A systematic review. Photodiagnosis Photodyn Ther. Mar 2015;12(1):150-9. PMID 25315968
70. Wisnivesky JP, Yung RC, Mathur PN, et al. Diagnosis and treatment of bronchial intraepithelial neoplasia and early lung cancer of the central airways: Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. Chest. May 2013;143(5 Suppl):e263S-e277S. PMID 23649442

71. Shaheen NJ, Falk GW, Iyer PG, et al. ACG Clinical Guideline: Diagnosis and Management of Barrett's Esophagus. Am J Gastroenterol. Jan 2016;111(1):30-50; quiz 51. PMID 26526079
72. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Esophageal and esophagogastric junction cancer. Version 2.2021. https://www.nccn.org/professionals/physician_gls/pdf/esophageal.pdf. Accessed May 27, 2021.
73. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Hepatobiliary cancers. Version 2.2021. https://www.nccn.org/professionals/physician_gls/pdf/hepatobiliary.pdf. Accessed May 27, 2021.
74. National Comprehensive Cancer Network (NCCN). NCCN Clinical Practice Guidelines in Oncology: Non-small cell lung cancer. Version 4.2021. https://www.nccn.org/professionals/physician_gls/pdf/nscl.pdf. Accessed May 27, 2021.
75. National Institute for Health and Care Excellence. Photodynamic therapy for bile duct cancer [IPG134]. 2005; http://www.nice.org.uk/guidance/IPG134/Guidance/pdf. Accessed May 27, 2021.
76. National Institute for Health and Care Excellence. Photodynamic therapy for localised inoperable endobronchial cancer [IPG137]. 2005; http://www.nice.org.uk/guidance/ipg137. Accessed May 27, 2021.
77. National Institute for Health and Care Excellence. Photodynamic therapy for advanced bronchial carcinoma [IPG87]. 2004; http://guidance.nice.org.uk/IPG87/Guidance/pdf/English. Accessed May 27, 2021.
78. National Institute for Health and Care Excellence. Interstitial photodynamic therapy for malignant parotid tumours [IPG259]. 2008; http://www.nice.org.uk/nicemedia/pdf/IPG259Guidance.pdf. Accessed May 26, 2021.
79. National Institute for Health and Care Excellence. Photodynamic therapy for Barrett's oesophagus [IPG350]. 2010; http://www.nice.org.uk/guidance/ipg350. Accessed May 27, 2021.
80. National Institute for Health and Care Excellence. Photodynamic therapy for brain tumours [IPG290]. 2009; http://www.nice.org.uk/nicemedia/pdf/IPG290Guidance.pdf. Accessed May 30, 2021.