Article ID: WMC005700 ISSN 2046-1690

Personal journey of in-mask nasopharyngeal temperature: Is it time to investigate whether one-year of pandemic mitigation measures has induced nasopharyngeal cellular changes detectable by narrow-band imaging and/or contact endoscopy?

Peer review status:
No

Corresponding Author:
Dr. Deepak Gupta,
Anesthesiologist, Self - United States of America

Submitting Author:
Dr. Deepak Gupta,
Anesthesiologist, Self - United States of America

Article ID: WMC005700

Article Type: My opinion

Submitted on:01-Apr-2021, 11:35:39 PM GMT **Published on:** 06-Apr-2021, 03:19:59 AM GMT

Article URL: http://www.webmedcentral.com/article_view/5700

Subject Categories:OTORHINOLARYNGOLOGY

Keywords:masks, nasopharyngeal temperature, nasopharyngeal cells, narrow-band imaging, contact endoscopy

How to cite the article: Gupta D. Personal journey of in-mask nasopharyngeal temperature: Is it time to investigate whether one-year of pandemic mitigation measures has induced nasopharyngeal cellular changes detectable by narrow-band imaging and/or contact endoscopy?. WebmedCentral OTORHINOLARYNGOLOGY 2021;12(4):WMC005700

Source(s) of Funding:

NOT APPLICABLE

Competing Interests:

NOT APPLICABLE

Personal journey of in-mask nasopharyngeal temperature: Is it time to investigate whether one-year of pandemic mitigation measures has induced nasopharyngeal cellular changes detectable by narrow-band imaging and/or contact endoscopy?

Author(s): Gupta D

My opinion

Unlike rare personalities who are able to do what they say [1], I am just like any other biological/non-biological algorithm-bound living thing who despite beingÂ physically free [2],Â will alwaysÂ be a prisoner of my thoughts. I used to sympathize with those who can't or won't wear masks during pandemic. Now I envy them because it is becoming difficult for me to let go my masks and take them off despite vaccination. I am chained to my thought of masks' potential therapeutic roleÂ secondary to masks creating non-physiological hot andÂ humid micro-environments. For the last one year or so, I have been feeling thatÂ my masks are not just passive bystandersÂ by preventingÂ SARS-CoV-2 infection in me but actively fighting against SARS-CoV-2 by heated humidity in my breathing environment. Moreover, besidesÂ always masked when at work orÂ if out-of-home,Â indoorÂ temperatures at my home haveÂ gotten dialed up from pre-pandemic 68-70 F to 77-78 FÂ since theÂ pandemic to avoid normal vasomotor physiology [3-4] of nose misrepresenting itself as pandemic era pathology. Now the questions arise how, when, and why I may have to let go myÂ hot and humidÂ micro-environmentsÂ in due course of time very soon [5].

The question of how is very simple. I will have toÂ change as perÂ updated guidelines of experts and authoritiesÂ to take my masks off [6]. The question of when isÂ simple too. Once IÂ haveÂ mustered enough courage, I willÂ set myÂ noseÂ free from the shackles of "therapeutic" masks [7]. The question of why is a little complicated as it is mostly unansweredÂ why I started wearing masks despite not liking them and why I have to stop wearing them despiteÂ being afraidÂ to take them off. Some explorative questions may help in allaying my fear to take them off althoughÂ my thoughtÂ about their therapeutic role may remain permanently imprintedÂ on toÂ my core.Â

ShouldÂ the worldÂ explore whetherÂ nose-mouth inhalation-exhalation patternÂ might have beenÂ better than mouth-mouth inhalation-exhalation pattern under the masks to keep nasopharynx cooler with maybe brain cooler too even though it might have been difficult-to-follow tedious, exhausting andÂ noisy nose-mouth inhalation-exhalation pattern day-in-day-outÂ under theÂ flow-resistive masks [8-12] which induceÂ breathing resistanceÂ considering that hotter nasopharynx with mouth-mouth inhalation-exhalation pattern might have been better for potential "therapeutic" role of masks?Â Â

ShouldÂ the worldÂ explore whether in-mask hot and humid micro-environments withÂ mouth-mouth inhalation-exhalation pattern may have correspondingly created hot and humid nasal and nasopharyngeal cavities which being non-physiological for those cavities may have the potential to induce cellular changes therein mimicking theÂ disuse atrophy or otherÂ patterns observed in these cavities among the laryngectomy patients [13] who have almost no air current flowing through their noses?

ShouldÂ the worldÂ explore whether non-physiological hot and humid nasal and nasopharyngeal environments may have forced them to go into overdrive as heat-exchangers with reversal of their role from warming and humidifyingÂ the colder and drier ambientÂ inhalations to potentially cooling and dehumidifying the hotter and wetter in-mask inhalationsÂ considering that absolute/specific humidity under the masksÂ and correspondingly within nasal and nasopharyngeal cavities increase toÂ discomforting supra-normal levelsÂ thus making the physiologically present 100%-saturated relative humidity within the nasopharynx

pathologicallyÂ irrelevant [14-15]?Â

ShouldÂ the worldÂ explore whether non-physiological trapped heat and humidity within the masks and correspondingly withinÂ nasal and nasopharyngeal cavities may lead envisioning the long term effects asÂ cellularÂ changes therein as similar toÂ hot and humid geographical climate related distribution of cellular changes in the nasopharynx especially when there is a discordance between the nasal andÂ nasopharyngealÂ anatomyÂ that had evolved to survive in cold-dry climateÂ and theÂ seasons-pandemics which are forcing thoseÂ evolved populations toÂ liveÂ in hot-humid ambient or in-mask climate [16-18]?

ShouldÂ the worldÂ explore whether hot and humid micro-environment may erroneously feelÂ "soothing"Â toÂ the oral cavity andÂ itsÂ swollen structures like tonsils, if any,Â especially if mouth-mouthÂ inhalation-exhalation pattern may appear warmingÂ butÂ dehumidifying the oralÂ mucosa andÂ the swollenÂ structures therein when mouth tries but fails miserably to mimic nose'sÂ heat-exchanging and humidity-holdingÂ mechanisms as demonstrated by collection of exhaled breath condensate during non-humidity holding oral breathing when compared to humidity-holding nasal breathing [19-27]?

ShouldÂ the worldÂ explore whether hot and humidÂ nasopharyngeal cavities of healthcare workers wearing N95 respirators day-in-day-out during pandemic need to be formally investigated for cellular changes by narrow-band imaging and/or contact endoscopy [28-30] to see if there are any long term cellular consequences of mask-wearing on their nasopharynxÂ because it is not clear whether it is the calculatedÂ changes in diet to avoid high-salty dishes orÂ it is the easedÂ provisions for controlled air-conditioningÂ providing cooler and drier living conditions which have brought downÂ the incidence of nasopharyngeal cellular changes in populations who had been at-risk for nasopharyngeal oncogeny [31-39]?Â

The bottom line is that there is so much which the world needs to explore and document. I am just sharingÂ the changes in my nasopharyngeal temperature. Figure 1 demonstrates my right-sided nasopharyngeal temperature having a roller coaster ride under masks worn in various combinations with head coverings and face shields while a second temperature probe just outside my left nostril keeping a track of the temperature of air being inhaled while wearing or not wearing mask/head covering/face shield.

Vertical Zones within Figure 1 represent what the combination of mask/head covering/face shield was:

Vertical Zone A: No mask/head covering/face shield

Vertical Zone B: Bouffant cap

Vertical Zone C: Bouffant cap + Simple mask

Vertical Zone D: Bouffant cap + N95 respirator

Vertical Zone E: Bouffant cap + N95 respirator + Simple mask

Vertical Zone F: Bouffant cap + N95 respirator + Simple mask + Face shield

Vertical Zone G: No mask/head covering/face shield

Vertical Zone H: Thick woolen hat

Vertical Zone I: Transitioning period

Vertical Zone J: Bouffant cap + Cotton mask + Bandana + Surgical mask + Face shield

Vertical Zone K: Bouffant cap + N95 respirator + Bandana + Surgical mask + Face shield

Vertical Zone L: No mask/head covering/face shield

Vertical Zone M: Thick woolen hat

During vertical zones A-H, only nasal breathing was happening. During vertical zones I-M, only oral breathing was happening.

Few interesting observations were unraveled. Thick woolen hat (vertical zones H and M in Figure 1) and not bouffant cap (vertical zone B in Figure 1) somewhat increased nasopharyngeal temperatures. Irrespective of mask/head covering/face shield, nasopharyngeal temperatures were higher during oral breathing (vertical zones I-M in Figure 1) as compared to during nasal breathing (vertical zones A-H in Figure 1), most likely due to the lost cooling effect of moving air which was not moving across the nasopharynx during oral breathing. Simultaneously, irrespective of mask/head covering/face shield, oral breathing related exhaled breaths seemed to warm the ambient air environment to be inhaled as demonstrated by higher temperatures outside left nostril during oral breathing (vertical zones I-M in Figure 1) as compared to during nasal breathing (vertical zones A-H in Figure 1); this exaggerated warming induced by exhaled breaths exiting mouth seemed to be secondary to the absence of cooling effect of nose on them during oral breathing because the cooling effect of nose during nasal breathing can even try to maintain nasopharyngeal temperatures below in-mask environment temperatures (vertical zones E-F in Figure 1) which can overshoot due to the trapped heat under the masks with/without head covering and/or face shield. It will be interesting to see in future if nasopharyngeal

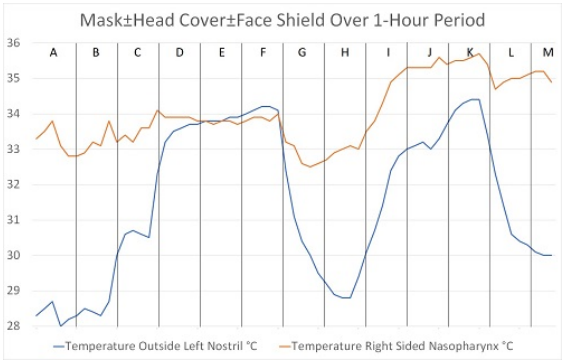
temperatures remain higher and/or increase further when duration of nasal and/or oral breathing is prolonged irrespective of mask/head covering/face shield thereby simulating healthcare workers wearing mask/head covering/face shield for many work-hours per workday because doffing the masks (vertical zones G and L in Figure 1) decreases nasopharyngeal temperatures rapidly although baseline nasopharyngeal temperatures may remain higher during oral breathing (vertical zone L in Figure 1) as compared to during nasal breathing (vertical zone G in Figure 1). Although, during this short duration ~1-hour graphing of nasopharyngeal temperatures at 1-minute intervals in Figure 1 the fluctuations with each breath were not recorded as similar to septal mucosal surface temperature recorded by others [40-41], it appeared that nasopharyngeal temperatures on the temperature monitor screen were fluctuating more often over a range with each breath in the absence of masks but not in the presence of masks making the case for exhaled breathsâ€™ heat trapped under masks reaching an equilibrium under masks thus potentially preventing the nasopharyngeal temperatures to fluctuate with each breath under masks. Similar thoughts can be investigated to make or break the case for more fluctuations in windy cold outdoor environments as compared to controlled temperature indoor climates or during rapid shallow breathing as compared to slow deep breathing (nasopharyngeal temperatures in Figure 1 were graphed with slow deep breathing in indoor environment controlled at 77 F temperature).

Although heat/humidity reducing masks with exhalation valves are no longer recommended to use and heat/humidity adsorbent/absorbent material-based non-valved masks are yet to be developed, the heat trapped under masks is surely raising nasopharyngeal temperature, more so during oral breathing, making the case for a heated microenvironment getting created within nasopharynx while wearing masks with or without wearing head covering and face shield concurrently. Herein, Figure 2 of ~2-hours graphing left nasopharyngeal and right nostril temperature combination demonstrates that nose-nose inhalation-exhalation pattern (rectangular curve A in Figure 2) and nose-mouth inhalation-exhalation pattern (rectangular curve C in Figure 2) ends up with nose reversing its warming the nasal inhalation role during cooler ambient climate to cooling the nasal inhalation role during warmer in-mask climate thus preventing too much rise in nasopharyngeal temperature while mouth-mouth inhalation-exhalation pattern (rectangular curve D in Figure 2) much more than mouth-nose inhalation-exhalation pattern (rectangular curve B in Figure 2) turns up the heat within the nasopharynx in the absence of heat-exchanging nasal inhalations. Interestingly for me, nose-nose inhalation-exhalation pattern has been natural during ambient living condition and mouth-mouth inhalation-exhalation pattern has been essential during in-mask living condition while nose-mouth inhalation-exhalation pattern has been exhausting during in-mask living condition despite being the coolest for nasopharynx and mouth-nose inhalation-exhalation pattern has been unnatural during any living condition.

It will be only time and future biomedical research that may prove or disprove if heated microenvironment in nasopharynx is going to be detrimental to cold viruses like SARS-CoV-2 [42] by inactivating them thus imparting masks a therapeutic role therein because, although it remains to be seen if 100% relative humidity constantly maintained within nasopharynx physiologically [15] means that absolute humidity during hotter nasopharyngeal temperatures will be more than during colder nasopharyngeal temperatures or whether nasal and nasopharyngeal cavities are equally effective in cooling the hotter ambient air as they are in heating the colder ambient air, warm mist inhalation (and NOT cool mist inhalation) that may raise nasopharyngeal temperature to higher level even during nasal breathing (Figure 3 of ~30-minutes graphing left nasopharyngeal and right nostril temperature combination) may not be always possible and certainly not feasible during many work-hours per workday and mouth breathing may not be always feasible or advisable over nasal breathing [43-47]. Hereafter, it will be very futuristic to investigate if there will be a trade off by nasopharyngeal heat inactivating viruses for now vs. nasopharyngeal heat activating oncogeny for later or a win-win by nasopharyngeal heat not only inactivating viruses but also oncogeny as well [48-53].

Fig 1:

Â



Â

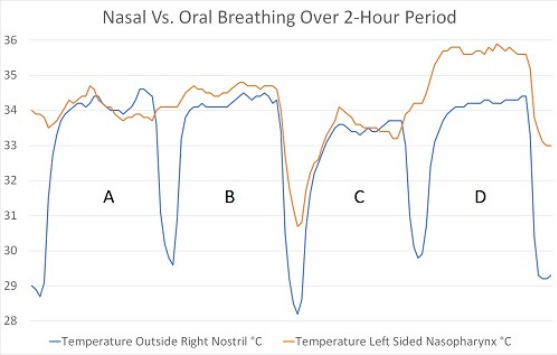
Â

Â

Â

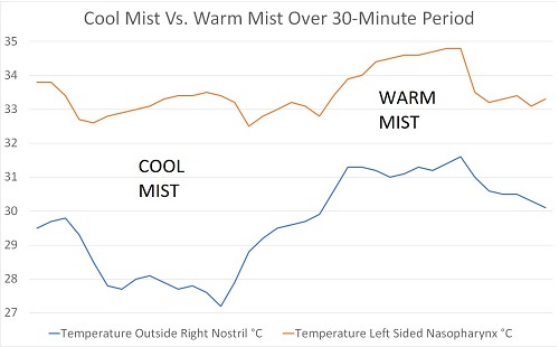
Fig 2:Â

Â



Â

Fig 3:Â



Conclusion

Summarily, while this avenue of heated nasopharynx under masks needs future investigations to validate or refute my personal observations before this avenueâ€™s generalization and applicability to explore potentially therapeutic role of heated nasopharyngeal microenvironment getting created under masks to make or break the case for masks serving as non-pharmacological therapeutic interventions [54] in the short term against cold viruses like SARS-CoV-2, it should NOT be overlooked that nasopharyngeal cells may have to be concurrently investigated for demonstrating the long term effects, if any, of pandemic mitigation measures which have warranted long duration use of non-physiological masks with or without head covering/face shield especially among the healthcare workers at the frontline.Â Â Â Â Â

Reference(s)

1. I Am the Master of My Fate. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3944843/pdf/AC-2003.pdf
2. Are humans the only species to imprison each other for doing wrong? https://www.quora.com/Are-humans-the-only-species-to-imprison-each-other-for-doing-wrong
3. Why does your nose run when it's cold? https://medicine.uq.edu.au/article/2017/10/why-does-your-nose-run-when-its-cold
4. Vasomotor Rhinitis. https://www.ncbi.nlm.nih.gov/books/NBK547704/
5. Pandemic isn't over, but there's hope â€” and confusion. https://www.msn.com/en-us/news/us/pandemic-isnt-over-but-theres-hope-%e2%80%94-and-confusion/ar-BB1eVlLf
6. When Youâ€™ve Been Fully Vaccinated. How to Protect Yourself and Others. https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated.html
7. â€œTherapeuticâ€• facemasks. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7236693/
8. Objective Assessment of Increase in Breathing Resistance of N95 Respirators on Human Subjects. https://academic.oup.com/annweh/article/55/8/917/265317
9. Inspiratory flow rates during hard work when breathing through different respirator inhalation and exhalation resistances. https://pubmed.ncbi.nlm.nih.gov/16857648/
10. Oronasal partitioning of ventilation during exercise in humans. https://pubmed.ncbi.nlm.nih.gov/1938727/
11. Breathing route and ventilatory responses to inspiratory resistive loading in humans. https://pubmed.ncbi.nlm.nih.gov/8087346/
12. Study of respirator effect on nasal-oral flow partition. https://pubmed.ncbi.nlm.nih.gov/9258395/
13. Long-Term Histologic Changes in Nasal Mucosa after Total Laryngectomy. https://www.hindawi.com/journals/ijoto/2010/137128/
14. Absolute humidity and the human nose: A reanalysis of climate zones and their influence on nasal form and function. https://onlinelibrary.wiley.com/doi/abs/10.1002/ajpa.23032
15. A technique to measure the ability of the human nose to warm and humidify air. https://journals.physiology.org/doi/pdf/10.1152/jappl.1999.87.1.400
16. Whence the Chinese? https://taiwantoday.tw/news.php?unit=20,20,29,35,35,45&post=25930
17. [The mongoloid nose] https://pubmed.ncbi.nlm.nih.gov/1718205/

18. Climate-related variation of the human nasal cavity. https://pubmed.ncbi.nlm.nih.gov/21660932/
19. Mouth breathing can affect sleep, tonsils. https://www.theglobeandmail.com/life/health-and-fitness/health/conditions/mouth-breathing-can-affect-sleep-tonsils/article572716/
20. Recurrent tonsillitis and parental perceptions of tonsillectomy during the COVID-19 pandemic. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7583584/
21. Enlarged tonsils and adenoids: Overview. https://www.ncbi.nlm.nih.gov/books/NBK536881/
22. Breathe Through Your Nose (Even While Wearing A Mask). https://www.bradfordfamilydentist.ca/breathe-through-your-nose/
23. The relationship between water vapour saturation of inhaled air and nasal patency. https://erj.ersjournals.com/content/21/2/313
24. Humidity and temperature profile in the nasal cavity. https://europepmc.org/article/med/11190750
25. Air Temp, Moisture Determine How Stuffy Nose Feels. https://www.medpagetoday.org/primarycare/preventivecare/29077?vpass=1
26. Surprising Facts About Your Nose. https://health.clevelandclinic.org/7-surprising-facts-nose/
27. Increased net water loss by oral compared to nasal expiration in healthy subjects. https://pubmed.ncbi.nlm.nih.gov/16550955/
28. Narrow-Band Imaging: A Novel Screening Tool for Early Nasopharyngeal Carcinoma. https://jamanetwork.com/journals/jamaotolaryngology/fullarticle/1106976 Â
29. Contact Endoscopy as a Novel Technique in the Detection and Diagnosis of Mucosal Lesions in the Head and Neck: A Brief Review. https://www.hindawi.com/journals/jo/2011/196302/
30. Surveillance tools for detection of recurrent nasopharyngeal carcinoma: An evidence-based review and recommendations. https://www.sciencedirect.com/science/article/pii/S2095881120301736
31. Hydrogen donors and acceptors and basic amino acids jointly contribute to carcinogenesis. https://pubmed.ncbi.nlm.nih.gov/28012602/
32. Why nasopharyngeal cancer is prevalent in hot and humid areas. https://science.sciencemag.org/content/why-nasopharyngeal-cancer-prevalent-hot-and-humid-areas
33. How Does Specific Humidity Vary Globally and Seasonally? https://geography.name/how-does-specific-humidity-vary-globally-and-seasonally/
34. RE: â€œACTIVE AND PASSIVE SMOKING AND RISK OF NASOPHARYNGEAL CARCINOMA: A POPULATION-BASED CASE-CONTROL STUDY IN SOUTHERN CHINAâ€• https://academic.oup.com/aje/article/187/2/398/4604572
35. Evaluation of non-viral risk factors for nasopharyngeal carcinoma in a high-risk population of Southern China. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4406046/
36. Nasopharyngeal carcinoma in the Northeastern states of India. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4013339/
37. Risk Factors for Nasopharyngeal Cancer. https://www.cancer.org/cancer/nasopharyngeal-cancer/causes-risks-prevention/risk-factors.html
38. Nasopharyngeal Carcinoma (NPC) Risk Factors: A Systematic Review and Meta-Analysis of the Association with Lifestyle, Diets, Socioeconomic and Sociodemographic in Asian Region. http://journal.waocp.org/article_88801.html
39. Non-viral environmental risk factors for nasopharyngeal carcinoma: A systematic review. https://www.sciencedirect.com/science/article/abs/pii/S1044579X12000119
40. Nasal mucosal temperature during respiration. https://onlinelibrary.wiley.com/doi/abs/10.1046/j.1365-2273.2002.00544.x
41. A Numerical Simulation of Intranasal Air Temperature During Inspiration. https://onlinelibrary.wiley.com/doi/abs/10.1097/00005537-200406000-00015
42. Disparate temperature-dependent virus â€“ host dynamics for SARS-CoV-2 and SARS-CoV in the human respiratory epithelium. https://www.biorxiv.org/content/10.1101/2020.04.27.062315v2
43. The right way to breathe during the coronavirus pandemic. https://theconversation.com/the-right-way-to-breathe-during-the-coronavirus-pandemic-140695
44. Study: Nose appears to be better at spreading COVID-19 than mouth. https://www.sentinelsource.com/news/local/study-nose-appears-to-be-better-at-spreading-covid-19-than-mouth/article_ffac5a53-f85f-5449-ae80-be6eae151d22.html
45. Could nasal nitric oxide help to mitigate the severity of COVID-19? https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7200356/
46. Nasal Breathing: Your Secret Weapon Against COVID-19? https://gallery57dental.com/nasal-breathing-your-secret-weapon-against-covid-19/
47. Can Nasal Breathing Help Reduce Your Risk of COVID-19? https://decisionsindentistry.com/2020/06/nasal-breathing-help-reduce-risk-covid/
48. Kangri cancer. https://pubmed.ncbi.nlm.nih.gov/19932909/
49. Mini tumors predict how cancer responds to heat treatment. https://www.news-medical.net/news/20200603/Mini-tumors-predict-how-cancer-responds-to-heat-treatment.aspxÂ
50. Cold environment makes cancer grow and spread faster. https://www.medicalnewstoday.com/articles/269266
51. Chilly temperatures help cancers grow. https://theconversation.com/chilly-temperatures-help-cancers-grow-20386

52. Update: Turning the Heat on Cancer. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2987268/
53. Proteotoxic stress of cancer: implication of the heat-shock response in oncogenesis. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3431153/
54. Does mask use affect the quantitative severe acute respiratory syndrome coronavirus 2 load in the nasopharynx? https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7511154/