Responding to COVID-19: lessons from Kerala on what worked under resource constraint settings and a glimpse into the surgical management of patients

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Background: The outbreak of COVID-19 into a pandemic took many countries by surprise and were found wanting for their response and containment measures that they undertook and resulted in unacceptably high mortality in number terms made them search for alternative approaches and models of containment to combat the scourge. In the state of Kerala in India, the response of the government and public response was different compared with rest of the country. Its success with containment to prevent the spillover of the virus into the general public for a long period of time made other states and countries sit up and take notice.

Materials and methods: Participatory observation in situ by the authors’ personal first hand experience in the public health and surgical practice fields enabled them to use the framework of components measures for outbreak containment following the Nipah outbreak in the state as a lens to capture the factors and measures undertaken for success in COVID-19 containment in Kerala.

Results: Kerala ensured that a very low proportion of population got infected and a low case fatality rate of 0.94%. What worked was anticipatory preparedness of the political and health systems, systematic contact tracing and quarantine of contacts, transparency in reporting of data and dynamic data-based policy decisions. These measures when combined with social security measures for vulnerable groups, instilled a sense of solidarity with the state government’s harsh “lockdown” measures taken and thereby ensured community wide people’s participation that proved critical for the success in containment.

Conclusion: By using the consolidated framework of components measures for outbreak containment following the Nipah outbreak in the state as a lens along with participatory observation by the authors, it was possible to capture the factors and measures undertaken for success in COVID-19 containment in Kerala.

Keywords: COVID-19 containment, Participatory observation, Kerala model, Pandemic, Community participation

In India the first case of COVID-19 was reported in a student from Kerala fleeing from Wuhan, China on January 31, 2020. With Kerala State’s large number of expatriates and students abroad, the State remained the primary place in India reporting increasing number of cases till the end of March[1]. Response and containment of pandemic in Kerala can be delineated into 4 distinct phases in the evolving pandemic timeline based on place of origin and containment namely the Wuhan phase, the Italy phase, lockdown phase, and post lockdown phase[2].

**First phase (January 30 to March 7) the Wuhan phase:** Within 3 days of the first case report on January 30, 324 Indian citizens were airlifted from Wuhan, with the second case getting confirmed on the same day, isolated, and managed[3,4].

**Second phase (March 8–23) the Italy phase:** In this phase 3 in a family returning from Italy, having “dodged” the airport screening, infected 6 of their contacts in the family. This period also witnessed cases among international travelers returning from UAE, Italy, and United Kingdom and a health professional on a trip back from Spain. Cases among contacts of returnees started getting reported from State’s northern districts of Kasargod and Malappuram. Kerala announced a week-long lockdown till March 31 to contain the virus[4].

**Third phase (March 24 to May 3) lockdown including extended lockdown:** This is the period of nation-wide lockdown. Three COVID-19 deaths occurred in this period, 2 deaths over 65 years age and 1 in a 4-month-old baby.

**Fourth phase (May 4–till date) post lockdown:** This challenging phase started with massive aerial and maritime repatriation of Indians from abroad. The wider distribution of cases from the earlier restriction of cases to certain zones of the state led to giving up of the Zonal classification of districts in the state to district-wise “red-zones.” The cumulative death toll rose to 16 by June. Suicide by 2 patients under observation jolted the caregivers[5].
The state government handled the first 2 phases (“Wuhan phase” and then “Italy” phase) in an exemplary manner, thereby setting up a “template to replicate” for political leadership and the global health community. By the January 24, State health department had already put in protocols recommended by the WHO: “test-trace-isolate and support”[2]. The state which was second in total number of infected cases at the national level in mid-March, slipped to the 10th position by mid-April and was well on its way to have a carefully drafted exit policy from the lockdown. This remarkable achievement of Kerala by now attracted international attention much like the famous “Kerala Model of development”[2,5]. Post Nipah outbreak, the authors had proposed a framework that can be adopted for pandemic response and containment studying the factors and components of the Nipah epidemic response which the state successfully tackled[6].

In this paper, we have described Kerala’s success with COVID-19 containment efforts through the lens of the above mentioned framework. Besides, as the state had a low proportion of infected persons and low case fatality rate of 0.94% and given the context of restricted screening of only contacts and the symptomatic, we also want to share practice guidelines followed in this epidemiological context by surgeons for surgical procedures in public and private health care institutions and the type of surgeries that were taken up by the Government hospitals with limited resources that instilled confidence among the care providers to carry out surgical procedures.

What worked in Kerala compared with other states in India?

Anticipatory preparedness of political and health systems

Credit for “flattening the (infection) curve” in the early phase goes to the path breaking planning, containment, and anticipatory preparedness taken by the Kerala state government primed by the lessons learned from its Nipah containment experience. As soon as the first case was detected, elaborate system of contact tracing was done to prepare and disseminate “route map of the infected person” to all levels of government and community leaders to initiate containment measures against all on this contact “route map”[7].

Early formulation of guidelines for early detection and rapid response

As early as January 2020, the Novel-Corona virus guidelines for testing, quarantine, hospital admission, and discharge were framed for the hospitals. State Medical Board, terms of reference (TOR) for state level committees and state Rapid Response Team (RRT) were constituted[8]. Guidelines for surveillance, lab testing and clinical management were framed, and disseminated to all the districts. The Health Department’s 24 × 7 helpline was setup for the public.

Early streamlining of dedicated anti-COVID-19 administrative system

Political commitment, urgent mobilization of manpower, and materials and multidisciplinary teams were the highlights of planning and coordination[9].

Early establishment of dedicated Covid-19 care centers

Government hospitals were converted into “Dedicated COVID-19 Hospitals “as early as March 2020. These dedicated COVID-19 hospitals functioned by following the “Revised Guidelines for Testing, Quarantine, Hospital Admission and Discharge. By the last week of March all Government medical colleges across the state had set up isolation wards and ICU facilities while the district hospitals had just the isolation wards. Standard operating procedures (SOPs) for dedicated COVID-19 hospitals were drawn based on the institutional capacities and assessment of surge capacity[10,11].

Surveillance and laboratory support

Kerala state being the first among Indian states to launch Airport surveillance in January for persons with a recent travel history to China revised the protocol in February to isolate all travelers from Wuhan irrespective of symptoms. A few weeks after the cluster from Italy got reported, a detailed advisory for infection control in health care settings including dental services, rational use of personal protective equipment (PPE), use of rapid diagnostic kits for diagnosis, and surveillance were introduced[12,13].

Swift, robust and sustained contact tracing was the cornerstone of containment strategies in the first 3 phases of COVID-19 transmission in Kerala with the outbreak monitoring units already in place in all the medical colleges in the State. A system of conducting in-depth telephonic interviews and preparation of route maps with time and location through social media platforms and visual media by the respective district administration, helped in making the public conscious about their need to approach the authorities to have their health evaluated[7,9].

The State government initiated expediting the process to identify positive cases commissioned the National Institute of Virology (NIV) Alappuzha to test samples for coronavirus in Kerala itself thereby avoiding the delay of sending it to central lab (https://www.thehindu.com/news/national/kerala/ncov-sample-testing-begins-in-alappuzha-unit-of-niv/article30729198.ece).

With increasing demand for testing COVID-19 sample collection and treatment facilities were made available in 22 hospitals in the state including 14 district hospitals (1 in each district) and 8 government medical colleges. A total of 200 taluk hospitals were set to provide facilities for sample collection if the need arises. Eight private testing centers were given approval for testing, including GeneXpert/TrueNatBeta-CoV as on June 3, 2020[14,15]. Of particular note is the aggressive surveillance strategy by the state which for quarantine purpose opted for choosing the maximum incubation period of 28 days, differing from the central guidelines of 14 days quarantine. Rapid antibody test for detecting community transmission started in April for 4 priority groups including the vulnerable. Efforts for early detection of emergence of population herd immunity were started with validation of around 100,000 antibody detection kits for understanding the applicability of these tests as a complementary tool to PCR by roping in the “Information Technology mission” to ensure real time and accurate collection of data in sync with the State-level “COVID-19 tracker Dashboard”[16].

Logistics including local resources mobilization

Adequate PPE gear were procured and stocked as early as in mid-January. In the first fortnight of March itself, masks and hand sanitizers which had disappeared from the market or had become too costly, were produced locally especially by Kudumbashree
(Women’s self-help poverty eradication mission) teams. Research and development (R&D) efforts were made to develop vaccines, improve testing systems and facilities, and even attempted advanced technological interventions such as plasma therapy\textsuperscript{[17]}. 

**Hospital systems**
In a dynamic planning exercise, the state identified around 100,000 hospital beds, with potential for ramping it up to 200,000 in the event of an emergency, including both private and public hospitals and even empty houses which are aplenty in Kerala\textsuperscript{[7]}. 

**Human resource management**
Guidelines were charted for optimal use of health care providers and volunteers to run the hospital system during the pandemic phase, designing workflow and duty rotation of staff under different categories including criteria for health management\textsuperscript{[18]}. 

Prophylaxis of SARS-CoV-2 infection for asymptomatic health care workers and asymptomatic household contacts of laboratory confirmed cases was advised by the state following the National task force recommendation in late March\textsuperscript{[19]}. 

**Performance assessment**
A Google drive with quality checklist was prepared to be accessed for ascertaining the level of functioning of the COVID-19 hospital in line with best practices being adopted into the SOP\textsuperscript{[20]}. 

**Clinical management protocols**
Uniform clinical management protocols published by the state health department were followed at all centers. Standard critical care guideline helped in reducing the mortality of patients in the COVID-19 hospitals across Kerala. “Risk assessment grid matrix” for discharge of persons from home/Hospital Isolation was formulated and put into practice. Management protocols were set for patient care provider disciplines such as Dentists, Obstetricians, Ophthalmologists, and Oncologists with a higher risk of close contact with COVID-19 patients\textsuperscript{[21,22]}. 

Care was taken to ensure uninterrupted routine Vaccination including outreach immunization program in all the 4 phases\textsuperscript{[23]}. Ethical issues related to protecting patients’ rights in clinical research activities were addressed. Comprehensive and standardized reporting of clinical data was ensured through an online portal developed in coordination with e-health to aid in generating hypothesis and drive future research\textsuperscript{[24]}. 

**Communications**
Transparency in reporting and data sharing was ensured through regular and accurate information made available on the number of persons under observation, numbers tested, numbers testing positive, and deaths. Punitive measures were taken to deal with fake messages in social media providing wrong information or were intended to create panic. Updated and reinforced key messages to health care functionaries and dissemination of health awareness materials through mass media and the website of the state health department needs special mention\textsuperscript{[25]}. 

**Regulatory framework**
The state was the first one in the country to come up with a separate law to handle the COVID-19 problem and resort to a lockdown to minimize the spread. State Police force including the “Janamaithri” (people-friendly) police supervised the enforcement of social distancing measures and universal mask-wearing by general population\textsuperscript{[9]}. 

**Community participation**
Mass public wearing of cloth masks was encouraged during the pandemic season. A tried and tested system for Nipah containment was in place for COVID-19 mitigation involving the local village council that galvanized local health and community workers and opened community kitchens to feed the people in isolation, including stranded migrant workers. Nongovernment organizations arranged for supplies including protective gear. Opinion leaders, religious leaders, media, civil society organizations were all co-opted into responding to the threat leading the community to trust government and follow directions\textsuperscript{[9]}. 

**Interdepartmental collaboration**
This included elected representatives of local governments, particularly village panchayats, members of the self-help group, Police department, and the citizens themselves. The level of coordination seen in this exercise is very difficult to achieve in a governmental set-up and that too in the face of real personal risk to all involved in the effort\textsuperscript{[7,9]}. 

**Care for the vulnerable and those with special needs**
Health workers supported people with special needs and the elderly living alone. Trained psychologists, psychiatric social workers, and counselors provided telephonic counseling and support to persons in isolation, quarantine, and personnel working in affected areas\textsuperscript{[26]}. Efforts were taken to ensure uninterrupted TB care services and routine immunization in the state. Tele-consultation of patients with suspected TB is recommended in the TB Care advisory (https://dhs.kerala.gov.in/wp-content/uploads/2020/04/Advisory-for-restarting-Immunisation-activities-regarding-Universal-Immunisation-Programme.pdf)\textsuperscript{[27]}. 

**Confidence instilled for public cooperation by Social Security measures**
As early as March 2020, the state came up with a massive relief package, disbursing social security pensions, releasing welfare funds, and interest free loans to self-help groups. The public distribution system was activated and free rice provided to every card holder irrespective of the type. Cooked food and food materials were distributed to an estimated 2.5 million migrants. Helplines were activated for elderly people to access their medicine or food materials through volunteers. Thus, the policy of “no one left behind” was operationalized\textsuperscript{[7,9]}. 

**Decentralized approach**
Kerala followed a community-based approach under the leadership of local governments, especially village panchayats, municipalities and municipal corporations. Under the leadership of the elected ward member, squads were formed for outreach and feedback with support of Kudumbasree. Coordination at the middle level has been largely done by the District Collectors working very closely with the District Medical Officers and the district-level heads of the police. These teams provided a vital link
between the government and the field formations and undertook the task of troubleshooting[7,9].

Hospital care surgical care delivery in Kerala during COVID times

In all surgical units of Government Medical colleges designated as COVID hospitals, elective surgeries have been postponed or deferred and only urgent or semi-urgent cases are being operated[28–30]. Practice guidelines formulated by many surgical associations have to be modified based on local case load statistics as well as available resources. In many private hospitals of Kerala, institutional guidelines had to be formulated to deal with the increasing clientele for surgeries.

Functioning of surgical units in COVID-19 designated facilities: overcoming the challenges

The earliest hospital preparedness included formulation of SOPs and airway training sessions for junior staff and residents by the Anesthesia and Emergency Medicine department. Toward the third week of March, all elective surgical admissions were curtailed, only emergency surgeries and Cancer surgeries were being performed. Surgical wards were closed in anticipation of the surge in COVID-19 admissions and pooled wards were allotted to the departments. Tiered Isolation wards for high-risk and positive cases were opened. Negative pressure OT was set up for dealing with positive and high-risk cases[31].

COVID-19 concurrence and surgical screening committees were set up to validate and assess risk of cases being posted for surgery. Emergency surgeries are being performed in Emergency OT after rapid screening. In high risk cases, surgeries are either deferred for 2 weeks or performed in COVID-19 OT with mandatory precautions as warranted by the surgical condition. Most departments are following the guidelines issued by American College of Surgeons and National Associations pertaining to their departments[32].

Emergency surgeries are done after doing rapid test using Genexpert or TruNat. If not possible to do this testing, surgery is done with full PPE. Elective cases are done with N95 and face shield. Outpatient consultations done with double mask and face shield. Physical examination reduced to minimum and close physical contact reduced as much as possible. Aerosol-generating procedures such as use of electric drill, electrocautery, powersaw,

Figure 1. Preoperative algorithm as recommended by International Society of Aesthetic Plastic Surgery (ISAPS) (only for orange and green zone*). *Red zone (hot spot)—areas with doubling of case in less than a week. Orange zone—doubling of cases in more than 7 days. Green zone—no new COVID-19 cases reported since last 28 days.
etc., are reduced to essential use only. Number of people present inside the OT is reduced to a minimum.

Patients are discharged mostly on third postoperative day with advice on wound care from home or local hospital, and continued care through Whatsapp communication. In Cardiovascular and Thoracic surgery department in the third author’s institution, the operative turnover has come down remarkably. Only the very sick acute coronary syndromes and acquired valve diseases in advanced heart failure are being taken up for surgery. Doing precision surgery for long hours with full PPE and N95 masks has made this unpopular in Cardiac surgical practice. All aerosol-generating procedures like OPCAB (CO2 blower usage) are avoided as far as possible.

In Plastic and Reconstructive surgery departments instances of procedures requiring urgent attention are acute high energy injury hand and failing flaps needing debridement. Exposed orthopedic implants needing flap cover is a procedure given next priority. All esthetic surgeries are deferred. In the post-operative period since all patients stay on ventilator, safe practices in theater is extended to ICU. Overreliance on x-rays, prolonged use of antibiotics and bronchodilators have become the order of the day. All invasive lines are kept for more time (compared with pre-COVID-19 era) just to make sure recovery is perfect and to avoid reintroduction of lines (preoperative algorithm shown in Fig. 1).

Post-COVID-19 preparedness

As the surgical services are going to be resumed in institutions, a huge backlog of surgical cases will need to be addressed. The increased patient influx will test the available resources and COVID-19 control measures and careful planning and governance will be needed to ensure patient management. In anticipation, a post-COVID-19 readiness checklist may get formulated to ensure adequacy of preparation in the event of resumption of elective surgeries (sample check list as shown in Table 1).

International Society of Aesthetic Plastic Surgery (ISAPS) has developed strategic suited to local, regional and/or national requirements and jurisdiction in the document on COVID-19: Recommendations for Management of Elective Surgical Procedures in Esthetic Surgery.

As and when the government and respective associations allow nonemergency work, the surgeons must aim for that delicate balance between containing viral transmission and yet providing our services to the needy patients. This imposes considerable strain on local administration as well as the surgical teams.

Conclusions

The State of Kerala was relatively better prepared to tackle the outbreak of a disease for which there were many unknowns mainly because of a system of surveillance and containment being in place due to the deadly Nipah virus outbreak. This helped the state in anticipating the potential gravity of the problem urging to initiate massive efforts very early. Community involvement together with village level local self-government in coordination with district and state level health and development agencies along with information technology-based communication helped in quick and dynamic decision making. The financial resource constraints in initiating large-scale testing compensated by strategic surveillance-based testing of contacts supplemented by sentinel surveillance testing to detect spillover into general population.

We have used the framework we proposed based on the Nipah containment experience to identify the factors that have helped in

| Table 1 Post COVID-19 readiness checklist. |
| --- |
| **Part I Core Facility Items Checklist** | **Part II Surgery Specific Items Checklist** |
| Public information & communication | Preop phase |
| COVID-19 informed patient program | Tele health communication |
| Control of outpatient census | Readiness evaluation |
| Screening & testing policies at entrance | Comorbidity assessment |
| Masking policy & social distancing | Decision making |
| Waiting room policy | Screening |
| Control of patient traffic & elevator policy | Protocol for consent |
| Scripted staff policy—name tags for staff | Triage criteria |
| Family update policy | Anesthesia, Surgical, Nursing consensus and preparation, |
| Safe food preparation and service for inpatients | Cleaning policy for equipment, OR, waiting area |
| HCW & PPE policy—training of HCW, facility and staff for COVID-19 | Intrapr phase |
| positive cases | Re-assess COVID-19 risk |
| COVID-19 rate tracking—daily updates | Intubation guidelines |
| | PPE guidelines |
| | Surgical safety guidelines |
| | Specimen pickup guidelines |
| | Postop phase |
| | Standardized care protocols |
| | Optimizing length of hospital stay reduce complication rates |
| | Post discharge phase |
| | Availability of postcare facility & COVID-19 safety in home setting |
| | Tele-consult facility for accessing surgeon |
the current outbreak in the state so that important factors contributing to containment in the state of Kerala are not missed. Hence we expect that this paper will provide important lessons for being prepared in other countries or states with resource constraints when such outbreaks happen in future.

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Author contribution

A.A.R. and T.V.C.: conceived and designed the paper. A.A.R. and S.R.: collected the data, contributed data or analysis tools. A.A.R., T.V.C., and S.R.: wrote the manuscript, revised the manuscript. T.V.C.: scholarly input.

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