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Determinants of implementing rapid bacterial–viral point-of-care testing for febrile children in UK emergency departments: a qualitative study

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Abstract

Background: Paediatric Emergency Departments (EDs) face sustained operational pressure from seasonal infections and high volume of febrile presentations. These pressures coupled with the risk of missed serious bacterial infections and rising antimicrobial resistance (AMR) highlight the need for rapid, accurate diagnostic tools. Despite validation and the potential to support timely decision making, MeMed bacterial-viral (MMBV) point of care tests (POCT) are not routinely used in paediatric EDs in the NHS. Determinants of implementing rapid bacterial–viral point-of-care testing within NHS paediatric Emergency Departments are examined in this study.

Methods: A new MMBV testing pathway was co-designed, implemented, and evaluated across three paediatric EDs in England (Alder Hey Children's Hospital, Liverpool; Great North Children's Hospital, Newcastle; and St Mary's Hospital, London). A qualitative process evaluation (n=17 semi-structured interviews with clinical staff) was conducted alongside an interventional study. Interview transcripts were analysed using hybrid deductive–inductive coding structured by Proctor's implementation outcomes and the Consolidated Framework for Implementation Research (CFIR).

Results: Overall acceptability of MMBV testing was high. When asked about test suitability for managing undifferentiated febrile presentations, 11/17 participants responded "yes," 3/17 "yes with conditions," and 3/17 "no." Penetration, fidelity, and feasibility were strongly associated with leadership engagement and governance structures. Appropriateness and opportunity cost were viewed favourably when testing targeted intermediate-risk (amber, NICE traffic-light system) children and supplemented clinical judgement, particularly amongst less experienced clinicians. Participants emphasised the importance of clear communication and safeguards to manage risks associated with reduced observation time. The MMBV host-protein assay was selected due to its diagnostic performance and 15-minute turnaround; however, strong preference was expressed for capillary sampling over the currently available venous sampling.

Conclusions: Rapid bacterial-viral point of care testing may support decision making for intermediate-risk febrile children in paediatric EDs, but routine NHS adoption requires targeted use within a governed pathway, sustained POCT governance and clinical leadership, training resilient to workforce rotation, and operational and digital integration to minimise burden and risk. These findings provide service-relevant guidance for Trusts and commissioners considering adoption or scale-up.

Background

Febrile illness is one of the most common reasons for children to present to Emergency Departments (EDs) [1]. Rapid and accurate differentiation between bacterial and viral infection remains a persistent clinical challenge despite availability of clinically validated diagnostic POCT [2]. Failure to establish the cause of fever early often results in sequential hospital laboratory diagnostic testing, precautionary hospital admission, and widespread use of broad-spectrum antibiotics [3, 4]. While these approaches aim to mitigate the risk of missing serious bacterial infection or sepsis, they contribute to increased

healthcare resource use, prolonged ED stays, and pressures on patient flow and bed capacity. Excessive antibiotic exposure in childhood has also been associated with adverse long-term health outcomes, including allergies, asthma, inflammatory bowel disease, obesity, and type 1 diabetes [5].

Although most febrile illnesses in children are self-limiting [6], a small proportion represent severe or rapidly progressive bacterial infections. Identifying these children is particularly challenging in the ED, where presentations may be non-specific and clinical signs evolve over time [7, 8]. Early recognition and treatment of sepsis within the so-called “golden hour” is associated with improved outcomes [9], yet existing diagnostic pathways often rely on clinical observation and formal laboratory results which take time. As a result, clinicians must balance the risk of overtreatment against the potentially catastrophic consequences of delayed antibiotic therapy.

Rapid host-response diagnostics have been proposed as a means of reducing diagnostic uncertainty and supporting more appropriate antibiotic decision-making [10]. However, such technologies represent complex interventions rather than simple tests as their successful use depends not only on test accuracy but also on how they are integrated into clinical workflows, interpreted alongside clinical judgement, and supported by staff and hospital infrastructure. Decisions about antibiotic use are shaped by multiple interacting factors, including institutional guidelines and protocols, professional norms, parental expectations, and system-level pressures [11, 12].

The test selected for evaluation as part of the pathway was the MeMed BV (MMBV) test, a rapid host-protein assay that differentiates bacterial from viral infection using whole blood and provides results within approximately 15 minutes [13, 14]. The test is FDA-cleared and CE-marked and is in routine use in selected international settings, with evaluation underway in select NHS hospitals in England. While early studies demonstrate promising diagnostic performance, there is limited evidence on how such tests are implemented in real-world paediatric ED settings, particularly within publicly funded health systems like the NHS, which faces financial and workforce pressures.

In England, the introduction of rapid diagnostics into ED care pathways raises important implementation questions. These include how testing fits within existing diagnostic workflows, the implications for staffing and training, and how results are communicated. There is also uncertainty about cost-effectiveness, appropriate patient targeting, and the extent to which such tests influence clinical behaviour beyond reinforcing existing decision-making.

To address these gaps the MMBV test was incorporated into the pathway and implemented across three paediatric EDs in England, and evaluated independently by Health Innovation North West Coast in collaboration with academic and clinical partners.

Method

Study Design

This study reports the qualitative component of a mixed-methods implementation evaluation examining the introduction of MMBV point-of-care testing within paediatric EDs. The qualitative process evaluation (n = 17 semi-structured interviews with clinical staff at Alder Hey Children's Hospital, Liverpool; Great North Children's Hospital, Newcastle; and St Mary's Hospital, London) was conducted alongside the cluster interventional study. Quantitative data collection is ongoing and will be reported separately. Baseline and end of project survey data aligned to the theoretical framework of acceptability [15], plus patient experience survey data, will also be reported on in due course. This manuscript focuses on the qualitative implementation findings.

The qualitative evaluation was designed to explore implementation processes, contextual influences, and stakeholder perceptions associated with the testing pathway delivery to build understanding of how and why testing could alter ED care for febrile children.

The qualitative evaluation objectives were to:

1. Assess the testing pathway implementation using a range of implementation outcome measures.
2. Examine whether introduction of point-of-care testing was perceived to improve patient care, ED workflow, and optimisation of antibiotic prescribing.
3. Identify barriers and facilitators influencing adoption and potential spread of MMBV POCT.
4. Generate implementation-relevant recommendations to inform future scale-up.

Intervention Development and Theory of Change

The clinical pathway and evaluation design were developed through a series of facilitated stakeholder workshops. A multi-professional design-thinking workshop held on 7 May 2025 was used to identify implementation challenges, explore anticipated benefits of the pathway, and identify potential unintended consequences.

In line with the UK Magenta Book guidance [16] and the Medical Research Council framework for evaluating complex interventions [17, 18], a Theory of Change (TOC) approach articulated hypothesised causal mechanisms underlying the pathway. A TOC workshop conducted on 9 May 2025 with stakeholders from participating sites mapped expected short- and long-term outcomes, required preconditions, contextual assumptions, and implementation mechanisms.

Pathway Design

The pathway was initiated when children aged 3 months to 16 years presented to the paediatric ED with suspected infection or sepsis and fever (> 38°C) or recent history of fever. Following standard triage and clinical assessment, children requiring venous blood tests were assessed for eligibility for MMBV testing and with parental consent, a small extra sample collected. The test was performed in the ED, and results informed clinical decision-making. Those not eligible for MMBV testing received usual care.

On-site technical training was provided by company representatives, alongside guidance in the study standing operating procedure (SOP)-document on patient selection and result interpretation. Staff involved included research nurses, advanced nurse practitioners, resident doctors, consultants, and advanced clinical practitioners (ACPs). Local pathology point-of- care teams, including biomedical and clinical scientists, whilst not directly involved in the study, were fully integrated into the pathway design and training, and available for advice and support on each site.

Data Collection Tools

Findings from the co-design and TOC workshops informed selection of two key implementation science frameworks and development of the semi-structured interview guides. The interview guides used in this study were developed specifically for this study and have been provided as supplementary information. There are two study guides with slightly modified questions for those clinicians not directly involved in testing.

Implementation Science Frameworks

Proctor's implementation outcomes framework (2011) [19] identifies eight implementation outcomes: acceptability, adoption, appropriateness, feasibility, fidelity, implementation cost, penetration, and sustainability. These outcomes are defined in Table 1, and provided standardised measures of well the intervention had been delivered in the ED settings.

Table 1
Table of Proctor's Implementation Outcome definitions:

Outcome	***Definition***
Acceptability	Perception among stakeholders that an intervention is agreeable or satisfactory
Adoption	Intention, initial decision, or action to employ an innovation
Appropriateness	Perceived fit, relevance, or compatibility of the intervention
Feasibility	Extent to which an intervention can be successfully carried out
Fidelity	Degree to which the intervention is implemented as intended
Implementation Cost	Financial impact of implementation efforts
Penetration	Integration of the intervention within a service setting
Sustainability	Extent to which the intervention is maintained over time

Adoption was excluded from singular outcome analysis because study conditions meant uptake was not reflective of real-world implementation, where adoption does not typically follow research activity.

A ninth implementation outcome, ethicality, has recently been proposed to ensure implementation research considers moral and equity dimensions alongside Proctor's original eight outcomes. Ethicality was therefore also assessed.

The Consolidated Framework of Implementation Research (CFIR) was used as a theory-informed approach to understand why MMBV testing succeeded or failed in the busy, real-world ED setting. CFIR enables systematic assessment of implementation barriers and facilitators and supports development of targeted recommendations for wider implementation. The five CFIR domains are:

1. Innovation: the innovation being implemented.

2. Outer setting: external influences on the implementation of MMBV test such as regulations, funding and societal pressures.

3. Inner setting: internal influences on the implementation of MMBV test such as hospital culture, physical infrastructure, staffing and technological systems.

4. Characteristics of individuals: roles and characteristics of individuals involved in the implementation of the innovation.

5. Implementation process: activities and strategies used to implement the innovation.

Qualitative Data Collection

Semi-structured interviews were conducted with staff involved in MMBV testing and its implementation. Participants were recruited across the three ED sites. Interviews were conducted remotely using Microsoft Teams, audio-recorded with consent, and transcribed verbatim. Interviews lasted 35–65 minutes in duration. The interview transcripts were cleaned manually, and coding supported with MAXQDA Analytics Pro (24.11.1) software. Qualitative data analysis software such as MAXQDA is rapidly advancing to facilitate integrative analysis in mixed methods research studies [20]. Coding was manually checked for errors.

Participants

All clinical staff involved in MMBV test implementation were invited to participate. Clinical staff aware of the testing but declining to participate were also invited to interview, including those known to have concerns. Participants were invited via email directly from the evaluation team using email lists provided by local site leads and research nurses.

Seventeen staff members participated in interviews across the three sites (St Mary's n = 5; Newcastle n = 8; Alder Hey n = 4). Participants included paediatric emergency medicine consultants (n = 3), paediatric consultants (n = 2), infectious diseases consultants (n = 1), research nurses (n = 2), paediatric registrars

(n = 4), associate practitioners (n = 1), clinical trials associates (n = 1), advanced paediatric nurse practitioners (n = 1), ACPs (n = 1) and trainee ACPs (n = 1).

This sample represented key stakeholder groups involved in clinical decision-making and implementation. Recruitment continued until thematic sufficiency was achieved, defined as no substantial new themes emerging in successive interviews [21].

Qualitative Data Analysis

Interview transcripts were analysed using hybrid deductive-inductive coding. Inductive coding revealed emergent themes, with data then analysed using a framework-guided thematic analysis approach. CFIR systematically captured multilevel determinants influencing implementation across the five domains. Proctor's Implementation Outcomes Framework was applied in parallel to structure analysis of implementation success outcomes. Coding was conducted iteratively, with emerging themes discussed between the two evaluators to refine analytic interpretations and ensure consistency. All transcripts and coding were cross checked to challenge any potential interpretive bias. This approach provided rigour and structure to the analysis of a large volume of gathered insights.

Ethics

The PREFACE evaluation was conducted as a sub-study of the ongoing DIAMONDS interventional study at participating centres, for which ethical approval was obtained from HRA and Health and Care Research Wales Approval: IRAS No: 278651 REC NO: 20/HRA/1714 Protocol No: 20IC5895.). Ethical approval was obtained at each participating centre (REC No: 16/LO/1684) in accordance with the Declaration of Helsinki and its relevant ethical principles governing research involving human participants and human data.

This study is also reported in accordance with the COREQ checklist for qualitative research and the StaRI guidelines for implementation studies (see supplementary information).

Results

Implementation Outcome Findings

Interviews with ED staff provided a detailed view of the MMBV test implementation through the lens of Proctor's implementation outcomes. Evidence highlighted both facilitators and challenges across each domain, demonstrating a nuanced picture of current implementation and considerations for wider adoption.

Fidelity

Participants reported that the test was implemented largely in accordance with study protocol. Children were selected according to inclusion criteria and SOPs were followed under the guidance of trained research nurses and assistant practitioners. The strength of research nurse support highlights a potential gap in less structured real-world conditions without the cushioning of the study team. The test was performed only on samples from children already undergoing diagnostic blood tests for other clinical reasons, avoiding unnecessary blood draws.

"We're following it pretty much to how it should be"

"We haven't deviated from the protocol"

However, several challenges to fidelity were noted. Limited training for other clinical staff (ED nurses and doctors) reduced the number of staff able to perform the test. Technical errors, cartridge delivery issues, and the meticulous cartridge handling required in a busy ED sometimes led to missed testing opportunities, particularly during night shifts.

"There have been issues that have been raised. Like I said, the errors on the test. We had some delivery issues with the cartridges."

Service implication: Fidelity in routine care is unlikely to match study conditions unless Trusts resource robust training to deliver testing reliably across shifts. Without this, intermittent testing will limit any impact on flow or antibiotic stewardship.

Appropriateness

The ED setting was generally considered appropriate due to the need for rapid diagnostic information and the high volume of ambiguous febrile cases in intermediate risk children. Participants emphasized the test's potential to support antimicrobial stewardship, and some felt that alternative settings, such as urgent care centres, in-patient or primary care, might also be appropriate for this test.

"The urgent care centres and GP practice, I would have thought there's plenty of instances there where it would be a useful test to run... It would also be helpful in a smaller group of children who are on the ward for a longer period of time who then develop a fever..."

"The chance of finding a true invasive bacterial infection is higher in ED than it would be in GP."

Nonetheless, concerns were raised about potential reductions in observation time which could lead to staff missing deterioration, particularly for junior staff. The requirement for venous sampling also limited applicability in some contexts.

"We probably need to think a little bit about education for junior staff members. They still need to be able to pick out a sick child and pick out the subtleties of this child just isn't quite right."

Service implication: The ED is an appropriate setting only when testing replaces uncertainty-driven practice (e.g., avoidable admissions or antibiotics) rather than adding steps. Targeted deployment to intermediate-risk cohorts is therefore essential to protect capacity.

Acceptability

MMBV testing was generally well accepted, especially for undifferentiated fever cases and supporting resident clinicians' decisions. Most participants valued it for guiding discussions with families about withholding antibiotics When asked about test suitability for managing undifferentiated febrile presentations, 11/17 said "yes," 3/17 "yes with conditions," and 3/17 healthcare professional answered "no," the test was not useful or suitable.

One clinician questioned the efficacy of the *test "if I believed the test was close to 100% reliable, then yes, but I don't"*.

One clinician expressed concerns about workload in routine conditions *"without dedicated resources, the workload could make it unacceptable for routine use"*.

One clinician raised concern about an increase in parental demand "*if parents hear about it, then you're going to get increased demand, aren't you? Like we did with the Group A strep epidemic"*

There was caution against relying on the test alone and emphasis of interpretation within the broader clinical context. Many senior clinicians felt experience remains the best determinant of invasive bacterial infection. Venous blood sampling also limited acceptability for some patients. These findings underscore a central theme: while the rapid diagnostic capability of MMBV is appreciated, clinicians remain cautious about any tool that might reduce reliance on comprehensive clinical assessment in the high-stakes environment of paediatric emergency care.

"Where you're in doubt. I think that is exactly the area where I would like to see this

working. I don't need a test if I'm already convinced that I'm dealing with a severe bacterial infection. If I'm already convinced it's a viral infection, I don't need any tests to tell me."

"Some juniors are quite enthusiastic, some more experienced consultants who rely on their clinical judgement at points are less enthusiastic."

"Older consultants are a bit like, 'I know what I'm doing, I don't need a machine, but all the resident doctors, they're all really keen on it.'"

Service implication: Acceptability varies by seniority and implementation should explicitly support less experienced clinicians while maintaining senior oversight and observation safeguards. False reassurance could compromise safety and service trust.

Penetration

Penetration of the pathway was strongest among research nurses, resident doctors and assistant practitioners, with limited direct use by other clinical staff. Awareness was growing through teaching sessions and departmental communications, and some resident doctors and ACPs expressed interest in using the test more widely.

"We have regular sort of teaching sessions, education stuff, research meetings, so we try and communicate with all our staff members in terms of knowing what's going on."

"When I heard about it, I thought it was a great initiative, something that gives you a quick answer to differentiate between bacterial and viral. And I think especially in accident & emergency (A&E) in a fast-pacing environment it's very helpful..."

Barriers to broader penetration included staff rotations, time pressures, and lack of training among wider clinical staff.

"It can be challenging during weekends when not all your nurse practitioners are trained and the same doctors that are trained are not on the weekend. So, I think weekends can be challenging..."

Service implication: Limited penetration beyond research roles indicates the pathway is not yet embedded as a routine service. Scaling will require training expansion, rota-aware onboarding and formal integration into departmental induction and governance processes.

Feasibility

For trained users, the test procedure was generally considered straightforward, with a rapid turnaround of results supporting workflow integration.

"Being able to just give me that blood sample and just go and test it. And within 15 minutes they can get a result. I think that's one of the main benefits really..."

"the staff that I've trained to use the machine. They've all said the same and they've found it very easy."

"the test itself is quite an easy thing to do"

Challenges to feasibility included additional workload, meticulous cartridge handling requirements, and potential impact on staffing and patient flow in busy ED periods. Pipetting, which is a common skill for lab technicians, required additional training. Capillary sampling was suggested as a potential solution to improve feasibility.

"*I think in a busy A&E setting it's not really practical from where the cartridges have to be upright..."*

Service implication: Feasibility hinges on reducing operational challenges such as sampling method, handling and calibration, and documenting results. Without mitigation, testing may be deprioritised during times of high service demand, undermining equitable access and consistent service delivery.

Opportunity Costs

Participants identified potential benefits including reduced antibiotic use, shorter hospital stays, and improved patient flow. Investment in staff training and equipment was viewed as worthwhile in the long term.

"We're just going to gain so much more back from it because we might not be giving out as many antibiotics. There's not going to be as many children staying on wards which costs money."

However, upfront costs, workload implications, and uncertainty around overall cost-effectiveness were highlighted as potential barriers.

"Money has to be put into something to gain something at the end of it. And I think a little bit of investments, invest in your staff, invest in what you've got, more machinery, more diagnostic machinery..."

Service implication: To demonstrate value for money, services should specify what MMBV enables them to stop or reduce e.g. unnecessary antibiotics, admissions and observation time. Adding testing without substitution will increase costs and workload.

Ethicality

The test was generally viewed as ethical when performed alongside clinically indicated blood tests with parental consent. Its ethical application is limited by the need for venous sampling, but broader use could be feasible if capillary testing were available.

"We're always mindful that we're not just doing tests on children just to trial a device. The child would be still getting the bloods."

Concerns were raised regarding over-reliance on the test potentially reducing observation time and challenges with deferred consent.

"When children come into the department with a sort of fever how sick are they? And that's what a period of observation is useful for."

A few participants questioned the commercial origins of the test.

“This isn't research or a trial to me. This is market penetration on behalf of a company producing a point of care test"

Service implication: Maintaining ethicality in routine care requires explicit policies for appropriate blood draw and clear parent communication to manage expectations and risks.

Sustainability

Sustainable implementation was viewed as dependent on demonstrated clinical value, leadership advocacy and support, integration into governance, and ongoing training. Expansion to broader patient groups, potentially such as infants under three months or children with complex needs was seen as important for routine use.

"It would be really nice to use it in the under three months..."

Barriers to sustainability included venous sampling requirements, logistical issues such as stock management and cartridge errors, and device maintenance. Development of a capillary sampling option was repeatedly highlighted as critical for long-term adoption.

"It's actually really hard taking blood in children. It's technically difficult... If you could remove that, then I think that would be a real bonus..."

Service implication

Sustainability is conditional on governance, funding, and a viable operational model (training, stock quality control, IT integration).

A summary of the evidence for and against successful implementation according to each of the outcome's measures is provided in Table 2.

Table 2

Evidence for and against successful implementation of BV testing, structured around Proctor's implementation outcomes.

Outcome	Evidence for	Evidence against/challenges
Fidelity	Consistent adherence to inclusion criteria (e.g. children with fever ≤ 7 days already undergoing blood tests). SOPs and trained research nurses/assistant practitioners ensured correct procedure.	Limited training for wider group of ED nurses and doctors; technical errors, cartridge issues, and meticulous handling required; missed opportunities during busy shifts or night hours.
Appropriateness	ED considered suitable due to rapid diagnostic needs and high case volume; test supports antimicrobial stewardship. Alternative settings (GP, urgent care) suggested as also appropriate.	Concerns that rapid results may reduce observation time; some senior clinicians believe clinical judgment is sufficient;
Acceptability	High acceptance for undifferentiated cases/ intermediate risk and for junior clinicians; supports communication with families; resident doctors value objective data.	Some senior clinicians concerned about undermining clinical judgment; venous sampling limits acceptability; concerns over use as a rapid "shortcut" for decision-making.
Penetration (usage)	Research nurses and assistant practitioners are primary users; resident doctors and ACPs enthusiastic; growing awareness through teaching and departmental communications; consultant advocates.	Limited direct involvement of frontline clinical staff; staff rotations and workload constraints impede wider adoption; weekend coverage gaps.
Feasibility	Procedure straightforward for trained users; 15-minute result supports rapid decision-making; integrates with workflow under SOPs and support.	Additional burden for clinical staff; careful handling, storage, and calibration required; busy ED workflow may impede routine use; venous sampling limits feasibility.
Opportunity costs	Potential reduction in antibiotic use, shorter hospital stays, improved patient flow, and support for antimicrobial stewardship; investment in training and equipment seen as worthwhile.	High upfront costs; uncertain overall cost-effectiveness; risk of adding tests rather than replacing existing ones; financial constraints in NHS setting.
Ethicality	Ethical when used in children already requiring blood tests and with parental consent.	Potential over-reliance reducing observation; challenges with deferred consent; perceived commercial motives for the test.
Sustainability	Likely sustainable if clinical value demonstrated; integration through leadership, governance, and training; potential expansion to broader patient groups.	Logistical and maintenance challenges; need for capillary sampling for optimal long-term implementation.

The key themes identified through hybrid deductive-inductive analysis are presented according to the key CFIR domains: Innovation Characteristics, Inner Setting, Outer Setting, Characteristics of Individuals, and Implementation Process.

1. INNOVATION: Characteristics of MMBV Test

Relative Advantage and Speed of Results

Rapid turnaround emerged as the most consistently cited advantage of the MMBV test. Clinicians reported that results within 15 minutes offered meaningful improvements over standard laboratory testing, which typically requires two to four hours. This speed was particularly valuable for time-sensitive decision-making, such as early antibiotic initiation in suspected sepsis or rapid exclusion of bacterial infection in intermediate-risk children. Participants linked faster results to improved ED flow, reduced waiting times, and earlier discharge for clinically stable patients.

Several clinicians highlighted alignment with the “golden hour” principle in sepsis management, noting that earlier confirmation of bacterial infection facilitated prompt treatment, while rapid viral classification enabled reassurance and avoidance of unnecessary antibiotics.

“If we are managing to get all the samples 15–20 minutes later, we can reassure parents that things are OK, … but then that made it easier to start and get the antibiotics within that first one hour which was impressive”.

“It's going to speed up the time that they're in A&E. It's going to give them a quick enough diagnosis and it's going to get them the right treatment that's needed”.

Sampling Methods

Venous blood sampling was widely viewed as a barrier to broader adoption. Clinicians highlighted that many febrile children are managed with capillary samples, particularly those with ambiguous but low-to-intermediate risk presentations. Venous access was described as technically more difficult, and test performance was sometimes precluded due to prioritisation of standard diagnostics.

"75% of patients will be capillary samples. So you're really limiting the use of it. The benefits of it obviously not as wide as they could be if we were able to do it on capillary samples".

"It can be a challenge if a child is very difficult to bleed, then you would just prioritise your bloods for normal investigation, that has happened multiple times where I couldn't do this test because I don't have enough blood".

Capillary sampling was viewed as a potential enabler, likely to broaden eligibility, improve workflow integration, reduce consumable costs, and decrease reliance on additional equipment. However, dual-access requirements were perceived as inefficient for children requiring additional blood tests.

"I think if this could be used on capillary bloods, that would make it even more useful for us."

"A lot of those cohort (with undifferentiated fever), in our department … would have finger prick bloods. We would do finger prick bloods, we wouldn't do venous bloods on those kids. But I think those kids can potentially really benefit".

Operational Considerations

Although many staff felt comfortable operating the device, pipetting was described as cumbersome and poorly suited to a busy ED. Calibration requirement, typically 45 minutes, occasionally disrupted workflow. Cartridge fragility and short expiry periods created challenges in stock management and routine testing. Site-specific technical issues, such as errors associated with low C-Reactive Protein (CRP) readings, further raised concerns regarding reliability.

Test Accuracy and Evidence Base

Clinicians recognised that MMBV demonstrated performance comparable to laboratory assays but some noted hesitancy when sensitivity and specificity were not near perfect. Expanded evidence generation was highlighted as necessary, particularly for high-risk populations like infants under three months and children with complex conditions.

2. INNER SETTING

Governance Structures

Standardised operating procedures (SOPs), patient flowcharts, and quality assurance mechanisms were consistently highlighted as critical for maintaining consistent use across shifts and staff turnover. Dedicated personnel for device maintenance and compliance with regulatory requirements were viewed as essential.

"You need somebody who's keeping up the machine all the time, doing the QC, doing quality checks. So you don't just need somebody to use it. You need somebody to check it and service it all the time. Yeah. And it's got quite specific quality check required".

Visible support from senior clinical leadership facilitated adoption. Enthusiastic ED consultants and departmental leads acted as champions, promoting engagement and normalising test use. Integration with point-of-care testing governance structures supported installation, maintenance, and oversight.

"Point-of- care testing always involve our point-of-care test leads within the diagnostic clinical board in our Trust because obviously there's a need for installation, maintenance, integration with reporting system".

Organisational and Technical Infrastructure

Integration with laboratory information systems and electronic health records was critical to avoid manual transcription errors. Single-sample processing capacity and limited physical space for equipment, fridges, and consumables were operational constraints. Backup equipment and dedicated storage solutions were viewed as essential to support routine use, particularly during peak periods.

Communication

Participants emphasised the importance of company support for troubleshooting and maintaining confidence during early adoption. Internal leadership communication provided oversight, ensuring results informed clinical decisions rather than dictating management. Departmental champions, including research-active consultants, study leads, and nurses, drove engagement, facilitated informal learning, and fostered team collaboration.

Clear communication with parents supported antibiotic stewardship and shared decision-making, though wider availability of the test could increase parental demand. Safety-netting practices, including discharge instructions and access to community nursing follow-up, were viewed as essential for safe implementation.

"Give good safety netting, which you should be doing anyway, but you must send them home with really good safety netting so they know when, where and why to come back and when, where and why to stay at home".

3. OUTER SETTING

Cost

Cost-effectiveness was a major determinant of feasibility. Venous-only sampling limited eligible populations, while capillary sampling was seen as a potential solution to reduce consumable costs and expand use. Evaluation of cost-effectiveness should encompass the full care pathway, including reductions in admissions, observation time, antibiotic use, and parental burdens such as childcare and travel.

Participants highlighted the current financial climate within the National Health Service (NHS) as a barrier, with heightened scrutiny of new technologies and limited discretionary funding. Focused use in intermediate-risk cohorts may yield greater value than universal testing.

"You need to look wider/broader than just the cost of testing. It's also the cost of observation, admission where you could save money. It's not just hospital cost."

Potential system-level benefits included reduced unnecessary antibiotic prescribing and mitigation of antimicrobial resistance, which, although aspirational, strengthened the rationale for adoption.

4. CHARACTERISTICS OF INDIVIDUALS

Clinicians described the greatest impact among resident doctors and advanced clinical practitioners, who were more cautious in the context of diagnostic uncertainty. High bacterial scores prompted earlier treatment, often validated by laboratory results. Senior consultants noted that results usually confirmed clinical impressions rather than altering management.

"Especially in a busy environment, it helps when we get the result very quickly, it helps us confidently say, OK, actually I'm more reassured it's viral and we can send the child home without having to wait for the full blood test to come back". – Resident doctor

Adoption was influenced by professional experience, comfort with innovation, and cultural shifts in diagnostic practice. Equity was also a consideration, ensuring ED-based testing reached populations with higher deprivation and limited primary care access.

5. IMPLEMENTATION PROCESS: Training

Comprehensive initial training was a key facilitator, including hands-on demonstrations, structured sessions, and refresher programmes. Clinical training emphasised patient selection and interpretation of results. High resident doctor turnover created ongoing training demands, necessitating continuous onboarding.

Informal peer support facilitated troubleshooting, awareness, and skill maintenance, and participants suggested formalising this infrastructure for routine implementation. Expanding training to include healthcare assistants (HCAs) and broader nursing staff was recommended to ensure consistent service coverage.

"Every 6 months you get new doctors coming in, you going to have to go through a new process of training and getting people engaged in the test".

In Table 3 each of the themes are aligned to their main CFIR domain and linked to both sub-domain CFIR construct and thematic sub-themes.

Table 3
Alignment of themes and subthemes with CFIR domains and constructs

CFIR Domain – theme	Construct	Subthemes
Innovation Characteristics	Relative advantage	Rapid results; specificity and sensitivity; evidence generation for other use cases
	Complexity	Pipetting; calibration; machine error
	Design quality	Cartridge fragility; expiry date
	Adaptability	Venous blood draw; capillary draw
Inner Setting – Governance	Work infrastructure	Clear SOPs; flowchart and guidance; quality assurance/auditing
	Relational connections	Clinical leadership (ED, medicines and higher paediatric management); point-of-care lead oversight
	Relational connections	Trust laboratory oversight and stock management
Inner Setting – Organisational & Technical Infrastructure	IT infrastructure	Laboratory record integration (trust and central); integration with Electronic Health Records (EHR)
	Physical and work infrastructure	Back up equipment; physical space for fridges, machines, cartridges; storage for consumables; dedicated staff for stock management and maintenance
	Structural characteristics	ED as a setting for testing
Inner Setting – Communication	Relational connections	Company support for errors
	Leadership communication	Senior leadership communication on optimal use of the test
	Culture	Clinical advocates to drive buy-in and manage change process
	Patient communication	Clear communication strategy with parents (antibiotics, demand for test)
	Structural characteristics	Safety netting
Outer Setting – Cost	External policy & incentives	Cost-effectiveness variable; funding challenge with financial climate; value unproven due to lack of clarity
	Available resources	Minimal clinician opportunity cost; parental costs

CFIR Domain – theme	Construct	Subthemes
	Relative advantage	Reduction in antibiotic resistance
Characteristics of Individuals	Innovation delivery team	More appropriate antibiotic prescribing; enhanced decision making; rapid treatment decisions from diagnostic certainty; optimal impact on ambiguity or uncertainty with clinical assessment
	Leadership and implementation team buy-in	Clinical buy-in
	Innovation recipients	Health equity
	Implementation leaders	Discharge time (anticipated positive outside study constraints)
Implementation Process – Training	Planning / executing	Technical implementation training; clinical training (appropriate patient selection); resident doctor specific training
	Engaging / peer opinion leaders	Peer support
	Planning / available resources	More staff trained

Discussion

Children that present with undifferentiated fever are at risk of delayed recognition of serious illness, delayed treatment or unnecessary antibiotic prescribing without rapid diagnostic certainty. This can impact on patient flow, resource use and early action to improve outcomes.

Rapid host-response protein tests like MMBV aim to address these challenges [22] but their success depends not only on diagnostic accuracy but also on real-world implementation [23, 24]. This study applied Proctor's framework to provide a structured lens to assess whether MMBV testing can be integrated successfully in EDs. The complementary use of CFIR constructs enabled identification of contextual determinants influencing pathway implementation. This approach responds to calls in the literature for more implementation-focused evaluations of POCT that move beyond diagnostic performance to examine how tests function within complex clinical systems [25].

This qualitative evaluation shows that MMBV testing is perceived as most useful in the ambiguous area of paediatric ED care: intermediate-risk febrile children where clinical assessment does not clearly indicate bacterial versus viral infection. In these cases, participants described the rapid result as supporting antibiotic decision-making and communication with families. Rapid turnaround times and improved diagnostic confidence aligned with CFIR intervention characteristics that facilitated acceptability and perceived usefulness. However, acceptability was tempered by technical and workflow-

related barriers, including venous-only sampling, cartridge fragility, and calibration requirements, which reduced perceived suitability in some clinical scenarios. This highlights how specific usability and workflow characteristics can shape perceptions of appropriateness in time-pressured paediatric ED environments.

Workforce rotation emerged as a central determinant of penetration. Staff turnover among resident doctors, combined with shift patterns and weekend coverage, can undermine consistent access unless training is embedded into departmental induction and supported through refresher models. Sites with clear governance structures, standard operating procedures, senior clinical oversight, and active clinical champions demonstrated rapid uptake. Resident doctors, nurses, ACPs, and HCAs should perform testing, supported by senior guidance.

Governance, safety and quality assurance as service stabilisers

Governance, senior clinical oversight and quality assurance were described not only as implementation facilitators, but as essential service stabilisers, and as prerequisites for safe use. These factors mitigate risks of over-reliance, reduced observation time and demand-driven testing. Embedding MMBV within existing pathology/POCT governance and clinical workflows may therefore be as important as the test's diagnostic performance, particularly in high-pressure environments where rapid results can influence discharge and treatment decisions. Communication from senior leadership and the presence of enthusiastic research-active consultants were critical in driving engagement and managing change. Conversely, limited staff trained to perform the test, competing clinical priorities, and reliance on specific individuals constrained consistent adoption, particularly during busy periods or out-of-hours.

Operational refinement

Feasibility and fidelity were achievable when adequate organisational and technological infrastructure was in place. Challenges related to physical space, stock management, cartridge expiry, and lack of full integration with electronic health records disrupted workflow and introduced inefficiencies. These operational barriers have been reported in other ED POCT implementations [26, 27} and indicate how infrastructure and digital integration can determine whether tests enhance or disrupt clinical workflow. These barriers highlight the importance of implementation process factors, particularly ongoing training, peer support, and adequate resourcing, to maintain fidelity beyond a research-supported environment. The findings therefore contribute practical insights into the operational requirements necessary for sustaining POCT use in routine paediatric emergency care.

Commissioning and value-for-money considerations

Cost and uncertain cost-effectiveness were prominent external determinants. Participants argued that value should be assessed across the whole pathway, including admissions avoided, observation time reduced, antibiotic exposure, and parent burden. They also cautioned that adding a new test without stopping existing tests or processes could increase costs and workload. This supports a commissioning approach that is cohort-targeted and explicit about substitution, specifying what the test enables services to do less of, and defining review points and de-implementation criteria if anticipated value is not realised.

Uncertainty around cost-effectiveness, commissioning, and long-term value limited confidence in sustainability, reflecting a common barrier to wider POCT adoption within publicly funded healthcare systems [28, 29]. Some of this uncertainty may be addressed when findings are shared from the accompanying quantitative evaluation of health outcomes and antibiotic prescribing rates.

Other studies have found that POCT in febrile children requires carefully designed implementation strategies and have set out the need for research examining how tests interact with clinical decision-making processes and clinician preferences [30, 31]. This study provides additional insight into how contextual factors influence implementation success and how POCT for febrile children can be positioned within existing diagnostic pathways.

Uptake and spread

Implementation of MMBV testing in paediatric EDs requires the removal of the barriers outlined before it can be recommended for sustainable spread. Despite efforts to act in accordance with best practice from other implementation studies and apply rigour to training, communication and other well-known barriers, there was some variation in success and as such they still require refinement for optimisation.

Strengths and limitations

Overall findings in this study build on and align with POCT implementation studies in other countries and settings, reinforcing that diagnostic performance alone is insufficient for successful implementation [32, 33]. They provide practical implementation insights that may inform future deployment of similar diagnostics, particularly where tests are intended to support clinical decision-making under diagnostic uncertainty.

A limitation of this study is the structured and supported implementation due to the input of dedicated research nurses. Research-supported implementation may increase fidelity and engagement compared with routine clinical environments, potentially overestimating feasibility and adoption. Where possible this has been acknowledged and mitigated for in the analysis to ensure insights are transferable to less supported ED environments. The focus on EDs in university teaching hospitals is a further limitation, as implementation barriers in district general hospitals and other acute care settings may differ and were

not fully explored. Additionally, clinicians participating in the study may have been more engaged with research and innovation than typical users, which may influence perceptions of acceptability and appropriateness.

Conclusions

In conclusion, the findings suggest that there are no immutable barriers to the spread of MMBV testing, and that it can meaningfully address diagnostic uncertainty and antibiotic stewardship challenges in paediatric EDs. However, successful and sustainable implementation depends on alignment between the innovation, local infrastructure, leadership, training, and funding models. Addressing identified barriers will be critical to achieving broader penetration and realising the anticipated clinical and system-level benefits. These findings do not exclusively inform implementation of the MMBV test but provide transferable recommendations on addressing the barriers to implementing POCT in busy acute settings.

Abbreviations

A&E
Accident & Emergency
ACP
Advanced clinical practitioners
BV
Bacterial-viral
CFIR
Consolidated Framework for Implementation Research
COREQ
Consolidated criteria for reporting qualitative research
CRP
C-Reactive Protein
DIAMONDS
Diagnosis and Management of Febrile Illness using RNA Personalised Molecular Signature Diagnosis
ED
Emergency Department
EHR
Electronic Health Records
GP
General Practice
HCAs
Health care assistants
MMBV
MeMed bacterial-viral
NHS

National Health Service
POCT
Point of care tests
PREFACE
PRe-Implementation Evaluation of Fidelity and Adherence of MeMed BV rapid test in febrile Children presenting to the Emergency Department
QC
Quality control
SOP
Standard operating procedure
STaRI
Standards for Reporting Implementation Studies

Declarations

Ethics approval and consent to participate

This study was conducted as a subpart of the DIAMONDS Study (HRA and Health and Care Research Wales Approval: IRAS No: 278651 REC NO: 20/HRA/1714 Protocol No: 20IC5895). Ethical approval was obtained at each participating centre (REC No: 16/LO/1684) as part of the larger study and in accordance with the Declaration of Helsinki and its relevant ethical principles governing research involving human participants and human data.

Participants provided informed consent prior to participation in interviews.

It was conducted as a service evaluation, with approval granted by all participating trust's research departments. Interviewers had no prior relationships with participants.

Consent for publication

Not applicable. No identifiable individual data are included in this manuscript.

Originality of manuscript

The authors confirm that this manuscript is original, has not been published elsewhere, and is not currently under consideration by any other journal. All authors have approved the final version and agree with its submission to BMC Health Services Research.

Availability of data and materials

The interview guides for this study are available from the corresponding author and have been submitted as supplementary files. The full dataset (which includes individual transcripts) is not publicly available due to confidentiality policies.

Additional supplementary materials include the COREQ and StaRI reporting checklists.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

LB: conceptualisation, study design, data collection/ interviewing, qualitative analysis, manuscript drafting.
OO: data collection/ interviewing, coding, CFIR thematic analysis, manuscript review.

PB, EC, SM, RN, JH, EL: manuscript review.
MT: study supervision, framework alignment, manuscript review.
All authors read and approved the final manuscript.

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