Coming in Too Hot? A Critical Analysis of the Utility of Thermal Home Remedies in COVID-19

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INTRODUCTION

Thermal home remedies using hot water and/or steam inhalation have been widely promoted in social media channels as an effective means of killing SARS-CoV-2, the causative agent of COVID-19.[1,2] Such remedies have even been proposed as a means of ending the pandemic.[3] The aims of this analysis are to examine the scientific basis behind thermal home remedies as they pertain specifically to COVID-19, and to ascertain the potential risks and benefits of such practices.

HISTORICAL PERSPECTIVE

Thermal inhalation therapy is a practice as old as modern human civilisation. Therapeutic dry powder inhalation using alkaloids and anticholinergic compounds have been described 4000 years ago in India.[4] The ancient Egyptians used therapeutic aerosols 3500 years ago, using compounds related to atropine.[5] Some fundamentals of these concepts remain relevant even in today's ailments such as asthma.

MEDICAL LITERATURE REVIEW

For generations, therapeutic steam inhalation has been viewed as a reliable ally in the battle against sinusitis, runny nose and upper respiratory infections.[6] Yet, the medical literature on thermal inhalation therapy demonstrates limited evidence in subjective and symptom-based improvement.[7,8]

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[1] https://timesofindia.indiatimes.com/city/bengaluru/doctors-warn-against-social-medias-steam-inhalation-prescription/articleshow/78687072.cms.

[2] https://factcheck.afp.com/new-hoax-shared-sri-lanka-suggests-who-approved-water-salt-and-vinegar-remedy-coronavirus

[3] https://www.facebook.com/emohanonline/posts/10223255876255336

[4] de Boer AH, Hagedoorn P, Hoppentocht M, Buttini F, Grasmeijer F, Frijlink HW. Dry powder inhalation: past, present and future. Expert Opin Drug Deliv. 2017;14(4):499–512.

[5] Stein SW, Thiel CG. The history of therapeutic aerosols: A chronological review. J Aerosol Med Pulm Drug Deliv. 2017;30(1):20–41.

[6] Scarborough A, Scarborough O, Abdi H, Atkins J. Steam inhalation: More harm than good? Perspective from a UK burns centre. Burns [Internet]. 2020; Available from: https://linkinghub.elsevier.com/retrieve/pii/S0305-4179(20)30509-X

[7] Ichiba T, Kakiuchi K, Suzuki M, Uchiyama M. Warm steam inhalation before bedtime improved sleep quality in adult men. Evid Based Complement Alternat Med [Internet]. 2019;2453483. Available from: http://dx.doi.org/10.1155/2019/2453483

[8] Forstall GJ, Macknin ML, Yen-Lieberman BR, Medendrop SV. Effect of inhaling heated vapor on symptoms of the common cold. JAMA. 1994;271(14):1109–11.

A 2017 Cochrane review failed to show any benefit (or harm) from the use of heated, humidified air delivered via a purpose-built device for the treatment of the common cold.[9]

ANATOMY AND PHYSIOLOGY

Paranasal sinuses are empty pockets within our skull, with the inner surfaces covered with a smooth epithelial lining. It is thought that paranasal sinuses provide for a lighter cranium, easing the stress on neck muscles and enabling an upright posture. The network of paranasal sinuses protect the brain by absorbing the shock of external blows to the skull through a mesh of air pockets (much like modern-day protective helmets). They also facilitate optimal hearing and vocal resonance by attenuating bone transmission of vibratory noise.

A variety of insults in the form of particulate matter, allergens and viruses result in the thickening of sinus secretions. Thickened secretions compromise the overall health in the sinus by impeding the normal mucus flow and flushing mechanisms, much like a malfunctioning washbasin. Thick mucus cannot pass through the small drain holes, or ostia, further aggravating the problem by causing congestion and headaches. A sinus thus clogged is ripe for secondary bacterial infection, causing fever, chills, malaise and worsening headaches. Furthermore, an overflowing sinus can cause a post-nasal drip (mucus dripping down the back of the throat) resulting in an itchy throat and a reflexive nagging cough - which are in fact protective mechanisms aimed to keep the lungs clean and dry from the hail of dripping mucus.

Heat transmitted through inhaled steam or hot water directed at the cranium serves to thin the congested mucus by thermal expansion (much like re-heating refrigerated gravy), facilitating resumption of mucus drainage through the drain holes and providing almost immediate symptomatic relief as a result of decongestion. However, re-accumulation of thick mucus will occur as long as the primary insult - dust, allergen, virus — continues unabated. Repeat treatments are therefore often necessary for continued symptomatic relief.

THERMAL EFFECTS ON VIRAL FACTORS

The effects of inhaled steam on viral shedding and viral titres in nasal washings have been studied through clinical trials. In a randomised, controlled, double blind analysis of patients with the common cold, nasal inhalation of air at 43°C versus 30°C failed to demonstrate any difference in the rates of viral shedding based on inhaled air temperature.[10] Another randomised, controlled, experimental rhinovirus

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[9] Singh M, Singh M, Jaiswal N, Chauhan A. Heated, humidified air for the common cold. Cochrane Database Syst Rev. 2017;8:CD001728.

[10] Tyrrell D, Barrow I, Arthur J. Local hyperthermia benefits natural and experimental common colds. BMJ. 1989;298(6683):1280–3.

infection trial measuring viral titres in nasal washings over 4 days following inhalation of air at 42-44°C versus air at 22-24°C, failed to demonstrate any effect of inhaled air temperature on viral shedding.[11]

SARS-CoV-2 gains entry into human cells by binding to the ACE2 receptors (Figure 1). The process of SARS-CoV-2 cellular binding and entry into human respiratory epithelial cells takes approximately 96 hours from the time of exposure.

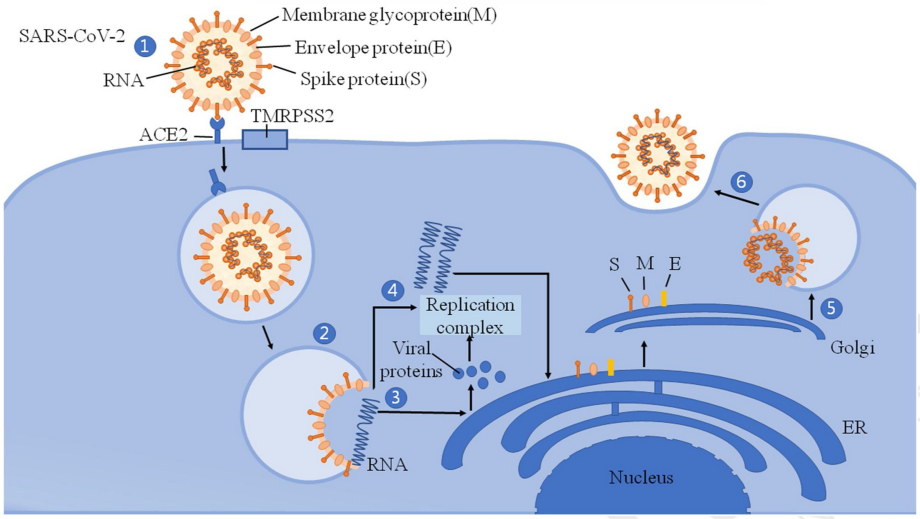

Figure 1: SARS-CoV-2 entry into respiratory epithelial cells. Step 1 demonstrates viral fusion at the ACE-2 receptor in the presence of the cell surface protease TMRPSS2. Adapted from Zhang, et al. [12]

SARS-CoV-2 has shown varying conformations of the spike protein receptor binding domains in low versus high temperatures. At 70°C, the residues on the receptor binding motif adopt a buried configuration, while at 30°C the motif conforms to an exposed configuration (Figure 2).[13]

[11] Hendley JO, Abbott RD, Beasley PP, Gwaltney JM Jr. Effect of inhalation of hot humidified air on experimental rhinovirus infection. JAMA. 1994;271(14):1112–3

[12] Zhang Y, Geng X, Tan Y, Li Q, Xu C, Xu J, et al. New understanding of the damage of SARS-CoV-2 infection outside the respiratory system. Biomed Pharmacother [Internet]. 2020;127(110195):110195. Available from: http://dx.doi.org/10.1016/j.biopha.2020.110195

[13] Rath SL, Kumar K. Investigation of the effect of temperature on the structure of SARS-CoV-2 Spike protein by molecular dynamics simulations. Front Mol Biosci [Internet]. 2020;7:583523. Available from: http://dx.doi.org/10.3389/fmolb.2020.583523

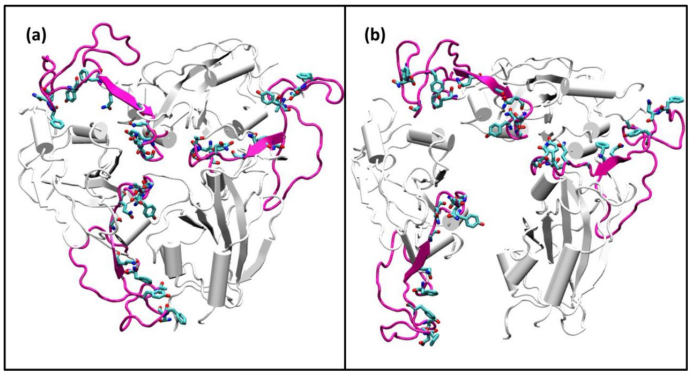

Figure 2. SARS-CoV-2 Spike protein showing conformations of Receptor Binding Domain at (a) 70°C (closed) and (b) 30°C (open). Adapted from Rath & Kumar. [13]

It may be extrapolated that cellular binding of SARS-CoV-2 is impeded in the buried or closed configuration of the receptor binding motif observed at 70°C. However, the reversibility of this process at lower temperatures has not been clearly established.

TEMPERATURE-TIME PARAMETERS

Through the analysis of 24 different combinations, temperature-time parameters for SARS-CoV-2 thermal inactivation have been obtained:[14]

- Above 75°C (160°F): 3 minutes
- Above 65°C (149°F): 5 minutes
- Above 60°C (140°F): 20 minutes

The temperature-time parameters necessary to sustain full-thickness (third-degree) burns in children at various hot water temperatures are summarised below:[15]

- At 52°C (125°F): 2 minutes
- At 54°C (130°F): 30 seconds

DISCUSSION

The outer layers of our skin are far more resistant to mechanical and thermal injury than the soft tissue within the nasal cavity, throat, and paranasal sinuses. Yet, the skin completely disintegrates in a matter of seconds at temperatures lower than what is required to inactivate SARS-CoV-2. Considering the temperature-time associations for inactivating SARS-CoV-2 and for sustaining full-thickness skin

[14] Abraham JP, Plourde BD, Cheng L. Using heat to kill SARS-CoV-2. Rev Med Virol [Internet]. 2020;30(5):e2115. Available from: http://dx.doi.org/10.1002/rmv.2115

[15] Pichoff BE, Schydlower M, Stephenson SR. Children at risk for accidental burns from hot tap water. Tex Med. 1994;90(11):54–8.

burns, the impossibility of killing SARS-CoV-2 through thermal inhalation therapy without sustaining extensive, debilitating and life-threatening burns is readily apparent.

RISKS OF THERMAL HOME REMEDIES

Therapeutic steam inhalation has been identified as a dangerous practice in regional burns centres across the United Kingdom due to accidental burns and scalds, particularly among children.[16] These accidents also incur significant financial burden on the healthcare system.[16] More than 50% of surveyed National Burns Services centres in the United Kingdom reported an increase in accidental burns and scalds due to thermal home remedies in relation to the COVID-19 pandemic.[17] Two-thirds of such centres noted an association with patients of South Asian ethnicity,[17] perhaps reflecting the higher prevalence of thermal steam inhalation in these cultures. Correspondingly, in India, the number of accidental burns and scalds has more than doubled following social media messages advocating steam inhalation to kill SARS-CoV-2.[18] Accidental spillage of hot water was identified as the most common cause of such injuries.[17] While external burns are more readily apparent, occult internal injury in the form of thermal epiglottitis can be life threatening. Delayed thermal epiglottitis from carelessly administered steam inhalation is especially ominous.[19]

CONCLUSION

The epithelial lining of the airway provides a sophisticated frontline defence system against respiratory viruses. Aside from the physical properties of protective brush-border mechanisms, the respiratory epithelium initiates critical immunological cascades such as the production and secretion of interferons (type I, type III), lactoferrin, β-defensins, nitric oxide, and various cytokines and chemokines, which result in a robust cell-mediated immune response leading to the rapid clearance of respiratory viruses.[20] Any injury or damage to the respiratory epithelial lining in the form of toxins, pollutants or thermal injury compromises its physical protective mechanisms and immune responses, leading to an

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[16] Himdani SA, Javed MU, Hughes J, Falconer O, Bidder C, Hemington-Gorse S, et al. Home remedy or hazard? Management and costs of paediatric steam inhalation therapy burn injuries. Br J Gen Pract [Internet]. 2016;66(644):e193–9. Available from: http://dx.doi.org/10.3399/bjgp16x684289

[17] Brewster CT, Choong J, Thomas C, Wilson D, Moiemen N. Steam inhalation and paediatric burns during the COVID-19 pandemic. Lancet [Internet]. 2020;395(10238):1690. Available from: http://dx.doi.org/10.1016/S0140-6736(20)31144-2

[18] Debroy S. Burns rose after fake social media messages that steam kills coronavirus. Times of India [Internet]. 2020 Nov 23 [cited 2021 May 1]; Available from: https://timesofindia.indiatimes.com/city/mumbai/burns-cases-rise-due-to-covid-steaming-fad/articleshow/79359662.cms

[19] Kudchadkar SR, Hamrick JT, Mai CL, Berkowitz I, Tunkel D. The heat is on... thermal epiglottitis as a late presentation of airway steam injury. J Emerg Med [Internet]. 2014;46(2):e43-6. Available from: http://dx.doi.org/10.1016/j.jemermed.2013.08.033

[20] Vareille M, Kieninger E, Edwards MR, Regamey N. The airway epithelium: Soldier in the fight against respiratory viruses. Clin Microbiol Rev. 2011;24(3):631–631.

increased risk of invasive viral infections. The temperature-time parameters required to effectively neutralise SARS-CoV-2 are above the limits at which extensive burns and scalds are suffered. As such, hot water consumption and therapeutic steam inhalation in the context of COVID-19 occupy a most unfavourable position in the risk-benefit equation. The recommendation of thermal home remedies to fight SARS-CoV-2 is not supported by evidence; furthermore, by increasing the risks of injury and invasive viral infection, these practices specifically violate the sacred tenet of clinical medicine: 'first, do not harm'.

About the Author

Dr. Changa Kurukularatne is a Specialist in Infectious Diseases, Infection Prevention & Control, and Tropical Medicine. He has practiced medicine in the United States, Singapore and New Zealand over the span of two decades. Dr. Changa has collaborated with the World Health Organisation, the US Centers for Disease Control and Prevention (CDC), the European Centre for Disease Prevention and Control (ECDC), the National Centre for Infectious Diseases (Singapore) and the Regional Emerging Disease Intervention (REDI). Dr. Changa has served as an advisor to several governments, and has contributed his vast experience in outbreak management towards the private sector's COVID-19 response. Dr. Changa is internationally published in a variety of subjects including COVID-19 and dengue fever— two areas where he is considered a global expert. He is the Managing Director of Sarva Medical and Wound Care Clinic (93 Dehiwala Road, Boralesgamuwa, Sri Lanka) which is the culmination of a shared vision for continuing the legacy of the late Dr. K.B.R. Kulapala in establishing a strong General Practice philosophy to serve the primary healthcare needs of a closely knit community. For further information on Dr. Changa Kurukularatne please visit www.linkedin.com/in/drchanga