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# Factors That Determine Areas Into Containment Zones of A Disease- A Review

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## Abstract

Containment zones, or areas with strictly enforced restrictions regarding social interactions and self-protective behaviour, are basically demarcated to ensure that in the early stages or at the least, as soon as possible, a disease is confined to particular areas and not allowed to spread to unaffected areas. Influenced by ecological, environmental, pathogenic and demographic factors, which still are just a few of the many formative factors, implementing such demarcations have helped prevent worsening situations in many cases. Building containment zones require analysing experiences from previous attacks of a disease, mathematical modelling and social spread pattern identification, as well as understanding the progression of the disease from rural areas to urban metro cities. Moreover, on account of the diverse characterisation of a geographical area and its population, all the parts of the area will not be uniformly affected. Thus, developing containment zones and implementing them require strategic planning. Further, if effectively dealt with and reviewed, containment zones even transform back into safe zones. This review will assess the necessity of a containment zone, its emergence and factors influencing it, its relation with hotspots and finally, how it could be transformed into safe zones, free of disease constraints.

***Keywords:*** *Containment zone, hotspot, disease spread, demographic, environmental factors, Buffer zone, Safe zone.*

## Introduction

Generally, a given geographic area with positive cases of infectious diseases, and where it is found to be tough to restrict the rates of cross-infection, is considered as a containment zone. Further spread is prevented by imposing behavioural and social restrictions. Hotspots, on the other hand, are areas with a concentrated disease occurrence. Even if it's just a small area, if those affected are confined to the same area, the entire area becomes a hotspot. Containment zones and hotspots are demarcated by assessing risk factors, high probability of spread, and attitude of the people in the area [1]. A containment zone may or may not become a hotspot, but a hotspot can become a containment zone. A containment zone will have harsher restrictions to check the further progression of a disease to such an extent that even essential services can be curbed [2].

Based on the extent of cases or contact mapped by local response teams [3], containment zones are categorized. In the case of an immediate need where mapping might cause a delay, an approximate radius of 3-5 km about an area is designated as a containment zone, that will be updated as and when mapping results are obtained. A buffer zone i.e. a zone of larger radius, than the containment zone, encircling it, will also be declared [4].

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Building containment zones include analysing experience from previous attacks of a disease, mathematical modelling and social spread pattern identification, understanding progression from rural areas to urban metro cities [5]. Besides, on account of the diverse characterisation of a geographical area and its population, it is only unlikely that all the parts of the area will be uniformly affected. Thus, developing containment zones and implementing them require strategic planning.

Large scale developments in the fields of agriculture, hydro-industry and extensive population movements like immigration & emigration, have inflicted an invasion of sorts into the natural environment [6]. Thus, it becomes necessary to understand parasitic and zoonotic diseases. Urbanization has brought rural diseases into urban areas where the course of the infection is apparated by greater populations of vectors and hosts [7]. It is to be noted that so far there has been only little work done in linking biomedical aspects of a disease with the socio-economic effects caused due to them. Or the latter must be just too extensive to comprehend adequately [8].

Recognition of the potential for a widespread infliction due to a disease and mobilisation, that too, timely, of required public health operations and mathematical modelling to predict any further cause of a disease is necessary in the initial stages itself [9]. These might also be accompanied by prophylactic medication, movement restrictions and other non-pharmaceutical interventions [10]. The rapid detection, investigation, and reporting of human cases enable mathematical modelling and analysing what possible actions at the moment would be required. In a study [11] it has been cited that timely deployment of adequate drugs to 80% of the population of a containment zone can ensure the disease does not progress beyond the initial stages.

## Materials and Methods

Around 30-40 articles were selected from portals like Google Scholar, PubMed, and Semantic scholar. They were analysed and reviewed based on their relevance to the study, after which their content was interpreted and incorporated into the present study. Uncontrolled variables like time frame of disease, pathogenesis etc. were excluded while control variables including demographics, human-caused natural habitat destruction etc. were included in the study.

### Disease emergence

A disease can be a familiar one resurfacing, or a completely unfamiliar newly surfacing one. However, this does not differentiate between some common driving factors in disease emergence, in both cases, like ecological and environmental changes including natural disasters, deforestation, droughts, agricultural interventions, demographic and behavioural aspects like population migration, urbanization, international trade and travel, technology, microbial adaptation [12] and public health measures [13].

Certain situations of conflict characterised by a civil strife are again more prone to disease emergence with frequent periods of violence, insecurities, economic downfall, poverty and after effects still ongoing after a war or disturbance, severe enough to sustain that long [14].

An infection might be introduced into the community through travel, commerce, or war, especially with the current widespread globalisation of the service sector. Certain studies cite examples of pathogens invading raw materials in cargo ships, and ending up in the larger batch of the manufactured products [15]. Inadequate surveillance, response teams, destroyed infrastructure and health systems, and poor disease control programs and infection control practices, accompanied by poor coordination among humanitarian organisations contribute to disease development [16].

Detecting and controlling emerging diseases already is a challenge as such, due to multiple uncontrolled factors like pathogenic mutations and suitable environments or niche [17]. Civil conflicts only add on to these hassles, leading to further population displacement, overcrowding, inadequate water and sanitation deficiency while in vector-borne diseases, enhanced transmission by vectors during the initial stages itself. Vulnerability to contracting infectious diseases in an area is very much linked to long term lack of investment in health, education, public works, malnutrition, low prophylaxis coverage, and chronic stress [18].

### Disease amplification

In the past (2000), Uganda saw an outbreak of

Ebola [19] which was attributed to poor infection control practices in health care facilities itself . In poor resource settings, sub-standard supply and maintenance of personal protective equipment, insufficiently trained staff, unhygienic practices [20]and inadequate sterilization protocol amplify disease transmission [21].

Delays in detection and reporting due to weak surveillance systems [22], limited laboratory infrastructure and expertise, and delayed specimen collection may impede the confirmation of the pathogen [23]. Poorly trained health staff and unorganized logistics are added factors that prevent the reach of drugs and medication to the wider public at the time of need [24].

Transmission heterogeneity [25] is a phenomenon observed in different pathogens where, within the same species, there tend to be differences in the mode of transmission making it unpredictable to outline a definitive pattern. Variability in host behaviour, host & pathogen genetics, co-infection and cross-infection patterns, and environmental exposure [26] are some variables leading to transmission heterogeneity. Variable population densities, environmental characteristics and some spatial characteristics which if understood can enable determining patterns of transmission. Pathogenic resistance to drugs is another factor contributing to disease amplification with resistance leading to confusing diagnoses and inappropriate drug regimens or outdated drugs [16,27].

Poor treatment compliance and insufficient procuring of drugs or interrupted treatment with sudden displacement or irregular health access [28] are some factors of amplification of diseases. International disease spread may occur through movements of refugees, relief workers, private sector employees, animals and products, especially those directly from factories and industries where a large number of people remain confined to the workplace [29].

**Demarcating containment zones**

A particular zone demarcated from the rest of the zone and feasibly maintained, large enough to include all infected persons in the vicinity and those in contact with them, is included as a containment zone [30]. Meanwhile, the surrounding 'buffer zone' of larger radius is to conduct surveillance for new cases and to see if the containment operations are effective. This enables modifying, continuing or terminating the containment operations [31].

The theoretically most inclusive form of a containment zone is the circular form with a defined radius, however, in reality, containment zones will be geographically determined. Movements of people, case contacts, administrative boundaries and natural boundaries, infrastructure and essentials like power, sanitation, food supply, contamination etc. affect/ influence containment and buffer zones [32]. If human-to-human transmission is still detected outside the containment and buffer zones, the WHO aids government authorities to constantly assess the situation and expand containment operations further [33].

**Pathogenic factors**

Several pathogens exist which infect across various species where contact rates and transmissibility vary [34]. It becomes necessary to also identify hosts that amplify pathogen transmissions and super spreaders to manage multi-host diseases. These hosts increase susceptibility of differing species to the disease on exposure, and ironically, tend to have a greater social interaction and reside in populated zones. They elevate overall disease prevalence in multi species communities [35].

The distribution of pathogens within an environment influences burdens on the host. For example, even in situations with a lesser pathogenic population, if a host comes across a concentrated pathogenic region, he will still be infected only, even from that less populated zone [36].

**Environmental factors**

As discussed previously, spatial heterogeneity also plays an important role in determining pathogenic prevalence. Hotspot or transmission rates may act as source areas for pathogens to traverse across landscapes to affect less infected areas [37]. Even a specific environment may facilitate elevated survival rates of pathogen or amplification hosts which are equally dangerous. In a study by Spira et al [38], the bacteria Vibrio cholerae was observed to thrive well in water hyacinth colonies causing areas with such colonies to become hotspots of the disease cholera.

**Demographic factors**

Alteration in community structure, contact rates and host susceptibility in humans, plants and all the occupants of an area are associated with anthropogenic changes such as genetic drift, which alter population and habitat size, changing reduced population diversity in host population, reducing host immunity, causing spatial variability [39]. Nutrient enrichment also elevated disease risk through pathogen abundance virulence even though this is probably being utilised by the human population [40]. A study by Lol et al [41] showed how nutrients enhanced in an agricultural land also caused a greater Anophele vestiti pennis (vector) population.

Further, day care facilities, hospitals, farms, markets and regional differences in socialising also enable hotspot development. The main areas of disease transmission include schools where multiple children aggregate wood places, construction sites where labourers work together, etc. A study by Chong et al [42] showed how the Nipah virus was contracted by Malaysian families from Bangladeshi nurses. Other 'social animals' like rodents and their 'lek' behaviour especially in feeding sites, watering holes etc, cause greater transmission of pathogens.

Cluster size, time lapse, and mitigation protocol since early cases determine the furthering of conditions in a containment zone. Geographical characteristics coupled with the interactions of social structures based on the area are determinants of the ease of pathogenic transmission. The feasibility of initiating and maintaining containment operations for the better, require consultation with the WHO and must aim to assess the general security of the situation, international support, financial and technical resources, food, water and sanitation, and the national government's willingness to address the situation [43].

**Table 1: Factors that determine disease emergence in population**

| **Factors that determine disease emergence in population** | |
|---|---|
| Pathogenic factors | Vectors<br>Amplification hosts<br>Multi-drug resistance<br>Multifactorial-health conditions |
| Environmental factors | Human animal interactions<br>Climatic conditions<br>Spatial heterogeneity |
| Demographic factors | Age<br>Multi-factorial health conditions<br>Human animal interactions<br>Population distribution<br>Urbanisation<br>Social behaviour/interaction<br>Population migration |

## Discussion

Thus, the review has highlighted what hotspots and containment zones are, what do they root from and how they enable controlling of diseases. Mostly, socioeconomic, environmental and ecological factors are attributed to the emergence of containment zones. One aspect to be noted is that containment zones are born out of necessity rather than of environmental or other extrinsic causative pathogenic factors.

A common finding is the emphasis on vectors, amplification hosts, population distribution, urbanisation, and social behaviour/interaction [44], as risk factors for the development of containment zones. Another study, [45] however argues that delayed detection could be due to unfamiliarity with disease and cannot be addressed in the same way as lack of infrastructure, which might be one of the reasons for the development of containment zones.

Age, population density, population movements, multi-factorial health conditions and human animal interactions can also be other factors that determine containment zones (Table 1). Again, it is reiterated that social contact occurs more within homes and workplaces, than in the course of travelling, so population migration can only be conditionally considered as a risk factor [46].

Containment zone formation is tedious enough but the recovery time surpasses this in terms of challenges faced for which rapid action is required. Antiviral medication [47], non-pharmaceutical [48] interventions, dispatching health care workers, consistent surveillance all form a part of outreach protocols and response team motives, to deal with situations alike.

Communication plays an important role [49] in dispatching information and implementing better preventive methods. Local, regional, national and even international public communication must form a support system for the affected and must guide and organise ways of information dispatching to those in the vicinity of containment and buffer zones. This also is a key to international coordination which might bring about a holistic betterment of the affected zones. With greater awareness, the public would also follow stringent practices for protecting oneself including disinfecting household items, using sanitizer, consuming immunity booster and stocking on protective masks and gloves [50,51]. The emphasis of careful determination of the affected zones is exhibited in one such case, in the city of Mumbai, India, where instead of selecting entire districts as containment zones in the face of the extensive spread of the Covid-19 disease, two regions, the Dilshad Gardens and Nizamuddin, are selected as hotspots, making population directed treatment, feasible [52].

Frequent physical reminders on the status of the situation are also necessary incentives to the population. Establishing clear cut exit and entry points, screening procedures, watch on the transit through sea, air, or land, and administering chemoprophylactic doses are necessary aspects of containment operations.

The review is however limited only to the discussion of controlled aspects of a setting, which are at least quantifiable and measurable. It does not highlight abstract factors like the genetic disposition of an individual or the pathogenesis of the disease [53].

## Conclusion

The review has assessed possible risk factors, demographic patterns, measures taken in the development of containment zones and has highlighted barriers and deficiencies in a social setting that might necessitate the formation of such zones. Future considerations might as well involve necessary measures to improve outreach across communities and countries, standardize quantification and assessment of disease progression and preparatory efforts to equip nations with resources to handle unfamiliar disease conditions.

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## References

1. Lessler J, Azman AS, McKay HS, Moore SM. What is a Hotspot Anyway? Am J Trop Med Hyg [Internet]. 2017 Jun;96(6):1270–3. Available from: http://dx.doi.org/10.4269/ajtmh.16-0427
2. Gayer M, Legros D, Formenty P, Connolly MA. Conflict and emerging infectious diseases. Emerg Infect Dis [Internet]. 2007 Nov;13(11):1625–31. Available from: http://dx.doi.org/10.3201/eid1311.061093
3. Singh R, Gupta V, Malhotra B, Singh S, Ravindran P, Meena D, et al. Cluster containment strategy: addressing Zika virus outbreak in Rajasthan, India. BMJ Glob Health [Internet]. 2019 Sep 5;4(5):e001383. Available from: http://dx.doi.

org/10.1136/bmjgh-2018-001383

4. Almogy G, Stone L, Bernevig BA, Wolf DG, Dorozko M, Moses AE, et al. Analysis of Influenza and RSV dynamics in the community using a "Local Transmission Zone"approach. Sci Rep [Internet]. 2017;7:42012. Available from: https://www.nature.com/articles/srep42012
5. Mary VNS, Nancy Selva Mary V, Saveetha Dental College, Chennai, Dhanraj, Ashok, et al. Consumption of sweets in children below 6 years of age related to dental caries in rural areas [Internet]. Vol. 6, International Journal of Current Advanced Research. 2017. p. 2829–30. Available from: http://dx.doi.org/10.24327/ijcar.2017.2830.0118
6. Sultana R, Fuad N, Ferdous J. Containment Strategy during COVID-19 Outbreak - Analysis of Hospitals Hotspots in Dhaka to prevent Community Transmission [Internet]. 2020 [cited 2020 Jun 1]. Available from: https://papers.ssrn.com/abstract=3581666
7. Wilkinson DA, Marshall JC, French NP, Hayman DTS. Habitat fragmentation, biodiversity loss and the risk of novel infectious disease emergence. J R Soc Interface [Internet]. 2018 Dec 5;15(149). Available from: http://dx.doi.org/10.1098/rsif.2018.0403
8. Jones BA, Betson M, Pfeiffer DU. Eco-social processes influencing infectious disease emergence and spread. Parasitology [Internet]. 2017 Jan;144(1):26–36. Available from: http://dx.doi.org/10.1017/S0031182016001414
9. Nørgaard LS, Phillips BL, Hall MD. Infection in patchy populations: Contrasting pathogen invasion success and dispersal at varying times since host colonization. Evol Lett [Internet]. 2019 Oct;3(5):555-66. Available from: http://dx.doi.org/10.1002/evl3.141
10. Sivabalan S, Srinath MV. Does a Crying Child Enhance the Risk for COVID-19 Transmission? Indian Pediatr [Internet]. 2020 Apr 26; Available from: https://www.ncbi.nlm.nih.gov/pubmed/32336688
11. Coveley M, Huang Y. Method and apparatus for cataloging and poling movement in an environment for purposes of tracking and/or containment of infectious diseases [Internet]. US Patent. 7817046, 2010 [cited 2020 Jun 1]. Available from: https://patentimages.storage.googleapis.com/08/b6/6f/b3b13d96b1f703/US7817046.pdf
12. J LP, Saveetha Dental College and Hospitals, Saveetha University, N UMT, Saveetha Dental College and Hospitals, Saveetha University. Regulatory guidelines and key aspects of guidelines in the use of biologics [Internet]. Vol. 6, International Journal of Current Advanced Research. 2017. p. 3267–9. Available from: http://dx.doi.org/10.24327/ijcar.2017.3269.0242
13. Kaszta Ż, Marino J, Wolff E. Fine-scale spatial and seasonal rangeland use by cattle in a foot-and-mouth disease control zones. Agric Ecosyst Environ [Internet]. 2017 Feb 15;239:161–72. Available from: http://www.sciencedirect.com/science/article/pii/S0167880917300117
14. Shoemaker TR, Balinandi S, Tumusiime A, Nyakarahuka L, Lutwama J, Mbidde E, et al. Impact of enhanced viral haemorrhagic fever surveillance on outbreak detection and response in Uganda. Lancet Infect Dis [Internet]. 2018 Apr;18(4):373–5. Available from: http://dx.doi.org/10.1016/S1473-3099(18)30164-6
15. Muhjazi G, Malik M, Mala P, Nabeth P, Dye C. WHO's reply to "Cholera in the time of War: implications of weak surveillance in Syria for the WHO"s preparedness—a comparison of two monitoring systems. BMJ global health [Internet]. 2017;2(2):e000258. Available from: https://gh.bmj.com/content/2/2/e000258?utm_source=trendmd&utm_medium=cpc&utm_campaign=alljjs&utm_content=consumer&utm_term=1-A
16. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. An insight into the emergence of Acinetobacter baumannii as an oro-dental pathogen and its drug resistance gene profile – An in silico approach [Internet]. Vol. 4, Heliyon. 2018. p. e01051. Available from: http://dx.doi.org/10.1016/j.heliyon.2018.e01051
17. Smiline ASG, Vijayashree JP, Paramasivam A. Molecular characterization of plasmid-encoded blaTEM, blaSHV and blaCTX-M among extended spectrum β-lactamases [ESBLs] producing Acinetobacter baumannii [Internet]. Vol. 75,

British Journal of Biomedical Science. 2018. p. 200–2. Available from: http://dx.doi.org/10.1080/09674845.2018.1492207

18. Paramasivam A, Vijayashree Priyadharsini J, Raghunandhakumar S. N6-adenosine methylation (m6A): a promising new molecular target in hypertension and cardiovascular diseases. Hypertens Res [Internet]. 2020 Feb;43(2):153–4. Available from: http://dx.doi.org/10.1038/s41440-019-0338-z
19. Woolhouse M, Scott F, Hudson Z, Howey R, Chase-Topping M. Human viruses: discovery and emergence. Philos Trans R Soc Lond B Biol Sci [Internet]. 2012 Oct 19;367(1604):2864–71. Available from: http://dx.doi.org/10.1098/rstb.2011.0354
20. Girija SAS, Jayaseelan VP, Arumugam P. Prevalence of VIM- and GIM-producing Acinetobacter baumannii from patients with severe urinary tract infection [Internet]. Vol. 65, Acta Microbiologica et Immunologica Hungarica. 2018. p. 539–50. Available from: http://dx.doi.org/10.1556/030.65.2018.038
21. Girija As S, Priyadharsini J V. CLSI based antibiogram profile and the detection of MDR and XDR strains of Acinetobacter baumannii isolated from urine samples. Med J Islam Repub Iran [Internet]. 2019 Feb 8;33:3. Available from: http://dx.doi.org/10.34171/mjiri.33.3
22. Preethy NA, Somasundaram S. Awareness of child abuse and neglect among working parents in Chennai, India: A knowledge, attitude and practice (KAP) survey. J Family Med Prim Care [Internet]. 2020 Feb;9(2):602–8. Available from: http://dx.doi.org/10.4103/jfmpc.jfmpc_1106_19
23. Poller B, Tunbridge A, Hall S, Beadsworth M, Jacobs M, Peters E, et al. A unified personal protective equipment ensemble for clinical response to possible high consequence infectious diseases: A consensus document on behalf of the HCID programme. J Infect [Internet]. 2018 Dec 1;77(6):496–502. Available from: http://www.sciencedirect.com/science/article/pii/S0163445318302615
24. Gamliel A, Fletcher J. Containment and Eradication of Invasive Pathogens. In: Gullino ML, Stack JP, Fletcher J, Mumford JD, editors. Practical Tools for Plant and Food Biosecurity: Results from a European Network of Excellence [Internet]. Cham: Springer International Publishing; 2017. p. 243–56. Available from: https://doi.org/10.1007/978-3-319-46897-6_12
25. Landmann T, Dubovyk O, Ghazaryan G, Kimani J, Abdel-Rahman E. Wide-area mapping of invasive species propagation and containment zones in somaliland using phenometric trends and generalized linear modelling. In: 2017 IEEE International Geoscience and Remote Sensing Symposium (IGARSS) [Internet]. 2017. p. 1103–6. Available from: http://dx.doi.org/10.1109/IGARSS.2017.8127149
26. M MA, Geetha RV, Thangavelu L. Evaluation oEvaluation of anti-inflammatory action of Laurus nobilis-an in vitro studyf anti-inflammatory action of Laurus nobilis-an in vitro study [Internet]. Vol. 10, International Journal of Research in Pharmaceutical Sciences. 2019. p. 1209–13. Available from: http://dx.doi.org/10.26452/ijrps.v10i2.408
27. Girija ASS, Smiline Girija AS, Vijayashree Priyadharsini J, Paramasivam A. Plasmid-encoded resistance to trimethoprim/sulfamethoxazole mediated by dfrA1, dfrA5, sul1 and sul2 among Acinetobacter baumannii isolated from urine samples of patients with severe urinary tract infection [Internet]. Vol. 17, Journal of Global Antimicrobial Resistance. 2019. p. 145–6. Available from: http://dx.doi.org/10.1016/j.jgar.2019.04.001
28. Priyadharsini JV, Vijayashree Priyadharsini J, Smiline Girija AS, Paramasivam A. In silico analysis of virulence genes in an emerging dental pathogen A. baumannii and related species [Internet]. Vol. 94, Archives of Oral Biology. 2018. p. 93–8. Available from: http://dx.doi.org/10.1016/j.archoralbio.2018.07.001
29. Palati S, Ramani P, Shrelin HJ, Sukumaran G, Ramasubramanian A, Don KR, et al. Knowledge, Attitude and practice survey on the perspective of oral lesions and dental health in geriatric patients residing in old age homes. Indian J Dent Res [Internet]. 2020 Jan;31(1):22–5. Available from: http://dx.doi.org/10.4103/ijdr.IJDR_195_18

30. Connolly C, Keil R, Ali SH. Extended urbanisation and the spatialities of infectious disease: Demographic change, infrastructure and governance. Urban Stud [Internet]. 2020 Mar 31;0042098020910873. Available from: https://doi.org/10.1177/0042098020910873

31. Quinlan MM, Megan Quinlan M, Mutunga JM, Diabaté A, Namountougou M, Coulibaly MB, et al. Studies of Transgenic Mosquitoes in Disease-Endemic Countries: Preparation of Containment Facilities [Internet]. Vol. 18, Vector-Borne and Zoonotic Diseases. 2018. p. 21-30. Available from: http://dx.doi.org/10.1089/vbz.2017.2192

32. Vaishali M, Geetha RV. Antibacterial activity of Orange peel oil on Streptococcus mutans and Enterococcus-An In-vitro study. Research Journal of Pharmacy and Technology [Internet]. 2018;11(2):513–4. Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume=11&issue=2& article=016

33. Subramanian VS, Saveetha Dental College and Hospitals Saveetha University, Road Chennai P, Gayathri R, VishnuPriya V, Saveetha Dental College and Hospitals Saveetha University, et al. Awareness of breast cancer among south indian women: a survey [Internet]. Vol. 6, International Journal of Current Advanced Research. 2017. p. 2882–5. Available from: http://dx.doi.org/10.24327/ijcar.2017.2885.0132

34. Ashwin KS, Muralidharan NP. Vancomycin-resistant enterococcus (VRE) vs Methicillin-resistant Staphylococcus Aureus (MRSA). Indian J Med Microbiol [Internet]. 2015 Feb;33 Suppl:166–7. Available from: http://dx.doi.org/10.4103/0255-0857.150976

35. Paramasivam A, Priyadharsini JV, Raghunandhakumar S, Elumalai P. A novel COVID-19 and its effects on cardiovascular disease. Hypertens Res [Internet]. 2020 Apr 30; Available from: http://dx.doi.org/10.1038/s41440-020-0461-x

36. Moturi E, Horton K, Bell L, Breakwell L, Dueger E. PanStop: a decade of rapid containment exercises for pandemic preparedness in the WHO Western Pacific Region. Western Pac Surveill Response J [Internet]. 2018 Dec 18;9(5 Suppl 1):71–4. Available from: http://dx.doi.org/10.5365/wpsar.2018.9.5.012

37. Pike J, Bogich T, Elwood S, Finnoff DC, Daszak P. Economic optimization of a global strategy to address the pandemic threat. Proc Natl Acad Sci U S A [Internet]. 2014 Dec 30;111(52):18519–23. Available from: http://dx.doi.org/10.1073/pnas.1412661112

38. Spira WM, Sack RB, Froehlich JL. Simple adult rabbit model for Vibrio cholerae and enterotoxigenic Escherichia coli diarrhea. Infect Immun [Internet]. 1981 May;32(2):739–47. Available from: https://www.ncbi.nlm.nih.gov/pubmed/7019078

39. Kortepeter MG, Kwon EH, Hewlett AL, Smith PW, Cieslak TJ. Containment Care Units for Managing Patients With Highly Hazardous Infectious Diseases: A Concept Whose Time Has Come. J Infect Dis [Internet]. 2016 Oct 15;214(suppl 3):S137–41. Available from: http://dx.doi.org/10.1093/infdis/jiw292

40. Ferguson NM, Cummings DAT, Cauchemez S, Fraser C, Riley S, Meeyai A, et al. Strategies for containing an emerging influenza pandemic in Southeast Asia. Nature [Internet]. 2005 Sep 8;437(7056):209–14. Available from: http://dx.doi.org/10.1038/nature04017

41. Lol JC, Castañeda D, Mackenzie-Impoinvil L, Romero CG, Lenhart A, Padilla NR. Development of molecular assays to detect target-site mechanisms associated with insecticide resistance in malaria vectors from Latin America. Malar J [Internet]. 2019 Jun 20;18(1):202. Available from: http://dx.doi.org/10.1186/s12936-019-2834-7

42. Chong CH, Zulkifli I, Blair R. Effects of Dietary Inclusion of Palm Kernel Cake and Palm Oil, and Enzyme Supplementation on Performance of Laying Hens. Asian-australas J Anim Sci [Internet]. 2008 Jul 3 [cited 2020 Jun 1];21(7):1053–8. Available from: http://www.ajas.info/journal/view.php?number=21884

43. Organization WH, Others. WHO interim protocol: rapid operations to contain the initial emergence of pandemic influenza. Geneva: World Health Organization. 2007;

44. Stiers KM, Beamer LJ. A Hotspot for Disease-Associated Variants of Human PGM1 Is Associated

with Impaired Ligand Binding and Loop Dynamics. Structure [Internet]. 2018 Oct 2;26(10):1337–45. e3. Available from: http://dx.doi.org/10.1016/j.str.2018.07.005

45. Kilpatrick AM, Marm Kilpatrick A, Salkeld DJ, Titcomb G, Hahn MB. Conservation of biodiversity as a strategy for improving human health and well-being [Internet]. Vol. 372, Philosophical Transactions of the Royal Society B: Biological Sciences. 2017. p. 20160131. Available from: http://dx.doi.org/10.1098/rstb.2016.0131
46. Rj I, Ilankizhai RJ, Saveetha Dental College and Hospitals, Saveetha university, - C, Geetha RV, et al. Antibacterial effect of garlic extract on growth of staphylococcus aureus [Internet]. Vol. 6, International Journal of Current Advanced Research. 2017. p. 2977–9. Available from: http://dx.doi.org/10.24327/ijcar.2017.2979.0159
47. Pratha AA, Geetha RV. Awareness on Hepatitis-B vaccination among dental students-A Questionnaire Survey. Research Journal of Pharmacy and Technology [Internet]. 2017;10(5):1360–2. Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume= 10&issue=5&article=015
48. Marickar RF, Geetha RV, Neelakantan P. Efficacy of contemporary and novel Intracanal medicaments against enterococcus faecalis. J Clin Pediatr Dent [Internet]. 2014 Autumn;39(1):47–50. Available from: http://dx.doi.org/10.17796/jcpd.39.1.wmw9768314h56666
49. Cetron M, Maloney S, Koppaka R, Simone P. Isolation and quarantine: Containment strategies for SARS 2003. Learning from SARS: Preparing for the Next Disease Outbreak [Internet]. 2004;71–83. Available from: https://books.google.com/books?hl=en&lr=&id=GSY0Tjq_M74C&oi=fnd&pg=PA71&dq=Cetron+M+Isolation+and+quarantine+containment+strategies+for+SARS+2003+In+Institute+of+ Medicine+Learning+from+SARS+ (Workshop+Summary)+National+Academy+ Press+2004+71+83 &ots=WccIPWBdhO&sig=-- jdkvH-tB600hAXd1G_VB_s23w
50. Renuka S, Muralidharan NP. Comparison in benefits of herbal mouthwashes with chlorhexidine mouthwash: A review. Asian J Pharm Clin Res. 2017;10:3–7.
51. Shahana RY, Muralidharan NP. Efficacy of mouth rinse in maintaining oral health of patients attending orthodontic clinics. Research Journal of Pharmacy and Technology [Internet]. 2016;9(11):1991–3. Available from: http://www.indianjournals.com/ijor.aspx?target=ijor:rjpt&volume=9&issue=11&article=035
52. Majumdar A, Mehta A. Heterogeneous contact networks in COVID-19 spreading: the role of social deprivation [Internet]. arXiv [physics.soc-ph]. 2020. Available from: http://arxiv.org/abs/2005.00491
53. Shahzan MS, Girija ASS, Priyadharsini JV. A computational study targeting the mutated L321F of ERG11 gene in C. albicans, associated with fluconazole resistance with bioactive compounds from Acacia nilotica. J Mycol Med [Internet]. 2019;29(4):303–9. Available from: https://www.sciencedirect.com/science/article/pii/S1156523319300496