

Received date: 13-12-2020 Accepted date: 1-3-2020 Available online date: 14-3-2021

Bacterial Vulnerability and Blood Types, Salmonella and Escherichia coli as

A Study Case

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Abstract

The patients with different ABO blood types and Rhesus factor are different in their vulnerability to numerous diseases. The association between the ABO blood types and bacterial infections has been the dialectical subject which is still under investigation and research. Typhoid fever and urinary tract infections are one of a main public health problem in the world. Therefore, this study was conducted to recognize the relevance between blood types and bacterial diseases, particularly; typhoid fever and urinary tract infection (UTI) caused by uropathogenic *Escherichia coli*.

A hundred eight of blood samples taken from people infected with typhoid fever and sixty nine of each urine and blood samples taken from people infected with UTI. The patients are from both genders and various age groups (12- 65) years.

Agglutination assay was achieved to check the blood groups of all patients. *Salmonella typhi* was diagnosed by using rapid diagnostic test (RDT) for hundred and eight patients. On the other hand, the uropathogenic *Escherichia coli* for sixty nine patients were diagnosed by the Vitek-2 device.

The results of typhoid fever study showed that a twenty eight individuals of A-type with a percentage of 25.92%, forty six individuals of B-type with a percentage of 42.59% and thirty four individuals of O-type with a percentage of 31.48%, whereas none of infected individuals belong to AB- type. It means that the blood B-type is carrying the highest rate of infection, O-type comes after and then A-type. Also, uropathogenic *Escherichia coli* study results showed that a thirty six individuals of A-type with a percentage of 52.17%, six individuals of each B&AB-type with a percentage of 8.69% and twenty one individuals of O-type with a percentage of 30.43%. It means that the A- type is carrying the highest infection rate, O-type comes after and then B &AB-types. In reference with gender factor, it was observed that the feminine

morbidity is higher than masculine in uropathogenic *Escherichia coli*. While finding the opposite in typhoid fever.

Keywords: Typhoid fever, urinary tract infection, ABO types, uropathogenic Escherichia coli.

1. Introduction

Bacteria are Omnipresence, and it's in charge of many bacterial infections which has a major public health impact. The vast majority of bacteria are harmless or it could be beneficial occasionally [1].

A few percentages of bacteria possess virulence factors that enable them to invade and then colonize the host after it has overstepped the body's defense mechanisms and eventually cause the disease.

Each type of bacteria has a tendency to infect a specific organ from the human body and not others. Thus, there are different mechanisms through which infection occurs [2].

Bacterial infections are ranging from mild to moderate even to severe infections sometimes, depending on some factors where it could be relevant to the bacteria itself or individual factors [3].

Urinary tract infection (UTI) is a common bacterial infection which describes as universe health problem. Annually, there are around 150 million cases for UTI [4]. The UTI is well known that affect both genders. Depending on the infected part of the urinary system, the UTI has been classified into upper and lower UTI. The lower infection (cystitis) means that the kidneys are impact whilst the upper infection (pyelonephritis) means that the urinary bladder, urethra and prostate are impact. Also, there is another classification to the UTI which is categorized into complicated and un-complicated [5].

The UTI is mostly caused by gram negative aerobic bacteria, namely the uropathogenic *Escherichia coli*. On the other hand, the gram-positive bacteria and some fungi can cause the UTI as well. Uropathogenic *Escherichia coli* has various virulence factors including different adhesins (P, Type 1, S and Dr) which responsible for bacterial adhesion and colonization [6].

The relationship between various blood types and UTI risks was well documented over the past years [7].

Typhoid fever is another global health issue and considered a systemic bacterial infection caused by Salmonella enterica serotype typhi. According to the latest world health organization (WHO) estimates there are between 11 and 21 million cases that suffer from typhoid fever and 128,000 to 161,000 deaths occurring annually [8,9,10]. It's one of the foodborne disease related to poor hygiene conditions and insufficient sanitation, spreads through fecal-oral route or via close contact with infected person [11]. Typhoid fever ranges from a mild to severe illness which may lead to critical complications and even death. It occurs at different ages, but it is considered a disease that mostly affects children and adults [10].

The incubation period of the disease averages from 8 to 14 days [12]. The

symptoms include fever that increases gradually, weakness and fatigue, headache, muscle aches, loss of appetite, nausea, mild vomiting, abdominal pain with either diarrhea or constipation [13].

Blood type antigens represent polymorphic attributes inherited among populations. Many of blood type antigens are available via antigenic determinants on erythrocyte membrane glycoproteins, proteins, or glycolipids. There are eight phenotypes of human blood groups resulting from the different expression pattern of blood group antigens on the red blood cells and these differences are likely to have a role in the individual's vulnerability whether to be infected or not [14].

For the past many years, there were several of studies which tried to link vulnerability to diseases with blood types resulting important evidences indicate that vulnerability to various infectious agents is influenced by blood types besides the ABO system; there are blood classification systems such as Rhesus factor (Rh), Lewis, Duffy and many others [15],[16].

Furthermore, there is some hypothesis to interpret this relation [17].Mostly accepted that the different blood groups have an affective role to work as receptors for different pathogens such as bacteria, viruses, parasites etc. [18]. This stage facilitates to enter the pathogens and invade the host's body after being able to evade the defense mechanisms of the immune system and cause the disease eventually.

Hence, the objective of this study is to find the relation between the bacterial vulnerability and different blood phenotypes in patients infected with typhoid fever and urinary tract infection (UTI).

2. Materials and Methods

2.1. Sampling

The study has included blood and urine samples whereas a hundred eight blood samples were taken from people infected with *Salmonella typhi* as well as sixty nine urine and blood samples were taken from people infected with uropathogenic *Escherichia coli* in Al-Hussein Teaching Hospital in Dhi-Qar Governorate

2.2. Blood Grouping

The blood grouping for each patient was performed by using a blood type testing commercial kit which contains of three types of solutions (Anti A, B & D). The reaction principle is to have blood agglutination with the solutions. If the reaction occur with anti-A which means the patient belongs to blood type A, and if it occurs with anti-B that means the patient belongs to blood type B. When the reaction appears with both anti -A & B that means the patient belongs to AB blood type. If there is no agglutination appears, neither with A nor B that means the patient has a blood type O.

To identify whether the blood type positive or negative to Rh factor, this can be performed by mingling of the blood drop with anti-D solution. When the reaction appears that means the patients' blood is classified as Rh positive, and if there is no reaction that means the patients' blood is Rh negative.

2.3. Rapid Diagnostic Test (RDT) for Salmonella typhi Antibody IgG/IgM

The test was performed by using one step Salmonella typhi Antibody IgG/IgM RDT kit (Weifang Kanghua Biotech Co. Ltd, economic development zone, Weifang, Shandong, China). The test was achieved by adding one drop (25 µl) of blood sample into the S-Well located in the designated place of the cassette, then two drops (80-100 µl) of sample buffer into the designated area for diluents (D- Well) of the cassette. After 15-20 minutes, the test results interpretation can be observed. The positive result means that two red lines appear. One line should be in the T1 region which indicates the IgG positive. The second red line should be in the T2 region which indicates the IgM positive. The results are correct when the red line appears in the control region (C). Else, the results would be void. The negative interpretation can be observed when the red line appears in the control region only. As it's illustrated in the figure(1).

2.4. Urine Samples Culture

The urine samples were cultured immediately after the centrifugation process on an enriched and selective media of uropathogenic *Escherichia coli* [19]. The diagnosis of pure isolates was confirmed by VITEK-2 device.

2.5. Study Hierarchy

It's illustrated in figure (2).

2.6. Statistical analysis

Statistical analysis of the data was made using social package statistical science (SPSS) version 20. Chi square tests (X^2) with probability (P) values were calculated at the 0.05 level of significance to evaluate the relationship between blood type of the infected patients with typhoid fever and urinary tract infection as shown in table (4), (5), (6).

3. Results

3.1. Diagnosis of bacteria

The study focused on two types of bacterial infections, typhoid fever and urinary tract caused infection by uropathogenic Escherichia coli. The other bacterial isolates from urine samples have been ignored, and only the required results (positive results) were calculated. During the study stage, there were a hundred and eight isolates of Salmonella typhi isolated from the blood of people infected with typhoid fever and sixty nine isolates of uropathogenic Escherichia coli isolated from UTI cases. Salmonella typhi was identified by using a rapid diagnostic test, whereas uropathogenic Escherichia coli was identified by using VITEK2 device.

3.2. Blood grouping

The outcomes have been determined in accordance with the association between ABO blood types and bacterial vulnerability in a hundred and seventy seven individuals for two types of infections, one hundred and eight patients infected with *Salmonella typhi* and sixty nine patients infected with uropathgenic *Escherichia coli* by using blood grouping test. Whereas, the patients distribution of typhoid fever was from the

highest to the lowest proportion as clarified, 46 individuals with type B, 34 individuals with type O and 28 individuals with type A. While none of infected individuals belong to type AB.

For patients infected with uropathogenic *Escherichia coli*, the results were as clarified, 36 individuals with type A, 21 individuals with type O and 6 individuals for both type B&AB. As it's shown in table (1) and figure (3) below.

Rhesus factor was determined for all patients involved in the study. The results indicate that the highest percentage of the infected patients have had a positive Rhesus factor for both case (typhoid fever and UTI) as illustrated in the table (2) and figure (4) below.

3.3. Gender factor

The differences according to gender factor have been highlighted as the results showed the feminine morbidity is higher than masculine in UTI cases. Unlike on what was found in typhoid fever.

The distribution of the infected males with typhoid fever was as follows, 26 patients with B-type, 20 patients with O-type and 16 patients with A-type. Whereas, there was no infection recorded for people who have ABtype.

Whilst, the distribution of the infected females with UTI was as follows, 27 patients with A-type, 21 patients with O-type, 6 patients with B-type and 3 patients with AB-type. As it's shown in table (3) and figure (5).

4. Discussion

The relationship between the various diseases and ABO blood system has been highlighted by many of researchers. Due to the importance of the urinary tract infections and typhoid fever as being considered one of the most important health issues in the world. Also, both infections have a great role on the society health because it affects both genders and all age groups.

The results indicate that the distribution of the different blood types antigens among the typhoid fever patients was uneven, as it was observed that the highest rate of the disease was in the people with B-type then it followed with O-type. This result conflicts with what was found in a previous study conducted in Erbil province [20], it indicated that people from O-type was more susceptible to typhoid fever in comparison with the other blood groups. While both studies agreed that the patients with AB-type have no infection.

Also, the relationship results between the typhoid fever and AB-type and O-type was in accord with another study [21].

Whilst, another study was found that there is no positive association between typhoid fever and blood groups. However, when each blood group was considered separately, the B-type may have a positive relationship with typhoid fever [22].

The possible connection between the bacterial diseases and ABO blood group rely on the superficial carbohydrates of RBCs which may act as a receptor for various pathogens such as bacteria, viruses and parasites and this connection facilitates their entry and eventually causes the disease [23].

Most studies indicated that the most common cause of recurrent urinary tract infections are *Escherichia coli*, and a prerequisite for causing the infection is to create an initial adherence of the this bacteria to the uroepithelial host cells through superficial structures (pili or fimbriae) even if the host defense system is existing [24].

Unlike on what was observed by George Garratty that, the UTI has more tendency to individuals of B-Type and AB-Type. It was found that the individuals of A-Type have more tendencies to the UTI, and then O-type comes after [25].

Kinane and his colleagues study has interpreted that why individuals of B-type got infected with UTI mostly, it because the absence of the specific epitopes on mucins that act as false receptor [26]. Another interpretation was presented by Ziegler and his colleagues that, the ability of UTI for the different ABO-individuals is because of the of ABO isohemoaggultinin presence antibody as well as presence of ABO antigen on urothelial cells [27]. As, other studies have not found any association between UTI and ABO-individuals [28]. During this study, also it was observed that the individuals who carry Rh positive factor were more sensitive to typhoid fever and UTI. This result harmonizes with the results that found by Carlos and Venezuela regarding individuals with typhoid fever [29].

Regarding gender factor, the study results showed that the individuals' gender has a tangible effect on the rate of typhoid fever. So, it was observed that, among One hundred and eight patients with typhoid fever, the males were more than females. These results harmonize with the previous study such as Amal study, 2018 [17] and Arshedi study, 2016 [30]. While the Kumsa and Damtew study, 2019 indicated that both males and females are having the same infection risk [31].

On contrary of the typhoid fever, the UTI results showed that the infection is more common among females than males, and this is what was approved by all previous researches and studies. The interpretation to this case is due to the gender anatomical differences such as the female's urethra length which is shorter than the male's urethra [32]. Additionally, the physiological and hormonal differences between males and females [27],[33]. Another study presented by Hootton confirmed the same results [34].

5. Conclusions

Typhoid fever and urinary tract infection (UTI) are one of the most common health problems globally, and they can be caused for all age groups and for both males and females. Otherwise, it will be developed and become fatal eventually.

It was concluded that ABO-blood types, Rhesus and gender have a great association for some bacterial vulnerability (*Escherichia coli* and *Salmonella typhi*).

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قابلية الأصابة البكتيرية وأنواع فصائل الدم : بكتيريا السالمونيلا والاشريكية القولونية كحالة للدراسة

كواكب ابراهيم الزبيدي ¹ قسم علوم الحياة ، كلية التربية – القرنة ، جامعة البصرة ، البصرة ، العراق ¹

الخلاصة

يختلف المرضى بأختلاف انواع فصائل الدم ABO وعامل الريسوس في قابليتهم للأصابة بالعديد من الأمراض. أن العلاقة بين فصائل الدم ABO والاصابات البكتيرية هو موضوع جدلي لا يزال قيد االتقصي والبحث. تعد حمى التيفوئيد والتهابات المسالك البولية إحدى مشاكل الصحة العامة الرئيسية في العالم. لذلك ، أجريت هذه الدراسة للتعرف على العلاقة بين أنواع الدم والأمراض البكتيرية ، وعلى وجه الخصوص حمى التيفوئيد والتهاب المسالك البولية (UTI) المتسبب عن الإشريكية القولونية الممرضة للجهاز البولي.

تم أخذ مائة وثمانية عينة دم من أشخاص مصابين بحمى التيفوئيد وتسعة وستون عينة لكل من الادر اروالدم المأخوذة من الأشخاص المصابين بالتهاب المسالك البولية ، حيث أن المرضى كانوا من كلا الجنسين ومن مختلف الفئات العمرية.

تم إجراء فحص التراص لمعرفة فصائل الدم لجميع المرضى.حيث تم تشخيص السالمونيلا التيفية باستخدام اختبار التشخيص السريع (RDT) لمائة وثمانية مصاب. من ناحية أخرى ، تم تشخيص الإشريكية القولونية الممرضة للجهاز البولي لتسعة وستين مصاب بواسطة جهاز 2-Vitek.

أظهرت نتائج دراسة الحمى التيفية أن ثمانية وعشرين فردًا من النوع A بنسبة 25.92٪، ستة وأربعون فردًا من النوع B بنسبة A2.59٪، وأربعة وثلاثون فردًا من النوع O بنسبة 31.48٪ ، بينما لا ينتمي أي من الأفراد المصابين إلى النوع AB. وهذا يعني أن فصيلة الدم B تحمل أعلى معدل إصابة ،حيث يأتي بعده النوع O ومن ثم النوع A. كما أظهرت نتائج دراسة وهذا يعني أن فصيلة الدم B تحمل أعلى معدل إصابة ،حيث يأتي بعده النوع O ومن ثم النوع A. كما أظهرت نتائج دراسة وهذا يعني أن فصيلة الدم B تحمل أعلى معدل إصابة ،حيث يأتي بعده النوع O ومن ثم النوع A. كما أظهرت نتائج دراسة وهذا يعني أن فصيلة الدم B تحمل أعلى معدل إصابة ،حيث يأتي بعده النوع O ومن ثم النوع A. كما أظهرت نتائج دراسة الإشريكية القولونية الممرضة للجهاز البولي أن ستة وثلاثين فردًا من النوع A بنسبة 72.17٪، ستة أفراد من كل نوع & A بيشريكية القولونية الممرضة للجهاز البولي أن ستة وثلاثين فردًا من النوع A بنسبة 82.17٪، ستة أفراد من كل نوع & a الإشريكية القولونية الممرضة للجهاز البولي أن ستة وثلاثين فردًا من النوع A بنسبة 82.17٪، ستة أفراد من كل نوع ه و AB بنسبة 82.17٪، ستة أفراد من كل نوع ما معدل معدل للأصابة ، ويأتي من بعده النوع O ومن ثم النوع B واحد و عشرون فردًا من النوع O بنسبة 30.43٪. وهذا يعني أن النوع A يحمل أعلى معدل للأصابة ، ويأتي من بعده النوع O ومن ثم النوع B و AB. . بالإشارة إلى عامل الجنس ، لوحظ أن معدل الأصابة لدى الأناث أعلى من ويأتي من بعده النوع O ومن ثم النوع B و AB. . بالإشارة إلى عامل الجنس ، لوحظ أن معدل الأصابة لدى الأناث أعلى من ويأتي من بعده النوع O ومن ثم النوع B و AB. . بالإشارة إلى عامل الجنس ، لوحظ أن معدل الأصابة لدى الأناث أعلى من

الكلمات المفتاحية :الحمى التيفية ، التهاب المسالك البولية ،أ نواع فصائل الدم ، الاشيريكية القولونية الممرضة للجهاز البولي





Figure (1): RDT Interpretations

Figure (2): Study Hierarchy

Table(1): Relationship between blood group and numbers & percentages of patients for typhoid fever and UTI.

Bacterial Diseases	Blood group	Patients Number	Patients Percentages	
	Α	28	25.92%	
Typhoid Fever	В	46	42.59%	
	AB	-	0%	
	0	34	31.48%	
Urinary tract infection	А	36	52.17%	
	В	6	8.69%	
	AB	6	8.69%	
	0	21	30.43%	



Figure (3): Relationship between blood group and numbers & percentages of patients for typhoid fever and UTI.

Bacterial Diseases	Blood group	Rh +ve	Rh –ve	
	А	22	6	
Typhoid Fever	В	42	4	
	AB	-	-	
	0	26	8	
	Total	90	18	
Urinary tract infection	А	33	3	
	В	3	3	
	AB	6	0	
	0	12	9	
	Total	54	15	

Table (2): Rhesus factor of patients infected with typhoid fever& UTI



patients infected with typhoid fever& UTI.

Table (3): Comparison between typhoid fever & UTI according to gender factor & blood group.

Bacterial Diseases	Blood group	Male	Female	
	А	16	12	
Typhoid Fever	В	26	- 20	
	AB	-		
	0	20	14	
	Total	62	46	
Urinary tract infection	А	9	27	
	В	0	6	
	AB	3	3	
	0	0	21	
	Total	12	57	



Figure (5): Comparison between typhoid fever & UTI according to gender factor & blood group.

 Table (4): Statistical analysis of relationship between blood group and numbers & percentages of patients for typhoid fever and UTI.

Bacterial Diseases	Blood group	X ²	Р
	A-B	4.056	0.044*
	A-AB	25.92	3.666
	A-0	0.539	0.462
Typhoid Fever	B-AB	42.59	0.000*
	B-O	1.666	0.196
	O-AB	31.48	0.000*
	A-B	31.063	0.000*
Urinary tract infection	A-AB	31.063	0.000*
	A-0	5.722	0.0167*
	B-AB	0	1

B-0	12.081	0.000*
O-AB	12.081	0.000*

Bacterial	Blood	Rh ^{+ve}]	Rh ^{-ve}		$\mathbf{Rh}^{+\mathrm{ve}}$ - $\mathbf{Rh}^{-\mathrm{ve}}$	
Diseases	group	X ²	Р	\mathbf{X}^{2}	Р	X ²	Р	
	A-B	6.25	0.012*	0.4	0.527			
	A-AB	22	0.000*	6	0.014*			
	A-0	0.333	0.5638	0.286	0.592			
	B-AB	42	0.000*	4	0.0455*			
	B-O	3.765	0.0523	1.333	0.2482			
Typhoid	O-AB	26	0.000*	8	0.004*			
Fever	A-A					9.143	0.002*	
	B-B					31.391	0.000*	
	AB-AB					0	1	
	0-0					9.529	0.002*	
	Total					48	0.000*	
	A-B	25	5.777	0	1			
	A-AB	18.692	0.000*	3	0.083			
	A-O	9.8	0.001*	3	0.0832			
	B-AB	1	0.317	3	0.083			
Uningent tragt	B-O	5.4	0.020*	3	0.0832			
infoction	O-AB	2	0.157	9	0.002*			
milection	A-A					25	5.777	
	B-B					0	1	
	AB-AB					6	0.014*	
	0-0					0.429	0.512	
	Total					22.043	0.000*	

Table (5): Statistical analysis of Rhesus factor of patients infected with typhoid fever& UTI

Table (6): Statistical analysis of comparison between typhoid fever & UTI according to genderfactor & blood group.

Bacterial	Blood	Male		Female		Male - Female	
Diseases	group	X ²	Р	X ²	Р	X ²	Р
	A-B	2.381	0.122	2	0.157		
	A-AB	16	0.000*	12	0.000*		
A-O B-AB	A-O	0.444	0.505	0.154	0.694		
	B-AB	26	0.000*	20	0.000*		
	B-O	0.783	0.376	1.059	0.303		
Typhoid Fever	O-AB	20	0.000*	14	0.000*		
	A-A					0.571	0.449
	B-B					0.783	0.376
	AB-AB					0	1
	0-0					1.059	0.303

	Total					2.37	0.1236
	A-B	9	0.000*	13.364	0.000*		
	A-AB	3	0.083	19.2	0.000*		
	A-O	9	0.000*	0.75	0.386		
	B-AB	3	0.083	1	0.317		
в-О	B-O	0	1	8.333	0.003*		
urmary tract	O-AB	3	0.083	13.5	0.000*		
meetion	A-A					13.444	0.000*
	B-B					6	0.014*
	AB-AB					0	1
	0-0					21	0.000*
	Total					29.348	0.000*