

## Evaluation of the immuno-hematological qualification of the blood donation at the Avicenne military hospital in Marrakech

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### Abstract

Blood transfusion is a therapeutic act that consists of administering blood, or one of its cellular or plasma components, from one or more healthy subjects called "donors" to a sick subject called "recipient. Transfusion safety is ensured by controlling all stages of the transfusion chain, from the collection of blood, its preparation and biological qualification, to the performance of the transfusion act and even the follow-up of the recipients. The basis of immunohematological safety is the compatibility between the erythrocyte characteristics of the donor and those of the recipient.

Donation Biological Qualification (DQ) laboratories have a duty and an obligation to ensure maximum reliability and sensitivity of results. They must therefore put in place the human, technical, material, computer and organizational resources, method validation, traceability of operations and risk analysis of all stages of the analysis process, to guarantee reliable results obtained in a timeframe compatible with the optimal use of the blood products.

Thus, the work methodology within the immunohematology laboratory must be structured in procedures and operating modes in order to respect the standards of the reference system and to reduce the causes of errors to a minimum. Our work focused on the evaluation of the immunohematological qualification of blood donations within the blood transfusion center (CTS) at the Avicenne military hospital (HMA) in Marrakech, including the state of the premises, personnel and techniques used in the QBD service with the following goals

- Review the level of qualification within the CTS of HMA.
- To highlight the techniques of immunohematological qualification of blood donation performed at the CTS at the Avicenne Military Hospital in Marrakech compared to what is done nationally and internationally.
- To draw the phenotypic profile of ABO, RHD and Kell blood groups in a representative population of donors from the city of Marrakech and regions, recruited over a period of 5 years.
- The study of the prevalence of phenotypic markers, blood donations collected in the blood transfusion center of the HMA in Marrakech between the years 2016-2017-2017-2018-2019-2020, led to the following results:
- For the ABO system, group O is the most frequent (50.47%), followed by group A (30.14%), then group B (15.45%) and lastly group AB (3.93%).
- The standard Rhesus system (D); the Rh positive phenotype (D+) predominates largely (89.21%) while the Rh negative (D-) is about 10.79%.
- Of the 7713 donations studied, only 3130 were used to study the prevalence of Rh phenotypes. For the remaining 4583 donations, phenotyping was not performed because of a stockout of gel cards. The Ccee phenotype is the most frequent (40.31%).
- For the Kell system, the prevalence of K anti-gen was 8.17%.

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- For the IAT: no IAT was positive in the donors.
- In our series, there was no return of the incident report form (IRF) and no traceability of the number of adverse transfusion reactions (ADR).

This study allowed us to highlight several shortcomings concerning

- The lack of trained personnel
- Insufficient techniques in terms of precision, sensitivity and specificity
- The lack of high level technical automatons
- Occasional reagent stockouts due to supply delays.

However, the transfusion system of the Avicenne Military Hospital of Marrakech (HMA) is still lacking in new techniques that have proven their worth in the development of this field; namely

- HLA histocompatibility typing.
- The research of antiplatelet antibodies: HPA;
- Molecular biology: by gene amplification (PCR) from genomic DNA, in particular when hemagglutination shows its limits in the con-text of transfusion medicine.

In the light of this work, a list of recommendations has been proposed in order to overcome these dysfunctions and to ensure a better immunohematological safety, in front of the various situations envisaged during the daily practice by reinforcing the operational and technical capacities of the blood transfusion service.

Furthermore, the improvement of automation and computerization will reduce the risk of human error, by automatically handling certain phases of the process. However, whatever the degree of automation safety, its quality is strictly linked to the pre-analytical phase of sample collection, sample acceptability and collection information entry, for which particular attention should be paid.

**Keywords:** Qualification; Immunohematology; Blood donation; transfusion

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## 1. Introduction

Blood transfusion is a therapeutic act that consists of administering blood, or one of its cellular or plasma components, from one or more healthy subjects called "donors" to a sick subject called "recipient."

Transfusion safety is ensured by controlling all stages of the transfusion chain, from blood collection, preparation and biological qualification to the performance of the transfusion act and even the follow-up of the recipients.

The basis of immunohematological safety is the compatibility between the erythrocyte characteristics of the donor and those of the recipient.

Donation Biological Qualification (DQ) laboratories have a duty and an obligation to ensure maximum reliability and sensitivity of results. They must therefore put in place the human, technical, material, computer and organizational resources, method validation, traceability of operations and risk analysis of all stages of the analysis process, to guarantee reliable results obtained in a timeframe compatible with the optimal use of the blood products.

Thus, the work methodology within the immunohematology laboratory must be structured in procedures and operating modes in order to respect the standards of the reference system and to reduce the causes of errors to a minimum.

Our work focused on the evaluation of the immunohematological qualification of blood donations within the blood transfusion center (CTS) at the Avicenne military hospital (HMA) in Marrakech, including the state of the premises, personnel and techniques used in the QBD service, with the following goals:

- To review the level of qualification within the CTS of HMA
- To highlight the techniques of immunohematological qualification of blood donation performed at the CTS at the Avicenne Military Hospital of Marrakech in comparison with what is done at the national and international levels

- To draw the phenotypic profile of ABO, RHD and Kell blood groups in a representative population of donors from the city of Marrakech and regions, recruited over a period of 5 years.

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## 2. Materials and methods

This is a retrospective, descriptive, evaluative and analytical study of the immunohematological qualification of blood donation conducted in the two CTS (the old and the new) of HMA of Marrakech on a military population (7713) of Marrakech and regions (Benguerir, Kasbat Tadla, Ouarzazate and khouribga), whose ages ranged between 18 and 55 years, taken according to scheduled collections fulfilling the conditions of blood donation.

During this study, all donors were systematically grouped ABO-RH1, while for RH-KEL phenotyping only 3148 out of 7713 donors were tested.

For the remaining 4565 donations, phenotyping was not performed due to a stockout of gel cards. The IAT was reserved for female personnel since the majority of donors are male, never transfused and therefore do not require IAT.

Extended phenotyping is performed at the re-request of the clinician. Testing for anti-A and anti-B hemolysis is not performed because the donors are young military personnel who have never been transfused.

From the data listed in the paper archives and computerized records of the CTS between 2016 and 2020, 8221 blood donations constituted the sample on which we conducted this study. The actual number of donations studied was 7713, for the 508 donations, the exploitation was not performed because of archiving problems.

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## 3. Results

The study of the prevalence of phenotypic markers, of blood donations collected in the blood transfusion center of HMA in Marrakech between the years 2016-2017-2017-2018-2019-2020, led to the following results:

- For the ABO system, group O is the most frequent (50.47%), followed by group A (30.14%), then group B (15.45%) and lastly group AB (3.93%).
- The standard Rhesus system (D); the Rh positive phenotype (D+) predominates (89.21%) while the Rh negative (D-) is about 10.79%.
- Of the 7713 donations studied, only 3130 were used to study the prevalence of Rh phenotypes. For the remaining 4583 donations, phenotyping was not performed because of a stockout of gel cards. The Ccee phenotype is the most frequent (40.31%).
- For the Kell system, the prevalence of K anti-gen was 8.17%.
- For the IAT: no IAT was positive in the donors.
- In our series there was no return of the incident report form (IRF) and no traceability on the number of adverse transfusion events (ATE).

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## 4. Discussion

Our study sample consists of 8221 donations/donors, over a five-year period (2016 to 2020). While the HMA CTS in Rabat performs about 7000 blood donations over a year (01)

Our study confirms the results of those previously carried out in different Moroccan hospitals (Rabat, Meknes, Marrakech, Agadir) by demonstrating almost the same orders of ABO blood groups in the population coming from different regions of Morocco (Table 1).

Our prevalence are comparable to those of the Mediterranean countries (Tunisia and Southern Italy). Compared to Asian countries, e.g. India, Morocco shows higher prevalence especially of groups O and A (Table 2).

**Table 1** Comparative table of prevalence of ABO system groups in our study and previous Moroccan studies

Authors	City	Year of study	O (%)	A (%)	B (%)	AB (%)
EL KHABOUS, Saida(02)	Rabat	2018	52	29.69	14.85	3.46
Khalloufi ,A (03)	Meknès	2016	46.43	33.32	15.92	4.32
Eddoum.K(04)	Rabat	2015	46.8	32.49	16.25	4.45
Zahid et al (05)	Marrakech	2015	49.01	31.47	15.15	4.35
Benahadi et al (06)	15 Different regions	2013	46.8	32.86	15.8	4.53
Chadli et al(07)	Agadir	2007	50.98	31.34	13.8	3.88
Our study	Marrakech	2021	50.47	30.14	15.45	3.93

**Table 2** Comparative table of national results of phenotypes A, B, AB and O with those of other countries

Authors	Countries	Year	O (%)	A (%)	B (%)	AB (%)
Kabemba et al(08)	Congo	2017	60.5	21.6	15.4	2.5
Tlamçani, (09)	France	2012	43.00	45.00	9.00	3.00
Said.N et al(10)	Tunisia	2003	46.18	30.94	17.83	5.00
Benazi nabil (11)	Algeria	2018	57.28	24.83	12.41	5.48
Bennaka(12)	South Italy	2002	49.97	33.65	15.27	4.00
Hemaquebec(13)	Canada	2014	46.00	42.00	9.00	3.00
Ivanov(08)	Russians	1977	37.01	32.66	23.11	7.22
Agarwal(14)	India	2013	38.75	18.85	32.69	5.27
Bennaka(12)	Thailand	2002	42.6	20.2	30.8	6.4
Our study	Morocco	2021	50.47	30.14	15.45	3.93

We conclude that the prevalence of the ABO system phenotypes in Moroccans is intermediate between that of sub-Saharan Africa and Europe (Table 2).

**Table 3** Prevalence of "D" antigen in the Moroccan population compared to other countries in the world

Countries	Prevalence of Rh positive in %.
China	99.71
Bangladesh	97.44
India	94.36
Uganda	98
Algéria	91.53
Tunisia	90.81
Canada	85
Germany	82.71
Our study	89.21

For the RHD system, we observe in our study, a clear predominance of Rh (+) subjects: 89.21%, compared to Rh (-) subjects: 10.79% (Table 3).

It appears from Table III that this prevalence is comparable to that of the Maghreb countries (Algeria and Tunisia), close to that of sub-Saharan Africa and clearly higher than that of the Mediterranean and Western European countries.

In Asian countries, the prevalence of D anti-gen is higher than in Morocco.

Table III summarizes the frequencies of the RH phenotypes in our study conducted in Morocco in 2021 and in 2016, as well as in Germany and France.

The phenotype "Ccee" represents the most answered phenotype in our population with more than one third (40.31%), followed by the phenotype ccee with a prevalence (29.16%), and in a decreasing order CCee, CcEe, ccEe, the other phenotypes (CCEe, ccEE, CceE) are minority or very rare.

The prevalence of the predominant phenotype "Ccee" in our study is comparable to that found in Germans which is 42.83%, while in the French population as a whole we observe a lower prevalence than that found in Morocco (Table 4).

**Table 4** Comparative table of the prevalence of the RH phenotype of the sample studied with previous Moroccan studies and those of other countries

Phenotype	Our study (2021) (%)	Morocco (2016) (%) (04)	Germany (1995)(%) (15)	France(2016) (%) (06)
Ccee	40.31	43.91	42.83	35
ccee	29.16	25.75	17.82	17
CCee	11.11	14.16	23.67	20
CcEe	9.48	8.07	14.05	12.42
ccEe	9.42	7.39	15.17	13
CCEe	0.31	0.022	0.18	--
ccEE	0.12	0.63	2.45	0.76
CceE	0.03	--	--	--

The prevalence of K-positive subjects in our study is 8.13%, it is lower than that of the 2016 study which is 11.36%. Table 5)

**Table 5** Comparative table of K+ phenotype prevalence in Moroccans

Authors	City	year	Prevalence of K antigen (%)
EL KHABOUS, Saida(02)	Rabat	2018	8.42
Khalloufi ,A (03)	Meknès	2016	11.36
Eddoum.K(04)	Rabat	2015	7.9
Tlamçani.Z (10)	Rabat	2012	7.1
Our study	Marrakech	2021	8.13

Our value is higher than that of Bangladesh (0.8%) and lower than that of Syria (17.8%) and close to European countries (9%) (Table 6).

**Table 6** Prevalence of K+ antigen in Moroccans and other foreign countries

Countries	Prevalence of K (%)
Our series	8.13
Bangladesh, 2010 (16)	0.8
Norwegian Committees, 2004 (13)	8.28
France, 2012 (09)	9
Syria, 2004 (13)	17.8

Blood grouping tests have been improved in Moroccan blood centers since the advent of monoclonal antibodies and the automation of laboratory analysis.

Tables 7 and 8 compare the tests performed, the techniques and the automats used for the immunohematological qualification of donations at the HMA CTS of Marrakech with the national (Table 7) and international (Table 8) levels.

**Table 7** Comparative table of tests performed and techniques and automats used for the immunohematological qualification of donations at the level of the CTS of HMA of Marrakech compared to the national scale

	CTS of the HMA of Marrakech	Regional CTS of Rabat	CTS of the military hospital of Rabat
Systematic tests performed	-ABO-RH1 blood typing -RH-KEL1 phenotyping. -RAI(screening) women -Search for weak RH	- Blood grouping ABO-RH1 -RH-KEL1 phenotyping. -RAI (screening) -Anti A and anti B hemolysin	-Blood grouping ABO-RH1 -RH-KEL1 phenotyping. - RAI (screening) Anti A and anti B hemolysin
Methods and techniques	Hemagglutination method on opaline plates and filtration on gel card	-Hemagglutination -Magnetized erythrocyte technology (EMA) -Erythrocyte genotyping by molecular biology	-hemagglutination on opaline plates, gel cards -Erythrocyte technology magnetized using microplate principle
Automats	IH-500 (broken) Often manual	-Pk 7400 -QWALYS® 3	QWALYS® 3 IH-1000

**Table 8** Comparative table of tests performed and techniques and automats used for the immunohematological qualification of donations at the CTS of HMA in Marrakech compared to the international level

	France	India	Korea	Germany
Tests performed	-ABO-RH1 grouping -Phenotyping Rhesus -Kell -hemolysin anti A and anti B -RAI	-ABO-RH1 grouping -RH-Kel Phenotyping -Phenotyping extended and expanded	-ABO-RH1 grouping -RH-Kel Phenotyping -Phenotyping extended and expanded -RAI	-ABO-RHD grouping, -RH-Kell phenotyping

		-RAI		
Methods and techniques	-tube -Gel filtration -Opaline plate -Technology E.M A (microplate)	-tube -gel filtration -E.M A technology (microplate)	-Technology agglutination and Gel filtration -Tube -Microplate -genotyping erythrocyte	-Gel filtration -Erythrocyte genotyping
Automats	-PK7300 -IH -1000 -IH-500 -Erytra -QWALYS® 3 -Autovue innova -Wadiana -Néo® Immucor for RAI	-MITIS II -QWALYS® 3 -IH-1000 -Autovue innova -Wadiana -Néo® -Galileo -Techno Twin Station	-IH-500 -ortho vision -daymate M -Ortho Auto Vue -Techno Twin station	-Olympus PK7100 -Olympus PK 7200 -QWALYS 2

This study has allowed us to highlight several shortcomings concerning

- The lack of trained personnel
- The lack of techniques in the sense of precision, sensitivity and specificity
- The lack of high level technical automatons
- Occasional reagent stockouts due to supply delays.

However, the transfusion system of the Avicenne military hospital in Marrakech (HMA) still has a lack of new techniques that have proven their worth in the development of this field; namely

- HLA histocompatibility typing.
- The research of antiplatelet antibodies: HPA;
- Molecular biology: by gene amplification (PCR) from genomic DNA, in particular when hemagglutination shows its limits in the context of transfusion medicine.

In the light of this work, a list of recommendations was proposed in order to overcome these dysfunctions and to ensure a better immunohematological safety, in front of the various situations envisaged during the daily practice by reinforcing the operational and technical capacities of the blood transfusion service by:

- The recruitment of a sufficient number of personnel; confirmed technicians trained abroad in reference centers.
- The development of the premises to have a separation between the immunohematological and microbiological qualification.
- The supply of the necessary reagents, the most sensitive and the most recommended by the WHO and experts.
- The improvement of techniques in the sense of precision, sensitivity and specificity.
- The installation of the most credible and widely used automated systems in the world, with a high level of technical expertise.
- The development of molecular genotyping for HR variants.

In addition, certain needs have been raised within the department such as:

- To equip the immuno-hematology laboratory with two IH-500 automatons, assisted by another automaton, with a good maintenance service.

- The installation of an automaton for HLA typing.

Phenotype as many donor bags as possible and compare them to the expanded phenotype of the recipient.

In addition, the improvement of automation and computerization will reduce the risk of human error, by automatically taking charge of certain phases of the process in order to

- Avoid repetitive sequences.
- To reduce, in part, the workload.
- To leave to the operators the noble part of the work: the decision.
- To provide automatic safeguards to make the system intolerant to error, especially in the context of time pressure such as emergency or peak activity.

However, whatever the degree of automation security, its quality is strictly linked to the pre-analytical phase of sample taking, sample acceptability and the entry of information relating to the sample, for which particular attention should be paid.

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## 5. Conclusion

Transfusion safety is ensured by controlling all stages of the transfusion chain, from the collection of blood, its preparation and biological qualification to the performance of the transfusion act and the follow-up of recipients.

The typing of blood grouping systems at the CTS is based on the hemagglutination technique; the historical technique for identifying the erythrocyte antigens and plasma antibodies of donors and recipients.

Currently, the determination of these antigens deduced from the analysis of blood group systems by molecular biology techniques (genotyping) has become an indispensable tool in specialized immunohematology laboratories. It offers an alternative when hemagglutination shows its limits in the context of transfusion practice.

The new technologies have mainly concerned extended phenotyping and genotyping. As far as genotyping is concerned, cost reduction, standardization, simplification and speed improvement are the last obstacles to be removed to allow a wider implementation in immunohematology laboratories.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

The authors declare no conflicts of interest.

### *Contributions of the authors*

All authors contributed to the conduct of this work. All authors also declare that they have read and approved the final version of the manuscript.

### *Statement of ethical approval*

The present research work does not contain any studies performed on animals/humans subjects by any of the authors'.

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## References

- [1] A. Belmekki , M. Nazih. Study of the prevalence of ABO groups and RH-KELL phenotypes in 7000 blood donations at the CTS - Mohammed V military hospital, Rabat, Morocco - EM
- [2] Masson E. Contribution of quality management at the blood transfusion center of Rabat [Internet]. EM-Consult. [Cited June 23, 2021]. Available from: <https://www.em-consulte.com/article/1305711/apport-du-management-qualite-au-centre-de-transfus>



- [3] El Khabous S. Prevalence of ABO, RH AND KELL system phenotypes in 10000 blood donors AT CTS OF HMIM-V Rabat- Morocco [Internet] [Thesis]. 2018 [cited May 25, 2021]. Available from: <http://ao.um5.ac.ma/xmlui/handle/123456789/16194>
- [4] Khalloufi A. Study of the prevalence of ABO, Rh and Kell blood groups: about 3589 blood donations in a region of central Morocco. Research en [Internet]. 20 Nov 2017 [cited 19 May 2021]; Available from: </en/Study-of-the-prevalence-of-ABO-Rh-and-Kell-blood-groups-About-3589-blood-donations-in-a-region-of-ce.html>
- [5] Eddoum K. The prevalence of abo, rh- kel1 system phenotypes in the Moroccan population. [Internet] [Thesis]. 2015 [cited May 25, 2021]. Available from: <http://ao.um5.ac.ma/xmlui/handle/123456789/16022>
- [6] Hadeif R, Messaoudi N, Abdelhak E. Phenotypic and allelic distribution of ABO And Rh-D blood Groups in Blood Transfusion Center of Avicenna Military Hospital. 1 Jan 2016;
- [7] Benahadi A, Alami R, Boulahdid S, Adou-ani B, Abderrahim L, Mokhtari A, et al. Distribution Of ABO And Rhesus D Blood Antigens In Morocco. *Internet Journal of Biological Anthropology*. 1 Jan 2013;6.
- [8] Chadli S, Brakez Z, Belhachmi A, Izaabel H. Distribution gradient of ABO system alleles in Morocco: ABO system polymorphism in the Souss population. :5.
- [9] Radia A, Ghita B, Hajar S, Hicham Y, Mus-tapha AA, Mohamed C. Prevalence of Blood Groups at the Blood Transfusion Center at the Military Hospital Avicenna of Marrakech. *American Journal of Laboratory Medicine*. 18 Nov 2019;4(6):101.
- [10] Zineb TLAMÇANI. Phenotypic and genotypic frequencies of ABO, RH and kell systems in the Moroccan population ,2012.n°34.p.36-40.
- [11] Said N, Ben Ahmed F, Doghri A, Ghazouani E, Layouni S, Gritli N, et al. ABO polymorphism in a population of Tunisian blood donors. *Clinical and Biological Transfusion*. Oct 2003;10(5):331 4.
- [12] Nabil B, Bounab S, Benazzi L, Yahiaoui M. Genetic polymorphisms of blood donors in Algeria through blood groups ABO, RH, and Kell. *Clinical and Biological Transfusion*. Feb 2020;27(1):43 51.
- [13] These 64-19.pdf [Internet]. [cited May 19, 2021]. Available from: <http://wd.fmpm.uca.ma/biblio/theses/annee-htm/FT/2019/these64-19.pdf>
- [14] Blood types [Internet]. Hema-Quebec. [cited May 25, 2021]. Available from: <https://www.hema-quebec.qc.ca/sang/savoir-plus/groupe-sanguins.fr.html>
- [15] Wagner FF, Kasulke D, Kerowgan M, Fle-gel WA. Frequencies of the Blood Groups ABO, Rhesus, D Category VI, Kell, and of Clinically Relevant High-Frequency Antigens in South-Western Germany. *Transfus Med Hemother*. 1995;22(5):285 90.
- [16] Talukder S. Distribution of ABO and Rh Blood Groups among Blood Donors of Dinaj-pur District of Bangladesh. *Dinajpur Med Col J*. 1 Jul 2010;3.