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RESEARCH ARTICLE

THE INCIDENCE OF MERS-CORONA VIRUS AMONG HEALTH PROVIDERS IN SAUDI ARABIA ESPECIALLY ICU DOCTORS.

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Abstract

This paper is aimed at doing extensive research on the impacts of MERS-CoV among the healthcare providers in the Kingdom of Saudi Arabia. The paper starts by doing research on the theoretical foundations of the existence of MERS-CoV across the world. It draws examples from the previous cases noted. The first case was reported in the year 2012 in the Middle East though it later spread to Europe and North Africa. Since the research is mainly centered in the Kingdom of Saudi Arabia, this paper contains some of the responses made by the Kingdom of Saudi Arabia in fighting this virus. It includes the measures that have been put in place to deal with the spread of this virus among the healthcare providers, particularly those in the ICU section. Laboratory findings are also necessary to provide a practical approach to the management and the containment of the spread of new infections among the healthcare workers.

Introduction:-

A case of a deadly respiratory disease was first noted in Saudi Arabia in the mid of 2012. The case was reported by a 60-year-old man who was reportedly healthy before the incidence*(The Middle East respiratory syndrome coronavirus (MERS-CoV) – Saudi Arabia*. 2016). After a thorough research on the disease, it was later discovered that the cause was a new coronavirus that was then named the Middle East respiratory syndrome coronavirus (MERS-CoV). Retrospective investigations that were done showed that the similar cases of the virus had been identified in previous cases in a cluster of different hospital-associated situations in the Republic of Jordan in the first quarter of 2012 *(The Middle East respiratory syndrome coronavirus (MERS-CoV) – Saudi Arabia*. 2016).

Since the first discovery of the virus and its symptoms, similar cases have been reported and documented both in Jordan as well as the Kingdom of Saudi Arabia and most other countries found in the Middle East including Qatar as

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well as the United Arab Emirates. In Europe and the North Africa, similar cases have been identified but were reportedly related to traveling. Among the European countries that were affected are Germany, France, the UK, and Italy. In the North Africa, the most affected country was Tunisia(Memish 2013). Secondary transmission of the virus has been reported due to travel-related causes.

The continued detection of the virus has raised concerns among various stakeholders across the globe. In response to the epidemic, the Kingdom of the Saudi Arabia urgently initiated many control measures as well as launching investigations, which included many associations with multiple international partners across the world. In May 2013, the Kingdom of Saudi Arabia Ministry of health requested the World Health Organization to organize a joint mission aimed at improving the understanding of the MERS-Co virus as well as to provide guidance among the people (Memish 2013).

Kingdom of Saudi Arabia's Response to MERS-CoV:-

Since the virus was first discovered in the Middle East in the year 2012, several countries within the Middle East as well as outside the Middle East have reported the cases of the virus. However, the kingdom of Saudi Arabia has been one single country that has suffered most casualties related to the MERS-VoC virus. The fatality of the epidemic raised concerns within various departments in of Saudi Arabia. As a result, the government initiated some measures to compact the spread of the deadly virus within its borders. The government of the Kingdom of Saudi Arabia invited the World Health Organization and other global stakeholders to help undertake a study that could help to contain the spread of the virus. Although, the treatment of the virus is yet to be confirmed, several measures and interventions aimed at combating the spread of the virus were put in place. Among the interventions carried out by the Saudi Arabia includes the following:

Interventions that were applied by Saudi Arabia's Ministry of Health immediately after registering the first case of infection were reported in September 2012. This formed the basis of devising a case definition of the MERS and then circulating it to all the healthcare workers across the Kingdom of Saudi Arabia. As a result, the government introduced active surveillance. All the patients admitted to the hospitals in Saudi Arabia who had bilateral pneumonia were subjected to MERS-CoV infection screening (Memish et al. 2014). The Saudi Arabia's ministry of health issued a requirement that stated that all the cases of MERS-CoV infection must be reported to the ministry as soon as they are found. All cases subsequent cases were reported to the world health organization within the first 24 hours and the respective information was placed by the Kingdom of Saudi Arabian authorities on ProMED. After the first official case was reported, experts from the world health Organization, Eastern Mediterranean Regional Office and headquarters, the CDC, EcoHealth Alliance as well as the Columbia University, were invited. In the month of April in the year 2013, the Kingdom of Saudi Arabia invited experts from the EcoHealth Alliance as well as the Columbia University who went to the country to collect samples for analysis.

Al-Ahsa had some substantial amount of cases reported, and the Health Directorate for Public Health visited the hospital to take samples for further analysis. In the analysis, it was found out that monthly mortality rates did not differ significantly from the rates that had been reported in the previous months. The causes of deaths shifted as time went by from the chronic co-morbidities to pneumonia as well as respiratory failure. The cases of influenza activity were not significantly reported in the report. As a result, most experts started to consider that there was a possibility of the occurrence of MERS-CoV related deaths. The Saudi Arabia's ministry of health sent an emergency team to the Al-Ahsa region. Once the Regional Director for the Eastern Mediterranean Region was notified about the existence of the virus in 2013, the following interventions were put in place to avert to severity of transmission: the full force application of infection control interventions in all the concerned healthcare facilities, the admission of new patients into the affected hospitals was closed, isolation of patients in the affected hospitals, dissemination of information pertinent to the control of the virus was done, reinforcement of droplet as well as contact precautions, increase of the nurse-patient ratio in affected medical facilities, and environmental cleaning using hydrogen peroxide.

Epidemiology and the Control of Infection

Findings

The first the first case of the MERS-CoV infections was registered in Zarqa, Jordan in a public hospital in the year 2013. By the end of June, 2013, 55 cases of the virus were confirmed in the laboratory with 31 deaths being registered in the process across Germany, France, Jordan, Italy, Saudi Arabia, Qatar, Tunisia, UK, and the UAE All the cases that were reported in those countries had either been living in Qatar, Jordan, UAE, and Saudi Arabia or had

a history of traveling to or having directly come into contact with travellers to those countries. The first case of the deadly virus in the kingdom of Saudi Arabia was first reported in June 2012. By June 2013, an about 1939 specimens from the suspected cases as well as all the contacts had been processed by the Kingdom of Saudi Arabia's Ministry of health (Hemida et al. 2014). Laboratory cases later confirmed the cases of the deadly virus in June 2013. The evaluation of the facts later revealed the following information: for the people aged between 14 to 94 years, the mean ages of the people infected was 58 years, where 30 of them (75%) were male, 55% of the people under the study had more than one underlying symptom, and the Al-Ahsa region of the eastern province in Saudi Arabia recorded the highest number representing 67% (Hemida et al. 2014). Of the 40 patients who were first noticed. The experience with the deadly MERS-CoV virus in the Kingdom of Saudi Arabia can be divided into two broad investigative stages: the period before and after the recognition of the individual to individual transmission in the healthcare facilities by April 2013.

During the first time of the investigation, 9 cases occurred among the people living in central and the western parts of Saudi Arabia. 89% of these casualties were men, occurring infrequently, and included two small families living the city of Riyadh. In the first family, the index case was a resident of a household that was extended and comprised of 28 males as well as females and nine children (Hemida et al. 2013). The subsequent cases noticed occurred in 2 sons who had an extended contact in the course of providing care to the index patient while the patient was under medication. A grandson also became infected in the process. There were no more casualties of MERS-CoV case, or any respiratory illness was reported among the family members.

The rate of household attack by the virus in this first family cluster was 11%, and it was not clear whether the transmission took place at home or in a hospital. The second group of infection involved two brothers and there were no other cases among the eight contacts were noted. The attack rate for the second cluster was 13%. The first investigate period did not reveal the interaction between humans and animals, and there were no cases of new infections for healthcare workers as well. The health care workers were not exposed to any dangers during the first investigative period. Almost all the cases of the viral infection (30 out of 31) were found to have occurred in the eastern region in the second investigative time. Hospital facilities played a significant role in the transmission of the virus. Two healthcare workers were infected, and two family members were also infected within the hospital facilities in a community hospital. The referral f patients, as well as patient readmission, also played a significant role in the transmission of the virus to the nearby and distant health facilities.

The median incubation period noted from the first infections was 5.2 days. Similarly, 95% of all the patients admitted with the virus were estimated to have registered the onset of the symptoms within 12.4 days. Also, the estimated serial interval was 7.6 days. Among the measures that were adopted in the first hospital to control and prevent the transmission of the virus included the following: education of the existing members of the staff, increasing hygienic auditing, implementation of droplet and contact precautions for every patient admitted to the hospital, all the patients having fever were tested for MERS-CoV virus, closing some of the wards, exclusion of some visitors and other non-essential staffs into the wards, all the dialysis patients were masked masking, and the space of dialysis of patients was increased to reduce contact between patients.

Two cases of MERS-CoV infections were confirmed in a family cluster in England. The attack rate, in this instance, was 6%. The most significant point to note is that among the 59 health workers involved in the process of treating the patients, there were no casualties reported since they wore full protective equipment while in contact with the patients. Although the MERS-CoV virus is easily transmissible and deadly, the secondary attack rates are significantly lower as compared to those of SARS coronavirus.

The origin of the deadly MERS-CoV virus has been discussed broadly. It was originally thought that an it originated from a bat reservoir while basing on the phylogenetic similarity of a specific bat coronaviruses that contained MERS-CoV. However, while this speculation continued, the strain of the MERS-CoV virus that was contained in the human beings was never found in any species of bats. Furthermore, in almost none of the cases that were known cases up to the current time, there was not an apparent source of infection that was related to bats. Neither was there any consistency with the contact with bats in history before the onset of the MERS-CoV virus.

Another significant possibility of the origin of the MERS-CoV virus can be traced to the dromedary camel. Dromedary camels have the same MERS-CoV as well as the antibodies like the MERS-CoV found in the bodies of human beings. The camels are also known to shed several numbers of the virus through their secretions in the upper

respiratory tract. Previous samples obtained from camels found in Dubai in the year 2005 revealed a significant breakthrough. The camels produced antibodies that neutralized the MERS-CoV virus. The findings indicated that the virus had previously infected the camels even in countries where human cases of the virus have never been reported. Camels are now identified as the reservoirs of the virus especially in places where they are useful to human life. Unpasteurized camel milk has been found to be among the main modes of transmission the virus. However, there are no accurate data that confirms that the camel milk contains the MERS-CoV virus.

The MERS-CoV virus has not been reported in animals, and there is no any single instance whereby the virus has caused any disease in animals. There has not been sufficient information to date that might form the basis for the design of more animal involvement in an environmental sampling to understand the virus. The case reporting form that has been in use currently while reporting data on the people's cases of the virus does not capture significant information that will allow enough investigation of the potential sources of exposure to the MERS-CoV virus. Also, the relatively insignificant number of all the human cases of the virus shows that it has been impossible to establish a significant hypothesis on the possible source of the MERS-CoV virus exposure. Detailed phylogenetic analysis indicated that the virus has a close relationship to the European bat coronaviruses that often circulates among different species of bats belonging to the Vespertilionidae family. Further analysis of the viruses that were isolated from the first two cases of human infections in June and September in the year 2012 indicated that these betacoronaviruses have the same ancestor which suggests that the diversity found in the human strain is due to compound zoonotic events. In the Kingdom of Saudi Arabia, responsibilities for animals as well as food are split among different ministries and different agencies. Livestock are taken care for by the ministry of livestock; municipalities are often in charge of the activities falling within the boundaries of the city which includes activities related to the domestic, companion or even stray animals as well as the slaughterhouses. However, the Saudi wildlife authority is in charge of the management of wildlife. The Saudi Ministry of Health is in charge of zoonosis.

Although the outbreak of the MERS-CoV virus was first noticed upon the death of a 60-year-old man in 2012, an unknown coronavirus was previously detected in his sputum, but it was then provisionally referred to as human coronavirus-Erasmus Medical Center. Shortly after that the same virus was detected in 2012 from a patient 2012 that had been suffering from severe respiratory illness and had been transferred to the United Kingdom for advanced treatment. Further analysis of the retrospective analysis of the samples of the previous patient that had been stored from the Jordan case led the researchers to rename the virus as the MERS-CoV.

Laboratory issues:-

Findings

A close analysis of the MERS-CoV's genome size, the organization as well as its sequence indicates that it is related to the bat coronaviruses. However, there is a significant difference found in the region between the spike as well as the envelope genes. By June 2013, samples of a total of 1939 respiratory tract were tested for the presence of the deadly MERS-CoV virus, and 40 were found to be positive. All the positive samples were taken from the symptomatic patients who had conditions that matched the case description at the time. Diagnostic tests were run differently by the ministry of health's laboratories in the kingdom of Saudi Arabia that targeted the upE gene which was the screening target that was recommended by the researchers from the University of the Bonn Medical Centre as well as the Public Health England agency the UK up to April 2013 through the use of the upE for screening as well as the ORF1b and the N genes for the confirmatory testing. Since the testing for the ORF1a is more sensitive than the testing for the ORF1b, both upE for screening as well as the ORF1a for confirmation are subjected to targeting in assays in the kingdom of Saudi Arabia. Serum from the cases of confirmed infections was taken.

The serum was systematically tested for the upE gene. It was found out that none was positive for the MERS-CoV virusswabs as well as the serum from all the healthcare workers who had been in contact with the patients infected with the virus. The upE screening was done in Kingdom of Saudi Arabia on the swabs, but all tested negative (Cotton et al. 2013). Testing in Kingdom of Saudi Arabia was done in a manner that was decentralized since the end of April 2013. The tests done involved the Riyadh Regional Laboratory of Microbiology as well as the Reference Laboratory based in Jeddah. The assays have since been centralized in Riyadh since May 2013. All the samples taken for the purpose of diagnosis and sent to the Health Protection Agency were then tested for the 15 common respiratory infections, but no infection was found. RNA extraction was then undertaken in the Kingdom of Saudi Arabia in an automatic way using various robots. The attempts to isolate the virus in Saudi Arabia have not resulted in significant results.

Healthcare Workers Exposure in Saudi Arabia:-

In an index case whereby the patient having a seven-day fever as well as the shortness of breath was admitted in the year 2012, precautions that help in the prevention of airborne transmission were taken to protect healthcare workers as well as other patients. The measures were taken by done by placing the infected patient in a private room that had negative pressure during the first two days of the patient's hospitalization. On day 2, the infectious disease consultation was done which led to the replacement of airborne transmission precautions with the precautions termed as droplet-transmission. A multidrug was isolated in the fourth day multidrug-resistant paving the way for the implementation of the contact transmission precautions (Cotton et al. 2013).

Using the dates as well as the units in which the patient used as the case study received care, the staff in the hospital initially identified health care workers who had come in contact with the case-patient. A comparison group of about the same numbers of healthcare workers was selected from healthcare workers with no known contact with the patient under the study. The hospital infection prevention workers administered a small standardized questionnaire to the two groups of healthcare workers. Data was collected on the healthcare worker's demographics, job responsibilities, as well as the symptoms of respiratory disease during the period under the study which directly corresponds to the period in which the case-patient was under the care of the healthcare workers and an incubation period of between 2–10 days, based on the MERS-CoV virus 'natural history information that was present at the time of the research. Specific data concerning the circumstances of the case-patient contact as well as the potential for the MERS-CoV virus' exposure was gathered from the healthcare workers who had come into contact with the case-patient.

In October 2013 which was four months after the death of the case patient. A blood specimen was collected from every healthcare worker, and they were transported first to the laboratory and then to the CDC in the US for the testing of the MERS-CoV virus. Upon receipt of the specimen from Saudi Arabia, the specimens were then gamma-irradiated on dry ice and then stored at −70°C *(The Middle East respiratory syndrome coronavirus (MERS-CoV) – Saudi Arabia*. 2016).

Of 56 healthcare workers who had been identified to have had close contact with the case patient, five were not available for an interview while 3 of them refused did not donate their serum, leaving 48 healthcare workers to participate in the final analysis (Hall et al. 2014). The median age of a range of 22 to 57 of the healthcare workers who had come in contact with the patient was 30.5. 6 (13%) of the healthcare workers reported having a prolonged medical condition like asthma, hypertension, and diabetes while 6 (13%) reported having smoked tobacco (Hall et al. 2014).

Most of the 48 healthcare workers had reportedly come close to contact with the patients. Most of them had come to within one meter of the case patient and even touched the case-patient, or touched the beddings used by the case-patient, equipment, or the patient's body fluids. During a single shift, most of the healthcare workers reported a case patient contact of less than an hour but 23% reported a more than five percent contact hours (de Groot et al. 2013). About half of the health care workers reported having close to the patient during the airway suction, about 30% said they were with the patient during a nebulizer treatment, 23% were close to the patient during sputum induction 9% during bronchoscopy and 6% during intubation (de Groot et al. 2013). The main control and prevention mechanism applied by the healthcare workers when with the case patient involved maintaining hygiene, the use of gloves, wearing the surgical mask, and the gown. However, most healthcare workers admitted that they did not always observe these precautions.

Important Features of Control Measures:-

Given that the healthcare workers are in a significant risk of contracting the deadly virus due to negligence, healthcare facilities should make sure that there is a strict adherence to the set standard infection control precautions. Such precautions should include hand hygiene, the use of appropriate protective equipment, and adherence to rigorous environmental cleaning.

There should be put in place measures that ensure that health authority as well as the staff members in the hospitalto always cooperate to efficiently implement an enhanced case finding as well as to make sure that there is an early separation of suspected cases of MERS-CoV-infected patients (Nowotny & Kolodziejek 2014).

Health authorities should not declare that an outbreak is over before the end of 28 days after the end of the last health care exposure to the MERS-CoV virus. This measure will ensure that undetected cases do no come to haunt the healthcare workers.

There should be system wide communication among the healthcare authorities as well as the implementation of case finding strategies to mitigate the risk brought about by those patients as well as the visitors who are exposed in different hospitals and may not have shown the symptoms of the viral infection.

Clinical Presentation and the Risk Factors:-
The incubation period referred as the median, and that has been scientifically identified as the MERS-CoV virus is five days within a range of 2 to 14 days. During this time, the affected person always remains symptoms free. The virus is difficult to be identified because the clinical manifestation begins from no signs to trivial upper respiratory signs including fever to severe pneumonitis as well as respiratory failure. Gastrointestinal symptoms are as well common when infected with this virus. Gastrointestinal symptoms include the loss of appetite, bad abdominal pain, feeling nausea, vomiting, and abnormal diarrhea.

There is currently no vaccination or any medication that is approved to treatthe patients suffering from MERS-CoV related cases. Therefore, the primary intervention plays a significant role in helping the patients.

Diagnosis:-
The world health organization has come up with clear guidelines for the characterization of the cases of MERS-CoV. The guidelines are based on the history of the patient's exposure and the characteristic findings (World Health Organization 2014). The clinical, as well as the radiological manifestations, do not always form the foundation for differentiating MERS-CoV from other causes of respiratory infections. Molecular rRT-PCR for two sites in the genome of the virus is the often accepted form of diagnosis: The success of the rRT-PCR testing usually depends on the experience as well as the expertise of the laboratory personnel, lack of contamination as well as the type and the condition of the specimen. Seroconversion is also another symptom of diagnosing the MERS-CoV virus (World Health Organization 2014). The immunosorbent assay that is often linked to enzyme can as well be used for the purpose of screening.

Discussion:-
This investigation on the incidences of coronavirus on the health workers in Saudi Arabia provides us with the pointers of transmission possible in the process of initial emergence of the MERS-CoV virus. The absence of MERS-CoV transmission among healthcare workers in this research is related to the study of some contact studies, but they differ from those that informed transmission to healthcare workers' contacts (Cotton et al. 2013).
Despite the fact that this study analyzed numerous case-patient contact episodes among the healthcare workers, there was no serologic evidence that suggested the association of health care workers with the MERS-CoV due to the index case-patient. Fast identification of the possibly infected patients, as well as the implementation of the precautions aimed at controlling the new infections among the health workers, can help protect healthcare workers. The US CDC recommendations for the management of the hospitalized patients who have known or supposed MERS-CoV virus' infection include the implementation of the standard, contact as well as the airborne transmission precautions

Conclusion:-
The emergence of this virus has resulted in complex situations for the countries that are affected as well as the world in general. This infection has a direct connection with the high rate of fatalities. Therefore, it has shown its ability to persist over any duration of time causing disease acquired from the in various locations that can be transferred from one individual to another under particular circumstances. The condition is surrounded by significant doubts. Regarding the control measures, the most critical problem is, how are the individuals developing the new infection? Under some settings, especially in the families as well as healthcare amenities, specific situations are clearly related with individual to individual transmission. However, how individuals are getting the infection in their respective societies has become unknown irrespective of the thorough efforts by the kingdom of Saudi Arabian authorities. When viewed from the viewpoint of the epidemiology of this new viral infection, another significant problem is whether a good number of people infected with MERS-CoV virus are still unrecognizable. Knowing the level of infections in various communities as well as other defined settings can potentially provide the awareness that is

needed to show the manner as to how individuals acquire the new infection. The overarching concern at the global level is if this virus has the potential to spread further across the globe extending its geographical scope. The global geographic concerns of this virus are solely related to traveling. Therefore, Saudi Arabia faces a complex situation in this context because the country has already recorded the highest number of casualties. The complex situation arises from the need to manage the transmission of the virus in distant places as well as the need to manage the transmission of the virus within the households of infected people. Although there is a big decline in the number of the infected people in Saudi Arabia's Al-Ahsa region, there is a great fear since there are cases of new infections in the country's eastern region.As a measure of responding to the spread of the virus across the country, the authorities in the kingdom of Saudi Arabia have done the following: increased extensive communication campaign aimed at increasing the awareness of the disease among the people, created a multisectoral management group aimed at improving collaboration as well as coordination among the government agencies and sectors, invited various professional groups to help in addressing the epidemic, and initiated various control measures.

Finally, the incidences of coronavirus among the healthcare workers in Saudi Arabia have been reported in various health facilities. However, measures have been undertaken by the government and other healthcare stakeholders to ensure that the healthcare workers as well as other people do not come into contact with patients infected with the virus. Such measures include the government, World Health Organization, and other countries initiated joint research aimed at combating the virus. The government also increased the number of healthcare workers in hospitals that reported cases of the virus. The measure reduced workloads per healthcare professional hence decreasing the chances of contact with the patients.

Reference:-

1. Cotten, M., Watson, S.J., Kellam, P., Al-Rabeeah, A.A., Makhdoom, H.Q., Assiri, A., Al-Tawfiq, J.A., Alhakeem, R.F., Madani, H., AlRabiah, F.A. and Al Hajjar, S., 2013. Transmission and evolution of the Middle East respiratory syndrome coronavirus in Saudi Arabia: a descriptive genomic study. *The Lancet*, *382*(9909), pp.1993-2002.
2. de Groot, R.J., Baker, S.C., Baric, R.S., Brown, C.S., Drosten, C., Enjuanes, L., Fouchier, R.A., Galiano, M., Gorbalenya, A.E., Memish, Z.A. and Perlman, S., 2013. Middle East respiratory syndrome coronavirus (MERS-CoV): announcement of the Coronavirus Study Group. *Journal of virology*, *87*(14), pp.7790-7792.
3. Hall, A.J., Tokars, J.I., Badreddine, S.A., Saad, Z.B., Furukawa, E., Al Masri, M., Haynes, L.M., Gerber, S.I., Kuhar, D.T., Miao, C. and Trivedi, S.U., 2014. Health care worker contact with MERS patient, Saudi Arabia. *Emerging infectious diseases*, *20*(12), pp.2148-2152.
4. Hemida, M.G., Chu, D.K., Poon, L.L., Perera, R.A., Alhammadi, M.A., Ng, H.Y., Siu, L.Y., Guan, Y., Alnaeem, A. and Peiris, M., 2014. MERS coronavirus in dromedary camel herd, Saudi Arabia. *Emerg Infect Dis*, *20*(7), pp.1231-4.
5. Hemida, M.G., Perera, R.A.P.M., Wang, P., Alhammadi, M.A., Siu, Y.L., Li, M., Poon, L.L.M., Saif, L., Alnaeem, A. and Peiris, J.S.M., 2013. Middle East Respiratory Syndrome (MERS) coronavirus seroprevalence in domestic livestock in Saudi Arabia, 2010 to 2013. *Eurosurveillance*.
6. Memish, Z.A., Cotten, M., Meyer, B., Watson, S.J., Alsahafi, A.J., Al Rabeeah, A.A., Corman, V.M., Sieberg, A., Makhdoom, H.Q., Assiri, A. and Al Masri, M., 2014. Human infection with MERS coronavirus after exposure to infected camels, Saudi Arabia, 2013. *Emerging infectious diseases*, *20*(6), pp.1012-1015
7. Memish, Z.A., Mishra, N., Olival, K.J., Fagbo, S.F., Kapoor, V., Epstein, J.H., AlHakeem, R., Al Asmari, M., Islam, A., Kapoor, A. and Briese, T., 2013. Middle East respiratory syndrome coronavirus in bats, Saudi Arabia. *Emerg Infect Dis*, *19*(11).
8. Middle East respiratory syndrome coronavirus (MERS-CoV) – Saudi Arabia. *(2016).* World Health Organization. *Retrieved 5 December 2016, from http://www.who.int/csr/don/21-june-2016-mers-saudi-arabia/en/*
9. Nowotny, N. and Kolodziejek, J., 2014. Middle East respiratory syndrome coronavirus (MERS-CoV) in dromedary camels, Oman, 2013. *Euro Surveill*, *19*(16), p.20781.
10. World Health Organization, 2014. Middle East respiratory syndrome coronavirus (MERS-CoV)–update. *Saudi Medical Journal*, *35*(6), pp.633-634.