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# Impact of COVID-19 contact tracing on human resources for health – A Caribbean perspective

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## 1. Introduction

Contact tracing (CT) and quarantine have been recognized as important non-pharmaceutical interventions (NPI) in controlling the spread of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-COV2) and COVID-19. The World Health Organization (WHO) described three main elements of CT: contact identification, contact listing and contact follow up (World Health Organization, 2017). Quarantine has traditionally been used to reduce spread among those who have been in close contact with a known case and during the global SARS-COV2 pandemic it has also been used as an additional form of border control to restrict movement of visitors from countries with community spread. Modelling studies suggest that CT has the potential to be highly effective in controlling the spread of SARS-COV2, but requires 70% of contacts to be successfully traced, assuming a basic reproductive rate (R0) of 2.5 (Hellewell et al., 2020). However, achieving this level of effectiveness, particularly in low-resourced settings, may create an unmanageable human resource demand. Most countries have attempted to implement CT as part of their COVID-19 outbreak response, but success has been varied (Economist, 2020). Countries such as South Korea, Vietnam and Germany which have been praised for their management and containment of COVID-19, all placed technological and human resources into CT and isolation (Tech, 2020; Pollack et al., 2020). While a vaccine may prove critical in curbing the spread of SARS-COV2, difficulties with access and availability in developing countries makes it likely that NPIs will remain critical in at least, the first half of 2021.

In addition to CT, movement restrictions have also been critical to reducing and delaying spread of the COVID-19 (Flaxman et al., 2020). Most countries in the Caribbean prevented community transmission of COVID-19 during the early phases (April to June 2020) of the disease in the region by restricting movement through early border closures and enactment of stringent stay-at-home orders in country (Murphy et al., 2020). However, this success has come at a high economic price to these tourism-dependent nations. In 2019, travel and tourism contributions to the gross domestic product(GDP) in the Caribbean ranged from 4.2% (Puerto Rico) to 73.6% (Aruba) and 17 of these nations recorded GDP tourism contributions above the global average (10.2%) (Lopez, 2019). Now in part due to successful containment and economic necessity, these Caribbean Small Island Developing States (SIDS) are re-opening borders and easing movement restrictions. Post border reopening, many Caribbean nations have seen outbreaks of COVID-19 that have threatened to overwhelm their health care systems while others have managed to maintain relatively low numbers using NPIs; particularly testing, contact tracing and quarantine.

SIDS have limited absolute resources, therefore, CT, quarantine and isolation must be cost efficient as well as effective. Digital technologies are available to complement labour intensive and time sensitive CT efforts. These technologies have been promoted as tools to increase CT effectiveness, and may also be valuable in increasing the efficiency of a CT team (ADA Lovelace Institute, 2020). Specific functions of these applications include identification of potential contacts, documenting symptoms of those already traced and location tracing of contacts who need to undergo mandatory quarantine (ADA Lovelace Institute, 2020). Modelling suggests that mobile app technology can reduce delays in CT thus increasing effectiveness (Kretzschmar et al., 2020). Systematic reviews and expert opinion suggest that digital technologies are unlikely to replace manual tracing methods because of challenges with uptake (most less than 20%) (Anglemyer et al., 2020). These challenges may be due to privacy concerns, intermittent network connectivity in some communities and the digital divide that may be greater among those most vulnerable (Gasser et al., 2020).

We have two main aims: to estimate the future human resource needs for a small population (Barbados) to effectively implement contact tracing given the reopening of their borders to tourists, and to quantify the extent to which CT supporting technologies can modify the workforce needs for CT. We have used Barbados as our Caribbean exemplar

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country because of its ready data availability and adequate initial COVID-19 outbreak control before border re-opening (Murphy et al., 2020). Barbados re-opened borders to its key tourism markets (United Kingdom, United States, European Union) which, as of December 2020, have ongoing community spread. In-country movement restrictions have been relaxed in Barbados, allowing for mixing of visitors and residents.

## 2. Methods

### 2.1. Estimating numbers of new cases

Based on the re-opening policy released on August 3, 2020 (BTMI, 2020), human resources are needed for quarantining as well as contact tracing. To estimate contact tracing needs for December 2020 to June 2021, we first calculated the number of expected new cases. Barbados was effective in eliminating new confirmed cases of COVID-19 for 17 days (May 24, 2020 to June 8, 2020) before documenting imported cases linked to repatriation flights which began on June 9,2020. Between the period July 12, 2020 and November 30, 2020 there were 173 cases, 5 (3%) of which were local cases traced to an infected imported case and all others (168) were imported cases. We therefore assume that new cases will be due to persons arriving in the country after re-opening to commercial flights on July 12, 2020. We used data from the annual reports of the Barbados Tourism Marketing Incorporation for Barbados to calculate numbers of cases that are likely to arise based on numbers of air tourism arrivals. Barbados Central Bank showed an 85% decline in tourism arrivals in April to September 2020 (Central Bank of Barbados, 2020). We therefore assumed an 85% reduction in arrivals would occur for the first half of 2021 and based on prevalence rates in source markets assumed as a baseline that 0.5% of persons tested will be positive (European Centre for Disease, 2020).

### 2.2. Border re-opening policies

Our model inputs are based on the travel border control document released by the Ministry of Health and Wellness on August 3, 2020 with the latest updates on November 9, 2020 on the WHO CT interim guidelines May 11, 2020 (World Health Organization, 2020). The border reopening national guidelines indicated that passengers arriving on commercial flights must have valid Polymerase Chain Reaction(PCR) negative results from an approved laboratory conducted within 72 h of arrival in country (Inc, 2020). Failure to produce a valid negative test results in the passenger being tested immediately on arrival and quarantined until the result of the mandatory PCR test is known in Barbados. The latest update (November 9) indicates that passengers from countries with high COVID-19 prevalence remain in quarantine either at a government facility or at a designated quarantine hotel until they receive a second negative test which is taken 4–5 days after the last negative test. If the second test is negative, they are allowed to mix with the general public. If there is a positive result on retesting they are isolated at a government facility and those who are deemed to have been in close contact with the case, are tested and quarantined.

### 2.3. Contact tracing and quarantining methods

We based our estimation of CT resources on three main elements previously described by WHO: contact identification, contact listing and contact follow-up (World Health Organization, 2017). The guidelines indicate that on identification of a positive case of COVID-19, case investigators conduct interviews to determine the number and type of contacts a case may have had from 2 days to 14 days after the onset of symptoms. After initial interviews, contacts are required to indicate their symptom status daily. Close contacts are followed for 14 days after their last contact with a case, visitors on entry to country are followed for 4–5 days after entry if they are arriving from medium- or high-risk countries. Monitoring involves daily self-temperature checks and sharing that information with public health nurses who contact visitors via call or text.

### 2.4. Estimations of work hours

We estimated the daily activities of a case investigator based on local expert opinion. We estimated that case investigators could achieve the following in a standard eight-hour work day: four interviews (contact identification), twelve calls to inform close contacts of the need for testing and quarantine (contact listing) and 20 follow-up calls to close contacts who had already been identified and who needed to report daily on the development of symptoms (contact follow-up).

All new cases will be arriving passengers on an aircraft thus we estimated the minimum number of airplane contacts to be eight given that close contacts on an aircraft are those sitting two seats in any direction from the positive case. We then accounted for contact made with locals at the airport and during transportation to hotel or other facility. We thus used the estimated number of contacts as 12 which is the average number found among cases during the first wave (April 2020) in Barbados. We acknowledge that using the average number of contacts in the first wave (April 2020) may not reflect current levels given the enhanced COVID-19 protocols in airports. Hence, we used a range (10 and 14) around the average in our model.

During the year, 2018, 80% of visitors to Barbados were from the United Kingdom, United States and Canada. The first two of these have had particularly high number of infections of SARS-COV2. Human resources are needed to follow-up persons from these markets daily for the first week after arrival. We estimated that approximately 20 follow-up calls could be made by one person in an eight-hour day. We added numbers of tracers needed to follow close contacts of positive cases to tracers needed to follow visitors under quarantine from medium and high-risk countries.

We calculated workforce needs under various scenarios. We used the model to predict the expected CT workforce needs for Barbados (December 2020 to June 2021) under the following border reopening scenarios:

BASELINE SCENARIO: 5% arriving without test from high-risk county: Of these 0.5% positive from first + 0.5% of all those entering retest positive assuming 10 and 14 contacts per case.

WORST-CASE SCENARIO: 5% arriving without test from high-risk country assuming a 50% increase in prevalence over the winter period. Of these 0.75% positive from first + 0.75% of all those entering retest positive assuming 10 and 14 contacts per case.

BEST-CASE SCENARIO: 5% arriving without test from low-risk country. Of these 0.025% test or retest positive. We used this value since countries with rates below this are considered by Centres for Disease Control and Prevention (CDC) to be of moderate-risk.

Despite the protocols requiring negative PCR tests, there are still a small percentage of passengers who arrive on island without a test. Additionally, all persons from high and medium risk countries receive a second test 4–5 days after their first negative PCR. Given the prevalence of SARS-COV2 was estimated as 1 in 200 (0.5%) in the United Kingdom in September 2020 (Iacobucci, 2020; European Centre for Disease, 2020) and numbers have since then increased, we estimated approximately 0.5% and 0.75% of persons may be positive on retesting identifying these as the baseline and worst-case scenarios respectively. The best-case scenario where only persons from low-risk countries are allowed to enter the country is also modelled. The notification rate of 25 per 100,000 is used as moderate-risk based on the travel classification of the CDC.

Having determined the numbers of contact tracers needed, we calculated the proportion of the current complement of doctors, nurses and public health inspectors (327) (PAHO, 2011) that would be necessary to fill this role. These are the category of staff that have been transferred from their usual duties to perform/supervise contact tracing

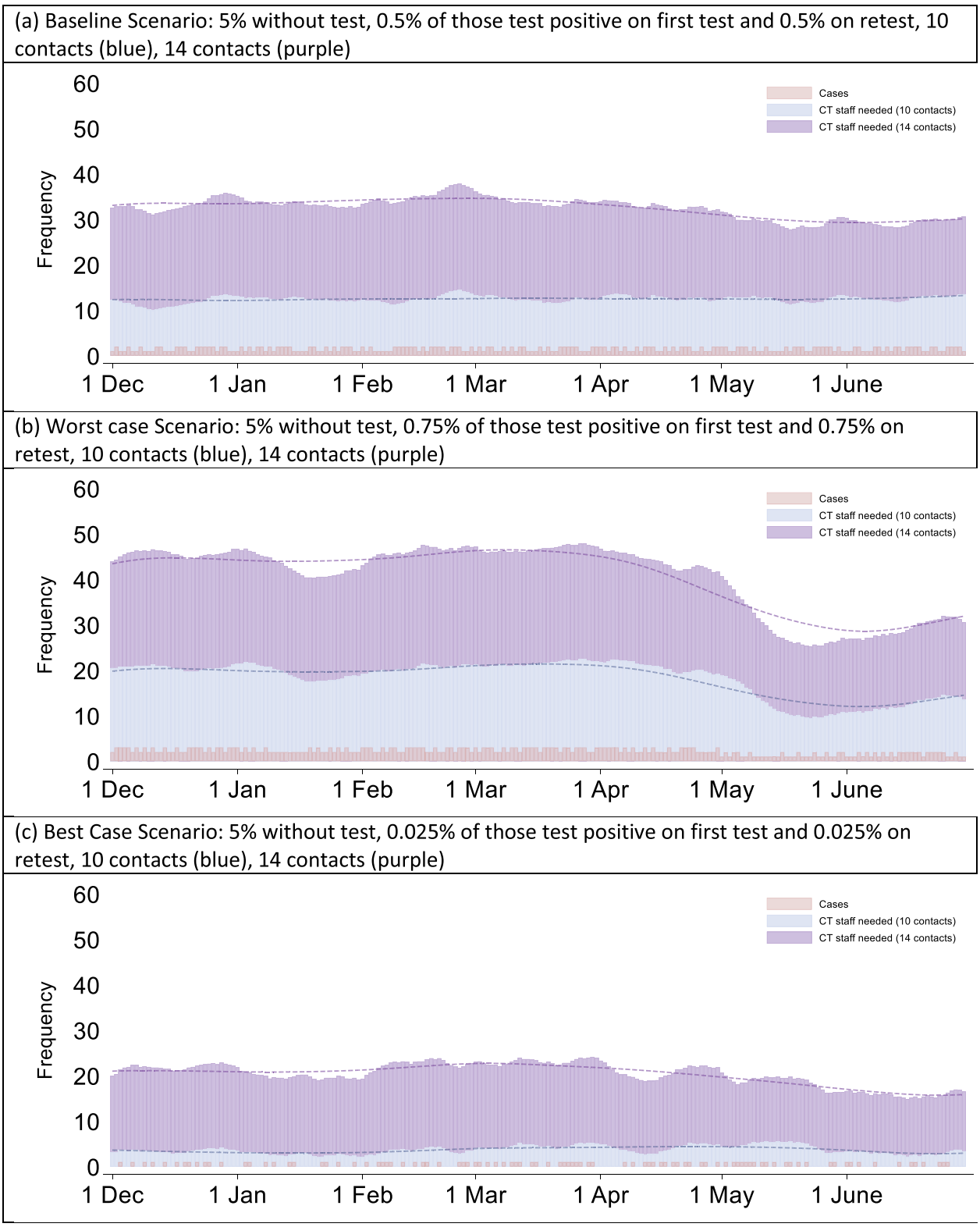


**Fig. 1.** Estimations of Contact Tracing Workforce Needs, given 3 possible scenarios for SARS-COV2 prevalence and PCR status (positive/negative).

activities in the first wave of the epidemic.

### 2.5. Impact of CT technology

We compared the workforce needed for each scenario had it occurred with the use of contact identifying and symptom identifying app versus no app use. We considered the impact of several types of CT apps. There are those which use Bluetooth or Global Positioning System (GPS) to facilitate the identification of contacts. WHO categorises CT tools into three main areas: tools concerned with the management of cases and their contacts; tools which allow the tracking of individuals' movements (proximity tools); and finally tools that facilitate self-report of signs and symptoms (symptom-tracking tools). Barbados has expressed plans to use proximity and symptom-tracking tools. Based on the use of

**Table 1**
Estimated percentage of total health care workers needed for CT activities per month with and without use of CT applications.

| CONTACTS | SCENARIO | MONTH (%) December | January | February | March | April | May | June |
|---|---|---|---|---|---|---|---|---|
| 10 | 1.BEST CASE | 1% | 1% | 2% | 7% | 1% | 1% | 1% |
| | 2.BASELINE | 4% | 4% | 4% | 4% | 3% | 3% | 4% |
| | 3.WORST CASE | 6% | 6% | 6% | 6% | 6% | 4% | 3% |
| 14 | 1.BEST CASE | 7% | 7% | 8% | 7% | 7% | 5% | 5% |
| | 2.BASELINE | 11% | 10% | 11% | 10% | 9% | 8% | 9% |
| | 3.WORST CASE | 14% | 13% | 14% | 14% | 13% | 10% | 8% |
| Estimates with use of CT applications | | | | | | | | |
| 10 | 1.BEST CASE | 1% | 1% | 1% | 1% | 1% | 1% | 1% |
| | 2.BASELINE | 3% | 3% | 3% | 3% | 3% | 3% | 3% |
| | 3.WORST CASE | 5% | 5% | 5% | 5% | 5% | 3% | 3% |
| 14 | 1.BEST CASE | 5% | 6% | 5% | 5% | 5% | 5% | 5% |
| | 2.BASELINE | 8% | 8% | 9% | 8% | 7% | 7% | 7% |
| | 3.WORST CASE | 11% | 11% | 11% | 11% | 10% | 8% | 7% |

proximity tools, although modelled estimates indicate an increase in contacts traced when apps are used (Kretzschmar et al., 2020) more recent data based on observational data found no difference in the number of contacts traced per case when they compared manual and digital contact tracing. Given this, we kept number of contacts traced constant. Based on the government's planned use of symptom-tracking tools, we accounted for applications which can be used to allow those in quarantine to upload their symptoms daily. We assumed the use of such an app will increase the number of cases that can be followed daily from 20 to 25.

## 3. Results

From implementation of first re-opening guidelines in August 2020 to November 2020, Barbados recorded 41 positive SARS-COV2 cases per month. Assuming an 85% reduction in tourist arrivals with 0.5% of arrivals testing positive we estimated that between the months of December 2020 to June 2021 there would be 45 cases per month using the model created. This slight increase can be explained by the fact that December to April traditionally has higher tourist arrivals. This baseline modelled scenario is in keeping with the current prevalence of SARS-COV2 notification rate in Barbados' main source markets- United Kingdom and United States.

For the period December 2020 to June 2021 between 28 and 35 full-time staff per month would be needed to manage the contact tracing efforts of the Ministry of Health and Wellness assuming 14 contacts on average. (Fig. 1). This represents approximately 10% of the current staff complement ( 327) of the public primary health care sector (Table 1).

Should the pandemic worsen and COVID-19 cases increase by 50% (worst-case scenario) in main tourism markets, CT workforce needs may range from 27 to 47 (14%) assuming 14 contacts per case (Fig. 1). If Barbados were to close its borders to countries with COVID-19 notification rates higher than 25 per 100,000 then very minimal CT staff are required. Model estimates for this best-case scenario was 17 to 25 workers.

In the baseline scenario, CT apps had a minimal effect on CT workforce needs. In the worst-case scenario CT apps resulted in marginal decreases of CT workforce needs (from 14% to 11%) while in the best-case scenario there was a 1%-point decrease in CT workforce needs (Table 1).

## 6. Discussion

Despite the discovery of effective vaccines, public health measures like testing and contact tracing remain critical especially in low resource settings such as SIDS. In this paper we explored the human resource needs necessary to facilitate COVID-19 CT in the context of small Caribbean population, with a tourism dependent economy. Using Barbados as an exemplar, we found the prevalence of COVID-19 in the country from which visitors arrive predicted the CT capacity needed. We note the robust mechanisms put in place in Barbados which has so far (December 2020) successfully maintained low numbers of COVID-19 cases through risk stratification of tourist arrivals and requirements of negative PCR testing prior to arrival. To facilitate greater tourism activity, governments must be prepared to place emphasis on building health workforce capacity to enhance quality as well as quantity. CT training is critical as countries prepare for the higher demand that usually occurs during the winter tourist season. Mobile app technology is expected to facilitate a small decrease in workforce needs.

Countries with high COVID-19 prevalence constitute the main tourism markets for SIDS in the Caribbean region and tourism receipts are especially important as many of them continue to be plagued with a high level of debt (The Bahamas, Barbados, Belize, Jamaica, Suriname, Trinidad and Tobago) (United Nations, 2020). In these Caribbean SIDS, with already depleted staff particularly in nursing, a 15% increase in demand could compromise care in other areas e.g. Maternal and Child Health and Non-Communicable Disease control as staff are deployed to complete COVID-19 related tasks. This may necessitate (as seen in United Kingdom, Serbia and Romania) the creation of new categories of staff and legislative amendments to facilitate this.

## 7. Limitations

CT must be enacted within a wider program of testing and isolation. In this model we have not considered the human and financial resources required to support the entire mechanism including testing and staff to manage isolation centres. There may be some overlap between close contacts of positive cases and quarantine of visitors but this was not taken into account given it's likely to be small. We also have not considered the added demands should border controls and CT measures fail and community spread occurs. In this scenario CT demands would be significantly increased.

## 8. Conclusion

Border reopening is seen as inevitable to facilitate growth of the global economy. To contain the spread of COVID-19 in the context of open borders, strong policy that emphasizes testing before arrival and has robust criteria for managing visitors from countries with a relatively high prevalence of COVID-19. Persons responsible for managing small populations must be aware of the potential impact a shift in resources to CT may have on other public health resources and prepare to build a competent well-resourced workforce in the context of highly available and responsive testing programme. Barbados has done well in achieving low numbers of COVID-19 cases using strict border control protocols including testing, monitoring and contract tracing. A delicate balance

must be maintained between the threat of COVID-19 and the more general threat to public health that will arise from the effect a profound economic recession could have on the government's ability to provide national healthcare.

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## CRediT authorship contribution statement

**N.P. Sobers:** Conceptualization, Methodology, Software, Formal analysis, Writing - original draft, Writing - review & editing. **C.H. Howitt:** Software, Methodology, Formal analysis, Writing - review & editing. **S.M. Jeyaseelan:** Methodology, Writing - original draft, Writing - review & editing. **N.S. Greaves:** Conceptualization, Validation, Writing - review & editing. **H. Harewood:** Methodology, Conceptualization, Validation, Writing - review & editing. **M.M. Murphy:** Conceptualization, Writing - review & editing, Supervision. **K Quimby:** Validation, Writing - original draft, Writing - review & editing. **I.R. Hambleton:** Conceptualization, Methodology, Software, Formal analysis, Writing - review & editing, Supervision.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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