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Optimizing and Implementing Contact Tracing through Behavioral Economics

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Contact tracing disrupts chains of communicable disease transmission by asking cases to identify contacts. The authors examine ways to enhance tracing's effectiveness and people's compliance with control measures such as isolation and quarantine. They call for a research and practice agenda around how best to do so within the context of the Covid-19 pandemic.

Contact tracing is a well-established approach to controlling communicable diseases, including tuberculosis, smallpox, and Ebola.¹⁻³ Contact tracing disrupts chains of transmission by asking individuals who have tested positive for the disease (*cases*) to identify people they may have exposed (*contacts*) and places they have visited.⁴ Contacts are notified and advised to follow appropriate infection control measures, including isolation and symptom monitoring (for cases) or quarantine, testing, and symptom monitoring (for contacts). Many countries are relying on contact tracing to contain the spread of Covid-19. In the U.S., the Centers for Disease Control and Prevention (CDC) states that it is a necessary precursor for easing lockdown restrictions.⁴

Covid-19 presents daunting challenges for contact tracing. First, while the median incubation period for Covid-19 is 6 days, the range is much longer, with the recommended quarantine period extending to 14 days from the time of exposure. Second, because Covid-19 currently has no treatment, contacts are asked to quarantine, not for their own benefit, but to reduce exposure to others. Third, within-household transmission is an important source of new infections, suggesting the importance of isolating each case not just from the public, but also from their household members.⁵ Fourth, transmission is possible in the absence of symptoms. Thus, asymptomatic contacts must adhere to quarantine even without the "cue" of feeling unwell. Finally, currently available tests may have low sensitivity (high rates of false negatives), so quarantine cannot safely be terminated early upon receipt of a negative test result.⁶

Embedded in these challenges are structural and behavioral barriers to interrupting chains of transmission. While policy solutions are urgently needed to address structural barriers to epidemic control for vulnerable communities (e.g., paid leave policies, access to safe quarantine facilities), behavioral strategies are also needed to improve the effectiveness of contact tracing and to promote adherence to isolation and quarantine.

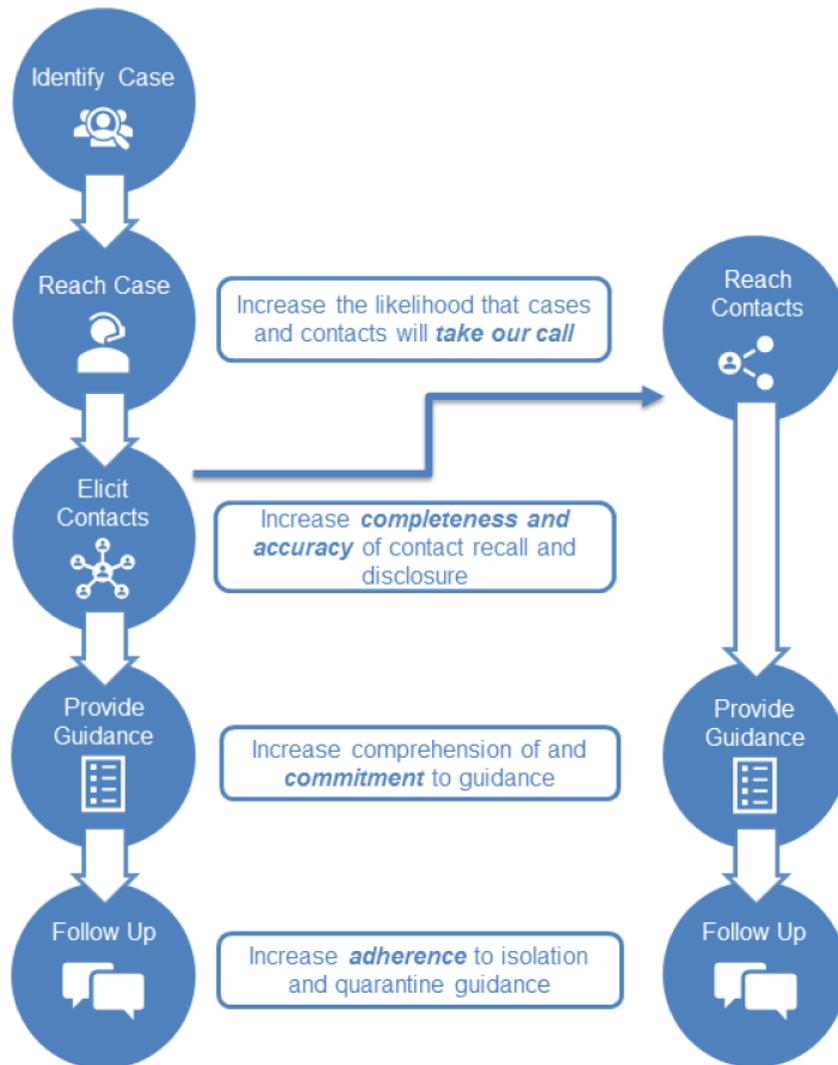
Behavioral economics offers a set of models and strategies that recognize that humans do not always make decisions based upon exhaustive analysis of all potential outcomes and assessment of all alternatives; instead, they are influenced by myriad psychological, social, cognitive, and emotional factors and use a wide range of simplifying shortcuts that are often inefficient and sometimes wrong.⁷ Behavioral economics reminds us that cases and contacts will not always follow necessary infection control recommendations even if they understand and accept their value. The same principles that help explain why cases and contacts may deviate from evidence-based pathways can also inform public health strategies to increase adherence to control measures.

Innovating Across the Contact Tracing Workflow

Contact tracing includes six steps depicted in Figure 1: (1)**make contact** with cases; (2)**elicit contact information** from cases; (3)**provide guidance** to cases; (4)**reach** contacts; (5)**provide guidance** to contacts; and (6)**follow-up** and**support** to monitor symptoms and adherence to recommendations or to escalate for clinical intervention. Below, we identify how behavioral strategies might improve effectiveness at each step.

FIGURE 1

Contact Tracing: Key Steps and Workflow to Interrupt Chains of Disease Transmission, and Targets of Behavioral Interventions.



Source: The author

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Make Contact with Cases and Contacts

As soon as a person is identified as a case or contact, the first step in breaking the chain of disease transmission is to connect with the individual. The Penn Covid-19 Contact Tracing team has achieved a 72% follow-up rate for cases and contacts using the phone numbers available in patients' electronic health records. Of those reached, 84% of cases and 88% of contacts have completed interviews. Factors contributing to success include informing cases during test result notification

that they will be called for contact tracing, having contact tracing team members identify themselves as representatives of our health system, and having the health system's name appear on caller ID. Constraints include inaccurate phone numbers and having no alternative mode of contact.

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We have learned much through trial and error and from prior contact tracing efforts for other diseases. For example, we learned that calling three times in rapid succession results in better reach, compared to leaving voicemails. However, additional behavioral experiments could further improve this step by identifying optimal timing of contact (e.g., morning, afternoon, or evening), how best to identify the contact tracing team (e.g., as part of a health system or a public health department), and mode of contact (e.g., text, phone call, email).

A second opportunity is public messaging to normalize response to contact tracing calls. Recent news reports tell of public reluctance to participate in contact tracing, which may be perceived as intrusive and a violation of privacy.⁸ While our team has encountered more acceptance and less resistance than these reports suggest, experiments are needed to optimize messaging. Possible strategies include celebrity endorsement or making participation visible and normative. Most people exhibit “conditional cooperation,” or willingness to cooperate for the greater good as long as they know others are also doing so.⁹ People may be even more inclined to engage if participation is not described as an act (“Please participate”) but as part of a socially desirable personal characteristic (“Be a participator”).¹⁰ Given that many Americans will receive a phone call from a contact tracer in the coming year, it is imperative to establish social norms that support participation in contact tracing as a collective responsibility. At the same time, new strategies may be needed to maintain cooperation and engagement in the face of “pandemic fatigue.”

Elicit Information from Cases

Once the connection is made with a case, the next step is to elicit complete and accurate information about contacts during the infectious period. Accurate recall is universally difficult due to the constraints of human memory, but may be particularly challenging for cases asked to distinguish close or epidemiologically meaningful contacts from more fleeting contacts.¹¹ For Covid-19, close contacts are often defined as those within 6 feet for 10 or more minutes.¹²

Tracers ask cases for sensitive and private contact information. There are different approaches to this that may optimize effectiveness.

With a priority on patient privacy, the Penn Covid-19 Contact Tracing team protocol specifies that the team member who conducts the initial case interview cannot also speak to that case's

contacts. This ensures that the tracer notifying the contacts is unaware of the case's identity. This is explained to cases to increase their willingness to disclose potentially sensitive information.

On the other hand, the Hopkins Covid-19 Contact Tracing team instructs those doing case investigation to also follow up with contacts, which may be more efficient and represents an opportunity to contrast the outcomes of these two approaches.

Yet a third approach would be to have cases themselves engage with their contacts, though contact tracing teams may be reluctant to relinquish control of the process. Perhaps cases, contact tracers, and technology can be leveraged together to provide the most complete approach. Testing these strategies would yield important evidence, as we do not know whether contacts will respond more positively to public health recommendations if they know the identity of the person who exposed them, whether cases will agree to participate, and whether this approach is better suited to family members and friends rather than to workplace contacts.

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We also see an opportunity for applying “defaults” — a powerful tool in the behavioral economics toolkit. Establishing case investigation as the default at point of testing could both improve willingness to provide contact information and increase the speed of contact notification. In a default strategy, potential cases could electronically provide information on their close contacts prior to receiving the test, thus guaranteeing participation in contact tracing and fostering immediate engagement with contacts in the event of a positive test result. While this approach could make the contact tracing process more thorough, it is resource intensive and may only make sense when test volume is low, the proportion of positive tests is high, and staffing is sufficient.

Behavioral experiments could also reveal the best protocols for prompting contact recall. For example, in terms of reporting accuracy and completeness, does a standard prompt such as “I would like you to think about everyone you may have come into close contact with during the 2 days prior to when you started feeling ill” perform better than “Tell me the people you have interacted with the **most** in the 2 days prior to when you started feeling ill”? Priming techniques may also help cases remember relevant interactions.¹³ For example, the contact tracer could ask the case to pull out their phone and look through their calendar, receipts, step counts, or other digital footprints to aid recall.

Technology can be helpful here. This can be as simple as asking the case to share contact phone numbers or email addresses electronically to minimize data errors and reduce perceived effort. At the more elaborate and complex end of the spectrum, the highly publicized Google/Apple collaboration augments accurate recall of close contacts with opt-in mobile phone-based data streams to automate contact identification.

Provide Guidance around Infection Control Measures for Cases and Contacts

Contact tracers make tailored recommendations to cases and contacts based on CDC and health department guidance and testing protocols. Insights from behavioral economics point to several strategies to increase motivation to comply with guidance. For example, making recommendations personal and salient may increase compliance. Tracers can prompt the case, “Who among your friends and family is in a high-risk category?” and then share that isolating will help protect that person.¹⁴⁻¹⁶ Reinforcing the collective nature of pandemic response may be powerful: “We are all in this together, this is your important job.”

“*Even the best of these suggestions are unlikely to overcome the challenges faced by cases or contacts who lack paid time off, who fear losing a job, or for whom staying at home is not safe.*”

Highlighting high rates of compliance also establishes adherence as a descriptive norm. Rather than stating that 10% of the population is not following recommendations, emphasize that “90% of positive cases are staying home and keeping our community safe.”¹⁷ Such descriptive norms may be very powerful in influencing behavior, as individuals generally want to do what others do. Of course, professional conduct requires giving accurate information. Currently, the true proportion of the population adhering to recommendations is unknown.

Adhering to isolation or quarantine guidance may be particularly challenging for asymptomatic cases as well as contacts with uncertain disease status. Incorrect but powerful mental models about viral transmission may make cases and contacts feel they are not “sick enough” to stay home. Debunking myths and correcting misinformation with clear visual communication and validating emotional responses to a positive diagnosis may increase adherence to recommendations. The use of persuasive narratives that describe successes of contact tracing in preventing disease transmission or failures with tragic consequences may also help in reshaping incorrect mental models and overcoming motivational barriers.¹⁸

Commitment devices — ways to increase the likelihood of carrying out a future behavior by deliberately constraining one’s future choices — may also maximize the effectiveness. A case could sign a commitment contract to comply with isolation, possibly with consequences for not carrying through on the commitment (e.g., losing money in an account, sending out a text message to one’s social network that they broke their commitment).

Follow-up and Support Cases and Contacts

The last step is follow-up. Following recommendations to remain at home for 14 days is challenging, particularly for people with contingent employment and without work-from-home provisions. Of course, these are often the same people who risk exposing many others at work (e.g., retail clerks, custodial staff, delivery workers). One option to counter this challenge is a standard

economic incentive to partially compensate for lost earnings. Such incentives could be provided as either fixed daily payments, or as escalating or de-escalating financial incentives.

Based on prior work, we hypothesize that a daily incentive that increases each day quarantine is successfully maintained might be the most effective strategy.¹⁹ Low-cost but highly-salient non-monetary incentives, such as grocery delivery or expedited testing for household members, could also be powerful. As more accurate tests become available, offering additional tests at 7–10 days after exposure could shorten duration of quarantine and be an additional incentive to engage with contact tracing efforts.

The approaches suggested here provide opportunities to optimize the effectiveness of contact tracing. Even the best of these suggestions are unlikely to overcome the challenges faced by cases or contacts who lack paid time off, who fear losing a job, or for whom staying at home is not safe. We must understand and mitigate these additional structural barriers, and epidemic control measures including contact tracing must take them into account.

Once we optimize contact tracing, we can draw from implementation science to answer key questions²⁰: (1) What characteristics of contact tracing make it easy or difficult to implement? (2) What are important characteristics of the contact tracing workforce that make them likely to implement successfully (e.g., interpersonal skills, self-efficacy)? (3) What organizational and health system factors (e.g., workflow issues, leadership) determine implementation success? (4) Which sociopolitical factors (e.g., relationship with public agencies like public health departments) are associated with better implementation and scale-up? These questions represent the next stage of critical inquiry.

As groups work across the globe to build contact tracing programs, they will face tremendous challenges of implementation and scale-up. In the era of Covid-19, the stakes are high, and behavioral insights may be key to breaking chains of transmission.

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