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Original Research

An evaluation of a pilot of daily testing of SARS-CoV-2 contacts in acute hospital and ambulance trusts in England

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ABSTRACT

Objectives: Healthcare worker (HCW) SARS-CoV-2 contacts in England have been required to quarantine, creating staff shortages. We piloted daily contact testing (DCT) to assess its feasibility as an alternative.
Study design: Observational service evaluation.
Methods: We conducted an observational service evaluation of 7-day DCT using antigen lateral flow devices (LFDs) at four acute hospital trusts and one ambulance trust in England. Mixed methods were used, using aggregate and individual-level test monitoring data, semi-structured interviews, and a survey of eligible contacts.
Results: In total, 138 HCWs were identified as contacts of a confirmed SARS-CoV-2 case. Of these, 111 (80%) consented to daily LFD testing, of whom 82 (74%) completed the required programme without interruption and 12 (11%) completed with interruption. Fifty-eight participants (52%) and two non-participants (7.4%) completed the survey. In total, 28 interviews were conducted with participants, site and infection control leads, and union representatives. One participant tested positive on LFD and polymerase chain reaction (PCR) test. Three participants tested positive on PCR but not LFD. DCT was well-accepted by trusts and staff. Participants reported no relaxation of their infection prevention and control behaviours. No incidents of transmission were detected. An estimated 729 potential days of work absence were averted.
Conclusions: DCT can be acceptably operated in a healthcare setting, averting quarantine-related work absences in HCW SARS-CoV-2 contacts.

Introduction

During the winter of 2020–21, large numbers of UK healthcare worker (HCW) staff were identified as contacts of a confirmed SARS-CoV-2 case and were required to quarantine. As a result, many hospitals struggled to staff critical services.[1]

Modelling suggests that daily contact testing (DCT) using antigen-detecting lateral flow devices (LFDs) could mitigate transmission as effectively as quarantining contacts.[2,3] LFDs are most sensitive for cases with high viral loads (a marker of infectiousness).[4] Daily LFD testing could detect asymptomatic but infectious individuals before they expose anyone else, whilst allowing non-infectious individuals to continue working. This could increase detection rates of asymptomatic infection (increasing the opportunities for contact tracing and surveillance of virus variants), whilst minimising the number of unnecessary quarantine days. School-based models suggest that DCT would result in fewer school days missed, at a cost of slightly higher levels of infection.[5,6]

A study of 1760 contacts from the UK general public reported DCT uptake of 50.1%, with 69.6% of participants reporting at least

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one result, 17.9% testing positive, and a secondary attack rate similar to a quarantine comparator group.[7,8] A cluster-randomised trial of 201 schools reported DCT uptake of 42.4%. It found DCT was non-inferior to quarantine for SARS-CoV-2 transmission, though did not demonstrate superiority in averting school absences.[9] DCT has also been conducted with essential workers and private businesses, although results have not been published.[10–12] This article evaluates a pilot of DCT conducted in HCWs to assess the acceptability and feasibility of implementation in the UK National Health Service (NHS), factors influencing participation and adherence, and the effect on behaviour, workplace infections, and workforce levels.

Method

Study design

NHS Test and Trace (T&T) and NHS England and NHS Improvement (NHSEI) recruited volunteers from NHS trusts experiencing high levels of workforce absence and operational pressure. Trusts commenced the pilot between 9th and 22nd January 2021. Recruitment of participants to the formal evaluation ended on 28th February 2021. Mixed methods were used, including an online survey of participants, semi-structured interviews with participants, site leads, union representatives and infection prevention and control (IPC) leads, and aggregate and individual-level test result monitoring data for all participants.

Intervention

A standard operating procedure for DCT was prepared by T&T and adapted for healthcare settings by NHSEI with one of the participating trusts. Subject to risk assessment, participating NHS trusts were permitted to tailor certain aspects, although the following components were common to all (see Supplementary materials 1 and 2).

HCWs were eligible if they were a non-household SARS-CoV-2 contact identified through workplace or national contact tracing, or the NHS COVID-19 app. On 26th January 2021, eligibility was extended to household contacts with evidence of recent SARS-CoV-2 infection (demonstrated by a positive polymerase chain reaction [PCR] test within the previous 90 days).

Contacts were required to self-test with an INNOVA SARS-CoV-2 LFD before attending work for seven consecutive days starting from the initial notification of exposure, or up till the end of their would-be 10-day quarantine period, if that was sooner.

Participants who developed major COVID-19 symptoms or tested positive on LFD were required to immediately quarantine and take a PCR test. If this was negative, they could continue with DCT.

Data collection

Participating trusts reported anonymised data about eligible HCWs, including age, ethnicity, gender, job role, vaccination status, date of exposure, and LFD and PCR test results. Trusts provided estimates of staff time required for setup and administration of the pilot.

Participating trusts were asked to email an online survey to all eligible HCWs, asking for sociodemographic, occupational and vaccination data (Table 2), views on the DCT policy, reasons for participating or declining, and experience of the daily LFD testing process (Supplementary materials 3 and 4).

Semi-structured telephone interviews were conducted with all trust DCT leads, and with up to one union representative and two DCT participants per trust, all of whom were recruited by trust DCT leads. DCT leads were asked about their experiences and the views of the workforce. Union representatives were asked about their perceptions. Participants were asked about their experience of DCT. IPC leads at each trust were asked whether there were any outbreaks or cases linked to DCT.

Relevant feedback from the working group of DCT pilot leads from T&T, NHSEI, and NHS trusts, which met weekly to oversee the operationalisation and evaluation of the pilot, was recorded.

Data analysis

Interview transcripts and survey responses were coded thematically, iteratively until saturation, by a single researcher.

National pay scales were applied to the staff resource estimates, to give a total financial value of initial setup and weekly running costs.[13–17] The number of potential days of work absence averted was counted as the number of LFD negative results during the quarantine period, plus any days remaining from the quarantine period for those who returned a negative result on their last day of testing, if on day 7, 8, or 9, up to a maximum of 10 per participant. The totals for each trust were divided by the number of weeks that the trust was in the pilot, giving the mean weekly number of potential days of work absence averted. Weekly running costs were divided by weekly potential days of work absence averted to calculate the mean cost per potential day of work absence averted.

Confidence intervals were calculated using the Wilson score method.

Results

Participants

Four large multisite acute hospital trusts in London (2), Oxford and Lancashire and a London ambulance trust participated.

In total, 138 HCW contacts were identified as eligible, of whom 80% (95% CI: 73%–86%, $n = 111$) chose to participate in DCT. Of these, 74% (95% CI: 65%–81%, $n = 82$) completed the full series of daily tests without interruption and a further 11% (95% CI: 6.3%–18%, $n = 12$) completed the series with an interruption, i.e., missed one or more days, but returned a result on the final day required. A total of 58 DCT participants (52%, 95% CI: 43%–61%) and two (7.4%, 95% CI: 2.1%–23%) non-participants completed the online survey. There was substantial variation between trusts (Table 1).

The characteristics of contacts who participated in DCT ($n = 111$) and those who declined ($n = 27$) were similar on most dimensions, with the exception of ethnicity. Black and minority ethnicity individuals (whose self-reported ethnicity was anything other than 'White British', 'White Irish', or 'White Other') made up a higher proportion of those who declined DCT (48%, 95% CI: 31%–66%, $n = 13$) than those who participated (38%, 95% CI: 29%–47%, $n = 42$).

Survey participants ($n = 60$) were broadly representative of all the pilot participants ($n = 138$), once the data were reviewed for missing data. Vaccination status was reported for 89 DCT participants (80%), of which 65 (73%) had received at least one dose of vaccine. In the survey, 40% of staff ($n = 24$) reported having had SARS-CoV-2 previously (Table 2).

Participants reported a total of 719 LFD results during the pilot period: a median of seven per participant (IQR = 6–7). Sixteen DCT participants (14.4%) reported more than seven results. One participant (0.9%; 95% CI: 0.2%-4.9%) tested positive on LFD during the testing period on day 3, which was confirmed by PCR. Three participants (2.7%; 95% CI: 0.9%-7.6%) tested positive on routine PCR during the DCT period, without developing symptoms or testing positive on LFD.

Table 1
DCT recruitment, participation and completion and survey response, by trust.

Eligible contacts	Trust 1	Trust 2	Trust 3	Trust 4	Trust 5	Total
	53	40	19	24	2	138
Quarantined (%)	3 (5.7)	17 (42.5)	4 (21.1)	2 (8.3)	1 (50.0)	**27 (19.6)**
Participated in DCT (%)	50 (94.3)	23 (57.5)	15 (78.9)	22 (91.7)	1 (50.0)	**111 (80.4)**
Completed DCT without interruption (%)	41 (82.0)	15 (65.2)	11 (73.3)	14 (63.6)	1 (100.0)	**82 (73.9)**
Completed DCT with interruption (%)	6 (12.0)	1 (4.3)	1 (6.7)	4 (18.2)	0 (0.0)	**12 (10.8)**
Did not complete DCT (%)	3 (6.0)	7 (30.4)	3 (20.0)	4 (18.2)	0 (0.0)	**17 (15.3)**
Survey responses						
Quarantining contacts (%)	0 (0.0)	0 (0.0)	2 (50.0)	0 (0.0)	0 (0.0)	**2 (7.4)**
DCT contacts (%)	32 (64.0)	3 (13.0)	8 (53.3)	15 (68.2)	0 (0.0)	**58 (52.3)**

In total, 28 interviews were conducted with trust staff: nine DCT leads, five DCT participants, four union representatives, and 10 IPC and contact-tracing leads. All trusts provided estimates of staff costs to set up and run the pilot.

Interview and survey findings

Operational feasibility

The DCT pilot was broadly welcomed by interviewed staff participants and trust DCT leads. Union representatives raised concerns that staff may have felt pressured to participate, about the legality of the quarantine exemption, and about the level of consultation. Ninety-three percent of survey respondents ($n = 54$) who participated in DCT said they were 'fairly positive' or 'very positive' about DCT and 97% ($n = 56$) said they would 'probably' or 'definitely' take part in DCT again.

Trust DCT leads reported that setting up the pilot was resource-intensive. However, all trusts had existing IPC, contact tracing, and testing functions, into which DCT was incorporated. The burden was reduced where templates and documentation were shared between trusts.

Table 2
Characteristics of DCT pilot participants and survey respondents.

		Eligible contacts				Survey respondents			
		DCT participants		Declined DCT		DCT participants		Declined DCT	
		Number	%	Number	%	Number	%	Number	%
Participants		111		27		58		2	
Sex	Male	33	30	1	4	19	33	1	50
	Female	54	49	3	11	39	67	1	50
	Unknown/not stated	24	22	23	85	0	0	0	0
Age (years)	18 to 24	7	6	1	4	2	3	0	0
	25 to 34	47	42	7	26	18	31	0	0
	35 to 44	21	19	4	15	9	16	1	50
	45 to 54	19	17	6	22	13	22	0	0
	55 to 64	14	13	1	4	12	21	1	50
	65 to 74	2	2	0	0	4	7	0	0
	Unknown/not stated	1	1	8	30	0	0	0	0
	Mean (SD)	38.6 (12.0)		39.6 (10.8)		–		–	
	Median (IQR)	35 (29–48.25)		38 (30–47)		–		–	
Ethnicity	Asian	16	14	5	19	5	9	0	0
	Black	12	11	3	11	5	9	0	0
	Mixed/Other	14	13	5	19	6	10	0	0
	White	67	60	6	22	42	72	2	100
	Unknown/not stated	2	2	8	30	0	0	0	0
Number in household	1	–		–		6	10	0	0
	2	–		–		19	33	0	0
	3–5	–		–		31	53	2	100
	6–9	–		–		2	3	0	0
Age of dependent children (years)	No children in household	–		–		29	50	1	50
	0–4	–		–		3	5	0	0
	5–10	–		–		8	14	0	0
	11–15	–		–		8	14	1	50
	16–18	–		–		11	19	0	0
	Prefer not to say	–		–		0	0	0	0
Job role	Clinical	99	89	14	52	51	88	1	50
	Non-clinical	12	11	5	19	6	10	0	0
	Unknown/not stated	0	0	8	30	1	2	1	50
Bank hours	Yes	–		–		7	12	0	0
	No	–		–		46	79	2	100
	Unknown/not stated	–		–		5	9	0	0
Vaccination status	Vaccinated	65	59	11	41	–		–	
	Unvaccinated	24	22	6	22	–		–	
	Unknown/not stated	22	20	10	37	–		–	
Known history of coronavirus	Yes	–		–		23	40	1	50
	No	–		–		28	48	1	50
	Unknown/not stated	–		–		7	12	0	0

Participation and adherence

In the survey, the most commonly cited reason for participation was the perceived ease of testing ($n = 34$, 59%). This perception was actualised; over 95% ($n = 55$) of participants rated their experiences of understanding instructions, swab-taking, speed of testing, and reading results, as either 'good' or 'very good'. In the survey, all DCT participants ($n = 58$) reported being at least 'fairly confident' that they conducted the test correctly.

Nineteen participants (33%) said they wanted to know whether they were infectious to protect family and friends. Twenty-one (36%) felt obliged to take part for employment reasons: 7 (12%) thought DCT was compulsory, 8 (14%) said they needed the pay, and 14 (24%) said their employer wanted them to do DCT.[1] Twelve (21%) said they participated because it would be hard for them to quarantine. Twenty-three (38%) also gave a free-text response (reported under 'other reasons for participating'), all of whom indicated a desire to keep working out of a sense of personal, professional, or institutional obligation.

In interviews, participants said many staff were already familiar with how to test and report LFD results as they were doing so routinely. Participants reported they received a high degree of one-to-one support from DCT pilot staff, which helped them to adhere to the testing regime. Staff reported testing at home was preferable to testing at work.

The main reasons interviewees gave for staff declining DCT were work fatigue leading to a preference for 10 days of quarantine, and scepticism over the performance of LFDs. Of the two survey respondents who did not participate in DCT, one did not meet the eligibility criteria, and the other gave no reasons for not participating, and reported that they would probably participate in DCT in future.

Behavioural impacts

Interviewed participants felt they were minimising the risk they posed to others by doing DCT. In survey responses, 45 of 53 participants (85%) reported thinking there was only 'a little' or 'hardly any' risk of passing the virus on to others the day after a negative test. Site and IPC leads reported that they observed no concomitant relaxation of IPC behaviours. Survey responses supported this: over 94% of DCT participants ($n = 50$) reported that their behaviour, in terms of leaving home and social mixing, did not change or became more cautious following a negative result. Sixty percent ($n = 35$) of DCT participants said that they would be 'somewhat' or 'much' more likely to disclose details of their contacts if they tested positive in future, if DCT was an alternative to quarantine.

Workplace infections

Although IPC leads at the pilot trusts acknowledged that their testing and contact tracing processes were not infallible, they expressed high confidence that any workplace transmission from DCT participants would have been detected. No such incidents were reported.

Strict IPC measures were already in place, the importance of which was emphasised to DCT participants, and there was an increasing rate of vaccination amongst HCWs. Consequently, trusts felt that the risk of onward transmission of SARS-CoV-2 in their settings was relatively low.

Workforce levels

Setting up the pilot required a median of 9 days per trust (IQR = 2.3–15), which equated to median gross pay costs of £2325 (IQR = £845-£4196). Running the pilot required a median of 9.4 days of staff time per week per trust (IQR = 1.4–10.8), which equated to median gross pay costs of £1475 (IQR = £359-£1882).

It was estimated that a total of 729 potential days of HCW work absence were averted, 88% of the maximum available (828). Ninety-one percent of these ($n = 660$) were for clinical staff. The estimated running cost per potential day of work absence averted was £50.

See Supplementary materials 3 and 4 for full survey results.

Discussion

This pilot of daily LFD testing in HCW in five trusts in England for 7 days following a SARS-CoV-2 exposure demonstrated an uptake rate of 80%. Eighty-two participants (74%) completed the full series of tests and 94 participants (85%) took a test on the final day of the DCT period, all but one of whom would have met the current criteria for successful completion of DCT (i.e. returning a negative result on day 7 and at least five negative results in total). The DCT pilot was widely viewed as acceptable by NHS trusts and staff as an alternative to quarantine. One potentially infectious participant (0.9%) was detected using LFD on day 3. Participating staff self-reported no relaxation of their IPC behaviours and no incidents of onward transmission were detected. Seven hundred twenty-nine potential days of HCW work absence were averted through participation in DCT in hospitals that were struggling to maintain critical services during the second peak of the SARS-CoV-2 pandemic.

DCT uptake in this pilot (80%) was higher than in the general public (50.1%) and schools (42.4%) studies. This is true even if the rates are adjusted by applying the more stringent schools definition of uptake: the comparable figure would have been below 35% in the general public pilot and 78% in this NHS pilot.[7,9] The higher uptake observed in our pilot may be attributable to HCWs' sense of obligation to keep working (a factor that was not evident in the general public pilot), and perception of ease of testing (59% of HCWs said DCT 'sounded easy to do', compared to 17% of the general public; presumably due to HCWs' pre-existing familiarity with LFD self-testing).[8,18] Recruitment and testing methods also differed between studies, and the NHS pilot combination of recruiting via existing administrative structures and testing at home may constitute optimal conditions.

A more concerning factor, that could have contributed to the high level of uptake, was the perception of pressure from employers on staff to participate in DCT. This is a potential problem for DCT in any workplace setting. Even if such perceptions are entirely unfounded, they could still erode staff trust.

The LFD positivity rate (0.9%) was similar to the apparent rate in the schools trial (1.0%; 32 of the 3166 available LFD-PCR pairs were LFD-positive), but noticeably lower than reported in the general public pilot (17.9%). This may be due to the exclusion of most or all household contacts from the NHS and school pilots, respectively, although lower prevalence of infection, and IPC measures and vaccination could have played a part.[7,9]

The lower effectiveness of LFDs to detect SARS-CoV-2 was highlighted by the three asymptomatic individuals who were PCR-positive but LFD-negative, but making direct comparisons between the two technologies is problematic.[19]

The evaluation found no evidence of onward transmission from DCT participants but it was not designed to quantify this risk, and the opportunity for transmission was limited by the small number of positives. We replicated the finding of the general public pilot that DCT would make people more likely to disclose details of their contacts.[8] This suggests DCT may have wider benefits for contact tracing that should be factored into future modelling, although the potential effect size needs quantifying.

[1] Numbers do not sum, as respondents could choose multiple responses.

Our finding that, following a negative LFD result, HCWs became more cautious with IPC and social mixing, runs counter to the general public pilot, where participants reported engaging in more non-essential activities.[8] This suggests DCT affects HCW behaviour in a unique way, which could be a reflection of their professional training and awareness of nosocomial transmission risks. There were, however, differences in the question phrasing in the two pilots, which could have led to divergent interpretations.

NHS settings have unique features that affect the balance of risks and benefits of DCT. On one hand is the risk of outbreaks, which could have grave consequences on vulnerable patients and jeopardise safe staffing levels. On the other hand, the risks of operating a DCT regime are mitigated by IPC measures, in-house contact tracing, local PCR testing, regular asymptomatic testing, and high vaccination rates, meaning that NHS settings are optimally positioned to implement DCT safely.[20–23]

For NHS trusts, the alternative to averting a frontline absence through DCT is to hire staff to cover the absence, which is not easy during a pandemic. The estimated DCT management cost of each averted absence (£50) was lower than the day rate of even the lowest-paid HCW (£69, based on a 7.5 h day and hourly rate of £9.21). This suggests that implementing DCT in frontline staff was cost-saving for trusts, and the saving may be greater for more senior staff and if the benefits of staff continuity are counted. However, the cost-benefit ratio would be more advantageous when more staff are identified as contacts, which is affected by factors such as prevalence, vaccination, circulating viral strains, and quarantine requirements. Furthermore, other factors beyond direct staffing costs must be considered by decision-makers, including LFD and PCR testing costs, staff time, and the impact of DCT on transmission.

Strengths and weaknesses

The short timeframe of the pilot enabled rapid generation of evidence for decision-making. The devolved delivery model allowed for variation in how DCT was experienced by participants in different trusts, providing real-world validity. However, the selected pilot trusts were experiencing particular operational pressures, and other trusts may not have the same motivation to deliver DCT.

The pilot did not have a predetermined statistical power, which limited the precision of the reported quantitative measures and precluded sub-group analyses. The absence of a control group meant we could not assess whether the number of cases detected by DCT was greater than the number that would have been detected anyway.

We had limited success in obtaining data from individuals who declined DCT. The consequent focus on those involved in administering or participating in the pilot poses a risk of bias. Furthermore, interviewees were recruited opportunistically, so they may not be representative.

The evaluation relied on workplace contact tracing teams for recruitment and monitoring. Therefore, some eligible participants may have been missed, increasing the risk of selection bias. Also, any transmission by DCT participants outside the workplace would not have been systematically detected.

Implications

Although at the time of writing, quarantine requirements have been relaxed, should this change, this pilot demonstrates the feasibility and acceptability of implementing DCT in acute NHS settings to avert unnecessary HCW absences. Potential concerns need to be anticipated and addressed, e.g., through consultation, informed consent processes and communications. Institutions could address concerns about employer pressure by assuring staff that the decision to participate (or not) in DCT will not affect their pay or employment. Trusts had confidence that the risk of transmission from DCT was low, and, had it occurred, would have been quickly identified. There remains a need to fully quantify the impact on SARS-CoV-2 transmission, to assess the trade-off between costs and benefits. The observed rates of DCT uptake and completion and the potential effect of DCT on willingness to disclose contacts should be used to inform future modelling.

Conclusion

This pilot suggests that a workplace-administered programme of daily LFD testing in NHS acute and ambulance services can be acceptably and feasibly operated to retain HCW contacts of SARS-CoV-2 who may otherwise be required to quarantine at home and not be available for work.

Author statements

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The pilot was substantially conceived and designed by ST and SF from NHS Test and Trace (T&T), and JS from NHS England and Improvement, with strategic direction and oversight provided by TF (T&T) and SH (T&T and Public Health England). The operationalisation of the pilot was coordinated by NS (T&T), and implemented, including collection of quantitative data, in NHS trusts by AR and SW (Royal Free

London), DH (Barts Health), Robert Bowen (London Ambulance Service), KJ (Oxford University Hospitals), and CW (Lancashire Teaching Hospitals). Qualitative data collection, verification and analysis was undertaken by GC, quantitative data verification and analysis was undertaken by AG (T&T). SB (T&T) repeated data verification, coordinated the evaluation report, and led on writing this paper. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Ethical approval

The pilot aimed to assess the feasibility of a wider roll-out of DCT. As such, a service evaluation approach was delivered and research ethics approval was not deemed necessary. Eligible individuals were informed about the pilot by trust DCT leads. Those who wanted to participate were consented at local organisational level. Participants were issued with a quarantine exemption letter from T&T. No personally identifiable information was collected, data were stored securely, and results were reported in a way to minimise the risk of deductive disclosure.

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Competing interests

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf. JS was seconded from Great Ormond Street Hospital for Children NHS Trust to NHS England and NHS Improvement during the time the DCT pilot was taking place. TF received an honorarium to act as a panellist in the 2020 National Priorities Research Program 13-S programmatic review for the Qatar National Research Fund. SH is partially funded by the NIHR Health Protection Research Unit from Oxford and Imperial University for HCAI and AMR. The evaluation team, which was responsible for data analysis and writing the report, comprised staff from NHS Test and Trace who were employed by the UK Department of Health and Social Care (DHSC). The views expressed in this publication are those of the authors and not necessarily those of the National Health Service or DHSC.

Data sharing

Aggregated data are available and reported in the supplementary materials. No patient-level data can be shared, due to local information governance and data protection regulations.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2022.05.013.

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