A Perspective Study on Oral-Fecal Transmission of COVID-19, its Prevention and Management

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Abstract

The novel coronavirus outbreak arose in Wuhan, China in Dec, 2019. It is declared the 6th public health emergency by the WHO and named as COVID-19. SARS-CoV-2 is non-segmented positive sense ssRNA virus, belongs to the Coronaviridae under the Nidovirales and spread largely in human beings and other mammals. Person to person, airborne and surface transmission is common, the virus gets entered to host through nose, mouth, eyes, food, water and feces. An infected patient can transmit the virus to 2.2 healthy individuals. A patient in the US showed gastrointestinal symptoms vomiting, nausea and passed loose stools. Later the patient declared positive for SARS-CoV-2 based on viral detection in stools and respiratory samples. The gastrointestinal symptoms like diarrhea, nausea, vomiting, abdominal discomfort and detection of SARS-CoV-2 in stools of infected and recovered patients indicates potential oral-fecal transmission route, it could be potential risk for the spread of COVID-19. The flatus is gas produced by aerophagia or bacterial fermentation in intestine and expelled out through esophagus or anus. It consists of Hydrogen, Oxygen, Nitrogen, Carbon dioxide and Methane, their percentage composition is 99%. Previous study showed that bacteria can transmit through bare-bottom farting. The gastrointestinal manifestation and possible oral-fecal transmission, the flatulence could be the risk of transmission for COVID-19. Personal hygiene must be adapted to prevent the spread of disease.

Keywords: Flatulence; Aerophagia; COVID-19; Transmission; SARS-CoV-2; Farting; Management

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Introduction

The novel coronavirus outbreak arose in Wuhan China in Dec 2019. As of April 27, 2020, a total 2.98 million positive cases and 207 thousand deaths have been registered worldwide. The mortality rate of SARS-CoV-2 is less than SARS-CoV and MERS. According to the China CDC, by Feb 16, 2020, there had been 70 641 confirmed cases of COVID-19 and 1772 deaths, with an average mortality rate of about 2-5% [1,2] which is less than mortality rate of the MERS (34.40%) & SARS-CoV (9.19%) [3], figure 1.

Recent studies revealed that respiratory symptoms of COVID-19 including fever cough and dyspnea are like SARS-CoV outbreak and MERS. The frequency of typical gastrointestinal features like vomiting, nausea, diarrhea, and abdominal aches significantly differs between distinct studied populations, however these symptoms are mild and followed by more severe respiratory signs and symptoms [4]. Evidences are there from past studies of SARS indicating the gastrointestinal tropism of SARS-CoV was confirmed by viral presence in stools and biopsy of infected and recovered individuals, may give partial explanation for the

Figure 1. Mortality rate of SARS-CoV-1, SARS-CoV-2 and MERS coronavirus

gastrointestinal manifestation and dissemination of SARS [5]. It was confirmed by the 2-day history of a patient in the US, at the time of admission vomiting and nausea were reported, and on the second day he passed a loose stool in hospital. Later the patient declared positive of SARS-CoV-2 on the basis of viral detection in stools and respiratory specimens [6]. 2019-nCoV nucleic acids were also detected in salivary samples of diseased individuals rather than aspirate from naso-pharynx, later the decline viral abundance was also reported in saliva after attending hospital [7].

Taking into consideration a number of growing clinical evidences revealed that digestive system may assist as a substitute way for infection in individuals in proximity with untamed and suffered animals. However, the individuals with mild symptoms or asymptomatic have been ignored in former studies. So doctors should take care and investigate the individuals with mild and primarily gastrointestinal manifestations and note the time span of infection to late viral transformation. The cases of severe acute respiratory syndrome are increasing day by day and the whole world is confronting the pandemic Covid-19. Shown in **figure 2**.

2. Transmission

As the first case reported was in Wuhan China so it is said that this virus came from Hunan Seafood Wholesale Market situated in Wuhan, but there is still no evidence. Human to human transmission is common as according to the CDC and WHO, it was obvious that close contact is the major facilitator to transmit COVID-19 infection. The virus travels up to one metre in the air and contracted by the person who is in close proximity to the infected person. From the analysis of the investigations and research conducted by the China CDC, the incubation period could be 3 to 7 days or may be up to 2 weeks [5]. It was also concluded from the data that within every seven days this novel SARS-CoV-2 doubles its progeny and the reproduction number is R_0 is 2.2, simply each patient can transmit the infection to an extra 2.2 individuals shown in figure 3. On the other hand, if we compare SARS-CoV with SARS-CoV-2 the Reproduction rate of the SARS-CoV epidemic were approximately 3 in 2002-2003 [8].

3. Person to Person Transmission

Experts believe that all routes of transmission for CoVID-19 are possible but in novel coronavirus the person to person transmission is very common [9]. This can happen in many ways: when an infected person with corona virus coughs, talks or sneezes in a close proximity with healthy individuals of about 6 feet distance [10]. The healthy one gets the virus into his lungs by nose or mouth and gets infected. Recent studies revealed that nCoV-19 can live in the air for up to 3 hours [11]. This virus floating in the air and contaminates the air for healthy individuals. Another way of transmission is surface transmission in which a patient coughs or sneezes on. The virus can live on plastic and stainless-steel surfaces for up to 2-3 days.

4. Oral-Fecal Transmission

Studies also suggest that the fecal-oral route could be a potential route of transmission. The virus has been detected in stools of infected patients [12]. Attending a washroom without hand washing spreads the virus. Symptomatic patients often spread the virus. But asymptomatic cases are alarming due to no sign of symptoms and act as a free vector, they don't know

Figure 2. As of March 30, 2020. These are the top 14 Countries of the world having highest number of confirmed cases.

How a virus with a reproduction number (R_0) of 2 spreads

Figure 3. Reproduction number and transfer rate of COVID-19
(Source: <https://ivoryembassy.com/blog/r0-of-covid-19>)

they've been infected and pass the virus to others easily [13]. Pre-symptomatic spread passes virus to others before noticing any signs and symptoms of infection. Community spread is also common in which persons didn't know from where and whom they were infected [14].

5. Flatulence

State of being flatulent is called Flatulence. Medically gas generated in the stomach or in large and small bowels is termed as Flatus [15]. These are the gases generated in intestine due to digestive problems or inhaled air during eating food, thus Flatus is not totally produced in the stomach or GI tract but a proportion of environmental air oxygen and nitrogen may be swallowed can cause intestinal gas [16]. Volume or frequency of flatus differs between individuals, but it's common to pass flatus and the feculent odor is normal for intestinal gas [17]. By the pressure of muscular layer surrounding the intestine the Flatus is brought to the rectum to be expelled out. The blowing noise of flatulence is created by the anal aperture and buttocks acting together in a manner similar to wind instrument (embouchure) that produce sound. The sound and the odor both are considered root of shame, anger or comedy [18]. Common symptoms linked to intestinal gas, the primary symptoms linked to intestinal gas are; aches in the anal and area around abdomen, a bloated feeling and abdominal discomfort, excessive flatus volume and smell, lack of voluntary control over gas. Moreover, sometimes belching or eructation (act of air expelling from the stomach via mouth) also known as burping is considered as flatulence [19]. Furthermore, in health disorders like lactose intolerance, irritable bowel syndrome and celiac disease, the excessive flatus can be a sign [20].

6. Mechanism of Production of Flatus

Bacterial fermentation in the gastrointestinal tract is the main production source of flatus, released as a byproduct especially during the fermentation occurring in colon [21]. There are rare

Table 1. Composition of Flatus

Oxygen	99%	Aerophagia, diffusion from blood	74 %
Nitrogen		Aerophagia, diffusion from blood	
Hydrogen		Bacterial fermentation in large intestine	
Carbon dioxide		Diffusion from blood, Bacterial fermentation (large intestine), Gastric acid plus food, saliva, or bicarbonate	25%
Methane		Bacterial fermentation (large intestine)	

reports of aerophagia causing intestinal gas [22]. The following four events are responsible for the production of naturally occurring gas in gastrointestinal tract. Aerophagia, Gastric acid interaction with alkaline food, pancreatic bicarbonate and saliva, Diffusion of Oxygen, carbon dioxide and nitrogen from blood, Bacterial metabolism, and fermentation process. The produced Gases are removed by either diffusion into blood and consumed by bacteria or expelled out through esophagus or anus. Primarily aerophagia is considered for gas production in GI tract during meal environmental air is swallowed [23]. UCT (ultrafast computed tomography) in humans revealed that 17 ml of air gets swallowed with drinking 10 ml of water [24]. Every day large amount of air reaches to the stomach with given food (solid or liquid) that is taken into the mouth all day. The N_2 component of swallowed air is then passed through rectum, if not belched [25].

Vigorous exercise and rapid eating habit increase the risk of aerophagia however some air also ingests with the propulsions of bolus through pharynx. Within 15 to 35 minutes flatus is produced in the stomach by aerophagia [25]. Gases can travel at velocity or speed of up to 10 cm/sec through the gastrointestinal tract however the intestinal transit time is longer for liquids and solids compared to gasses. Production of CO_2 occurs in the stomach by the interaction of HCL with alkaline food, saliva and bicarbonates present in pancreatic juice. Swallowed air plus variable quantities of CO_2 constitute belched air however bacterial fermentation can also produce large amounts of gas in the colon. Fiber, poorly digestible protein, carbohydrates, mucin, bile acids are the substrates for bacterial fermentation to produce gas. Non-digestible oligosaccharides raffinose, stachyose, verbacose are more likely to generate more gas in the intestine [26]. Composition of flatus consists of gasses over 99% of the whole composition including hydrogen, oxygen, nitrogen, carbon dioxide and methane gas, these gasses are non-smelly in nature [27]. Patients with problems of intense intestinal gas mainly consists of N_2 [28]. Nitrogen and oxygen are not produced in the GI tract but it is from environmental air. H_2 , CO_2 and CH_4 are generated in the bowel and constitute 74% of the whole volume of flatus (28) and 25% O_2 and N_2 as shown in table 1. Flatus contains proper amounts of methane and hydrogen because of their flammable nature [29]. But not all humans produce methane

containing flatus. For example, Miller et al, conducted study on 9 feces samples only 5 of them having archaea which is capable of generating CH₄ gas [30]. As Archaea oxidizing hydrogen into methane gas can enhance the metabolic capability to absorb fatty acids from food, thus presence of methane in human farts may correlate with obesity [26].

The noxious smell of flatus in humans and animals strongly correlates with H₂S concentration [25]. The trace compounds present in amount less than 1% gives smell to flatus. Ammonia, indole, skatole and short chain fatty acids cause smell similar to flatus. Volatile sulfur compounds are the main contributor to the smell [26]. Methanethiol, hydrogen sulfide, dimethyl sulfide, di and trisulfide are found in flatus. Smell of volatile indole and skatol are noxious but do not contribute to flatus smell.

It is revealed by Levitt et al study that H₂S, methyl mercaptan and dimethyl sulfide concentration have correlation with perceived bad smell of flatus respectively, subjecting pinto beans as a diet to stimulate flatus production [31]. It is also reported that methanethiol is the contributor to the flatus smell in those patients whose specific diet is not altered [32]. It has now been revealed that methanethiol and H₂S, are present in human flatus in concentrations above thresholds which increase the noxiousity in smell [33]. Such smell can also be caused by bacterial micro flora in feces through fermentation in rectal canal. Sulfur containing amino acids increases the smell of flatus significantly.

7. Does Flatulence present any Risk of Transmission for COVID-19?

Recently on Friday, 17th April, Dr. Norman Swan stated that bare-bottom farting should be avoided near each other as it could potentially spread the virus, he told in a live podcast "Coronacast". Dr. Andy Tagg tweeted a related question "can the bottom-based emissions of someone with coronavirus be silent and deadly?" subject to farts as a risk of transmission for COVID-19. A hot discussion started on it and Tagg gave information about GI tract and flatulence. Tagg concluded that the SARS-CoV-2 could potentially spread through farts. He linked his conclusion with the Tang et al study that showed SARS-CoV-2 virus can be spread through feces and it has been detected in asymptomatic patients up to 17 days past the point of exposure [33]. A well-known epidemiologist Dr. Aaron E. Glatt wrote an email to The New York Post stating that studies revealed that there is a significant percentage of covid-19 patients who have gastrointestinal symptoms [34]. So, farts could transmit it but there is no published data on it to confirm. However, among different study populations the incidence of nausea, diarrhea, vomiting and other abdominal discomforts varies significantly with early mild onset of respiratory symptoms [35]. Former studies of SARS-CoV indicated and verified viral detection in biopsy and stools specimen even in discharged patients [36] which may provide partial explanation that the virus exists in stools and could be transmitted through flatulence. Recently two Chinese laboratories reported live SARS-CoV-2 in stools samples of infected patients.

Dr Karl Kruszelnicki designed his experiment to know whether the farting can contaminate the sterilized environment of operation theatres or not. For this he contacted to a microbiologist Mr. Luke Tennent and set up an experiment. He took two petri dishes and

Figure 4. Dr karl's experiment designed for to check whether bare-bottom farting transmits microbes or not

asked his colleague to break out wind directly into petri dishes keeping at a 5 centimeters distance, first fully clothed and then with his trousers down. He keeps the petri dishes overnight in an incubator. The observation was shocking, the flatus that were directly passed to the petri dishes with trousers down, sprouted two types of bacteria one from the gut and the other from the skin. No growth was observed in the petri dish that was exposed to flatus wearing trousers. He concluded that wearing trousers acted as a filter that is why there is no growth observed in the second petri plate. He further deducted that enteric zone observed in the first Petri dish was due to the direct flatus, the fart blew some normal micro flora of buttocks skin blasted into the petri dish. Further study revealed the observed bacteria were not harmful. So therefore, it seems, that flatus may cause infection if the emitter is infected and naked, but not if he or she is clothed. Shown in figure 4.

Medical and health related professionals are cautioned about the new and interesting information to take it as a fact and evidence. While it is not something to believe so quickly but it needs some solid research to confirm farting as a risk for transmission of COVID-19. Regardless of the information whether farting is a risk for transmission of COVID-19, as the viral detection in feces is confirmed so there is a possibility that farting could be a risk for transmission.

In light of the above discussion, we all need good bathroom hygiene. The CDC reminds us that infectious diseases may spread in many ways, such as through mouth, nose, eyes, food, water, broken skin, genital fluids, sexual contact and even through feces.

8. Prevention and Management

1. Social distancing is the best way to slow down the spread of COVID-19. There are a few ways to do it [37].

2. Avoid travel, do not get out of your home unnecessarily, if going then wear a mask and keep 6 feet distance from others.
3. Avoid working in organization or company and if possible, work from home.
4. Avoid physical contact or visits with friends and family and use phone for communication [38].
5. Make a habit of washing your hands before and after the meal for 20 sec with soap, take great care of washing your hands after attending toilet.
6. Avoid unnecessary shopping, groceries or drugs and other daily usage things should be ordered online.
7. Avoid close contact with pets, their waste and toys they touched.
8. Don't share your personal items like towels, utensils etc.
9. Clean and disinfect the surfaces frequently like phone, tables, doorknobs etc.
10. The infected people must self-quarantine in a separate room to stop the spread of coronavirus to healthy individuals.
11. Gastrointestinal symptoms in COVID-19 infection such as diarrhea could be treated by available medicine used for it.
12. Bare-bottom farting should be avoided in proximity with others in case of infection. So far, there is no vaccine for prevention of COVID-19, but some potential vaccines are being tested or under trial [39] as shown in table 2. These vaccines will be available soon to treat or prevent COVID-19 pandemic. Some experimental drugs are also being tested such as chloroquine and hydroxychloroquine [40]. Convalescent sera are the current available best options as there is no vaccine so far [41]. If the situation worsens call the doctor. Many countries around the world have limited large gatherings by closing markets, shopping malls, schools, universities, restaurants, and theaters [42]. These measures might be extreme. But according to health professionals it is the only way to slow down the spread of COVID-19.

As of yet there are no vaccines, but hopes are alive. Prevention is better than cure. We have only this option. By taking precautionary measures we can compete with COVID-19.

9. Conclusion

Diarrhea, vomiting and abdominal discomfort are frequent symptoms in patients infected with SARS-CoV-2. Increasing evidences and the detection of viral sequences in stools and gastrointestinal manifestations indicating the possible oral-fecal transmission and this route of transmission could be a potential risk. Asymptomatic spread is more alarming. Proper care is

needed. An infected person can transmit infection to 2 healthy individuals. Bacteria spreads through bare-bottom farting so the virus could also. Close contact with feces of humans and animals and bare-bottom farting should be avoided. To minimize the oral-fecal transmission hands must be washed before and after attending toilet with soap for 20 sec. Moreover, the virus can live for hours on surface proper disinfection and prevention must be adapted. Keep social distancing and stay home, stay safe.

Declarations of interest

The authors declare no conflicts of interest.

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Table 2. Composition of Flatus

Vaccine	Phase
DNA	Phase II
Viral vector	Phase I
Subunit	Preclinical stage
Inactivated	Preclinical stage
Live-attenuated virus	Preclinical stage
Virus-like particles	Preclinical stage

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