

**RED CELL SIZING AS A NEW SCREENING METHOD FOR
HEMATOLOGISTS
THESIS SUBMITTED
FOR PARTIAL FULFILMENT OF
MASTER DEGREE**

**IN
CLINICAL PATHOLOGY**

**BY
MOHAMED HASSAN SHAHEEN**

**SUPERVISED BY
PROFESSOR WAGEEH NAGUIB IBRAHIM
PROFESSOR OF CLINICAL PATHOLOGY
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY**

**PROFESSOR SAWSAN FAYAAD
PROFESSOR OF CLINICAL PATHOLOGY
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY**

**DR. NEVINE AHMED KASSEM
LECTURER OF CLINICAL PATHOLOGY
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY**

**FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY**

1986

22924
616.07561
A.H

RED CELL SIZING AS A NEW SCREENING METHOD FOR
HEMATOLOGISTS
THESIS SUBMITTED
FOR PARTIAL FULFILMENT OF
MASTER DEGREE

IN
CLINICAL PATHOLOGY



BY

MOHAMED HASSAN SHAHEEN

616.07561
M.H

SUPERVISED BY

PROFESSOR WAGEEH NAGUIB IBRAHIM
PROFESSOR OF CLINICAL PATHOLOGY
- FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

PROFESSOR SAWSAN FAYAAD
PROFESSOR OF CLINICAL PATHOLOGY
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

DR. NEVINE AHMED KASSEM
LECTURER OF CLINICAL PATHOLOGY
FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY



FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY

1986

[Handwritten signatures and marks]



RED CELL SIZING AS A NEW SCREENING METHOD FOR

HEMATOLOGISTS

THESIS SUBMITTED

FOR PARTIAL FULFILMENT OF

MASTER DEGREE

IN

CLINICAL PATHOLOGY

BY

MOHAMED HASSAN SHAHEEN

SUPERVISED BY

PROFESSOR WAGEEH MAGUIB IBRAHIM

PROFESSOR OF CLINICAL PATHOLOGY

FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

PROFESSOR SAWSAN FAYAAD

PROFESSOR OF CLINICAL PATHOLOGY

FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

DR. NEVINE AHMED KASSEM

LECTURER OF CLINICAL PATHOLOGY

FACULTY OF MEDICINE - AIN SHAMS UNIVERSITY

FACULTY OF MEDICINE

AIN SHAMS UNIVERSITY

1986

CONTENTS

	Page
Acknowledgment	
Introduction	1
Chapter I	
Historical aspects and principles of red cell sizing..	4
Chapter II	
The mean cell volume "MCV". Principle and technic of measurement.....	9
Chapter III	
The hematocrit "HCT"	19
Chapter IV	
Clinical importance of the mean corpuscular volume..	33
Chapter V	
Statistics	49
Chapter VI	
Red cell distribution width "RDW"	53
Chapter VII	
Erythrocyte volume distribution curves	66
Summary	79
References	
Arabic Summary	

- List of Figures

Figure		Page
1	The projection apparatus for measurement of red cell diameter.....	6
2	The Coulter principle.....	9
3	The aperture unit in Coulter Counter.....	10
4.	The Sensing zone of Coulter aperture.....	12
5	Non axial flow through the Coulter aperture.....	14
6	The Sweep flow technic.....	15
7	Orientation of normal red cell through Coulter aperture....	16
8	Orientation of Spherocyte through Coulter aperture.....	16
9	Diagnostic approach to microcytic hypochromic anemia.....	40
10	Diagnostic approach to macrocytic anemia.....	44
11	Dialgnostic approach to normocytic anemia.....	46
12	The normal frequency distribution Curve.....	49
13	The skewed distribution curve.....	51
14	The percentile chart.....	52
15	Normal red cell volume histogram.....	54
16	Calculation of RDW in Coulter S Plus instruments.....	56
17	Flagging of RDW in Coulter S Plus III.....	57
18	Calculation of RDW in Contraves 800 hematology System.	58
19	Probability chart of red cell volume distribution.....	59
20	Calculation of RDS in Contraves 800 hematology System..	60
21	RDW in iron deficiency anemia and anemia of chronic disorders.....	62
22	RDW in megaloblastic and non megaloblastic macrocytic anemia.....	63

Figure		Page
23	<i>The two Gaussian population distribution of Laushbaughe....</i>	67
24	<i>Normal RBC histogram from Coulter S Plus III.....</i>	69
25	<i>Stages of recovery from iron deficiency.....</i>	73
26	<i>Stages of recovery from megaloblastic anemia.....</i>	73
27	<i>Development of iron deficiency during treatment of megaloblastic anemia.....</i>	74
28	<i>Development of iron deficiency in polycythemia vera.....</i>	74
29	<i>Effect of reticulo cytositis on red cell histogram.....</i>	75
30	<i>Effect of red cell fragmentation on red cell histogram.....</i>	77
31	<i>Effect of transfusion on red cell histogram.....</i>	77

- List of Tables -

Table		Page
1	<i>Morphologic Classification of anemia</i>	36
2	<i>Discriminant factors for differentiation between iron deficiency anemia and thalassemia minor.....</i>	41
3	<i>Morphologic Classification of anemia by MCV and RDW.....</i>	64
4	<i>Bessman's morphologic Classification of anemia.....</i>	65

TO MY PARENTS

ACKNOWLEDGEMENT

I sincerely express my grattitude to Professor Wageeh Naguib not only for supervising this thesis but also for his remarkable way in teaching hematology. Indeed, we enjoyed the interesting discussions throughout his lectures which rendered the subject far from being theoretical.

I feel most grateful to Professor Samir Hanna for his valuable lecture on "thesis writing". In fact, his new trend in teaching statistics to candidates of clinical pathology was of great benefit that I have felt while dealing with this subject.

Thanks to Professor Sawsan Fayaad for her valuable assistance.

Lastly, I highly appreciate the kind co-operation of Dr. Nevine Kassem, who raised the idea of this work.

INTRODUCTION

INTRODUCTION

The modern hematologist should follow the advances of technology in medical laboratory. In recent years, there is a great increase in the laboratory generated data which need to be understood by clinicians. Red cell size measurements are among these laboratory data which have been subjected to intensive studies over the past century.

The observations made by earlier workers that the red cell size varies in different disease states, has excited the invitation of so many technics for red cell sizing. The clinical utility of red cell size measurements have been the matter of intensive study.

Four red cell size measurements are going to be discussed here namely, the mean corpuscular volume "MCV", the hematocrit "HCT", red cell distribution width "RDW" and red cell volume distribution curves. Although these parameters are routinely available from multifunctional electronic cell counters, technics for their measurements were available earlier in this century. These early technics were tedious and time consuming especially those used for quantitative assessment of the variation of red cell size distribution by Price-Jones (1910).

This essay aimed at two objectives, the first is to

give short note on various technics used for red cell sizing. Two of these technics, the Coulter aperture impedance method for counting and sizing blood cells and the centrifugal hematocrit method are discussed in details. The second objective is to clarify the clinical importance and utility of these parameters as a screening method for; possible cause of anemia, selection of further diagnostic and confirmatory tests and monitoring patients progress on an appropriate therapy.

The various technics used for determination of the MCV and the hematocrit and their clinical utility were subject of intensive studies over the past 60 years. The clinical utility of the relatively new parameters; red cell distribution width "RDW" and the red cell volume distribution curves which were first introduced on routine basis in 1978 by Coulter counters Model S plus series has not been fully established.

The introduction of these new measurements has evoked criticism by clinicians, what information they give more than those we get from stained blood film, are they measurements searching for clinical role ?.

Therefore, the clinician who will use these parameters should have good idea about the mechanism of measurement, meaning, indications and pitfalls. Only then

may these parameters be judged to possess clinical utility. After reading this essay one hope to give the answer of this question; is red cell size output from Coulter S plus series of instruments "convenient, precise and clinically informative" as claimed by Jones (1982) ?.

CHAPTER I

HISTORICAL ASPECTS AND PRINCIPLES OF RED CELL SIZING