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Point-of-care tests for infectious diseases: barriers to implementation across three London teaching hospitals

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Left running header: *Bustinduy and others*

Right running header: *Implementation barriers for POCT*

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List of abbreviations

POCT- Point-of-care tests

CRP-C-reactive protein

RSV- Respiratory Syncytial Virus

NHS- National Health Service

ED- Emergency Department

KCH- King's College Hospital

SGH-St George's Hospital

GSTT- Guy's and St Thomas' Hospital

PCR-Polymerase Chain Reaction

AMR- Antimicrobial Resistance

Existing Point-of-care tests (POCT) to help identify infection-related causes of illness can complement diagnostic and disposition decisions in children attending emergency departments.(1) Evidence-based clinical algorithms can integrate such POCT to aid in the admission and discharge decision process. Paediatric studies validating these tools are scarce, with very few studies conducted in UK centres.(2-5) POCT can be based on host infection markers (e.g. finger prick tests for C-reactive protein (CRP) to help decide if the patient has a bacterial or viral infection) or pathogen detection tests (e.g. throat/nose swabs to rapidly diagnose viral infections such as RSV or influenza). The use of POCT may reduce time in the emergency department,(6) help rationalise antibiotic prescribing,(4) and reduce investigations in these children.(1, 5) On admission to the ward, POCT can also help with

infection control procedures to reduce the risk of transmission of hospital-related infections. These benefits however have been mostly documented in adults (7).

We present the experience across of three paediatric tertiary centres in South London with different POCT implementation strategies, research driven, during one respiratory disease season (winter 2014 -spring 2015) with the aim of improving paediatric clinical process outcomes and potentially reduce antibiotic use, and primarily focus on the barriers encountered for implementation.

At St George's NHS trust, a service evaluation of febrile children presenting to Emergency Department (ED) was undertaken from October 2014 to March 2015. The aim of the study was to collect clinical information on febrile children and to develop an evidence-based tool to reduce avoidable admissions in those with low-risk infections. Results from the main study are reported elsewhere (8)Outcome data included disposition of the patient, antibiotic use and re-attendance to the ED within 28 days. As a secondary outcome, ED staff were trained on the use of three POCT that were introduced by company provided training: Alere-Afinion™ CRP test (4 minutes), Alere i influenza A/B ™ (10 minutes) and Alere BinaxNOW ® RSV card (15 minutes). ED nurses and doctors were interviewed about their experience of managing febrile children, following national guidelines [9], and their perceptions on using POCT. Semi-structured interviews were carried out following an interview guide and interviews were audio-recorded and transcribed verbatim. At King's College Hospital (KCH, an observational study of children presenting with symptoms or signs of upper respiratory tract infection to was undertaken from January to July 2015. A ward-based diagnostic platform called BioFire Filmarray (BioMérieux, Marcy-l'Étoile, France) was used with company provided training. Ward staff were trained to perform the respiratory pathogen assay which detects seventeen respiratory viruses and three bacteria by polymerase chain reaction (PCR) in 70 minutes. A staff satisfaction questionnaire was used with a graded response 1-5 on ease of use and utility. Questionnaires were distributed trust wide. At Guy's and St Thomas' NHS trust – Evelina Children's Hospital (GSTT), a ward-

based service evaluation was conducted from October 2014 to March 2015 at,using the Enigma® MiniLab™ FluAB-RSV PCR assay (Enigma Diagnostics Ltd, Salisbury, UK), a fully automated molecular platform able to detect influenza A and B and RSV in under 90 minutes. (9-11) The platform was introduced by company provided training of staff with a competency assessment then by the research nurse at which point staff got a barcode for the machine. Relevant staff identified by ward matron and interested clinical teams. Ward staff were trained to perform the test on any child with signs or symptoms of upper or lower respiratory tract infection. Duplicate samples were obtained in viral transport medium and tested in parallel with the standard laboratory-based assay (RVP Fast v2, Luminex, Austin, TX, USA). Diagnostic accuracy, error rate, turnaround time and use of hospital resources were measured and compared with the previous influenza season in which only the RVP was used. A staff satisfaction questionnaire was offered to all ward staff (trained or untrained in the use of the test) contacted through an electronic trust wide email distribution list, and they were asked to provide quantitative and qualitative feedback about their experience of using the Enigma test.

A total of 942 paediatric patients had a POCT performed across the three centres during October 2014 to July 2015. (**Table 1)** At St. George's ED, POCT uptake was 30% less than the laboratory counterpart test for CRP and viral respiratory panel, with 102 POCT compared to 341 laboratory-based tests. This was mainly for serum CRP samples, whereby 225 were sent to the laboratory compared to 41 tested by POCT. Fifteen medical ED staff including 3 consultants, 5 junior doctors, 4 senior registrars and clinical fellows and 3 nurses were interviewed to explore individual perceptions on the use of these tests. Overall, the concerns about using the CRP POCT were; being unsure about performance of the test, missing the 'odd sick child' and using the test in isolation. The advantages mentioned were; the immediateness of the result available in 4 minutes, the ease of use and being a blood sparing procedure. For the respiratory viruses POCT they were highly appreciated for the possibility of quickly cohorting patients, decreasing antibiotic use and being able to reassure

parents. Downfalls mentioned included questions about performance of the test, error messages and sample duplication.

At KCH, 460 tests were performed on the ward. The BioFire platform was well received. Any concerns from staff members were shared with the PI. Thirty-four respondents, a mixture of nursing staff and paediatric consultants, completed the survey. Highlighted advantages included; fast results in 1 hour, good tests for infection control, early treatment and reduction of length of stay. Concerns included a limitation on space to house the equipment, needed for additional trained staff and high cost of the test.

In the GSTT paediatric ward, the ENIGMA platform POCT used had a good uptake among staff. More POCT were done compared to routine laboratory testing (462 patients tested by POCT vs 370 patients tested by routine laboratory). Results from the free text portion of the questionnaire from 34 staff who completed it were analysed for themes. Advantages included; parental anxiety reduction, better bed allocation, fast cohorting or isolation, increased safety and reduction in antibiotic use. Concerns raised by staff members included difficulty handling discrepant results (POCT-laboratory), more people needed to be trained and no changes to patient care observed.

We have described three hospitals across South London with different settings (ED and ward-based) and testing/clinical protocols but that all implemented a POCT to improve process outcomes and complement antibiotic stewardship programmes. In the two ward-based centres, although staff overall welcomed the POCT, the main issue was not having enough trained personnel in all shifts. As the uptake of their test increased beyond the ward where the machines were housed, excessive demands were placed on the trained staff to run tests from patients outside their ward, leading to a queue of tests to be run. The decision by the KCH and GSTT trusts to implement such a POCT will ultimately depend on impact on length of stay, antibiotic use and cost-effectiveness analysis (analysis awaited). In the ED-based study (St. George's ED), implementation barriers were centred around the clinician's

uncertainty about the test and fear of under-investigating a potentially sick child. Other problems included running a new technology within a busy service that was not yet integrated into the departmental clinical care pathways. Particular reticence was found with the implementation of CRP and the fear of a poor negative predictive value as a rule-out test, despite the growing evidence that this is not the case. (12) Overall, the ward-based implementation had a more positive feedback from the staff, however parallel sampling for laboratory testing makes this platform difficult to justify its cost.

This report is set within context of the global threat of antimicrobial resistance (AMR) and the growing recognition on the value of POCTs as valuable rapid diagnostic tools. (13, 14) Scaling up of these tests may help reduce unnecessary empiric antibiotic use and reduce invasive investigations often performed to overcome diagnostic uncertainty.(15) Implementing these tests, however, is challenging. (2) Behaviour changes are needed to modify long-established ways of providing clinical care and empirically prescribing antibiotics for febrile children. (16) New technology needs time to become established as part of routine care and to build evidence on its potential benefits.(17) The need to shift practice and integrate POCT into paediatric care as in adult settings is clear, and will require a multi-stage approach. Overcoming implementation barriers is paramount in order to succeed in this approach and to make local and national recommendations. (18)

We propose a stepwise framework to integrate POCT into paediatric clinical practice based on the three major areas identified from the different centres as summarised in **Figure 1**. 1) POCT RCT paediatric studies: multi-centred studies with cost-effective analysis to demonstrate improved outcomes. 2) Increasing staff knowledge and confidence to decrease uncertainty on the tests: Need for more comprehensive and teaching and training on the different devices, with particular emphasis on their evidence-based efficacy; 3) Integration: integrate POCT into existing care pathways and guidelines.

Qualitative assessment on the impact of interventions are helpful to understand implementation difficulties and can help pave the way for future integration of novel interventions such as POCT into paediatric practice.

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Table 1: Number of patients tested within the study period by POCT and in the reference laboratory.

	POCT	Main Laboratory
St George's NHS trust (Children's ED)	102	341
King's College Hospital (Paediatric ward)	460	520
Guy's and St Thomas' trust (Paediatric ward)	462	370

Figure 1: Proposed step-wise process for the full integration of POCT into paediatric clinical practice. Randomised control trials (RCT) with integrated cost effectiveness analysis. Training of medical staff to increase uptake leading to practice change.