COVID-19-like illness in Mojiang miners (2012) and the mine could provide important clues to the origin of SARS-CoV-2

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Running Title: Links of Mojiang mineshaft pneumonia to COVID-19

One line summary: COVID-19-like illness in Mojiang miners and the mine could provide an important link to the origin of SARS-CoV-2.

(Manuscript in review)

Abstract

There is currently a lack of information regarding the precise origin of the SARS-CoV-2 virus. The nearest genomic relative to SARS-CoV-2 was reported in February to be a bat virus RaTG13. The sequence RaTG13 (CoV/4991) is in fact derived from a sample originally collected from a mineshaft in Mojiang, Yunnan in July 2013. The reason for the coronavirus surveillance in this bat population was an outbreak of lethal pneumonia in six miners in 2012. Three of the miners succumbed to the infection. A medical student's Masters thesis from Kunming Medical University describes clearly the miners' conditions, the details of which upon review show a striking resemblance to COVID-19. The similarities were in terms of bilateral pneumonia, thrombotic complications, and secondary infections. The treatment was a combination of antivirals, steroids, anti-thrombotic, and antibiotics are similar to what is given for COVID-19. This thesis also confirms that samples from these miners were sent to WIV. However, no report of any viruses recovered from these miners exists. This single mine was visited multiple times between 2012 and 2013 by researchers representing three institutes and the bat virus samples were collected and used for at least eight reports. The similarities between the 2012 illness in Mojiang miners and COVID-19, the subsequent sampling of the bats by various labs, and finding the SARS-CoV-2 nearest relative from this single mine in Mojiang warrants further investigation into the full history of this incident.

Key Words: Mojiang mineshaft; pneumonia; miners; COVID-19; SARS-CoV-2; origin; ancestor

The Nature and Impact of the COVID-19 Pandemic

COVID-19 is a contagious respiratory illness that emerged in late 2019 in Wuhan, a city of 10 million inhabitants located in the Hubei Province of central China. It became an epidemic there, leading to a public health emergency. It soon turned into a global pandemic affecting more than 23 million people with a death toll of 0.8 million affecting 188 countries and territories.

The closest kin of SARS-CoV-2 is RaTG13, is the same virus referred as CoV/4991

The causative agent for COVID-19 is a novel coronavirus (CoV) designated SARS-CoV2 [1] in recognition of its phylogenetic relationship to SARS, another CoV which caused a smaller-scale pandemic of respiratory disease in the 2002-2003 timeframe. Phylogenetic analysis places SARS-CoV-2 within the clade of SARS-like CoV at the whole-genome level [1; 2]. The publication by Wuhan Institute of Virology (WIV) which first described SARS-CoV-2 mentioned that the closest relative of it was a betacoronavirus derived from a bat fecal swab, named as RaTG13 (MN996532.1), showing 96.2% nucleotide identity to SARS-CoV-2 [1]. RaTG13 was mentioned to be collected from *Rhinoplohus affinis*, an intermediate horseshoe bat from the Yunnan province. The horseshoe bats usually inhabit the Yunnan Province in China's southern sub-tropical zone [3]. Although the WIV publication described RaTG13 as the closest relative of SARS-CoV-2, a paper by another lab from Wuhan published during the same time (2/3rd February) [2], stated that the RdRp region of SARS-CoV2 showed 98.7% similarity to a beta coronavirus named as CoV/4991 (KP876546). After blast analysis, we found that the 370 bases RdRp region of CoV/4991 and RaTG13 were the same. Also, there were other preprints e.g. [4] which reflected that the scientific community largely questioned that RaTG13 and CoV/4991 represented the same virus or sample [5]. On 24th July 2020, in a recent question and answer article, the principal bat coronavirus scientist from WIV, Zheng-Li Shi clarified that RaTG13 and CoV/4991 indeed represented the same fecal swab collected from a mineshaft in Tongguan, Mojiang, Yunnan [6].

RaTG13 (CoV/4991) recovered during surveillance of bat coronaviruses in Mojiang mineshaft where lethal pneumonia cases occurred

After finding out that RaTG13 and CoV/4991 might represent the same sample, it was noted that CoV/4991 was a betacoronavirus from a bat fecal sample from an abandoned mineshaft in Yunnan[7]. As per the reference for CoV/4991 [7], surveillance of the bat coronaviruses was conducted in 2012-2013, in an abandoned mineshaft in Mojiang, Yunnan province, China by Zheng-Li Shi and her coworkers. In total, four trips were done over a year (2012-2013), and 150 alphacoronaviruses and only two betacoronaviruses, of which only one SARS-related Lineage B coronavirus (CoV/4991) were detected from a 2013 sample [7]. A high prevalence of coronaviruses was found in the mineshaft and also higher numbers of the horseshoe bats were observed. Though this study [7] is interesting with respect to the coronavirus diversity and prevalence it does not mention the reason why this longitudinal surveillance was conducted. During the interview of Zheng-Li Shi by Jane Qiu published in Scientific American, [3] a mineshaft in Yunnan was mentioned in the context of fatal pneumonia which affected six mine workers of which three died. Zheng-Li Shi also mentioned that they were asked to do surveillance in a mineshaft in Mojiang and found a high prevalence of coronaviruses in the bat species studied there. A Science article also described this incident about pneumonia in miners which was caused by probably an unknown virus [8].

Lethal pneumonia occurred in miners working in the Mojiang mineshaft (2012)

A lethal pneumonia-like illness occurred in six miners who were cleaning the bat feces from a copper mineshaft in Mojiang, Yunnan, in 2012 [3; 8]. Three of the miners died due to pneumonia and complications and three survived. In a preprint published on 20th May 2020, we documented the link that the same mineshaft in Mojiang, Yunnan which was surveyed for bat coronaviruses [7] was linked to the fatal pneumonia cases in six miners https://www.preprints.org/manuscript/202005.0322/v1.

However, there was a complete lack of any scientific publications or articles which mentioned the pneumonia cases in detail. No publications by WIV commented on the pneumonia cases and their link to the surveillance carried out. We obtained a Master's thesis that described the miners pneumonia cases in detail [9].

The Master's thesis [9] was the result of the study done by a medical college student, Li Xu, who studied the pneumonia cases in the six miners. His study was done in the Emergency Department, The first affiliated hospital of Kunming, Kunming Medical University, China where the six miners were admitted, and the thesis was submitted to Kunming Medical University in May 2013. The original thesis is in Chinese [9] and was translated using google translation. During the submission of our paper, we found that https://bioscienceresource.org/ did a professional translation of the thesis which is now available online (https://www.documentcloud.org/documents/6981198-Analysis-of-Six-Patients-With-Unknown-Viruses.html).

As per the details mentioned in the thesis [9] and in the news in Science [8], in April 2012, a total of six mine workers started working in a mineshaft situated in Tongguan, Mojiang, Yunnan Province in China. The six mineworkers were employed to clear the slag from a copper mine shaft which was full of bat feces and waste. After working for a few days (4-14), each of them started facing breathing problems, cough, and fever which lead to severe respiratory issues and severe pneumonia [8]. All the patients were admitted to the hospital in Kunming during the period of late April and early May [9]. The mineworkers suffered from severe pneumonia, breathing difficulties, and high fever in most of the cases. Three miners died and the rest three survived. We mentioned the major details of the miners illness in our updated preprint [5]. The illness in the miners was unlike any other diseases with symptoms of primarily pneumonia (which was later found to be of a viral origin), severe breathing difficulties, fever, thromboembolism (in some cases) accompanied by secondary bacterial and fungal

infections. The details of the pneumonia cases concerning the admission of the patients, their hospital stay, and the outcome of the disease (death or recovery) are summarized in Table 1 as given in [9]. The keywords mentioned in the thesis are: severe pneumonia, SARS-like coronaviruses and bats, making it clear that the pneumonia cases were related to SARS-like coronaviruses from bats. The details of the course of illness and diagnosis for individual patients is summarized in **Supplementary Information**.

Supplementary Information

Details of the lethal pneumonia illness in the six Mojiang miners

1. The **first patient**, 63 years old, was exposed to the mine for 14 days. During admission to the hospital, he reported having signs of fever, cough, dyspnea, chest pain, and hiccups for more than 10 days. The illness progressively developed and he showed an increasing tendency of fever with a decline in lymphocytes. The condition worsened and the patient died after 12 days of admission. This patient was the oldest of all and had a tumor history (co-morbidity). The discharge (death) diagnosis was: severe pneumonia, sepsis, septic shock, abdominal infection, and cardiac arrest.

2. The **second patient**, aged 42 years, worked for 14 days in the mine. He was admitted to the hospital after cough and fever for ~15 days. He reported that he was also exposed to a lot of bat waste. The CT scans showed severe pneumonia in both the lungs. The condition worsened and after ~40 days the heart showed poor outline and indications of deep vein thrombosis. During the disease, the patient's lymphocytes decreased suggesting his immune function was impaired. He also had chronic Hepatitis B infection (co-morbidity). The arterial blood gas analysis suggested that he has persistent respiratory failure and poor oxygenation. The patient died after 48 days in the hospital and the diagnosis on discharge was respiratory and cardiac arrest, severe pneumonia, respiratory failure, sepsis, and death.

3. The **third patient** was 45 years old, male, and worked for 14 days in the mine. After 10 days he developed a cough, chest tightness, and shortness of breath with fever and sore limbs and headache. A remote video consultation by the famous doctor, Dr. Zhong Nanshan, the most expert doctor in China for SARS and Covid-19 was provided after ~52 days. Dr. Nanshan diagnosed the patient to have interstitial pneumonia (primarily of viral origin), a possibility of secondary infection (invasive pulmonary aspergillosis), and ordered to do a swab testing and SARS antibody testing (to be carried in Wuhan Institute of Virology). Also, he asked to confirm with the Kunming Institute of Zoology for confirmation of the type of the bat. He died after 109 days after admission to the hospital and treatment. In the case of patient 3, the discharge diagnosis after his death was: severe pneumonia; multiple organ failure; aspiration lung injury; acute respiratory distress syndrome (ARDS), interstitial pneumonia (highly viral probabilities); invasive pulmonary aspergillosis (secondary) followed by death.

4. Patient 4, aged 46 years worked for 14 days in the mine after which he developed a cough, sputum, and fever. In the CT scans, he showed bilateral interstitial pneumonia of severe kind. There were multiple ground glass exudates in both lungs, the lower lungs showed consolidation and a small number of pleural effusions on both sides. Similar to patient 3, this patient also received remote video consultation by Dr. Zhong Nanshan. He diagnosed him with interstitial pneumonia (viral possibility high) and invasive aspergillosis (secondary). The day after the antithrombotic treatment with warfarin, the patient's respiratory function was significantly improved, indicating that anticoagulation and antithrombotic treatment have an effect. Since the viral pneumonia was diagnosed and the patients had worked in the environment of bat feces, it was suggested to determine the bat types, pharyngeal dipstick or swab test, and SARS antibody test, by Dr. Nanshan. After struggling for 107 days as per the thesis actual for 137 days, and receiving a prolonged treatment he was discharged live.

5 and 6. Patients 5 and 6: These patients were relatively young (32/33 years) and exposed to the mine only for a short time (4/5 days). After admission, patients 5 and 6 were given antibiotics, anti-inflammatory, and anti-viral treatment. Patient 6 was not given antifungal drugs and still, the condition improved. Therefore, it was concluded that the initial onset of the disease was very unlikely to be caused by a fungal infection. Both of the patients were discharged after 24/26 days (Table 1).

Summary of lethal pneumonia and illness in the Mojiang miners [9]:

The main clinical symptoms of the six patients were cough and fever, and the main accompanying symptoms were dyspnoea, aching limbs, sputum/bloody sputum, and headache. They showed interstitial pneumonia, fever, difficulty breathing, and required a mechanical ventilator in many cases. Some patients (1,2 and 4) showed clotting complications such as pulmonary thromboembolism and all showed elevated D-dimer values. The radiological findings according to the CT scans were: diffuse ground-glass opacities, areas of peripheral consolidation. In the Master's thesis, it has been clearly concluded that the pneumonia cases were due to viral pneumonia, primarily from SARS-like coronaviruses originating from horseshoe bats. The percentage of lymphocytes, T, B, and NK cells decreased significantly after the admission of the patients, which indicated that the immune system of the patients was seriously damaged by a viral infection and multiple opportunistic infections had occurred. The longer the patient worked in the mine, the higher the mortality rate. The age of the patient and co-morbidities resulted in complications and death (patients 1 and 2). The prognosis was, shorter the working time and the younger the age, the better the prognosis and the shorter the hospitalization time. Dr. Zhong Nanshan, the most famous doctor who was the face of China during the SARS epidemic and national advisor during COVID-19, had provided remote consultation for patients 3 and 4, the most serious patients. The diagnosis he provided for patients 3 and 4 was: interstitial pneumonia (primarily of viral origin), a possibility of secondary infection (invasive

pulmonary aspergillosis). He had ordered to do a swab testing and SARS antibody testing (to be carried in Wuhan Institute of Virology). Also, he asked to confirm with the Kunming Institute of Zoology for confirmation of the type of the bat. His opinion that Mojiang miners pneumonia could be primarily viral probably due to bat-related coronaviruses was very valuable for this incident. Later, after the consultation of Dr. Zhong Nanshan, the WIV tested the serum (IgM) antibodies (probably for SARS-like CoV) of the patients, which were positive, indicating the existence of SARS-like infection. Additionally, positive IgG antibodies (for SARS-like CoV) were tested in WIV and detected in 4 of the 4 patients tested (probably the last four patients as two died earlier) as reported in Chapter 3 of a Ph.D. thesis [10]. Chapter 3 of the Ph.D. thesis by Canping Huang highlights the miners case [10] and the translation is provided as Supplementary material. The Master thesis, Ph.D. thesis, and [7], all report the dominance of Chinese horseshoe bats (*Rhinolophus sinicus* and *Rhinolophus affinis*)in the mine. Also, Kunming Institute of Zoology confirmed that the six patients were exposed to Chinese horseshoe bats (*Rhinolophus* species). *Rhinolophus* species harbor SARS-like coronaviruses [11]. The blood work indicated elevated markers such as Serum Amyloid A (SAA) with a normal range of PCT (procalcitonin), which suggested that the six patients had a viral infection. The treatment given to the pneumonia patients included antivirals (ganciclovir, acyclovir injections), steroids (methylprednisone), antibiotics (meropenem, vancomycin, etc.), antifungals (caspofungin, fluconazole) and anti-thrombotic medicines (warfarin, low molecular weight heparin).

Mojiang miners pneumonia and illness resembles COVID-19

The Master thesis concluded that a SARS-like coronavirus (unknown) originating from horseshoe bats was the causative agent of lethal pneumonia and illness in the miners

Various symptoms of COVID-19 started becoming clear by the end of January [12]. However, the additional symptoms, secondary infections [13], clotting, and distinct laboratory markers like elevated D-dimers [12], SAA, etc. were clear later after February. The retrospective analysis of pneumonia

illness in miners (2012) showed a strong resemblance with COVID-19 and is given further and summarized (Table 2).

1. Clinical symptoms

Common symptoms seen in the Mojiang miners pneumonia: Cough, fever, fatigue, sore limbs (in all except one), sputum, and severe pneumonia. In some patients, bloody sputum, headache, and chest pain were seen [9].

Common symptoms seen in COVID-19: The most common symptoms of COVID-19 are the same: fever, cough, and tiredness. Other symptoms that are less common and may affect some patients include aches and pains, nasal congestion, diarrhea, headache, conjunctivitis, etc. (as per the WHO).

2. **Age and co-morbidities** increased the complications and resulted in death, in both the Mojiang miners pneumonia cases (though the patient number is small) and COVID-19.

3. The radiological picture seen in the CT scans of COVID-19 patients [14] and miners cases [9] is very similar which includes ground-glass opacities, peripheral consolidation, and clear indications of bilateral pneumonia.

4. **Blood clotting and pulmonary thromboembolism**, a complication seen in COVID-19 were also found in three of the six miners in 2012 [9]. The use of heparin, warfarin, and anticlotting drugs was successful in treating the respiratory condition in the 4^{th} miner. In the case of COVID-19, pulmonary thromboembolism and blood clotting have been a serious complication. Anti-thrombotic medicines or blood thinners are given in COVID-19 to treat thrombotic complications such as pulmonary thromboembolism.

5. **Lymphocytopenia**, i.e. low lymphocyte counts is another common feature in both, the miners pneumonia cases and Covid-19. Especially the T cell depletion is a common feature observed in both the diseases.

6**. The similarity in treatments:** Treatment given to the miners were: antivirals, steroids, mechanical ventilation, antibiotics (for treating the secondary bacterial infections) and antifungals (for treating the secondary fungal infections). Also, anti-thrombotic agents like warfarin, heparin were given in case of patient 4 who successfully recovered. Very similar treatment is given for COVID-19 where an array of antivirals, steroids, blood thinners, antibiotics, and antifungals are given (in conjunction with the secondary infections).

7. Secondary infections: In the case of the miners pneumonia illness, most of the patients had secondary infections due to bacteria (*Acinetobacter baumannii*, *Klebsiella pneumoniae*) or secondary aspergillosis [9]. This scenario is very similar to COVID-19 where secondary bacterial infections due to similar organisms [13] and aspergillosis infections are commonly being observed [15].

8. **Elevated SAA values**: The Mojiang miners pneumonia cases showed that the serum amyloid A protein (SAA) was elevated in the case of the first 4 patients and showed very high values (~198-400 mg/L) just after admission. These values are exceptionally high and show poor prognosis if considered to be similar to COVID-19 [16]. The SAA protein is characteristically elevated in the case of COVID-19 patients showing poor prognosis and is used as a marker for the declining condition [16].

9. **Different nature to SARS1**: In the case of SARS1, mostly unilateral pneumonia is seen in the CT scans [17]. In contrast to that, both pneumonia illness in miners and COVID-19 show mostly bilateral pneumonia. The kind of complications seen in the pneumonia of miners, e.g. pulmonary thromboembolism, are seen both in pneumonia illness is miners and COVID-19. Also, Dr. Nanshan did not classify the pneumonia cases as SARS1. (We have not compared the symptoms with MERS, as MERS emerged in September 2012 in Saudi Arabia, later than the miners pneumonia).

We found no published evidence of human to human transmission of pneumonia from the miners to others.[9; 10].

Mojiang miners samples and mine: a missing link to SARS-COV-2?

The pneumonia cases have not been discussed in any of the scientific papers (except the two theses) and not mentioned in the scientific papers published by the WIV laboratory [1; 7]. Also, the Mojiang mineshaft pneumonia outbreak has not been discussed in context with COVID-19 in any other scientific papers worldwide. The illness was not attributed to MojV (a paramyxovirus) detected in the same mineshaft in the rats [18; 19].

Although the miners pneumonia outbreak in 2012 was known to the major concerned scientists and medical professionals in China, namely: Dr. Zheng-Li Shi (WIV) [3] [7], Dr. Gao Fu [10] (Director, Chinese Center for Disease Control and Prevention) and Dr. Zhong Nanshan [9; 10], this case has not been mentioned in the context of COVID-19 to the best of our knowledge.

According to the thesis, WIV was involved in analyzing the pharyngeal swab samples (probably for the presence of coronaviruses) and blood samples for the SARS antibody tests of these patients. Additionally, the WIV group led by Zheng-Li Shi also was also responsible for the surveillance of the bat coronaviruses found in the Tongguan mine shaft [9]. The samples were also sent to two other laboratories in China (Chengdu laboratory and probably to Zhong Nanshan's laboratory- not clear) [9; 10]. However, there are no documented reports on the analysis of the Mojiang miners samples by WIV.

Looking at the stark similarities in the disease presentation in the pneumonia of the miners and COVID-19, it is highly probable that the miners were infected by a SARS-CoV-2 like or the ancestral SARS-CoV-2. The hosts of SARS-like CoV, the horseshoe bats are small in size and can fly only maximum up to 30 km, they cannot travel huge distances [11]. Due to the limited flying capacities of the horseshoe bats and their habits, the host having the virus cannot have traveled from Yunnan to Wuhan which is 1100 km apart [11].

The following questions would be worth exploring by the agencies like WHO, NIH, etc. which would investigate the origin of SARS-CoV-2. If the SARS-CoV-2 virus originated in Mojiang, Yunnan, how did the pandemic start in Wuhan? Many of the samples collected from the mine (bat fecal samples), and the samples from the pneumonia patients (pharyngeal swabs, blood/serum, etc.) were sent to WIV, Wuhan. Would these samples act as a potential source of the ancestral virus? Were any SARS-like or other coronaviruses isolated from the miners samples? There were at least three research groups (Shi group, WIV, Wuhan Huang Canping, George Gao, CDC group, and Qi Jin lab, State Key Laboratory for Molecular Virology and Genetic Engineering, Beijing) who sampled the mineshaft between 2012-2014 (for about 8 times in total) [7; 10; 19], to the best of our information. The extensive sampling of bat coronaviruses has resulted in at least eight publications from three institutes in China [1; 7; 10; 18; 19; 20; 21; 22]. Zheng-Li Shi mentioned in her interview [3] that the mine was promptly closed (in 2013), however, sampling was done till October 2014 [10] (Supplementary Data 1) is in contrast to this statement [3]. Why were the Mojiang miners pneumonia cases in 2012 not reported to any public health agency like WHO? Why did programs like PREDICT not mention these cases as a mini-outbreak? Was the mineshaft in Mojiang actually closed? If yes, when did it close? Was it still open for the researchers? Did any of these researchers get infected by any coronavirus between 2012-2019? The only important difference between the pneumonia cases and COVID-19 was that the Mojiang miners pneumonia cases were not human to human transmissible from the available information. Also, Zheng-Li Shi in the recent question and answers article told that the people near the Tongguan mine were seronegative [6]. This indicates that the virus was not so transmissible and unless people were directly exposed to the bat feces in large amounts (e.g. miners) it produced infection. Or was it present at that particular time (April 2012) or was seasonal [10]? We conclude that studying the Mojiang miners pneumonia illness (2012) could provide important clues to the origin of the SARS-CoV-2. The samples collected from the mines and especially the miners would be very important in the context of

the investigation which would be undertaken in the future regarding SARS-CoV-2 origin. The coincidence between the 2012 illness in Mojiang miners, the subsequent samplings, and finding the SARS-CoV-2 nearest relative from this single mine warrants further inquiry into the full history of this incident.

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Number of the patient*	**Age**	**Admitted to the hospital on**	**Worked in the mine for**	**Days in the hospital**	**Outcome/ Date of discharge/ death**
1.	63	26.04.2012	14 days	12	**Death** 07.05.2012
2.	42	25.04.2012	14 days	48	**Death** 12.06.2012
3.	45	27.04.2012	14 days	109	**Death** 13.08.2012
4.	46	26.04.2012	14 days	107 (actual days 137)	Improved and discharged on 10.09.2012
5.	30	02.05.2012	5 days	26	Alive, discharged on 28.05.2012
6.	32	26.04.2012	4 days	32	Alive, discharged on 28.05.2012

Table 1: Summary of the six pneumonia patients in 2012 (as per [9]. *Names not given.

Features	**COVID-19** [12; 14]	**Six pneumonia patients** [9] (Master thesis 2013)
Major Symptoms		
Fever	✓	✓
Dyspnoea/Fatigue	✓	✓
Cough	✓	✓
Minor Symptoms		
Sputum/bloody sputum	✓/ in some cases	✓
headache	✓ (in some)	✓ (in some)
ARDS	✓	✓
Laboratory results	✓	✓
lymphocytopenia	decrease	decrease
Serum amyloid A protein, mg/L	High	High
D-dimers, mg/L	Increase	Increase in size
Radiology		
Chest X-ray, Chest C. T. scan	Ground glass opacities, bilateral pneumonia, peripheral consolidation	Ground glass opacities, bilateral pneumonia, peripheral consolidation
Complications		
Pulmonary thromboembolism	✓	✓
Vascular complications	✓	✓
Hypoxia	✓	✓
Secondary infections (bacterial, fungal)	✓	✓
Role of age	✓	✓
Co-morbidities	✓	✓
Male sex	✓	✓All were males
Reason of death	Cardiac arrest, ARDS, pulmonary failure	Cardiac arrest, ARDS, pulmonary failure

Table 2: Common features observed in the six pneumonia patients and COVID-19

Acknowledgments:

We are extremely grateful to Dr. Luigi Warren, CA, USA, for important scientific discussions, content finalization, and the help in the language (@luigi_warren). We would like to especially thank @TheSeeker268 for finding and sending us the links for two important references (Xi, Lu et al 2013, Master's thesis and Huang, C. 2016, Ph.D. thesis in Chinese). We are very thankful to the twitter group members of the DRASTIC group (Decentralised Radical Autonomous Search Team Investigating COVID-19) for the valuable discussions on twitter which helped us to write the paper. Some of the important members who contributed are: (@luigi_warren, @The_Seeker268, @BillyBostickson, @franciscodeasis @AntGDuarte @Real_Adam_B, @DrAntoniSerraT1, @KevinMcH3). I would like to thank Dr. Rossanna Segreto for her important suggestions. We would like to thank Dr. Jonathan Latham of bioscienceresource.org for the link to the professional translation of the Master's thesis. We would like to thank Francisco (@franciscodeasis) and Rossanna Segreto for the help in the initial translation of the thesis. We specially would like to thank Dr. (Prof.) Anand Rahalkar, MD radiology, Bharti Vidyapeeth Medical College, Pune, India, for the review of the X-rays and CT scans in the Xi Lu 2013, Master's thesis. We thank all the anonymous people who helped us in this paper. We would like to specifically thank the reviewers for their valuable comments. **Earlier version of the paper has been published as a pre-print on 24th May 2020 at [https://www.preprints.org/manuscript/202005.0322/v2], Rahalkar and Bahulikar [5]''.**

Authors Contributions: Conceptualization- MCR. Writing of the paper- MCR, and RAB. Both the authors reviewed and approved the final version.

Funding and conflict of interest: We declare that there is no conflict of interest. No project or institutional funding was used for this research.

Important links:

1. Master's Thesis in Chinese (Li Xu 2013) L. Xu, 'The analysis of 6 patients with severe pneumonia caused by unknown viruses' The First Clinical Medical College of Kunming Medical University, Kunming Medical University, China, China, 2013 Master's Thesis, pp. 66.

Link:

http://eng.oversea.cnki.net/Kcms/detail/detail.aspx?filename=1013327523.nh&dbcode=CMFD&dbname=CMFD2014

2. Ph.D. Thesis in Chinese (Huang, Canping, 2016) C. Huang, Novel virus discovery in bat and the exploration of receptor of bat coronavirus HKU9, National Institute for viral disease control and prevention, China, 2016 Ph.D. Thesis.

Link:

http://eng.oversea.cnki.net/kcms/detail/detail.aspx?dbcode=CDFD&QueryID=11&CurRec=1&dbname=CDFDLAST2018&filename=1017118517.nh&UID=WEEvREcwSlJHSldTTEYzWEpEZktmRXB3Sm9JeHRKZExVOG5ySkJjK0xHMD0%3d%249A4hF_YAuvQ5obgVAqNKPCYcEjKensW4IQMovwHtwkF4VYPoHbKxJw!!&autoLogin=0

3. Translation of the Master's Thesis

https://www.documentcloud.org/documents/6981198-Analysis-of-Six-Patients-With-Unknown-Viruses.html.