

**DE NOVO CLASSIFICATION REQUEST FOR
MUCOSAL INTEGRITY CONDUCTIVITY (MI) TEST SYSTEM**

REGULATORY INFORMATION

FDA identifies this generic type of device as the following:

Esophageal tissue characterization system. An esophageal tissue characterization system is a device intended for obtaining measurement of electrical properties within esophageal tissue.

NEW REGULATION NUMBER: 21 CFR 876.1450

CLASSIFICATION: Class II

PRODUCT CODE: QIS

BACKGROUND

DEVICE NAME: Mucosal Integrity Conductivity (MI) Test System

SUBMISSION NUMBER: DEN180067

DATE DE NOVO RECEIVED: December 20, 2018

CONTACT:

Diversatek Healthcare, Inc.
102 East Keefe Avenue
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INDICATIONS FOR USE

The Mucosal Integrity Conductivity Test System is indicated for use by gastroenterologists, surgeons, and medically trained personnel during an endoscopy to obtain a real time measurement of esophageal epithelial impedance. The device is not for use as a sole diagnostic screening tool.

LIMITATIONS

The sale, distribution, and use of the Mucosal Integrity Conductivity (MI) System are restricted to prescription use in accordance with 21 CFR 801.109.

The MI Test System should be used as directed in the labeling to avoid adverse interaction within the esophagus.

PLEASE REFER TO THE LABELING FOR A COMPLETE LIST OF WARNINGS, PRECAUTIONS AND CONTRAINDICATIONS.

DEVICE DESCRIPTION

The Mucosal Integrity Conductivity (MI) Test System provides real-time measurements of alterations in esophageal epithelial integrity. The device is intended to aid in the evaluation of esophageal epithelial integrity by means of a balloon probe with direct electrical contact with the mucosal epithelium of the esophagus along with associated signal conditioning, hardware, and software for measuring and displaying information.

The patient undergoing an esophageal mucosal impedance study will first have an endoscope placed with the distal end of the scope proximal to the area under study. The MI Probe is advanced into the patient's esophagus by guiding it alongside the endoscope. The MI Probe is positioned under visual guidance using the optics of the endoscope. The probe also contains proximal markings on the catheter portion outside the patient to aid in positioning. The total time of deployment for collecting mucosal impedance values is expected to be less than 5 minutes. Figure 1 shows the MI Probe and its components along with its inflated and deflated state.

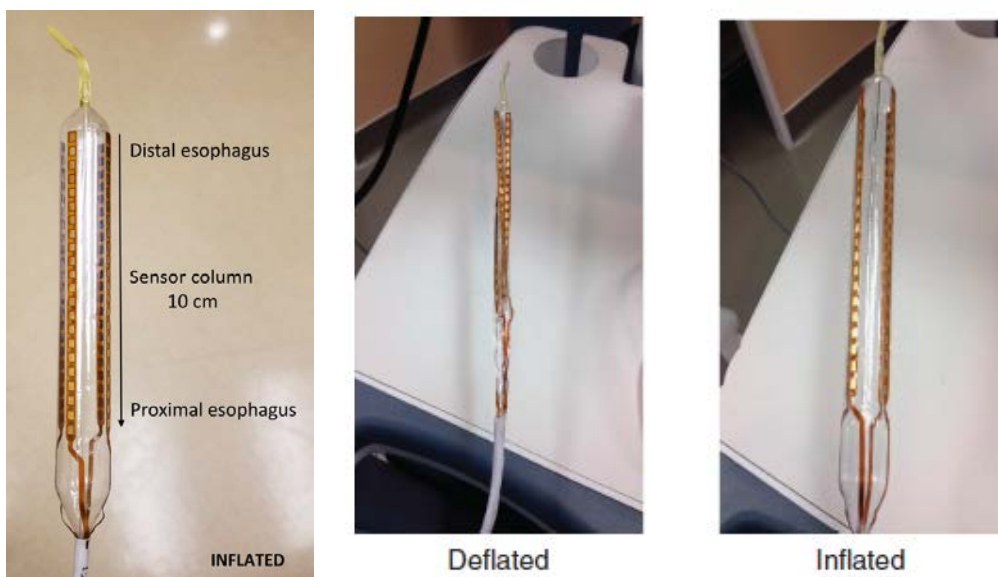


Figure 1. Inflated and Deflated Probe.

The impedance values are transmitted from the MI Probe to the non-patient contacting MI Adapter as standard impedance signals, measured, converted to digital data and are then transmitted to the Central Unit via the MI Cable. The Central Unit then transfers the processed data to the PC for display and analysis through the MI Software. This data is displayed through the use of a color map for easy identification of impedance values. The color map displays real-time impedance measurements for the duration of the individual study, and results are reported as both raw data and a summary.

The inflation and deflation of the probe is controlled via the MI Inflator Gauge Box, which has a pressure gauge to display the pressure within the balloon. The components are illustrated in

Figure 2 below. The impedance values are transmitted from the MI Probe to the non-patient contacting MI Adapter as standard impedance signals, measured, converted to digital data and are then transmitted to the Central Unit via the MI Cable. The Central Unit then transfers the processed data to the PC for display and analysis through the MI Software. This data is displayed through the use of a color map for identification of impedance values. The color map displays real-time impedance measurements for the duration of the individual study, and results are reported as both raw data and a summary.

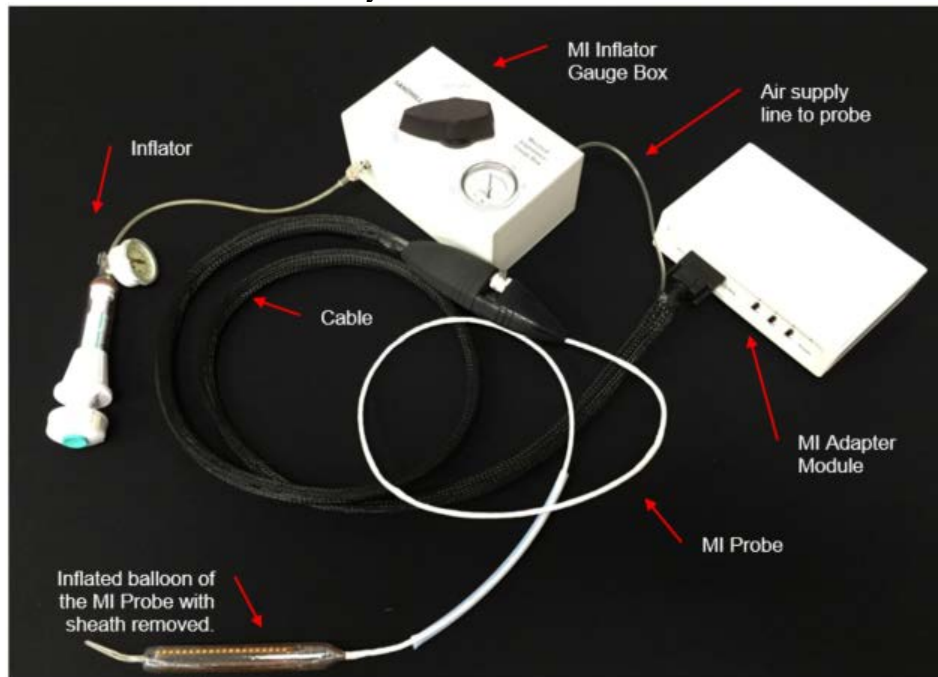


Figure 2. The complete MI System with all components aside from the Central Unit

SUMMARY OF NONCLINICAL/BENCH STUDIES

Non-clinical/bench studies conducted on the MI Test System to demonstrate a reasonable assurance of safety and effectiveness of the device are summarized below.

REPROCESSING

As illustrated in Figure 3 below, the MI Probe makes direct patient contact and is connected to reusable components that do not make direct patient contact. Those reusable components will be manipulated by the user at the same time they are using the patient-contacting probe, thereby making cross-contamination between the probe and the reusable components possible. This risk was addressed by the inclusion of validated reprocessing instructions in the labeling for the reusable components.

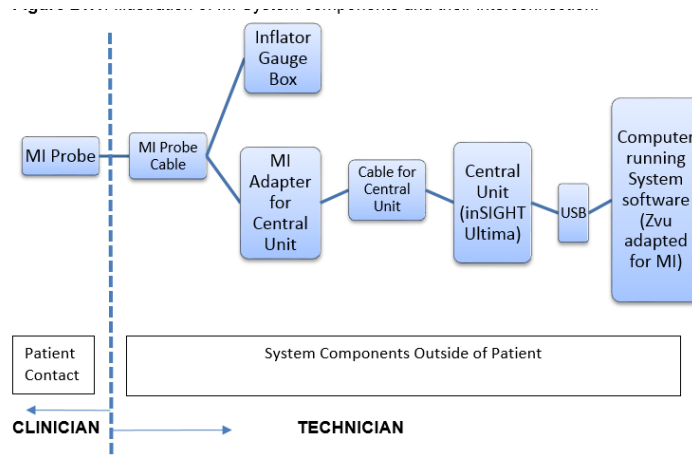


Figure 3. Diagram of patient contacting and non-patient contacting components. This involved the use of cleaning instructions and disinfection instructions per FDA’s 2015 reprocessing guidance document, “Reprocessing Medical Devices in Health Care Settings: Validation Methods and Labeling”. The instructions for the MI Test System provide step-by-step instructions for the user to first clean and then low-level disinfect the reusable components using a Sani-Cloth wipe.

The instructions indicate that reprocessing should occur immediately following use, they include the words “thoroughly clean,” they provide endpoints for each step (i.e., visibly clean for cleaning and contact time of 2 minutes per wipe manufacturer’s instructions for disinfection), they include a visual inspection step following cleaning and state that the user should repeat the cleaning steps if still visibly dirty, and they include drying steps post-cleaning and disinfection.

Furthermore, the reuse inspection instructions to indicate that the user should inspect the device for damage, corrosion, cuts, punctures, and cracked seals following cleaning and disinfection.

SOFTWARE

Software documentation was provided in accordance with the FDA Guidance Document, “Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices,” (issued May 11, 2005) for a Moderate Level of Concern (LOC). A Moderate LOC is deemed appropriate as malfunction of the device software or a latent design flaw in the device software may lead to a delay in the delivery of appropriate medical care, which would likely result in minor injury, but would likely not result in serious injury or death due to the availability of other patient vital signs.

Cybersecurity information was provided in accordance with the FDA Guidance Document, “Content of Premarket Submissions for Management of Cybersecurity in Medical Devices – Guidance for Industry and Food and Drug Administration Staff” (issued October 02, 2014).

BIOCOMPATIBILITY/MATERIALS

The MI Test System is classified as mucosal membrane contacting for repeat, prolonged contact during clinical use (< 24 hours). The MI Probe was evaluated according to the FDA guidance (2016), "Use of International Standard ISO 10993-1, Biological evaluation of medical devices – Part 1: Evaluation and testing within a risk management process," and the following biocompatibility endpoints were assessed for the MI Test System:

- Cytotoxicity
- Sensitization
- Irritation

Results support the biocompatibility of the MI Test System.

ELECTRICAL SAFETY AND ELECTROMAGNETIC COMPATIBILITY (EMC)

The test reports address the basic safety evaluation (which includes electrical safety testing) per the FDA-recognized standard IEC 60601-1:2005 + A1:2012. In addition, the EMC testing was conducted per IEC 60601-1-2:2007 and passed the applicable clauses. The results support the electrical safety and EMC of the device.

PERFORMANCE TESTING - BENCH

The integrity and performance of the MI Test System were evaluated with the nonclinical testing summarized in the tables below.

Table 13.1 Balloon Functionality Testing Summary

Test	Acceptance Criteria	Diversatek Healthcare Test Article Result
Double Wall Thickness	.00045" +/- .00025"	(b)(4) Pass
Compliance Diameter @ 0.5atm	20 mm +/- .65 mm	(b)(4) Pass
Burst Pressure	2.04 atm minimum	(b)(4) Pass

Sample size of the tests above are n=10. The double wall thickness and compliance diameter was measured using digital height gauge.

A hydraulic burst tester was used to record the balloon burst pressure (n=10), and the compliance of the diameter of the balloons at 0.5 atm was measured with a ruler.

Table 13.3 Dimensional Design Verification Testing Summary

Test	Acceptance Criteria	Diversatek Healthcare Test Article Result
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Probe Overall Length	55.25" +/- 2.0"	(b)(4) Pass
Probe, Balloon Diameter when Inflated	2.0 cm +/- 0.1 cm	(b)(4) Pass
Probe Weight	2.8 oz. +/- 0.5 oz.	(b)(4) Pass

Dimensional verification test for the probe overall length, probe-balloon inflated diameter (n=33) were measured using a ruler, and the probe weight was measured with a digital scale.

Table 13.4 Bond between Sensors and Balloon Testing Summary

Test	Acceptance Criteria	Diversatek Healthcare Test Article Result
Adhesive Strength after Exposure to Saline	≥ adhesive strength without saline exposure 2.267 lbf	(b)(4) Pass

For the Adhesive Strength test, samples (b) (4) were prepared by (b) (4)

Table 13.5 Tensile Strength, Distal Tip to Catheter of MI Probe

Test	Acceptance Criteria	Diversatek Healthcare Test Article Result
Tensile Strength Distal Tip Joint MI Probe	≥ 3.0 lbf based on independent study	(b)(4) Pass
	Added to this Submission: ≥ 4.5 lbf from EN 1617 (20 Newtons) for max break force of sterile drainage catheters	(b)(4) Pass

An initial pull test (n=(b) (4)) on the distal tip joint of the MI Probe, where a (b) (4) acceptance criteria was used. Another test (n=(b) (4)) was then conducted in accordance with the FDA recognized standard EN 1617:1997 Sterile Drainage Catheters and Accessory Devices for Single Use with a (b) (4) acceptance criteria. In both tests, the joints were pulled until the point of failure and the maximum tensile strength of the joints was recorded. All breakages happened either at the distal tip or on the balloon material of the sample.

Table 13.6 Impedance Measurements of MI Probe Sensors

Test	Acceptance Criteria	Diversatek Healthcare Test Article Result
Impedance Measurement Accuracy	174+/- 100 Ohms	(b)(4) Pass
Impedance Signal Noise	< 20 Ohms	(b)(4) Pass
Impedance Thermal Stability	+/- 100 Ohms	(b)(4) Pass
Impedance Temporal Stability	+/- 100 Ohms	(b)(4) Pass

To demonstrate impedance measurement accuracy in bench testing, a single probe was placed in (b)(4)% saline (which had a (b)(4) ohms impedance). The impedance measurements from all ten sensors on the probe were then recorded over the course of 1 minute via analog-to-digital (A/D) counts (The MI Adapter can function as an analog-to-digital converter, which converts the voltage or current into a digital number). The average measurement was (b)(4) Ohms, which is within the acceptance criteria (shown above).

The impedance signal noise was measured by setting the MI software to report the maximum and minimum A/D counts for each channel on each probe for a period of 1 second. The differences between the minimum and maximum A/D counts for every channel was then calculated.

For the impedance thermal stability and impedance temporal stability, the software was set to report the average A/D counts for each channel of each MI probe sensor still in saline over a 1 minute period and 5 minute period respectively. For both tests the average resistance values were taken after 1 minute in room temperature saline and were compared to the impedance after 1 minute in body temperature saline (for thermal stability) and 5 minutes in room temperature saline (for the temporal stability).

Only one probe was tested for the impedance measurement tests. All sensors were tested on the probe.

SUMMARY OF CLINICAL INFORMATION

Clinical data from the sponsor was used to support the safety and effectiveness of the device. The clinical information also supported the benefit-risk determination.

The first prospective study was performed on (b)(4) patients undergoing esophagogastroduodenoscopy, with or without wireless pH monitoring. Some patients had symptoms of GERD (erosive esophagitis or abnormal pH testing, n = 24) or active eosinophilic esophagitis (EoE, confirmed with pathology at both distal and proximal esophagus, n = 21); there were also patients with normal esophagogastroduodenoscopy (EGD) and pH testing (n = 24). The study results show that the device was able to measure the esophageal mucosal impedance in ohms for all (b)(4) patients. There was only one reported adverse event (a chest pain unrelated to the device) and there was no follow-up of the patients after the procedure ended.

Another prospective study was conducted with the subject device in a population that consisted of 23 adult patients with EoE, of whom 18 patients had > 15 eosinophils per high-power field (eos/HpF), and 5 patients had inactive EoE (4 patients were effectively treated with budesonide and 1 with omeprazole). There were 10 additional control patients consisting of 8 adults undergoing endoscopy for clinically-indicated Bravo capsule placement for assessment of GERD, and 2 patients were undergoing endoscopy for evaluation of possible celiac disease. The study results show that the MI Test System was able to measure the esophageal mucosal impedance in ohms for all 23 patients. There were no reported adverse events and there was no follow-up of the patients after the procedure ended.

Pediatric Extrapolation

In this De Novo request, existing clinical information was not leveraged to support the use of the device in pediatric patient population

LABELING

The labeling comprises physician labeling that includes the device indications for use, a description of the device, warnings, and precautions, clinical data on the device, and instructions for the safe and effective use of the device. The labeling satisfies the requirements of 21 CFR 801.109 Prescription devices.

Per the special controls for this generic type of device, labeling includes the following:

- Specific instructions regarding proper placement and use of the device.
- An expiration date and shelf life for single use components.
- Reprocessing instructions for the reusable components.

RISKS TO HEALTH

The table below (**Table 4**) identifies the risks to health that may be associated with use of the esophageal tissue characterization system and the measures necessary to mitigate these risks.

Table 4: Identified Risks to Health and Mitigation Measures

Identified Risks to Health	Mitigation Measures
Device Malfunction Related to: <ul style="list-style-type: none"> • Breaking • Fractures • Unintentional separation of components • Inaccurate reading • Failure to sense • Endoscope incompatibility 	Non-clinical performance testing Shelf life testing Software verification, validation, and hazard analysis Labeling
Adverse tissue reaction	Biocompatibility evaluation

Electrical shock and electrical interference from other devices	Electrical safety testing Electromagnetic compatibility (EMC) testing Labeling
Procedural risks (which may include procedures of endoscopy with sedation)	Labeling
Infection/cross-contamination	Reprocessing validation Labeling

SPECIAL CONTROLS

In combination with the general controls of the FD&C Act, the esophageal tissue characterization system is subject to the following special controls:

- (1) All patient contacting components of the device must be demonstrated to be biocompatible.
- (2) Performance testing must demonstrate the mucosal impedance system can accurately measure the designated electrical characteristics.
- (3) Mechanical safety testing must demonstrate that the device will withstand forces encountered during use.
- (4) Software verification, validation, and hazard analysis must be performed.
- (5) Electromagnetic compatibility and electrical safety, mechanical, and thermal safety testing of the device must be performed.
- (6) Performance data must validate the reprocessing instructions for any reusable components of the device.
- (7) Labeling must include:
 - (i) Specific instructions regarding the proper placement and use of the device;
 - (ii) Instructions for reprocessing of any reusable components; and
 - (iii) An expiration date for single use components.

BENEFIT-RISK DETERMINATION

The probable benefits of the device are based on the ability to obtain the electrical characteristic of the esophageal tissue. In the case of the MI Test System, the device can be used by gastroenterologists, surgeons, and medically trained personnel during an endoscopy to obtain a real time measurement of esophageal epithelial impedance. This information as an adjunct to standard clinical practice can provide the clinician with information to assist in making a more informed decision for patient care.

The probable risks of the device include the risks associated with endoscopy and sedation, device malfunction, adverse tissue reaction, electrical shock and electrical interference, and cross-contamination or infection. Device-related adverse events were not reported in the clinical studies. The risk of device malfunctions includes the risk of inaccurate reading which could result in an incorrect determination by the clinician.

Based on the available performance data, the probability of such harmful events is low, and the incidence is reduced with the mitigation measures and special controls identified above.

The probable benefits of the device outweigh the probable risks.

Patient Perspectives

This submission did not include specific information on patient perspectives for this device.

Benefit/Risk Conclusion

In conclusion, given the available information above, for the following indication statement:

The Mucosal Integrity Conductivity Test System is indicated for use by gastroenterologists, surgeons, and medically trained personnel during an endoscopy to obtain a real time measurement of esophageal epithelial impedance. The device is not for use as a sole diagnostic screening tool.

The probable benefits outweigh the probable risks for the MI Test System. The device provides benefits, and the risks can be mitigated using general controls and the identified special controls.

CONCLUSION

The De Novo request for the Mucosal Integrity Conductivity Test System is granted and the device is classified as follows:

Product Code: QIS
Device Type: Esophageal tissue characterization system
Regulation Number: 21 CFR 876.1450
Class: Class II