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The Most Common Causes of Transfusion-Transmitted Diseases among Blood Donors in the Middle Eastern States

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

The need for blood is essential, but there is no timely access to safe blood for millions of individuals who need a transfusion. Additionally, blood transfusions can also be the fastest and simplest form of checking for the existence of transfusion-transmitted diseases to the recipients. Blood safety concerns are an issue of great concern in Middle Eastern Countries in which the inaccessibility or provision of unsafe blood has an adverse effect on morbidity and mortality in the region. Additionally, many organizations and safety procedures of blood transfusion in this region need to be updated. Articles containing the key phrases Middle Eastern Countries, Blood, blood donor, blood transfusion, transfusion safety, transfusion-transmitted infections, and transfusion guidelines published from 2003 to 2020 in MEDLINE, PubMed, Scopus, and Google Scholar. Therefore, to determine the most prevalent causes of transfusion-transmitted disease among blood donors in the Middle East countries, this literature review was intended for research.

Based on the data gathered were potentially related to HBsAg and HCV prevalence in blood donors from most of the middle eastern countries. While no positive cases of either HIV Ag-Ab or syphilis antibodies have been recorded especially among the blood donated from Egypt and Saudi

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Arabia. Based on recent studies findings, WHO, and the Food and Drug administration transfusion transmission of SARS-CoV-2 to recipients did not occur via blood transfusion. So that, In Middle Eastern countries, transfusion-transmitted infection remains a formidable problem. A similarly wide constellation of economic and operational challenges in the area parallels the diverse array of pathogens; this calls for a systemic solution that, as proposed by the WHO, involves regulatory, structural, and training initiatives.

Keywords: Transmitted diseases; blood donors; SARS-CoV-2; HIV.

1. INTRODUCTION

Blood donation is recognized as an effective life-saving procedure in medicine and, most prominently, in medical emergencies [1]. Yearly, public health often faces challenges of blood safety due to transfusion- transmissible infections (TTI). This has become higher, especially within risk groups such as children and pregnant women with Malaria, hemorrhage, or pregnancy anemia [2].

Based on the WHO's Global database, at least 92 million blood donations are collected from 164 different countries annually [3]. Forty-one low-income countries were unable to screen for the Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), and Hepatitis C Virus (HCV), and syphilis in blood donations. In developed countries, only 47% of blood donors were screened [4]. At least 13 million donors were also deferred because of TTI infection that could be spread by blood, including HIV, HBV, HCV and syphilis, a pre-existing medical condition or anemia [3].

The Middle East is an unclearly defined geographical area of Africa-Eurasia; it historically includes Southwest Asia and some North Africa parts [5]. The Regional Office for the Eastern Mediterranean is one of WHO's six regional offices, comprising 22 Member States with 605 million [6].

According to a WHO report, many nations do not have access to sufficient supplies of safe blood for transfusion. In the Middle East, only Iran and Turkey rely totally on unpaid voluntary blood donations. In the 1940s, Iran had a non-centralized, fragmented, and intermittent supervised blood transfusion service. Until almost 40 years ago, blood was mainly supplied by commercial organizations and professional blood donors. In 1947, the Iranian Blood Transfusion Organization was established to coordinate blood transfusion activities nationwide. However, similar services in other Middle Eastern countries developed more slowly. In Egypt, for example, blood transfusion services were fragmented until 1997 [7].

Therefore, to determine the most prevalent causes of transfusion-transmitted disease among blood donors in the Middle East countries, this literature review was intended for research.

2. STUDY DESIGN

An electronic literature search was carried out and it contained the following keywords in titles and abstracts Middle Eastern Countries, Blood, blood donor, blood transfusion, transfusion-transmitted infections, transfusion safety, and transfusion guidelines published from 2003 to 2020 MEDLINE, PubMed, Scopus, and Google Scholar. According to WHO classification, EMR countries include: (Afghanistan, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Pakistan, Palestine, Oman, Qatar, Saudi Arabia, Somalia, Syria, Tunisia, Turkey, United Arab Emirates (UAE) and Yemen) these countries in the Middle Eastern region were included in the keywords. Research articles in English and Arabic were considered if they met the following requirements, such as cross-sectional studies. Overall, the published reports recorded positive TTI cases among safe blood donors from Middle Eastern countries. Then studies that record confusing information and studies with less than 1,000 samples were the excluded. The author's name or journal-title did not affect the option to exclude or include an article.

2.1 Blood Donation and Blood Safety in the Middle East Countries

Middle East countries have different economies, populations, and medical care [5]. However, they all express similar concerns about the protection of blood [8]. Based on WHO data, 112.5 units of blood are collected annually worldwide, half of which come from countries in the low- and middle-income nations. About 80 percent of the world population receives blood. The levels of donors in low-income and middle-

income countries are average 11.7 and 4.6 per 1000 person, respectively, compared to the high-income countries that stand at 33.1. Also, blood collection rates in 6 out of 21 EMR nations are below 10 per 1000 residents, and more than half of the collected blood in countries of low incomes is used by children less than five years old [9].

In 2004, 17 countries collected around two million blood units. The amount of blood obtained through a voluntary donation in these countries has fallen significantly, ranging from 3-100 %. Rates of donation ranging from 0.2% in Syria to 2.7% in Kuwait [10].

Despite recent advances in blood safety in the Middle East, concerns related to blood transfusion are still prevalent in rising TTIs [11]. Therefore, WHO suggests that all countries ensure blood donors' safety by promoting safe blood donation, promoting quality assurance, and ensuring blood products safety [4]. The prevalence of TTIs in blood donors is significantly lower in those who donate voluntarily. Even so, more nations also rely on voluntary contributions or alternative donors; the patients were unrelated/unknown and had come to the center to donate blood to replace the patients needed. [12].

Blood safety policies apply throughout Egypt to screen blood donated for hepatitis B, hepatitis C, HIV, and syphilis. From 2008 to 2009, 52 positive HIV blood bags were identified and removed. In 2009, 1,280,000 blood units were checked and 44 HIV-positive blood bags were found and discarded [4,13]. The prevalence of hepatitis C infection in thalassemia patients has been recently assessed in the EMR. Patients with thalassemia are, for example, among the most prone to TTIs. Therefore, infectious agents' prevalence in this community of patients may provide valuable information about the blood safety index [14]. Over the years, Pakistan's blood transfusion situation has remained far from reasonable [15–17]. Blood transfusion services in Pakistan are largely hospital-based, and most blood donors pay and direct the donors. HIV, HCV, and HBV are not assertively tested for commercial blood donors in Pakistan [18]. The study reviews the serological testing of HBV, HCV, HIV, and syphilis in blood donors from 1996 to 2005 in Lahore. Serological marker frequency ranged from 1.46–2.99% for HBV, with a steady decline for HCV (from 3.01 to 4.99 %), for HIV (from 0 to 0.06%) and for syphilis (from 0.19 to 0.57%) [17].

2.2 Transfusion-Transmitted Diseases (TTDs)

The safe procedure of blood transfusion saves millions of lives every year worldwide. Whole blood can be transfused to one patient, or blood-derived products can be separated so that multiple patients can use them. However, it has been established that blood transfusion can present a risk of spreading certain diseases [19,20]. These infections are referred to as transfusion-transmissible infections (Table 1) that occur when blood products are supplied to people without proper blood-borne infection screening. Allowing unsafe transfusion can lead to several negative outcomes, as it can cause an acute clinical sickness, be passed on to the receiver as a carrier, or cause asymptomatic infection [21].

Four things are needed for an infectious agent to cause TTS. First, the agent must be present in the donor's blood, and the donor must be qualified to donate, healthy and feeling well on the day of donation, and must pass our screening board and consenting interview. Secondly, sensitive cells must be located in which to invade and proliferate by the agent. Finally, it must render the receiver sick to be a TTD. Viral, bacterial, parasite and prion infections are included [22,23]. The increasing rate of these infectious diseases raises blood safety risk, especially in middle and low-income countries [24]. HIV, HBV and HCV, due to their high prevalence rates, are the most common among these [23]. Other agents are Dengue Viruses, bacterial and Malaria [19].

2.3 Viral

2.3.1 Human immunodeficiency virus (HIV)

In the 1990s, one of the main ways to be infected with HIV in the Middle east was blood transfusion [25]. The average number of AIDS cases reported from countries in the region was 3,745 by the end of 1995. Despite major improvements in transfusion safety in the region, the main route of HIV transmission remains blood transfusion. The relevant information was available in 3,461 diagnosed cases (92.4%). Of those who received blood or blood products, 368 cases were, and the majority of these were reported in Saudi Arabia, Iran, Egypt, Iraq, and Morocco. For example, subsequent studies proved that most HIV infections were not due to Iranian products, but rather due to imported coagulation factors

[26]. Sexual contact is the most common way (71%) in Egypt to transmit HIV. Until recently and collectively, blood and blood products were contaminated in 5% of Iran's cases [13].

In the study of voluntary student blood donors at Mansoura University, El-Gilany and El-Fedawy reported no HIV cases among donors [27]. From 2000 to 2005, a retrospective study analyzing the history of 99,757 donors at the National Cancer Institute Blood Bank confirmed that no HIV positivity was found compared to two cases five years before [28]. During the five years 2010-2014, Senosy *et al.* examined the prevalence of HIV across blood donors in the Blood Bank of Beni-Suef University Hospital, Egypt. 93.5 % of the blood donors were male and 6.5 % were female. The HIV prevalence was 0.1%; 92.9% male donors and 7.1% female donor were among them, but this difference was not statistically significant. HIV-HCV coinfections have occurred in two donors (14.3%) [29]. Recent study by Kamel and Rageh estimated the seroprevalence of HBV, HCV, HIV, and *T. Pallidum* antibodies among blood donors in a Suez Canal university blood bank from 2015-2019. In blood donors, the prevalence of HCV Ab and HBsAg are about 1.87% and 0.97%. No positive cases of either HIV Ag-Ab or syphilis antibodies has been recorded among the blood donated from this duration [24]. Research have been published throughout the world to determine the prevalence of HIV in blood donors. For example, seroprevalence of HIV is 0.004% in Iran [30], 0.002% in Turkey [31], and 0.06%% in Iraq [32] among blood donors.

2.3.2 Hepatitis virus

Information collected from blood tests of over 211,772 people from Egypt showed hepatitis B surface antigen (HBsAg) and HCV antibodies prevalence are 1.65% and 9.02%, respectively. There is a significantly higher prevalence of anti-HCV than HBsAg; there is a significantly greater incidence of these in rural versus urban donors (11.3% and 2.27%, respectively) [33].

The only blood and blood components provider in Kuwait is Kuwait's central blood bank, which performs collected, processed, tested, distributed, and transfused services for any hospital. A study conducted in 2002 showed that 51.2% of blood donors in Kuwait are Kuwaiti nationals, and 48.8% of blood donors are non-Kuwait Arabs. Out of the first-time national and non-Kuwaiti Arab donors, prevalence rates of anti-HCV were 0.8 and 5.4%. In these age groups, the prevalence of HBsAg was 1.1% and 3.5%. These data illustrated that Kuwait's heterogeneous population and the reliance on blood donations from replacement donors might affect the incidence of hepatitis infection between blood donors [34].

Several studies have been conducted in the Middle East and Eastern Mediterranean Regions concerning HBsAg positivity in blood donors. Below is a summary of the findings. HBsAg prevalence assessed between 1998 and 2007 among blood donors in Iran [35]. During the ten years in Maghsudlu et al. were collected 14,599,783 donations. Due to improvements in the recruitment, selection of donors, import of automatic supply and the implementation of transfusions services, and the potentially decreasing HBV prevalence in all populations, the total HBsAg rates decreased from 1.79% to 0.41% [35]. Another study also examined the viral screening in 15 million Iranian blood donors for syphilis, HBV, HCV, and HIV from 2004 to 2007 [36]. They reported that about 1% of blood donors were HBsAg positive, and the prevalence decreased over the study period [37]. Mohammadali and Pourfathollah conducted another large-scale study for over six years. They showed that only 0.5% of Iran's blood donors were HBsAg positive [38]. Gurol et al. reported the prevalence of HBsAg 1.5% in Turkish blood donors [39]. In addition, a study conducted by Tigen et al. on 6 million Turkish blood donors stated that HBsAg was positive for over 4 percent of the population [40]. The prevalence increases in Djibouti's blood donors [41] and Pakistan [42], with 10% and 6%, respectively.

The Blood Donor Unit collected 78,428 blood units from Qatar's multinational donors from 1994 to 2001. Out of the 10,382 units, 13% were positive for at least one tested hepatitis markers. Seven hundred sixty-nine units were positive for HBsAg, 516 units were positive for HBcAb, and 976 units were positive for HCV Abs. The positivity rate for HBsAg was similar among Qataris and those from other countries. A striking finding was that 11.2% of Egyptian donations have antibodies for HCV [43].

Table 1. Pathogen, Clinical Manifestation, Screening Methods, Blood donor seroprevalence from published studies in Middle East countries

Pathogen	Clinical Manifestation	Screening Methods	Blood donor seroprevalence from published studies
Viral Human Immunodeficiency Virus (HIV)	AIDS	Serology anti-HIV	Egypt: 2000 - 2005 (0% HIV positivity) [29]. 2006 (0% HIV) [27]. 2010-2014 (HIV infection 0.01%) and (HIV-HCV coinfection 14.3%) [29]. 2015-2019 (0% HIV positivity) [23]
			Iraq: (2017-2018) HIV 0.06%. The seropositive donors 1.8% HIV [32].
			Iran:(2004-2007) 0.004%[30]
			Turkey: anti-HIV 0.002% [31]
			Saudi Arabia:(1984 -2009) 15,157 positive HIV cases [98,99],(2000-2002) [99], and 2001 [123] (0% HIV), 1985-2010 (HIV-HCV and HBV coinfection 10% and 20% , retrospective) [100], 2017-2019 (0% HIV) [124].
Hepatitis virus	Viral hepatitis	Serology anti-HBsAg, anti-HCV	Turkey: (2004-2010) 1.31% HBsAg and HCV 0.38% [31]
			Iraq: (2017-2018) HBV 3% and HCV 0.5%. The seropositive donors: HBV 84.3% and 13.9% HCV [32].
			Saudi Arabia: (1985-2010) HBsAg 3 % [100]. (2015-2017) 0.33% HBsAg; 0.40% HCV; 0.13% HIV Ab/Ag; 9.81% HBcAb; and7.80%; HBsAbs. 0.53% syphilis. No samples were positive for malaria [125].
			Kuwait: prevalence rates of anti-HCV were 0.8 and 5.4 %. The prevalence of HBsAg was 1.1 % and 3.5 % [34]
severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)	COVID-19	enzyme-linked immunosorbent assay (ELISA)	Saudi Arabia: 19.31% [121].
Middle East respiratory syndrome coronavirus (MERS-CoV)	Middle East respiratory syndrome	Immunofluorescence assay, ELISA and confirmed by testing for neutralizing Abs (nAbs)	Saudi Arabia: 0% [118]. (2011 – 2016) 0.23 % [126].
Dengue virus	Dengue fever	ELISA	Saudi Arabia: 3.2% primary infections and 2.3% secondary infections [122].
Bacterial *T. pallidum*	Syphilis	VDRL/TPHA	Iran: 0% seroprevalence syphilis cases [53]
			Egypt: 0% seroprevalence syphilis cases [52,53]
			Turkey: 0.02% [54]
			Pakistan: 0.75% [55].
			Saudi Arabia: (2006-2015) 0.044 % syphilis positive cases [58]
Protozoa *P falciparum*	Malaria	Donor history questionnaire; *blood smear microscopy*	Saudi Arabia: (2006 – 2015) 79% Saudi, and 13 % non-Saudi [58]. antibody 7.6 % and antigen 0.17 % [110].
T. gondii	Toxoplasmosis	Donor history questionnaire; blood smear microscopy	Jordan: 47.1% [67] Egypt: 72.6% [69], 59.6% anti-T. gondii IgG [71] Saudi Arabia: 37.5 and 52.1 % [112,113]

Siddiqui and his colleagues' study aimed to establish the various TTIs in blood donors in Islamabad. This study was conducted at a blood bank from 2016 to 2017. Almost 847 prospective donors' samples were screened for the TTIs. They reported that 32 (3.72%) of the blood donors had TTIs. The prevalence of HBV, HCV, Malaria, Syphilis, and HIV was found to be 11 (1.29%), 15 (1.77%), 01 (0.11%), 03 (0.35%) and 02 (0.0.23%), respectively. They determine that TTIs were significantly lower among voluntary blood donors [2].

2.4 Bacterial Infections

2.4.1 Bacteria contamination

Blood transfusion can lead to immunosuppression, which may increase an individual's risk of acquiring an infection. Bacterial infection is the greatest threat posed by the transfusion of blood products. One of the most common causes of blood contamination is direct effect through blood products' processing, but increasing attention is now being paid to an indirect effect [44]. Bacterial contamination of blood products can include bacteria found on the skin and the environment, such as Yersinia, Pseudomonas, Proteus, Escherichia coli, Klebsiella, Acinetobacter, and Serratia [45].

Nevertheless, Transfusion Transmissible Bacterial Infections remain a major source of blood-borne infections leading to high morbidity and mortality rate, especially through platelets concentrates in hospitalized patients. Bacterial sepsis is more common when platelets that have been contaminated with bacteria are transfused. Approximately 18% of all transfusion-related deaths are due to bacteria's presence in platelet donations [46,47].

2.4.2 Syphilis

Syphilis is a transmissible venereal disease due to a spirochete called Treponema pallidum. The bacteria mix with the blood of a blood donor and infects the blood of a recipient. Syphilis is still a very prevalent public health problem in the world. Fordyce was the first person to report transmission of syphilis via transfusions. Many people have suffered from syphilis in different countries, including the United States (US) and Great Britain [48]. Syphilis can be passed from sexual contact, transfusions, and a pregnant woman during childbirth to her fetus [49]. Moreover, the number of cases of syphilis transmitted through transfusions has decreased across the world. Within the past 35 years, only three cases of syphilis transmission by blood transfusion were recorded in literature and the last one occurred more than 40 years ago in the US [50]. However, blood transfusion plays a minor role because many blood-testing methods are sensitive, and routine blood screening for syphilis is performed. Screening for syphilis is required before receiving routine blood transfusions, as well as blood donations. Despite its prevalence in developing countries, syphilis has re-emerged as a widespread health concern in many nations in recent decades [51]. Interestingly, there were 0% seroprevalence syphilis cases among Iranian and Egyptian blood donors [52,53], 0.02% in Turkey [54], and 0.75% in Pakistan[55].

2.5 Malaria and Protozoa

Bacteria, viruses and other bloodborne pathogens can be transmitted through blood transfusion. Parasitic infections through blood transfusions are generally rare. However, Malaria is a major cause of TTIs in tropical countries [56]. In addition to malaria transmission through mosquito bites, there have been rare malaria reports occurring through transfusion. The condition occurs because the donors' parasite load is very low, and no symptoms may be seen during donation. Also, some *Plasmodium* species do not cause symptoms in their hosts, and those who may have acquired immunity to the parasite may still carry a low level of infectious parasitemia [57]. Blood from asymptomatic donors or blood from imported malaria cases is becoming increasingly available due to travel and demand for transfusions [58]. Transmission of malaria has been reported mostly from single-donor products such as red cells, platelets or white cell concentrates, cryoprecipitate, and red cells after thawing and washing [59]. Because the parasites are stable for at least 18 days at +4°C in plasma and whole blood, they are also stable in the frozen state for more extended periods [59,60].

Toxoplasma gondii (*T. gondii*) was first discovered a century ago in North Africa by scientists investigating *Leishmania* [61]. *Toxoplasma gondii*, an obligate intracellular parasite, is a generally successful microorganism that globally infects around 30% of the human population and may be transmitted via whole blood [62–64]. The Middle East's total infection rate is around 30%-50%, making it the highest in the global regions [65,66]. Several studies across

the Middle East countries reported higher *T. gondii* rates in pregnant women in Jordan 47.1% [67] and Egypt 72.6% [68].

A cross-sectional study was performed at six blood donation centers in Iran. A total of 491 serum samples were collected from 2014 to 2015. Totally, 200 (40.7%) samples were seropositive for anti-*T. gondii* antibodies; 184 (37.5%) donors tested seropositive for only IgG antibody, 8 (1.6%) tested seropositive for both IgM and IgG and 8 (1.6%) were positive for IgM antibody alone. Therefore, appropriate screening programs should set up to prevent the spread of transfusion-transmitted toxoplasmosis [64]. Many studies have reported *T. gondii* seropositivity in southeastern Iran's blood donors [69,70]. However, a cross-sectional study was conducted to evaluate the seroprevalence of *Toxoplasma gondii* antibodies among 260 blood donors who attended blood banks at Mansoura University Hospital, Egypt. Multivariate logistic regression analysis showed a significant association between *T. gondii* seropositivity and eating meat by-products or being non-educated. These findings highlight that *T. gondii* is prevalent among blood donors in Egypt [71]. This difference in *T. gondii* seropositivity among the blood donors worldwide could be associated with geographical and environmental factors, sociocultural habits, transmission routes, and sample size in the studied population [64].

2.6 Specific Agents of Recent Concern

2.6.1 Middle east respiratory syndrome (MERS

The disease first appeared in the Middle East and spread to many countries around the world. [72,73]. However, the exact way in which MERS transmission is unknown. The main concern with blood transfusion is the possibility of its transmission to a recipient by blood. Since the MERS-causing virus is a coronavirus similar to the one that causes severe respiratory distress syndrome (SARS), the focus should be on the transmission via blood transfusion. The possibility of transmission through blood transfusion is confirmed, emphasizing SARS, and the inactivation of the virus in infected blood is the subject of current research [74,75]. However, there is still no case report of MERS transmitted by blood transfusion until now.

2.6.2 Dengue virus

The Dengue virus is the world's most widespread viral arthropod-borne infection, attributed to millions of individuals. A dengue virus with four main serotypes is a single-stranded RNA virus. The predominant transmission route is through the mosquito vector of *Aedes aegypti*, but dengue also spread through blood transfusion and organ transplantation. [76].

In endemic areas where the vector is widespread, it could be difficult to differentiate a small number of transfusion transmission reports between non-mosquito transmission and mosquito-borne infection. Many infections can also lead to mild or asymptomatic diseases that are not recognized as transfusion-acquired infections, and many endemic countries also do not have diagnostic laboratories to record infections and their origins [77].

There are only two reported cases of blood transfusion transmission. As a consequence of a blood transfusion in Hong Kong, a patient developed fever three days after the transfusion, with severe thrombocytopenia, moderate neutropenia, and hypotension. At the time of donation, the donor was asymptomatic, but dengue fever occurred one day later. The sample also tested positive for dengue virus by Real-Time PCR [78].

The second case involved dengue transmission from a blood donor who became sick the day after blood donation. They completed further investigation and found evidence of dengue infection in the recipients of this blood donation. Two recipients experienced fever with some capillary leak-evidence, while the third recipient experienced no fever. A stored serum sample from the donation tested positive [79].

2.6.3 Coronavirus disease (COVID-19)

With the outbreak of the new coronavirus, *Severe Acute Respiratory Syndrome Coronavirus 2* (SARS-CoV-2) in Wuhan, China, in 2019, a new coronavirus gained the attention of the world [80]. Several published studies indicate that SARS-COV-2 RNA is found in the blood, plasma, and serum of infected people [81–83]. Unsurprisingly, some of these reports include RNA detection in blood donors[84,85]. Researchers identified traces of RNA of the virus in a SARS patient's blood nine days after the appearance of the symptoms. The viral plasma was low [86]. Investigators were able to identify SARS-CoV RNA in plasma specimens when the load of the virus reached 190 copies/mL. The investigators did not identify RNA in the plasma from two contacts, although only one sputum

specimen was positive in three or four different PCR assays, and the viral load was as high as six million copies/mL [86]. Based on this study's findings and others, WHO [87] and the Food and Drug Administration (FDA) [88] implemented suggestions as a precautionary measure against the spread of the SARS via blood transfusion. They suggested some preventative values with regards to deferring blood donations from areas with recent local transmission. Blood donors diagnosed as confirmed or suspected patients with SARS must also alert collection agencies. In such circumstances, efforts will be made to identify receivers and recollect any blood donations that are not transfused.

To date, few studies have addressed the pandemic's impact on blood donation. When completing the questionnaire, 505,000 confirmed cases existed, ranging from 122 in Syria to 148,950 in Iran's Islamic Republic [89]. The drop in blood supplies within the reporting nations was variable during the first months and probably reflected the virus's degree of spread by the community and governmental steps in the reporting countries. The magnitude of the shift in supply depends on the blood supply system's organizational structure and the blood sources, which differ between the region's countries. Different factors can adversely affect the number of blood donors during a viral pandemic [90].

Kwon et al. observed that none of the transfusion recipients exhibited signs of COVID-19-related disease from SARS-CoV2, and none of them tested positive for SARS-CoV-2 infection. Therefore, transfusion transmission of SARS-CoV-2 to recipients did not occur. Although transfusion to recipients all occurred before COVID-19 diagnosis in donors, blood services should receive the details of all COVID-19 cases from their health authorities and not solely rely on post-donation information provided by blood donors [91].

2.7 The prevalence of transfusion-transmitted diseases in Saudi Arabia among blood donors

Generally, in Saudi Arabia, blood donation is performed in hospitals and blood collected from relatives and colleagues of concerned patients (replacement donors) and volunteer donors. Also, in Saudi Arabia, most blood is obtained from replacement donors [92,93].

According to the Joint United Nations Program on HIV/acquired immune deficiency syndrome (AIDS) (UNAIDS), about 34 million people are infected with HIV worldwide [94]. There is not a lot of HIV prevalence data available for the Middle East. AIDS was first discovered and reported in Saudi Arabia in 1984 [95]. The data on HIV prevalence in Saudi Arabia comes mostly from surveys of high-risk groups, facility-based surveillance, and mandatory screening programs [96]. The UNAIDS estimate of 2011 put the endemic rate at about 0.02%. From 1984 through 2009, 15,157 HIV cases were reported in Saudi Arabia, with 4003 cases occurring among Saudis and 11,194 occurring among foreign residents [97,98].

Serological markers of HBV, HCV, HIV 1, 2 and HTLV-I/II were examined in 20423 Saudi and 3750 non-Saudi blood donors at King Khalid University Hospital, Riyadh, using commercially available kits from 2000-2002. The prevalence rates of HIV, HBV, and HCV infections were 0%, 1.5%, and 0.4%, respectively. The prevalence in males was not significantly greater than in female donors, but was significantly higher in non-Saudi donors relative to Saudi donors [99].

Data were collected and reported on all HIV-positive individuals over 18 years of age between 1985 and 2010 at King Faisal Specialist Hospital and Research Centre in Riyadh, Saudi Arabia. In the study of over 341 HIV-infected patients, HCV was found in over 41 patients. The most common risk factor for HCV and HIV infection was blood/blood product transfusion in 24 (60%) of patients, of whom 21 (88%) were hemophiliacs, followed by heterosexual transmission in 9 (22%) of patients. HBsAg was detected in 11 (3%) patients. Heterosexual transmission was the most common risk factor for HBV and HIV infection in 8 (73%) patients, followed by blood/blood product transfusion in 2 (18%) patients. The results of this study concluded that HCV and HBV are ten and twenty times more prevalent among those infected with HIV than in the general population, respectively [100].

Survey data from Saudi Arabia released in 2007 revealed prevalence of HBV of 0.22% among adults. The average reported prevalence was 0.15% and the variation in prevalence was wide (ranging from 0 to 0.72%) [101,102]. The prevalence of HCV infection in Saudi blood donors clearly shows between 0.4% to 1.7% among adults and 0.1% among children. [103,104]. In a large study in Riyadh province among 557 813 Saudis of all ages, the prevalence of HCV in adults was 1.1%, while the prevalence in children was 0.1%. [105].

In 24173 (23952 males and 221 females), 20423 Saudi and 3750 non-Saudi blood donors, the serological markers of HBV, HCV and HIV were studied using commonly produced kits three years in Riyadh, from January 2000 to December 2002. The investigators examined different sexes, ages, and nationalities for the prevalence of confirmed-positive test results for these viruses. This research found prevalence rates of 1.5 percent for HBV and 0.4 percent for HCV, and 0 cases of retroviral infections. For males, the incidence was not substantially higher than for female donors. With an increase in age, HBsAg and anti-HCV positivity appear to increase. Compared to Saudi donors, the prevalence of HBsAg and anti-HCV positivity was much more prevalent among non-Saudi donors. The prevalence was the lowest among Saudi and young donors. Extensive recruiting of Saudi and young donors should also help ensure that blood supply is increased in the long term without jeopardizing protection [99].

The risk of Targeted temperature management (TTM) is complicated because, for a long, relatively-asymptomatic time, infectious organisms may remain viable in the blood. In Saudi Arabia, *Falciparum malaria* is normal and can persist in the bloodstream for years while displaying no infection signs [58]. Therefore, most facilities for blood transfusions have a policy of excluding donors that may be at risk. Many countries mandate a waiting period ranging from 6 months to 3 years, depending on the possible health risk [59]. While a deferral policy can work, the increase in people who are ineligible to donate blood can cause a shortage of stock in non-endemic countries [106].

The incidence of transfusion malaria in Saudi Arabia is unknown. However, it was noted that a report documented two cases of postoperative transfusion malaria after heart surgery [107] and another two neonates transfused from the same blood donor were described in Riyadh [108]. Furthermore, over six years out of the 137,402 blood donors checked in Riyadh, a total of 18/100,000 were reported [109]. These studies do not fully capture the burden of transfusion malaria that can only be measured through a comprehensive national surveillance program.

Saeed and his colleagues [110] evaluated ELISA screening's potential usefulness for malaria antibody and *falciparum* antigen among Saudi blood donors. One thousand seven hundred fifty-six donors were analyzed, 1,028 in the Southern Region where malaria was endemic and 656 donors from the malaria-free Riyadh area. The antibody prevalence for the antibody was 7.6%, compared with just 0.17% for the antigen. In the non-endemic region, the antibody positivity rate was seven percentage points lower than that of the endemic region, 4.8%. They determined that excluding antibody-positive blood donors in malaria-endemic countries like Saudi Arabia would result in too much wastage of blood donations. Although antigen-based malaria testing is useful, only a few donations were rejected.

In 2005, the Prince Sultan Military Medical City, Saudi Arabia, started to screen their blood donors for malaria. Of all blood donors, 120,000 were screened for malaria from June 2006 to June 2015. The researchers found over 180,000 donations of blood screened for malaria. Seventy-nine thousand percent of the donors were Saudi, and only 13 % were non-Saudi. As of this data, the prevalence rate was zero percent among the blood donors with negative thick blood films, which are the only screening test for blood donors. They believed that blood donors' current screening methods could not be deemed fit for low-level identification of parasitaemic malaria cases. A new collection and upgrade of reference tests are suggested [58]. The prevalence rate of malaria among blood donors from Prince Sultan Military Medical City was different from similar studies conducted in Saudi Arabia [109-111].

The prevalence of *T. gondii* infection varies in blood donors between countries. A recent Saudi Arabian study found that blood donors' infection ranges between 37.5 and 52.1% [112,113].

A cross-sectional analysis involving all blood donors in the target population at Al-Noor Hospital, located in Makkah, Saudi Arabia, from June to August 2017. In this research, the total population was 220 male donors (100%). About 43 of the 220 samples showed positive IgG antibodies for chronic toxoplasmosis, with a prevalence rate of 19.5%. The laboratory detected no IgM in the study target group. A significant difference between getting chronic toxoplasmosis and age group 30-39 years was recorded. Asian race was more suspected to be infected by chronic toxoplasmosis. High significant was detected between working in the home garden and infection acquired with chronic toxoplasmosis. The results obtained from this survey suggests that long-term exposure to

Toxoplasma gondii exists in blood donors. Latent toxoplasmosis may become acute in the body in certain conditions. [114].

A cross-sectional analysis examining platelet bags was performed at a tertiary care hospital in Saudi Arabia from January to June 2012. Samples were taken from blood bags for bacterial identification and biochemical examination of platelet bags on day 6 of the donation. The investigators recorded that on day 6 of collection, 1(0.28%) of 352 platelet bags showed bacterial growth. Staphylococcus epidermidis was the bacterium. The platelet bag's glucose and pH levels were 144.14 mg/dl and 5 mg/dl, respectively [115].

There is very little data on sexually transmitted diseases in Saudi Arabia and other Islamic countries. Detailed information on HIV epidemiology has recently been released in Saudi Arabia [116]. A five-year surveillance study was conducted to evaluate and ascertain the prevalence of sexually transmitted diseases in Saudi Arabia [117].

In the ten-year data from 2006-2015, the Elyamany *et al.* analysis was performed at the Prince Sultan Military Medical City in Riyadh, Saudi Arabia. They evaluated the seroprevalence of infection and compared sex and other variables. In the study period, approximately 240,000 blood donors were screened and examined. Most blood donors (98.3%) were male, and 89 percent were citizens of Saudi Arabia. However, according to their results, they reported that about 0.044 % of all blood donors had syphilis positive cases in the last ten years. No cases of syphilis among stem cell donors have been confirmed as positive. Just 60 blood donors tested syphilis positive. In addition, during the same time, we examined 202 stem cell transplant donors, of which % were male, and none were positive for syphilis [58].

Until now, no case report on MERS transmitted by blood transfusion has been published. An interesting article from Saudi Arabia is here. Aburizaiza et al. analyzed donated blood samples through immunofluorescence assay during the emerging illness in Saudi Arabia and registered no positive findings [118]. This could mean that MERS transmission through blood transfusion is low or not at risk. There are, however, many factors. First, it may be possible to use the immunological approach to evaluate the MERS virus, but it is not the gold standard. The standard PCR test is inferior to the immunological process. Fortunately, the risk of finding the virus in blood samples is also very low in confirmed MERS cases [119].

An earlier cross-sectional study at the King Abdullah Hospital was conducted between 2019-2020. Data from donor attendance records, mobile blood drives and blood inventory records were obtained retrospectively. Donor participation and blood supply at blood bank-based collections showed a decrease of 39.5% after imported cases of COVID-19 were registered in Saudi Arabia. Blood demand, on the other hand, was decreased by 21.7% [120].

Mahallawi and Al-zalabani investigated antibody prevalence in blood donors in Al-Madinah, Saudi Arabia, between mid-May and mid-July 2020, against SARS-CoV-2 among blood donors [121]. A total of 1,212 individuals were studied here. The donors were males and met the blood donation requirements. The researchers reported that the SARS-CoV-2 prevalence in blood donors was nearly 19%. They found significant differences according to blood groups. In their study, researchers found a high rate among blood donors, demonstrating a high level of SARS-CoV2 exposure in the population [121].

Between 2015 and 2016, a cross-sectional study and a total of 910 healthy and eligible Saudi male blood donors were selected from the blood banks of Hira General Hospital and Holy Makkah Regional Laboratory. The researchers studied the prevalence of dengue virus and its serotypes. The overall prevalence was 3.2 % and 2.3 % for primary and secondary infections [122].

3. CONCLUSION

In Middle Eastern countries, transfusion-transmitted infection remains a formidable problem. A similarly wide constellation of economic and operational challenges in the area parallels the diverse array of pathogens; this calls for a systemic solution that, as proposed by the WHO, involves regulatory, structural, and training initiatives. The contribution of creative, tailored methods, such as donor recruiting, and innovations, such as rapid testing, which aim to make substantial gains in the future, should not be ignored. In order to be both suitable and effective, initiatives will need to be adapted to that of the region. This depends on awareness within the continent of the enormous heterogeneity.

4. LIMITATION

Regarding this research's limitations, a poorly organized paper file and a computerized database are the main difficulties we encountered during our study. This literature review did not involve projects for university study and theses from students. Also, not all TTIs, such as Leishmaniasis, Human T-cell lymphotropic virus 1 and 2, Herpes Viruses, and Cytomegalovirus, have not been covered. Besides, in order to reduce the effect of studies with small sample sizes on the estimated prevalence, we excluded studies with fewer than 1,000 participants.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Tariq S, Jawed S. Knowledge and attitude of blood donation among female medical students in Faisalabad. J Pak Med Assoc. 2018;68(1):65–70.
2. Siddiqui FM, Siddiqui N, Oluwatayo O, Jabeen S, Qadir SM. Prevalence of Transfusion-Transmissible Infections among Voluntary Blood Donors in Tertiary Health-Care Facility in Islamabad. Pakistan J Clin Trials. 2019;9(383)2.
3. Organization WH. Blood donor selection: Guidelines on assessing donor suitability for blood donation. World Health Organization; 2012.
4. Cheraghali AM. Blood safety concerns in the Eastern Mediterranean region. Hepat Mon. 2011;11(6):422.
5. Fallahian F, Najafi A. Epidemiology of hepatitis C in the Middle East. Saudi J Kidney Dis Transplant. 2011;22(1):1.
6. Babanejad M, Izadi N, Najafi F, Alavian SM. The HBsAg prevalence among blood donors from Eastern Mediterranean and Middle Eastern countries: A systematic review and meta-Analysis. Hepat Mon. 2016;16(3).
7. Habibzadeh F. Blood transfusion in the middle east. Lancet; 2013. Available:http://download.thelancet.com/flatcontentassets/middle-east/June13_MiddleEastEd.pdf,
8. Qirbi N, Hall AJ. Epidemiology of hepatitis B virus infection in the Middle East. EMHJ-Eastern Mediterr Heal Journal. 2001;7(6):1034-1045.
9. Darbandi A, Mashati P, Yami A, Gharehbaghian A, Namini MT, Gharehbaghian A. Status of blood transfusion in World Health Organization-Eastern Mediterranean Region (WHO-EMR): Successes and challenges. Transfus Apher Sci. 2017;56(3):448–453.
10. Boukef K. Overall strategy for blood safety and availability; 2006.
11. Allison RD, Teleb N, Al Awaidy S, Ashmony H, Alexander JP, Patel MK. Hepatitis B control among children in the Eastern Mediterranean Region of the World Health Organization. Vaccine. 2016;34(21):2403–2409.
12. Organization WH. Universal access to safe blood transfusion. 2008 World Heal. Organ. Geneva; 2007.
13. Mathers BM, et al. Estimating the level of HIV prevention coverage, knowledge and protective behavior among injecting drug users: What does the 2008 UNGASS reporting round tell us?, JAIDS J Acquir Immune Defic Syndr. 2009;52:132–142.
14. Alavian SM, Tabatabaei SV, BAGHERI LK. Epidemiology of HCV infection among thalassemia patients in eastern Mediterranean countries: A Quantitative Review of Literature; 2010.
15. Zaheer HA, Waheed U. Blood safety system reforms in Pakistan. Blood Transfus. 2014;12(4):452.
16. Ghani E, Rathore MA, Khan SA. Trends in human immunodeficiency virus seroprevalence in blood donors in northern Pakistan. Public Health. 2016;131:71–74.
17. Sultan F, Mehmood T, Mahmood MT. Infectious pathogens in volunteer and replacement blood donors in Pakistan: a ten-year experience. Int J Infect Dis. 2007;11(5):407–412.
18. Saleem T, Syed M, Ishaque S. Blood transfusion practices: leasing life or injecting death. J Pak Med Assoc. 2009;59(6):421–422.

19. Aabdien M, et al. Prevalence and trends of transfusion transmissible infections among blood donors in the State of Qatar, 2013–2017. BMC Infect Dis. 2020;20(1):1–9.
20. Organization WH. Global status report on blood safety and availability 2016. Geneva World Heal Organ; 2017.
21. Vučetić D, et al. Transfusion-transmissible infections among Serbian blood donors: declining trends over the period 2005–2017. Blood Transfus. 2019;17(5):336,
22. Stramer SL, et al. Emerging infectious disease agents and their potential threat to transfusion safety. Transfusion. 2009;49:1S-29S,
23. Kamel N, Rageh F. Transfusion-Transmissible Infections: Seroprevalence among Donors in an Egyptian University Blood Bank. Suez Canal Univ Med J. 2019;22(1);79–84.
24. Song Y, Bian Y, Petzold M, Ung COL. Prevalence and trend of major transfusion-transmissible infections among blood donors in Western China, 2005 through 2010. PLoS One. 2014;9(4):94528.
25. Shrestha PN. Transmission of HIV through blood and blood products in the Eastern Mediterranean Region. EMHJ-Eastern Mediterr Heal Journal. 1996;2(2):283-289.
26. Cheraghali AM, Abolghasemi H. Plasma fractionation, a useful means to improve national transfusion system and blood safety: Iran experience. Haemophilia. 2009;15(2):487–493.
27. El Gilany AH, El Fedawy S. Bloodborne infections among student voluntary blood donors in Mansoura University, Egypt. EMHJ-Eastern Mediterr Heal Journal. 2006;12(6):742-748.
28. Eissa SA, Abdel Meguid LM, Ebeid SM, Abou Elfetouh RM, Abdel Moneim GM. National Cancer Institute experience in healthy Egyptian blood donors as regards blood group frequencies and seroprevalence of hepatitis b virus, hepatitis C Virus & HIV: 10 year evaluation. J Egypt Natl Canc Inst. 2007;19(1):71–76.
29. Senosy S. Prevalence of HIV among blood donors at beni-suef university hospital blood bank, Egypt. J Egypt Public Health Assoc. 2015;90:157–160.
30. Kafi-abad SA, Rezvan H, Abolghasemi H, Talebian A. Prevalence and trends of human immunodeficiency virus, hepatitis B virus, and hepatitis C virus among blood donors in Iran, 2004 through 2007. Transfusion. 2009;49(10):2214–2220.
31. B Uzun, Güngör S, Demirci M. Seroprevalence of transfusion transmissible infections among blood donors in western part of Turkey: a six-year study. Transfus Apher Sci Off J World Apher Assoc Off J Eur Soc Haemapheresis. 2013;49(3):511–515.
32. Al-Charrakh A, Talib Al-Nafakh R, Alfadhul S. Seroprevalence of HBV, HCV, and HIV among blood donors in main blood bank in Najaf Province, Iraq. Indian J Public Heal Res Dev. 2019;10:385–390.
33. Khattab MA, Eslam M, Sharwae MA, Hamdy L. Seroprevalence of hepatitis C and B among blood donors in Egypt: Minya Governorate, 2000-2008. Am J Infect Control. 2010;38(8):640–641.
34. Ameen R, et al. Prevalence of viral markers among first-time Arab blood donors in Kuwait. Transfusion. 2005;45(12):1973–1980.
35. Maghsudlu M, Nasizadeh S, Abolghasemi H, Ahmadyar S. Blood donation and donor recruitment in Iran from 1998 through 2007: ten years' experience. Transfusion. 2009;49(11):2346–2351.
36. Kafi-Abad SA, Rezvan H, Abolghasemi H. Trends in prevalence of hepatitis B virus infection among Iranian blood donors, 1998–2007. Transfus Med. 2009;19(4):189–194.
37. Kafi-abad SA, Rezvan H, Abolghasemi H. Trends in prevalence of hepatitis B virus infection among Iranian blood donors, 1998-2007. Transfus Med. 2009;19(4):189–194.
38. Mohammadali F, Pourfathollah AA. Changes in frequency of HBV, HCV, HIV and syphilis infections among blood donors in Tehran province 2005 - 2011. Arch Iran Med. 2014;17(9):613–620.
39. Gurol E, Saban C, Oral O, Cigdem A, Armagan A. Trends in hepatitis B and hepatitis C virus among blood donors over 16 years in Turkey. Eur J Epidemiol. 2006;21(4):299–305.
40. Tigen ET, Doğru A, Karadağ FY. Hepatitis B, Hepatitis C and human immunodeficiency virus prevalences among first time blood donors in Istanbul, Turkey, 2004-2011. Transfus Apher Sci Off J World Apher Assoc Off J Eur Soc Haemapheresis. 2015;53(2):176–179.
41. Dray X, Dray-Spira R, Bronstein JA, Mattera D. Prevalences of HIV, hepatitis B

and hepatitis C in blood donors in the Republic of Djibouti. Med Trop (Mars). 2005;65:39–42.
42. Mujeeb SA, Pearce MS. Temporal trends in hepatitis B and C infection in family blood donors from interior Sindh, Pakistan. BMC Infect Dis 2008;8(1):43.
43. Fawzi Z, et al. Survey of Hepatitis Markers Among Donors in the State of Qatar. Qatar Med J. 2007;2007(2).
44. Lannan KL, Sahler J, Spinelli SL, Phipps RP, Blumberg N. Transfusion immunomodulation--the case for leukoreduced and (perhaps) washed transfusions. Blood Cells Mol Dis. 2013;50(1):61–68.
45. Fong IW. Blood transfusion-associated infections in the twenty-first century: New challenges. Curr Trends Concerns Infect Dis. 2020;191–215.
46. Dodd RY. Emerging pathogens and their implications for the blood supply and transfusion transmitted infections. Br J Haematol. 2012;159(2):135–142.
47. Das S, Kale M, Beena PM, Kumar H. Bacterial contamination of platelet at university hospital: A prospective surveillance study. Int J Curr Microbiol App Sci. 2015;4:805–812.
48. Tayou C. Syphilis and Blood Safety in Developing Countries. Syph - Recognition Descr Diagnosis, no; 2011.
49. Kim JK, Choi SR, Lee HJ, Kim DH, Yoon MS, Jo HS. Congenital syphilis presenting with a generalized bullous and pustular eruption in a premature newborn. Annals of dermatology. 2011;23(1):127-30.
50. Brant LJ, Bukasa A, Davison KL, Newham J, Barbara JA. Increase in recently acquired syphilis infections in English, Welsh and Northern Irish blood donors. Vox Sang. 2007;93(1):19–26.
51. Organization WH. Global incidence and prevalence of selected curable sexually transmitted infections-2008. Geneva World Heal Organ; 2012.
52. Samkange-Zeeb FN, Spallek L, Zeeb H. Awareness and knowledge of sexually transmitted diseases (STDs) among school-going adolescents in Europe: a systematic review of published literature. BMC Public Health. 2011;11:727.
53. Nada H. Seroprevalence of HBV, HCV, HIV and Syphilis Markers among Blood Donors at Suez Canal University Hospital Blood Bank. J Blood Disord Transfus. 2014;5(1):1–5.
54. Öner S, Yapici G, Şaşmaz CT, Kurt AÖ, Buğdayci R. Hepatitis B, hepatitis C, HIV, and VDRL seroprevalence of blood donors in Mersin, Turkey. Turkish J Med Sci. 2011;41(2):335–341.
55. Bhatti FA, Ullah Z, Salamat N, Ayub M, Ghani E. Anti-hepatits B core antigen testing, viral markers, and occult hepatitis B virus infection in Pakistani blood donors: Implications for transfusion practice. Transfusion. 2007; 47(1):74–79.
56. Singh K, Ghosh S, Verma M, Gupta S. Imaging findings in a case of synovial chondromatosis of temporomandibular joint. Asian J Transfus Sci, 2010;4(2):73–77.
57. Antwi-Baffour S, Kyeremeh R, Amoako AP, Annison L, Tetteh JOM, Seidu MA. The incidence of malaria parasites in screened donor blood for transfusion. Malar Res Treat. 2019; 1457406.
58. Elyamany G, Al Gharawi A, Alrasheed M, Alsuhaibani O. Blood donors screening for malaria in non-endemic area in the Kingdom of Saudi Arabia: Is it necessary to introduce immunological testing? Electron Physician. 2016;8(2)2001.
59. Grande R, Petrini G, Silvani I, Simoneschi B, Marconi M, Torresani E. Immunological testing for malaria and blood donor deferral: the experience of the Ca'Granda Polyclinic Hospital in Milan. Blood Transfus. 2011;9(2):162.
60. WH Organization, WHO global malaria programme: world malaria report 2010. WHO global malaria programme: World Malaria Report. 2010;204.
61. Dubey JP, Jones JL. Toxoplasma gondii infection in humans and animals in the United States. Int J Parasitol. 2008;38(11):1257–1278.
62. Hill D, Dubey JP. Toxoplasma gondii: Transmission, diagnosis and prevention. Clin. Microbiol Infect Off Publ Eur Soc Clin Microbiol Infect Dis. 2002;8(10):634–640.
63. Flegr J, Prandota J, Sovičková M, Israili ZH. Toxoplasmosis--A global threat. Correlation of latent toxoplasmosis with specific disease burden in a set of 88 countries. PLoS One. 2014;9(3):90203–90203.
64. Sadooghian S, et al. Prevalence of toxoplasma gondii infection among healthy blood donors in northeast of Iran. Iran J Parasitol. 2017;12(4):554–562.

65. Pappas G, Roussos N, Falagas ME. Toxoplasmosis snapshots: global status of Toxoplasma gondii seroprevalence and implications for pregnancy and congenital toxoplasmosis. Int J Parasitol. 2009;39(12):1385–1394.
66. Ahmadpour E, et al. Toxoplasmosis in immunocompromised patients in iran: A systematic review and meta-analysis. J Infect Dev Ctries. 2014;8(12):1503–1510.
67. Jumaian NF. Seroprevalence and risk factors for Toxoplasma infection in pregnant women in Jordan. East Mediterr Heal J = La Rev sante la Mediterr. Orient = al-Majallah al-sihhiyah li-sharq al-mutawassit. 2005;11(1–2):45–51.
68. El Deeb HK, Salah-Eldin H, Khodeer S, Allah AA. Prevalence of Toxoplasma gondii infection in antenatal population in Menoufia governorate, Egypt. Acta Trop. 2012;124(3):185–191.
69. Mahmoudvand H, et al. Seroprevalence and risk factors of Toxoplasma gondii infection among healthy blood donors in south-east of Iran. Parasite Immunol. 2015;37(7):362–367.
70. Jafari Modrek M, Mousavi M, Saravani R. Toxoplasma gondii Seroprevalence Among Blood Donors in Zahedan, Southeastern Iran. Int J Infect. 2014;1(2):21111.
71. Elsheikha HM, Azab MS, Abousamra NK, Rahbar MH, Elghannam DM, Raafat D. Seroprevalence of and risk factors for Toxoplasma gondii antibodies among asymptomatic blood donors in Egypt. Parasitol Res. 2009;104(6):1471–1476.
72. Wiwanitkit V. Novel Middle East respiratory syndrome coronavirus. J Formos Med Assoc. 2014;113(1):65.
73. Al Hajjar S, Memish ZA, McIntosh K. Middle East respiratory syndrome coronavirus (MERS-CoV): A perpetual challenge. Ann Saudi Med. 2013.33(5):427–436.
74. Shang G, Biggerstaff BJ, Yang B, Shao C, Farrugia A. Theoretically estimated risk of severe acute respiratory syndrome transmission through blood transfusion during an epidemic in Shenzhen, Guangdong, China in 2003. Transfus Apher Sci. 2007;37(3): 233–240.
75. Darnell MER, Taylor DR. Evaluation of inactivation methods for severe acute respiratory syndrome coronavirus in noncellular blood products. Transfusion. 2006;46(10):1770–1777.
76. Teo D, Ng LC, Lam S. Is dengue a threat to the blood supply?, Transfus Med. 2009;19(2):66–77.
77. Chen L, Wilson M. Non-vector transmission of dengue and other mosquito-borne flaviviruses. Dengue Bull; 2005.
78. Chuang V, et al. Review of dengue fever cases in Hong Kong during 1998 to 2005. Hong Kong Med J. 2008;14:170–177.
79. Tambyah PA, Koay ESC, Poon MLM, Lin RVTP, Ong BKC. Dengue hemorrhagic fever transmitted by blood transfusion. The New England Journal of Medicine.2008;359(14):1526–1527.
80. Chang L, Yan Y, Wang L. Coronavirus disease 2019: Coronaviruses and blood safety. Transfus Med Rev; 2020.
81. Wang W, et al. Detection of SARS-CoV-2 in different types of clinical specimens. Jama. 2020;323(18):1843–1844.
82. Zhang W, et al. Molecular and serological investigation of 2019-nCoV infected patients: implication of multiple shedding routes. Emerg. Microbes Infect. 2020;9(1):386–389.
83. Huang C, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. Lancet. 2020;395(10223):497–506.
84. Katz LM. Is SARS-CoV-2 transfusion transmitted? Transfusion. 2020;60(6):1111.
85. Kwon S, Kim E, Jung YS, Jang JS, Cho N. Post-donation COVID-19 identification in blood donors. Vox Sang; 2020.
86. Drosten C, et al. Identification of a novel coronavirus in patients with severe acute respiratory syndrome. N Engl J Med. 2003;348(20):1967–1976.
87. Organization WH, WHO recommendations on SARS and blood safety; 2003. Available:http//www. who. int/csr/sars/guidelines/bloodsafety/en
88. USF, Administration D. Revised recommendations for the assessment of donor suitability and blood product safety in cases of suspected severe acute respiratory syndrome (SARS) or exposure to SARS: Guidance for industry; 2003.
89. Organization WH. Global Situation Report-132 31 May 2020. A A Pract. 2020;01218.
90. Al-Riyami AZ, et al. The impact of COVID-19 pandemic on blood supplies and transfusion services in Eastern Mediterranean Region. Transfus Clin Biol; 2020.

91. Kwon SY, Kim EJ, Jung YS, Jang JS, Cho NS. Post-donation COVID-19 identification in blood donors. Vox Sang. 2020;601–602.
92. Alam M, El Din Masalmeh B. Knowledge, attitudes and practices regarding blood donation among the Saudi population. Saudi Med J. 2004;25(3):318–321.
93. Gader AMA, Momen AK, Hashash AJ. King Saud University Donor Drive: a creative stimulus on the way to a Saudi National Blood transfusion Service. Ann Saudi Med. 1988;8:403.
94. UNAIDS. Global response progress construction of core indicators for monitoring. 2012;1–61.
95. Alrajhi A. Human immunodeficiency virus in Saudi Arabia. Saudi Med J. 2004;25:1559–1563.
96. Abu-Raddad LJ, et al. Epidemiology of HIV infection in the Middle East and North Africa. AIDS. 2010.24(2):5-23.
97. Al Mazroa MA, et al. HIV case notification rates in the kingdom of Saudi Arabia over the past decade (2000-2009). PLoS One. 2012;7(9):7–11.
98. Ministry of Health. Country progress report on HIV / AIDS Ctry Prog Rep HIV/AIDS. 2018;4:1–45.
99. El-HazmiMM. Prevalence of HBV, HCV, HIV-1, 2 and HTLV-I/II infections among blood donors in a teaching hospital in the Central region of Saudi Arabia. Saudi Med J. 2004;25(1):26–33.
100. Alhuraiji A, Alaraj A, Alghamdi S, Alrbiaan A, Alrajhi AA. Viral hepatitis B and C in HIV-infected patients in Saudi Arabia," Ann. Saudi Med. 2014;34(3):207–210.
101. Madani TA. Hepatitis C virus infections reported in Saudi Arabia over 11 years of surveillance. Ann Saudi Med. 2007;27(3):191–194.
102. Madani TA. Trend in incidence of hepatitis B virus infection during a decade of universal childhood hepatitis B vaccination in Saudi Arabia. Trans R Soc Trop Med Hyg. 2007;101(3):278–283.
103. Abdelaal M, Rowbottom D, Zawawi T, Scott T, Gilpin C, Epidemiology of hepatitis C virus: A study of male blood donors in Saudi Arabia. Transfusion. 1994;34(2):135–137.
104. Bashawri LAM, Fawaz NA, Ahmad MS, Qad i AA, Almawi WY. Prevalence of seromarkers of HBV and HCV among blood donors in eastern Saudi Arabia, 1998-2001. Clin Lab Haematol. 2004;26(3)225–228.
105. Shobokshi OA, Serebour FE, Al-Drees AZ, Mitwalli AH, Qahtani A, Skakni LI. Hepatitis C virus seroprevalence rate among Saudis. Saudi Med J. 2003;24(2):81-6.
106. Hänscheid T, Valadas E, Grobusch MP. Polymerase chain reaction for screening blood donors at risk for malaria: safe and useful? Emerg Infect Dis. 2002;8(8):872.
107. Arafa AS. Post-operative transfusion malaria. Trop Geogr Med. 1992;44(1–2):58.
108. Vijayakumar E, Shaheed MM, Katugampola MS, Haque KN. Transfusion malaria in newborn infants: report of two cases. Ann Saudi Med. 1990;10(5):569–572.
109. Alkhalife IS. Imported malaria infections diagnosed at the malaria referral laboratory in Riyadh, Saudi Arabia. Saudi Med J. 2003;24(10):1068–1072.
110. Saeed AA, Al Rasheed AM, Al Nasser I, Al Onaizi M, Al Kahtani S, Dubois L. Malaria screening of blood donors in Saudi Arabia. Ann Saudi Med. 2002;22(5–6):329–332.
111. Alkhunaizi AM, Al-Tawfiq JA, Al-Shawaf MH. Transfusion-transmitted malaria in a kidney transplant recipient. How safe is our blood transfusion? Saudi Med J. 2008;29(2):293–295.
112. Al-Amari OM. Prevalence of antibodies to Toxoplasma gondii among blood donors in Abha, Asir Region, south-western Saudi Arabia. J Egypt Public Health Assoc. 1994;69(1–2):77–88.
113. Makki SM, Abdel-Tawab AH. Anti-Toxoplasma gondii antibodies among volunteer blood donors in eastern Saudi Arabia. J Egypt Soc Parasitol. vol. 2010;40(2):401–412.
114. Mohamed K, et al. Seroprevalence of Toxoplasma gondii Infection in Blood Donors in Makkah Al Mukarramah. Asian J Epidemiol. 2018;12(1):25–31.
115. Chaudhary HT, Hasnain S. Can dipstick method help in bacterial detection in platelet bags? A tertiary care hospital's blood bank review, J Pak Med Assoc. 2016;66(10)1258–1261.
116. Madani TA, Al-Mazrou YY, Al-Jeffri MH, Al Huzaim NS. Epidemiology of the human immunodeficiency virus in Saudi Arabia; 18-year surveillance results and prevention from an Islamic perspective. BMC Infect Dis. 2004;4:25.
117. Madani TA. Sexually transmitted infections in Saudi Arabia. BMC Infect. Dis. 2006;6: 3.

118. Aburizaiza AS, et al. Investigation of anti–Middle East respiratory syndrome antibodies in blood donors and slaughterhouse workers in Jeddah and Makkah, Saudi Arabia, fall 2012. J Infect Dis. 2014;209(2):243–246.
119. Al-Abdallat MM, et al. Hospital-associated outbreak of Middle East respiratory syndrome coronavirus: A serologic, epidemiologic, and clinical description. Clin Infect Dis. 2014;59(9):1225–1233.
120. Yahia AIO. Management of blood supply and demand during the COVID-19 pandemic in King Abdullah Hospital, Bisha, Saudi Arabia. Transfus Apher Sci. 2020;59(5):102836.
121. Mahallawi WH, Al-Zalabani AH. The seroprevalence of SARS-CoV-2 IgG antibodies among asymptomatic blood donors in Saudi Arabia. Saudi J Biol Sci; 2020.
122. Ashshi AM. The prevalence of dengue virus serotypes in asymptomatic blood donors reveals the emergence of serotype 4 in Saudi Arabia. Virol J. 2017;14(1):1–8.
123. Ankra-Badu GA, Ahmad M, Sowayan S, Bashawri L. Demographic characteristics of seropositive donors in Al-Khobar. Ann. Saudi Med. 2001;21(1–21):13–116.
124. Al-Hababi FH, Al-Deailej IM, Al-Sulatan HA, Al-GhamdiYA, Al-Dossari KM. Human T lymphotropic virus antibodies seroprevalence among healthy blood donors and high risk groups at Riyadh regional laboratory in Riyadh, Saudi Arabia. Saudi Crit Care J. 2020;4(2): 73.
125. Shabir Ahmad et al. The prevalence of transfusion-transmitted infections and nucleic acid testing among blood donors in Majmaah, Saudi Arabia. J Infect Public Health; 2018.
126. Degnah AA, et al. Seroprevalence of MERS-CoV in healthy adults in western Saudi Arabia, 2011–2016. J Infect Public Health; 2020.

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