

Comparison of Check-Point PCR to Multi-Resistant Gram Negative Screening Media for the detection of Carbapenemase Producing Enterobacteriaceae.



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BACKGROUND/ INTRODUCTION

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Carbapenemase producing Enterobacteriaceae (CPE) are an emerging threat to public health. CPE display partial or complete resistance to carbapenem antibiotics and other B-lactams, reducing treatment options for those infected or colonised. Rapid identification of positive patients is essential for prompt treatment & infection control measures in order to reduce transmission. Infections with CPE are associated with increased morbidity & mortality compared to infections with susceptible Enterobacteriaceae. Length of hospital stay and invasive devices are predictors for high mortality (PHE, 2013).

The Sheffield Teaching Hospitals NHS Trust (STH) Spinal Injuries Unit (SIU) is a centre focused on provision of specialist intensive therapy for those with decreased ability after injury, accident or neurological conditions. The long term nature of the patients and the frequent use of invasive devices makes this unit of particular interest for CPE detection.

Since August 2012, 7 patients on the SIU have acquired CPE at STH. The SIU is one of seven in the country and patients may have been treated abroad, increasing the risk of CPE importation. Culture is time consuming and relies on reference laboratories for confirmation, so exploration of alternative techniques for CPE detection was needed.

The vast majority of carbapenemase enzyme production is plasmid encoded, with the following 4 types: KPC, VIM, OXA-48 and NDM. We compared the CRE Brilliance medium (Thermo fisher Scientific), Check-Direct CPE for BD Max (Check Points Health BV, Beckton Dickinson) with current in-house culture based methods used in CPE detection at STH.

The BD MAX platform is a fully automated, walk away system which is capable of running user defined protocols from third party manufacturers. Extraction can be performed on or off board and little skill or hands on time is required for the setup of the assay. Sample preparation was approximately 20-30 minutes with a run time of 2.5 hours for 24 samples, including extraction.



The BD MAX system

Detector	475/520	530/565	585/630	630/665	680/715
Channel	1	2	3	4	5
Target	KPC	VIM	OXA-48 like	NDM	SPC*

*SPC: Sample Preparation Control

Table 1: Multiplex PCR targets and detectors for positive control and samples

The Check-Direct CPE assay is a real time multiplex PCR designed for the rapid detection of the genes encoding KPC, VIM, OXA-48 and NDM carbapenemases using specific recognition and amplification of target sequences, alongside fluorescent probes for real time detection. The four target sequences use different reporter dyes and the PCR has been optimised to minimise cross talk between the signals. The intended sample type is fresh bacterial culture. This study focused on whether directly inoculating the charcoal swab into the sample diluent tube would produce satisfactory results.

CRE brilliance medium is a selective chromogenic agar for the presumptive identification of CRE including; *Escherichia coli*, *Klebsiella pneumoniae*, *Enterobacter sp*, *Serratia sp* and *Citrobacter sp* (KESC) organisms, in 18 hours. The media is suitable for inoculation with rectal swabs, faecal swabs and for use as a sub-culture plate. The media contains a modified carbapenem, at a level 'recommended by the European Committee on Antimicrobial Susceptibility Testing (EUCAST) and the Clinical and Laboratory Standards Institute (CLSI), in order to screen out organisms which may be CPE's.



Figure 2: Expected Results of CRE Brilliance Media

Figure 1: BD MAX Instrument & Check-Direct PCR for CPE detection.

AIMS

To assess the impact Check-Point CPE may have if implemented as a screening tool on patients within STH and infection control procedures.

To validate charcoal swabs for Check-Point PCR.

To compare Oxoid CRE Brilliance to in-house media.

MATERIALS AND METHODS

111 rectal swabs were received over the course of several weeks from patients on the SIU. The following workflow was observed: Swabs were inoculated onto 1/2 CLED containing Ertapenem 0.5mg/L and 1/2 a plate CRE Brilliance media. Plates were incubated at 37°C for 24h.

Plates read for growth at 24h and negative cultures reincubated for a further 24h, as per manufacturer guidelines. After culture, swabs were inoculated directly into BD DNA Sample buffer tubes. These were vortexed and pulse spun to remove as much of the charcoal from the suspension as possible.

Check-Direct CPE protocol was installed onto the BD MAX system. Setup and assay performance was carried out according to manufacturers' guidelines. Specimen preparation and extraction performed using BD MAX™ ExK™ DNA-1 Extraction Kit. Interpretation of amplification curves and crossing threshold (CT) values by the BD MAX software was double checked visually prior to accepting results.

RESULTS

111 Swabs were tested by PCR and in-house culture methods. Of the valid results 72 were negative, 6 positive (see figure 3) and 6 inhibitory. The 6 positive samples contained an NDM producing *E.coli* (2), *E.aerogenes* (2), *S.marcesens* and *K.pneumoniae*. The remaining 27 results were void as one or all of the targets in the positive control failed to amplify. All PCR positives were confirmed by culture.

53 specimens were cultured onto CRE Brilliance media, bacterial growth was observed in 10 cases. These isolates were identified and antibiograms produced. All isolates were found to be susceptible to carbapenems. At this stage the CRE Brilliance media was withdrawn from the study as it had failed to isolate 5 CPE that were identified by PCR and the in-house method.

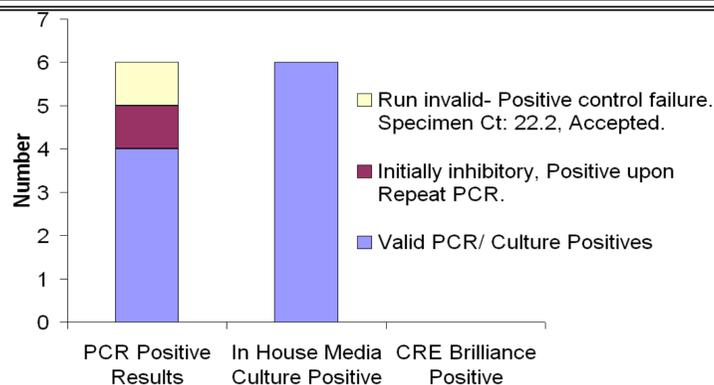


Figure 3: Summary of Positive Results.



Figure 4. Left: NDM Positive *E.coli* at 24h on CLED+ Ertapenem. Right: Same sample on CRE Brilliance at 48h.

CONCLUSIONS

Check-Direct CPE PCR is a rapid and reliable alternative to culture for the detection of CPE from rectal swabs, with results available within 4 hours. Conventional methods may take up to 72 hours to produce comparable results, delaying the implementation of relevant infection control measures.

The presence of charcoal in the samples did not appear to adversely affect PCR performance. It would be useful to carry out further evaluation with a direct comparison between charcoal and non-charcoal containing swabs, however time and resource constraints prevented this from being achieved.

The performance of the BD MAX was satisfactory overall however we experienced some technical issues which BD technicians quickly resolved. Assay setup was simple and efficient with minimal technical ability required. In order to further simplify setup of the assay on the BD MAX, Check-Points is now introducing the Check-Direct CPE in a 'snap in' tube format reducing preparation time and bubble formation (cause of positive control failure in this study). The positive controls are also now combined in a single tube further improving robustness.

In this study, performance of the CRE Brilliance media was sub-optimal. It should be noted however that the NDM strain isolated has an unusual antibiogram. Without further information about the media we cannot conclude why the organisms were not cultured successfully.