Near-patient testing in microbiology: experiences and future prospects

David Westrip, on behalf of the British Society for Microbial Technology, looks back at the last Annual Scientific Conference on COVID-19 and in particular at one of the consequences of the pandemic – the increased demand for near-patient testing and some of the hurdles that will have to be overcome if it is to be introduced more widely.

The SARS-CoV-2 pandemic and the subsequent healthcare response has affected many aspects of society and required adaptation and novel solutions to be explored. One area that has responded to the changing faces of the pandemic is hospital pathology. A significant burden has fallen on microbiology departments across the UK, an often unseen section of the hospital suddenly thrust into the forefront.

The instigation, implementation and upscaling of polymerase chain reaction (PCR) testing may, in retrospect, be recognised as an underrated achievement of the UK's response to the pandemic. National testing capacity seemed to be reported with a negative bias in the early phases, labelled as inadequate, insufficient and impossible to access. Some of this criticism was undoubtedly valid, although it also demonstrated the lack of general understanding as to the complexity of rapidly introducing large-scale testing. A succession of seemingly arbitrary targets were introduced and these required a massive increase in testing numbers in a relatively short space of time.

This focus on test numbers perhaps inadvertently undermined the efforts of commercial developers and testing facilities across the country. The conventional processes of test selection, acquisition, communication with service users, verification, quality control, documentation, training and arranging logistical and administrative support that normally take months and often years were cut down to weeks and days. Different situations and local requirements meant that different solutions needed to be explored. These included a nationally networked approach as seen in Wales, or the setting up of large scale 'lighthouse' laboratories for mass screening.

These different approaches were discussed recently by Dr Moore and Professor McNally, respectively, as part of the BSMT webinar series of lecture, which were recorded so that anyone can now view the presentations and associated Q&A sessions on the British Society for Microbial Technology (BSMT) website.[1]

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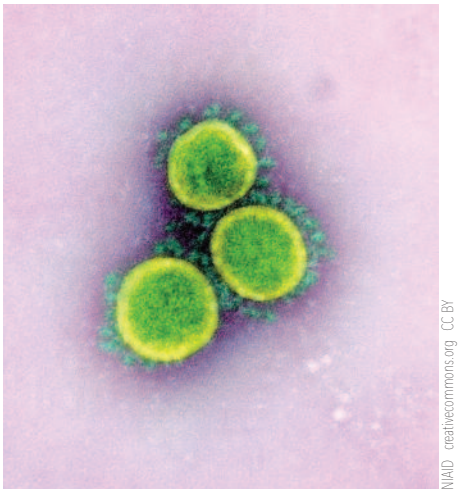

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In response to the SARS-COV-2 pandemic, multiple systems quickly became commercially available, often representing technology that has been repurposed from its original intended use (coloured transmission electron micrograph).

Response to an ever-changing situation

As the pandemic progressed there was a drive to upscale testing rapidly, resulting in hospital microbiology departments being required to absorb significant additional workload. In many case, this was offset partially with a decrease in elective and GP activity as SARS-CoV-2 testing became the dominant proportion of departmental workload. Staff were redeployed and retrained to support the introduction and upscaling of SARS-CoV-2 testing.

Modifications were made to working patterns to accommodate extended working days, bank and locum staff brought in, and in some cases recently retired returned to help deal with the workload. As the 'business as usual' work began to return, this produced additional strain requiring further adaptation and, where possible, resource investment to

accommodate this increasing burden, all in the context of an ever-changing national situation.

Prior to this, the drive to consolidate laboratories following the Carter Report has resulted in a situation whereby one microbiology department serves multiple acute hospital sites and often several other healthcare facilities. While this streamlining has resulted in cost savings, the additional logistical barriers it created inevitably increases the time between the specimen being taken and its receipt at the testing laboratory.

In many scenarios the effects of this has been mitigated through organised logistical support between different sites and within individual facilities. This gets the specimen to the right place to allow testing to be performed, thus minimising test turnaround times. However, COVID has highlighted the limitations built into this system when rapid testing is required to guide patient and bed management decisions from a centralised laboratory.

CDC/James Gathany

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Near-patient testing: a potential solution

In order to manage patients appropriately, there is a need to identify those infected with SARS-COV-2 quickly and accurately. This allows timely segregation from non-infected patients, thus limiting opportunity for onward transfer of the virus to vulnerable patient groups and staff. This virus presents with a wide spectrum of clinical severity and a significant proportion of asymptomatic cases that may or may not correlate to viral load and infectivity. Therefore, assessment on clinical symptoms is problematic and testing is essential. The screening of acute admissions and accident and emergency (A&E) attendees is a key tool that even laboratories with a highly efficient workflow would find it difficult to provide results fast enough to influence this initial triage.

This problem is of course not unique to COVID-19; there has been a need for rapid testing for other respiratory viruses such as influenza and respiratory syncytial virus (RSV) as well as bacterial infections such as methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile*, which in many cases has not been addressed successfully. A potential solution to this is to bring the test to the patient, whether in A&E or a planned admission, or to the actual bedside in the ward.

Key to the success of near-patient testing (NPT) is that tests must be simple to perform and interpret without significant scientific or laboratory experience, and must deliver results of high quality in a shorter timescale. However, taking analysis outside the proficient walls of the laboratory has perhaps been a difficult concept for microbiology departments to embrace enthusiastically because of fears over the quality of NPT results and possible loss of income to the department.

Traditional microbiology techniques do not lend themselves easily to being performed outside controlled laboratory environments as most molecular technologies have not until relatively recently been sufficiently simple or cost-effective to be a viable introduction to the wards. However, in response to SARS-COV-2, multiple systems quickly became commercially available, often representing technology that has been repurposed from its original intended use. COVID-19 may now have created an opportunity for the widespread introduction of NPT for a microbiological target.

Introducing near-patient diagnostics: the issues

Rapid near-patient diagnostics would seem to have a role but its use raises interesting challenges regarding governance and oversight. Emergency department staff are already under intense pressures and if they are to be burdened with an additional testing workload then the advantages must be evident for effective buy-in to the process. Conversely, NPT can be seen as a threat to the sanctity of the laboratory and is rightly viewed with a degree of suspicion by those of us who spend our professional lives within the quality controlled, verified, accredited, competence-assessed scientific environment.

Staff engagement is essential to ensure success and such defined boundaries and traditional roles may not be conducive to success; a more patient-focused holistic approach is required. 'Departmentalism' may be the greatest barrier to implementation; however, establishing clear lines of responsibility and accountability are likely to be necessities to ensure that the benefits of such testing can be realised.

Introducing NPT to an A&E department can result in a significant tangible impact by producing timely and clinically actionable results. The advantages may be clear to staff involved at all levels as patients are triaged more effectively. What may be harder to communicate is the importance of regular quality control (QC), maintenance or training documentation. Should the burden of this fall back onto the microbiology laboratory perhaps via pathology POCT committees? Scientific staff may be more appropriately skilled to manage these aspects of the process but there may be reluctance to become involved with protocols that are not fully under the laboratories control.

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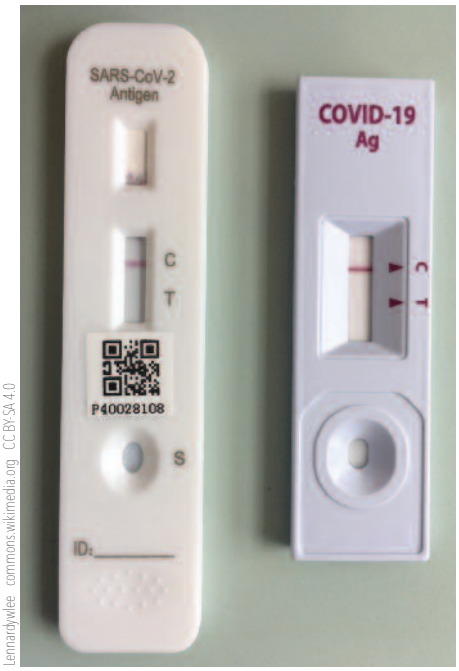
Is external quality assessment (EQA) relevant to NPT and if so should laboratory staff coordinate this process? Alternatively, is it more appropriate for those staff actually performing the testing to take responsibility for these QC obligations? Arguably, this would provide a better measure of the quality of the process. Is there any desire to bring such testing into the laboratories' UKAS accreditation schedule? This would mean seeking accreditation to ISO 22870:2016 in addition to ISO 15189:2012. This may require an initial investment of resources to achieve, and questions around which departmental budget that will come out of is another likely source of debate. The thought of pursuing a new set of ISO standards just as we have got to grips with ISO 1518. will surely be viewed with unbounded enthusiasm! An alternative practice whereby non-accredited molecular testing is performed outside the 'safety' of the laboratory, which would then take no responsibility for the results, also does not feel like a comfortable scenario.

Another question is whether the results of tests performed outside a laboratory's control should be entered onto the normal laboratory reporting system or directly onto the patient records. The challenge of interfacing multiple NPT units into the laboratory information management system (LIMS) should not be underestimated, nor the administrative burden of manual transcription of results with the associated risk of transcription errors. However, without somehow linking these results to the laboratory or trust information technology (IT) systems, significant limitations in accessibility, data extraction, or surveillance monitoring may present themselves further down the line.

The introduction of these systems has been necessarily rapid as required by the pandemic response. While they will be verified initially for use, there may be a need for a degree of retrospective review and evaluation. The performance of different technologies and systems will be different and their suitability for different patient groups (asymptomatic vs. symptomatic) or scenarios may also need to be assessed.

An excellent overview of these problems was given by Professor John Deeks at the BSMT conference in May, although he was specifically looking at the problems of SARS-CoV-2 testing by lateral-flow testing (LFT) and PCR, a lot of his comments apply equally to other pathogens and test scenarios. It is not clear if follow-up laboratory confirmatory testing will continue to be required for confirmatory or surveillance purposes. If the NPT results are not included in the normal microbiology system, how will the laboratory be aware of that result? How can we resolve discrepant results between systems that may have completely different targets ranging from antigenic epitopes to RNA sequences? As ever, a clear scientific understanding of the specific mechanisms and limitations behind the individual assays and systems is key to answering some of these questions, and likely require laboratory input.



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Lateral-flow testing has played a major NPT role in response to the current pandemic

In many ways these are not new questions and many NHS trusts will already have experienced organising NPT perhaps through their blood science departments, and some may even have microbiology involvement in these processes. For others this is likely to be their first foray into the relatively unfamiliar territory of formal microbiological NPT. This may require closer relationships and communication between laboratory biomedical scientist staff and ward colleagues to realise the rewards, and perhaps could play a part in raising the status of pathology within the hospital and even the wider public as it becomes more visible.

Future prospects

The course of this current pandemic remains difficult to predict with much uncertainty remaining; the role of diagnostics will undoubtedly need to continue to change and adapt in response, and NPT is likely to continue to play its part. Perhaps it may prove that the drive to roll out near-patient SARS-CoV-2 testing may lay the framework to expand the microbiology testing performed at the bedside. The role of the laboratory in overseeing these tests will develop and if embedded in the long term it must be desirable at the least to bring these tests into the schedule of accreditation eventually.

> Near-patient testing technology is likely to continue to develop, particularly if a proven market can be established

Once these hurdles are overcome, the requirements are more familiar and relationships are built, perhaps NPT will be regarded with less trepidation. The technology is likely to continue to develop, particularly if a proven market can be established. Perhaps a wider range of diagnostic and screening tests operated at the bedside but overseen by pathology governance structures might not be the distant fantasy it once was. The pressure that has fallen on microbiology departments to respond to the increased need for SARS-CoV-2 testing may unwittingly have provided leverage to open some doors long viewed as closed.

Changes to working practices and expansion of molecular capabilities are both likely legacies. However, it may also force renewed consideration of areas such as NPT that have previously been viewed with some suspicion. It will be down to individual trusts and departments to determine the enthusiasm by which they will approach these challenges going forward.

Reference

1 British Society for Microbial Technology. *COVID19: The Infection Challenging the World* (https://bsmt.org.uk).

Davis Westrip is a British Society for Microbial Technology committee member.

The next Annual Microbiology Conference of the BSMT will be held on 12 May 2022. The keynote presentation will be by Professor Sharon Peacock who will talk about how laboratory testing in clinical microbiology is changing in the wake of SARS-COV-2 sequencing. In addition, Professor Paul Dark from Manchester will look at how to evaluate molecular diagnostic technologies in sepsis and how this has been affected by the SARS-CoV-2 pandemic, and Dr Elaine McCulloch from QCMD will address the topic of quality assurance for molecular diagnostics. See the BSMT Website (https://bsmt.org.uk) for up-to-date information on the programme.