Hybridization is performed at 55°C. The mixture of fluorescein-labeled and tetramethylrhodamine-labeled PNA probes hybridizes to specific Gram-negative bacilli on smears from positive blood cultures containing Gram-negative bacilli on Gram stain.

Sub-culturing of positive blood cultures is necessary to recover organisms for susceptibility testing and/or differentiation of mixed growth. The Gram-Negative QuickFISH BC assay is indicated for use as an aid in the diagnosis of *E. coli*, and/or *K. pneumoniae*, and/or *P. aeruginosa* bacteremia.

### Summary and Explanation

*E. coli*, *P. aeruginosa*, and *K. pneumoniae* are recognized as causes of both community and hospital acquired bacteremia. The identification of *E. coli*, *P. aeruginosa*, and *K. pneumoniae* in blood cultures is routinely based on presumptive identification as gram-negative bacilli (GNB) followed by final identification after subculture and biochemical analysis (1).

Gram-Negative QuickFISH is a multicolor fluorescence in situ hybridization (FISH) method using PNA probes hybridizing to specific ribosomal RNA sequences of *E. coli*, *P. aeruginosa* and *K. pneumoniae* (including the three subspecies: *pneumoniae*, *ozaaeae* and *rhinoscleromatis*). The test provides rapid identification of *E. coli*, *P. aeruginosa*, and *K. pneumoniae* on smears made from positive blood cultures.

### Principle of the Procedure

A mixture of fluorescein-labeled *E. coli* specific PNA probe, tetramethylrhodamine labeled *P. aeruginosa* specific PNA probe and fluorescein and tetramethylrhodamine labeled *K. pneumoniae* specific PNA probe are added to a smear prepared from a positive blood culture. Hybridization is performed at 55 ± 1 °C for 15 min. and the smear is examined by fluorescence microscopy.

### Reagents

Gram-Negative QuickFISH BC FISH is comprised of the following kit components:

- **Gram-Negative PNA Blue**
  - 0.85 mL PNA probes in hybridization solution. Contains 15% formamide.

- **Gram-Negative PNA Yellow**
  - 0.85 mL PNA probes in hybridization solution. Contains 15% formamide.
Storage and Preparation of Kit Components

To ensure optimal kit performance, it is important that kit components are stored according to the following instructions:

Store kit components at 2-8 °C. Store bottles upright and tighten caps after use. Reagents are supplied ready for use.

QuickFISH slides are provided in individually sealed pouches with nitrogen and a desiccant. Store slides at 2-8 °C. Slides must be used immediately after breaking pouch seal. Do not use slides after the expiration date.

Specimen Collection and Preparation

Preparation of Gram-Negative QuickFISH Smears

Gram-Negative QuickFISH BC is not compatible with blood culture media containing charcoal or VersaTREK REDOX 2 blood culture bottles.

- Follow the blood culture system manufacturer’s instructions to properly mix the blood culture bottle before smear preparation.
- Place slide on SlideStation at 55 ± 1 °C. When running multiple samples, ensure slides do not come in contact with each other to avoid contamination.
- Do not allow dropper bottle tip to touch the smear as this may cause cross contamination of material between slides, or cause contamination of the reagent.
- Add 1 or more drops of blood culture sample into a secondary vessel (e.g., microcentrifuge tube).
  - For bottles containing resin beads – Add 10 or more drops of sample to an AdvanDx Filter vial. Do not exceed fill line. Insert the filter plunger into the vial and push all the way down to remove the resin beads.
  - Remove cap of AdvanDx Filter Vial to access sample for smear preparation.
- Ensure the blood culture sample is well mixed, using the AdvanDx 10 µL Pipette, transfer 10 µL of sample to the center of the sample area of a QuickFISH slide. Refer to reference 2 in the QuickFISH Slide Diagram.
- Immediately place one drop of QuickFix-1 onto the sample and spread evenly throughout sample area with a plastic inoculating needle. Avoid air bubbles.
- Allow the smear to dry (~1 minute). Smear must be visibly dry.
- Add two drops of QuickFix-2 to the center of the sample area. Refer to reference 3 in the QuickFISH Slide Diagram.
- Allow the smear to dry (~1 minute). Smear must be visibly dry.
- Fixed QuickFISH smears may be left on the slide warmer at 55 ± 1 °C for up to 5 minutes. Prepared smears which are not used within 5 minutes can be kept at room temperature for 1 hour prior to testing or may be stored at 2-8 °C for up to 1 day before testing.

QuickFISH Slide Diagram

Test Procedure

Material Provided
Gram-Negative QuickFISH BC QFGNRBC1-25

Each kit contains sufficient material for 25 tests. Reagents are supplied ready for use. The expiration date of the kit is as indicated on the outer box label.

Material Required and Available from AdvanDx

<table>
<thead>
<tr>
<th>Name</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Coverslips 50 x 24 mm No. 1 Glass coverslip</td>
<td>AC027</td>
</tr>
<tr>
<td>AdvanDx Microscope Filter</td>
<td>AC007</td>
</tr>
<tr>
<td>AdvanDx Metal Halide Filter</td>
<td>AC033</td>
</tr>
<tr>
<td>AdvanDx SlideStation-10 Slide warmer (55 ± 1°C)</td>
<td>AC028</td>
</tr>
<tr>
<td>QuickFISH Coverslip Mixing Station</td>
<td>AC030</td>
</tr>
<tr>
<td>AdvanDx Filter Vials Sample filtration device</td>
<td>AC008</td>
</tr>
</tbody>
</table>

*QuickFISH Slide, QuickFix-1, and QuickFix-2 are available in the QuickFISH Fixation Kit.

Material Required but Not Provided

- Fluorescence microscope equipped with a 60x or 100x oil objective and a high pressure mercury vapor arc lamp, modified mercury vapor arc lamp (metal halide) or light source with equivalent spectral output.
- Immersion oil. Must comply with the microscope objective and be non-fluorescent.
- Pipette tips
- Plastic inoculating needles.

Assay Procedure:

- QuickFISH smears should be tested immediately following fixation; however, if smears were stored at 2-8 °C or room temperature they must be placed on the slide warmer for approximately 5 minutes at 55 ± 1 °C before adding the hybridization reagents.

Hybridization

- Place a coverslip onto one of the QuickFISH Coverslip Mixing Station slots. Refer to Diagram #1.
- Invert and hold each bottle and allow a drop to form in the dropper tip before squeezing the bottle to avoid formation of foam in the hybridization mixture.
- Add one drop of Gram-Negative PNA Blue to the center of the coverslip. Note: the ovoid cutout of the QuickFISH Coverslip Mixing Station slot denotes the center of the coverslip. Place one drop of Gram-Negative PNA Yellow directly on top of the first drop. Avoid air bubbles. Refer to Diagram #1.
- Thoroughly mix PNA Blue and PNA Yellow together using a plastic inoculating needle until they produce a uniform green color, or no identifiable blue or yellow color remains. Spread lengthwise in order to fill the ovoid template. Refer to Diagram #2.
Flip coverslip and apply to slide aligning the edges with the printed border markers on the slide. The coverslip must be placed within the markers. If the coverslip is placed on the white frosted area, the assay may fail due to insufficient flow of reagents.

Incubate for 15 - 20 min. at 55 ± 1 °C.

Note: Avoid cross contamination of bottles. Replace dropper caps on appropriate bottles.

Examine slides as described below
Do not expose the slides to direct sunlight or strong light sources as this may lead to fluorescence bleaching.

Quality Control
Quality control for fluorescent testing should be performed each time testing is performed.

Control material should be tested in accordance with guidelines or requirements of local, state, and/or federal regulations or accrediting organizations.

Use QuickFISH Slides with Controls (CS012). QuickFISH slides are provided in individually sealed pouches with nitrogen and a desiccant. Store slides at 2-8 °C. Slides must be used immediately after breaking pouch seal. Do not use slides after expiration date.

The Positive Control will display multiple fluorescent green, red and yellow bacilli. The Negative Control will not contain fluorescent cells. Positive (POS, +) and Negative (NEG, -) control wells contain representative organisms for all AdvanDx QuickFISH BC kits. Control organisms for other kits may be weakly visible (non-fluorescent) in both the Positive and Negative Control wells.

Cell morphology may vary between samples and controls due to natural variations.

If the Positive and Negative Controls do not perform in accordance with the Interpretation of Results below, results are invalid and patient results should not be reported.

Locating Controls:
Align the center of the microscope objective with the dts of the POS (+) well on the QuickFISH Slide (See QuickFISH Slide Diagram). Move the slide stage forward or backward until the green outline of the well appears in the field of view. Use the fine focus knob to focus on the green well outline (this is the correct focal plane for reading the slide). Move the objective into the central region of the POS control to view. To view the NEG control, move the objective laterally into the center of the NEG well. Continue moving laterally to find the viewing area of the sample well.

Procedural Notes
Major Blood Culture Systems and Bottle Type Compatibility:
The QuickFISH platform is compatible with commercially available continuously monitoring blood culture systems and bottle types except bottle types supplemented with charcoal and the VersaTREK REDOX 2 Anaerobic bottle. The bottle types tested were:

Clinically:
BacT/ALERT (SA, SN), BACTEC (Lytic/10 Anaerobic/F, Plus Aerobic/F, Standard/10 Aerobic/F)

Analytically:
VersaTREK REDOX 1 Aerobic, BACTEC (Plus Anaerobic/F, Standard/10 Aerobic/F, Standard/10 Anaerobic/F, Peds Plus/F). The clinical performance of these blood culture bottle types with the Gram-Negative QuickFISH BC has not been established.

Temperature Control:
It is important that the AdvanDx SlideStation-10 is level and equilibrated to 55 ± 1 °C prior to the test procedure.

Interpretation of Results
Read slides within 2 hours after hybridization.

Examine slides using a fluorescence microscope equipped with a 60x or 100x oil objective and either the AdvanDx Microscope Filter or AdvanDx Metal Halide Filter. The smear background appears reddish in color. E. coli is identified as multiple bright green fluorescent bacilli in multiple fields of view, whereas P. aeruginosa is identified as multiple bright red fluorescent bacilli in multiple fields of view and K. pneumoniae is identified as multiple bright yellow fluorescent bacilli in multiple fields of view. Gram-Negative bacilli that are not E. coli, K. pneumoniae, or P. aeruginosa appear non-fluorescent. Floating organisms or debris should not be interpreted or confused with positive organisms.

Representative examples of green-positive E. coli (top-left); yellow-positive K. pneumoniae (top-middle); red-positive P. aeruginosa (top-right); mixture of green-positive E. coli, yellow-positive K. pneumoniae and red-positive P. aeruginosa (bottom-left). Negative test results with reddish background (bottom-middle).

Troubleshooting
False Positive and/or Negative Control and Sample test results may occur if the AdvanDx Microscope Filters are not used, or by contamination of the specimens.

False Negative Control or Sample test results may occur if AdvanDx QuickFISH Slides (CS012) are not used or if the temperature is not accurately controlled during hybridization.

Please refer to the Precautions and Limitations sections in this product insert or contact AdvanDx.

The lid on the SlideStation is not required to be in place for the kit to perform properly.

The assay may be sensitive to small changes in drop volumes of Gram-Negative PNA Blue and Gram-Negative PNA Yellow. If foam is dispensed from bottles, DO NOT USE, discard the coverslip and prepare a new one using fresh hybridization reagents.

Limitations

- Gram-Negative QuickFISH BC is not compatible with blood culture media containing charcoal or VersaTREK REDOX 2 blood culture bottles.
- False Green-Positive results will occur with Shigella spp. (serogroups A, B, C, and D), Escherichia albertii and Escherichia fergusonii due to rRNA sequence similarity.
- False Red-Positive results will occur with Brevundimonas diminuta, Herbaspirillum hutteniense, Pseudomonas fulva, Acinetobacter radioresistens and some strains of Pseudomonas putida.
- False Yellow-Positive results will occur with Escherichia vulneris and Klebsiella varicola.
- Clinical studies were conducted using the BACTEC Plus Aerobic/F, BACTEC Lytic/10 Anaerobic/F, BacT/ALERT SA and SN blood culture bottles. The performance of Gram-Negative QuickFISH BC with other blood culture bottle types has not been established.
• BACTEC Plus Anaerobic/F and BACTEC Ped’s Plus/F bottles were not extensively evaluated during the clinical investigation, and therefore the performance has not been adequately established.
• The performance of VersaTREK REDOX 1 and BACTEC (Standard/10 Aerobic/F, Standard/10 Anaerobic/F) blood culture bottles was evaluated in an internal compatibility study only. Therefore, the performance is unknown.
• False Positive green autofluorescence may occur if a standard FITC filter is used instead of AdvanDx Microscope Filters.
• False negative results may infrequently occur due to mixed growth or due to error in assay technique.
• The type and condition of the instrumentation used will influence the visual appearance of the image obtained. The fluorescence may vary due to the type of microscope employed, the light source, and the level of rRNA in the cells. Each laboratory should establish its own criteria for reading the results using appropriate controls.
• False-Negative K. pneumoniae or False-Positive green results may occur, leading to misidentification of K. pneumoniae as E. coli if light sources other than high pressure mercury vapor arc lamps and modified mercury vapor arc lamps (metal halide) are used.
• Isolation on solid media is needed to differentiate mixed growth with other organisms and to identify positive blood cultures yielding a negative FISH result.
• The product has not been validated with specimens other than blood cultures.

Expected Results

The clinical study population of Gram-Negative-positive blood culture bottles was derived from 5 healthcare centers in the United States and included 306 blood cultures from 263 patients and 43 spiked samples. The E. coli, P. aeruginosa and K. pneumoniae positive result rates ranged from 23-38%, 0-12%, and 19-33% respectively. Other gram-negative organisms were identified in 25-48% of the samples.

The rates presented are a percentage of unique patient blood cultures (multiple samples from the same patient and spiked samples were not included) as identified by routine methods as a percent of the total number of all species identified in the studies. Rates of positive and negative species results obtained with Gram-Negative QuickFISH BC may vary depending on institution and patient population (2).

Performance Characteristics

The clinical study population of Gram-Negative-positive blood culture bottles was derived from 5 health care centers in the United States and included 306 blood cultures from 263 patients and 43 spiked samples. The sensitivities of Gram-Negative QuickFISH BC against routine laboratory methods are 96.8% (91/94) for E. coli, 98.1% (52/53) for P. aeruginosa, and 100% (60/60) for K. pneumoniae, and the specificity is 99.0% (99/100) from positive blood culture bottles containing gram-negative bacilli.

Clinical Performance Data for Gram-Negative QuickFISH BC vs. Routine Identifications on GNB-positive Blood Culture Bottles

<table>
<thead>
<tr>
<th>E. coli</th>
<th>P. aeruginosa</th>
<th>K. pneumoniae</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli</td>
<td>91.3%</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>P. aeruginosa</td>
<td>0</td>
<td>52.0%</td>
<td>0</td>
</tr>
<tr>
<td>K. pneumoniae</td>
<td>1</td>
<td>0</td>
<td>60.7%</td>
</tr>
<tr>
<td>Negative</td>
<td>2</td>
<td>1</td>
<td>99</td>
</tr>
</tbody>
</table>

Limit of Detection

The analytical sensitivity of Gram-Negative QuickFISH BC as measured as the detection limit of the assay for E. coli, P. aeruginosa, and K. pneumoniae was determined to be approximately 2.3x10^3, 4.0x10^5 and 4.5x10^6 CFU/mL, respectively by serial dilutions. This is consistent with the analytical sensitivity of other slide-based staining techniques.

Analytical Specificity and Sensitivity (inclusivity)

Gram-Negative QuickFISH BC was tested on 152 reference and clinical laboratory samples including 16 strains of E. coli, 21 strains of P. aeruginosa, and 12 strains of K. pneumoniae. All 16 strains of E. coli tested green-positive, all 21 strains of P. aeruginosa tested red-positive, and all 12 strains of K. pneumoniae tested yellow-positive. In addition to these three target species, testing included 86 strains of other gram-negative bacilli. Seventy-eight of these produced the expected negative results. The following 5 strains produced False Positive green results: Escherichia albertii, Escherichia fergusonii, and Shigella serogroups A,B C and D. The following 3 strains produced False Positive red results: Pseudomonas fulva (2 strains) and Acinetobacter radioresistens. Testing also included of 17 strains of other bacteria (11) and yeast (6), all of which tested negative.

Reproducibility

A reproducibility study was performed with Gram-Negative QuickFISH BC and the results are presented below by site across 3 days and by day across 3 sites, with 2 operators at each site.

Summary of Reproducibility Results by Site Across 3 Days

<table>
<thead>
<tr>
<th>Site</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Agreement Green</td>
<td>42/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Positive Agreement Red</td>
<td>42/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Positive Agreement Yellow</td>
<td>45/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Negative Agreement</td>
<td>42/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Total Agreement</td>
<td>95.0%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Summary of Reproducibility Results by Day Across 3 Sites

<table>
<thead>
<tr>
<th>Day</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Agreement Green</td>
<td>42/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Positive Agreement Red</td>
<td>45/45</td>
<td>42/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Positive Agreement Yellow</td>
<td>45/45</td>
<td>45/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Negative Agreement</td>
<td>45/45</td>
<td>42/45</td>
<td>45/45</td>
</tr>
<tr>
<td>Total Agreement</td>
<td>98.3%</td>
<td>96.7%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Bibliography

Definitions

<table>
<thead>
<tr>
<th>REF</th>
<th>Product code/catalog number</th>
<th>LOT</th>
<th>Batch code</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>Consult the instructions for use</td>
<td></td>
<td>Storage temperature limitations</td>
</tr>
<tr>
<td>✓</td>
<td>Contains sufficient for &lt;n&gt; tests</td>
<td></td>
<td>Health Hazard</td>
</tr>
<tr>
<td></td>
<td>Manufacturer</td>
<td></td>
<td>Skull and Crossbones</td>
</tr>
<tr>
<td>EC REP</td>
<td>Authorized Representative</td>
<td></td>
<td>Flame</td>
</tr>
<tr>
<td>Use by</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technical Advice and Customer Service

For all inquiries, please contact OpGen or your local distributor.

OpGen, Inc.
708 Quince Orchard Rd
Gaithersburg, MD 20878
USA

Tel: +1 301 869 9683
Fax: +1 301 869 9684

Curetis GmbH
Max-Eyth-Straße 42
71088 Holzgerlingen,
Germany

Tel: +49 7031 49195 10
Fax: +49 7031 49195 19

techsupport@opgen.com
www.OpGen.com

Produced under license from Boston Probes, Inc.
The product must not be used for Slide-Based human Cytochemistry,
ISH-based Cancer Cytogenetics and Flow Cytometry.

30 April 2020
PN2014J-EN
DCR 20-0034

Purchase of this kit licenses its use under patent numbers: US 5,985,563; US 5,888,733;
US 6,664,045; US 6,395,474; US 6,357,163; US 5,539,082; US 7,223,833; US 6,361,942;