Global burden of hemoglobin disorders

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Distribution of thalassemia disorders worldwide

thalassemia α: China, SEA, Africa, Middle East, Mediterranean
thalassemia β: Mediterranean, Middle East, India, Pakistan, Africa, SEA

Thalassemia are now common worldwide due to migration spreading to much of Europe, the Americas and Australia
# Global Regions

## Thalassaemia Carriers

<table>
<thead>
<tr>
<th>Region</th>
<th>(\beta)-thalassemia</th>
<th>(\alpha^0)-thalassemia</th>
<th>(\alpha^+)-thalassemia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Americas</td>
<td>0–3</td>
<td>0–5</td>
<td>0–40</td>
</tr>
<tr>
<td>Eastern Mediterranean</td>
<td>2–18</td>
<td>0–2</td>
<td>1–60</td>
</tr>
<tr>
<td>Europe</td>
<td>0–19</td>
<td>1–2</td>
<td>0–12</td>
</tr>
<tr>
<td>Southeast Asia</td>
<td>0–11</td>
<td>1–30</td>
<td>3–40</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>0–12</td>
<td>0</td>
<td>10–50</td>
</tr>
<tr>
<td>Western Pacific</td>
<td>0–13</td>
<td>0</td>
<td>2–60</td>
</tr>
</tbody>
</table>

Global Epidemiology of Hemoglobin Disorders (WHO)

- Around **7% of the global population** carries an abnormal hemoglobin gene
- **300,000-500,000** children are born with clinically significant hemoglobin disorders annually
- About **80%** of affected children are born in developing countries
- About **70%** are born with Sickle Cell Disease and the rest with Thalassemia Syndromes
- **50-80%** of children with SCD die each year in low and middle income countries
- **50,000-100,000** children with thalassemia major die each year in low and middle income countries
Birth Defects (March of Dimes, 2006)

Frequency
7.9 million/yr.  3.3 million deaths

25% comprised of 5 diseases
  Congenital heart disease (1 m);
  Neural tube defect (324,000);
  Hemoglobinopathy (308,000);
  Down syndrome (217,000);
  G6PD deficiency (177,000)

Relationship to GNI
  Low income  60.2%
  Middle income  33.5%
  High income  6.3%
Annual births of severe disorders of hemoglobin

Sickle cell anemia
Sub-Saharan Africa 240,932
Elsewhere 92,997

HbSC disease 54,736

Thalassemia
β thalassemia major 23,329
HbE β thalassemia 20,588
HbH disease 14,504
HbS β thalassemia 12,321
Hb Bart’s hydrops 5,183
Beta thalassemia

Mendel Law: Autosomal recessive

Heterozygote: No. symptom; Homozygote: severe-intermedia
Morbidity & Mortality caused by *Transfusional Iron Overload*

Before The Era of Iron Chelation (1970):

PREVENTION AND CONTROL OF THALASSEMIA

1) PROVIDE THE BEST TREATMENT FOR THE PATIENTS

2) PREVENT BIRTH OF NEW CASES
Standard Treatment of Thalassemia

1) Regular blood transfusion
2) Treatment of various complications
3) Iron chelation for those with iron overload
4) Cure: stem cell transplantation and Gene therapy
Standrad Treatment of Thalassemia
# Projections of the Cost of Treating β-Thalassemia in Selected Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (millions)</th>
<th>Annual β-thalassaemia births (no prevention)</th>
<th>Annual per-capita health expenditure (US $)</th>
<th>Percentage of per-capita health expenditure required for thalassaemia services</th>
<th>Annual increase in treatment cost if no prevention</th>
<th>Ultimate annual treatment cost if no prevention (year 50)</th>
<th>Annual cost of prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maldives</td>
<td>0.3</td>
<td>57</td>
<td>248</td>
<td>0.81</td>
<td>43.0</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td>134.5</td>
<td>4,428</td>
<td>71</td>
<td>0.51</td>
<td>25.5</td>
<td>0.41</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>207.4</td>
<td>3,013</td>
<td>56</td>
<td>0.37</td>
<td>18.6</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>Bangladesh</td>
<td>126.9</td>
<td>2,124</td>
<td>70</td>
<td>0.26</td>
<td>13.1</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>61.8</td>
<td>2,557</td>
<td>327</td>
<td>0.14</td>
<td>7.0</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>Jordan</td>
<td>4.7</td>
<td>81</td>
<td>178</td>
<td>0.11</td>
<td>5.4</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td>62.7</td>
<td>1,155</td>
<td>200</td>
<td>0.10</td>
<td>5.1</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>0.8</td>
<td>43</td>
<td>731</td>
<td>0.09</td>
<td>3.9</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>986.6</td>
<td>4,279</td>
<td>84</td>
<td>0.06</td>
<td>2.8</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Tunisia</td>
<td>9.5</td>
<td>83</td>
<td>239</td>
<td>0.04</td>
<td>2.0</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>22.7</td>
<td>101</td>
<td>202</td>
<td>0.02</td>
<td>1.2</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>

## Estimated Direct Cost for the Management of One β-Thalassemia Major for 30 Years: 2006

<table>
<thead>
<tr>
<th>Items</th>
<th>1-10 years</th>
<th>11-20 years</th>
<th>21-30 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Blood transfusion plus filter/month</td>
<td>2,500 (1 unit)</td>
<td>5,000 (2 units)</td>
<td>7,500 (3 units)</td>
</tr>
<tr>
<td>2. Desferrioxamine Vial/month</td>
<td>5,000 (20 vials)</td>
<td>10,000 (40 vials)</td>
<td>150,000 (60 vials)</td>
</tr>
<tr>
<td>3. Hospital care 1 day/month</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>4. Other: Lab tests/month</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>5. Total cost/month</td>
<td>10,500</td>
<td>18,500</td>
<td>26,500</td>
</tr>
<tr>
<td>6. Total cost/year</td>
<td>126,000</td>
<td>222,000</td>
<td>318,000</td>
</tr>
<tr>
<td>7. Total cost/10 years</td>
<td>1,260,000</td>
<td>2,220,000</td>
<td>3,180,000</td>
</tr>
</tbody>
</table>

**Grand total**: 6,660,000 Baht (150,000 Euro)

(1 Euro = 44 Baht)

(Leelahavarong P et al 2010)
Sequences in prevention and control program:

(a) Improving therapeutic services that required a common management protocol.
(b) Availability of adequate safe blood.
(c) Availability of laboratory facilities and obstetricians for screening and detection of high risk couples including prenatal diagnosis.
(d) Population screening and counseling.
(e) Community involvement, public information and education.
(f) Evaluation is necessary to measure and report progress in patient care and prevention from time to time.
Comparison of the cost of treatment and and prevention of severe thalassemia in 1000 pregnant women in Thailand

<table>
<thead>
<tr>
<th>Prevention</th>
<th>Expected No. Birth</th>
<th>Treatment (av. life= 30 yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hb Bart’s hydrops fetus</td>
<td>48,280 B (US$ 1379)</td>
<td>2</td>
</tr>
<tr>
<td>Beta thalassemic Disease*</td>
<td>48,280 B (US$ 1379)</td>
<td>4#</td>
</tr>
</tbody>
</table>

(* include both homozygous beta thalassemia and beta thal/HbE, #1 homozygous beta thalassemia and 3 beta thal/HbE , ** cost per case = 6,660,000 B)
The cost-benefit analyses of thalassemia screening vs cost of treatment at Chiangmai University

- Period of screening test: 8 years
- 21,975 pregnant women has been screened
- The program prevent birth of 80 severe thalassemia cases
- Total cost of screening (husband and wife) and PND = 3,091,000 Thai Baht (US$ 93,667)
- The cost of treatment of thalassemia patients = 222,961,250 Thai Baht (US$ 6,756,401)

**Benefit : Cost = 72 : 1**

(Wanapirak 2008)
Thalassemia in Developing Countries

1. Many communicable diseases

2. Poverty

3. Limited data on frequency and lack of data on economic issue

4. Lack of awareness: government/NGO

5. Ethical, social, religious and legal issues
Organization required for control of thalassemia in the developing countries

North/South and South/South partnerships
Support by WHO, funding agencies, NGOs, Governments
Definition of economic issues. GBD program

(DJ Weatheral, 2010)
Global Control of Hemoglobinopathies

Goals

1) Define magnitude of problems
2) Evidence-based control and/or management
3) Adequate economic data
4) Advise government and NGOs
5) Approaches and technology transfer
6) More effective collaborative research
7) North-south partnerships
8) South-south partnerships, regional net work
9) Input from NGOs and government
Global Burden of Disease (GBD) 2010

Years Lived with Disability (YLDs)
Disability-Adjusted Life Years (DALYs)

DALYs: composite health indicators

$$\text{DALYs} = \text{YLLs} + \text{YLDs}$$

(YLLs = years of life lost due to premature mortality
YLDs = healthy years lost due to disability)
Global Burden of Disease (GBD) 2010

<table>
<thead>
<tr>
<th>Condition</th>
<th>YLDs (thousands)</th>
<th>DALYs (thousands)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin disorders</td>
<td>10,197 (7166-13843)</td>
<td>15,640 (12225-19722)</td>
</tr>
<tr>
<td>Malaria</td>
<td>4,078 (1853-6980)</td>
<td>82,685 (63426-109816)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>21,985 (16947-27516)</td>
<td>295,036 (273061-309562)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>20,758 (14415-28762)</td>
<td>46,823 (40085-55215)</td>
</tr>
</tbody>
</table>

(DJ Weatheral, 2010)
Sickle-cell anaemia

Having examined the report on sickle-cell anaemia;¹

Recalling resolution WHA57.13 on genomics and world health, and the discussion of the Executive Board at its 116th session on control of genetic diseases, which recognized the role of genetic services in improving health globally and in reducing the global health divide;²

Recalling decision Assembly/AU/Dec.81 (V) of the Assembly of the African Union at its Fifth Ordinary Session;

Noting the conclusions of the 4th International African American Symposium on sickle-cell anaemia (Accra, 26-28 July 2000), and the results of the first and second international congresses of the International Organization to Combat Sickle-Cell Anaemia (respectively, Paris, 25-26 January 2002 and Cotonou, 20-23 January 2003);
118th Session

Agenda item 5.2

Thalassaemia and other haemoglobinopathies

The Executive Board,

Having considered the report on thalassaemia and other haemoglobinopathies;¹

Recalling resolution WHA57.13 on genomics and world health, resolution EB117.R3 on sickle-cell anaemia and the recognition by the Executive Board at its 116th session of the role of genetic services in improving health globally and in reducing the global health divide;²

Concerned at the impact of genetic diseases, and of haemoglobinopathies (thalassaemia and sickle-cell anaemia) in particular, on global mortality and morbidity, especially in developing countries, and by the suffering of patients and families affected by the disease;

Recognizing that the prevalence of thalassaemia varies between communities, and that insufficient epidemiological data may hamper effective and equitable management;
Resolutions on Hemoglobinopathies

Thalassaemia and other Haemoglobinopathies
EB118, May 2006 – Resolution EB118.R1

Requests the Director-General

- provide technical support and advice to national programs
- expand the training and expertise of personnel
- support the further transfer of affordable technologies
- drafting guidelines on prevention and management
- fostering the establishment of regional groups of experts;
- support needed research

Sickle cell anaemia

WHA59, May 2006 – Resolution WHA59.20
The objectives of the meeting are as follows:

- To learn from the experiences of the countries
- To review draft regional guidelines on management and prevention of Thalassemia
The Lalit Hotel
Barakhamba Avenue, Connaught Place, New Delhi, India
August 7-8, 2014
Table 6: Thalassemia diagnosis in different Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Blood Cell Analyzer</th>
<th>OF</th>
<th>Hb Analysis</th>
<th>DNA Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Electrophoresis</td>
<td>HPLC/LPLC/CE</td>
</tr>
<tr>
<td>Australia</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>(+)</td>
<td>-</td>
<td>(+)</td>
<td>(+)</td>
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<tr>
<td>Cambodia</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
<td>(+)</td>
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<tr>
<td>China: Guangxi</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>China: Hong Kong</td>
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<td>-</td>
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<td>+</td>
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<tr>
<td>India</td>
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<tr>
<td>Indonesia</td>
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<tr>
<td>Laos</td>
<td>(+)</td>
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<td>Malaysia</td>
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<td>Maldives</td>
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<tr>
<td>Sri Lanka</td>
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<tr>
<td>Thailand</td>
<td>+</td>
<td>(+)</td>
<td>+</td>
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<tr>
<td>Vietnam</td>
<td>+</td>
<td>-</td>
<td>+</td>
<td>(+)</td>
</tr>
</tbody>
</table>
### Table 7: Treatment available in different Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Blood Transfusion</th>
<th>Iron Chelation</th>
<th>BM Transplant.</th>
<th>PND</th>
<th>National Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DFO</td>
<td>L1</td>
<td>Exjade</td>
<td></td>
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<tr>
<td>Australia</td>
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<td>+</td>
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<tr>
<td>Bangladesh</td>
<td>(+)</td>
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<td>Cambodia</td>
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<td>Guangxi</td>
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<td>India</td>
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<td>Laos</td>
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<td>Maldives</td>
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<td>Myanmar</td>
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<td>Singapore</td>
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<tr>
<td>Sri Lanka</td>
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<tr>
<td>Thailand</td>
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<tr>
<td>Vietnam</td>
<td>(+)</td>
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</tr>
</tbody>
</table>
Research alone does not lead to policy

“Triangle That Moves The Mountain”

Knowledge
(creation of relevant knowledge)

Social mobilization

Political involvement

(P. Wasi 2010)
Knowledge-base policy development

1. Burden
2. Etiology
3. Efficacy of intervention
4. Cost-effectiveness
5. Policy decision
6. Implementation
7. Monitoring
8. Evaluation

Thalassemia control Policy Development Forum

(P. Wasi 2010)
Country Report

1. Australia (John Prior)
2. Bangladesh (Syed Khairul Amin)
3. Cambodia (Sam Vuthy, Robyn Devenish)
4. China, Guangxi (Chen Ping)
5. China, Hong Kong (Vivian Chan)
6. India (Roshan Colah)
7. Indonesia (Iswari Setianingsih)
8. Laos (Douangdao Souk Aloun)
9. Malaysia (Elizabeth George)
10. Maldives (Naila Firdous)
11. Myanmar (Sann Sanda Khin)
12. Singapore (Hai Yang Law)
13. Sri Lanka (Shanthimala de Silva)
14. Taiwan (Ching-Tien Peng)
15. Thailand (Vichai Tienthavorn)
16. Vietnam (Lam Thi My)
ASIAN NETWORK FOR THALASSAEMIA CONTROL

July 4, 2005
Miracle Grand Hotel
Bangkok, Thailand
ASIAN NETWORK FOR THALASSAEMIA CONTROL

October 17, 2007
Rama Gardens Hotel, Bangkok, Thailand
Proposes:

1) Set up Regional Working Group on Hemoglobinopathies (RWGH)
2) Provides partial support to run the RWGH
3) Have a regular annual meeting of the working group, rotate to all member countries
4) The annual meeting should be mainly sponsored by local government (with partial support from SEARO)
5) The RWGH can help local organizer (of annual meeting) to organize education symposium or laboratory workshop for the local people (administrators, doctors, technicians, nurses)
6) The RWGH will help to develop lab manual (for diagnosis), GCP guidelines, etc.
7) The RWGH will help training of personals (doctor, nurse, technicians, counselor etc.)

SEARO should work in collaboration with other regions
# Thalassemia in Thailand

<table>
<thead>
<tr>
<th>Disorder</th>
<th>Prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\alpha)-Thalassemia ((\alpha)-thal1 and (\alpha)-thal2)</td>
<td>20 - 30%</td>
</tr>
<tr>
<td>Hb Constant Spring ((\alpha)-thal 2 like effect)</td>
<td>1 - 8%</td>
</tr>
<tr>
<td>(\beta)-Thalassemia</td>
<td>3 - 9%</td>
</tr>
<tr>
<td>Hemoglobin E</td>
<td>10 - 53%</td>
</tr>
</tbody>
</table>

**Total number of thalassemic patients and the number of births per year (total births = 800,000/year)**

<table>
<thead>
<tr>
<th>Diseases</th>
<th>Couple at risk (per year)</th>
<th>Birth (per year)</th>
<th>Living patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homozygous (\beta)-thalassemia</td>
<td>828</td>
<td>207</td>
<td>2,070</td>
</tr>
<tr>
<td>(\beta)-Thalassemia/Hb E</td>
<td>12,852</td>
<td>3,213</td>
<td>96,390</td>
</tr>
<tr>
<td>Hb Bart's hydrops fetalis</td>
<td>3332</td>
<td>833</td>
<td>0</td>
</tr>
<tr>
<td>Hb H disease</td>
<td>22,400</td>
<td>5,600</td>
<td>336,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>39,412</strong></td>
<td><strong>9,853</strong></td>
<td><strong>434,460</strong></td>
</tr>
</tbody>
</table>

*Modified from Fucharoen S. and Winichagool P., 1988*
Immunochromatographic Strip Test for α-Thalassemia

1. 0.1 ml. blood + hemolysis agent
2. Insert strip, leave 2 min.
3. wash
4. Read result

3 minutes

TWO LINES POSITIVE
ONE LINE NEGATIVE
ประชุมสัมมนาวิชาการ
глаลัสซีเมียแห่งชาติ ครั้งที่ 19
"ภาคีเครือข่ายการป้องกันและควบคุม
โรคกลัสซีเมียเพื่อการบริหารจัดการ"

กิจกรรมที่ 1:
การสร้างเครือข่ายการป้องกันและควบคุม
โรคกลัสซีเมียเพื่อการบริหารจัดการ

GPO-L-ONE
Deferiprone Tablets
500 mg
Iron Chelating Agent

Hospital use only
Figure 2: Thalassemia born per 1000 live birth in different part of Thailand

Total cases = 5.4:1000
Case Registration (year)

Year

Number

CMU  MOPH

Hb E/beta-thal
beta-Thal major
The 2nd International Conference on Thalassemia & Birth Defects

October 11, 2014  Nanning, P. R. China
Prevention and Control of Thalassemia and Birth Defects

NANNING DECLARATION

The 2\textsuperscript{nd} International Conference on Thalassemia & Birth Defects, jointly organized by the National Health and Family Planning Commission (NHFPC) of the People’s Republic of China and the Thalassemia International Federation (TIF) has been taking place on 11 October 2014 in Nanning, China. 100 government officials and experts from China, Cyprus, Indonesia and Thailand, together with conference
时要做产前筛查、产前诊断，才能有把握生下健康的孩子。

正常人 和 地贫基因携带者 结婚，生育后代有两种结果：

1. 后代是地贫基因携带者的几率为50%
2. 后代正常的几率为50%
3. 后代是重症地贫患儿的几率为25%

（红色显示就是需要重点干预的后代）
Key Event 2015:

1) TIF is planning the 2nd Pan Asian Conference on Hemoglobinopathies, September 26-27, 2015, Hanoi
2) 10th Cooley’s Anemia Meeting in Chicago, October 18-22, 2015
3) ASEAN will join as AEC

What shall or what can we do about Thalassemia?
GLOBAL GLOBIN 2020 CHALLENGE (GG2020) CONFERENCE 2017
16 - 18 July 2017
Impiana Hotel, Kuala Lumpur, Malaysia

TOPICS

Understanding GG2020 Challenge
Global update of GG2020: Country report
Databases and data sharing - where are we today?
Funding and sharing of resources
Sickle cell disease
The way forward for GG2020 - 2017 and beyond

Registration fees
Student: RM500
Professional: RM550
International: USD250

Organised by:

Secretariat:
Malaysian Node of the Human Variome Project (MY-VP)
Universiti Sains Malaysia
Health Campus, Kubang Kanai, 16150 Kubang Kru, Kedah
Tel: 09-7676521/2
Email: myhp@usm.my
14th International Conference on Thalassaemia & Haemoglobinopathies &
16th TIF International Conference for Patients & Parents

Date: 17 – 19 November 2017
Venue: Grand Hotel Palace
Thessaloniki, Greece
EMERGING ISSUE!

MIGRATION
- From Indochina to US, Europe, Australia
- From Middle East to Europe
- Labor migration in Asia
Hemoglobin Disorders Identified by Newborn Screening in California

Annual Thalassemia Births in the U.S. Asian Population

- In 2006, 71 Asian newborns with a thalassemic disorder were identified in CA.
- In 2006, 298 Asian births with thalassemia were predicted in U.S.
- Only 135 (50%) were reported.
- **50% of Asian newborns with thalassemia are not identified by newborn screening.**

Source: National Newborn Screening and Genetics Resource Center
Top 10 origins of people applying for asylum in the EU

First-time applications in 2015, in thousands

- Syria: 363,000
- Afghanistan: 105,000
- Iraq: 100,000
- Kosovo: 60,000
- Albania: 50,000
- Pakistan: 30,000
- Eritrea: 20,000
- Nigeria: 15,000
- Iran: 10,000
- Ukraine: 10,000

Source: Eurostat
Where are immigrants going?

Asylum claims in Europe, 2015

Total EU claims* 1,321,560

Number of asylum claims

Source: Eurostat

* Map also shows claims for non-EU members Norway and Switzerland
Statistics of Migrant Workers in Thailand

Data from Office of Foreign Workers Administration, Department of Employment, Ministry of Labor.
Cambodia

- **Normal**: 45.5%
- **Hb E trait**: 34.4%
- **α-thal 2 trait**: 9.1%

- Normal
- Heterozygous alpha thalassemia 1
- Heterozygous alpha thalassemia 2
- Homozygous alpha thalassemia 2
- Hb H disease
- Heterozygous Hb E
- Double heterozygous for Hb E and alpha thalassemia 1
- Double heterozygous for Hb E and alpha thalassemia 2
- Heterozygous Hb E with homozygous alpha thalassemia 2
- Homozygous Hb E
- Homozygous Hb E with Heterozygous alpha thalassemia 2
Laos

- Normal 32.7%
- Hb E trait 35.9%
- Hb E homozygous 10.3%
- α-thal 2 trait 9.6%
- Heterozygous alpha thalassemia 1
- Heterozygous alpha thalassemia 2
- Homozygous alpha thalassemia 2
- Hb H disease
- Heterozygous Hb E
- Double heterozygous for Hb E and alpha thalassemia 1
- Double heterozygous for Hb E and alpha thalassemia 2
- Heterozygous Hb E with homozygous alpha thalassemia 2
- Homozygous Hb E
- Homozygous Hb E with Heterozygous alpha thalassemia 2
- Heterozygous beta thalassemia
- Double heterozygous for beta thalassemia and alpha thalassemia 2
- HPFH
- Beta thalassemia/Hb E
- EABart’s disease
Myanmar

- Hb E trait 13.9%
- α-thal 2 trait 15.7%
- Normal 57.7%

- Normal
- Heterozygous alpha thalassemia 1
- Heterozygous alpha thalassemia 2
- Homozygous alpha thalassemia 2
- Hb H disease
- Heterozygous Hb E
- Double heterozygous for Hb E and alpha thalassemia 1
- Double heterozygous for Hb E and alpha thalassemia 2
- Heterozygous Hb E with homozygous alpha thalassemia 2
- Homozygous Hb E
- Homozygous Hb E with Heterozygous alpha thalassemia 2
- Heterozygous beta thalassemia
- Double heterozygous for beta thalassemia and alpha thalassemia 2
- HPFH
- Beta thalassemia/Hb E
- EABart’s disease
Conclusion

1. Thalassemia is a public health problem, especially in Asia, Middle East, Africa, Mediterranean countries.
2. Magnitude of problems is not well established in some countries.
3. Different levels of knowledge and technology in member countries.
4. The abnormal genes have spread throughout the world because of the migration of people from these regions.
5. Questions: How to cope up with thalassemia problem worldwide? Where is the fund?