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## Medical Policy



Nonprofit corporations and independent licensees  
of the Blue Cross and Blue Shield Association

**Joint Medical Policies are a source for BCBSM and BCN medical policy information only. These documents are not to be used to determine benefits or reimbursement. Please reference the appropriate certificate or contract for benefit information. This policy may be updated and is therefore subject to change.**

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**\*Current Policy Effective Date: 7/1/23**  
(See policy history boxes for previous effective dates)

### **Title: Near-Infrared Spectroscopy-Intravascular Coronary Imaging**

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#### **Description/Background**

Near-infrared spectroscopy (NIRS) can be used to examine the coronary artery wall and identify the chemical composition of coronary plaques, specifically those with large lipid cores. NIRS is based on the absorbance of light by organic molecules. This technology has been used to identify the chemical composition of biological tissue.

Coronary artery plaque is a deposit consisting of cholesterol-rich fat, calcium and other substances found in the blood. As plaque accumulates on the artery wall, it reduces blood flow to the heart muscle and increases the risk of blood clots which can lead to a heart attack. Lipid core-containing plaque is believed to be “vulnerable plaque”, or fatty plaque that can rupture and form dangerous blood clots. Vulnerable coronary artery plaque is widely considered to be the primary cause of acute coronary events.

While NIRS can localize and quantify lipid core burden, more recently this technology has been combined with intravascular ultrasound imaging to characterize plaque composition.

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#### **Regulatory Status:**

The United States Food and Drug Administration has cleared near-infrared spectroscopy and near-infrared intravascular ultrasound systems for coronary imaging. Examples of such devices are mentioned below.

The Makoto Intravascular Imaging System, TVC-MC10/TVC-MC10i Dualpro IVUS + NIRS Imaging Catheter, TVC-C195-42 (Infraredx, Inc., Burlington, MA), received FDA clearance for marketing through the FDA 510(k) approval process in 2019. The 510(k) summary states that

the Makoto Intravascular Imaging System™ is intended for the near-infrared examination of coronary arteries in patients undergoing invasive coronary angiography for the detection of lipid-core-containing plaques of interest, the assessment of coronary artery lipid core burden and the identification of patients and plaques at increased risk of major adverse cardiac events. The system is also intended for ultrasound examination of coronary intravascular pathology in patients who are candidates for transluminal coronary interventional procedures. Product code: IYO, OGZ, OBJ

The TVC™ Imaging System (Infraredx, Inc., Burlington, MA), received FDA clearance for marketing through the FDA 510(k) approval process in 2013. The 510(k) summary states that the device is intended for near-infrared examination of coronary arteries in patients undergoing invasive coronary angiography for the detection of lipid-core-containing plaques of interest and coronary artery lipid core burden. The system is also intended for ultrasound examination of coronary intravascular pathology in patients who are candidates for transluminal coronary interventional procedures. Product code: OGZ, IYO

The LipiScan™ IVUS Imaging System (Infraredx, Inc., Burlington, MA), a near-infrared intravascular ultrasound coronary imaging received FDA clearance for marketing through the FDA 510(k) approval process in 2010. The 510(k) summary states that the modifications from the LipiScan Coronary Imaging System to the LipiScan IVUS Imaging System are the inclusion of ultrasound imaging within the same dimensions of the catheter and an expanded indication for use (i.e., ultrasound examination of coronary intravascular pathology). Product Code: OGZ, OB3J, JYO

The LipiScan™ Coronary Imaging System (Infraredx, Inc., Burlington, MA) was cleared for marketing through the Food and Drug Administration (FDA) 510(k) process in April 2008. According to the 510(k) summary the device is intended for the intravascular catheter-based examination of coronary arteries, for the detection of lipid-core-containing plaques of interest and for the assessment of coronary artery lipid core burden. Product Code: OGZ

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## **Medical Policy Statement**

Near-infrared imaging of coronary arteries alone or combined with intravascular ultrasound does not provide any additional clinically relevant information in the diagnosis and or treatment of coronary events over available tests or procedures. These imaging tests are therefore considered experimental/investigational.

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## **Inclusionary and Exclusionary Guidelines**

N/A

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**CPT/HCPCS Level II Codes** *(Note: The inclusion of a code in this list is not a guarantee of coverage. Please refer to the medical policy statement to determine the status of a given procedure)*

**Established codes:**

N/A

**Other codes (investigational, not medically necessary, etc.):**

93799

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**Rationale**

**Near-Infrared Imaging of Coronary Arteries**

According to Honda et al (2008), the ultimate goal in cardiology is to use systemic treatments to prevent vulnerable patients from experiencing adverse events. In order to overcome the limitations of present-day intravascular imaging techniques, the development of more advanced technologies must be ongoing. According to the authors, the clinical utility of intravascular imaging will be realized when it is combined with treatment modalities.

Gardner et al (2008) examined the ability of the (near-infrared spectroscopy) NIRS system to detect lipid core-containing plaques in human coronary artery autopsy specimens. The authors concluded that the NIRS system can correctly identify lipid core-containing plaques in autopsy specimens. Further studies are required to improve both risk stratification and treatment of patients with coronary artery disease. Study limitations included the use of nonliving tissue, the lack of coronary motion and the avoidance of tortuous anatomy of the coronary vasculature.

Caplan et al (2010) described efforts to use NIRS to identify chemical components of coronary artery plaque as a means to assess vulnerability. Although recent studies in aortic and coronary artery autopsy specimens have confirmed the ability of the technique to identify lipid-rich plaque through blood, additional studies are required to validate the ability of the technique to identify lipid-rich coronary artery plaques and ultimately link chemical characterization with subsequent occurrence of an acute coronary syndrome.

Schaar et al (2007), describes imaging techniques which are being studied to detect coronary vulnerable plaques in human coronary arteries in vivo. The author acknowledges that currently NIRS can attain information on the chemical components of the coronary vessel but states that future studies should concentrate on existing imaging problems such as acquisition time and blood scattering. In addition, other elements such as pH and temperature must also be incorporated into the spectroscopic system in order to further improve vulnerable plaque detection.

Goldstein et al (2011) analyzed the relationship between the presence of large lipid core plaques (LCP) detected by NIRS and periprocedural myocardial infarction. Study participants were obtained from the COLOR Registry, an ongoing prospective observational study of patients undergoing NIRS before percutaneous coronary intervention. Included were patients with stable preprocedural cardiac biomarkers undergoing stenting (N=62). NIRS was used to

measure the extent of LCP in the treatment zone, calculated as the maximal lipid-core burden index (LCBI) for each of the 4-mm longitudinal segments in the treatment zone. A periprocedural MI was defined as new cardiac biomarker elevation above 3 times the upper limit of normal. Large LCP ( $\text{maxLCBI}_{4\text{mm}} \geq 500$ ) was present in 14 of 62 lesions (22.6%), and periprocedural MI was documented in 9 of 62 (14.5%) of cases. Periprocedural MI occurred in 7 of 14 patients (50%) with a  $\text{maxLCBI}_{4\text{mm}} \geq 500$ , compared with 2 of 48 patients (4.2%) with a lower  $\text{maxLCBI}_{4\text{mm}}$ . The authors concluded that can be used to identify large, stenotic, coronary LCPs. In this study large LCPs were associated with a 50% risk of periprocedural MI when dilated during percutaneous coronary intervention, whereas lesions without a large lipid core had a low risk of periprocedural myocardial infarction. Hence this technology may prove useful for improved risk assessment before coronary stenting.

Oemrawsing et al (2014) conducted a single center, prospective, observational study to assess the prognostic value of NIRS imaging in patients with coronary artery disease (CAD). Between April 2009 and January 2011, a total of 203 individuals were enrolled in the study prior to undergoing coronary angiography for stable angina pectoris (SAP) or acute coronary syndrome (ACS). The primary endpoint was the composite of all-cause mortality, nonfatal ACS, stroke, and unplanned coronary revascularization. The median follow-up was 1 year in all study participants. The cumulative incidence of the primary endpoint was 10.4% at 1 year. Cumulative 1-year rates in those with a lipid core burden index (LCBI) at and above the median (43.0) versus those with LCBI values below the median were 16.7% versus 4.0% (adjusted hazard ratio 4.04; 95% CI 1.33-12.29;  $p=0.01$ ). Similar relationships were reported between LCBI and the primary endpoint in participants with initial SAP and ACS. CAD patients with an LCBI equal to or above the median of 43.0, as assessed by NIRS had a 4-fold risk of adverse cardiovascular events during the follow-up period of the study. However, the authors noted that these observations need to be confirmed by larger studies with longer follow-up.

Danek et al (2016) reported on long-term follow-up after near-infrared spectroscopy coronary imaging based upon insights from the lipid cORe plaque association with CLinical events (ORACLE-NIRS) registry. Two hundred and thirty-nine patients who underwent NIRS coronary imaging between 2009-2011 were analyzed. The median follow-up period was 5.3 years. High LCBI in a non-percutaneous coronary intervention target vessel identified by NIRS imaging was associated with increased incidence of major adverse cardiac events (MACE). The 5-year MACE rate was 37.5% (cardiac mortality was 15.0%).

Madder et al (2016) studied the association between large lipid-rich plaques (LRP) detected by NIRS at non-stented sites in a target artery and subsequent major adverse cardiovascular and cerebrovascular events (MACCE). This study evaluated 121 consecutive registry patients undergoing NIRS imaging in a target artery. After excluding stented segments, target arteries were evaluated for a large LRP, defined as a maximum lipid core burden index in 4 mm ( $\text{maxLCBI}_{4\text{mm}} \geq 400$ ). Detection of large LRP by NIRS at non-stented sites in a target artery was associated with an increased risk of future MACCE.

### **Near-Infrared Intravascular Ultrasound Coronary Imaging**

Pu et al (2012) undertook a study to determine whether combining NIRS with IVUS can lead to better characterization of coronary plaques. Greyscale-IVUS, virtual histology (VH)-IVUS, and NIRS imaging technologies were used to compare 131 native lesions (66 vessels) during catheterization by all 3 imaging techniques. Greyscale-IVUS detected attenuated and echolucent plaques correlated with NIRS-detected lipid-rich areas. The attenuated plaques

contained the highest NIRS probability of lipid core, followed by echo-lucent plaques. Using VH-IVUS, 93.5% of attenuated plaques contained confluent necrotic core (NC) and were classified as VH-derived fibro-atheromas (FAs). Although 75.0% of echo-lucent plaques were classified as VH-FAs, VH-NC was seen surrounding an echo-lucent zone, but not within any echo-lucent zone. Furthermore, echo-lucent zones themselves contained fibro-fatty and/or fibrous tissue. All calcified plaques with arc greater than 90° contained greater than 10% VH-NC (range of 16.0% to 41.2%) and were classified as calcified VH-FAs, but only 58.5% contained NIRS-detected lipid core. A positive relationship between VH-derived % NC and NIRS-derived LCBI was found in non-calcified plaques, but not in calcified plaques. Hence, the authors concluded that these results support the notion that NIRS combined with IVUS helps with plaque characterization.

Madder et al (2013) reported on a study of 20 patients who underwent combined NIRS and intravascular ultrasound to assess culprit lesions in ST-segment elevation myocardial infarction (STEMI). STEMI culprit findings were compared to nonculprit segment findings of the artery and also to findings in segments from autopsy controls. The study found MaxLCBI<sub>4mm</sub> was 5.8-fold higher in STEMI culprit segments than in 87 nonculprit segments of the STEMI culprit vessel and 87-fold higher than in 279 coronary autopsy segments free of large LCP by histology. A threshold of maxLCBI<sub>4mm</sub> >400 distinguished STEMI culprit segments from specimens free of large LCP by histology. Therefore, NIRS was able to accurately distinguish between culprit and nonculprit segments of the artery.

In a subsequent study, Madder et al (2014) used NIRS to assess the lipid burden of culprit lesions in non-ST-segment elevation myocardial infarction (non-STEMI) and unstable angina (UA). The authors noted that it is currently not known whether culprit lesions in non-STEMI and UA are characterized by a similarly large lipid burden. This study observed that large lipid cores similar to those recently detected by NIRS at STEMI culprit sites were frequently observed at culprit sites in patients with non-STEMI and UA.

In 2016, Madder et al studied combined NIRS and IVUS imaging of pre-existing coronary artery stents to determine if neoatherosclerosis could be reliably detected. At the site of LRP detected by NIRS in a cohort of pre-existing stents, intravascular ultrasound was used to determine the presence of neointimal tissue. The lipid-core burden index and maximum lipid-core burden index in 4 mm were measured within stented segments. Findings were compared between pre-existing stents and a control group of freshly implanted stents. Among 60 pre-existing stents implanted 5.5 ±4.0 years earlier, NIRS detected LRP in 33%. At the site of LRP, intravascular ultrasound found no neointimal tissue in 35% of cases. NIRS findings in pre-existing stents were indistinguishable from those of freshly implanted stents (lipid-core burden index: 50 ±72 versus 42 ±58; P=0.40 and maximum lipid-core burden index in 4 mm: 156 ±184 versus 155 ±203; P=0.69). The authors concluded that the detection of LRP in a pre-existing stent by NIRS alone is not sufficient evidence of neoatherosclerosis, as the lipid signal may originate from fibroatheroma underlying the stent, however IVUS may provide additional insight into the potential source of the lipid signal in pre-existing stents.

Shuurman et al (2017) reported on a study using near-infrared spectroscopy to examine the association between lipid rich core containing plaques in a non-culprit coronary artery and the occurrence of adverse cardiac events during a 4-year follow-up period. The study period occurred during 2009-2013. NIRS was performed in a non-culprit artery of 275 patients undergoing coronary angiography for acute coronary syndrome (ACS) or stable angina. LCBI was quantified by an independent core lab for the region of interest LCBI<sub>ROI</sub>) and the 4 and

10mm long segment with the maximum LCBI. The primary endpoint was major adverse cardiac events (MACE), defined as the composite of all-cause death, non-fatal ACS, or unplanned revascularization. Hazard ratios were adjusted for age, gender, clinical risk factors, and segment plaque burden based on intravascular ultrasound. During a median follow-up of 4.1 years, 79 patients had MACE. A statistically significant and independent continuous relationship was observed between higher MaxLCBI<sub>4mm</sub> values and a higher risk of MACE. Each 100 units increase of MaxLCBI<sub>4mm</sub> was associated with a 19% increase in MACE. Continuous MaxLCBI<sub>4mm</sub> continued to be independently associated with MACE after exclusion of target lesion-related events and after exclusion of adverse events related to the NIRS-imaged coronary segment. Results for MaxLCBI<sub>10mm</sub> were comparable with these findings.

Little is known about the impact of clinical presentations such as chronic coronary syndrome (CCS) and acute coronary syndrome (ACS) including unstable angina (UA), non-ST-segment elevation MI (NSTEMI), and ST-segment elevation MI (STEMI) on LCP. Tateishi et al (2021) conducted a prospective single-center study to evaluate the impact of clinical presentations on lipid core plaque assessed by near-infrared spectroscopy intravascular ultrasound. A total of 178 patients underwent percutaneous coronary intervention under NIRS-IVUS guidance. Patients were divided into CCS and ACS groups, and ACS patients were further sub-divided into the 3 groups according to the clinical presentation. The primary endpoint was coronary LCP in the target lesion assessed by NIRS-IVUS with maximal lipid core burden index over any 4 mm segment (maxLCBI<sub>4mm</sub>). The study population included 124 and 54 patients with CCS and ACS. MaxLCBI<sub>4mm</sub> in the target lesion was significantly higher in the ACS group than in the CCS group (503 [284-672] vs. 406 [250-557], p = 0.046). Among ACS patients, MaxLCBI<sub>4mm</sub> in the target lesion was also significantly different in those with UA (n = 18), NSTEMI (n = 21), and STEMI (n = 15) (288 [162-524] vs. 518 [358-745] vs. 646 [394-848], p = 0.021). In conclusion, LCP assessed by NIRS-IVUS, a surrogate of coronary plaque vulnerability, was significantly different according to the clinical presentations such as CCS, UA, NSTEMI, and STEMI.

## Summary

Near-infrared spectroscopy is one of the methods being investigated for the detection and evaluation of vulnerable coronary artery plaque. At the present time, there is insufficient evidence to determine the clinical utility of both near-infrared coronary imaging alone or combined with intravascular ultrasound. Additional studies are needed to determine how this technology can be used to improve health outcomes.

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## Government Regulations

### National/Local:

There is no National or Local Coverage Determination for this technology.

*(The above Medicare information is current as of the review date for this policy. However, the coverage issues and policies maintained by the Centers for Medicare & Medicare Services [CMS, formerly HCFA] are updated and/or revised periodically. Therefore, the most current CMS information may not be contained in this document. For the most current information, the reader should contact an official Medicare source.)*

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## Related Policies

N/A

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## References

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*The articles reviewed in this research include those obtained in an Internet based literature search for relevant medical references through 2/15/23, the date the research was completed.*



### Joint BCBSM/BCN Medical Policy History

Policy Effective Date	BCBSM Signature Date	BCN Signature Date	Comments
7/1/10	5/13/10	4/20/10	Joint policy established
7/1/12	4/10/12	5/18/12	Routine maintenance
1/1/14	10/17/13	10/25/13	Routine maintenance
5/1/15	2/17/15	2/27/15	Routine maintenance Added near-infrared intravascular ultrasound coronary imaging to policy. Added "coronary imaging" to policy title.
7/1/16	4/19/16	4/19/16	Routine maintenance
7/1/17	4/18/17	4/18/17	Routine maintenance
7/1/18	4/17/18	4/17/18	Routine maintenance
7/1/19	4/16/19		Routine maintenance
7/1/20	4/14/20		<ul style="list-style-type: none"> <li>• Routine maintenance</li> <li>• 0205T deleted code update – Encoder redirects to NOC to report - 93799 (unlisted code)</li> </ul>
7/1/21	4/20/21		Routine maintenance
7/1/22	4/19/22		Routine maintenance
7/1/23	4/18/23		Routine maintenance (slp) Vendor managed: N/A

Next Review Date: 2<sup>nd</sup> Qtr, 2024

### Pre-Consolidation Medical Policy History

Original Policy Date	Comments
BCN: N/A	Revised: N/A
BCBSM: N/A	Revised: N/A

**BLUE CARE NETWORK BENEFIT COVERAGE**  
**POLICY: NEAR INFRARED SPECTROSCOPY – INTRAVASCULAR CORONARY IMAGING**

**I. Coverage Determination:**

<b>Commercial HMO (includes Self-Funded groups unless otherwise specified)</b>	Not covered
<b>BCNA (Medicare Advantage)</b>	Refer to the Medicare information under the Government Regulations section of this policy.
<b>BCN65 (Medicare Complementary)</b>	Coinsurance covered if primary Medicare covers the service.

**II. Administrative Guidelines:**

- The member's contract must be active at the time the service is rendered.
- Coverage is based on each member's certificate and is not guaranteed. Please consult the individual member's certificate for details. Additional information regarding coverage or benefits may also be obtained through customer or provider inquiry services at BCN.
- The service must be authorized by the member's PCP except for Self-Referral Option (SRO) members seeking Tier 2 coverage.
- Services must be performed by a BCN-contracted provider, if available, except for Self-Referral Option (SRO) members seeking Tier 2 coverage.
- Payment is based on BCN payment rules, individual certificate and certificate riders.
- Appropriate copayments will apply. Refer to certificate and applicable riders for detailed information.
- CPT - HCPCS codes are used for descriptive purposes only and are not a guarantee of coverage.