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Real-world performance of a single-use, analyser-free, molecular point-of-care test for COVID-19 used in the emergency department: Results of a prospective trial (ED-POC)

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SUMMARY

Background: A novel single-use, analyser-free, molecular point-of-care test for SARS-CoV-2 (Veros COVID-19 test, Sherlock Biosciences) could reduce time to results and improve patient care and flow in the emergency department (ED), but its performance in this setting is unknown.

Methods: Adults aged ≥18 years presenting to Southampton General Hospital (UK) with suspected COVID-19 were tested with the Veros COVID-19 test in addition to standard of care near-patient PCR. Measures of diagnostic accuracy were calculated for the Veros COVID-19 test stratified by Ct value. Discrepant results underwent viral culture.

Findings: Between Jan 16 and May 2, 2023, 400 patients were enrolled with a median (IQR) age of 60 (34–77) and 141 (35·3%) were SARS-CoV-2 positive by PCR. The Veros test gave valid results on the first test in 384 (96·0%), and sensitivity and specificity were 127/141 (90·1%, 95%CI 83·9–94·5) and 258/259 (99·6%, 95%CI 97·9–100) overall. For those with high or moderate viral load (Ct ≤30), sensitivity was 125/129 (96·9%, 95%CI 92·3–99·2). One (7·1%) of 14 PCR positive/Veros test negative samples was culture positive. Median (IQR) time from sample collection to result was 19 (18–20) mins with the Veros test versus 73 (59–92) mins with PCR ($p < 0·0001$).

Interpretation: The Veros COVID-19 test generated results in near real-time, around 1 h sooner than rapid, near-patient, analyser-based PCR, and accuracy was excellent for samples with moderate and high viral loads. The Veros test represents a step-change in molecular diagnostics for infection and could significantly reduce time to results and improve patient management in EDs and other settings.

Introduction

Patients presenting to hospital with symptoms of COVID-19 are routinely tested by PCR in accordance with national guidance to guide therapy and infection control measures.[1] Currently, testing of patients in the Emergency Department (ED) generally relies on rapid PCR testing using 'sample-to-answer' type testing platforms housed in near-patient settings or in a central laboratory.[2] Although these test platforms often have run times of under an hour, there is still a considerable delay in availability of results due to pre and post analytical steps, which leads to reduced patient flow and overcrowding in EDs and the risk of nosocomial transmission.[2,3] Emergency departments in the United Kingdom (UK) are currently facing an unprecedented period of high demand and so measures to improve patient flow are desperately needed.[4]

The UK Health Security Agency has relaxed is position on mandating PCR testing for SARS-CoV-2 in symptomatic patients presenting to secondary care and allowed for the use of antigen based Lateral Flow Devices (LFDs) in this setting.[1] LFDs have the advantage of delivering results more rapidly but at the cost of reduced sensitivity compared with PCR, with the subsequent risk of erroneously co-locating infected patients who test falsely negative on LFD with

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vulnerable non-infected patients and resultant nosocomial transmissions. LFDs may miss up to a third of symptomatic SARS-CoV-2 infections compared to PCR.[5]

A novel, Conformité Européene (CE) marked, analyser-free, single-use, point-of-care molecular test for COVID-19 (Veros COVID-19 test, Sherlock Biosciences) has been developed and could significantly reduce time to results and improve patient care and flow in the ED and may have advantages over LFD in terms of improved sensitivity; however, its performance in this setting is unknown.[6]

The objective of this study was therefore to evaluate the real-world performance, usability, and potential clinical impact of this novel test in the ED setting.

Methods

Study design

We did a single-centre, prospective study evaluating the diagnostic accuracy, usability, and potential clinical impact of an analyser-free, molecular point-of-care test for SARS-CoV-2: the Veros COVID-19 test. Patients were prospectively recruited from the ED and acute medicine unit (AMU) within Southampton General Hospital, a large acute teaching hospital in the UK. The hospital serves as a secondary care service to a population of 650,000 people and is run by University Hospital Southampton NHS Foundation Trust, which was the trial sponsor.

The study was approved by the North East - Tyne & Wear South Research Ethics Committee on 5th December 2022 (reference 22/NE/0225). The study was prospectively registered on an international trials database (ISRCTN66255490) and has been completed. The study protocol is available online and in the appendix.[7]

Participants

Adults aged ≥18 years presenting to hospital with acute respiratory illness (ARI) +/- fever, or who did not have an ARI but were a suspected case of COVID-19 for other clinical reasons, were eligible for recruitment providing they had the capacity to give informed consent. Patients not fulfilling inclusion criteria or declining upper respiratory tract swabbing were ineligible.

Procedures

Eligible patients were approached and consented by research staff within cohorted areas within the ED or Acute Medical Unit (AMU). As part of routine clinical care, a combined nose and throat swab was taken by trained clinical staff from all patients then PCR tested using the Xpert Xpress CoV-2/Flu/RSV *plus* test (Cepheid, Sunnyvale, CA, USA) on the GeneXpert instrument (Cepheid, Sunnyvale, CA, USA) housed in a near-patient setting within the AMU, and operated by trained AMU nurses. The run time of this test is around 40 mins with results interfaced with the electronic patient record. Two additional upper respiratory tract swabs were obtained contemporaneously by research staff from enrolled patients: the first (anterior nares) was tested immediately on the Veros test at the point-of-care (i.e. within the ED), and the second (combined nose and throat in viral transport medium) was stored at −80 °C pending viral culture should the Veros result be discordant from the PCR result. Patients, clinical teams, and PCR test operators were blinded to Veros test results. Operators of the Veros test were not necessarily blinded to the results of the PCR test. The research staff operating the Veros test consisted of doctors, clinical research nurses and clinical trials assistants.

PCR testing

The Xpert Xpress CoV-2/Flu/RSV *plus* is a CE-marked test cartridge that runs on the 'sample-to-answer' GeneXpert RT-PCR platform. The SARS-CoV-2 assay component of the test was considered the reference standard for this study and tests for 3 gene targets, the S, E, and N genes. The results are given with combined a Cycle threshold (Ct) value that allows semi-quantification. Results with a Ct value of < 35 are locally reported as 'RNA detected' and those with Ct ≥35 are locally reported as 'low-level RNA detected'. Patients with a Ct value of > 40 were considered negative. The performance of this SARS-CoV-2 assay using nasal swabs is excellent with a quoted positive percentage agreement (i.e. sensitivity) of 100% (95%CI 92·4 to 100) and negative percentage agreement (i.e. specificity) of 100% (95%CI 98·0 to 100) and lower limit of detection of 138 copies/mL.[8] Other multi-centre evaluations have shown similarly excellent diagnostic accuracy results.[9]

Veros COVID-19 test

Veros COVID-19 (Sherlock Biosciences, USA) is a new point-of-care device designed as a single-use, instrument-free (disposable) nucleic acid amplification test (NAAT) for use by healthcare professionals that runs in about 15 min, requires neither formal laboratory training nor power supply. The intended use specimen is anterior nasal swab obtained from the patients with signs and symptoms of COVID-19, resuspended in the Veros sample buffer. Subsequently, 200 µL of the specimen are transferred into the device, which is then activated by closing the sample chamber with the blue lid (Fig. 1a). The Veros COVID-19 amplification reaction targets one region on the Orf1ab gene of SARS-CoV-2. Briefly, the amplification consists of an initial step of reverse transcription followed by a combined single-strand endonuclease and DNA polymerase activity for about 12 min at a constant temperature of 50°C. After that, the reaction volume is transferred onto the lateral flow strip sealed within the Veros COVID-19 device. The strip is printed with two lines of dried oligonucleotide probes, one for the SARS-CoV-2 amplicon detection and a second for the control amplicon detection. From the device activation, the process takes approximately 15 min to complete and then a blue light is actuated indicating the results can be interpreted. The test strip is interpreted based on the presence or absence of the control and test lines (Fig. 1b and 1c). Absence of a line in the control position or a red light instead of blue indicates an invalid test result. Company-generated performance data show a positive percentage agreement of 95·2% (95%CI 89·2 to 97·9) and negative percentage agreement of 99·5% (95%CI 97·1 to 99·9) compared with laboratory PCR, with a lower limit of detection of around 2600 copies per swab.[6]

Data collection

All data was entered into a bespoke electronic Case Report Form (ALEA, FormsVision BV) by research staff. Patient data from the electronic patient record was collected at enrolment for baseline characteristics (age, sex, ethnicity, vaccination status, comorbidity, physiological measurements, duration of illness, symptoms) and retrospectively for outcomes (total time spent in ED, time to discharge or admission, antiviral usage, time to antivirals, time to PCR results, Ct value of PCR result). Result and time to results were measured for the Veros device as well as if the test returned a valid result on the first attempt or had to be repeated (reliability). Ease-of-use scores (modified from Nicholson et al., 2014) were collected from clinical research staff who used the Veros COVID-19 test.[10] In brief, there are 11 usability fields (equipment, test site, materials and reagents, operational steps, training, calibration, interpretation, troubleshooting and maintenance, time to results, health and safety,

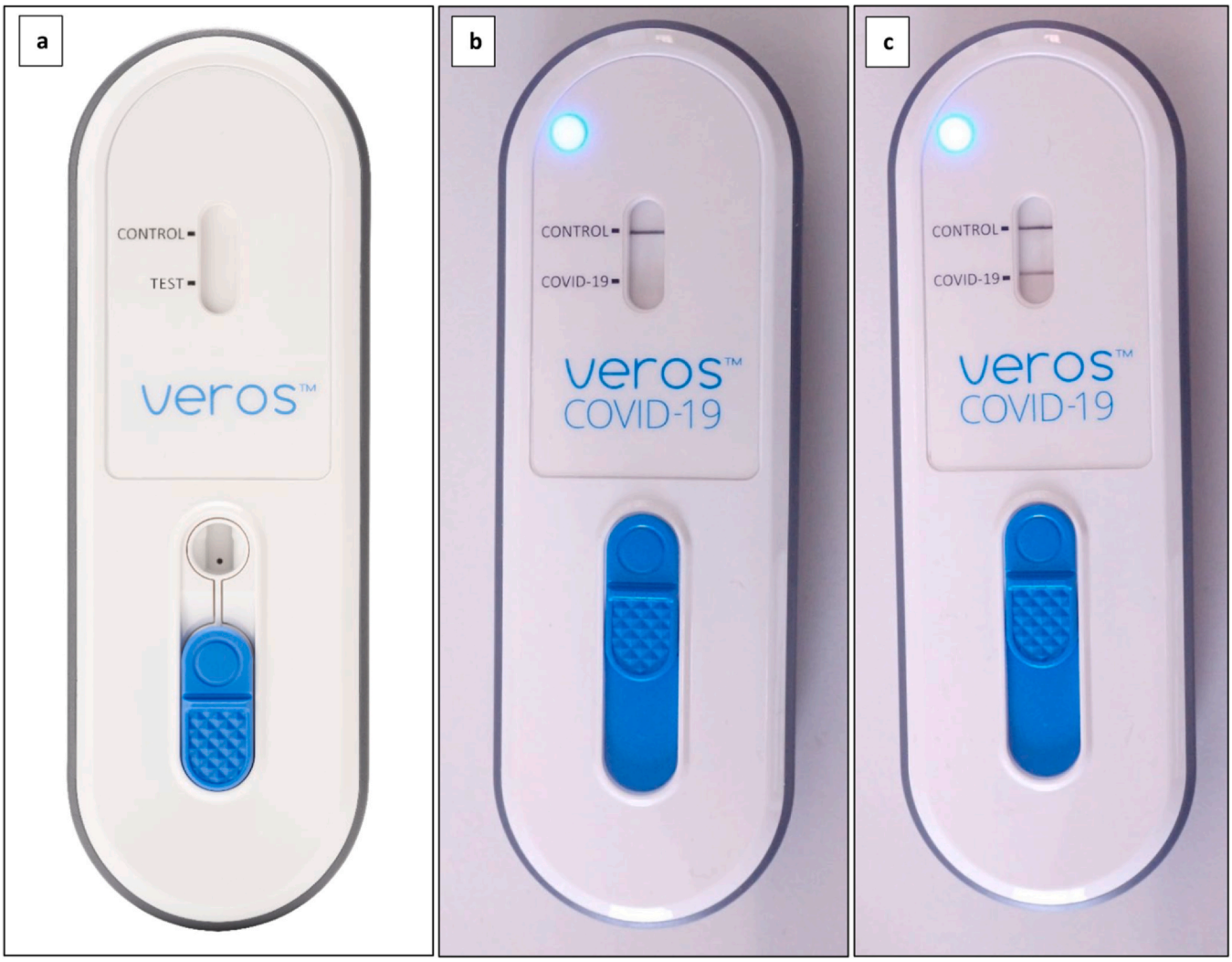

Fig. 1. The Veros COVID-19 test device: (a) before use, (b) negative result, and (c) positive result.

storage and disposal). Each field was rated on a scale of 1 to 3, with 1 being the easiest and 3 being the most complex. Ease-of-use scoring is shown in the appendix (pp 2–3).

Outcomes

The primary outcome measures were sensitivity (true positive rate) and specificity (true negative rate) with associated 95% confidence intervals (95%CIs) for the Veros COVID-19 test compared to the reference standard of GeneXpert SARS-CoV-2 PCR (as part of the Cepheid Xpert Xpress CoV-2/Flu/RSV *plus* test). Secondary outcome measures included: performance of the Veros test across high, medium and low viral loads as determined by Ct value bin (< 25, 25–30, and > 30), time to result, total time spent in ED to admission or discharge, time from swabbing to admission or discharge, proportion of Veros tests giving an initial valid result (i.e. failure rate), ease-of-use score for the Veros COVID-19 test, and proportion of discordant results positive and negative by viral culture. Methods for viral culture are described in the appendix (p 4). The study was reported according to STARD guidelines.[11]

Sample size

The sample size of 400, with an aspiration to include approximately 150 SARS-CoV-2 PCR positive and 250 PCR negative patients, was chosen based on the Medicines and Healthcare products Regulatory Agency (MHRA) Target Product Profile (TPP) for SARS-CoV-2 tests which aims to enable estimation of sensitivity and specificity with high precision (i.e. narrow 95% confidence intervals).[12] The TPP also states: "the samples should cover a clinically meaningful range of viral loads (i.e. should be from people with high, medium and low viral load) that represents the population the test is intended to be used in".

Statistical analysis

Descriptive statistics were used to summarise baseline demographic and clinical variables. For continuous variables, the mean and standard deviation were used for normally distributed data. For non-normally distributed, the median and interquartile range were calculated. Categorical or binary variables were summarised as frequency and percentage of total.

Measures of diagnostic accuracy with 95% confidence intervals were calculated for the Veros test and stratified by viral load using Ct value bins (Ct value < 25 = high viral load, Ct 25–30 = moderate viral load and Ct > 30 = low viral load) in accordance with MHRA Coronavirus Test Device Approvals assessment criteria.[13] Exact binomial confidence intervals are reported for sensitivity and specificity. Time to results were compared between tests using the Wilcoxon matched-pairs test.

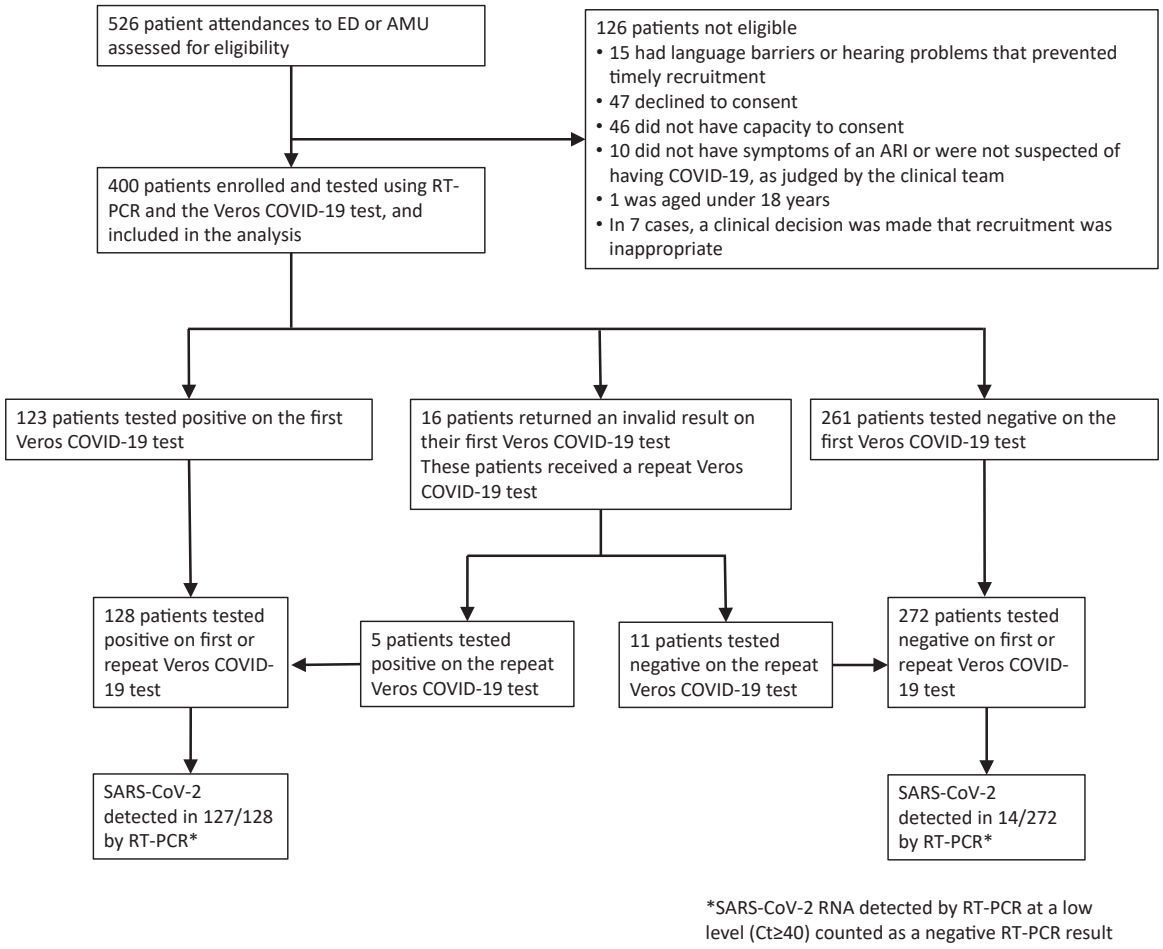

Fig. 2. Trial profile.

All analyses were done using Prism version 9·4·1 (GraphPad Software, La Jolla, CA, USA) and Stata version 17·0 (StataCorp, College Station, Texas, USA).

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Between 16th January and 3rd May 2023, 400 patients were enrolled and tested using the Veros COVID-19 test device in addition to the PCR reference standard (Fig. 2 shows the trial profile). Median (IQR) age of patients was 60 (34–77) years, 181 (45%) of 400 patients were male and 346 (87%) were of White British ethnicity. 357 (90%) of 397 patients were fully vaccinated (having received at least two vaccinations against SARS-CoV-2) and 15 (4%) of 397 were partially vaccinated against SARS-CoV-2. Comorbidity was common with 357 (89%) of 400 having any comorbidities (143 (36%) having hypertension, 105 (26%) having other cardiovascular disease, 70 (18%) having COPD, 77 (19%) having asthma, 72 (18%) having diabetes mellitus and 43 (11%) having chronic renal disease). 298 (85%) of 352 presented with a new or worsening cough, and 194 (49%) of 392 had fever. 46 (12%) of 398 required supplementary O_2 and the median NEWS2 score was 2 (1–4). Baseline characteristics of all patients are shown in Table 1.

141 (35·3%) of 400 patients were SARS-CoV-2 PCR positive by GeneXpert (the reference test). The Veros COVID-19 test gave a valid result on the first test in 384 (96·0%) of 400 tests. In the 16 instances where initial test failed to give a valid result, a valid result was obtained using a second Veros COVID-19 test with the same sample in all cases. The overall sensitivity and specificity of the Veros device was 127/141 (90·1%, 95%CI 83·8 to 94·5) and 258/259 (99·6%, 95%CI 97·9 to 100). 129 (91·5%) of 141 PCR-positive patients had a high or moderate viral load (Ct value ≤30), and sensitivity and in this group was 125/129 (96·9%, 95%CI 92·3 to 99·1). For those small numbers of patients with a low viral load (Ct > 30), sensitivity of the Veros COVID-19 test was 2/12 (16·7%, 95%CI 2·1 to 48·4). Performance of the Veros COVID-19 test is shown in Table 2.

20 patients were PCR positive for Influenza (4 Influenza A and 16 Influenza B) and 9 were positive for RSV. 1 patient was PCR positive for both Influenza B and SARS-CoV-2 (Ct 18·6) and was Veros COVID-19 test positive. None of the other Influenza or RSV positive patients tested positive by Veros COVID-19 test.

The median (IQR) Ct value from PCR positive/Veros COVID-19 test positive patients was 19 (17 to 22) compared to 33 (30 to 36) from PCR positive/Veros COVID-19 test negative patients (difference of 14, 95%CI 10 to 15; p < 0·0001). One (7·1%) of the 14 PCR positive/Veros COVID-19 negative samples was positive by highly sensitive viral culture and another was deemed indeterminate, with a titre at or below that of the limit of detection of the assay. Viral culture results according to GeneXpert PCR Ct values are shown in Table 3. The single PCR positive/Veros COVID-19 test negative sample that was positive by highly sensitive viral culture had a Ct value of 21·8.

As part of the validation of the viral culture assay 6 high viral load and 5 moderate viral load samples which were concordant (i.e. positive by both PCR and Veros COVID-19 testing) were selected at

Table 1
Baseline characteristics for all patients.

Characteristic	n = 400
Age (years)	60 (34–77)
> 65 years	163/400 (41%)
Male sex	181/400 (45%)
Ethnicity	
White	346/400 (87%)
Black etc	10/400 (3%)
Asian etc	28/400 (7%)
Mixed	6/400 (2%)
Other	10/400 (3%)
Vaccination status	
Fully vaccinated	357/397 (90%)
Partial	15/397 (4%)
Unvaccinated	25/397 (6%)
Comorbidity	
Hypertension	143/400 (36%)
Other Cardiovascular diseases	105/400 (26%)
COPD	70/400 (18%)
Asthma	77/400 (19%)
Other respiratory disease	35/400 (9%)
Chronic renal disease	43/400 (11%)
Chronic liver disease	10/400 (3%)
Diabetes mellitus	72/400 (18%)
Cancer	21/400 (5%)
Immune suppression	33/400 (8%)
Symptoms	
Cough	298/352 (85%)
Fever	194/393 (49%)
Shortness of Breath	210/298 (70%)
Duration of symptoms, days	3 (2–5)
Physiological parameters	
Heart rate, bpm	90 (78–107)[a]
Respiratory rate, bpm	20 (18–24)[b]
Systolic BP, mmHg	131 (119–148)[c]
Diastolic BP, mmHg	76 (66–86)[c]
Temperature, °C	37·0 (36·7–37·4)[d]
Oxygen saturations, %	96 (95–98)[c]
Received Supplementary O_2	46/398 (12%)
NEWS2 score	2 (1–4)[e]

Data are n/N (%) or median (IQR). COPD = chronic obstructive airways disease. bpm = beats or breaths per minute. O_2 = oxygen. NEWS2 = national early warning score 2.
[a] n = 396.
[b] n = 391.
[c] n = 398.
[d] n = 399.
[e] n = 387. (data availability).

Table 2
Diagnostic performance of Veros COVID-19 test compared to the reference standard of PCR for all patients and by viral load.

All viral loads combined	n/n	%	95% CI
Prevalence of SARS-CoV-2	141/400	35·0	31·0–40·0
Sensitivity	127/141	90·1	83·9–94·5
Specificity	258/259	99·6	97·9–100
PPV	127/128	99·2	95·7–100
NPV	258/272	94·9	91·5–97·2
Overall accuracy	385/400	96·3	93·9–97·9
High viral load (Ct < 25)			
Prevalence	112/400	28·0	24·0–33·0
Sensitivity	110/112	98·2	93·7–99·8
Moderate viral load (Ct 25 to 30)			
Prevalence	17/400	4·0	3.0–7·0
Sensitivity	15/17	88·2	63·6–98·5
Moderate and high viral load (Ct ≤30)			
Prevalence	129/400	32·0	28·0–37·0
Sensitivity	125/129	96·9	92·3–99·1
Low viral load (Ct > 30)			
Prevalence	12/400	3·0	2·0–5·0
Sensitivity	2/12	16·7	2·1–48·4

Ct = Cycle threshold. PPV = positive predictive value. NPV = negative predictive value.

Table 3
Viral culture results for PCR positive/Veros COVID-19 test negative patients according to PCR Ct value, n = 14.

Sample number	PCR Ct value	Viral culture result	Viral culture titre, FFU/mL
1.	21·8	Positive	256
2.	23·2	Negative	< 5
3.	28·6	Negative	< 5
4.	30·0	Negative	< 5
5.	30·1	Negative	< 5
6.	30·5	Negative	< 5
7.	31·5	Negative	< 5
8.	33·9	Negative	< 5
9.	34·3	Negative	< 5
10.	34·4	Negative	< 5
11.	35·6	Negative	< 5
12.	35·7	Indeterminate	5/ < 5[a]
13.	36·4	Negative	< 5
14.	39·5	Negative	< 5

Ct = Cycle threshold. FFU = Focus Forming Units.
[a] Only a single FFU was seen on initial testing with none seen on repeat testing.

random and also underwent culture. All samples with a Ct value of ≤22 were culture positive and all samples with a Ct value of ≥25 were culture negative, shown in the appendix (p 5).

Median (IQR) time from enrolment to Veros COVID-19 test result was 19 (18–20) minutes versus 73 (59–92) minutes with near-patient PCR (difference of −54 mins (95%CI −72 to −40); p < 0·0001). 384 (96·0%) of 400 patients were recruited in the ED and 194 (50·3%) of 384 were admitted to a hospital ward from the ED. Patients who were admitted from the ED spent a median (IQR) time of 6·1 (4·0 to 8·2) hours in the ED and the median time from test swab to admission was 4·9 (3·3–7·2) hours. Patients who were discharged home from ED spent a median time of 4·0 (3·5–6·2) hours in the ED and the median time from test swab to discharge was 3·5 (2·5–5·4) hours. Table 4 shows the time to results and time spent in the ED.

The Veros COVID-19 test failed to give a valid result on the first test in 16 (4·0%) of 400 tests. In all cases, a valid result was obtained on repeating the test. The reasons for invalid test results in all cases was failure to produce a visible control line at the time the test was read. For those with an initial valid result, 38 (9·9%) of 384 were noted by the operator to have a faint line for either the control or the SARS-CoV-2 test results or both (all visible lines are considered to represent a valid result, even when faint, according to the Veros COVID-19 test instructions for use).[6] The GeneXpert PCR failed to give a valid result on the first test in 1 (0.25%) of 400 tests. There were no adverse events recorded from use of the index or reference tests.

Table 4
Time to results and time spent in the Emergency Department.

Variable	n = 400
Time to Veros results, mins	19 (18–20)
Time to PCR result, mins	73 (59–92)
Veros COVID-19 test Versus PCR time to results, mins	−54 (−72 to −40), p < 0·0001
Recruited in ED	384 (96%)
Admitted to ward from ED	193/384 (50%)
Total time spent in ED prior to admission, hours[a]	6·1 (4·0–8·2)
Time from PCR swab to admission, hours[b]	4·9 (3·3–7·2)
Discharged home from ED	191/384 (50%)
Total time spent in ED prior to discharge, hours[c]	4·0 (3·5–6·2)
Time from PCR swab to discharge, hours[c]	3·5 (2·5–5·4)

Data are presented as Median (IQR) or n (%). ED = Emergency Department.
[a] n = 193.
[b] n = 189.
[c] n = 191. (data availability).

Eight members of research team (three doctors and five clinical research nurses and clinical trials assistants, employed by the hospital or university) used the Veros COVID-19 test and completed an ease-of-use scoring questionnaire. The median (IQR) total ease-of-use score across all respondents was 11 (11–12) out of 33. The median score for all of the 11 usability fields was 1 (1–1) – where a score of 1 represents the easiest and 3 the hardest, and therefore 11 was the lowest possible combined score. Ease-of-use scores are shown in the appendix (p 6).

Discussion

In this study we have demonstrated that the single-use Veros COVID-19 device was reliable, considered by operators to be easy to use, and generated results in near real-time, around 1 h sooner than rapid, near-patient, analyser-based PCR. Accuracy compared with reference standard of PCR was excellent for samples with moderate and high viral load and much lower for those with a low viral load (Ct value > 30). Nearly all of these discordant low viral load samples were also negative by highly sensitive viral culture, suggesting that the clinical significance of the PCR result was questionable and that they represented a negligible risk of transmission to others. In this real-world study of unselected patients with suspected COVID-19 presenting to ED, the vast majority of those who were SARS-CoV-2 PCR positive had a high or moderate viral load with only a small proportion (< 10%) having a low viral load. Omicron variants are known to produce higher peak viral loads compared to ancestral strains of SARS-CoV-2 and the median duration of illness prior to presentation in this study was 3 days in this study which is likely to be close to the peak viral load.[14]

Although PCR is a very sensitive and specific test, it does not distinguish between replication-competent virus and residual RNA and the issue of PCR tests detecting persisting low levels of virus that are clinically insignificant and do not represent a risk of infection to others is well known.[15] For this reason lateral flow devices (LFD), which detect antigen and are considered a better correlate of infectiousness, have been used to determine the time to end isolation periods in preference to PCR.[16,17] Although LFDs correlate well to infectiousness compared to RNA, they may miss some infectious cases due to their lower sensitivity, especially early in infections when viral levels are low but rising and the need for a reliable test is arguably the greatest.[16] Accepting the variability of different PCR assay Ct values in representing a level of virus, LFDs have been shown to reliably detect SARS-CoV-2 infections with PCR Ct values of between 20–25, whereas in this study, the Veros COVID-19 test reliably detected infections with a PCR Ct value up to 30 using a highly sensitive PCR assay.[18] This increased sensitivity of the Veros COVID-19 test would allow reliable detection of infectious patients presenting to ED that would be missed by LFD but without detecting those with an even lower level of RNA who are not infectious. In addition, if used for testing in the community, the Veros COVID-19 test could detect new infections earlier in the course of the disease than LFD, including on the first day of symptoms, thereby reducing transmission.

In addition to the theoretical benefits of increased sensitivity over LFDs, the Veros COVID-19 test has the advantage over PCR of not requiring an instrument or reader for testing. In addition to the cost of the instruments themselves, there are additional costs associated with the staffing, maintenance and quality management systems that need to be in place to run tests safely and efficiently on such instruments. A single-use molecular test allows on-demand, point-of-care patient testing without any of these costs or constraints.

In this study the Veros COVID-19 test returned results in less than 20 min from recruitment, and around 1 h quicker than with rapid, near patient PCR. Patients in this study spent prolonged periods of time in the ED whilst awaiting ward placement or discharge home, and it is likely that the provision of diagnostic results by 1 h could reduce this, improving patient flow and reducing crowding in the ED. In this study the Veros COVID-19 test was also shown to be reliable with an acceptably low failure rate of less than 5%.[12] It was also deemed to be very easy to use by a range of healthcare and research staff operators.

Although other single-use molecular tests for COVID-19 have also been developed recently, including the Visby COVID-19 and Lucira COVID-19 devices (Visby Medical and Pfizer respectively), the Veros COVID-19 arguably has advantages over these test platforms. The Veros COVID-19 test generates results considerably more rapidly, in 15 min compared to up to 30 min, while also not requiring an external power source making it deployable in any setting including, potentially, in patients' homes or by ambulance crews.[2,6] In addition, although published diagnostic accuracy studies of these two platforms have reported similar levels of diagnostic accuracy to our results with the Veros COVID-19 test, smaller numbers of samples were tested. Furthermore, they did not evaluate on the failure rate or usability of these tests.[19,20]

The strengths of this study include its real-world prospective nature, taking place in a busy UK ED, and its large samples size aligned with MHRA TPP guidance for the assessment of diagnostic tests. Because of these factors, the results are likely to be generalisable to other healthcare settings. In addition, the inclusion of assessments of ease-of-use and potential impact on clinical pathways gives added value to the assessment of real-world performance.

Limitations of the study include the small numbers of SARS-CoV-2 positive patients with low viral loads meaning that the estimates for performance of the Veros COVID-19 test are imprecise for this group. It is notable though that in this unselected group of patients with COVID-19 presenting to ED, at a time when omicron variants were circulating, that very few had low viral loads. Therefore, the impact of this imprecision on the overall estimates for measures of diagnostic accuracy is likely to be small. As per manufacturer instructions, we used anterior nasal swabs for the Veros COVID-19 test and combined nose and throat swabs for the reference PCR test. The reference test swabbing the throat in addition to the nose may have put the Veros COVID-19 test's potential sensitivity at a disadvantage, however, nasal swabbing alone may be preferable to patients. This study was conducted during a period of relatively high prevalence and over one winter season with likely one predominant variant, and therefore future implementation into clinical practice should also evaluate the Veros COVID-19′s diagnostic accuracy to ensure it remains high. This study was a diagnostic accuracy study and further trials are now needed to prospectively assess the clinical impact and cost-effectiveness of using the Veros COVID-19 test in the ED and other settings. Previous trials have demonstrated a wide range of clinical benefits associated with molecular point-of-care testing for respiratory viruses in hospitalised adults, and the faster time to results and other novel features of the Veros test might result in additional benefits.[21,22]

While not currently capable of multiplex testing, the technology in the Veros COVID-19 test has the potential to be adapted to detect other infectious pathogens. The development of additional assays and multiplexing for other infections, including those where detection by lateral flow is not feasible, such as sexually transmitted infections may be transformative in terms of facilitating rapid diagnosis and early treatment in a range of different settings including patients' homes.

In summary, our study shows that the Veros COVID-19 single-use test was rapid, reliable, easy to use and had high accuracy in patients with high and moderate viral loads. The device represents an advance in molecular diagnostics for infection and could significantly reduce time to results and improve patient management in ED and

other settings such as primary care, pre-hospital care, and long-term care facilities.

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Sherlock Biosciences.

Author contributions

TWC reviewed the medical literature, conceived of and designed the study, oversaw the conduct of the study, collected data, interpreted results, and co-wrote the manuscript. MEC reviewed the medical literature, participated in the trial design, recruited patients, generated and collected data, and co-wrote the manuscript. NJB participated in the trial design, drafted and reviewed the manuscript. MM recruited patients, generated, and collected data and reviewed the manuscript. CJM and CMS performed the viral culture work, and reviewed the manuscript. HEM designed the statistical analysis plan, analysed the data, and reviewed the manuscript. TWC and MEC verified the underlying data for this study.

Data availability

All de-identified participant data analysed and presented in this study are available from the corresponding author following publication, on reasonable request.

Declaration of Competing Interest

The author Professor Tristan W Clark is an Associate Editor for *Journal of Infection* and was not involved in the editorial review or the decision to publish this article. The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: TWC has received speaker fees, honoraria, travel reimbursement, and equipment and consumables at discount or free of charge for the purposes independent of research, outside of this submitted study, from BioFire diagnostics, BioMerieux and QIAGEN. He has received consultancy fees from Cepheid, Synairgen research, Roche, Janssen, Biofire diagnostic and BioMerieux. He has received honoraria for participation in advisory boards from Cepheid, Roche, Janssen, Shionogi, GSK, Seqirus and Sanofi. He is a member of an independent data monitoring committee for a trial sponsored by Roche. He has acted as the UK chief investigator for a study sponsored by Janssen. All other authors declare no competing interests.

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The views expressed in this publication are those of the authors and not necessarily those of the National Health Service (NHS), the NIHR, or the Department of Health and Social Care.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.jinf.2024.106264.

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