

7.01.54 Transmyocardial Revascularization			
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Policy Statement

Transmyocardial laser revascularization may be considered **medically necessary** for patients with class III or IV angina, who are not candidates for coronary artery bypass graft (CABG) surgery or percutaneous transluminal coronary angioplasty surgery, who meet **all** of the following criteria:

- Presence of class III or IV angina refractory to medical management
- Documentation of reversible ischemia
- Left ventricular ejection fraction greater than 30%
- No evidence of recent myocardial infarction or unstable angina within the last 21 days
- No severe comorbid illness such as chronic obstructive pulmonary disease

Transmyocardial laser revascularization may be considered **medically necessary** as an adjunct to coronary artery bypass graft (CABG) in those patients with documented areas of ischemic myocardium that are not amenable to surgical revascularization.

Transmyocardial laser revascularization is considered **investigational** for all other indications not meeting the above criteria.

Percutaneous transmyocardial laser revascularization is considered **investigational**.

Policy Guidelines

Coding

The following CPT code is used for transmyocardial laser revascularization performed as a **stand-alone** procedure:

- **33140:** Transmyocardial laser revascularization, by thoracotomy; (separate procedure)

The following CPT code is an add-on code and is to be used as an **adjunct** to other open cardiac procedures:

- **33141:** Transmyocardial laser revascularization, by thoracotomy; performed at the time of other open cardiac procedure(s) (List separately in addition to code for primary procedure)

CPT Code 33141 (above) will be used in conjunction with the following CPT codes:

- 33390-33391
- 33404-33496
- 33510-33536
- 33542

Description

Transmyocardial revascularization (TMR), also known as transmyocardial laser revascularization, is a surgical technique that attempts to improve blood flow to ischemic heart muscles by creating direct channels from the left ventricle into the myocardium. TMR may be performed via a thoracotomy or percutaneous TMR (PTMR).

Related Policies

- N/A

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

In 1998, the Heart Laser™ was approved by the FDA through the premarket approval process for the treatment of patients with stable class III or IV angina refractory to medical treatment and secondary to objectively demonstrated coronary artery atherosclerosis not amenable to direct coronary revascularization. In 1999, the Eclipse TMR 2000™ was approved by the FDA through the premarket approval process for similar indications. Neither device is approved for use as an adjunct to coronary artery bypass surgery. Use of either device for this purpose would be considered an off-label indication. FDA product code: MNO.

Rationale

Background

Coronary Ischemia

Two populations of patients are candidates for transmyocardial revascularization (TMR): (1) those with ischemic heart disease and angina pectoris and (2) those undergoing percutaneous coronary intervention or coronary artery bypass surgery who do not achieve complete revascularization.¹

Transmyocardial Revascularization

TMR is performed via a thoracotomy, with the patient under general anesthesia. Cardiopulmonary bypass is not required. A laser probe is placed on the surface of the myocardium, and while the heart is in diastole, the laser is discharged to create a channel through the myocardium into the left ventricle. Less invasive approaches to TMR are also being studied, including port access procedures using novel robotic and thoracoscopic techniques.

Percutaneous TMR

TMR can also be performed percutaneously (PTMR). PTMR (also called percutaneous myocardial channeling) is a catheter-based system using holmium: YAG laser revascularization under fluoroscopic guidance. It is performed in Europe but is not currently approved by the U.S. Food and Drug Administration (FDA). PTMR is performed by interventional cardiologists who create myocardial channels with lasers positioned at the endocardial surface inside the left ventricle. Although less invasive than TMR, PTMR has potential disadvantages. To minimize the risks of cardiac tamponade, a potentially fatal condition in which the pericardium fills with blood, the myocardial channels created by PTMR are not as deep as those made by TMR. Also, positioning the laser under fluoroscopic guidance is less precise than the direct visual control of TMR. Less invasive (e.g., robotic) techniques for use of this procedure are also being studied.

Other potential applications of TMR include its use as an adjunct to stem cell-based therapy.

Literature Review

Evidence reviews assess the clinical evidence to determine whether the use of technology improves the net health outcome. Broadly defined, health outcomes are the length of life, quality of life (QOL), and the ability to function- including benefits and harms. Every clinical condition has specific outcomes that are important to patients and managing the course of that condition. Validated outcome measures are necessary to ascertain whether a condition improves or worsens; and whether the magnitude of that change is clinically significant. The net health outcome is a balance of benefits and harms.

To assess whether the evidence is sufficient to draw conclusions about the net health outcome of technology, two domains are examined: the relevance, and quality and credibility. To be relevant, studies must represent one or more intended clinical use of the technology in the intended population and compare an effective and appropriate alternative at a comparable intensity. For some conditions, the alternative will be supportive care or surveillance. The quality and credibility of the evidence depend on study design and conduct, minimizing bias and confounding that can generate incorrect findings. The randomized controlled trial (RCT) is preferred to assess efficacy; however, in some circumstances, nonrandomized studies may be adequate. RCTs are rarely large enough or long enough to capture less common adverse events and long-term effects. Other types of studies can be used for these purposes and to assess generalizability to broader clinical populations and settings of clinical practice.

Clinical Context and Test Purpose

The purpose of transmyocardial vascularization (TMR) for the treatment of angina refractory to medical therapy or coronary artery disease (CAD) undergoing coronary artery bypass graft (CABG) with areas of the myocardium that cannot be revascularized is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: does the use of TMR for angina refractory to medical therapy or for the treatment of CAD undergoing CABG with areas of the myocardium that cannot be revascularized improve net health outcomes?

The following PICOTS were used to select literature to inform this review.

Patients

The relevant population of interest are patients with angina refractory to medical therapy or CAD undergoing CABG with areas of the myocardium that cannot be revascularized.

Interventions

The therapy being considered is TMR performed via a thoracotomy, with the patient under general anesthesia. Cardiopulmonary bypass is not required.

Comparators

The following therapies and practices are currently being used; continued medical therapy or CABG without TMR.

Outcomes

The general outcomes of interest disease-specific survival (DSS), symptoms, functional outcomes, health status measures, QOL, and treatment-related mortality (TRM) and treatment-related morbidity.

Timing

Patients who receive TMR would require acute post-procedure follow-up and at least 6-12 months to ascertain in cardiac functional status.

Setting

Patients receive TMR in a tertiary care setting.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- a. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- b. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- c. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

Studies with duplicative or overlapping populations were excluded.

Open Transmyocardial Revascularization

This portion of the evidence review was informed in part on 2 Blue Cross Blue Shield Association Technology Evaluation Center (TEC) Assessments, a 1998 Assessment², that focused on the use of open TMR (or transmyocardial laser revascularization) as an alternative to inoperable CAD, and a 2001 Assessment³, that focused on its use as an adjunct to CABG.

TMR in Patients with Inoperable CAD

Systematic Reviews

The 1998 TEC Assessment offered the following observations and conclusions on the available RCTs (described in detail in the Randomized Controlled Trials section)²:

"Results of randomized controlled trials suggested that patients with refractory, nonoperable class III or IV angina respond well to TMR. Specifically, results of 1 trial reported that 86% of those assigned TMR were in angina class I or II at 12 months of follow-up compared with 30% in the medical management group. In addition, a decline in the number of hospital admissions favored TMR. The data on morbidity and mortality were inconclusive but favored an equivalent or lower mortality rate with TMR."

Patients enrolled in these trials were carefully selected to maximize the benefit of TMR. All patients had class III or IV angina that was refractory to medical management and objective evidence of reversible ischemia on exercise testing or perfusion scanning. In addition, a variety of exclusion criteria were used to minimize the risk of open thoracotomy. These exclusion criteria varied slightly across the trials and have evolved in response to recognition of high-risk subgroups among the initial RCTs. In general, patients with recent unstable angina or myocardial infarction (MI), an ejection fraction of less than 30%, and severe comorbid illness were excluded from these trials.

A 2009 Cochrane review included RCTs assessing TMR in patients with grade III or IV angina who were excluded from other revascularization procedures.⁴ In the 7 studies of TMR that met inclusion criteria, while the improvement in angina was greater in treated patients than in control patients (30-day mortality was greater in the TMR group), 1-year mortality was similar between the groups. Reviewers concluded there was insufficient evidence to determine whether the clinical benefits of TMR outweighed the potential risks. This Cochrane review was updated in 2015 with a search of the literature through 2014.⁵ Reviewers included the same 7 studies of TMR (total n=1137 participants; 559 randomized to TMR). While angina classes improved by at least 2 classes in the TMR group (43.8% vs 14.8%; odds ratio, 4.63; 95% confidence interval [CI], 3.43 to 6.25), there were no significant differences in 30-day or in 1-year mortality in the intention-to-treat analysis between groups. However, in the as-treated analysis, 30-day mortality was higher in the TMR group due to higher mortality in individuals who crossed over to TMR treatment (pooled odds ratio=3.76; 95% CI, 1.63 to 8.66). Reviewers concluded: "This review shows that risks associated with TMLR [transmyocardial laser revascularization] outweigh the potential clinical benefits."

Randomized Controlled Trials

The three unpublished RCTs cited in the original TEC Assessment² have since been published.^{6,7,8} Since then, three other RCTs with similar designs have been published. Schofield et al (1999) randomized 188 patients with refractory angina to TMR via a high-energy CO₂ laser or medical management alone.⁹ At 12 months, 25% of the patients assigned to TMR improved by at least 2 Canadian Cardiovascular Society (CCS) anginal classes, compared with only 4% in the medical management group ($p<0.001$). There were no statistically significant differences in exercise duration, 12-minute walk distance, or radionucleotide perfusion. The number of patients improving by two or more angina classes was much lower than in the three previously cited RCTs. There was 5% perioperative mortality for the TMR group, and that group had a lower OS rate at 12 months (89%) than the medical management group (96%; $p=0.14$), but this difference was not statistically significant.

Aaberge et al (2000) compared 50 patients randomized to pulsed CO₂ laser TMR with 50 patients randomized to medical management.¹⁰ At 12 months, 39% of the TMR patients improved by at least 2 New York Heart Association anginal classes vs 0% in the medical management group (both the New York Heart Association and CCS contain 4 anginal classes, but class 1 in the New York Heart Association system permits no symptoms, potentially making a 2-class improvement more difficult to achieve). Exercise capacity did not improve using TMR. There was a 4% perioperative mortality rate with lower OS at 12 months in the TMR group (88% vs 92%, respectively), but this difference was not statistically significant.

Jones et al (1999) randomized 86 patients with refractory angina to TMR with a holmium: YAG laser or to medical management.¹¹ At 12 months, the TMR group had an average improvement of slightly more than 2 CCS anginal classes over the medical management group. The TMR group also had a significant improvement in exercise duration (490 seconds vs 294 seconds, respectively, $p<0.001$). There was only one perioperative death in the TMR group, but OS data were not provided.

These three studies differ from the original three trials in that fewer patients improved by at least two anginal classes, suggesting that the magnitude of benefit may be lower than in the first three trials. These trials did not provide conclusive evidence on whether TMR improves survival or exercise capacity. Patient selection criteria based on the data are as follows:

- Patients with class III or IV angina refractory to medical management
- Documentation of reversible ischemia
- Left ventricular ejection fraction greater than 30%
- No evidence of recent MI or unstable angina within the last 21 days
- No severe comorbid illness such as chronic obstructive pulmonary disease.

Observational Studies

Peterson et al (2003) reported on utilization and outcomes for TMR from registry data of 173 hospitals participating in the Society for Thoracic Surgeons National Cardiac Database.¹² The registry included 661 patients who underwent TMR alone for refractory angina.^{12,13} The study by Peterson et al (2003) reported that many patients undergoing TMR in clinical practice differed from those in the randomized trials, especially in regard to the presence of high-risk factors (e.g., unstable angina, recent MI).¹³ Patients with unstable angina undergoing TMR had a 30-day mortality that was almost double that of patients without unstable angina (8.3% vs 4.3%, respectively, $p<0.05$), while patients with MI in the last 21 days had a mortality risk that was more than double that of patients without recent MI (13.0% vs 5.4%, respectively, $p<0.05$). Finally, Allen et al (2004)¹⁴ reported on the 5-year results of their 1999 trial.⁷ At 5 years, the significant anginal relief observed 12 months after TMR alone was sustained long-term and continued to be superior to that observed for patients on continued medical management alone.

Section Summary: TMR in Patients with Inoperable CAD

For individuals with severe angina refractory to medical treatment who are not candidates for surgical revascularization, RCTs comparing TMR with medical therapy have demonstrated

improvements in angina symptoms. The available study designs raise some concern that the effect seen could be related to placebo effects. However, for patients without other options, TMR may be an option.

Open TMR as an Adjunct to CABG

The 2001 TEC Assessment offered the following observations and conclusions about 2 randomized, single-blind trials that compared outcomes of patients who underwent CABG alone with CABG plus TMR³:

- While the smaller of the 2 trials, enrolling only 42 patients, showed a trend toward improved perioperative mortality associated with TMR, this outcome was statistically significant in the second larger trial, enrolling 266 patients. In the larger trial, perioperative mortality was 7.5% in the control group and 1.5% in the TMR group.
- The scientific basis of the improvement in perioperative mortality is unknown, yet the randomized trial was well-designed and conducted at multiple institutions, which supported the conclusions.
- There was no significant improvement in subjective symptoms and exercise tolerance, which was the inverse of prior findings evaluating TMR as sole therapy (see above).

Campbell et al (2008) conducted a systematic review of TMR and percutaneous TMR (PTMR) for refractory angina pectoris as part of the development of guidelines from the National Institute of Health and Care Excellence.¹⁵ Reviewers evaluated 16 RCTs (10 TMR, 6 PTMR) and 13 nonrandomized studies (8 TMR, 5 PTMR); they concluded TMR and PTMR were not effective in treating refractory angina and did not improve objective measures of MI (i.e., myocardial perfusion tests and left ventricular ejection fraction) or 12-month survival. While subjective, patient-reported outcomes showed some improvement with TMR and PTMR, reviewers noted improvements in angina symptoms and exercise tolerance were lost or reduced when blinding of treatment occurred. Reviewers found the risks of mortality and adverse events raised safety concerns. Additionally, reviewers noted most studies were conducted in the United States on male patients and, therefore, evidence on outcomes lacks application to wider populations.

A meta-analysis of 7 randomized trials by Liao et al (2005; total n=1053 patients) concluded, at 1-year follow-up, that TMR produced a significant improvement in angina class but no improvement in survival.¹⁶

Section Summary: TMR as an Adjunct to CABG

Similar to the case of TMR as a stand-alone treatment, some trials of TMR as an adjunct to CABG have shown improvements in angina symptoms, although results are mixed.

Percutaneous Transmyocardial Revascularization

Clinical Context and Test Purpose

The purpose of PTMR for the treatment of angina refractory to medical therapy is to provide a treatment option that is an alternative to or an improvement on existing therapies.

The question addressed in this evidence review is: does the use of PTMR for angina refractory to medical therapy improve net health outcomes?

The following PICOTS were used to select literature to inform this review.

Patients

The relevant population of interest are patients with angina refractory to medical therapy.

Interventions

The therapy being considered is PTMR. Cardiopulmonary bypass is not required.

Comparators

The following therapies and practices are currently being used; continued medical therapy or CABG without TMR.

Outcomes

The general outcomes of interest DSS, symptoms, functional outcomes, health status measures, QOL, and TRM and treatment-related morbidity.

Timing

Patients who receive PTMR would require acute post-procedure follow-up and at least 6-12 months to ascertain in cardiac functional status.

Setting

Patients receive PTMR in a tertiary care setting.

Study Selection Criteria

Methodologically credible studies were selected using the following principles:

- d. To assess efficacy outcomes, comparative controlled prospective trials were sought, with a preference for RCTs;
- e. In the absence of such trials, comparative observational studies were sought, with a preference for prospective studies.
- f. To assess long-term outcomes and adverse events, single-arm studies that capture longer periods of follow-up and/or larger populations were sought.

Studies with duplicative or overlapping populations were excluded.

Although PTMR was designed as a less invasive alternative to TMR, no studies have directly compared the two procedures. Differences between PTMR and TMR outlined here require that they are considered as distinct entities.

Systematic Reviews

For the 1998 TEC Assessment,² no outcomes data on PTMR were available, although 2003 observational data suggested the symptomatic benefit of PTMR approached that seen with TMR.¹² As noted, in a systematic review, Campbell et al (2008) concluded PTMR was not an effective treatment for refractory angina pectoris.¹⁵

A meta-analysis by McGillion et al (2010) evaluated 7 RCTs comparing PTMR with maximally tolerated antianginal therapy management.¹⁷ A total of 1213 patients with CCS class III or IV angina refractory to optimal medical management were included in the trials analyzed. Exclusion criteria included recent MI, aortic stenosis, mechanical aortic valve, peripheral vascular disease precluding catheter insertion, left ventricular ejection fraction less than 25% to 30%, and myocardial wall thickness in laser-targeted areas of less than 8 to 9 mm. All patients randomized to PTMR groups in the trials received low-dose holmium: YAG lasers except for one arm of one trial, which used high-dose holmium: YAG laser. The high-dose laser arm was excluded from the primary analysis. Maximally tolerated antianginal therapy was not changed in any treatment group across the trials.

Data on 12-month outcomes from 5 of the trials were analyzed and data from 3 trials demonstrated that PTMR significantly reduced angina symptoms by at least 2 CCS classes (pooled odds ratio=2.13; 95% CI, 1.22 to 3.73). PTMR also significantly improved self-reported, health-related QOL, as measured by the Seattle Angina Questionnaire. For angina frequency, the standardized mean difference was 0.29 (95% CI, 0.05 to 0.52); for disease perception, the standardized mean difference was 0.37 (95% CI, 0.14 to 0.61); and for physical limitations, it was 0.29 (95% CI, 0.05 to 0.53) (n=2 studies). Significant differences were not found for patient-reported angina stability, treatment satisfaction, exercise duration, or all-cause mortality. In the only trial using blinded outcomes assessment (the phase 2 DMR In Regeneration of

Endomyocardial Channels Trial, reported by Leon et al [2005]), there were no significant differences between treatment and control groups in improvement in angina class, change in exercise duration or improvement in QOL.¹⁸

This meta-analysis suggested that PTMR may have benefits similar to open TMR, but conclusions were limited. Although seven trials were included in the review, results for each outcome were based on only two or three studies. The findings of outcome benefits on combined analysis were not robust, because the addition of a third treatment arm from one trial eliminated the significant findings. Sensitivity analysis was not performed by study quality, the presence of blinding, the presence of a sham placebo, or trial design measures that might have helped determine whether group differences reported in some trials were due to a treatment effect or a placebo/nonspecific effect. Reviewers identified a need for further studies to evaluate adverse events, disease-specific mortality, laser dosages, and underlying mechanisms of PTMR.

Randomized Controlled Trials

The following are examples of RCTs included in the McGillion et al (2010) meta-analysis¹⁷ (previously discussed), which compared PTMR with medical management. In the Potential Angina Class Improvement From Intramyocardial Channels trial, Oesterle et al (2000) compared PTMR (n=110) with medical management (n=111) in patients with refractory angina.¹⁹ Several patients in the PTMR group (n=10) and the medical management group (n=14) received percutaneous transluminal coronary angioplasty, CABG, or TMR within the 12-month follow-up period. When these patients were included in a 12-month analysis, 46% in the PTMR group improved by at least 2 CCS anginal classes compared with 11% in the medical management group. However, a subsequent masked assessment of anginal scores revealed that 28% of the improvement was attributable to investigator bias. When patients who received an additional procedure were excluded, there was still an 82.5-second improvement in exercise duration in the PTMR group over the medical management group. There were more deaths at 12 months in the PTMR group, but the difference was not statistically significant (8 vs 3, p=0.21).

In the second published RCT, Stone et al (2002) studied 141 patients with refractory angina and 1 or more chronic total occlusions in territories with reversible ischemia.²⁰ This trial group was derived from a larger group of patients in whom percutaneous transluminal coronary angioplasty of a chronic total occlusion was attempted. If percutaneous transluminal coronary angioplasty was not possible, patients were immediately randomized to PTMR (n=71) or to a sham PTMR procedure followed by medical management (n=70). At 6 months, 49% of the patients assigned to PTMR improved by at least 2 CCS classes vs 37% in the sham group. This difference was not statistically significant (p=0.33). There was a small increase in exercise duration in the PTMR group (64 seconds) over the sham group (52 seconds) that was also not statistically significant (p=0.73). There was no difference in mortality at 6 months between groups (8.6% vs 8.8%, p=0.91). The trialists concluded that the similar degree of benefit in the sham group compared with the PTMR group suggested that improvement from PTMR might have been largely due to a placebo effect.

Section Summary: PTMR

RCTs of PTMR have shown some improvements in refractory angina symptoms, but some trial analyses have suggested that those results may have been due to the placebo effect.

Summary of Evidence

For individuals who have class III or IV angina refractory to medical treatment who receive TMR, the evidence includes several RCTs. The relevant outcomes are DSS, symptoms, functional outcomes, health status measures, QOL, and TRM and treatment-related morbidity. The available RCTs have demonstrated that TMR may provide significant improvements in angina symptoms compared with optimal medical management, but not in survival outcomes or other objective outcomes. The unblinded design of the RCTs with subjective outcomes raises concern about bias. In addition, all of the studies of TMR were conducted in an era prior to the availability of drug-eluting stents, and some were notable for unexpectedly high mortality rates in the

control groups. Although studies have not shown improvements in survival or significant increases in exercise duration, the improvement in symptoms represents a health benefit for patients with class III or IV angina who are not candidates for revascularization, who are refractory to medical management, who have reversible ischemia, and who have a left ventricular ejection fraction greater than 30%. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have CAD and are undergoing CABG with documented areas of ischemic myocardium that cannot be surgically revascularized who receive TMR as adjunctive treatment, the evidence includes meta-analyses of RCTs. The relevant outcomes are OS, DSS, symptoms, morbid events, functional outcomes, health status measures, QOL, hospitalizations, TRM, and treatment-related morbidity. Meta-analyses of these RCTs have reported an improvement in angina, but no improvement in mortality or other relevant outcomes. Similar to TMR as a stand-alone procedure, the unblinded design of the RCTs with subjective outcomes raises concern about bias, but the improvement suggests a health benefit to this patient population. The evidence is sufficient to determine that the technology results in a meaningful improvement in the net health outcome.

For individuals who have class III or IV angina refractory to medical treatment who receive PTMR, the evidence includes a number of RCTs. The relevant outcomes are DSS, symptoms, functional outcomes, health status measures, QOL, TRM and treatment-related morbidity. Although PTMR is less invasive than TMR and some studies have shown improvements in angina symptoms and health-related QOL, the available evidence is less robust in showing whether PTMR improves the net health outcome. Additionally, no U.S. Food and Drug Administration–approved PTMR devices are available. The evidence is insufficient to determine the effects of technology on health outcomes.

Supplemental Information

Practice Guidelines and Position Statements

American College of Cardiology Foundation et al

In 2012, guidelines for stable ischemic heart disease were developed by the American College of Cardiology Foundation and 6 other cardiovascular medical associations.²¹ As an alternative therapy for “relief of symptoms in patients with refractory angina... transmyocardial revascularization (TMR) may be considered for relief of refractory angina in patients with SIHD” (Class IIb recommendation, level of evidence B; benefit greater than risk, evidence less well-established).

These guidelines indicated TMR may be considered as an alternative therapy for refractory angina in patients with stable ischemic heart disease (class IIb, level of evidence B: benefit greater than risk, evidence less well-established).

The American College of Cardiology Foundation and the American Heart Association (2011) published guidelines for coronary artery bypass surgery²² (with the Society of Thoracic Surgeons) and percutaneous artery intervention (with the Society for Cardiovascular Angiography and Interventions).²³ These guidelines both indicated that TMR may be performed as an adjunct to coronary artery bypass surgery on viable ischemic myocardium that is perfused by arteries not amenable to grafting (class IIb, level of evidence B: benefit greater than risk, evidence less well-established).

National Institute for Health and Care Excellence

The National Institute for Health and Care Excellence (2009) issued guidance on TMR²⁵, and percutaneous TMR²⁶, based on the 2008 systematic review by Campbell et al (noted earlier).¹⁵ The guidance on TMR stated: “Current evidence on transmyocardial laser revascularization for refractory angina pectoris shows no efficacy, based on objective measurements of myocardial function and survival. Current evidence on safety suggests that

the procedure may pose unacceptable risk. Therefore, this procedure should not be used.” The 2009 guidance for percutaneous TMR stated: “Current evidence on percutaneous laser revascularization for refractory angina pectoris shows no efficacy and suggests that the procedure may pose unacceptable safety risks.”

U.S. Preventive Services Task Force Recommendations

Not applicable.

Medicare National Coverage

The Centers for Medicare and Medicare Services²⁷:

“cover TMR as a late or last resort for patients with severe (Canadian Cardiovascular Society, classification Classes III or IV) angina (stable or unstable), which has been found refractory to standard medical therapy, including drug therapy at the maximum tolerated or maximum safe dosages. In addition, the angina symptoms must be caused by areas of the heart not amenable to surgical therapies such as percutaneous transluminal coronary angioplasty, stenting, coronary atherectomy, or coronary bypass. Coverage is further limited to those uses of the laser to perform the procedures that have been approved by the Food and Drug Administration for the purpose for which they are being used.

Patients would have to meet the following additional selection guidelines:

1. An ejection fraction of 25% or greater;
2. Have areas of viable ischemic myocardium (as demonstrated by diagnostic study) that are not capable of being revascularized by direct coronary intervention; and
3. Have been stabilized, or have had maximal efforts to stabilize acute conditions such as severe ventricular arrhythmias, decompensated congestive heart failure, or acute myocardial infarction.”

Ongoing and Unpublished Clinical Trials

Some currently unpublished trials that might influence this review are listed in Table 1.

Table 1. Summary of Key Trials

NCT No.	Trial Name	Planned Enrollment	Completion Date
Unpublished			
NCT01827319 ^a	A Multi-Center Single Arm Observational Registry of the Cardiogenesis Holmium: YAG Laser System Transmyocardial Revascularization for Angina Reduction	1000 Completed enrollment 203	Jun 2015 (completed)
	(There is an agreement between Principal Investigators and the Sponsor [or its agents] that restricts the PI's rights to discuss or publish trial results after the trial is completed.)		

NCT: national clinical trial.

^a Denotes industry-sponsored or cosponsored trial.

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Documentation for Clinical Review

Please provide the following documentation (if/when requested):

- History and physical and/or consultation notes including:
 - Clinical findings (i.e., pertinent symptoms and duration)
 - Comorbidities
 - Activity and functional limitations
 - Family history if applicable
 - Reason for procedure/test/device, when applicable
 - Pertinent past procedural and surgical history
 - Past and present diagnostic testing and results
 - Prior conservative treatments, duration, and response
 - Treatment plan (i.e., surgical intervention)
- Consultation and medical clearance report(s), when applicable
- Radiology report(s) and interpretation (i.e., MRI, CT, discogram)
- Laboratory results
- Other pertinent multidisciplinary notes/reports: (e.g., psychological or psychiatric evaluation, physical therapy, multidisciplinary pain management) when applicable

Post Service

- Results/reports of tests performed
- 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 codes 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.

Type	Code	Description
CPT®	33140	Transmyocardial laser revascularization, by thoracotomy; (separate procedure)
	33141	Transmyocardial laser revascularization, by thoracotomy; performed at the time of other open cardiac procedure(s) (List separately in addition to code for primary procedure)
	33390	Valvuloplasty, aortic valve, open, with cardiopulmonary bypass; simple (i.e., valvotomy, debridement, debulking, and/or simple commissural resuspension)
	33391	Valvuloplasty, aortic valve, open, with cardiopulmonary bypass; complex (e.g., leaflet extension, leaflet resection, leaflet reconstruction, or annuloplasty)
	33404	Construction of apical-aortic conduit
	33405	Replacement, aortic valve, open, with cardiopulmonary bypass; with prosthetic valve other than homograft or stentless valve
	33406	Replacement, aortic valve, open, with cardiopulmonary bypass; with allograft valve (freehand)
	33410	Replacement, aortic valve, open, with cardiopulmonary bypass; with stentless tissue valve
	33411	Replacement, aortic valve; with aortic annulus enlargement, noncoronary sinus
	33412	Replacement, aortic valve; with transventricular aortic annulus enlargement (Konno procedure)
	33413	Replacement, aortic valve; by translocation of autologous pulmonary valve with allograft replacement of pulmonary valve (Ross procedure)
	33414	Repair of left ventricular outflow tract obstruction by patch enlargement of the outflow tract
	33415	Resection or incision of subvalvular tissue for discrete subvalvular aortic stenosis
	33416	Ventriculomyotomy (-myectomy) for idiopathic hypertrophic subaortic stenosis (e.g., asymmetric septal hypertrophy)
	33417	Aortoplasty (gusset) for supravulvar stenosis
	33418	Transcatheter mitral valve repair, percutaneous approach, including transseptal puncture when performed; initial prosthesis
	33419	Transcatheter mitral valve repair, percutaneous approach, including transseptal puncture when performed; additional prosthesis(es) during same session (List separately in addition to code for primary procedure)
	33420	Valvotomy, mitral valve; closed heart

Type	Code	Description
	33422	Valvotomy, mitral valve; open heart, with cardiopulmonary bypass
	33425	Valvuloplasty, mitral valve, with cardiopulmonary bypass
	33426	Valvuloplasty, mitral valve, with cardiopulmonary bypass; with prosthetic ring
	33427	Valvuloplasty, mitral valve, with cardiopulmonary bypass; radical reconstruction, with or without ring
	33430	Replacement, mitral valve, with cardiopulmonary bypass
	33440	Replacement, aortic valve; by translocation of autologous pulmonary valve and transventricular aortic annulus enlargement of the left ventricular outflow tract with valved conduit replacement of pulmonary valve (Ross-Konno procedure) (Code effective 1/1/2019)
	33460	Valvectomy, tricuspid valve, with cardiopulmonary bypass
	33463	Valvuloplasty, tricuspid valve; without ring insertion
	33464	Valvuloplasty, tricuspid valve; with ring insertion
	33465	Replacement, tricuspid valve, with cardiopulmonary bypass
	33468	Tricuspid valve repositioning and plication for Ebstein anomaly
	33470	Valvotomy, pulmonary valve, closed heart; transventricular
	33471	Valvotomy, pulmonary valve, closed heart; via pulmonary artery
	33474	Valvotomy, pulmonary valve, open heart, with cardiopulmonary bypass
	33475	Replacement, pulmonary valve
	33476	Right ventricular resection for infundibular stenosis, with or without commissurotomy
	33477	Transcatheter pulmonary valve implantation, percutaneous approach, including pre-stenting of the valve delivery site, when performed
	33478	Outflow tract augmentation (gusset), with or without commissurotomy or infundibular resection
	33496	Repair of non-structural prosthetic valve dysfunction with cardiopulmonary bypass (separate procedure)
	33510	Coronary artery bypass, vein only; single coronary venous graft
	33511	Coronary artery bypass, vein only; 2 coronary venous grafts
	33512	Coronary artery bypass, vein only; 3 coronary venous grafts
	33513	Coronary artery bypass, vein only; 4 coronary venous grafts
	33514	Coronary artery bypass, vein only; 5 coronary venous grafts
	33516	Coronary artery bypass, vein only; 6 or more coronary venous grafts
	33517	Coronary artery bypass, using venous graft(s) and arterial graft(s); single vein graft (List separately in addition to code for primary procedure)
	33518	Coronary artery bypass, using venous graft(s) and arterial graft(s); 2 venous grafts (List separately in addition to code for primary procedure)
	33519	Coronary artery bypass, using venous graft(s) and arterial graft(s); 3 venous grafts (List separately in addition to code for primary procedure)
	33521	Coronary artery bypass, using venous graft(s) and arterial graft(s); 4 venous grafts (List separately in addition to code for primary procedure)
	33522	Coronary artery bypass, using venous graft(s) and arterial graft(s); 5 venous grafts (List separately in addition to code for primary procedure)

Type	Code	Description
	33523	Coronary artery bypass, using venous graft(s) and arterial graft(s); 6 or more venous grafts (List separately in addition to code for primary procedure)
	33530	Reoperation, coronary artery bypass procedure or valve procedure, more than 1 month after original operation (List separately in addition to code for primary procedure)
	33533	Coronary artery bypass, using arterial graft(s); single arterial graft
	33534	Coronary artery bypass, using arterial graft(s); 2 coronary arterial grafts
	33535	Coronary artery bypass, using arterial graft(s); 3 coronary arterial grafts
	33536	Coronary artery bypass, using arterial graft(s); 4 or more coronary arterial grafts
	33542	Myocardial resection (e.g., ventricular aneurysmectomy)
HCPCS	None	
ICD-10 Procedure	02QA3ZZ	Repair Heart, Percutaneous Approach
	02QA4ZZ	Repair Heart, Percutaneous Endoscopic Approach
	02QB3ZZ	Repair Right Heart, Percutaneous Approach
	02QB4ZZ	Repair Right Heart, Percutaneous Endoscopic Approach
	02QC3ZZ	Repair Left Heart, Percutaneous Approach
	02QC4ZZ	Repair Left Heart, Percutaneous Endoscopic Approach

Policy History

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

Effective Date	Action	Reason
03/30/2015	BCBSA Medical Policy Adoption	Medical Policy Committee
04/01/2016	Policy revision with no position change	Medical Policy Committee
02/01/2017	Coding update	Administrative Review
04/01/2017	Policy revision without position change	Medical Policy Committee
04/01/2018	Policy revision without position change	Medical Policy Committee
04/01/2019	Policy revision without position change	Medical Policy Committee

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.