A Public Value Crisis Model Approach to COVID-19 Outbreak Control in the Dominican Republic

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Abstract

In the Dominican Republic (DR) the first official COVID-19 case was registered on February 29th, 2020. On March 31, 2020, the president of the Dominican Republic via Decree 140-20, created the Covid-19 Emergency Committee. This Presidential Committee was tasked with creating public-private partnerships as well as developing public policy, strategies, and operations to combat COVID-19 at a national level with the engagement of all possible public and private actors creating synergies and scale that would result in a strong public value. The centerpiece of the strategy for the Dominican Republic (DR) COVID-19 Emergency Committee was the "Public Value Crisis Model" piloted on April 12, 2020 at San Francisco de Macoris (SFM) Duarte province. We sought out to evaluate the epidemiological impact of Plan Duarte Public Value Crisis Model.

Methods

An Interrupted Time Series Analysis (ITSA) based on segmented regression models was used to evaluate the impact of a lock down policy as the public health intervention in the Duarte Province, fitted utilizing segmented longitudinal data. Ordinary least squares (OLS) regression models, Newey-West method and Dickey-Fuller statistics were used. The following segmented regression model was built $\boldsymbol{Y = \beta_0 + \beta_1 * time_t + \beta_2 * Intervention_t + \beta_3 * after\ Intervention_t}$. Results were calculated with their 95% confidence interval (CI) and p-values set at values < 0.05 were considered significant. All statistical analyses were done by means of Stata V15.

Results

As of April 4th, 2020 a total of 5926 cases were confirmed in the DR, 9.3% from the Duarte Province and a positivity rate of 37.6% (n=562). Accumulated death in the capital city of 37 cases versus 75 in Duarte. Dickey-Fuller statistics showed that the residuals were stationary and normally distributed (Z = -5.821, p = .000, for Duarte cases and Z = -3.638, p = .005 for all the cases except Duarte). The initial number of new confirmed cases in the province of Duarte before the implementation of the Locking down the province policy was estimated at .45 and had a daily growth of .88 before the implementation of the policy, which was statistically significant (p = 0.000). The slope of changes in new confirmed cases following the implementation of the social distancing policy decreased by 1.63, which was statistically significant (p < 0.001). On the other hand, the initial number of new confirmed cases in all the provinces except Duarte before the implementation of the Locking down the province policy was estimated at 29 and had a daily growth of 6 before the implementation of the policy, which was statistically significant (p = 0.000).

Conclusions

Collective and collaborative action is key to stop the spread of the pathogen, closing borders, testing and tracing, bans on gatherings, school closures, and the stay-at-home policies, along with a political turmoil may provoke resentment and even resistance; therefore, leadership remains a quintessential value to sustain the model of intervention. The development and implementation of a collaborative public value in crisis model proved to be effective in controlling the COVID-19 pandemic in the Dominican Republic.

Keywords: *COVID-19, Dominican Republic, Public Value Crisis Model, Outbreak Control*

Introduction

Emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) following a cluster of unexplained pneumonia in the city of Wuhan, China in the late months of 2019 (1) provoking an unprecedented global health impact. Later, January 30th, 2020, the World Health Organization (WHO) declared the outbreak as a public health emergency of international concern (PHEIC) and producing the first guidelines for country preparation and response plans (SPRP), focused on detection, preparation, and rapid response to the outbreak (2). These guidelines along with the first sequences and laboratory assays were delivered to all regional offices (2,3).

Meanwhile in the Dominican Republic (DR) the first official case was registered on February 29th, 2020, in a European visitor located in the National District (Figure 1); posteriorly a second case was confirmed in another European visitor but in Duarte province, in Villa Riva locality in the north-central plateau (Figure 1). Both cases were asymptomatic at the moment of identification, and both survived the infection (3).

Ancestral SARS-CoV-2 lineage has a smaller dispersion in effective reproduction numbers (*Rt)*, meaning that transmission chains are somewhat less likely to be dead ends, which makes it easier to reliably spread SARS-CoV-2 that the preexisting SARS-CoV-1 (4,5). In Europe, the 614G variant was first observed in genomes sampled on January 28 in a small outbreak in Bavaria, Germany, which was initiated by a visitor from Shanghai and subsequently controlled through public health efforts. It is therefore likely that the D614G mutation occurred in China before being introduced on multiple occasions to European countries where it increased in frequency. This scenario is consistent with the rapid increase in February and March of European virus genomes that carry the 614G variant.

In responses to epidemics different non-pharmaceutical interventions have proven to be effective to reduce the rapid expansion of viral transmission: a) "*Cordon Sanitaire*", with ribbons of forts and military outposts interspersed along a border and patrolled by troops in an attempt to prevent the movement of contaminated goods and people, in this interventions outsiders are denied entry or were subject of quarantine; and b) collective & individual closing borders, shutting schools, banning large gatherings, disinfecting public spaces, instituting testing and contact tracing and quarantines along with massive public education and community engagement. This later has been widely discussed to induce resentment and even resistance form the population, mostly when electoral periods are concurrently with the pandemic response.

On March 31, 2020, the president of the Dominican Republic via Decree 140-20, created the Covid-19 Emergency Committee. This Presidential Committee was tasked with creating public-private partnerships as well as developing public policy, strategies, and operations to combat COVID-19 at a national level. The committee presented on April 5 a comprehensive technology utilization, hospital capacity augmentation and Test-Trace-Treat strategy with a focus on strengthening local government capacities via public-private partnerships, at the heart of the committee was the engagement of all possible

public and private actors creating synergies and scale that would result in a strong public value (6,7,8,9,10).

Even though the country may not be prepared to respond to a public health catastrophe, it might escape from worse outcomes by taking bold and drastic actions to minimize the COVID transmission, testing strategies are an appropriate instrument to identify the extent of the virus within a community at a certain time, while giving equal importance to the monitoring of available beds, maintain outbreak awareness, communication with the public and coordinating field response activities with the corresponding organizations (11).

Methods

Pillars of Rapid Response

Starting and coordinating a rapid response amidst these challenging and unprecedented times in recent history, is a difficult task, as it requires the coordination of different sectors, such as healthcare, education, social protection services, tourism, the farming sector, and others. The world was caught napping by COVID-19, and forced authorities across all continents to act swiftly, as if the house was set afire.

Countries like Singapore (population 5.8 million) adopted swift measures, given the preparation after the SARS outbreak in 2002. The first line of defense from the Singapore health officials was to reduce the importing of cases from Wuhan, by screening temperature levels at ports, following up patients at home, providing masks to asymptomatic patients and their family members, and extending screening measures to the community level. Making screening one of the pillars of a rapid response (12).

Massive testing within the context of a global pandemic, should be the quintessential tool to stop the fast spreading of a highly infectious disease. Massive testing, while costly, reduces the economic impact of hospitalizations and resources that might be used for treating patients. The real-time polymerase chain reaction (RT-PCR) is the gold standard for diagnosis, and at times, shortages have been reported due to the high demand, consequence of the quickly spreading COVID-19. The Singapore healthcare officials tried to work on their experience with the 2002 SARS outbreak by working on rapidly available biotechnology, and personnel to operate that technology, in the case of a future pandemic (12).

Contact tracing quickly became a trend to follow-up asymptomatic patients, who compromise a large pool of the cases, that can also spread the disease, with reports stating that as much as 40-45% of patients do not present symptoms at any stage. The biggest difference with previous pandemics, is that this is the digital era, where countries such as South Korea have used technology to spread useful information (encouraging hand washing, the usage of masks, and social distancing), efficient testing and analysis, and the usage of geotagging for tracing asymptomatic patients (13,14).

If anything, the COVID-19 pandemic has accentuated the socioeconomical differences between the upper and working classes, as it has affected tourism, education, professional sports, education and even healthcare. The new normality forced the rapid expansion of telehealth, which is poorly accessible by those in the working classes of low-income countries, because of lack of access to internet.

With the introduction of the new normality, a new term arose, having a national lockdown. Travel of people for essential activities, and contact, are the cornerstone of the COVID-19 spreading. Encouraging social distancing by shutting down countries, is the most effective way to stop transmission. Having a lockdown slows down community transmission, aids in the isolation of asymptomatic patients and contacts, and helps quarantine. In Wuhan, the introduction of the lockdown helped massively in the containment, mitigation, and suppression when there was neither an effective drug or vaccine, taking measures which included traffic restriction, prohibition of social gatherings, and home quarantine, that proved to be highly effective in controlling the quick spread of COVID-19 within a city with 10 million residents (15).

The positive impact of technology within the context of a global pandemic, equally has a negative counterpart. Misinformation spreads as fast as useful information, whether it is from official or unofficial sources. There have been reports from Latin American countries, such as the Dominican Republic, where initial efforts to slow down the rate of infection were seen as an overreaction from the government, with concerns specially regarding the economic impact a national lockdown would have on daily life (16).

The centerpiece of the strategy for the Dominican Republic (DR) COVID-19 Emergency Committee was the "Public Value Crisis Model" piloted on April 12, 2020 at San Francisco de Macoris (SFM) Duarte province. #PlanDuarte (11) targeted SFM as the highest case and mortality city at that time. Within two weeks of implementing #PlanDuarte the province started showing evidence of a positive impact in reported positivity, critical care use and mortality (12) in early May the focused and targeted approach to Duarte Province resulted in a statistically significant impact on Case Fatality Ratio for the whole country (13,14). The Public Value in Crisis model was reproduced successfully in multiple other provinces and more recently became the hallmark on the National District strategy under the leadership of Mayor Carolina Mejia. On April 22, 2020, the first Dominican Epidemiology Intelligence Center was developed by the Presidential COVID-19 Committee under the leadership of Minister of Defense Lt General Paulino Sem, Counter Admiral Lee Ballester and Doctor Amado Alejandro Baez. The Epi Intel Center was housed out of the Ministry of Defense C5i Center (15) and tasked with creating inter-agency "Intelligence Fusion" efforts that guided country-wide strategies and COVID-19 operations (16). After the successful implementation of the C5i Epidemiology Intelligence Fusion Center, the Dominican Ministry of Public Health viewed this model as especially important and effective and proceeded reproduced this effort four months later in August 2020, creating the MOH "Center for Public Health Intelligence" (17,18).

Public Value Model

Public value is value for the public. It equates managerial success in the public sector with initiating and reshaping public sector enterprises in ways that increase their value to the public in both the short and the long run. Public value describes the value that an organization contributes to society. The term was originally coined by Harvard professor Mark H. Moore who saw it as the equivalent of shareholder value in public management. Public value is supposed to provide managers with a notion of how entrepreneurial activity can contribute to the common good. Management concepts, such as shareholder value, stakeholder value, customer value, sustainability, or corporate social responsibility, should legitimize themselves regarding their impact on the common good (17). In his (social-)psychological-based concept, public value emerges for individuals from the experiences made in social structures and relationships (18).

As of April 4th, 2020 a total of 5926 cases were confirmed in the DR, 9.3% from the Duarte Province and a positivity rate of 37.6% (n=562) an incidence rate 188 times higher compared with the national District (the Capital City) which had a positivity rate of 22.1%. Accumulated death in the capital city of 37 cases versus 75 in Duarte, representing twice higher than the most populous city in the country.

Community Intervention

Strategic elements of Plan Duarte included, 1) A province-wide lockdown policy fully enforced by police and military assets beginning on March 24th, 2020. 2) Enhancement of testing capacity. Community surveillance with antibody kits and optimizing PCR testing capacity. 3) Enhancement of hospital (public and private system) doubling the hospital capacity to 77 COVID beds, 23 COVID- ICU and 21 ventilators. 4) Root-cause analysis of crowing clusters with key interventions at banks, and markets. 5) Incident Command System Implementation with Military, police, municipal political leadership, private and public health system, and community leaders. 6) Decompressing hospital utilization by: Deployment of 15 medicalized home visit units, a COVID-19 Hotline and deployment of 199 COVID-19 “isolation” beds for mild and asymptomatic positive patients who cannot safely home isolate. 7) Weekly video-conference consults with community local press leaders. To create ownership and empowerment. As well as measure effectiveness at the grass roots level.

Table 1. Public Value in Crisis Framework for #PlanDuarte

Public Value Standard	Output
1. Articulate a clear, and compelling idea of the public value that their agency exists to produce.	Comprehensive plan at the municipal level with Public-Private partnerships.
2. Develop a set of measures to record the agency's performance in producing that public value.	Standard COVID-19 Indicators: • Case Fatality Ratio (CFR) • Positivity Rate (PR) • Availability of Hospital Resources
3. Invite and embrace external accountability for defining and creating that value.	Active Community Engagement Business Community leaders and press
4. Create management systems that distribute internal accountability.	The Incident Command System integrated and adapted with the Public Value Elements socialized and well communicated. Embracing telemedicine and home health visits to decongest the hospital system

Statistical analysis

To understand the impact of interventions we used Interrupted Time Series Analysis (ITSA) based on segmented regression models to evaluate the impact of a lock down policy as the public health intervention in the Duarte Province on the trends of COVID-19 cases, compared with all the provinces except Duarte where the lock-down and interventions were not performed. These models were fitted utilizing segmented longitudinal data.

The Newey-West method was selected. Several diagnostic and sensitivity assessments were performed. The results of the Dickey-Fuller statistics showed that the residuals were stationary and normally distributed ($Z = -5.821$, $p = .000$, for Duarte cases and $Z = -3.638$, $p = .005$ for all the cases except Duarte). Ordinary least squares (OLS) regression models with a time series specification (an intercept and a trend term, a level, and a trend change) were used to verify serially correlated errors by visually inspecting the residuals from the OLS regression and plotting the autocorrelation and partial autocorrelation functions (ACF/PACF). Also, the Durbin-Watson test was utilized for assessing the autocorrelation between data in the generalized least squares regression models for Duarte new cases ($\chi^2 = 0.306$, $p = .580$), and for All provinces except Duarte new cases ($\chi^2 = 1.267$, $p = .260$).

The following segmented regression model was built:

$$Y = \beta_0 + \beta_1 * time_t + \beta_2 * Intervention_t + \beta_3 * after\ Intervention_t$$

β0 is the initial number of new confirmed cases at the starting of the study. Time is the temporal interval from baseline. β_1 is the slope of the number of new confirmed cases before the implementation of the public health policy. β_2 and β_3 are the slopes of the numbers of new confirmed cases at the first day of the policy implementation and in the following days, respectively. After Policy is the time passed after the policy implementation. Results were calculated with their 95% confidence interval (CI) and p-values set at values < 0.05 were considered significant. All statistical analyses were done by means of Stata V15.

Results

Lock down policy

The initial number of new confirmed cases in the province of Duarte before the implementation of the Locking down the province policy was estimated at .45 and had a daily growth of .88 before the implementation of the policy, which was statistically significant (p = 0.000). The slope of changes in new confirmed cases following the implementation of the social distancing policy decreased by 1.63, which was statistically significant (p < 0.001). (**Table 2**)

On the other hand, the initial number of new confirmed cases in all the provinces except Duarte before the implementation of the Locking down the province policy was estimated at 29 and had a daily growth of 6 before the implementation of the policy, which was statistically significant (*p* = 0.000). The slope of changes in new confirmed cases following the implementation of the social distancing policy decreased by .88, which was not statistically significant (*p* < 0.723). (**Table 3**)

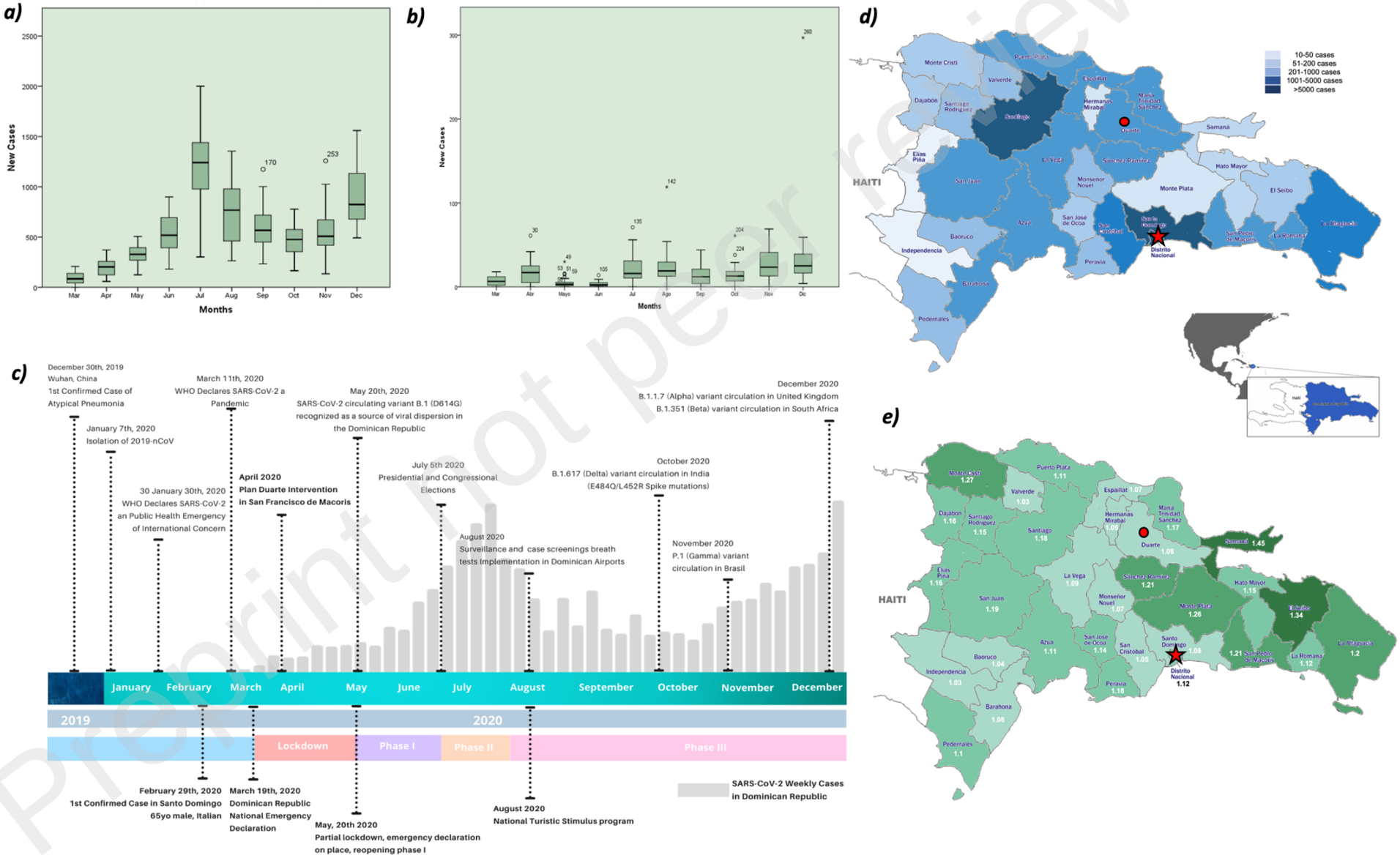
Table 2. Coefficients of the segmented regression model for Lock down policy

Parameters	Coefficients	Newey-West Standard Errors	*t*	*p*	[95% Confident Interval	
Intervention	46.064	10.077	4.57	0.000	25.843	66.284
Time	0.884	0.253	3.48	0.001	0.375	1.393
Time after	-1.630	0.333	-4.89	0.000	-2.29851	-0.962
Constant	-0.474	2.379	-0.2	0.843	-5.2484	4.301
Number of observations	56					
Maximum lag	1					
F (3, 52)	10.93					
Probability > F	0.000					

Table 3. ***Coefficients of the segmented regression model for the lock down policy except for Duarte***

Parameters	Coefficients	Newey-West Standard Errors	*t*	*p*	[95% Conf. Interval]	
Intervention	5.782	88.031	0.07	0.948	-170.865	182.430
Time	5.893	0.928	6.35	0	4.030	7.756
Time after	-0.813	2.279	-0.36	0.723	-5.386	3.759
Constant	28.978	13.799	2.1	0.041	1.287	56.669
Number of observations	56					
Maximum lag	1					
F (3, 52)	35.73					
Probability > F	0.000					

Figure 1. a) boxplot analysis of SARS-CoV-2 reported cases in quartiles from March-December 2020 in the Dominican Republic (all provinces), b) reported cases in Duarte´s province only; c) timeline of relevant epidemiological dynamics in the DR; d) frequencies of reported cases in each province; e) effective reproductive number (*Rt*) of COVID-19 cases per provinces. Duarte´s province is marked with a green circle, and the capital city Santo Domingo depicted with a red star.



Discussion

Public value refers to the value created by government through services, laws, regulation, and other actions. It is produced by public managers successfully navigating a strategic triangle encompassing the following: a) producing valued outcomes (in this case clearly defined by international epidemiological metrics); b) Within the constraints of available resources and capability, and c) In an authorizing environment of formal and informal jurisdiction, legal frameworks, and mandate. This model attempts to: 1. Articulate a clear, and compelling idea of the public value that their agency exists to produce; 2. Develop a set of measures to record the agency's performance in producing that public value; 3. Invite and embrace external accountability for defining and creating that value; and 4. Create management systems that distribute internal accountability for public value creation across the managers and the employees of the agency so that they will feel motivated to perform in the short run and to innovate and learn over the long run (19).

From this point of view, there are two sources of public value, those values that results from improving the government itself as an asset to society, and values that results from the delivery of specific benefits directly to persons or groups.

Moore acknowledges that among the problems left unresolved by Creating Public Value "the most obvious issue was the difficulty to give a clear, objective definition of what constitutes public value" In our case the roadmap to value was clearly defined by international standards: Flatten the curve (positivity rate), increase hospital capacity/availability, reduce mortality (case fatality ratio and gross mortality).

In a public health crisis, public value can be instituted as an organizing principle in a public sector organization, providing a focus in the context of which the collective response agencies are focused on the same goals and principles, in this case, already determined by international organizations, flatten the curve, increase testing capacity, enhance hospital capacity, ultimately reduce positivity rate and case fatality rate, all by in terms of efficiency articulating public and private services (20).

In the case of #PlanDuarte all these elements were executed successfully with a strong public-private partnership. The measurement of outcomes and performance was directly addressed by standard COVID-19 indicators as reflected on this article. By controlling epi at Duarte, as a hotspot, the pandemic was able to be controlled and begin the deescalate, opening the economy in various phases, decongesting hospitals, and allowing for economic growth. An important element to the success of this model was the empowerment of the local community, where everyone had buy-in understanding that protecting their community was the correct approach, families were empowered to provide solutions with home health and telemedicine options, local business people understood that by creating a healthier community their business would thrive and the private and public healthcare system understood the value to scalability and integrating technologies to offer combined solutions. By creating a community "empowerment culture" the long-term repercussions of this model can be seen 1 year later, as Duarte maintains the lowest provincial COVID-19 indicators.

Conclusions

Although responsibility of the pandemic cannot be placed solely on the shoulders of any single person, group, or institution. One of the great tragedies of the COVID-19 pandemic is that some of the worst outcomes could have been avoided had our predicament been acknowledged and acted upon at the appropriate time. Public value models are demonstrating the importance of community mobilization around local, regional, and central leaderships. Collective action is key to stop the spread of the pathogen, closing borders, testing and tracing, bans on gatherings, school closures, and the stay-at-home policies (***Quedate en Casa***), along with a political turmoil may provoke resentment and even resistance; therefore, leadership remains a quintessential value to sustain the model of intervention.

Pandemics have become more frequent and lethal; the past decade has been the most active in viral epidemics in the entire history of man. The obvious needs to prevent another pandemic catastrophe include the storage of large quantities of supplies, such as medicines and personal protective equipment, sustained and maintained by new government funding initiatives. Politicians in power should increase academic initiatives to fight the virus. The creation of a national center for the detection and monitoring of epidemics would be an important step. For developing countries, reaching these goals is like reaching a difficult-to-reach summit, however, it would make the difference in flattening the escalation curve in the face of future pandemics.

Author´s Contributions:

AAB and RPR conceived the study; AAB, RPR and CRM designed the study protocol; AAB, RPR, and CRM analyzed data, and IR, ES, and LT drafted the manuscript, all critically revised the manuscript. All authors read and approved the final manuscript. AAB and RPR are the guarantors of the paper.

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