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Ayurvedic paradigm for COVID-19 prophylaxis and management strategies

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The prophylactic and therapeutic potential of traditional systems of medicine like Ayurveda has not being explored to its maximum in the search for effective solutions to the COVID-19 crisis. The present work is an attempt to strategize the strength of Ayurveda in the prophylaxis and management of COVID-19 as a standalone system or integrated with conventional medicine. The restorative protocols for COVID-19 may be planned on the line of management principles described for infectious diseases, epidemics, fever, and respiratory ailments in Ayurveda with single herb and formulations having proven immunomodulatory and anti-viral properties. The way forward is to adopt an integrative approach by taking leads from Ayurveda and incorporating it into the action strategy to fight this pandemic.

Keywords: Ayurveda, COVID-19 pandemic, Immunomodulator, Integrative medicine, Prophylaxis, Traditional medicine

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Coronavirus disease (COVID-19) is an infectious disease caused by SARS-CoV-2 (Severe acute respiratory syndrome coronavirus 2)[1]. World Health Organization (WHO) declared it a Public Health Emergency of International Concern on 30th January 2020 and a pandemic on 11th March 2020 after assessing its global spread[2,3]. A total of 7,039,918 cases have been confirmed with COVID-19 disease and 404,396 reported deaths globally with the highest number of cases in the USA, Brazil, Russian Federation, UK, India, Spain, Italy, Peru, Germany, Iran, Turkey, and France. A total of 266,598 cases have been confirmed in India with 7,466 reported deaths as of 9th June 2020(ref.4). Various guidelines have been developed for its prevention and control but the number of confirmed cases as well as death tolls is going-up aggressively day by day[5].

As of now, there is no specific vaccine or treatment option available to prevent or cure COVID-19. Lots of efforts by the conventional system of medicine are going on to find out effective management of this deadly disease, still, no significant solution has been appeared even in the countries having the best public healthcare systems[6,7]. Alongside, traditional medicine experts are also working diligently to play their part in the prevention as well as treatment of COVID-19. Currently, several clinical trials are going-on including both western and traditional medicines and it has been observed that traditional medicines are found effective in alleviating the symptoms of COVID-19(ref.8).

India has a well-established, holistic, and scientific system of traditional medicine namely *Ayurveda*, which often gets criticized for lack of scientific research data to validate its relevance and reliability in the present-day healthcare scenario. Although research studies have been conducted to generate scientific evidence regarding the efficacy and safety of *Ayurvedic* interventions, however, lack of full-fledged support and discretion to create a conducive innate research environment without compromising its fundamental principles has been a major hindrance in tapping its true potential.

In this scenario, where conventional medicine is still not able to find any cure to this pandemic disease and traditional and complementary medicines are not having any alternative to the tertiary healthcare services for terminally ill patients, an integrated approach including all medicine systems may give promising results in COVID-19 management. This

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type of medical pluralism with all the rationale is required to apply in a controlled environment along with conventional approaches and guidelines provided by global health agencies.

The present paper is an attempt to explore the potential of *Ayurveda* in the prevention and management of COVID-19 as a standalone system or integrated with the western system of medicine with pivotal evidence from quintessential classical *Ayurveda* texts of time immemorial and contemporary published literature. It is also aimed to make the policy-makers and healthcare stakeholders of the country appreciate this wealth of traditional scientific knowledge and give due recognition by incorporating its management principles in the prophylaxis and treatment of COVID-19 as per the requirement.

Materials and Methods

All the relevant sources like *Ayurvedic* texts with their commentaries, *Ayurvedic* Pharmacopoeia and Formulary of India, electronic databases (PubMed, Google Scholar, etc.) and websites of government health agencies, etc. were searched thoroughly to collect the relevant material by using the keywords – COVID-19, WHO, CDC, traditional, Chinese medicine, *Ayurveda*, immunity, immunomodulator, *Rasayana*, anti-viral, *Vyadhikshamatva*, etc.

Results

Coronavirus disease-2019

In December 2019, it was observed that clusters of pneumonia cases are occurring in China with unknown etiology. The disease was caused by an unknown virus initially named as Novel Coronavirus (nCoV). Later on, WHO named this virus as Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) and disease as Coronavirus disease (COVID-19) on 11th February 2020. Coronaviruses are a large family of viruses that infect animals as well as humans. Primary observation determined that SARS-CoV-2 spreads through small droplets of saliva or discharge from the nose or mouth of an infected person when he/she coughs or sneezes. Another mode of transmission is from infected hands and surfaces i.e. when these droplets land on objects and surfaces other people may get infected by touching these objects or surfaces and then touching their eyes, nose, or mouth. Its incubation period ranges from 1 to 14 days, most commonly around 5 days[9].

These viruses can cause manifestations of the respiratory or gastrointestinal system. The common signs and symptoms are fever, cough, and shortness of breath in mild cases. In more severe cases, the infection can cause pneumonia, severe acute respiratory syndrome, renal failure, and sometimes death. Some patients may experience nasal congestion, runny nose, sore throat, aches, and pains or diarrhea. Older persons and persons with pre-existing medical conditions (such as high blood pressure, heart disease, lung disease, diabetes mellitus, or patients on cancer medication) appear to develop serious illness more often than others[9].

The confirmation of COVID-19 disease is based on the detection of a unique sequence of virus RNA by a nucleic acid amplification test (NAAT) such as real-time reverse transcription-polymerase chain reaction (rRT-PCR) with confirmation by nucleic acid sequencing when necessary[10].

Clinical classification of COVID-19 cases as per the diagnosis and treatment protocol for Novel Coronavirus Pneumonia (Trial Version 7) released by the National Health Commission and State Administration of Traditional Chinese Medicine on 3rd March 2020 is shown in Table 1[(ref. 11)].

As of now, there is no specific treatment or vaccine of COVID-19, however, many ongoing clinical trials are evaluating potential treatments. Considering its contagiousness, the best method, especially in the absence of treatment, is being well informed about the disease, its causes, and spreads[6]. Alongside this, one has to strictly follow the preventive measures e.g. Respiratory etiquettes, good sanitizing practices, and social distancing. The exact mortality rate of the disease is also yet unknown; however, it is observed that it is having varied fatality rates in different countries. Countries like France, Italy and Spain with the most efficient healthcare systems (1, 2, and 7th ranks respectively in WHO Health System Performance Ranking-2019)[7] are among the countries having most COVID-19 positive cases. In this scenario, where the countries with efficient healthcare systems are finding it difficult to control its spread, another best way after prevention is the integration of conventional measures with other traditional and complementary systems of medicine for prophylaxis and initial-stage management.

Ayurvedic concept of infectious diseases

Ayurveda is probably the world's first medical science describing the concept of contagious or

Table 1 — Clinical classification of COVID-19 cases

S. No.	Clinical classification	Criteria (Signs & Symptoms)
1.	Mild cases	• Mild symptoms. • No signs of pneumonia on imaging.
2.	Moderate cases	• Fever and respiratory symptoms. • Radiological findings of pneumonia.
3.	Severe cases	**Adult cases (meeting any of the following criteria):** • Respiratory distress (Respiratory Rate ≥ 30 Breaths/Min); • Oxygen saturation ≤ 93% at rest; • Arterial partial pressure of oxygen (P_aO_2) / Fraction of inspired oxygen (FiO_2) ≤ 300 mmHg (l mmHg = 0.133 kPa)[#]; • Cases with chest imaging that shows obvious lesion progression within 24-48 hours > 50% shall be managed as severe cases. **Child cases (meeting any of the following criteria):** • Tachypnea (Independent of fever and crying) – ✓ Respiratory Rate ≥ 60 Breaths/Min for infants aged < 2 months; ✓ Respiratory Rate ≥ 50 Breaths/Min for infants aged 2-12 months; ✓ Respiratory Rate ≥ 40 Breaths/Min for children aged 1-5 years, ✓ Respiratory Rate ≥ 30 Breaths/Min for children > 5 years • Oxygen saturation ≤ 92% on finger pulse oximeter taken at rest; • Labored breathing, cyanosis, and intermittent apnea; • Lethargy and convulsion; • Difficulty feeding and signs of dehydration.
4.	Critical cases	Cases meeting any of the following criteria: • Respiratory failure and requiring mechanical ventilation; • Shock; • With other organ failure that requires ICU care.

[#]In areas at altitude of over 1000 meters above the sea-level, P_aO_2/FiO_2 shall be corrected by the formula : P_aO_2/FiO_2 x (Atmospheric pressure in mmHg/760)

communicable diseases under the heading '*Aupasargika Roga*'. Diseases like *Kushtha* (Dermatological conditions of contagious nature), *Jvara* (Fevers of infectious origin), *Shosha* (Pulmonary tuberculosis), *Netrabhishyanda* (Infective conjunctivitis), *Shitalika* (Smallpox), *Masurika* (Chickenpox), etc. may spread from one person to another through various modes of exposures i.e. *Gatra-samsparsha* (Direct contact with an infected person or his infective body fluids), *Nih-shvasa* (Inhalation of infective droplets), *Saha-bhojana* (Ingestion of infective organisms when eating together), *Saha-shaiyya* (Sleeping and/or lying together with an infected person), *Saha-asana* (Sitting together with an infected person) and *Vastra-malya-anulepana* (Use of contaminated articles)[12]. Sexual contact with an infected person has also been mentioned in the etiology of diseases like *Upadamsha* (Sexually transmitted disease causing inflammation of male genitals) and *Phiranga* (Syphilis)[13,14].

The concept of epidemics or pandemics is also well described in *Ayurveda* under the heading of '*Janapadodhvamsa*' (Societal collapse), where it has been clearly mentioned that vitiation of factors common to all inhabitants of a particular region i.e. *Vayu* (Air), *Jala* (Water), *Desha* (Land) and *Kala* (Season) may lead to the simultaneous manifestation of diseases with similar symptoms leading to the societal collapse[15]. The given examples of epidemic or pandemic diseases in *Ayurveda* include *Pratishyaya* (Coryza), *Kasa* (Cough), and *Shvasa* (Dyspnea) etc.[16].

Pragyaparadha (Imprudent conduct and unjust actions of humans) e.g. Interference with the bio-ecology, pollution, and depletion of natural resources, etc., have been considered the main reason for the vitiation of these common factors[17].

Moreover, etiology of *Agantuja Vyadhi* described in *Ayurveda* includes external factors like *Bhuta* (Micro-organisms), *Vayu* (Air), *Abhighata* (Trauma), *Visha* (Poison) etc[18]. These factors exhibit mild symptoms initially but the full-blown disease appears only after the vitiation of other host factors i.e. *Dosha*, *Dhatu* which are responsible for further pathogenesis and progression of the disease[19].

Ayurvedic concept of immunity and Rasayana (Rejuvenation)

In Ayurveda, the concept of immunity is described under multiple headings i.e., *Vyadhikshamatva* and *Bala*. *Vyadhikshamatva* is the power of the body to fight with a disease by either way[20]

1. *Vyadhi-Bala-Virodhitvam* – The resisting power of the body to restrain or withstand the strength or severity or progression of the disease.
2. *Vyadhi-Utpada-Pratibandhakatvam* – The resisting power of the body to prevent the manifestation of the disease.

Bala is said to be of three types which can be correlated with different types of immunity i.e.[21] –

1. *Sahaja Bala* – Natural or innate immunity.
2. *Kalaja Bala* – Acquired immunity which depends upon the seasons and age of the individual.
3. *Yuktikriti Bala* – Acquired immunity which is achieved by rational use of *Ahara* (Diet), *Cheshta* (Daily activities e.g. Exercise, etc.).

Rasayana in *Ayurveda* is defined as a measure or method used to obtain the optimal level of *Dhatu* (Different structural components of the body)[22]. *Rasayana* drugs or formulations have multiple pharmacological effects on various body systems. Free-radical scavenging property is the most studied activity of *Rasayana* followed by immunomodulatory activity[23]. Immunomodulators are those intrinsic or extrinsic substances that regulate or alter the scope, type, duration, or competency of the immune system[24]. Various *Rasayana* drugs having immunomodulatory action have been studied and are used to deal with a vast array of clinical conditions like viral infections, non-specific fevers, immunodeficiency and inflammation, etc.

Discussion

Understanding the patho-physiology of COVID-19 as per Ayurveda principles

According to *Ayurveda*, all the diseases cannot be named with standard nomenclature. Instead of trying to name the disease entity, the physician needs to examine the three important factors, viz. *Samutthana-vishesha* (Specific causative factors of the disease), *Adhishthana-vishesha* (Site of manifestation of the disease), and *Vikara-prakriti* (Pathophysiology of the disease), for designing a rational line of management[25].

Samutthana-Vishesha

COVID-19 pandemic can be understood based on the *Ayurveda* principles of *Aupasargika Roga*[12] and *Janapadodhvamsa*[15]. Further, the disease can be grouped under *Bhutabhishangaja Agantuja Jvara* (Fever caused by the micro-organisms). *Agantuja* factor (*Bhutabhishanga*) causes prodromal symptoms initially and eventually leads to the vitiation of *Nija* (Host) factors i.e., *Tridosha* in the due course of the disease, which in turn manifests the clinical features of the disease[19,26,27].

Adhishthana-Vishesha and Vikara-Prakriti

A recent systematic review and meta-analysis show that the fever (87.3%), cough (58.1%), dyspnea (38.3%), muscle soreness or fatigue (35.5%), and chest distress (31.2%) were the most common clinical manifestations. Among the patients, the incident for intensive care requirement, acute respiratory distress syndrome, and multiple organ dysfunction syndrome was 29.3%, 28.8%, and 8.5%, respectively with a 6.8% case fatality rate[28].

On the basis of symptomatology, its clinical appearance can be depicted in *Shat-kriyakala* (Six levels of pathogenesis) described in *Ayurveda*[29]. The progression and clinical manifestations of COVID-19 across six stages of pathogenesis may vary with reference to severity or time-lapse depending upon the epidemiological triad of the Host-Agent-Environment. This variation can rightly be explained with *Ayurvedic* concept of '*Vikara-Vighata-Bhava-Abhava*' (Disease presentation) leading to *Vikara-Ajananam* (Asymptomatic condition), *Chirena-Jananam* (Insidious onset or longer incubation period) or *Shighra-Jananam* (Acute onset or shorter incubation period), *Anuvikara-Jananam* (Mild stage), *Asarvalinga-Vikara-Jananam* (Moderate stage) and *Sarvalinga-Vikara-Jananam* (Full-blown disease manifestation)[30]. Among the triad (Host-Agent-Environment), the ability of the host to resist the disease manifestation (*Vyadhi-Kshamatva*) is crucial and the extent of encompassment of factors related to *Apathya*, *Dosha* & *Sharira* will eventually decide the severity of disease manifestation & its prognosis[20].

Sanchaya (Stage of accumulation) and Prakopa (Stage of provocation)

These are the initial stages of pathogenesis where only the symptoms of *Dosha-vriddhi* (Quantitative increase in *Dosha*) will be present, mostly subjective to the patient, hence mostly ignored. However, in a

subset of people, due to their habitual non-conducive diet and regimens, the *Alpa Prakupita* (Mildly provoked) *Dosha* are already in *Leena Avastha* (Quiescent state) at the level of *Shakha* or *Dhatu* (Different structural components of the body), even prior to the infection. After contact with the pathogen, it leads to an accelerated progression to the next stage[31]. This subclinical stage can be identified by the presence of the symptoms like heaviness of the body, lethargy etc[32]. in a quarantined person and should be managed promptly to arrest the progression of the disease or to reduce its severity.

Prasara (Stage of migration)

It is also a pre-clinical stage but with moderate symptoms e.g. Anorexia, languor, etc. caused by the migration of vitiated *Dosha*[33]. Anecdotal evidence of anosmia and ageusia with no other symptoms of COVID-19, a short period before the patients ultimately tested positive, draws attention to this stage[34]. *Aprasannendriyatvam* (disability of the sense organs to perceive) is also a deductive tool to understand *Dosha* vitiation[35].

Sthana-samshraya (Stage of localization)

This is the first clinical phase where the vitiated *Dosha* get confined to a site or system causing the onset of prodromal symptoms[36]. In COVID-19, the vitiated *Dosha* afflict *Koshtha* (Viscera), *Rasavaha Srotas* (Channels carrying various types of body fluids), and *Pranavaha Srotas* (Channels of the respiratory system) causing the onset of prodromal symptoms of fever and cough e.g. Lethargy, heaviness of the body, anorexia, distaste in mouth, myalgia, throat irritation with prickly sensation etc[37,38].

If any *Sroto-vaigunya* (Deformity in body channels) is already present there e.g. Respiratory disorders, Cardio-vascular disorders, etc., it makes the COVID-19 manifest in a more complex pattern during upcoming stages.

Vyakti (Stage of manifestation)

This stage of full-blown disease manifests with the features of *Vata-Kapha* predominant *Sannipata Jvara* (Fever with a conglomeration of *Tridosha* due to *Bhutabhishanga*)[26,27] and *Vata* predominant *Kasa* (Dry cough). Here, the predominance of *Vata* and *Kapha* in fever is inferred by the presence of symptoms like cough & dyspnea[39]. While the predominance of *Vata* in *Kasa* is inferred by the presence of symptoms like dry coughing (*Shushka Kasa*) caused by *Pratiloma Gati* (Upward movement) and *Ruksha* (Dry) property of *Vata Dosha*[40].

Here, the site of localization of migrating *Dosha* i.e., *Pranavaha Srotas* (Channels of the respiratory system) and site of origin of fever i.e. *Amashaya* (Part of Gastro-intestinal tract dealing with undigested food) are directly related with the physiological sites of *Kapha Dosha*[41].

Bheda (Stage of complications)

In this stage, the *Vata-Kapha* predominant fever progresses into *Sama-Sannipata Jvara* (Fever with an equal conglomeration of *Tridosha*) with all the signs and symptoms, ultimately ending in the development of *Upadrava* (Complications) i.e., *Shvasa Roga* (Severe pneumonia and ARDS)[40-42]. As per *Ayurveda*, the complication arises due to the undergoing *Dhatupaka* (Excessive inflammation in different structural components of the body as a result of the overwhelmed immune response)[43]. This may further lead to multi-organ failure and shock which require life support measures and has very poor prognosis or the person may survive with some sequel finally leading to death.

The factors e,g. *Samsrishta-yoni* (Involvement of other tissues or organs), *Viruddha-upakrama* (Need of administration of multiple therapies which are contradictory in nature), *Gambhira-anugatam* (Complex pathogenesis), *Chira-sthitatvam* (Chronicity), *Pranayatana-samuttham* (Involving vital organs) and *Marma-upagathi* (Causing damage to vital organs) can also influence the severity of symptoms and duration of their onset[20].

Integrative approach – The key

During this ongoing COVID-19 pandemic, although numerous efforts are being made by conventional medicine to find effective therapy, no significant outcome has been achieved until now. Therefore, in this global crisis, where the countries even with the efficient healthcare systems are unable to control its spread, it's crucial to explore the best possible options available and integration of traditional & complementary systems of medicine with conventional medicine appears to be the way forward.

WHO advocates that Traditional and Complementary Medicine (T & CM) can make a significant contribution to the goal of universal health coverage by being included in the provision of

essential healthcare services. According to the latest report of WHO on T & CM, the uniformly high use of T & CM across all regions reinforces the integration of T & CM products, practices, and practitioners into health systems. It has also mentioned that countries aiming to integrate the best of T & CM and conventional medicine would do well to look at areas where both converge to help tackle the unique health challenges of the 21st century and emphasized the significance of T & CM that balances curative services with preventive care[44].

Also, the key principle of the National Health Policy of India-2017 is to promote the pluralism based approach of integrative healthcare. It advocates the co-location and integration of AYUSH systems at various levels to meet the national health goals and objectives. It also highlights the promotion of healthy living and preventive strategies of AYUSH systems in the community[45]. The AYUSH manpower and therapeutics have already been implemented at different levels throughout the country in various states[46]. National Institution for Transforming India (NITI) *Aayog*, a policy think tank of the Government of India, also focuses on integrative practices, prevention & lifestyle interventions, and dissemination of traditional cultural practices[47].

Moreover, the Government of China, in it's campaign to contain and eradicate SARS-CoV-2, has successfully integrated Traditional Chinese medicine (TCM) in the patients of COVID-19[48]. In this regard, guidelines of diagnosis and treatment for COVID-19 using TCM have been published wherein different TCM protocols for different stages of COVID-19 are detailed and for critical patients, TCM has been recommended along with western medicine[11]. Further, the National Health Commission of China had approved a TCM drug namely '*Qing-Fei-Pai-Du-Tang*' (QPT) for a clinical trial on COVID-19 cases and subsequently recommended it across the country after obtaining clinically valid data with an overall effective rate of ≥ 90. Accordingly, a total of 701 COVID-19 cases were treated with it, out of which, 18.5% cases cured completely whereas 7.27%, 38.2% and 30.2% cases got symptomatic relief, symptomatic improvement, and clinically stabilized respectively. After this significant outcome, they decided to use TCM in combination with conventional medicine for the treatment of COVID-19 and also reported that a total of 60,107 confirmed COVID-19 cases have been treated using TCM[8].

Among 382 registered clinical trials (379 in China) on the WHO's International Clinical Trials Registry Platform aiming to evaluate the efficacy and safety of treatment and prevention of COVID-19, 98 trials are related to the TCM (includes 48 named TCMs; 27 unspecified methods; 18 combinations with unspecified western therapies; and 5 others, e.g. acupuncture)[49].

In India where seasonal and non-specific viral-illnesses are quite common, *Ayurveda* has been used for centuries for dealing with such conditions. Tremendous research work has also been carried out to evaluate the antiviral and immune-modulating properties of various *Ayurvedic* herbs. In recent developments related to the management of COVID-19, various Indian states i.e. Kerala, Haryana & Goa have implemented an integrative approach using different *Ayurveda* protocols for prevention and treatment of COVID-19 in different types of cases viz. quarantined and confirmed mild cases.

Ministry of AYUSH (MoA), Government of India has also issued the various guidelines for the prevention of COVID-19 incorporating immunity-boosting measures which are based on *Ayurvedic* principles and are supported by researches[50,51]. MoA has asked the stakeholders to manufacture '*Ayush Kvatha*' and has taken steps to expedite the process of manufacturing of *Ayurvedic* immunity-boosting products[52,53]. It is supporting the research projects evaluating AYUSH interventions in prophylaxis and management of COVID-19[54]. In recent developments, MoA has launched clinical research studies using *Ayurvedic* interventions as an add-on to standard care to the COVID-19 situation. A population-based study, through the 'AYUSH *Sanjivani*' mobile app, has also launched to assess the acceptance and usage of *AYUSH* advisories and other measures among the population and to understand its role in the prevention of COVID-19(ref. 55). In addition, scientific efforts to develop a pragmatic action plan to address COVID-19 through *Ayurveda* are also being done[56].

Broadly the *Ayurvedic* strategy of management can be divided into preventive & curative aspects as per the stage and severity of the illness based on the *Ayurvedic* principles of management of *Janapadodhvamsa*, *Balagraha*, *Jvara*, *Pratishyaya*, *Kasa*, and *Swasa*.

Pre-exposure prophylaxis

Along with conventional guidelines designed for prevention of COVID-19, some additional *Ayurvedic*

guidelines are proposed which can be followed by the asymptomatic, healthy, and non-risky groups.

Pratimarsha Nasya[57] (Nasal application by instilling two drops in each nostril once in the morning) of *Anu Taila*[58] may be taken to strengthen the first line of defense i.e., Nasal mucosa, hairs, and cilia, etc. Epidemics-specific measures of *Ayurveda*[59] e.g. *Shodhana* (Bio-purification therapy) to subside previously accumulated *Dosha* (Previously disturbed homeostasis), *Rasayana* (Rejuvenation therapy) to obtain an optimal level of different structural components of the body), *Sadvritta* (Nobel moral conducts)[61] and *Achara Rasayana* (Good rejuvenating conducts)[62] to strengthen the mental attributes may be adopted. *Sadyo-Snehana* (Immediate oleation of the body) with 50 to 100 mL of plain Ghee along with *Yavagu* (Rice-gruel) in the night meal or when you feel hungry followed by *Sadyo-Virechana* (Immediate purgation) with 10 to 15 grams of *Avipatti Yoga*[60] with warm water, empty stomach in the early morning may be used for *Shodhana*. 10 to 20 g of *Chyavanprasha*[58] with warm milk on empty stomach in the morning may serve the purpose of using *Rasayana*. De-addiction, observing charity, *Yogasana* (Postures) like *Suryanamskara* (Sun salutation), *Pranayama* (controlled breathing exercises), Emotional equipoise, etc. are the measures which can be adopted under *Sadvritta* and *Achara Rasayana*. *Ayurvedic* measures of *Graha Roga* (Infectious diseases)[63] i.e., *Dhupana* (Fumigation) with *Krimighna* and *Rakshoghna* (Herbal anti-microbial) drugs e.g. Onion and garlic tunics, mustard seeds, *Neem* leaves and Ghee, etc. may be used in order to sanitize the surrounding environment.

Ayurvedic Ahara-Vidhi (Dietary conducts)[64] may be adopted to get optimal dietary benefits e.g. *Dhatu-Poshana* (Overall nutrition) and *Bala-Vriddhi* (Immunity enhancement) etc. Taking *Laghu Ahara* (Easily digestible food), *Matravat Ahara* (Food in appropriate quantity), *Kalanusara Ahara* (Food in accordance with age, season, etc.), *Jirne Ashniyat* (Taking meal only after proper digestion of previously taken meal) and *Susamskarita Ahara* (Diet with desired properties e.g. adding ginger, Ghee, garlic, black-pepper & turmeric, etc. while cooking food to increase metabolism) is the chief dietary conducts should be followed. Intake of *Ushna Jala*[65] (Boiled warm water) as and when required may also be beneficial in this stage.

The interventions in these groups are planned with the assumption that contact with the virus has not occurred. Here the target is to prepare the host to respond better when the person comes in contact with the virus.

Post-exposure prophylaxis

Some additional guidelines proposed here may be followed along with conventional guidelines designed for prevention of COVID-19 and specific measures mentioned in pre-exposure prophylaxis by the high risk-groups e.g. quarantined population and healthcare workers etc.

Intake of *Shadangapaniya*[58] (lukewarm medicated water prepared by adding 30 g of the powder of *Shadangapaniya* into two liters of water and boiling it to half) throughout the day may be beneficial.

Clinically, the immune responses induced by SARS-CoV-2 infection are two-phased. During the incubation and non-severe stages, a specific adaptive immune response helps in the elimination of the virus that in-turn helps to prevent disease progression to severe stages. The successful elimination of the infection relies on the general health status and appropriate genetic background of the infected individual eliciting specific antiviral immunity[56]. Therefore, the use of immunomodulatory *Rasayana* drugs at this stage will be certainly fruitful. However when the patient enters the severe stage, when a strong damaging inflammatory response occurs, especially in the lungs, the immunostimulatory approach will be of no use. Hence the use of some most widely practiced and researched *Rasayana* drugs with known immunomodulatory activities e.g. *Guduchi* (*Tinospora cordifolia*)[67,68], *Ardraka* (*Zingiber officinalis*)[69,70], *Amalaki* (*Emblica officinalis* or *Phyllanthus emblica*)[71,72], *Haridra* (*Curcuma longa*)[73,74], *Tulasi* (*Ocimum sanctum*)[75,76], *Ashwagandha* (*Withania somnifera*)[77,78] & *Madhuyashti* (*Glycyrrhiza glabra*)[79,80], etc. may be of utmost importance in high-risk groups and quarantined people as a prophylactic measure.

The interventions in these groups are planned with the assumption that the contact with the virus has already occurred but the person is asymptomatic and suspected to contract the infection. Here the target is to improve the host response to reduce virulence and arrest the further progression of the pathogenesis.

Management of COVID-19 cases

If any clinical manifestation of COVID-19 appears and the individual is found confirmed with COVID-19, it can be managed with conventional treatment of

COVID-19 along with below proposed *Ayurvedic* guidelines. The interventions are planned according to the clinical manifestations and disease progression as per *Ayurveda* staging system and on the management principles of *Jvara* (Infective fevers), *Pratishyaya* (Coryza), *Kasa* (Cough) and *Shvasa* (Dyspnea) described in standard *Ayurveda* classics.

Stage-I: Anuvikara-Jananam (Mild clinical cases)

In cases with early symptoms of COVID-19 i.e., Dry cough, body-ache and fever, etc. corresponding to *Vata-Kapha* predominant fever, some additional strategies can be used along with prophylactic measures described earlier.

Herbal drugs having *Aama-Pachana* (Eliminating intermediate inflammatory metabolites by improving sluggish metabolism) property e.g. *Amrittottara Kvatha*[58] and *Jvarahara* (Fever pacifying) property e.g. *Samshamani Vati*[81] *and Sudarshana Churna*[58] etc. may be administered at this stage. Herbal drugs with known antiviral properties e.g. *Kalmegha* (*Andrographis paniculata*)[82,83], *Haridra* (*Curcuma longa*)[83,84], Ashwagandha (*Withania somnifera*)[85,86], *Guduchi* (*Tinospora cordifolia*)[86,87], *Tulasi* (*Ocimum sanctum*)[87,84], *Madhuyashti* (*Glycyrrhiza glabra*)[84,88], *Ardraka* (*Zingiber officinalis*)[89,90] & *Haritaki* (*Terminalia chebula*)[91,92], etc. may also be administered here.

Stage-II: Asarvalinga-Vikara-Jananam (Moderate clinical cases)

Herbal drugs having *Shvasa-Kasahara* (Dyspnoea and cough pacifying) properties may be administered along with Stage-I measures in the cases of COVID-19 having respiratory symptoms i.e., Shortness of breath etc. Some widely practiced *Shvasa-Kasahara* formulations are *Sitopaladi Churna*[58], *Talisadi Churna*[58], *Gojihvadi Kvatha*[80], *Agastya Haritaki Rasayana*[58] & *Vyaghri Haritaki Rasayana*[81], etc.

Stage-III: Sarvalinga-Vikara-Jananam (Severe cases) along with Upadrava (Complications)

Along with the measures described in Stage-II, few additional measures can be adopted for COVID-19 cases developing severe pneumonia & ARDS, corresponding to *Sama-Sannipata-Jvara* with underlying *Dhatupaka* (Fever with organ damage).

Herbal formulations having *Sannipata Jvara* pacifying property *e.g. Shatyadi Kvatha*[93] may be administered in this stage. The herbo-mineralo-metallic formulations having the cumulative properties of pacifying *Jvara*, *Shvasa*, *Kasa* & *Pratishyaya* e.g. *Mahalakshmivilasa Rasa*[58], *Shvasakasachintamani Rasa*[81] & *Shringarabha Rasa*[81], etc. may also be administered.

Safety & efficacy of said formulations can be inferred from their high use in general practice & also by relatively high production by leading *Ayurveda* Pharmaceutical establishments in accordance with *Ayurvedic* pharmacopeia & formulary of India. Appropriate modifications in treatment can be made in children, old persons & those with comorbidities. However, the *Ayurveda* is a personalized medicine system, so one can choose the dosage, number & combination of formulations described above rationally. It is also recommended to use all preventive measures as described in pre-exposure prophylaxis during follow-up to prevent a recurrence.

Conclusion

In the case of COVID-19, it may be hypothesized that initial *Bhutabhishanga* (Infection) leads to the vitiation of *Tridosha* which in-turn manifests as *Vata-Kapha* predominant *Sannipata Jvara* with prominent features of *Jvara* (Fever), *Kasa* (Cough) & *Shvasa* (Dyspnea). The vitiation of *Dosha* manifests through *Sanchaya*, *Prakopa*, *Prasara* & *Sthana-Samshraya* stages causing prodromal symptoms. Further vitiation of *Tridosha*, leads to the progression of the disease to *Vyakti* & *Bheda* stages where advanced manifestations of COVID-19 i.e. Severe Pneumonia, ARDS & septic shock are manifested.

The manifestation of the disease from carrier state to mild symptoms to full-blown disease with fatal outcome depends upon *Vyadhikshamatva* & *Bala* (Immunity) and status of the *Srotas* (Body systems) of the host. Hence, the individuals with impaired *Vyadhikshamatva* & *Bala* i.e. old age, etc. & with pre-existing *Sroto-Vaigunya* (Co-morbidities) have more severe & fatal outcomes.

Preventive & management protocols of *Ayurveda* for COVID-19 may be planned on the principles of management described in *Janapadodhvamsa* (Epidemics), *Graha-roga* (Infectious diseases), *Jvara* (Infective fevers), *Pratishyaya* (Coryza), *Kasa* (Cough) & *Shvasa* (Dyspnea), and information available through contemporary published literature related to immunomodulatory & antiviral properties of selected *Ayurvedic* herbs. The same can also be taken up for further research towards the prevention and management of COVID-19.

In this crisis of global pandemic, it's high time for the policy-makers and healthcare stakeholders of the

country to acknowledge the treasure of scientific traditional wisdom and to give due recognition by incorporating *Ayurveda* into the action strategy as a full-fledged healthcare system to fight against COVID-19 for successful prevention, management & eradication.

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Conflict of Interest

Authors declare they have no conflict of Interest

Author Contribution Statement

ACC conceived of the idea. ACC and SKC worked on the Ayurvedic concepts. AKR developed the clinical aspects of Ayurveda. DL developed the T & CM part. RS compiled the policy level matter and developed the integrated approach part of the manuscript. SK worked on the clinical aspect of the COVID-19. SG worked on searching online databases. AK worked on the introduction & treatment parts, final editing, and referencing. All authors worked on their parts, discussed and reached on a consensus. All authors critically appraised the final draft and approved it for submission. AK is the corresponding author.

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