New Emirates Medical Journal

Content list available at: https://newemiratesmedicaljournal.com

CROSS SECTIONAL STUDY

Prevalence of ABO Blood Grouping among Hemodialysis Patients in Dubai

Fakhriya Alalawi[1,*], Kashif Gulzar[1], Waleed Mohamed Galaleldin[1] and Amna Alhadari[1]

[1]*Department of Nephrology, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates*

Abstract:

Background:

Beyond their vital role in blood transfusion, ABO antigens were speculated to be involved in developing various human illnesses, including infectious, neoplastic, cardiovascular, and many others. Many researchers attempted to highlight the relationship between kidney disease and ABO phenotypes. The majority of these reports showed a predominance of blood group O antigen among patients with chronic kidney disease, while few had opposed these findings. We aimed in this study to elaborate on blood group typing among our hemodialysis patients and whether it has a prognostic effect on the overall mortality.

Methods:

This is an observational, cross-sectional, retrospective study among chronic adult hemodialysis patients being dialyzed at Dubai Hospital over the past six months, from Jan 2021 till June 2021. The patient's demographic characteristics (age, sex, etiology of chronic kidney disease, medical comorbidities, and blood groups) were retrieved using an electronic hospital medical record system.

Results:

Our study population constituted 224 hemodialysis patients; their mean age was 55.4 years (16-94 years), 83.6% were UAE nationals, and 59.8% were males. Diabetic nephropathy was the etiology of end-stage kidney disease in 46%. ABO blood group distribution among our study population was as follows; group O was the commonest (45%), followed by group B positive (23%) and A Positive (20.9%). Among the UAE national patients group, O+ constitutes 46.9%, followed by B+ in 24%, and A+ in 21%. Nevertheless, group O+ was still the commonest among the non-national hemodialysis patients in 37.7%, A+ in 28.8%, and B+ in 24.4%. Additionally, group O-positive was the predominant group among all diabetic dialysis patients (47%). Nine patients died during the study period of different causes; out of them, 4 patients (44.4%) had group O positive.

Conclusion:

Blood group O was the commonest blood group among our hemodialysis patients. Additionally, it was the commonest group in all diabetic dialysis patients. More studies from Arab countries are needed to comprehend the relationship between ABO blood phenotypes and kidney disease and whether certain blood groups have any role in a patient's progression to ESKD.

Keywords: ABO group, HD: hemodialysis, ESKD: End-Stage Kidney Disease, Mortality, Blood group phenotype, Diabetic nephropathy.

Article History	Received: December 10, 2021	Revised: January 5, 2022	Accepted: January 29, 2022

1. INTRODUCTION

Worldwide, 2.6 million people are suffering from End-stage kidney disease (ESKD), which includes 11.5% population of UAE [1, 2]. Diabetes mellitus, hypertension, obesity, and glomerulonephritis are the commonest causes of ESKD in Dubai and the world [3, 4]. Historically, the ABO antigen system was widely used for blood transfusion and organ transplantation. Also, increasing evidence accumulated over the past few decades suggests that these antigens are implicated in developing many human illnesses, including infectious, neoplastic, cardiovascular, neurological diseases, and many others [5]. Furthermore, ABO blood group antigens have been accounted for inflammation and infections, primarily involved in developing and advancing immune-mediated diseases [6].

Similarly, many investigators tried to highlight the association between kidney diseases and ABO phenotypes. The majority of these reports showed a prevalence of blood group O antigen among patients with renal failure, while few had

* Address correspondence to this author at the Department of Nephrology, Dubai Hospital, Dubai Health Authority, Dubai, United Arab Emirates;
E-mail: fjalalawi08@yahoo.co.uk

opposed these findings. Therefore, we aimed in this study to elaborate more on blood group typing among our hemodialysis patients and whether it has a significant prognostic effect on the overall mortality.

2. METHODS

2.1. Study Design and Participants

This is a retrospective, cross-sectional, observational study among chronic adult hemodialysis patients being dialyzed in our center at Dubai Hospital over the past six months, from Jan 2021 till June 2021, including patients who died during this period. All adults patients on chronic hemodialysis irrespective of their age, gender, nationality, and duration of dialysis were enrolled. This study excluded less than 14 years old and renal transplant recipients.

2.2. Data Collection

Medical records of the study population were reviewed using electronic medical records (Epic Hyperspace; SALAMA) to retrieve patients' demographic characteristics (such as age, sex, etiology of chronic kidney disease (CKD), and other medical comorbidities), in addition to blood group data (Table **1**).

2.3. Statistical Analysis

Continuous variables were defined as median and interquartile range (IQR) values, and categorical variables were presented as frequency and percentage. Independent t-test and Mann Whitney test were utilized for continuous variables, and categorical data were matched with the help of Pearson's chi-square test or Fischer's exact test. The relationship between mortality and blood group in hemodialysis patients was analyzed using Cox proportional hazard regression. A p-value of <0.05 was considered statistically significant. SPSS version-20 was used for statistical analysis.

3. RESULTS AND DISCUSSION

Nine hemodialysis patients were excluded from the study because of the unavailability of the blood group in their records; thus, a total of 224 patients were included. Their median age was 56 years (16-94) old. Male patients were 59.82% (n=134) out of which 83.6% (n=179) were from U.A.E. The most common cause of end-stage kidney disease (ESKD) is diabetic nephropathy (n=104, 46.42%), followed by chronic glomerulonephritis (n= 67, 29.91%). Predominant comorbid were hypertension (148, 66.07%) and diabetes mellitus (131, 58.48%).

The distribution of the ABO group among hemodialysis populace was as follows (Table **2**); group O positive were the commonest among our dialysis population, which consists of 101 patients (45.08%), followed by group B positive and A positive in 52 (23.21%), 47(20.9%) patients respectively, while 24 (11.62%) patients had less common blood groups {A-ve (n=4,1.8%), AB -ve (n=2, 0.9%), AB +v (n=15, 6.7%), and B -ve (n=3, 1.3%)}. In our study population, Blood group O positive remained the commonest among UAE nationals (46.9%) and expats (37.7%) as well, while A+ and B+ were the second most common blood group in expats (28%) and UAE (24%) nationals, respectively. Additionally, O-positive blood group was the predominant among male (n=62, 46.26%), diabetics (n=66, 50.38%), and hypertensive patients (n=64,43.24%). Total nine (4.01%) hemodialysis patients expired during the study period. The mortality rate was 3.96% (n=4, consisting of 44.4% of the total mortality) among O-positive hemodialysis patients and 4.25% (n=2) and 3.84% (n=2) in A+ and B+, respectively (Fig. **1**).

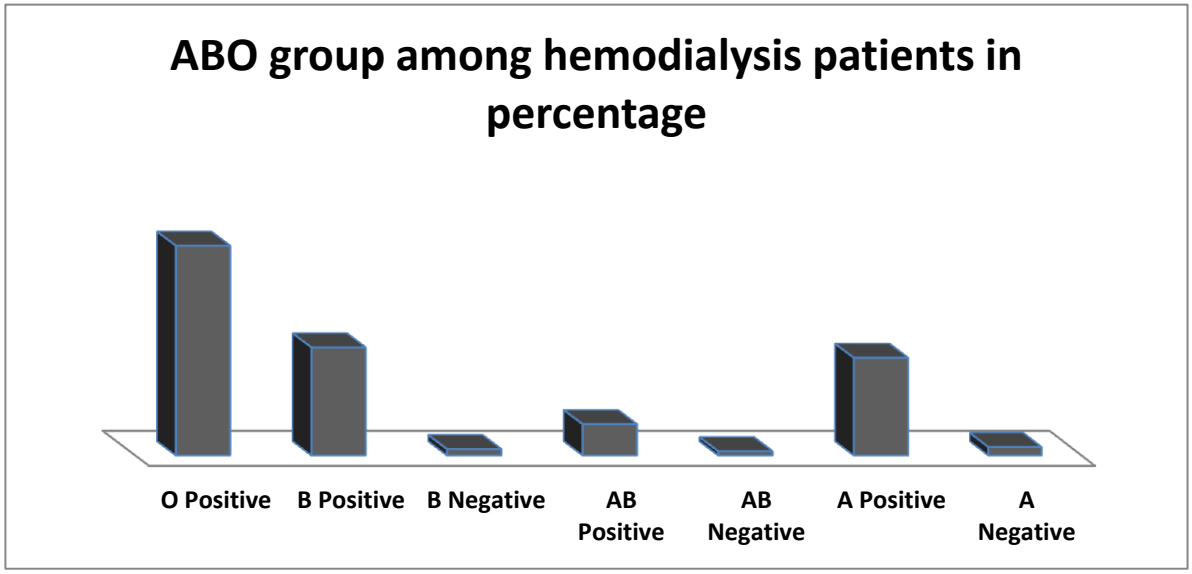

Fig. (1). ABO group distribution among hemodialysis patients.

Table 1. Baseline hemodialysis patient's characteristics (n=224).

Age in Years, Median (IQR)	56(16-94)
Gender	-
Male (n, %)	134(59.82)
Nationality	-
UAE	179(79.91)
Others	45(20.90)
Cause of Renal Failure (n %)	-
D.Nephropathy	104(46.42)
A.D.P.K.D	2(0.89)
Alport's Syndrome	1(0.47)
Chronic GN	67(29.91)
Chronic Pyelonephritis	2(0.89)
Obstructive uropathy	8(3.57)
Hypoplastic kidneys	5(2.23)
Thrombotic microaniopathy	3(1.33)
FSGS	7(3.12)
MN	2(0.89)
Pauci immune	2(0.89)
Ig A Nephropathy	3(1.33)
SLE	6(2.67)
Others	12(5.34)
Co-Morbid (n %)	-
Diabetes Melitus	131(58.48)
Hypertension	148(66.07)
Blood Group (n %)	-
A negative	4(1.78)
A Positive	47(20.98)
AB negative	2(0.89)
AB positive	15(6.69)
B negative	3(1.33)
B Positive	52(23.21)
O Positive	101(45.08)

Table 2. Group distribution according to nationality, gender, co-morbid and mortality rate.

	A Positive (47, 20.98%)	**A-Negative (4,1.78%)**	**AB Positive (15, 6.69%)**	**AB Negative (2, 0.89%)**	**B Positive (52, 23.21%)**	**B Negative (3, 1.33%)**	**O Positive (n=101,45.08)**
Nationality (n,%)	-	-	-	-	-	-	-
UAE (n=179)	34 (18.99%)	4(2.23)	12(6.70)	1(0.55)	41(22.90%)	3(1.67)	84(46.92%)
Others (n=45)	13 (28.88%)	0(0)	3(6.66)	1(2.22)	11(24.44)	0(0)	17(37.78)
Gender	-	-	-	-	-	-	-
Male (n=134)	29 (21.64)	3(2.23)	10(7.46)	1(0.74)	28(20.89)	1(0.74)	62(46.26)
Female (n=90)	18 (20)	1(1.11)	5(5.55)	1(1.11)	24(26.66)	2(2.22)	39(43.33)
Co-morbid	-	-	-	-	-	-	-
DM (n=131)	23 (17.55)	4(3.05)	8(6.10)	1(0.76)	29(22.13)	0(0)	66(50.38%)
HTN (n=90)	29 (19.59)	3(2.02)	12(8.10)	1(0.67)	37(25)	2(1.35)	64(43.24)
	-	-	-	-	-	-	-
Died (n=9)	2 (0.89)	0(0)	0(0)	0(0)	2(0.89)	1(33.33)	4(1.785)

4. DISCUSSION

ABO phenotype is crucial for blood transfusion and organ transplant compatibility since it was first described by the Austrian Nobel Prize Karl Landsteiner in 1900 [7]. The ABO grouping system is composed of 3-main alleles, two co-dominants A and B and one recessive O, and is organized by a solitary gene positioned on the terminal part of the long arm of chromosome-9 [8]. The blood groups antigens are glycolipids and glycoproteins expressed on the surface of red blood cells and other tissues, including platelets, the epithelium, vascular

endothelium, and sensory neurons [9]. Blood group O-positive is the most popular blood group globally; 37.37% of the world population carry this blood group. Its prevalence is up to 100% observed in Peru. In the Arab world, its prevalence in Egypt, Saudi Arabia, and UAE is 52%, 48%, and 44%, respectively, while the least prevalence is reported in Hungry, 27% [10, 11].

ABO antigens might be involved in the progress of many human disorders, including infectious, neoplastic, cardiovascular, and neurological illnesses, though agreement about this association is not accepted universally [5]. Subjects with blood group-A were noticed to have an elevated risk for *H. pylori* infection, gastric cancers, and chronic atrophic gastritis and experienced more refractory iron deficiency anemia than other blood phenotypes [12, 13]. On the other hand, individuals with blood group-O have a greater risk for peptic ulcers and raised inflammatory reactions to *H. pylori* [14, 15]. Expanding proof hypothesize that those blood group antigens may fill in as receptors for bacteria, parasites, and different viruses [6, 16]. It is possible to influence host-pathogen interactions at various levels of glycosylation since infectious organisms frequently use cell surface glycosylated receptors for their connection, although exact mechanisms triggering these immune-mediated diseases are not yet known [17]. Such association is believed to exist between P. falciparum malaria and people with blood group O, where group O individuals will, in general, have favorable outcomes and better survival for P. falciparum malaria compared to group A subjects [18, 19]. This was further validated in subsequent studies [20, 21]. Similarly, Ray *et al*. reported a low risk of severe COVID-19 disease and related mortality in individuals carrying type O blood group versus other blood groupings in 225,556 Canadian patients [22]. In contrast, Coluk *et al*. reported an equal risk of COVID-19 disease among all blood group phenotypes**;** however, his sample included 211 patients [23]. On the contrary, patients with group O confer a greater possibility of severe infection and complications from Vibrio cholera than non-O-blood group carriers [24]. One more field that has been comprehensively studied over the past decades is the association between the ABO blood grouping and malignancies, with the steadiest association being seen between participants holding blood group A, AB, or B and the high incidences of pancreatic and gastric cancers, compared with blood group O subjects [25 - 27]. Molecular dynamics-based methods are being used to understand the complex interaction of carbohydrates and protein within ABO antigens since these interactions might be important in defining an association between ABO phenotypes and other diseases [28]. Rajshri and colleagues investigated the conformational preferences of Lewis Y oligosaccharide blood group antigen and determined the molecular basis of its interaction with cholera toxin, which may help develop a potent cholera toxin inhibitor or vaccine to fight one of the oldest diseases [28]. Further studies had covered different additional areas of ABO phenotypes. Individuals with non-O blood phenotype carry an approximately twofold higher risk of venous thromboembolism (VTE) [29] and arterial thrombosis and trigger a high risk for myocardial infarction and cerebrovascular accidents, in a latest systematic review of 28 analysis enrolling 12,231 individuals admitted with ischemic stroke or myocardial infarction [30]. Additionally, in a retrospective case-control publication, the O blood group population has a 10% less risk of developing coronary artery disease [31]. Also, it protects atrial fibrillation patients from developing peripheral arterial thrombosis [32]. Similarly, there is an increased risk to acquire nonalcoholic fatty liver disease among non-O blood antigens than blood group O antigen carrying population [33]. In regards to kidney diseases, few studies highlighted such association. Hamed *et al*. in 1979, probably was the first to conduct a study to compare the ABO blood phenotype distribution among 184 patients with parenchymal kidney disease, confirmed by renal biopsy and 3,820 normal populations [34]. The appropriation of renal patients corresponding to the blood groups was considerably unique from the distribution of the ordinary subjects. The dissimilarity happened primarily in the B and O blood groups, showing a 7 percent increase in group B and a 10% decline in group-O in renal patients [34]. We observed a prevalence of blood group O positive in 45.08% and B positive in 23.21% of dialysis patients. Alanan U and Hasson *et al*. also reported O positive to be the most predominant group in their dialysis population, in 51.1% and 55%, respectively [35, 36]. Whereas Alhawary *et al*. found a prevalence of group A (45.7%), followed by group O (30.4%) in patients with renal failure. Additionally, he studied different variables in relation to ABO groups (HCT, MCV, Ferritin, BUN, Creatinine, phosphorous, calcium, albumin, and Sodium), and the association between all variables and blood groups of patients with renal failure were not statistically significant, except for potassium level, which was statistically high in patients with blood group A [37]. A recent analysis by Yang *et al*. in 2017, for patients with advanced IgAN, reported those with blood type O or A (non-B antigen group) to have a fast decline in kidney functions, compared to patients with type B/ or AB, and the relationship is independent to sex, age, systolic blood pressure (SBP), baseline eGFR or other variables. Furthermore, they had a higher systolic BP, lactate dehydrogenase, uric acid, higher C-reactive protein, and tumor necrosis factor-α than patients with type B/AB blood groups. Additionally, the non-B group was independently associated with increased risk for ESKD [6].

Table 3. Comparison of variables between dead and alive hemodialysis patients.

	Expired (n=9)	**Alive (n=215)**	**p-value**
Age in Years, median (IQR)	58.25(22-85)	55.13(16-92)	0.680848
Gender	-	-	-
Male (n, %)	5(55.55)	129(60)	0.125987
Nationality	-	-	-
UAE (n, %)	8(88.89)	171(8.41)	0.08

(Table 3) contd.....

Others (n, %)	1(11.11)	44(20.47)	0.07
Co-morbid (n, %)	-	-	-
Diabetes Mellitus	6(66.66)	125(58.13)	0.31
Hypertension	6(66.66)	142(66.04)	0.4
Blood Group (n, %)	-	-	-
A Positive	2(22.22)	45(20.93)	0.06
B negative	1(11.11)	2(0.93)	<0.05
B Positive	2(22.22)	50(23.25)	<0.06
O Positive	4(44.44)	97(45.11)	0.298

Whether our data reflects group O dominance in the UAE population, rather being a real dominance related to kidney diseases is possible, yet our dialysis center has different nationalities with different predominant blood groups in their countries. Nevertheless, in non-national hemodialysis patients, blood group O positive was still the commonest in 37.7%, followed by A+ 28.8%, then B+ 24.4%. Moreover, among our UAE national hemodialysis patients, group B+ is the second dominant group in 24%, followed by A+ in 21%, which is different from ABO distribution in the UAE general population, pointing out that certain blood groups have a particular affinity for dialysis patients. On the other hand, diabetic patients had a predominance of group O-positive in 47% of the cases, followed by group B-positive in 23% and group A-positive in 17%. In contrast, Bener *et al*. found B positive significantly more common among diabetics than the general population (25.7% *vs*. 20.4%, p= 0.01) [38]. Whether blood group O positive can lead to a worse prognosis for kidney disease in diabetic patients or not, this needs to be validated in further studies. Nine patients died during the study period of different causes. The mortality rate was only 1.78% (p=0.298, Table **3**) among the total dialysis patients with O-positive and 33% (1 out of 3 patients) in B negative dialysis patients; however, this was not statistically significant, and the sample size was less. In a large Canadian study in 1989, including 8,432 patients with ESKD, those with group AB were noted to have a low risk of death compared to other blood groups, although it was not statistically significant. Authors clarified this finding that patients with phenotype AB easily get a transplant than other blood groups [39].

CONCLUSION

Group O was the commonest blood group among our hemodialysis population. In addition, it was the commonest group among national and non-national patients and the commonest in all diabetic dialysis patients. However, these results remained crude, and more studies from Arab countries are necessary to comprehend the relationship between ABO blood phenotypes and kidney disease and if certain blood groups have any role in the patient's progression toward ESKD.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study was approved by the Dubai Scientific Research Ethics Committee of Dubai Health Authority, approval number DSREC-08/2021_13.

HUMAN AND ANIMAL RIGHTS

Not applicable.

CONSENT FOR PUBLICATION

Informed consent was waived.

STANDARDS OF REPORTING

STROBE guidelines and methodologies were followed in this study.

AVAILABILITY OF DATA AND MATERIALS

The data supporting the findings of this study are available within the article.

FUNDING

None.

CONFLICT OF INTEREST

All authors declare no conflict of interest, financial or otherwise

ACKNOWLEDGEMENTS

Declared none.

REFERENCES

[1] van der Tol A, Lameire N, Morton RL, Van Biesen W, Vanholder R. An international analysis of dialysis services reimbursement. Clin J Am Soc Nephrol 2019; 14(1): 84-93. [http://dx.doi.org/10.2215/CJN.08150718] [PMID: 30545819]

[2] Ali A. Demographics and key clinical characteristics of hemodialysis patients from the GULF cooperation council (GCC) participating in DOPPS. Nephrol Dial Transplant 2016; 31(Suppl. 1): i279-97.

[3] Wang J, Zhang L, Tang SC, *et al.* Disease burden and challenges of chronic kidney disease in North and East Asia. Kidney Int 2018; 94(1): 22-5. [http://dx.doi.org/10.1016/j.kint.2017.12.022] [PMID: 29573819]

[4] Alalawi F, Ahmed M, AlNour H, Noralla M, Alhadari A. Epidemiology of end-stage renal disease in Dubai: Single-center data. Saudi J Kidney Dis Transpl 2017; 28(5): 1119-25. [http://dx.doi.org/10.4103/1319-2442.215126] [PMID: 28937072]

[5] Franchini M, Bonfanti C. Evolutionary aspects of ABO blood group in humans. Clin Chim Acta 2015; 444: 66-71. [http://dx.doi.org/10.1016/j.cca.2015.02.016] [PMID: 25689219]

[6] Yang M, Xie J, Ouyang Y, *et al.* ABO blood type is associated with renal outcomes in patients with IgA nephropathy. Oncotarget 2017; 8(43): 73603-12. [http://dx.doi.org/10.18632/oncotarget.20701] [PMID: 29088730]

[7] Landsteiner K. Zur kenntnis der antifermentativen, lytischen und agglutinierenden wirkungendes des blutserums und der lymphe. Zentralbl Bakteriol 1900; 27: 357-63.

[8] Storry JR, Olsson ML. The ABO blood group system revisited: A review and update. Immunohematology 2009; 25(2): 48-59. [http://dx.doi.org/10.21307/immunohematology-2019-231] [PMID:

19927620]
[9] Franchini M, Liumbruno GM. ABO blood group: old dogma, new perspectives. Clin Chem Lab Med 2013; 51(8): 1545-53. [http://dx.doi.org/10.1515/cclm-2013-0168] [PMID: 23648637]
[10] DHA urges rare blood type holders to donate. ARN News Centre 2021. Available from: https://www.arnnewscentre.ae/news/uae/dha-urges-rare-blood-type-holders-to-donate/
[11] Blood type distribution by country - Wikipedia Enwikipediaorg 2021. Available from: https://en.wikipedia.org/wiki/Blood_type_distribution_by_country
[12] Nakao M, Matsuo K, Ito H, *et al.* ABO genotype and the risk of gastric cancer, atrophic gastritis, and helicobacter pylori infection. Cancer Epidemiol Biomarkers Prev 2011; 20(8): 1665-72. [http://dx.doi.org/10.1158/1055-9965.EPI-11-0213] [PMID: 21680535]
[13] Wang Z, Zhang L, Guo Z, *et al.* A unique feature of iron loss *via* close adhesion of Helicobacter pylori to host erythrocytes. PLoS One 2012; 7(11): e50314. [http://dx.doi.org/10.1371/journal.pone.0050314] [PMID: 23185604]
[14] Alkout AM, Blackwell CC, Weir DM. Increased inflammatory responses of persons of blood group O to Helicobacter pylori. J Infect Dis 2000; 181(4): 1364-9. [http://dx.doi.org/10.1086/315375] [PMID: 10753728]
[15] Aird I, Bentall HH, Mehigan JA, Roberts JAF, *et al.* The blood groups in relation to peptic ulceration and carcinoma of colon, rectum, breast, and bronchus. BMJ 1954; 2(4883): 315-21. [http://dx.doi.org/10.1136/bmj.2.4883.315] [PMID: 13182205]
[16] Garratty GE. Do blood groups have a biological role. Immunobiology of Transfusion Medicine 1994; 201-55.
[17] Vojdani A. A potential link between environmental triggers and autoimmunity. Autoimmune Dis 2014; 2014: 437231. [http://dx.doi.org/10.1155/2014/437231] [PMID: 24688790]
[18] Cserti CM, Dzik WH. The ABO blood group system and plasmodium falciparum malaria. Blood 2007; 110(7): 2250-8. [http://dx.doi.org/10.1182/blood-2007-03-077602] [PMID: 17502454]
[19] Rowe JA, Handel IG, Thera MA, *et al.* Blood group O protects against severe Plasmodium falciparum malaria through the mechanism of reduced rosetting. Proc Natl Acad Sci USA 2007; 104(44): 17471-6. [http://dx.doi.org/10.1073/pnas.0705390104] [PMID: 17959777]
[20] Fry AE, Griffiths MJ, Auburn S, *et al.* Common variation in the ABO glycosyltransferase is associated with susceptibility to severe plasmodium falciparum malaria. Hum Mol Genet 2008; 17(4): 567-76. [http://dx.doi.org/10.1093/hmg/ddm331] [PMID: 18003641]
[21] Rowe JA, Opi DH, Williams TN. Blood groups and malaria: fresh insights into pathogenesis and identification of targets for intervention. Curr Opin Hematol 2009; 16(6): 480-7. [http://dx.doi.org/10.1097/MOH.0b013e3283313de0] [PMID: 19812491]
[22] Ray JG, Schull MJ, Vermeulen MJ, Park AL. Association between ABO and Rh blood groups and SARS-CoV-2 infection or severe COVID-19 illness: A population-based cohort study. Ann Intern Med 2021; 174(3): 308-15. [http://dx.doi.org/10.7326/M20-4511] [PMID: 33226859]
[23] Coluk Y, Hizli O, Gunaydın S, Yildirim G, Baysal E, Ozgen Hergul G. Association of blood subgroups with PCR test positivity and lung involvement in patients With COVID-19. Cureus 2021; 13(3): e14172. [http://dx.doi.org/10.7759/cureus.14172] [PMID: 33936883]
[24] Harris JB, Khan AI, LaRocque RC, *et al.* Blood group, immunity, and risk of infection with vibrio cholerae in an area of endemicity. Infect Immun 2005; 73(11): 7422-7. [http://dx.doi.org/10.1128/IAI.73.11.7422-7427.2005] [PMID: 16239542]
[25] Liumbruno GM, Franchini M. Hemostasis, cancer, and ABO blood group: The most recent evidence of association. J Thromb Thrombolysis 2014; 38(2): 160-6. [http://dx.doi.org/10.1007/s11239-013-1027-4] [PMID: 24233389]
[26] Edgren G, Hjalgrim H, Rostgaard K, *et al.* Risk of gastric cancer and peptic ulcers in relation to ABO blood type: A cohort study. Am J Epidemiol 2010; 172(11): 1280-5. [http://dx.doi.org/10.1093/aje/kwq299] [PMID: 20937632]
[27] Rizzato C, Campa D, Pezzilli R, *et al.* ABO blood groups and pancreatic cancer risk and survival: Results from the PANcreatic Disease Research (PANDoRA) consortium. Oncol Rep 2013; 29(4): 1637-44. [http://dx.doi.org/10.3892/or.2013.2285] [PMID: 23403949]
[28] Roy R, Ghosh B, Kar P. Investigating conformational dynamics of lewis Y oligosaccharides and elucidating blood group dependency of cholera using molecular dynamics. ACS Omega 2020; 5(8): 3932-42. [http://dx.doi.org/10.1021/acsomega.9b03398] [PMID: 32149220]
[29] Dentali F, Sironi AP, Ageno W, *et al.* Non-O blood type is the commonest genetic risk factor for VTE: Results from a meta-analysis of the literature. Semin Thromb Hemost 2012; 38(5): 535-48. [http://dx.doi.org/10.1055/s-0032-1315758] [PMID: 22740183]
[30] Dentali F, Sironi AP, Ageno W, Crestani S, Franchini M. ABO blood group and vascular disease: An update. Semin Thromb Hemost 2014; 40(01): 049-59.
[31] Franchini M, Rossi C, Mengoli C, *et al.* ABO blood group and risk of coronary artery disease. J Thromb Thrombolysis 2013; 36(3): 286-7. [http://dx.doi.org/10.1007/s11239-012-0836-1] [PMID: 23096597]
[32] Franchini M, Rossi C, Frattini F, *et al.* ABO blood group and risk of peripheral arterial thrombosis in patients with atrial fibrillation: A single center survey. J Thromb Thrombolysis 2014; 38(1): 30-1. [http://dx.doi.org/10.1007/s11239-013-0995-8] [PMID: 24057604]
[33] Zhong GC, Liu S, Wu YL, *et al.* ABO blood group and risk of newly diagnosed nonalcoholic fatty liver disease: A case-control study in han chinese population. PLoS One 2019; 14(12): e0225792. [http://dx.doi.org/10.1371/journal.pone.0225792] [PMID: 31800606]
[34] Hamed IA, Mandal AK, Parker D, Czerwinski AW, Mask DR, Wenzl JE. ABO blood groups and renal disease. Ann Clin Lab Sci 1979; 9(6): 524-6. [PMID: 518016]
[35] Alanan U, Abbas A, Sulaiman I. Relationship between ABO blood group and end-stage renal disease in Latakia, Syria. Saudi J Kidney Dis Transpl 2017; 28(2): 445. [http://dx.doi.org/10.4103/1319-2442.202762] [PMID: 28352039]
[36] Hassoon WA, Melconian AK. AL-Safar JM. Study the relationship between hemodialysis (HD) patients and their ABO blood grouping as well as screening of hemodialysis access-related bacterial infections. J Biol Sci 2013; 5(6): 291.
[37] Alhawary SY, Al-Abdallat ME, Alamro SA, *et al.* Frequency of blood groups among a sample of patients with renal failure at royal medical services. Eur Sci J 2015; 11(33)
[38] Bener A, Yousafzai MT. The distribution of the ABO blood groups among diabetes mellitus patients in Qatar. Niger J Clin Pract 2014; 17(5): 565-8. [http://dx.doi.org/10.4103/1119-3077.141418] [PMID: 25244264]
[39] Silins J, Fortier L, Mao Y, *et al.* Mortality rates among patients with end-stage renal disease in Canada, 1981-86. CMAJ 1989; 141(7): 677-82. [PMID: 2790603]