November 21, 2017

Perspectum Diagnostics Ltd.
% Jaco Jacobs
Chief Compliance Officer
23-38 Hythe Bridge Street
Oxford, Oxfordshire OX1 2ET
UNITED KINGDOM

Re: K172685
Trade/Device Name: LiverMultiScan
Regulation Number: 21 CFR 892.1000
Regulation Name: Magnetic resonance diagnostic device
Regulatory Class: II
Product Code: LNH
Dated: September 1, 2017
Received: September 6, 2017

Dear Jaco Jacobs:

We have reviewed your Section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR 803); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820); and if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR 1000-1050.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR Part 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to http://www.fda.gov/MedicalDevices/Safety/ReportaProblem/default.htm for the CDRH's Office of Surveillance and Biometrics/Division of Postmarket Surveillance.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (https://www.fda.gov/MedicalDevices/DeviceRegulationandGuidance/) and CDRH Learn (http://www.fda.gov/Training/CDRHLearn). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (http://www.fda.gov/DICE) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

For

Robert Ochs, Ph.D.
Director
Division of Radiological Health
Office of In Vitro Diagnostics
and Radiological Health
Center for Devices and Radiological Health

Enclosure

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Food and Drug Administration

Indications for Use

Form Approved: OMB No. 0910-0120
Expiration Date: January 31, 2017
See PRA Statement below.

510(k) Number *(if known)*
K172685

Device Name
LiverMultiScan (LMSv2)

Indications for Use *(Describe)*
LiverMultiScan (LMSv2) is indicated for use as a magnetic resonance diagnostic device software application for non-invasive liver evaluation that enables the generation, display and review of 2D magnetic resonance medical image data and pixel maps for MR relaxation times.

LiverMultiScan (LMSv2) is designed to utilize DICOM 3.0 compliant magnetic resonance image datasets, acquired from compatible MR Systems, to display the internal structure of the abdomen including the liver. Other physical parameters derived from the images may also be produced.

LiverMultiScan (LMSv2) provides a number of quantification tools, such as Region of Interest (ROI) placements, to be used for the assessment of regions of an image to quantify liver tissue characteristics, including the determination of triglyceride fat fraction in the liver, T2* and iron-corrected T1 measurements.

These images and the physical parameters derived from the images, when interpreted by a trained clinician, yield information that may assist in diagnosis.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D) ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) Summary

This summary of 510(k) safety and effectiveness information is submitted in accordance with the requirements of 21 CFR 807.92.

1. Submitter

Name:	Perspectum Diagnostics Ltd
Address:	Perspectum Diagnostics Ltd 23-38 Hythe Bridge Street Oxford OX1 2ET United Kingdom
Contact Person:	Dr. Jaco Jacobs
Date Prepared:	1st September 2017

2. Subject Device

Name of Device:	LiverMultiScan (LMSv2)
Classification Name:	Magnetic Resonance Diagnostic Device
Regulation:	21 CFR 892.1000
Regulatory Class:	Class II
Product Classification Code:	LNH

3. Predicate Device

Name of predicate device:	LiverMultiScan (LMSv1)
Predicate Manufacturer:	Mirada Medical Ltd Oxford Centre for Innovation New Road Oxford OX1 1BY United Kingdom
Predicate Trade Name:	LiverMultiScan
Predicate 510(k) Number:	K143020

4. Reference Device

No reference devices were used in this submission.

5. Device Description

LiverMultiScan (LMSv2) is a standalone software application for displaying 2D Magnetic Resonance medical image data acquired from compatible MR Scanners. LiverMultiScan runs on a general purpose workstation with a colour monitor, keyboard and mouse.

LiverMultiScan (LMSv2) is designed to allow the review of DICOM 3.0 compliant datasets stored on the workstation and the operator may also create, display, print, store and distribute reports resulting from interpretation of the datasets.

LiverMultiScan (LMSv2) allows the display and comparison of combinations of magnetic resonance images and provides a number of tools for the quantification of magnetic resonance images, including the determination of triglyceride fat fraction in the liver, T2* and iron-corrected T1 measurements.

LiverMultiScan (LMSv2) provides a number of tools, such as circular region of interest placements, to be used for the assessment of regions of an image to support a clinical workflow.

LiverMultiScan (LMSv2) allows the operator to create relaxometry parameter maps of the abdomen which can be used by clinicians to help determine different tissue characteristics to support a clinical workflow. Examples of such workflows include, but are not limited to, the evaluation of the presence or absence of liver fat.

LiverMultiScan (LMSv2) is intended to be used by trained operators. Reports generated by trained operators are intended for use by interpreting clinicians, including, but not limited to radiologists, gastroenterologists, and hepatologists.

LiverMultiScan (LMSv2) is an aid to diagnosis. When interpreted by a trained clinician, the results provide information, which may be used as an input into existing clinical procedures and diagnostic workflows.

LiverMultiScan (LMSv2) offers the following.

- Advanced visualisation of MR data.
- Processing of MR data to quantify tissue characteristics including MR relaxivity constants such as T2*, T1, iron-corrected T1 (cT1) and triglyceride fat fraction (expressed as liver fat percentage).
- Circular region of interest statistics.
- Snapshot of images to include in a report.
- Report to include region statistics, snapshot images and user-entered text.
- Export of snapshot images to report.

6. Indications for Use

*"*LiverMultiScan (LMSv2) is indicated for use as a magnetic resonance diagnostic device software application for non-invasive liver evaluation that enables the generation, display and review of 2D magnetic resonance medical image data and pixel maps for MR relaxation times.

LiverMultiScan (LMSv2) is designed to utilize DICOM 3.0 compliant magnetic resonance image datasets, acquired from compatible MR Systems, to display the internal structure of the abdomen including the liver. Other physical parameters derived from the images may also be produced.

LiverMultiScan (LMSv2) provides a number of quantification tools, such as Region of Interest (ROI) placements, to be used for the assessment of regions of an image to quantify liver tissue characteristics, including the determination of triglyceride fat fraction in the liver, T2* and iron-corrected T1 measurements.

These images and the physical parameters derived from the images, when interpreted by a trained clinician, yield information that may assist in diagnosis.*"*

7. Comparison to Predicate

The following characteristics were compared between the subject device and the predicate device in order to demonstrate substantial equivalence.

Overview

The subject device is substantially equivalent to the predicate device, both regulated under regulation 21 CFR 892.1000, Magnetic Resonance Diagnostic Device.

- The indications for use and intended uses of both the subject device and predicate device are equivalent.
- The subject device and predicate device both support multi-slice MR data acquired using the specific acquisition protocols, from supported MR Systems, to acquire the input data.
- The subject and predicate devices include software applications which utilise MR data to visualise and enable quantification of physiological characteristics in the liver to provide measurements which may be used to aid diagnosis.
- The subject and predicate devices are both standalone software applications to facilitate the import and visualization of MR data sets.
- Both the subject and predicate devices are designed to run on general-purpose computers.
- Both the subject device and the predicate device include applications to facilitate the import and visualization of MR data sets and include tools to enable the manipulation of the views and to enable the quantification and analysis of tissue characteristics in the liver from the MR data.
- The subject and predicate devices enable the quantification of analysis of tissue characteristics in the liver from the MR data.
- The subject and predicate devices use the same algorithmic specifications to support quantitative analysis.
- The subject and predicate devices both support region of interest measurements derived from MR images and parametric maps of tissue characteristics.
- The subject and predicate devices facilitate the creation of a medical report containing the images and analysis output derived from quantification of liver tissue parameters.
- The subject - and predicate device reports all include tabular display of quantification statistics, parametric map images and include normal range references.
- Performance testing demonstrates that the subject device performs at least as safely and effectively as the proposed predicate.

Device Comparison Table

Characteristic	LMSv2 (Subject)	LMSv1 (Predicate)
510(k)	Not known	K143020
Regulation	21 CFR 892.1000	21 CFR 892.1000
Regulatory Class	Class II	Class II
Product Code	LNH	LNH
Manufacturer	Perspectum Diagnostics Ltd	Mirada Medical Ltd
Intended Use and Indications for Use	LiverMultiScan is indicated for use as magnetic resonance diagnostic device software application for non-invasive liver evaluation that enables the generation, display and review of 2D magnetic resonance medical image data and pixel maps for MR relaxation times.	LMS is indicated for use as magnetic resonance diagnostic device software application for non-invasive liver evaluation that enables the generation, display and review of 2D magnetic resonance medical image data and pixel maps for MR relaxation times.

	LiverMultiScan is designed to utilize DICOM 3.0 compliant magnetic resonance image datasets, acquired from compatible MR Systems, to display the internal structure of the abdomen including the liver. Other physical parameters derived from the images may also be produced. LiverMultiScan provides a number of quantification tools, such as Region of Interest (ROI) placements, to be used for the assessment of regions of an image to quantify liver tissue characteristics, including the determination of triglyceride fat fraction in the liver, T2* and iron-corrected T1 measurements. These images and the physical parameters derived from the images, when interpreted by a trained clinician, yield information that may assist in diagnosis.	LMS is designed to utilize DICOM 3.0 compliant magnetic resonance image datasets, acquired from Siemens MAGNETOM Skyra MR Scanners, to display the internal structure of the abdomen including the liver. Other physical parameters derived from the images may also be produced. LMS provides a number of quantification tools such as rulers and region of interest to be used for the assessment of regions of an image to support existing clinical workflows. These images and the physical parameters derived from the images, when interpreted by a trained physician, yield information that may assist in diagnosis.
Target Population	Patients suitable to undergo an MRI scan and not contra-indicated for MRI.	Patients suitable to undergo an MRI scan and not contra-indicated for MRI.
Device User	Trained operator	Trained clinician
Report User	Interpreting clinician	Interpreting clinician
Anatomical Location	Abdomen, Liver	Abdomen, Liver
Energy Considerations	Software only application. The device, a standalone software application, does not deliver or depend on energy delivered to or from patients.	Software only application. The device, a standalone software application, does not deliver or depend on energy delivered to or from patients.
Design: Purpose	Standalone software application to facilitate the import and visualization of MR data sets encompassing the abdomen, including the liver with functionality independent of the MRI equipment vendor. Software application intended to display and visualize 2D multi-slice, spin-echo MR data sets encompassing the abdomen. The user may process, and review DICOM 3.0 compliant datasets within the system and/or across computer networks.	Standalone software application to facilitate the import and visualization of MR data sets encompassing the abdomen, including the liver with functionality independent of the MRI equipment vendor. Software application intended to display and visualize 2D multi-slice, spin-echo MR data sets encompassing the abdomen. The user may process, and review DICOM 3.0 compliant datasets within the system and/or across computer networks.
Design: MR Relaxometry	T1, iron-corrected T1 (cT1) and T2* mapping.	T1, iron-corrected T1 (cT1) and T2* mapping.
Design: Liver Fat Quantification	Utilizes MR images that exploit the difference in resonance frequencies between hydrogen nuclei in water and triglyceride fat using the three point DIXON method.	Utilizes MR images that exploit the difference in resonance frequencies between hydrogen nuclei in water and triglyceride fat using the three point DIXON method.

Design: Parametric Maps	Iron corrected T1 (cT1), T2* and triglyceride fat (also known as Proton Density Fat Fraction (PDFF)) parametric maps are supported.	Iron corrected T1 (cT1), T2* and triglyceride fat (also known as Proton Density Fat Fraction (PDFF)) parametric maps are supported.
Design: Visualisation	Iron corrected T1 (cT1) displayed using LMS colourmap, designed to have maximum contrast on liver parenchymal tissue.	Iron corrected T1 (cT1) displayed using LMS grayscale colourmap.
Design: Region of Interest (ROI)	Median and interquartile range measurements created from a cross sectional slice of liver tissue. For each parametric map, statistics from multiple Regions of Interest (ROIs) – potentially placed across multiple slices – are summarised.	Mean, median, standard deviation, interquartile range measurements created from a cross sectional slice of liver tissue.
Design: Supported Modalities	DICOM 3.0 compliant MR data from GRE Echo and MOLLI acquisition protocols.	DICOM 3.0 compliant MR data from GRE Echo and MOLLI acquisition protocols.
Design: Reporting	Liver quantification images and analysis collated in a report.	Liver quantification images and analysis collated in a report.
Performance	Validated with phantom scans, synthetic raw data and volunteer scans covering a range of physiological values for cT1, T2* and PDFF.	Validated with volunteer and phantom scans.
Supported Systems	Validated across all supported manufacturers and field strengths.	Validated on Siemens Skyra (3T).
Standards	IEC 62304, DICOM 3.0, ISO 14971, ISO 13485	IEC 62304, DICOM
Operating System	Mac OS	Microsoft Windows
Materials	Not applicable, standalone software.	Not applicable, standalone software.
Biocompatibility	Not applicable, standalone software.	Not applicable, standalone software.
Sterility	Not applicable, standalone software.	Not applicable, standalone software.
Electrical Safety	Not applicable, standalone software.	Not applicable, standalone software.
Mechanical Safety	Not applicable, standalone software.	Not applicable, standalone software.
Chemical Safety	Not applicable, standalone software.	Not applicable, standalone software.
Thermal Safety	Not applicable, standalone software.	Not applicable, standalone software.
Radiation Safety	Not applicable, standalone software.	Not applicable, standalone software.

In conclusion, the subject device does not result in any new potential safety risk and performs in accordance with its intended use as well as comparatively with the intended use of the chosen predicate.

8. Performance Data

Introduction

Substantial equivalence performance testing will consist of a head-to-head evaluation of the subject and predicate devices' ability to measure (corrected) T1, $T2^*$ and PDFF using phantoms as well as in-vivo volunteer data.

For in-vivo performance data please see

For each of the comparisons, the following will be calculated:

- Mean difference in T1/ $T2^*$ and PDFF (magnitude of the bias)
- Standard deviation
- Bland-Altman 95% limits of agreement

- Slope of bias

Phantom

The performance of LMSv2, as summarised in the tables below demonstrates that:

- The MOLLI-based T1 measurement produced by LMSv2 is consistent with the literature-reported underestimation of ground truth T1 using MOLLI techniques [1],[2].
- LiverMultiScan (LMSv2) measurement of T2* is accurate over the expected physiological range of values.
- LiverMultiScan (LMSv2) measurement of PDFF is accurate over the expected physiological range of values.

Phantom metric	Accuracy 95% CI Limits of Agreement
	Performance metric
T1	19-25% lower than ground truth
T2*	+/- 2ms
PDFF < 30%	+/- 3%
PDFF ≥ 30%	+/- 21%

- LiverMultiScan (LMSv2) measurement of T1 is highly repeatable.
- LiverMultiScan (LMSv2) measurement of T1 is both repeatable within the same system and reproducible between systems.
- LiverMultiScan (LMSv2) measurement of T2* is highly repeatable.
- LiverMultiScan (LMSv2) measurement of T2* is both repeatable within the same system reproducible between systems at the same field strength.
- LiverMultiScan (LMSv2) measurement of PDFF is highly repeatable.
- LiverMultiScan (LMSv2) measurement of PDFF is reproducible between systems.

Phantom metric	Repeatability 95% CI Limits of Agreement	Reproducibility 95% CI Limits of Agreement
	Performance metric	Performance metric
T1	+/- 10ms	-34 to 27ms
T2*	+/- 1.7ms	+/- 4ms
PDFF < 30%	-2.5 to 1 %	+/- 4%
PDFF ≥ 30%	+/- 5%	+/-10 %

[1] Piechnik et al. (2010) Journal of Cardiovascular Magnetic Resonance 12:69
[2] Puntmann et al. (2013) Journal of Cardiovascular Magnetic Resonance 15(Suppl 1):E18

In Vivo

The *in vivo* performance testing of LMSv2, as summarised in the table below demonstrates that:

- LiverMultiScan (LMSv2) measurement of cT1 is highly repeatable.
- LiverMultiScan (LMSv2) measurement of cT1 is reproducible between systems.
- LiverMultiScan (LMSv2) measurement of T2* is highly repeatable.
- LiverMultiScan (LMSv2) measurement of T2* is reproducible between systems at the same field strength.
- LiverMultiScan (LMSv2) measurement of PDFF is highly repeatable.
- LiverMultiScan (LMSv2) measurement of PDFF is reproducible between systems.

Volunteer metric	Repeatability 95% CI Limits of Agreement Performance metric	Reproducibility 95% CI Limits of Agreement Performance metric
cT1	+/- 60ms	+/- 120ms
T2*	+/- 7ms	+/- 10ms
PDFF	+/- 1%	+/- 2%

As demonstrated in the table below, the variation introduced by operator reading (use of LMSv2) is well within the proscribed acceptance criteria. There is only minor additional variation introduced by having two readers read the same study compared to the same reader performing a second analysis blinded.

Volunteer metric	Intra-operator 95% CI Limits of Agreement Performance metric	Inter-operator 95% CI Limits of Agreement Performance metric
cT1	+/- 18ms	+/- 25ms
T2*	+/- 3ms	+/- 4ms
PDFF	+/- 1%	+/- 1.1%

Substantial Equivalence

The substantial equivalence testing of LMSv2 versus its predicate device, LMSv1, is summarised in the tables below.

Phantom measurements show that LMSv2 produces T1 and T2* values within 1ms of the predicate (negligible difference). PDFF is within 1% of the predicate where PDFF < 30%, and within 2% at higher percentages.

Metric	Phantom Equivalence 95% CI Limits of Agreement

	Performance metric
T1	-0.5 to 0.4ms
T2*	-0.4 to 0.2ms
PDFF < 30%	-0.6 to 0.4%
PDFF ≥ 30%	-1.6 to 2%

In vivo measurements show that cT1 values produced by LMSv2 lie within 40ms of the predicate device, with T2* values within 1ms. There is negligible difference in the measurement of PDFF between LMSv2 and the predicate.

Metric	In vivo Equivalence 95% CI Limits of Agreement
	Performance metric
cT1	-14.8 to 40ms
T2*	-0.5 to 0.8ms
PDFF	-0.4 to 0.2%

In summary, as all acceptance criteria were met, we conclude that LMSv2 is substantially equivalent to its predicate, LMSv1.

Summary

In conclusion, performance testing demonstrates that LiverMultiScan (LMSv2) is substantially equivalent to, and performs at least as safely and effectively as the listed predicate device. In-vivo and phantom clinical performance criteria established were successfully met during the performance evaluation.

LiverMultiScan (LMSv2) meets requirements for safety and effectiveness and does not introduce any new potential safety risks.

9. Biocompatibility Testing

Not applicable as the LiverMultiScan (LMSv2) device is standalone software.

10. Electrical Safety and Electromagnetic Compatibility (EMC)

Not applicable as the LiverMultiScan (LMSv2) device is standalone software.

11. Software Verification and Validation Testing

LiverMultiScan is validated and verified against its user needs and intended use by the successful execution of planned software verification and validation testing included in this submission. The results of verification and validation testing demonstrate that LiverMultiScan meets the user needs and requirements of the device, which are demonstrated to be substantially equivalent to those of the listed predicate device.

Verification and Validation for LiverMultiScan has been carried out in compliance with the requirements of ISO 13485:2003, 21 CFR Part 820 and in adherence to the DICOM standard.

In conclusion, software verification and validation testing demonstrates that LiverMultiScan is substantially equivalent to, and performs at least as safely and effectively as the listed predicate device. LiverMultiScan meets requirements for safety and effectiveness and does not introduce any new potential safety risks.

12. Mechanical and Acoustic Testing

Not applicable as the LiverMultiScan (LMSv2) device is standalone software.

13. Animal Study

Animal performance testing was not required to demonstrate safety and effectiveness of the device.

15. Benchtop Performance Data

Please see *Phantom* and *Substantial Equivalence* sections under Performance Data.

14. Clinical Studies

Please see *In Vivo* and *Substantial Equivalence* sections under Performance Data.

15. Conclusion

In conclusion, Perspectum Diagnostics Ltd is of the opinion that:

- the subject device LiverMultiScan (LMSv2) performs in accordance with its intended use as well as comparatively with the intended use of the chosen predicate, LiverMultiScan (LMSv1)
- the subject device LiverMultiScan (LMSv2) is as safe and effective as the predicate device LiverMultiScan (LMSv1);
- the subject device LiverMultiScan (LMSv2) does not raise new questions of safety and effectiveness; and
- the subject device LiverMultiScan (LMSv2) is substantially equivalent to the currently marketed predicate device LiverMultiScan (LMSv1).