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Brief Report

Utility of BioFire FilmArray Gastrointestinal Panel in the Diagnosis of Gastrointestinal Infections

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Abstract

Background Conventional diagnostic methods like culture and microscopy are time-consuming and have low diagnostic yield for gastrointestinal infections. New rapid molecular methods such as multiplex polymerase chain reaction (PCR) have recently been introduced for etiological diagnosis. The aim of this study was to evaluate the utility of the FilmArray gastrointestinal panel (GIP) in the diagnosis of gastrointestinal infections.

Materials and Methods This is a retrospective study performed in the microbiology department of a tertiary care hospital. Stool samples were received and processed according to the manufacturer's instructions by FilmArray GIP. Stool culture and routine microscopy were also performed.

Results The mean age of the 32 patients was 46 ± 24.2 years and with a male-to-female ratio of 1:1. Out of 32 stool samples received for testing by BioFire GIP, 23 samples (71.9%) were found to be positive for one or the other target. A total of 41 targets were detected from 23 positive patients, with predominant bacterial etiology (65.9%) followed by parasitic (31.7%) and viral (4.9%). *Giardia lamblia* was the most common (26.8%) target detected in all age groups. Additionally, in 56.5% of patients, more than one target was detected. The stool culture was positive in 2 of the 16 patients (12.5%).

Conclusion The FilmArray GIP showed very good diagnostic performance compared with culture for the diagnosis of gastrointestinal infections. Further studies are needed to determine whether multiplex PCR improves patient outcomes and reduces costs.

Keywords
- gastrointestinal infections
- FilmArray gastrointestinal panel
- stool culture

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Introduction

Gastrointestinal infections (GIs) are linked to high rates of morbidity and mortality worldwide.[1] Acute gastroenteritis was responsible for 1.45 million deaths per year as per the Global Burden of Disease Study 2016. The U.S. data show that approximately 179 million individuals suffer from diarrheal diseases each year.[2]

An extensive array of pathogens has been recognized to be responsible for overlapping symptoms such as vomiting, diarrhea, abdominal pain, and fever[3–5] and hence cannot be related to a specific pathogen, most of the time. Nonjudicious use of antibiotics in viral, parasitic, or uncomplicated bacterial gastroenteritis may lead to the development of antimicrobial resistance or have serious consequences. For example, the use of antibiotics for *Escherichia coli* O157 infection may increase the chances of hemolytic uremic syndrome.[6,7] Therefore, a rapid and precise identification of etiological agents is warranted for targeted therapy.

Stool culture is considered the gold standard diagnostic method for the diagnosis of bacterial gastroenteritis. However, microscopic examination is important in the diagnosis of parasitic infections. Additionally, immunoassays have some role in the diagnosis of bacterial, viral, and parasitic infections. But most of these tests lack either sensitivity or specificity and also only one pathogen can be tested at one instance.[8,9]

The syndromic approach for the simultaneous identification of multiple pathogens with common clinical presentation, based upon multiplex polymerase chain reaction (PCR), is gaining more and more importance. One such platform is the BioFire FilmArray (BioFire Diagnostics, Inc., Salt Lake City, UT, United States), which provides different panels for the detection of common pathogens (bacteria, viruses, and parasites) associated with diverse infectious conditions, including respiratory tract infections, meningitis, and GIs.

Gastrointestinal panel (GIP) can simultaneously detect 22 targets within an hour. Specificity and sensitivity of the GIP have been reported to vary between 95 and 97% and 94 and 100%, respectively.[10,11]

The study aimed to investigate the role and utility of FilmArray GIP in the diagnosis of GIs.

Materials and Methods

Stool samples were collected from the patients presenting with diarrhea and sent to the microbiology laboratory to be tested for BioFire FilmArray. The samples received between January and December 2022 were included in the study. The samples were immediately processed after receiving in the laboratory, according to the manufacturer's instructions. Briefly, stool samples were transported into Cary Blair transport media and the tube was inverted several times. Afterward, a hydration solution was injected into the FilmArray GI pouch, 200 µL of homogenized sample was mixed with the provided buffer, and the mixture was injected into the test pouch (provided with all necessary reagents in a freeze-dried state). The pouch was inserted into the instrument. At the end of each run (approximately 1 hour per each sample), results were obtained in the system and recorded.

The BioFire FilmArray system detects the following targets[11]:

- Bacteria: *Campylobacter jejuni*, *C. coli*, *C. upsaliensis*, *Clostridioides difficile*, *Plesiomonas shigelloides*, *Salmonella* spp., *Yersinia enterocolitica*, *Vibrio parahaemolyticus*, *V. vulnificus*, and *V. cholera*; six diarrheagenic *Shigella* spp./*E. coli: enteroaggregative E. coli* (EAEC), *enteropathogenic E. coli* (EPEC), enterotoxigenic *E. coli* (ETEC), *Shiga*-like toxin producing *E. coli* (STEC), *E. coli* O157, and *enteroinvasive E. coli* (EIEC)/*Shigella* spp.
- Parasites: *Cryptosporidium*, *Cyclospora cayetanensis*, *Entamoeba histolytica*, and *Giardia lamblia*.
- Viruses: Adenovirus F40/41, astrovirus, norovirus GI/GII, *Rotavirus A*, and sapovirus.

Stool culture and routine microscopy were also performed for the stool samples received.

Results

A total of 32 stool samples received for GIP BioFire FilmArray, from admitted patients, were included in the study. The age of these patients varied from 10 to 82 years, with a mean age of 46 ± 24.2 years, and a male-to-female ratio was 1:1. Out of these patients, 71.9% (23 patients) of the GIP was found to be positive for at least one or more gastrointestinal pathogen. A total of 41 targets from these patients were detected, including 27 (65.9%) bacterial, 2 (4.9%) viral, and 13 (31.7%) parasitic. *G. lamblia* was the most common (26.8%; 11/41) target detected, followed by EPEC (14.6%; 6/41) and EAEC (12.2%; 5/41).

The analysis of pathogens by age group showed that within the 0- to 10-year age group (3 patients were positive in this group and all were of 10 years), the most common pathogen was *G. lamblia* followed by EAEC, EIEC/*Shigella*, and *Salmonella*. Similarly, *G. lamblia* and EPEC were the most prevalent agents in the 11- to 20- and 21- to 60-year age groups. In patients older than 60 years, infections with *G. lamblia* along with EAEC, EIEC/*Shigella*, and *Salmonella* were common (►**Fig. 1**)

A single target was detected in only 10 (43.5%) samples and two targets were detected in 7 (53.8%) samples. On the other hand, six (46.2%) of the specimens were positive for three gastrointestinal pathogens simultaneously. The distribution of these targets is shown in ►**Fig. 2**.

Stool culture was received in only 16 patients and positive in only 2 patients (*Shigella* spp. and *V. parahaemolyticus*: one each). In stool routine microscopy, *G. lamblia* was detected in two samples.

Discussion

In this study, we evaluated the utility of syndromic testing in the diagnosis of GIs. The diagnostic yield was found to be higher using the FilmArray GIP: one or more pathogen was detected in 71.9% of the patients compared with 12.5% by

Fig. 1 Distribution of targets ($N = 41$) detected by gastrointestinal panel. EAEC, enteroaggregative *Escherichia coli*; EIEC, enteroinvasive *E. coli*; EPEC, enteropathogenic *E. coli*; ETEC, enterotoxigenic *E. coli*.

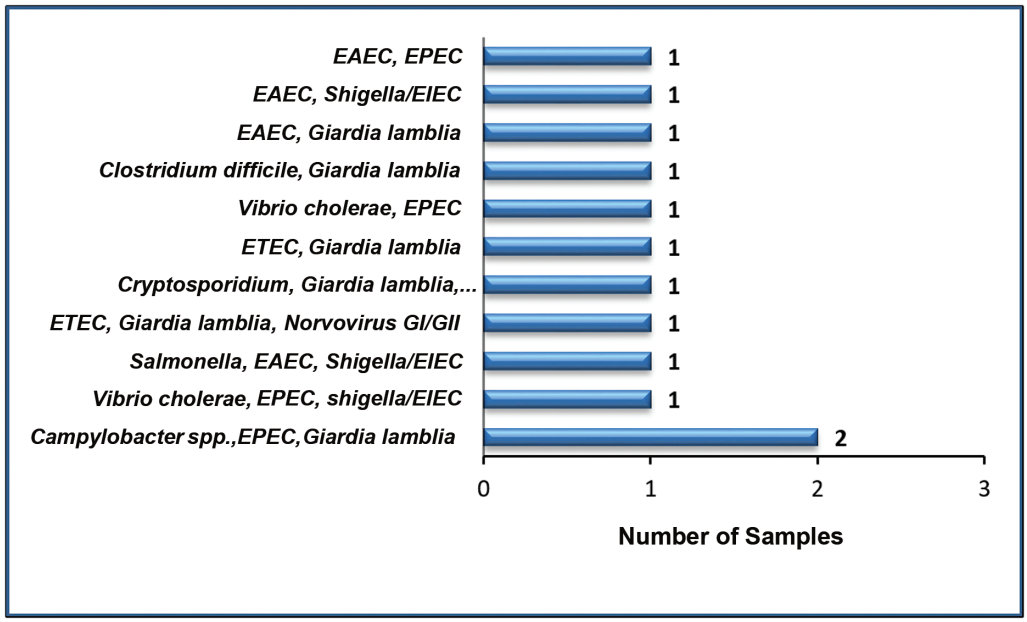

Fig. 2 Coinfections detected in gastrointestinal-positive specimens. EAEC, enteroaggregative *Escherichia coli*; EIEC, enteroinvasive *E. coli*; EPEC, enteropathogenic *E. coli*; ETEC, enterotoxigenic *E. coli*.

routine stool culture. Similar observation has also been made by Baiya et al, who reported a positivity of 57.3% by multiplex PCR and 20.9% of stool culture.[12] Another Indian study also detected one or the other targets by FilmArray GIP in 50.9% of the samples in contrast to 17.6% by stool culture.[13] In line with previously conducted studies,[12,14] in the present study, FilmArray detected bacterial pathogens that were difficult to cultivate or difficult to identify using conventional methods, for example, *Campylobacter*, EPEC, ETEC, EAEC, EIEC, and *C. difficile*. Additionally, parasitic targets were detected in 31.7% of the clinical samples by FilmArray including *Cryptosporidium* spp. and *G. lamblia*, which are generally missed out in the microscopic examination.

Conventionally viral etiology may be identified in patients with GIs by electron microscopy, tissue culture, or immunological assays. However, there is limited availability of these investigations in most of diagnostic laboratories. In the present study, viral targets could be detected in 4.9% of the total targets detected. However, another study identified viral etiology in 13% of patients using FilmArray. In concordance with the current study, the most commonly found virus was norovirus.[12]

In our study, more than one target was detected in 56.5% of samples. Nonetheless, previous studies have reported a variable range (10.2–51.7%) of coinfections responsible for GIs.[13,15] The notable coinfection rates are a challenge for determining the exact etiology, as some of the pathogens may be regarded as irrelevant; for example, the presence of *C. difficile* in infants and young children is thought to be asymptomatic colonization.[16]

Using the FilmArray, turnaround time was significantly shortened compared with routine investigations, which may result in decreased hospital stay and outcome. Further early detection of viral and parasitic targets helps reduce the nonjudicious use of antibiotics and emergence of antimicrobial resistance, which is the need of the hour. In addition, it provides a comprehensive, rapid, and streamlined alternative to conventional methods for the etiologic diagnosis of infectious gastroenteritis in the laboratory setting.

Almost all the required targets are available in the FilmArray GIP, as per the recommendations for fecal microbiota transplantation (FMT). It has further been suggested that multiplex PCR gastrointestinal pathogen panels could potentially help in selecting an ideal donor for FMT, since screening stool for potential pathogens (bacterial, viral, and parasitic agents) is a critically important step in reducing risk to FMT recipients.[17]

Clinical judgment combined with multiplex PCR can provide an approach to infectious gastroenteritis that is both rapid and accurate. Further research is needed to understand the optimal use, cost-effectiveness, and interpretation of multiplex PCR methods in the diagnosis of infectious diarrhea, specifically when more than one target is detected.

Ethical Statement
Not applicable.

Author Contributions
All authors contributed equally to the article.

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There is no data associated with this work.

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Conflict of Interest
None declared.

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