

Digital contact tracing in Aotearoa New Zealand: a scan in the right direction, or a digital dead-end?

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ABSTRACT

AIM: With the phase one Royal Commission COVID-19 report published, it is an opportune time to reflect on the various public health interventions used to consider if they were effective and how they could be improved. As we look to the future, it is important to understand if digital contact tracing (DCT) was an effective public health intervention during the COVID-19 pandemic and how it could be improved.

METHOD: We summarise a series of articles detailing the population and public uptake of the various DCT technologies implemented in Aotearoa New Zealand during the COVID-19 pandemic.

RESULTS: New Zealand had one of the highest population uptakes of DCT in the developed world. However, there were additional barriers to the full implementation of these tools that likely reduced their efficacy.

CONCLUSION: DCT was just one of many interventions aiming to eliminate, and then suppress, COVID-19. This context makes it difficult to isolate and conclude that the efficacy of DCT during this pandemic would translate to future pandemic conditions, especially if there is improved design and implementation. However, this research shows that the self-service survey approach worked better than expected, and that there is some promise in automating notification processes.

The Royal Commission COVID-19 Lessons Learned has focussed on the experiences of people involved in responding to the COVID-19 pandemic to help prepare for future outbreaks. With the phase one report published,¹ it is an opportune time to reflect on the various public health interventions used to consider if they were effective and how they could be improved. The *Australian and New Zealand Journal of Public Health* has recently published the final in a set of articles related to a significant research project investigating digital contact tracing (DCT) in Aotearoa New Zealand. As we look to the future, it is important to understand if DCT was an effective public health intervention during the COVID-19 pandemic and how it could be improved.

At the beginning of the COVID-19 pandemic, DCT was seen as a promising tool to help control the spread of the SARS-CoV-2 virus.² For respiratory infectious diseases transmitted between people, isolating cases then tracing and quarantining their contacts is a key public health measure that can potentially control or even eliminate an outbreak, potentially without vaccines and effective treatments. It stood to reason that with modern technology, we could significantly improve the speed

and coverage of contact tracing. Consequently, many jurisdictions developed DCT solutions, from smartphone apps to customised hardware.³ But no one really knew if theory would translate to meaningful impact on reducing pandemic harms.

DCT was adopted in various ways across the world, with an estimated 171 implementations globally (including some at the state and city level), particularly in wealthier jurisdictions across Europe, Asia and the Americas.⁴ These implementations had different characteristics, such as choice of technology (Bluetooth, GPS, QR codes and others), varied in their data architecture (centralised and decentralised) and had disparate levels of compulsion (from fully voluntary to mandatory in some conditions to fully mandatory).⁵ This makes it challenging to fairly compare DCT implementations between jurisdictions, especially in the context of multiple complex public health interventions and policy settings also influencing outcomes. However, a scoping review found that 60% of studies found DCT implementations to be effective either epidemiologically, technically or with end-users.⁴ Some of these studies showed that DCT was competitive against manual contact tracing methods in iden-

tifying high-risk contacts and disrupting chains of transmission, although the overall effectiveness varied depending on the presence of other interventions.

In New Zealand, DCT was implemented through the “NZ COVID Tracer” application (app), and later “My Covid Record”. These digital tools offered mechanisms for collecting information about a person’s contacts, providing that information to contact tracers and notifying those contacts that they were proximate to an infected person. At different times during the pandemic, those contacts were asked to monitor their symptoms, get tested or self-isolate, thus reducing the likelihood of them passing SARS-CoV-2 onto others.

Which technology worked?

There were three main mechanisms of DCT used in New Zealand: QR code scanning, Bluetooth tracing and an online self-service survey. These tools were available and promoted during different phases of the pandemic, so it can be difficult to make a fair comparison. New Zealand achieved very high rates of public participation (~60%)⁶⁻⁸ in comparison to other countries with voluntary systems (~15–30%).³ However, we found that both QR code scanning and Bluetooth likely did not make a significant impact in the New Zealand context due to the low number of close contacts notified with meaningful calls to action (e.g., to self-isolate).^{6,7}

One of the main reasons for the low notification rates was a lack of utilisation of the technologies by contact tracers, who had discretion to choose whether to use the information from these systems. Despite a ~60% public uptake, only small proportions of cases were provided with an opportunity to upload their QR code (18.7%) and Bluetooth data (1.3%) by clinically trained contact tracers.^{6,7} In contrast, National Case Investigation Service staff (generally non-clinically trained individuals in a call centre following a script) provided a higher proportion of COVID-19 cases the opportunity to upload their QR code (45.5%) and Bluetooth data (31.4%) during similar periods in the pandemic. In focus groups, clinically trained contact tracers told the researchers that they had reservations about the technology’s effectiveness and criticised the belief that an app would solve the challenges of contact tracing.^{9,10} In particular, there were reservations about the accuracy of the technology itself, the reductive interpretation of contact tracing process and the increased workload imposed on

an already stretched workforce.

However, the self-service survey, which was introduced in early 2022 and allowed people to complete an online form to provide contact tracing information, had high utilisation.⁸ At least two-thirds of people who reported testing positive for COVID-19 during the study period completed the self-service survey, with a median completion time of 1.8 hours from case notification.⁸ As the contacts of these people were automatically notified, this approach achieved significant speed improvements in comparison with manual contact tracing. Bluetooth integration into the self-service survey also showed promise, with 111,000 cases (13.4% of survey completers) uploading Bluetooth data alongside the survey, resulting in a total of 496,592 contacts being notified with an average of 4.5 notifications per case, despite a substantial decrease in communication about Bluetooth tracing and de-prioritisation of the Bluetooth component within the self-service survey user journey. The combination of high public uptake and rapid response time suggests that the self-service survey approach, potentially with other tools such as Bluetooth tracing integrated, could be a useful tool for future pandemics.

Was the technology equitable?

Through focus groups and interviews with Māori, Pacific, and disabled people, the researchers found that people were generally willing to use DCT tools like NZ COVID Tracer and support its adoption in their communities.¹¹ However, one shortcoming was that the design of the tool did not sufficiently account for accessibility issues, such as for people with low vision or blindness, limited English fluency or intellectual impairments. Secondly, participants indicated that members of priority communities may have higher levels of distrust of the government’s COVID-19 interventions, which challenged participation. However, while Māori had far lower participation in the QR code and Bluetooth systems overall than other ethnicities, the majority of this difference was due to prioritised allocation of Māori cases to clinically trained staff who systematically under-utilised these tools compared to the National Case Investigation Service,⁶ which was reinforced by high Māori participation rates in the self-service survey.⁸ Participants in focus groups also expressed concern that elderly people may be one priority group excluded from DCT technologies.¹¹ However, in New Zealand, those aged 60+ had greater

uptake of the QR code, Bluetooth and self-service systems than those aged 15–24.^{6–8}

Findings also highlight the “digital divide” within these communities, which was not adequately addressed in the government’s response to COVID-19. An additional intervention, such as providing free or discounted smartphones capable of running NZ COVID Tracer or offering different contact tracing options to accommodate diverse user needs, may have helped bridge the digital divide.

A confronting finding is that overcoming these issues is not achievable within the confines of a single-issue marketing campaign. For example, distrust can be influenced by a disordered information ecosystem, and this barrier goes beyond the privacy concerns that most research has focussed on, as technical solutions to improve privacy are insufficient to address the root issues of distrust. The researchers found that systemic injustices eroded trust within communities, which contributed to inequitable participation in digital COVID-19 interventions.

The researchers also conducted a Māori data governance (MDG) assessment of NZ COVID Tracer and the overall DCT programme.¹² While MDG¹³ was not an explicit design consideration when NZ COVID Tracer was developed, some choices such as the decentralised architecture, data minimisation and opt-in voluntary participation meant that some of the principles of MDG were fully met, with many others partially met. However, there is much room for improvement, and the researchers encourage the use of MDG assessment tools to help those in the public sector uphold Māori data sovereignty and address systematic barriers to genuine partnership with Māori.¹³

Considerations for DCT utilisation for future pandemics

DCT tools should be considered in the context of the infectious disease strategy and the characteristics of the pandemic disease.¹⁴ An essential condition for any contact tracing tool is the ability to isolate cases, as well as trace and quarantine their contacts to control the infection. Table 1 provides an overview of the different manual and DCT tools used in New Zealand, their relative strengths and limitations, and which ones could be considered in future pandemic scenarios.

The main advantages of the DCT tools used in New Zealand were the ability to: 1) rapidly conduct contact tracing (QR code slowest, self-

service survey fastest); 2) identify potential contacts of an infected case who had not been recalled via traditional methods (QR code had the least specificity/greatest sensitivity, while self-service survey had the most specificity while retaining reasonable sensitivity for close contacts); 3) supplement traditional contact tracing methods (QR codes allowed automatic entry of locations of interest; Bluetooth recorded proximity; self-service surveys documented information about contacts).

There were also several limitations of these DCT tools to varying degrees. For the QR code and Bluetooth systems, there were several manual touchpoints for Ministry of Health staff and the public, which decreased the speed and extent of their integration. Arguably, some of these limitations could be engineered out in a future system. The self-service survey demonstrated the speed and uptake possible without some of these manual steps. The QR code system notified far more people than other systems as it had the lowest threshold for contact definition, likely resulting in large numbers of false positives, i.e., decreased specificity. The self-service survey facilitated a similar process to the manual system (self-reported contact histories with contact information), also with Bluetooth integration, and was completed faster.

DCT tools may be more useful in a pandemic situation where transmissibility (the reproduction number) is higher, where manual contact tracing capacity is more likely to be overwhelmed. In New Zealand, manual contact tracing for non-household contacts was abandoned during the Delta wave, while it was largely abandoned for all contacts during the Omicron phase. Throughout the pandemic there were widespread reports of contact tracer burnout, raising questions of the sustainability of manual approaches, even if it were logistically possible to scale it. In our focus groups with contact tracing staff, the need for increased training and support during this period was highlighted.⁶

Clinical severity relates to the outcome of infection, including case fatality risk and risk of long-term morbidity and disability. When the clinical severity is high, each missed contact (false negative) has a greater impact (more hospitalisations or deaths). Thus, the marginal cost of additional false positive contacts is less when the clinical severity is high. Even if DCT tools have lower specificity and positive predictive value than manual systems, the identification of each additional contact not found through manual

systems could have a substantial benefit.³ However, DCT tools can require a major and sustained effort to increase population uptake and use. If the clinical severity is low, then it may not be justified to implement and maintain DCT tools.

Controllability can be thought of as a joint property of the infection dynamics (such as transmissibility, incubation period and level of asymptomatic transmission), the availability of effective and acceptable interventions and the resources and infrastructure to deliver them. Pathogens with higher transmissibility or a short incubation period can hamper efforts to control the outbreak when relying on isolation, contact tracing and quarantine. The incubation period (the time from a person being exposed to developing illness) is longer for COVID-19 than many viruses, but also decreased with successive variants (Alpha, Beta, Delta and Omicron variants were 5.00, 4.50, 4.41 and 3.42 days, respectively).¹⁵ DCT tools may be more effective than manual systems when incubation times are shorter.

Presymptomatic or asymptomatic transmission, a non-specific syndromic profile and social stigma may reduce the visibility of infections at a system level. For example, for sexually transmitted diseases including HIV, a major barrier to disease control is visibility as stigma can impact contact tracing effectiveness. If visibility is lower, DCT tools may become more useful, for example by anonymously notifying potential contacts of a case without the need for potentially stigmatising interactions with health officials. With COVID-19 there was a substantial proportion of asymptomatic transmission, which decreased visibility of the disease. In the Netherlands, 3–5% of cases detected via the Bluetooth notification system were also asymptomatic, while 77% of contacts booking a diagnostic test because of the Bluetooth notification had not been contacted by manual contact tracers.³

Recommendations

- DCT tool selection should be influenced by

the context of the infectious disease strategy and the characteristics of the disease.

- Development and implementation of DCT tools (and alternative strategies) need to more effectively work with priority communities including Māori, Pacific, and disabled communities.
- Any future use of DCT tools requires high levels of support from contact tracers and other public health officials.
- DCT tools should be implemented with minimum necessary reliance on manual processes.
- DCT tools need to be developed and used for managing selected infectious diseases during non-pandemic periods so that the systems and technology can be scaled up when needed.

Conclusions

DCT was just one of many interventions aiming to eliminate, and then suppress, COVID-19. This context makes it difficult to isolate and conclude that the efficacy of DCT during this pandemic would translate to future pandemic conditions, especially if there is improved design and implementation.

However, this research shows that the self-service survey approach worked better than expected, and that there is some promise in automating notification processes. This also has potential for wider use in non-pandemic periods for supporting contact tracing of other infectious diseases.

A stronger emphasis on equity is needed in future digital health interventions to ensure that people are not left behind. Addressing communication inequality is an important component of that, including during the development of these systems, to increase the likelihood that interventions are both effective and equitable.

Table 1: An overview of the different contact tracing tools used throughout the pandemic and scenarios in which they could be considered in future pandemics.

	Manual contact tracing	Digital contact tracing		
		Self-service survey	NZ COVID Tracer app (QR code)	NZ COVID Tracer app (Bluetooth)
Method of contact identification	Self-reported contacts and locations of an identified case	Manual entry by case of known contacts via online platform, plus Bluetooth contacts	QR code entry of place(s) visited by case when infectious	Bluetooth record of contacts in proximity of case when infectious
Contact follow-up	Contact contacted by phone or other means	Electronic notification of reported contacts plus Bluetooth contacts	Electronic notification of those matching location and time of case	
Advantages/strengths	<ul style="list-style-type: none"> - Established and legally supported response for notifiable diseases - Clinical input into contact determination and case support 	<ul style="list-style-type: none"> - Could be implemented as a simple extension of existing manual contact tracing - Potential to increase sensitivity by adding Bluetooth contacts - High speed to notify contacts from case ascertainment 	<ul style="list-style-type: none"> - Wide net of potential contacts identified - More easily scalable 	<ul style="list-style-type: none"> - Tighter contact definition than QR code approach - No active participation required - More easily scalable
Disadvantages/limitations	<ul style="list-style-type: none"> - Human (and clinical) capacity limitations - Case recall bias - Difficulty identifying unknown contacts 	<ul style="list-style-type: none"> - Requires access to internet service and digital literacy 	<ul style="list-style-type: none"> - Large numbers of false positives (low specificity) - Required active participation (high compliant adoption) - Required multiple manual steps to process data 	<ul style="list-style-type: none"> - Required manual steps to be implemented (contact tracer approvals) - Does not facilitate clinical judgement - Cannot follow-up contacts as they are anonymous

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	Manual contact tracing	Digital contact tracing		
		Self-service survey	NZ COVID Tracer app (QR code)	NZ COVID Tracer app (Bluetooth)
Pandemic scenarios most suited for	<ul style="list-style-type: none"> - Transmissibility is relatively low - Controllability is high because of visibility of infection and relatively long incubation period 	<ul style="list-style-type: none"> - Transmissibility is relatively high - Controllability using conventional public health approaches is relatively low because of low visibility of infection or short incubation period - If clinical severity is high or if pursuing an elimination strategy, then it is justifiable to invest more effort in high sensitivity of contact tracing even at the expense of low specificity 		
Other relevant features influencing future use	<ul style="list-style-type: none"> - Alignment with pandemic characteristics and response strategy - Capacity of the health sector to implement - Likely to remain important for well-circumscribed outbreaks within wider pandemics 	<ul style="list-style-type: none"> - There must be sufficient social license to implement the tool - A sufficient proportion of the population needs to be digitally included with a response for those who are not - Support from public health officials is needed - Likely to become more effective as rapid point-of-care diagnostics and digital health surveillance tools improve - The self-service survey method could be introduced for selected non-pandemic infectious diseases following careful design and evaluation with patients, communities and system operators 		

COMPETING INTERESTS

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