SMJ Singapore Medical Journal

Full steam ahead or full of steam? Risks and benefits of thermal home remedies in COVID-19

Changa Kurukularatne, MD

Correspondence: Dr Changa Kurukularatne, Managing Director and Head of Infection Prevention and Control, Sarva Medical & Wound Care Clinic, 93 Dehiwala Road, Boralesgamuwa, Sri Lanka. changak.2020@gmail.com

Singapore Med J 2022, 1–9
https://doi.org/10.11622/smedj.2022062
Published ahead of print: 25 May 2022

INTRODUCTION

Thermal home remedies such as hot water consumption and steam inhalation have been widely promoted in social media as effective means of killing SARS-CoV-2, the causative agent of COVID-19,[1,2] and as a means of ending the pandemic by halting the transmission of SARS-CoV-2.[3]

Our aim is to ascertain the risks and benefits of thermal home remedies in the treatment and prevention of COVID-19.

HISTORICAL PERSPECTIVE

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 compounds related to atropine in therapeutic aerosols 3500 years ago.[5] The fundamentals of these concepts remain relevant even today in the treatment of respiratory ailments such as asthma.

ANATOMY AND PHYSIOLOGY

Paranasal sinuses have a smooth respiratory epithelial lining that is contiguous with the nasal cavity.[6] Paranasal sinuses serve to heat and humidify inhaled air, facilitate our upright posture by providing for a lighter cranium, protect our brain and other vital intracranial structures from external trauma through a lattice of air pockets (much like modern-day protective helmets) and facilitate optimal hearing by attenuating bone transmission of vibratory noise.[7] A variety of insults such as dust particles, allergens and viruses increase the viscosity of sinus secretions. Thickened secretions impede mucus flow and cause sinus congestion, thereby increasing the risk

of secondary infections. Thermal home remedies serve to thin the viscous mucus by thermal expansion, which facilitates mucus drainage through the sinus ostia, providing the rationale for symptomatic relief.

THERMAL EFFECTS ON SARS-COV-2 VIRAL FACTORS

The process of SARS-CoV-2 cellular binding to ACE2 receptors and entry into human respiratory epithelial cells takes approximately 96 hours from the time of exposure.[8] SARS-CoV-2 has demonstrated varying conformations of the spike protein receptor-binding domain in low (30°C) and high (70°C) temperatures. At 30°C, the residues on the receptor binding motif assume an exposed, or open, configuration, while at 70°C the motif conforms to a buried, or closed, configuration.[9] 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.[9]

TEMPERATURE-TIME PARAMETERS

Through the analysis of 24 different combinations, the following temperature-time parameters for SARS-CoV-2 thermal inactivation have been obtained:[10]

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

Concurrently, hot water temperature-time correlations in full-thickness (third-degree) burns in children are summarised below:[11]

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

MEDICAL LITERATURE REVIEW

The medical literature on thermal inhalation therapy demonstrates limited evidence in subjective and symptom-based improvement.[12,13] The effects of inhaled steam on viral shedding and titres in nasal washings have been studied through clinical trials. In a randomised, controlled, double blind analysis of patients with the common cold, inhaled air at 43°C versus 30°C failed to demonstrate any difference in the rates of viral shedding.[14] Another randomised, controlled, experimental rhinovirus infection trial measuring viral titres in nasal washings over 4 days of air at 42-44°C versus air at 22-24°C, failed to demonstrate any effect on viral shedding.[15] A 2017 Cochrane review failed to show any benefit (or harm) from the use of heated humidified air delivered through a purpose-built device for the treatment of the common cold.[16]

A single-centre, open-label, prospective study used cycles of steam inhalation aimed at disrupting the SARS-CoV-2 capsid.[17] Steam at temperature 55–65 °C was reported to prevent SARS-CoV-2 infection and replication in the upper airway. However, this study has significant limitations: of the small sample size of 10, only 7 persons (6 with symptoms) successfully completed the study protocol. Only 3 of the 6 symptomatic patients reported clearance of symptoms. Only 5 of 10 persons enrolled achieved the desired outcome of sustained short term PCR negativity by Day 10. Furthermore, all 10 enrolled were either asymptomatic or pauci-symptomatic; those with higher symptom scores were excluded from enrolment. Lastly, steam parameters used in the study - 55-65 °C for 20 minutes - is not compatible with human tissue integrity. Such parameters will cause severe internal and external scalding. The stated steam

temperature was therefore most likely measured at the steam/water interface, and not the steam/body tissue interface, which is the target site of action. This is not clearly stated in the methodology. These limitations preclude the general applicability of the study protocol to prevent SARS-CoV-2 infection and replication.

A SARS-CoV-2 prediction model based on *in-vitro* data described an estimated 3-log reduction in viral titres when exposed to heated air at 45°C.[18] However a continuous exposure time of 1.7 hours (95% confidence interval, 0.6-4.6 hours) was required for the specified viral titre reduction. Although the authors suggest delivering heated air as a viable option for post-exposure prophylaxis, the feasibility of administering a continuous dose of 45°C heated air into the upper airway for 1.7 hours (or 4.6 hours at the upper limit of 95% confidence interval) is wrought with practical challenges. Furthermore, with the worldwide spread of the Delta strain of SARS-CoV-2, estimated to be 40-60% more transmissible and with viral loads 1000-fold higher than in previous strains,[19] defining significant exposure is a challenge in and of itself, let alone instituting a cumbersome post-exposure prophylaxis with hours-long administration of heated air.

RISKS OF THERMAL HOME REMEDIES

The epidermis and dermis - far more resistant to thermal injury than the nasopharynx - completely disintegrate in a matter of seconds at temperatures lower than those required to inactivate SARS-CoV-2 as stated above. 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.[20] These accidents incur significant financial burden on the healthcare system.[21] 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.[22] Two-thirds of such centres noted an association with patients of South Asian ethnicity,[22] 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.[23] 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.[24] In Sri Lanka, a recent news article reported health authorities' observation that 'many people' are presenting to 'several hospitals' with thermal injuries when attempting steam inhalation in the context of COVID-19.[25]

DISCUSSION

The epithelial lining of the airway provides a sophisticated frontline defence system against respiratory viruses. Aside from the physical properties of protective mucociliary 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.[26] 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 increased risk of invasive viral infections. The temperature-time parameters required to effectively neutralise SARS-CoV-2 as quoted in various studies are above the limits where extensive burns and scalds are inflicted. Worldwide reports of accidental burns and scalds related to COVID-19 thermal home remedies therefore come as little surprise.

The use of thermal home remedies to fight SARS-CoV-2 is not conclusively supported by

current evidence. By increasing the risk of injury and invasive viral infections, these practices specifically violate the sacred tenet of clinical medicine: 'first, do not harm'. Accidents related to thermal home remedies are a particularly disturbing trend in children and are typically sustained while being forcibly held down for steam inhalation, by well-meaning albeit stronger adults. While adults may have the wherewithal and reflexes to immediately withdraw from or abort an impending thermal injury, children being held down forcibly to inhale steam are denied this safety option. We conclude, based on available data, that the risks of thermal injury from steam inhalation aimed at treating or preventing COVID-19 far outweigh potential benefits. Immediate, large-scale public health campaigns are therefore necessary to promote awareness of the epidemic of thermal injury occurring within the pandemic of COVID-19.

REFERENCES

1. Rao S. Doctors warn against social media's steam inhalation prescription. The Times of India 2020 Oct 6. Available at: https://timesofindia.indiatimes.com/city/bengaluru/doctors-warn-against-social-medias-steam-inhalation-prescription/articleshow/78687072.cms. Accessed May 3, 2021.
2. AFP Sri Lanka. New hoax shared in Sri Lanka suggests WHO approved water, salt and vinegar remedy for coronavirus. In: AFP Fact Check [online]. Available at: https://factcheck.afp.com/new-hoax-shared-sri-lanka-suggests-who-approved-water-salt-and-vinegar-remedy-coronavirus. Accessed April 30, 2021.
3. Jackson J, Meesaraganda R, Haque S. So much hot air: Twitter and Facebook let quack Covid cures spread unchecked in India [Internet]. The Bureau of Investigative Journalism. 2021. Available at: https://www.thebureauinvestigates.com/stories/2021-06-10/so-much-hot-

air-twitter-and-facebook-let-quack-covid-cures-spread-unchecked-in-india. Accessed May 18, 2022.

4. de Boer AH, Hagedoorn P, Hoppentocht M, et al. Dry powder inhalation: past, present and future. Expert Opin Drug Deliv 2017; 14:499-512.
5. Stein SW, Thiel CG. The history of therapeutic aerosols: a chronological review. J Aerosol Med Pulm Drug Deliv 2017; 30:20-41.
6. Lafci Fahrioglu S, Van Kampen N, Andaloro C. Anatomy, Head and Neck, Sinus Function and Development. Treasure Island, FL: StatPearls Publishing, 2021.
7. Singh A, Meyers AD. Paranasal sinus anatomy. In: Medscape [online]. Available at: https://emedicine.medscape.com/article/1899145-overview. Accessed April 30, 2021.
8. Zhang Y, Geng X, Tan Y, et al. New understanding of the damage of SARS-CoV-2 infection outside the respiratory system. Biomed Pharmacother 2020; 127:110195.
9. 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 2020; 7:583523.
10. Abraham JP, Plourde BD, Cheng L. Using heat to kill SARS-CoV-2. Rev Med Virol 2020; 30:e2115.
11. Pichoff BE, Schydlower M, Stephenson SR. Children at risk for accidental burns from hot tap water. Tex Med 1994; 90:54-8.
12. Ichiba T, Kakiuchi K, Suzuki M, Uchiyama M. Warm steam inhalation before bedtime improved sleep quality in adult men. Evid Based Complement Alternat Med 2019; 2019:2453483.
13. Forstall GJ, Macknin ML, Yen-Lieberman BR, Medendrop SV. Effect of inhaling heated vapor on symptoms of the common cold. JAMA 1994; 271:1109-11.

14. Tyrrell D, Barrow I, Arthur J. Local hyperthermia benefits natural and experimental common colds. BMJ 1989; 298:1280-3.
15. Hendley JO, Abbott RD, Beasley PP, Gwaltney JM Jr. Effect of inhalation of hot humidified air on experimental rhinovirus infection. JAMA 1994; 271:1112-3.
16. Singh M, Singh M, Jaiswal N, Chauhan A. Heated, humidified air for the common cold. Cochrane Database Syst Rev 2017; 8:CD001728.
17. la Marca G, Barp J, Frenos S, et al. Thermal inactivation of SARS COVID-2 virus: are steam inhalations a potential treatment?. Life Sci 2021; 265:118801.
18. Kang D, Ellgen C, Kulstad E. Possible effects of air temperature on COVID-19 disease severity and transmission rates. J Med Virol 2021; 93:5358-66.
19. American Society for Microbiology. How dangerous is the Delta variant (B.1.617.2)? Available at: https://asm.org/Articles/2021/July/How-Dangerous-is-the-Delta-Variant-B-1-617-2. Accessed August 14, 2021.
20. Scarborough A, Scarborough O, Abdi H, Atkins J. Steam inhalation: more harm than good? Perspective from a UK burns centre. Burns 2021; 47:721-7.
21. Al Himdani S, Javed MU, Hughes J, et al. Home remedy or hazard?: management and costs of paediatric steam inhalation therapy burn injuries. Br J Gen Pract 2016; 66:e193-9.
22. Brewster CT, Choong J, Thomas C, Wilson D, Moiemen N. Steam inhalation and paediatric burns during the COVID-19 pandemic. Lancet 2020; 395:1690.
23. Debroy S. Burns rose after fake social media messages that steam kills coronavirus. The Times of India 2020 Nov 23. Available at: https://timesofindia.indiatimes.com/city/mumbai/burns-cases-rise-due-to-covid-steaming-fad/articleshow/79359662.cms. Accessed May 1, 2021.
24. 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 2014; 46:e43-6.

25. Incidents of face burns due to steaming reported from several hospitals. Hiru News 2021 May 24. Available at: https://www.hirunews.lk/english/272277/incidents-of-face-burns-due-to-steaming-reported-from-several-hospitals. Accessed August 11, 2021.

26. Vareille M, Kieninger E, Edwards MR, Regamey N. The airway epithelium: soldier in the fight against respiratory viruses. Clin Microbiol Rev 2011; 24:210-29.