510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY ONLY

I Background Information:

A 510(k) Number
K213280

B Applicant
BD Kiestra B.V.

C Proprietary and Established Names
BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application, BD Kiestra MRSA App

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
QQY	Class II	21 CFR 866.2190 - Automated Image Assessment System For Microbial Colonies On Solid Culture Media	MI - Microbiology

II Submission/Device Overview:

A Purpose for Submission:
To obtain a substantial equivalence determination for the BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application (BD Kiestra MRSA App)

B Measurand:
Digital images of colonies cultured on BD BBL CHROMagar MRSA II culture plates to determine presence or absence of methicillin-resistant *Staphylococcus aureus* (MRSA)

C Type of Test:
The BD Kiestra MRSA Application is an *in vitro* diagnostic software program that provides a qualitative assessment of microbial growth on BD BBL CHROMagar MRSA II culture plates inoculated with anterior specimens to aid in the prevention and control of MRSA infection.

III Intended Use/Indications for Use:

A Intended Use(s):
See Indications for Use below.

B Indication(s) for Use:

The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application is an *in-vitro* diagnostic software program that requires the BD Kiestra Laboratory Automation Solution in order to operate.

The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application is applied to digital images of BD BBL CHROMagar MRSA II culture plates inoculated with anterior nares samples.

Algorithms are applied to digital images to provide a qualitative assessment of colony growth and colorimetric detection of target colonies to screen for nasal colonization by MRSA, and to serve as an aid in the prevention and control of MRSA infection. Applied algorithms provide the following results:

- " No growth", which will be manually released individually or as a batch (with other no growth samples) by a trained microbiologist upon review of the digital plate images.
- "Growth - other" (growth without mauve color), which digital plate images will be manually reviewed by a trained microbiologist.
- "Growth MRSA Mauve" (growth with mauve color), which digital plate images will be manually reviewed by a trained microbiologist.

The assay is not intended to guide, diagnose, or monitor treatment for MRSA infections. It is not intended to provide results of susceptibility to oxacillin/methicillin.

The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application is indicated for use in the clinical laboratory.

C Special Conditions for Use Statement(s):

Rx - For Prescription Use Only

D Special Instrument Requirements:

BD Kiestra ReadA or BD Kiestra ReadA Compact which is part of the BD Kiestra Laboratory Automation Solution

IV Device/System Characteristics:

A Device Description:

The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application (herein referred to as the BD MRSA App) is an optional *in vitro* diagnostic software application for the BD Kiestra Laboratory Automation Solution (described for the BD Kiestra IdentifA, K191964). The BD MRSA App analyzes images of BD BBL CHROMagar MRSA II plates inoculated with anterior nares swab specimens from patients to screen for MRSA colonization. Images are generated with the BD Kiestra ReadA or the BD Kiestra ReadA Compact using BD Kiestra Optis technology. The BD MRSA App provides a qualitative assessment of colony growth and color as it pertains to MRSA growth as: no growth, growth without mauve color, or growth with mauve color.

B Principle of Operation:

Anterior nares specimens are inoculated manually or automatically by the BD Kiestra InoqulA+ or BD Kiestra InoqulA, which is part of the BD Kiestra Laboratory Automation Solution, onto BD BBL CHROMagar MRSA II plates. Plates are then transferred to the BD Kiestra ReadA or the BD Kiestra ReadA Compact for incubation at 35°C and image acquisition by the onboard camera at specific timepoints. Each plate is imaged at least three times to provide a time series for the algorithm to evaluate: an initial image to evaluate the appearance of the plate prior to the presence of observable bacterial growth, an intermediate image halfway through the incubation cycle, and a final image taken at the end of the evaluation time. The algorithm determines what has grown on the plate between the first and final image. The final interpretation of all digital images, regardless of the BD MRSA App interpretation, will be made by the microbiologist.

The system uses three different light sources (top, bottom and side) and has two different backgrounds (black and white). At the timepoint the plate is imaged, multiple acquisitions are done by the camera with each light source and background to get an optimal image and to enhance the signal to noise ratio. The ReadA instrument creates a single high contrast image from the multiple acquisitions. The same image is used for both the BD MRSA App and the digital image displayed for user review.

V Substantial Equivalence Information:

A Predicate Device Name(s):

APAS Independence with IC Chromogenic MRSA BD Analysis Module; APAS Independence with IC Chromogenic MRSA TFS/S Analysis Module

B Predicate 510(k) Number(s):

K200839

C Comparison with Predicate(s):

Device & Predicate Device(s):	Device: K213280	Predicate: K200839
Device Trade Name	BD Kiestra MRSA Application	APAS Independence with IC Chromogenic MRSA BD Analysis Module; APAS Independence with IC Chromogenic MRSA TFS/S Analysis Module
General Device Characteristic Similarities		
Intended Use/Indications For Use	The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application is an in-vitro diagnostic software program that requires the BD Kiestra Laboratory Automation Solution in order to operate. The BD Kiestra Methicillin-resistant *Staphylococcus aureus* (MRSA) Application is applied to digital images of BD BBL CHROMagar MRSA II culture plates inoculated with anterior nares samples. Algorithms are applied to digital images	The APAS Independence is an in vitro diagnostic system comprised of an instrument and software analysis module(s) for specific indications that are used to automate imaging and interpretation of microbial colonies on plates of solid culture media. The APAS Independence is an in vitro diagnostic system comprised of an instrument for automated imaging of agar culture plates and a software analysis module for the following use:

Device & Predicate Device(s):	Device: K213280	Predicate: K200839
	to provide a qualitative assessment of colony growth and colorimetric detection of target colonies to screen for nasal colonization by MRSA and to serve as an aid in the prevention and control of MRSA infection. Applied algorithms provide the following results: • "No growth", which will be manually released individually or as a batch (with other no growth samples) by a trained microbiologist upon review of the digital plate images. • "Growth – other" (growth without mauve color), which digital plate images will be manually reviewed by a trained microbiologist. • "Growth MRSA Mauve" (growth with mauve color), which digital plate images will be manually reviewed by a trained microbiologist. The assay is not intended to guide, diagnose, or monitor treatment for MRSA infections. It is not intended to provide results of susceptibility to oxacillin/methicillin. The BD Kiestra Methicillin-resistant Staphylococcus aureus (MRSA) Application is indicated for use in the clinical laboratory.	1. The APAS Independence, when using its IC MRSA Chromogenic BD analysis module, automates culture plate imaging and interpretation to detect the presence or absence of colonies with colors suggestive of methicillin-resistant *Staphylococcus aureus* (MRSA) growth on Beckton Dickson BBL CHROMagar MRSA II agar that has been inoculated with anterior nares swabs and incubated at 36°C ± 1°C for 24 hours. The APAS Independence, when using its IC MRSA Chromogenic BD analysis module, provides an aid in routine screening for colonization with MRSA. It provides one of two screening results: Presumptive MRSA or Negative. All culture plates that are identified as Presumptive MRSA by the APAS Independence, when using the IC MRSA Chromogenic BD analysis module require review by a trained microbiologist. 2. The APAS Independence, when using its IC MRSA Chromogenic TFS/S analysis module, automates culture plate imaging and interpretation to detect the presence or absence of colonies with colors suggestive of methicillin-resistant *Staphylococcus aureus* (MRSA) growth on Thermo-Fisher Spectra MRSA agar that has been inoculated with anterior nares swabs and incubated at 36°C ± 1°C for 24 hours. The APAS Independence, when using its IC MRSA Chromogenic TFS/S analysis module, provides an aid in routine screening for colonization with MRSA. It provides one of three screening results: Presumptive MRSA, Presumptive non-MRSA, or Negative. All culture plates that are identified as Presumptive MRSA or Presumptive non-MRSA by the APAS Independence, when using the IC MRSA Chromogenic TFS/S analysis module, require review by a trained microbiologist.
Imaging Station	BD Kiestra ReadA and the BD Kiestra ReadA Compact are equipped with the imaging station using Light Emitting Diode (LED) illumination of plated media and image capture using High Speed CMOS Image Sensor camera	Light Emitting Diode (LED) illumination of culture plates and image capture using a Charged Coupled Device (CCD) camera

Device & Predicate Device(s):	Device: K213280	Predicate: K200839
Controller PC	BD Kiestra ReadA and the BD Kiestra ReadA Compact, has its own controller PC that controls the image capturing and images storing	Control image capture, analysis, report generation and result storage
Analysis Module	The Plate Image Analyzer and Plate Algorithm libraries run on a server to process the images and meta data for analysis. These results are sent to BD Synapsys informatics solution which is installed on the BD Kiestra Solution to provide user configuration of image visualization and user configurable workflow rules for imaging result interpretation.	Installed on the APAS Controller PC to provide the configuration and instructions for image capture and analysis
Calibration	Occasional calibration of the camera when alerted to do so and after cleaning. Calibration is performed with BD provided calibration plates.	Performed daily using a manufacturer-provided Color Check Tool
Biological Quality Control	Performed per BD BBL CHROMagar MRSA II media package insert instructions.	Performed daily using standardized suspensions of *Staphylococcus aureus* ATCC 43300 (MRSA positive strain)
Plate Handling	Automatic	Automatic
General Device Characteristic Differences		
Instrumentation	BD Kiestra ReadA or BD Kiestra ReadA Compact which are part of the BD Kiestra Laboratory Automation Solution	APAS Independence
Instrument Controller PC	Provides the user interface for the BD MRSA App powered by BD Synapsys informatics solution	Provides the user interface for the APAS Independence and controls plate movement
Laboratory Information System (LIS) Data import	Data import through BD Synapsys informatics solution	Analysis result for each plate sent to the LIS. Sample ID details retrieved from the LIS
Result Reporting	Results are sent to LIS by BD Synapsys informatics solution after being manually reviewed and released individually or as a batch by a trained microbiologist upon review of the digital plate images.	Consists of software for image analysis and presentation of reports. APAS-generated result is sent to the LIS, after review by a trained microbiologist, when applicable.

VI Standards/Guidance Documents Referenced:

- **ISO 14971**: 2019, Medical devices - Application of risk management to medical devices
- **IEC 62304:2006/AC** 2008, Medical device software – software life-cycle processes
- **IEC 62304:2006/A1** 2016, Medical device software – software life-cycle processes
- ***General Principles of Software Validation***; Final Guidance for Industry and FDA Staff, January 11, 2002
- ***Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices***, May 11, 2005

- ***Off-The-Shelf Software Use in Medical Devices***, Guidance for Industry and Food and Drug Administration Staff; September 27, 2019
- ***Content of Premarket Submissions for Management of Cybersecurity in Medical Devices***, Guidance for Industry and Food and Drug Administration Staff; October 2, 2014
- ***Postmarket Management of Cybersecurity in Medical Devices***, Guidance for Industry and Food and Drug Administration Staff; December 28, 2016
- ***Guidance on Informed Consent for In Vitro Diagnostic Device Studies Using Leftover Human Specimens that are Not Individually Identifiable***, Guidance for Sponsors, Institutional Review Boards, and Food and Drug Administration Staff; April 25, 2006

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

The organisms listed in **Table 1** were used to evaluate the analytical performance of the BD MRSA App.

Table 1. Organisms tested in analytical studies

Organism Name (Source)	Code*	Interpretation (identifier)	Study Evaluated
Staphylococcus aureus (clinical stock)	POS 10575	MRSA (mauve growth)	Reproducibility
Staphylococcus aureus (ATCC 43300)	POS 3890	MRSA (mauve growth)	Reproducibility, Limit of Detection
Staphylococcus aureus (clinical stock)	POS 8161	MRSA (mauve growth)	Reproducibility
Staphylococcus aureus (clinical stock)	POS 8214	MRSA (mauve growth)	Reproducibility
Staphylococcus aureus (clinical stock)	POS 9246	MRSA (mauve growth)	Reproducibility
Staphylococcus aureus (ATCC 33591)		MRSA (mauve growth)	Limit of Detection
Staphylococcus aureus (clinical stock)	POS 3679	MRSA (mauve growth)	Limit of Detection
Staphylococcus haemolyticus (clinical stock)	POS 3441	Non-MRSA (non-mauve growth)	Reproducibility
Staphylococcus haemolyticus (clinical stock)	POS 8113	Non-MRSA (non-mauve growth)	Reproducibility

* Internal codes used for the purpose of tracking during the studies.

1. Precision/Reproducibility:

Reproducibility

The reproducibility of the BD MRSA App within runs, between runs, and between instruments was evaluated at two internal sites. A panel of seven simulated clinical nares samples, comprised of 5 MRSA strains and 2 non-MRSA strains (**Table 1**), were streaked in triplicate on BD BBL CHROMagar MRSA II plates at three dilutions (10^2, 10^3, 1-5 x10^4

CFU/mL), as well as a saline control, using the InoqulA+ inoculation method. Plates were incubated at 35 ± 2°C, then imaged and analyzed in 5 replicates after 22 hours using the BD Kiestra ReadA Compact 5MP camera, per the instructions for use, on 3 days (2 sites x 3 replicates x 5 images x 3 days = 90 images/dilution). Data in which the expected result was not obtained after manual review were excluded from analysis.

The results of the reproducibility study are summarized in **Table 2**. The BD MRSA app was able to detect all plates with MRSA growth but was unable to detect growth for one replicate of a non-MRSA strain (code 3441). This is acceptable since all digital images are reviewed by a microbiologist and there is a low risk associated with not detecting a non-MRSA strain. Overall, reproducibility was determined to be acceptable.

Table 2. Reproducibility of the BD MRSA App

Organism (Code)	Dilution	Percent Agreement (%)					
		Instrument 1		Instrument 2		Combined	
		Growth	Color	Growth	Color	Growth [95% CI]	Color [95% CI]
Saline	-	1029/1033 (99.6)	1029/1033 (99.6)	1053/1056 (99.7)	1053/1056 (99.7)	2082/2089 (99.7) [99.3-99.8]	2082/2089 (99.7) [99.3-99.8]
MRSA (10575)	10^2	55/55 (100)	55/55 (100)	40/40 (100)	40/40 (100)	95/95 (100) [96.1-100]	95/95 (100) [96.1-100]
	10^3	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
	10^4	75/75 (100)	75/75 (100)	73/73 (100)	73/73 (100)	148/148 (100) [97.5-100]	148/148 (100) [97.5-100]
MRSA (3890)	10^2	35/35 (100)	35/35 (100)	45/45 (100)	45/45 (100)	80/80 (100) [95.4-100]	80/80 (100) [95.4-100]
	10^3	59/59 (100)	59/59 (100)	60/60 (100)	60/60 (100)	119/119 (100) [96.9-100]	119/119 (100) [96.9-100]
	10^4	60/60 (100)	60/60 (100)	55/55 (100)	55/55 (100)	115/115 (100) [96.8-100]	115/115 (100) [96.8-100]
MRSA (8161)	10^2	60/60 (100)	60/60 (100)	59/59 (100)	59/59 (100)	119/119 (100) [96.9-100]	119/119 (100) [96.9-100]
	10^3	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
	10^4	75/75 (100)	75/75 (100)	90/90 (100)	90/90 (100)	165/165 (100) [97.7-100]	165/165 (100) [97.7-100]
MRSA (8214)	10^2	50/50 (100)	50/50 (100)	35/35 (100)	35/35 (100)	85/85 (100) [95.7-100]	85/85 (100) [95.7-100]
	10^3	59/59 (100)	59/59 (100)	59/59 (100)	59/59 (100)	118/118 (100) [96.8-100]	118/118 (100) [96.8-100]
	10^4	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
MRSA (9246)	10^2	40/40 (100)	40/40 (100)	45/45 (100)	45/45 (100)	85/85 (100) [95.7-100]	85/85 (100) [95.7-100]
	10^3	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
	10^4	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
Non-MRSA (3441)	10^2	25/25 (100)	25/25 (100)	30/30 (100)	30/30 (100)	55/55 (100) [93.5-100]	55/55 (100) [93.5-100]
	10^3	40/45 (88.9)	40/45 (88.9)	45/45 (100)	45/45 (100)	85/90 (94.4) [87.6-97.6]	85/90 (94.4) [87.6-97.6]
	10^4	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]

Organism (Code)	Dilution	Percent Agreement (%)					
		Instrument 1		Instrument 2		Combined	
		Growth	Color	Growth	Color	Growth [95% CI]	Color [95% CI]
Non-MRSA (8113)	10^2	40/40 (100)	40/40 (100)	40/40 (100)	40/40 (100)	80/80 (100) [95.4-100]	80/80 (100) [95.4-100]
	10^3	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]
	10^4	45/45 (100)	45/45 (100)	45/45 (100)	45/45 (100)	90/90 (100) [95.9-100]	90/90 (100) [95.9-100]

Digital Image Quality

A Digital Image Quality study was performed to evaluate the accuracy of microbiologists' interpretation of a digital image generated by the BD MRSA App (i.e., technologist examining the digital image on the computer screen; "digital image read") compared to the interpretation of the same agar plate manually (i.e., technologist examining the physical plate; "manual plate read"). Two hundred contrived samples (described below) were prepared from 25 unique isolates for evaluation. Contrived samples were diluted at $10^2 – 10^3$ CFU/mL, $10^3 – 10^4$ CFU/mL, $10^4 – 10^5$ CFU/mL, $>10^5$ CFU/mL and inoculated onto BD BBL CHROMagar MRSA II agar plates using the InoqulA+ inoculation method. A panel of three microbiologists blindly interpreted all agar plates and the corresponding digital images.

A total of 85 expected "mauve" samples were prepared (61 pure cultures of MRSA strains, 3 mixed cultures with two different MRSA strains, and 21 mixed cultures of MRSA and non-MRSA strains). A total of 115 expected "no growth" or expected "non-mauve growth" samples were prepared (82 pure cultures of non-MRSA strains, 18 mixed cultures of non-MRSA strains, and 15 saline samples). Non-MRSA strains were organisms that were either expected to grow as non-mauve colonies ("non-mauve growth") or expected to have growth inhibited ("no growth") on the CHROMagar plates. The non-MRSA strains included isolates from the following species: *Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, Staphylococcus epidermidis, Staphylococcus haemolyticus, Staphylococcus lugdunensis, Staphylococcus pettenkoferi,* and *Staphylococcus saprophyticus.*

The data generated in this study were analyzed in two different ways: microbiologists digital image read compared to the manual plate read (**Table 3** – **Table 6**) and reproducibility of microbiologists' interpretation of a digital image read (**Table 7**).

a) *Microbiologists digital image read compared to manual plate read*
The purpose of this study was to assess whether a microbiologist's digital image read is equivalent to their manual plate read. A summary of the combined results is provided in **Table 3** as well as stratified by each microbiologist in **Table 4, Table 5** and **Table 6**. Results in which the microbiologist's digital image read and manual plate read were inconsistent with the expected result were excluded from analysis as they were considered a technical error.

Table 3. Digital Image Quality: Digital Image Read vs Manual Plate Read (combined)

	No. of Results	Percent Agreement[1]		
		No Growth	Non-Mauve Growth	Mauve Growth
Microbiologist 1	174	48/51 (94.1%)	56/58 (96.6%)	64/65 (98.5%)
Microbiologist 2	172	49/55 (89.1%)	58/59 (98.3%)	61/62 (98.4%)

	No. of Results	Percent Agreement[1]		
		No Growth	Non-Mauve Growth	Mauve Growth
Microbiologist 3	175	51/53 (96.2%)	58/59 (98.3%)	63/63 (100%)
Combined	**521**	148/159 (93.1%)	169/172 (98.3%)	188/190 (98.9%)

[1]Percent agreement determined by dividing number of digital image read results by the number of manual plate read results from the same microbiologist for each designation (i.e., "no growth", "non-mauve growth", "mauve growth").

Table 4. Digital Image Quality – Microbiologist 1: Digital Image Read vs Manual Plate Read

Microbiologist 1		Manual Plate			
		No Growth	Non-Mauve Growth	Mauve Growth	Total
Digital Image	No Growth	48	2	0	50
	Non-Mauve Growth	3	56	1	60
	Mauve Growth	0	0	64	64
	Total	51	58	65	174
	No Growth Agreement: 48/51 (94.1%) Non-Mauve Agreement: 56/58 (96.6%) Mauve Agreement: 64/65 (98.5%)				

Table 5. Digital Image Quality – Microbiologist 2: Digital Image Read vs Manual Plate Read

Microbiologist 2		Manual Plate			
		No Growth	Non-Mauve Growth	Mauve Growth	Total
Digital Image	No Growth	49	0	1	50
	Non-Mauve Growth	4	55	0	59
	Mauve Growth	2	0	61	63
	Total	55	55	62	172
	No Growth Agreement: 49/55 (89.1%) Non-Mauve Agreement: 55/55 (100%) Mauve Agreement: 61/62 (98.4%)				

Table 6. Digital Image Quality – Microbiologist 3: Digital Image Read vs Manual Plate Read

Microbiologist 3		Manual Plate			
		No Growth	Non-Mauve Growth	Mauve Growth	Total
Digital Image	No Growth	51	0	0	51
	Non-Mauve Growth	1	58	0	59
	Mauve Growth	1	1	63	65
	Total	53	59	63	175
	No Growth Agreement: 51/53 (96.2%) Non-Mauve Agreement: 58/59 (98.3%) Mauve Agreement: 63/63 (100%)				

The digital image quality study determined that an BD MRSA App-generated digital image can be equivalently interpreted by a microbiologist compared to reading the plate manually. This was achieved >98% of the time for both the non-mauve growth and mauve growth designations, which is acceptable. Although agreement for the no growth designation was <95%, this is considered acceptable since the BD MRSA App is designed to maximize sensitivity which may result in over-calling of growth.

b) *Reproducibility of the BD MRSA App-generated digital image interpretation*
The data obtained from the digital image quality study was further analyzed to evaluate the ability of an BD MRSA App-generated digital image to be reproducibly interpreted by a panel of microbiologists. Here, each microbiologist's interpretation of a digital image was compared to the final panel interpretation of the digital image (i.e., majority result). The study determined that a digital image generated with the BD MRSA App can be reproducibly interpreted by a microbiologist. This was achieved >98% of the time for each of the three result designations (summarized in **Table 7**), which is acceptable.

Table 7. Digital Image Reproducibility Summary

	No. of Results[1]	Percent Agreement[2]		
		No Growth	Non-Mauve Growth	Mauve Growth
Microbiologist 1	173	50/51 (98.0%)	58/58 (100%)	63/64 (98.4%)
Microbiologist 2	171	49/51 (96.1%)	58/58 (100%)	61/62 (98.4%)
Microbiologist 3	174	51/51 (100%)	59/59 (100%)	64/64 (100%)
Combined	**518**	**150/153 (98.0%)**	**175/175 (100%)**	**188/190 (98.9%)**

[1]Three results were excluded from the reproducibility analysis since results from at least one microbiologist was determined to be invalid.
[2]Percent agreement determined by dividing number of individual microbiologist digital image read results by the number of microbiologist panel digital image read results for each designation (i.e., "no growth", "non-mauve growth", "mauve growth").

Camera (5MP vs 25MP) and Inoculation (InoqulA+ automated vs manual) Equivalency
An equivalency study was performed to determine whether: (1) the InoqulA+ automated and manual streaking methods can be equivalently interpreted by the BD Kiestra MRSA App and (2) the BD Kiestra ReadA Compact camera subsystems (5MP and 25MP) can generate equivalent images for evaluation by the BD Kiestra MRSA App. A total of 399 samples, including 200 clinical anterior nares specimens and 199 seeded samples prepared in saline (71 MRSA, 28 non-MRSA, 100 uninoculated), were inoculated onto BD BBL CHROMagar MRSA II media plates, in nine replicates, for multiple variable evaluations (i.e., 5MP camera vs 25MP camera; automated (InoqulA+) vs manual 10 µL vs manual 30 µL inoculation. Since plate incubation, imaging and processing are done in one instrument, a single plate cannot be imaged by both a 5MP and a 25MP camera. Therefore, two plates were prepared from the same seeded sample for imagining of the plate in incubators with either camera. Images were acquired at 2, 12 and 24 hours using the 5MP or 25MP camera. A total of ~3600 images were analyzed by the BD Kiestra MRSA App (399 samples x 9 replicates = 3591 total images/timepoint).

The equivalency data are summarized in **Table 8** for growth and **Table 9** for color, each stratified by sample type (clinical, saline, seeded). Agreement was determined by comparing the MRSA App generated result with a microbiologist interpretation of the digital image. Although variation among inoculation methods and camera subsystems was observed, each variable was determined to be acceptable since MRSA App detection of mauve color was >95% for each variable and all digital images are reviewed by a microbiologist.

Table 8. Camera and Inoculation Equivalency – Growth Agreement

Camera	Inoculation Method	Growth Agreement (%)[1]			
		Clinical	Saline	Seeded MRSA	Seeded non-MRSA
5MP	**InoqulA+**	197/201 (98.0)	92/100 (92.0)	70/71 (98.6)	25/28 (89.3)
5MP	**10ul manual loop**	191/201 (95.0)	89/100 (89.0)	68/71 (95.8)	27/28 (96.4)
5MP	**30 ul pipet**	190/201 (94.5)	98/100 (98.0)	70/71 (98.6)	28/28 (100)
25MP	**InoqulA+**	191/201 (95.0)	95/100 (95.0)	69/71 (97.2)	27/28 (96.4)
25MP	**10ul manual loop**	191/201 (95.0)	99/100 (99.0)	70/71 (98.6)	28/28 (100)
25MP	**30 ul pipet**	188/201 (93.5)	94/100 (94.0)	70/71 (98.6)	27/28 (96.4)

[1]Percent growth agreement between the BD MRSA App result and digital image read.

Table 9. Camera and Inoculation Equivalency – Color Agreement

Camera	Inoculation Method	Color Agreement (%)[1]						
		Clinical Samples				Seeded Samples		
		Mauve	Non-Mauve	No Growth	Clinical (combined)	No Growth (Saline)	Mauve (MRSA)	Non-Mauve (non-MRSA)
5MP	**InoqulA+**	105/110 (95.5)	64/64 (100)	23/26 (88.5)	192/201 (95.5)	92/100 (92.0)	70/71 (98.6)	25/28 (89.3)
5MP	**10ul manual loop**	122/123 (99.2)	39/41 (95.1)	27/36 (75.0)	189/201 (94.0)	89/100 (89.0)	68/71 (95.8)	27/28 (96.4)
5MP	**30 ul pipet**	111/113 (98.2)	56/58 (96.6)	17/26 (65.4)	187/201 (93.0)	98/100 (98.0)	70/71 (98.6)	28/28 (100)
25MP	**InoqulA+**	112/115 (97.4)	60/61 (90.9)	12/20 (60.0)	184/201 (91.5)	95/100 (95.0)	69/71 (97.2)	27/28 (96.4)
25MP	**10ul manual loop**	117/117 (100)	48/50 (96.0)	23/31 (74.2)	190/201 (94.5)	99/100 (99.0)	69/71 (97.2)	28/28 (100)
25MP	**30 ul pipet**	117/119 (98.3)	49/53 (92.5)	13/22 (59.1)	182/201 (90.5)	94/100 (94.0)	69/71 (97.2)	26/28 (92.9)

[1]Percent color agreement between the BD MRSA App result and digital image read.

2. Linearity:
   Not applicable

3. Analytical Specificity/Interference:
   Not applicable

4. Assay Reportable Range:
   Not applicable

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):
   Calibration of the BD Kiestra ReadA Compact camera is described with the BD Kiestra IdentifA, K191964. When alerted, occasional calibration of the camera is required as well as after cleaning using BD provided calibration plates. In addition, biological quality control testing must be performed according to the BD BBL CHROMagar MRSA II media package insert instructions.

6. Detection Limit:
   In lieu of a limit of detection study to identify the smallest colony size (diameter) that can reproducibility be detected as a mauve colony by the BD MRSA App, a study was performed

to determine the average colony size (diameter) when first detected as mauve by the BD MRSA App. Three MRSA strains (see **Table 1**) were diluted into saline (final concentrations of 1 x 10^3 and 1 x 10^5 CFU/mL) and plated onto BD BBL CHROMagar MRSA II media with the InoquA+ in 5 replicates (3 MRSA isolates x 2 dilutions x 5 replicates = 30 total plates imaged). To allow such testing, an unlocked, non-commercially available functionality in the BD MRSA App was used to process digital images of plates with MRSA isolates in 1-hour increments. After two hours of incubation, image acquisition occurred every hour with the last image time point set as 22 hours. The BD MRSA App as well as a panel of three microbiologists evaluated the digital images at each timepoint and reported the colony diameter when a mauve colony was first detected.

A total of 857 mauve colonies were evaluated amongst the three MRSA strains. The average colony diameter for each strain is summarized in **Table 10**.

Table 10. Average Mauve Colony Diameter When First Detected

Organism Code	Number of Mauve Colonies Evaluated	Colony diameter	
		Average (mm)	Standard Deviation (mm)
ATCC 43300	277	0.42	0.12
ATCC 33591	236	0.38	0.10
POS3679	344	0.39	0.09

7. Assay Cut-Off:
   Not applicable

B Comparison Studies:

1. Method Comparison with Predicate Device:
   Not applicable

2. Matrix Comparison:
   Not applicable

C Clinical Studies:

1. Clinical Sensitivity:
   The clinical performance of the BD Kiestra MRSA App was evaluated at three testing sites (2 US and 1 outside US). Remnant anterior nares specimens that were leftover from standard of care for surveillance screening were processed per the BD Kiestra MRSA App instructions for use and evaluated for plate growth and color after 24 hours of growth with the BD Kiestra ReadA Compact. After the plates were imaged, two trained and proficient operators evaluated the digital image for plate growth and color to be compared with the BD Kiestra MRSA App result. A third operator (arbiter) performed an additional, blinded evaluation if the results between the two operators did not agree. If all three operators provided different results, the readings were considered “non-compliant”. A total of 1775 images were evaluated; 1609 images were compliant. An additional 16 images were excluded from analysis due to mixed purity growth that could not be interpreted for color. Results for the remaining 1593 images are summarized in **Table 11**. The overall agreement of the BD

Kiestra MRSA App is 76.6% for "no growth", 84.5% for "non-mauve growth", and 98.2% for "mauve growth" detection. These performance results are acceptable since all digital plate images will be reviewed by a trained microbiologist.

Table 11. BD Kiestra MRSA App Clinical Study Performance

		Microbiologist Interpretation of Digital Image			
		No Growth	**Non-Mauve**	**Mauve**	**Grand Total**
BD Kiestra MRSA App	**No Growth**	773	9	1	783
	Non-Mauve	237	207	5	449
	Mauve	13	29	319	361
	Grand Total	**1023**	**245**	**325**	**1593**
	No Growth Percent Agreement: 75.6% (773/1023) Non-Mauve Percent Agreement: 84.5% (207/245) Mauve Percent Agreement: 98.2% (319/325)				

2. Clinical Specificity:
   Not applicable

3. Other Clinical Supportive Data (When 1. and 2. Are Not Applicable):
   Not applicable

D Clinical Cut-Off:
Not applicable

E Expected Values/Reference Range:
A summary of the number and percentage of samples with "no growth", "non-mauve growth", and "mauve growth" interpretations, as determined by a panel of microbiologists and the BD MRSA App is summarized in **Table 12**.

Table 12. Microbiologist (comparator) and BD MRSA App Results from Clinical Study

Interpretation	Microbiologist (comparator)	BD Kiestra MRSA App
No Growth	1023 (64.2%)	784 (48.7%)
Non-Mauve Growth	245 (15.4%)	456 (28.3%)
Mauve Growth	325 (20.4%)	369 (22.9%)
TOTAL	1593[a]	1609

[a]16 results excluded from analysis due to CHROMagar MRSA plates with mixed purity growth that could not be interpreted for color.

VIII Proposed Labeling:
The labeling supports the finding of substantial equivalence for this device.

IX Conclusion:
The submitted information in this premarket notification is complete and supports a substantial equivalence decision.