SOME SUGGESTIONS FOR ALLOCATION OF WORLD NEUROSURGERY ASSETS (SUPPLY, COST AND CURE)

TIGRAN KHACHATRYAN
HOLLIS FLOYD
SINAN RUMMAN
JOE SAM ROBINSON M.D.

I. Introduction

- As the world grows closer together and as scientific and medical advances become more evident, major question arises as for the best use for world healthcare resources.
- The practicalities of geopolitical arrangement make easy reallocation difficult and indeed rarely considered.
- We endeavor to explore the subject

I.a. Outline of the presentation

- **INTRODUCTION**
- **THE VIEW FROM MT. OLYMPUS – AT PRESENT**
  - **World population, income and healthcare dynamics**
  - **Breakdown of health expenditures in the world**
  - **Neurosurgery expenditures**
- **THE VIEW FROM MT. OLYMPUS - RESOURCE REALLOCATION (COMPARATIVE ANALYSIS)**
  - **Glioblastomas**
  - **Ruptured intracranial aneurysms**
- **WHY NOT WORLDWIDE ACCESS TO STANDARD OF CARE/ CLINICAL GUIDELINES/ TREATMENT OF GLIOBLASTOMAS AND RUPTURED ANEURYSMS?**
- **THE VIEW FROM MT. OLYMPUS - HOW CAN WORLDWIDE HEALTHCARE RESOURCE DYSFUNCTION BE IMPROVED?**
  - **Altruistic coefficient graph**
  - **Collaborative arrangement between the developed and developing world**
  - **The developed world's efforts**
  - **What can developing countries do?**
  - **A third solution**

I.b. Limitations of presented data

- Fluctuations in currency rates
- Insufficiency or inaccuracy of the available international data
- Errors in population numbers
- Errors in international statistical data
- Methodological difficulties and data summation

II. THE VIEW FROM MT. OLYMPUS

- at present

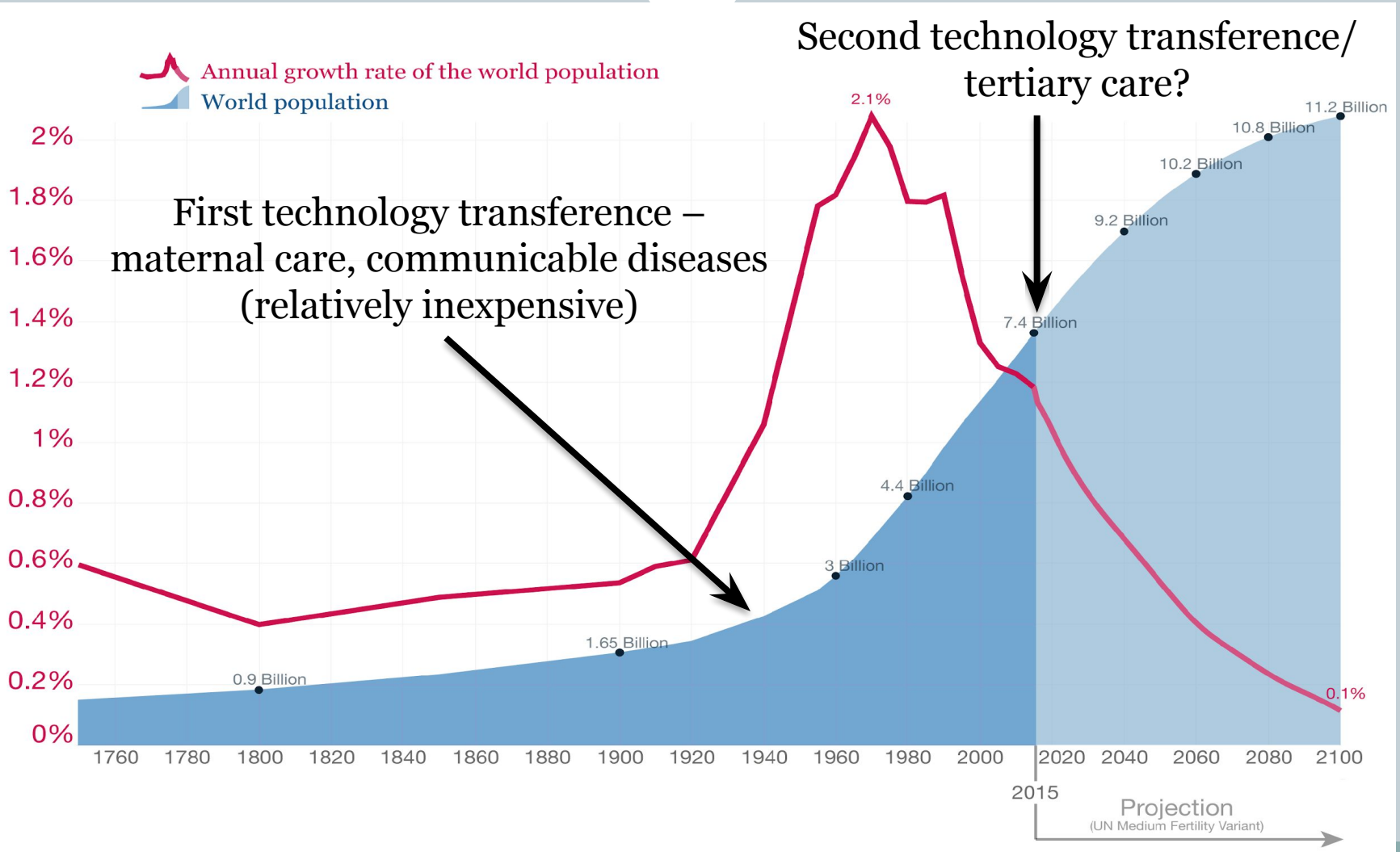
Total Value - $256 trillion (Credit Suisse 2016)

GWP – $77.9 trillion (CIA World Factbook 2014)

Health expenditure – $9.5 trillion (World Bank/WHO 2015)

II. World population, income and healthcare dynamics

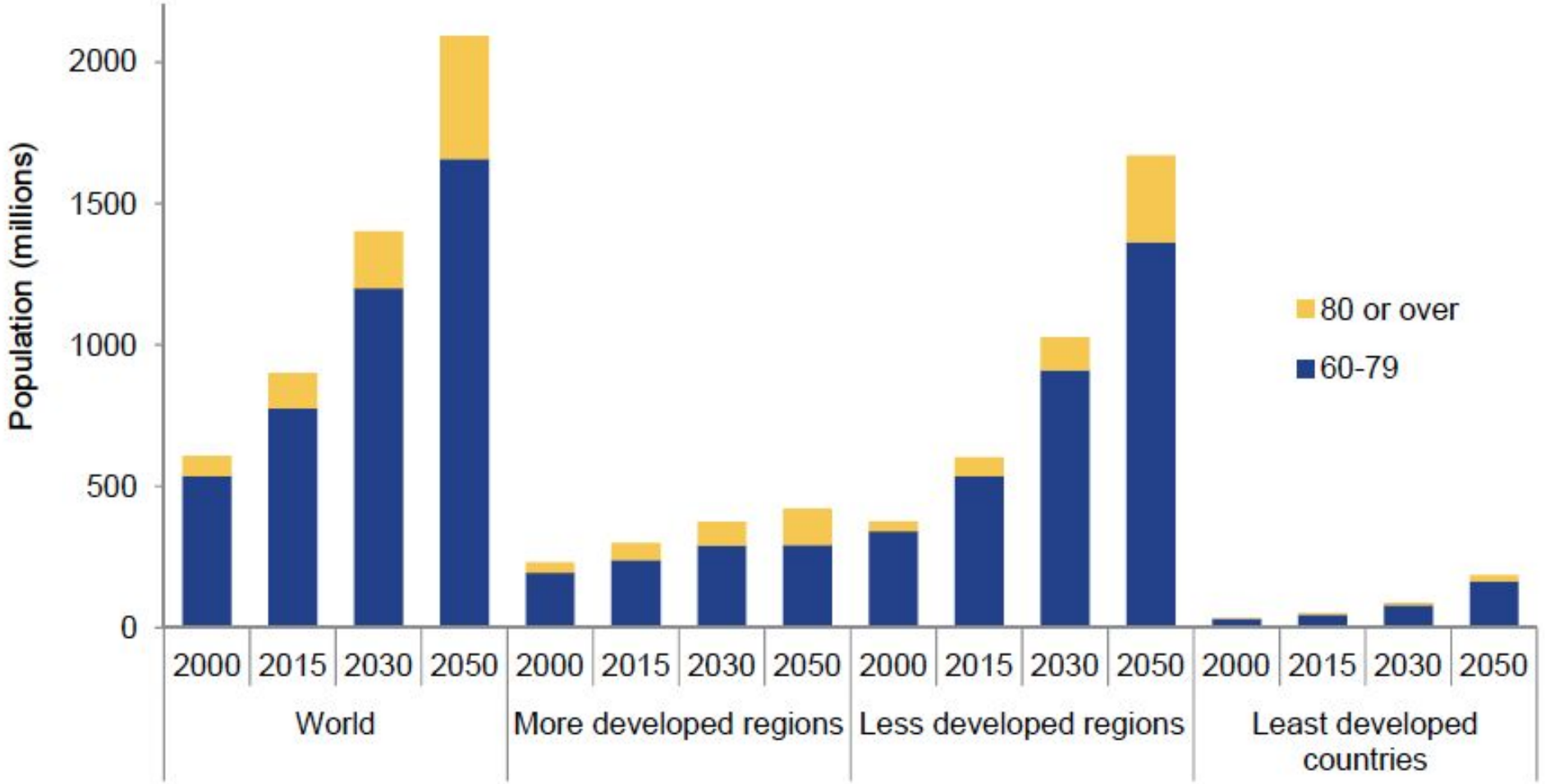
i. World population growth and growth rate



Data sources: Up to 2015 OurWorldInData series based on UN and HYDE. Projections for 2015 to 2100: UN Population Division (2015) – Medium Variant.
The data visualization is taken from OurWorldinData.org. There you find the raw data and more visualizations on this topic.

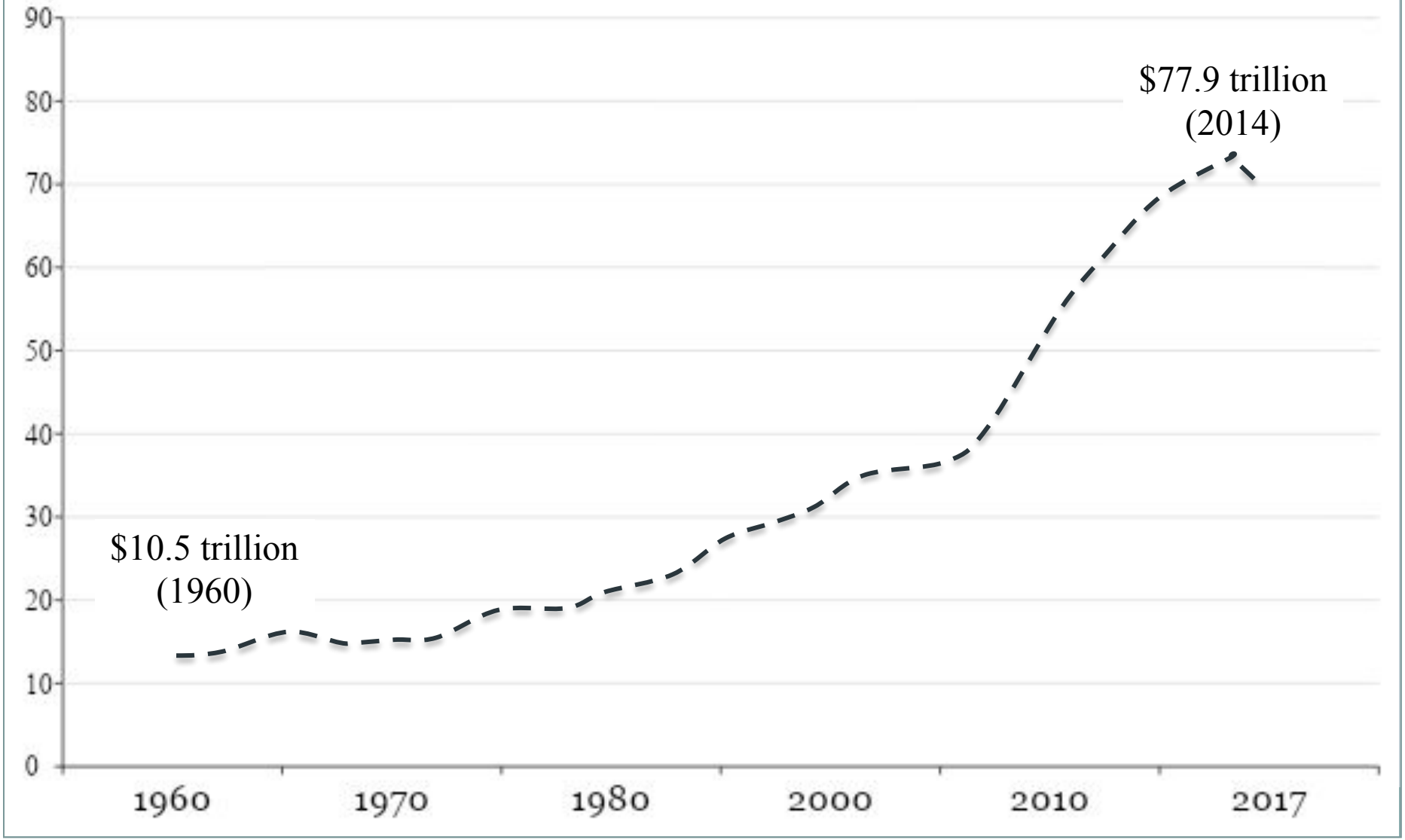
ii. Population aging

Population aged 60-79 years and aged 80 years or over by development group, 2000, 2015, 2030 and 2050

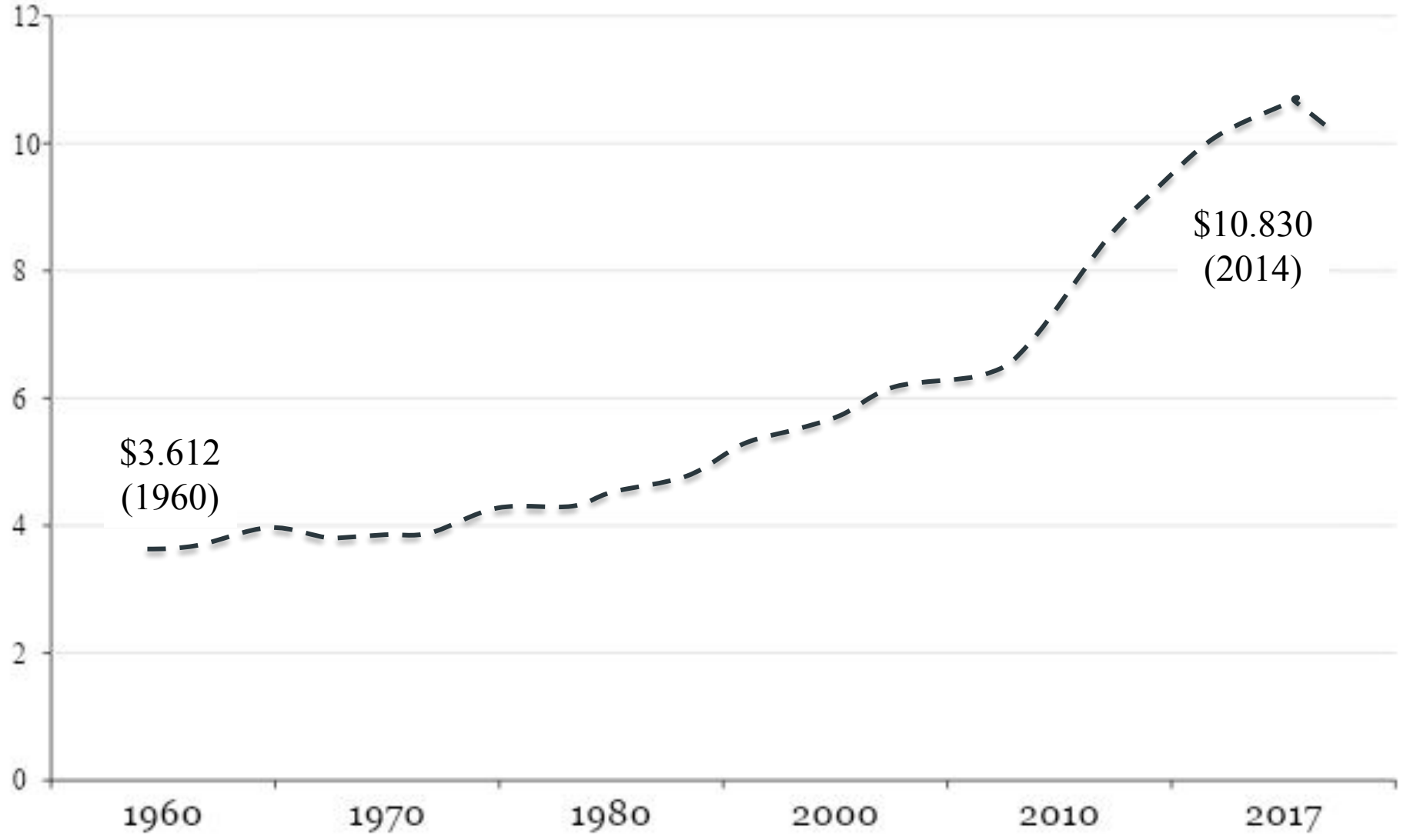


Data source: United Nations (2015). *World Population Prospects: The 2015 Revision*.

iii. Increase in world GNP (Constant 2014 US$)

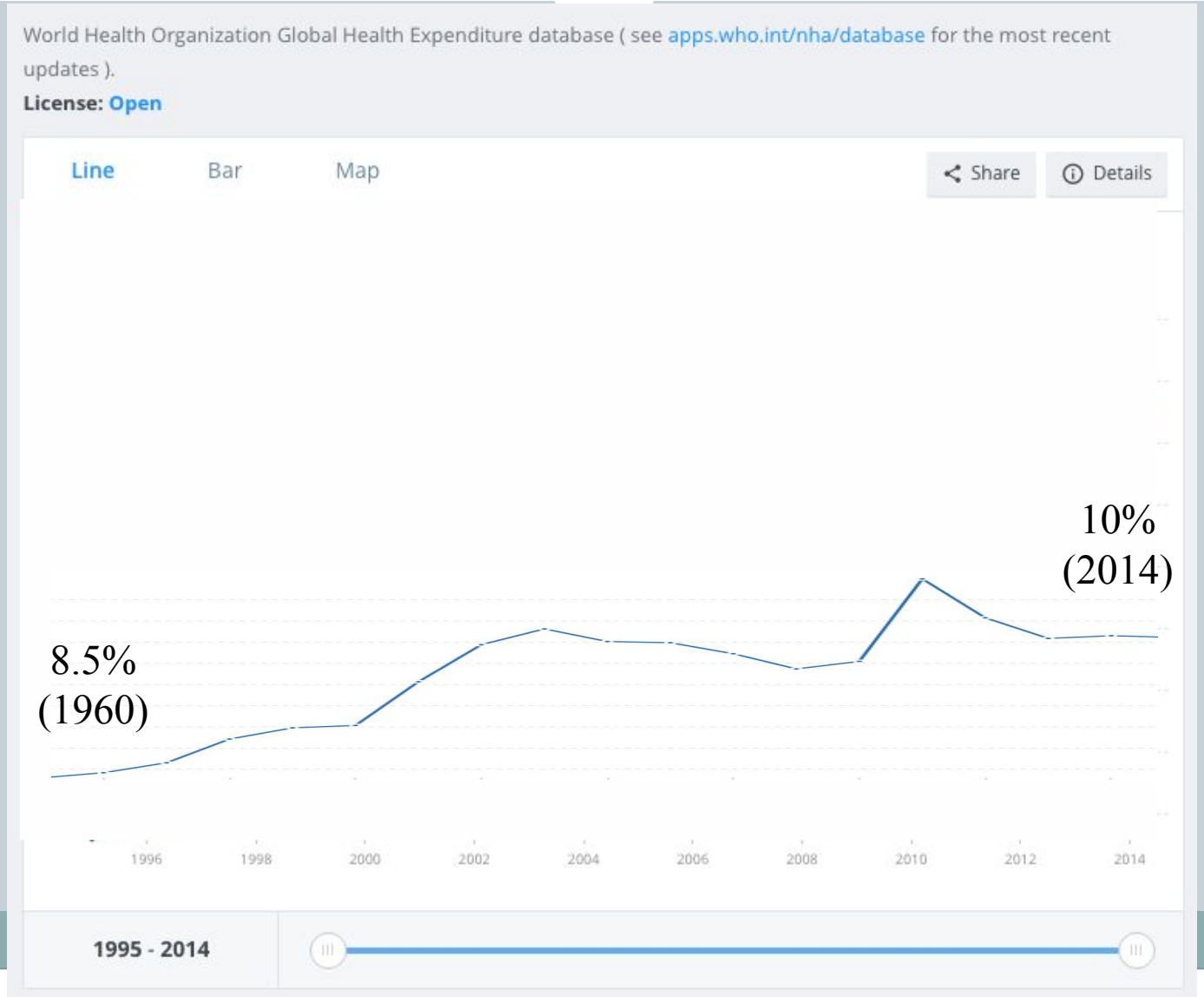


iv. Increase in world GNP per capita (constant 2014 US$)

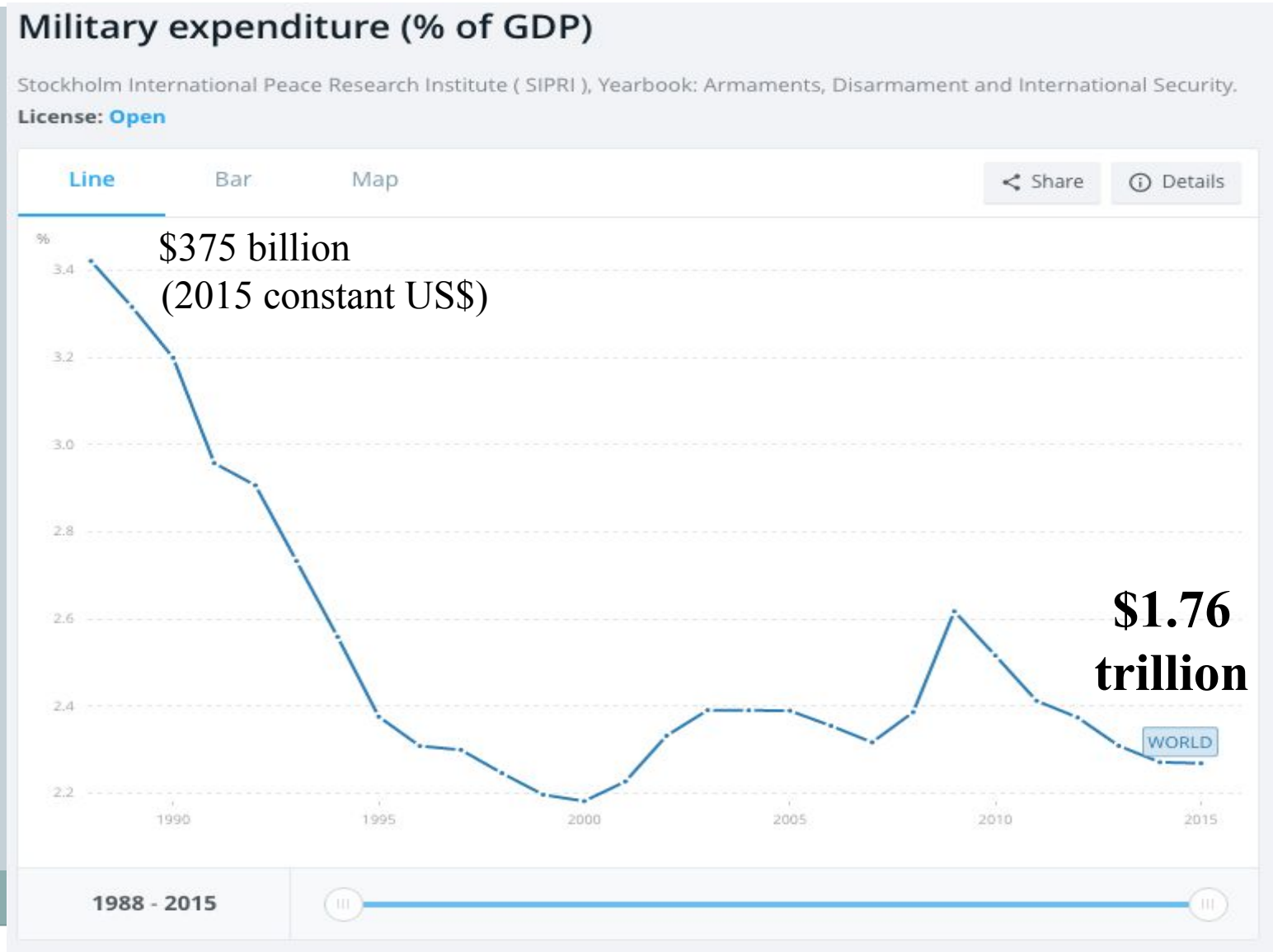


v. Increase in world health expenditure per capita

vi. Increase in world health expenditure (% of GNP)

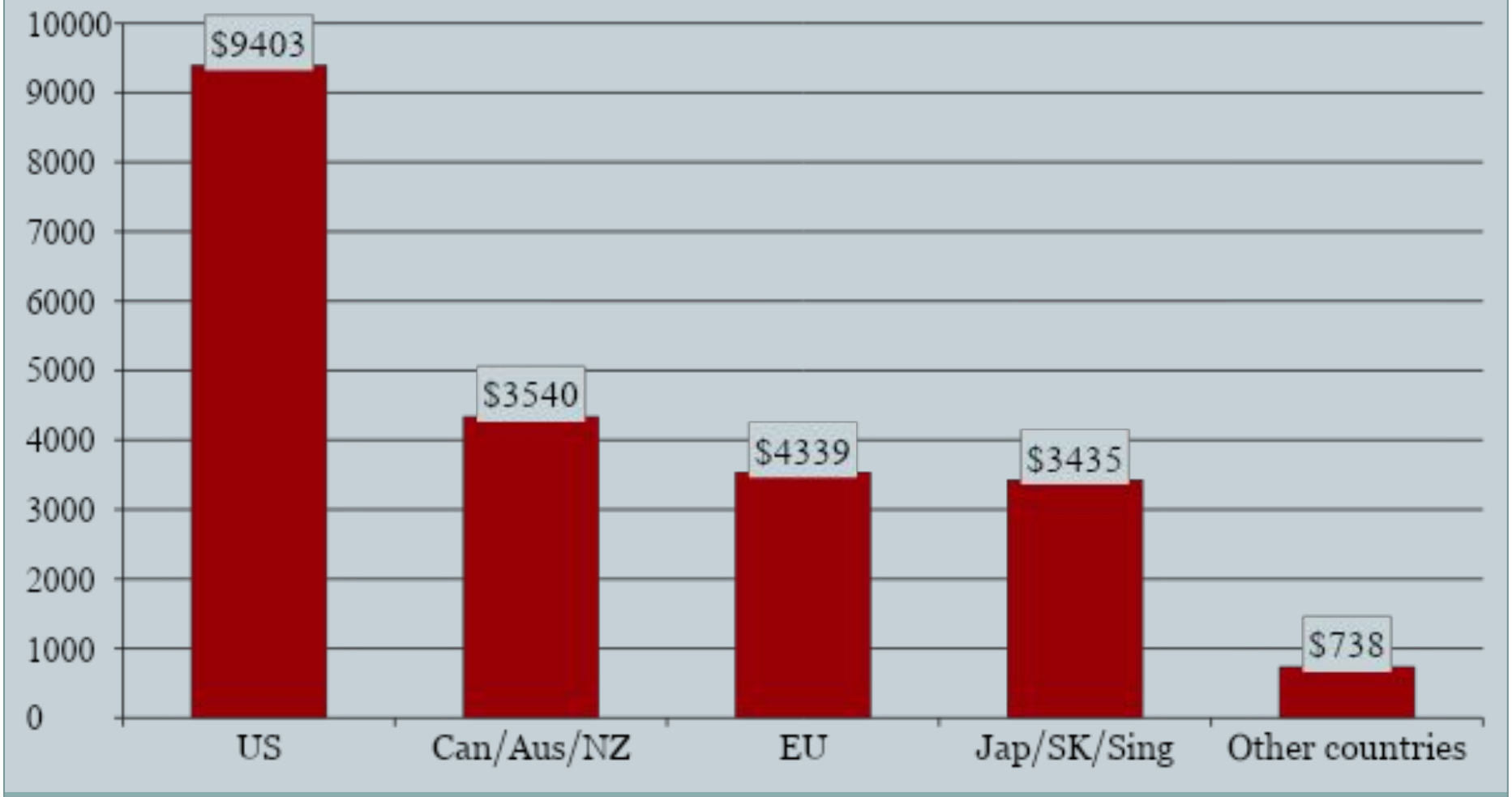


vii. Increase in world actual military expenditure

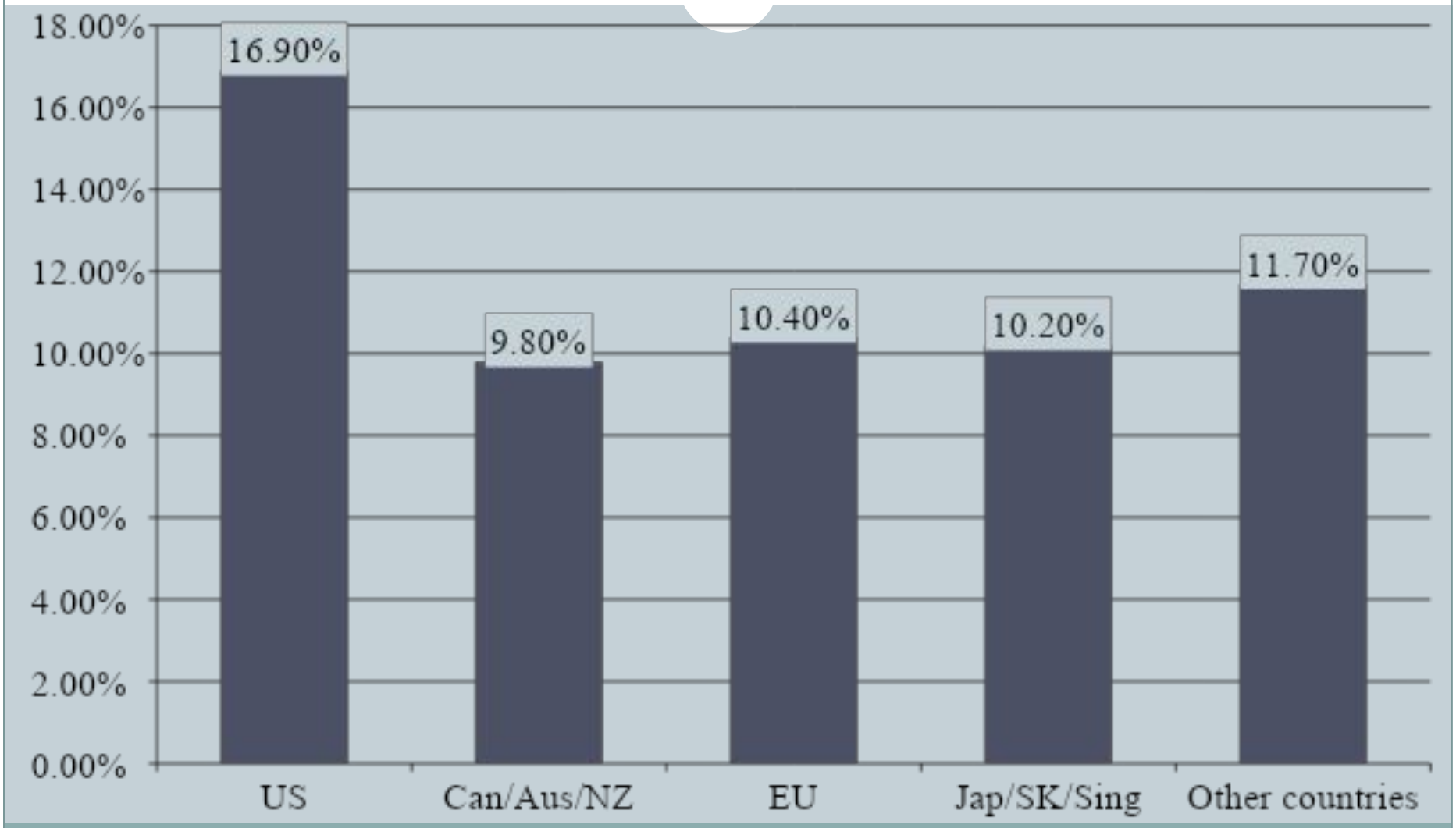


II.b. BREAKDOWN OF HEALTH EXPENDITURES IN THE WORLD

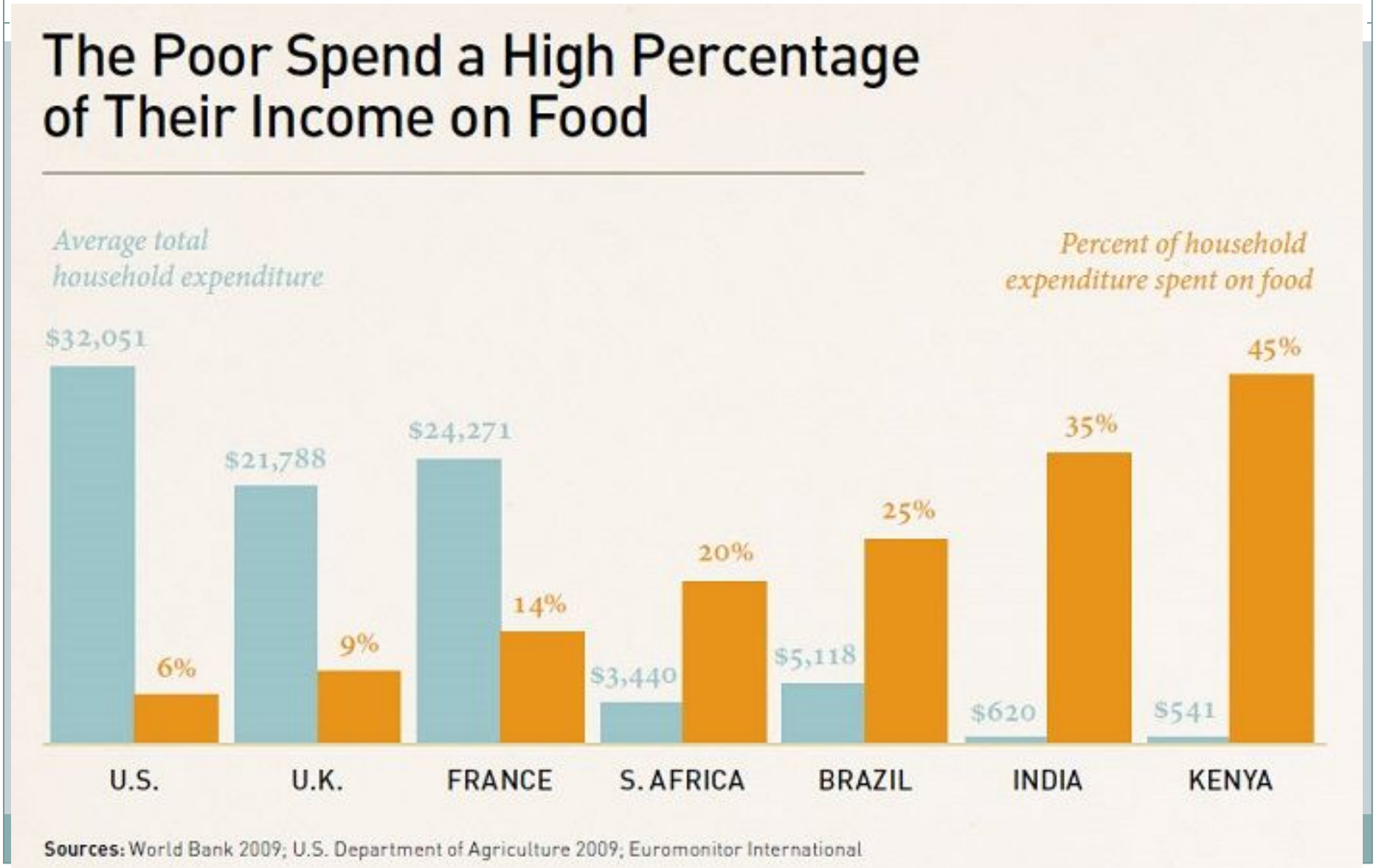
i. Average Health Expenditure Per Capita



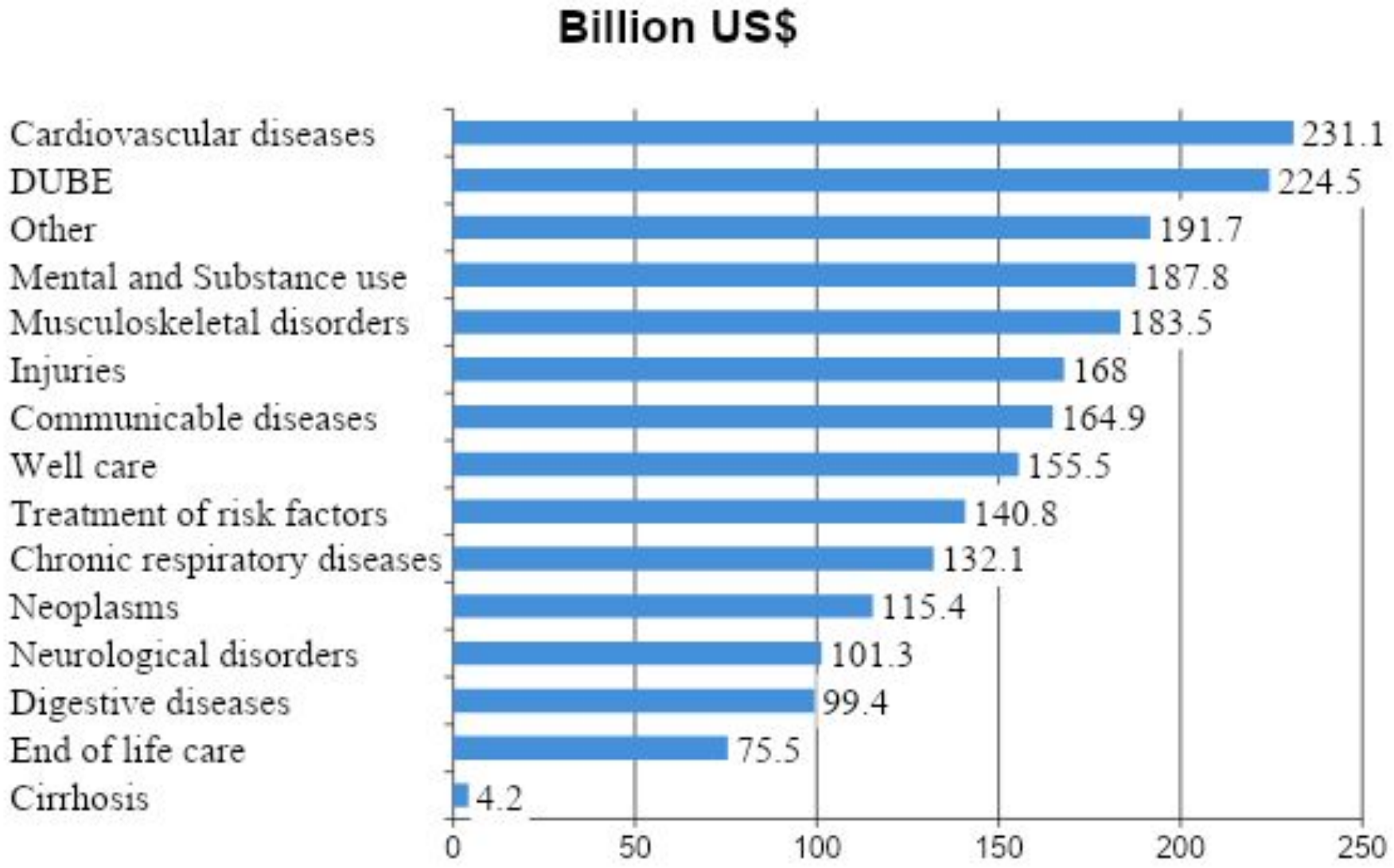
ii. Health expenditure % of GNP (HE/GNP)



iii. Expenditure priorities in poor countries



iv. US health expenditures by disease group



v. UK health expenditures by disease group

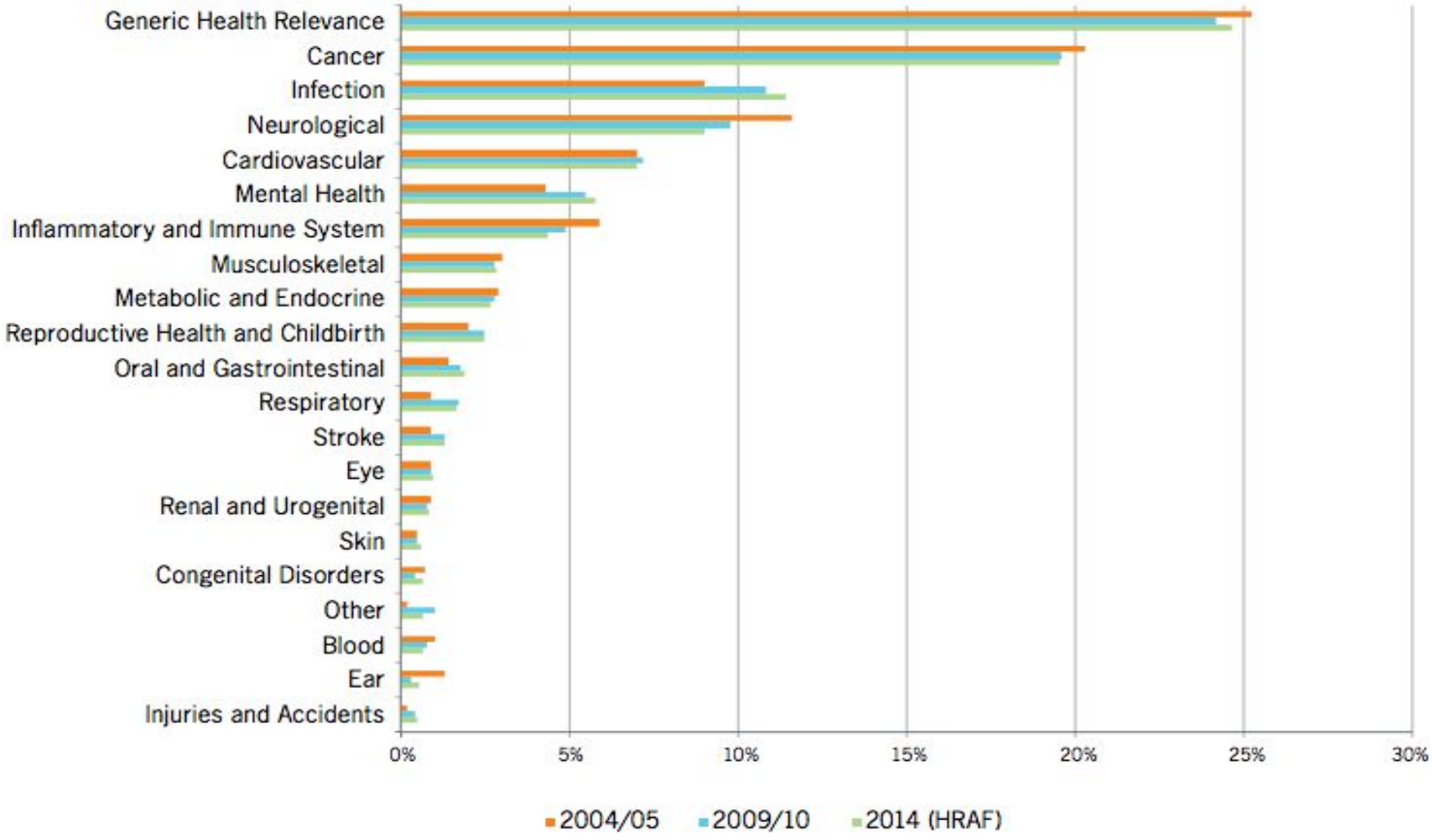
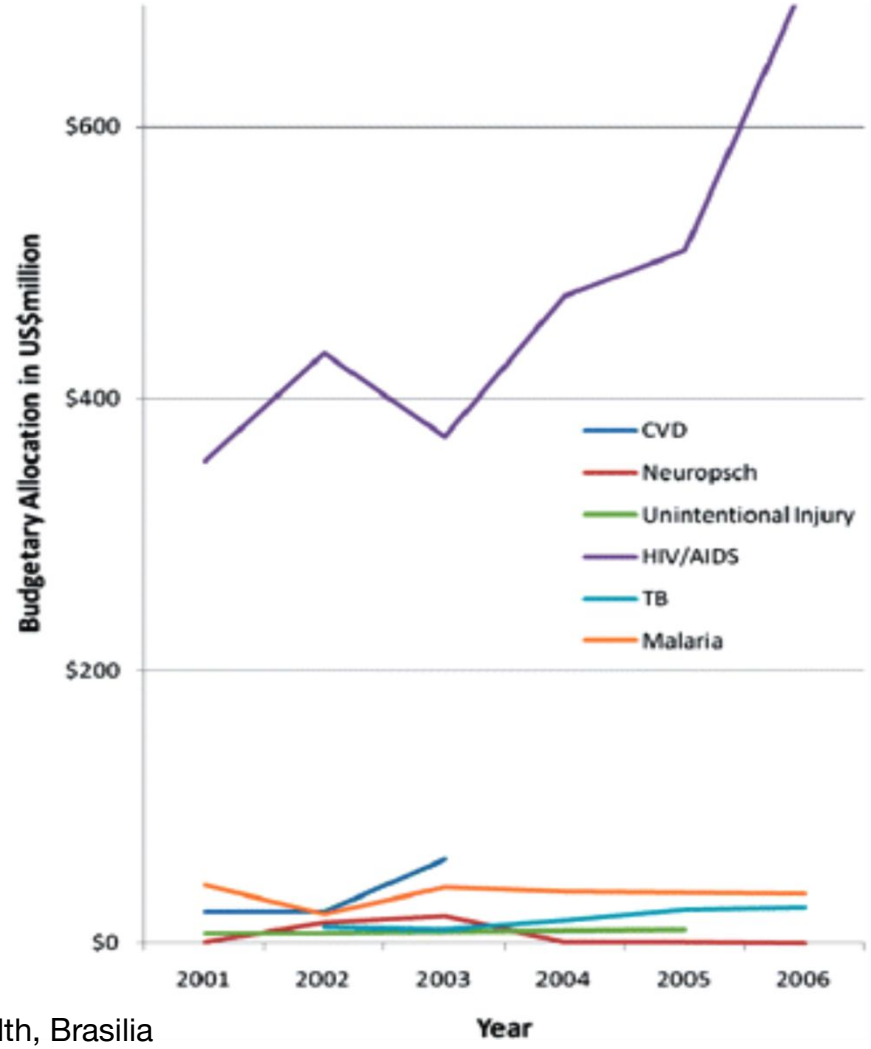


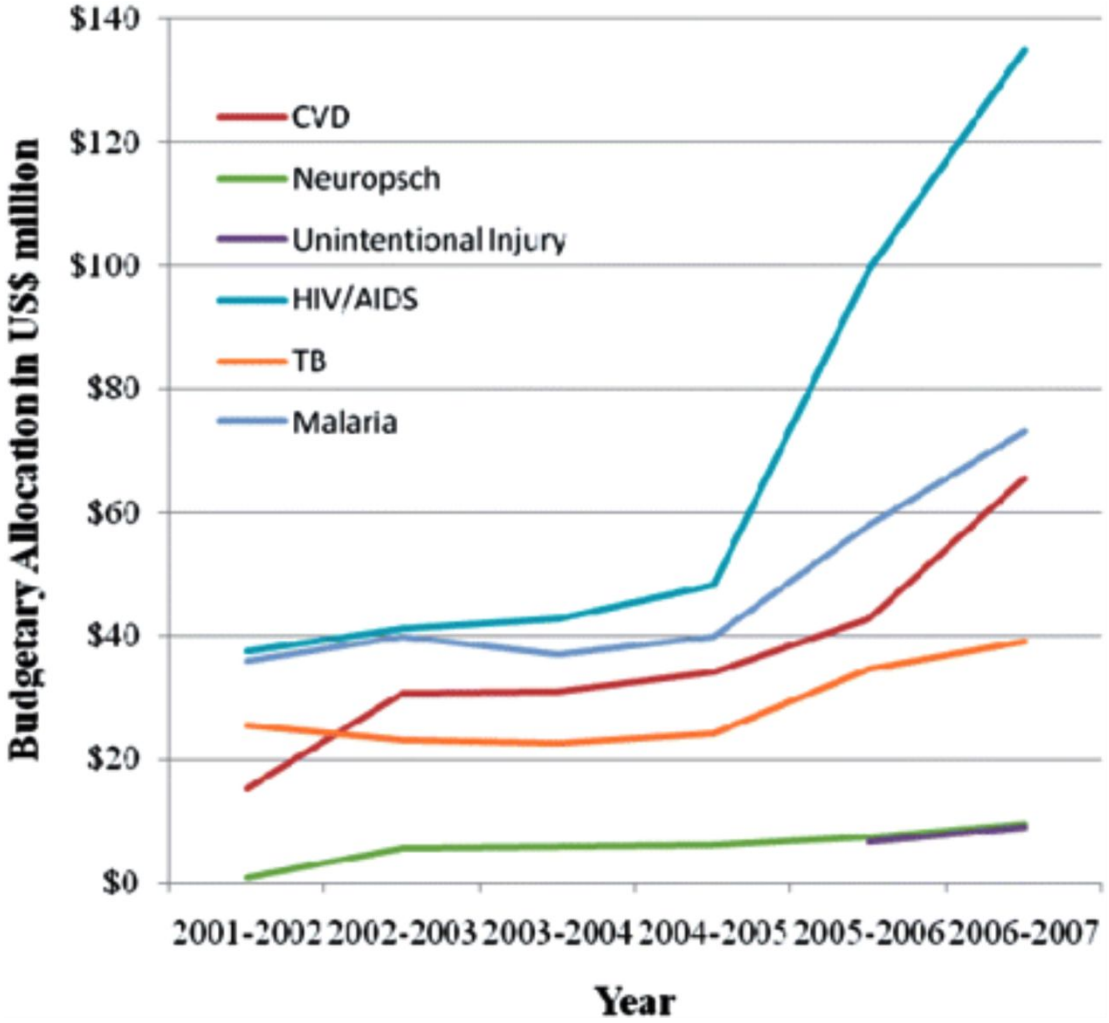
Figure 9 *– Proportion of combined spend by health category for 2004/05, 2009/10 and 2014 (HRAF, 12 funders).*

vi. Brazil's budgetary allocation for health (US$ million) from 2001 to 2006



Source: Brazil Ministry of Health, Brasilia

vii. India's budgetary allocation for health (US$ million) from 2001 to 2007

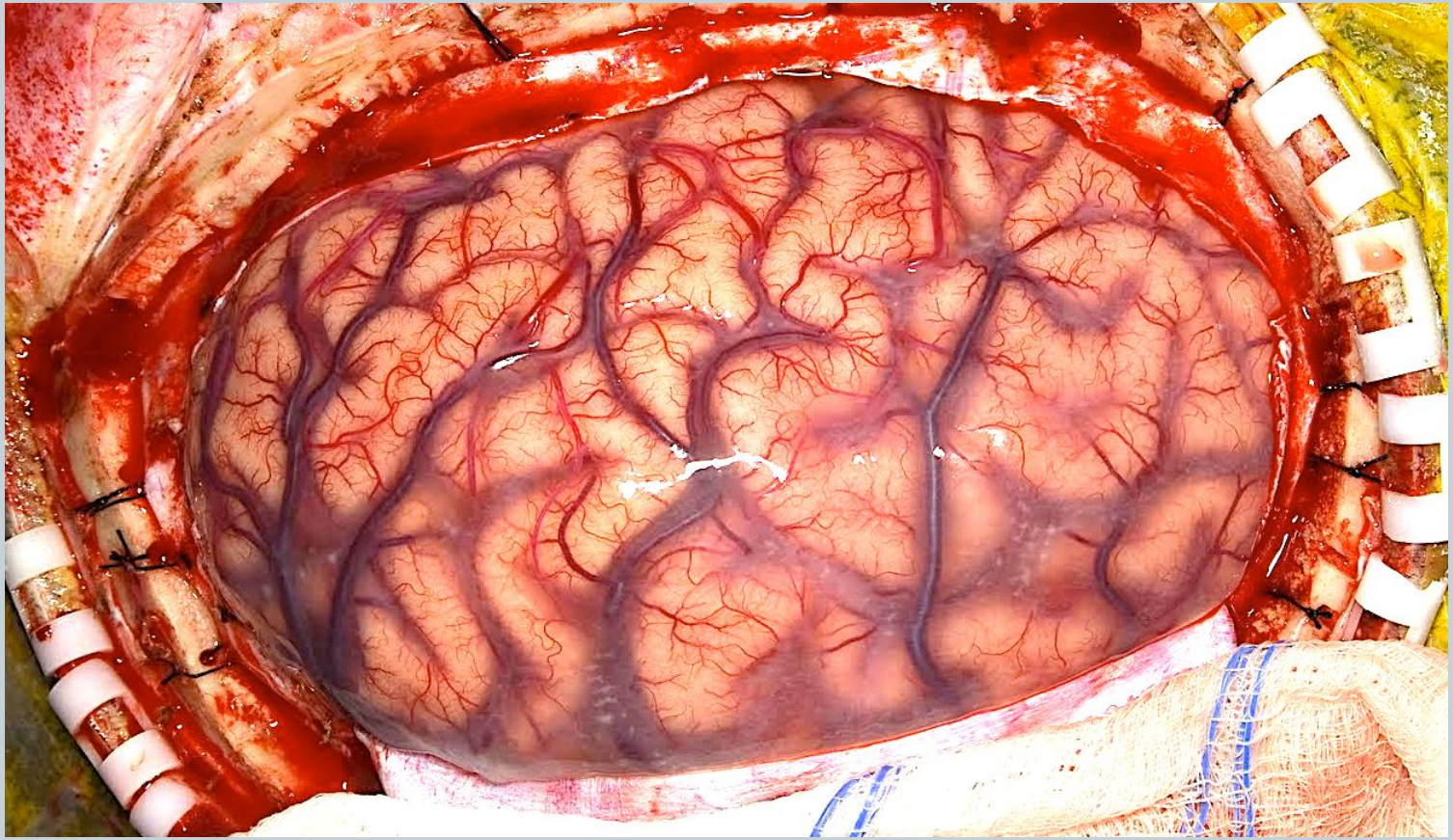


Source: India Ministry of Finance, available at: http://indiabudget.nic.in

viii. Summary

- □ Population
  - Thanks to relatively inexpensive (first) technology transference
- □□ Gross World Product
- □□□ World Health Expenditure
- Most of the world's health expenditure is in wealthy countries
- Most of that expenditure is for chronic diseases in a mature population
- Poorer countries spend more money on food, infectious disease and primary care

II.c. NEUROSURGERY EXPENDITURES



i. Neurosurgery Expenditures in the United States

Calculated using Center of Medicare & Medicaid data

- Medicare payments to Neurosurgeons as salary in 2014 - $612.417.016

Medicare makes 20% of total insurance expenditures

- Thus, total Neurosurgery salaries paid by Insurance – $3.062.085.080

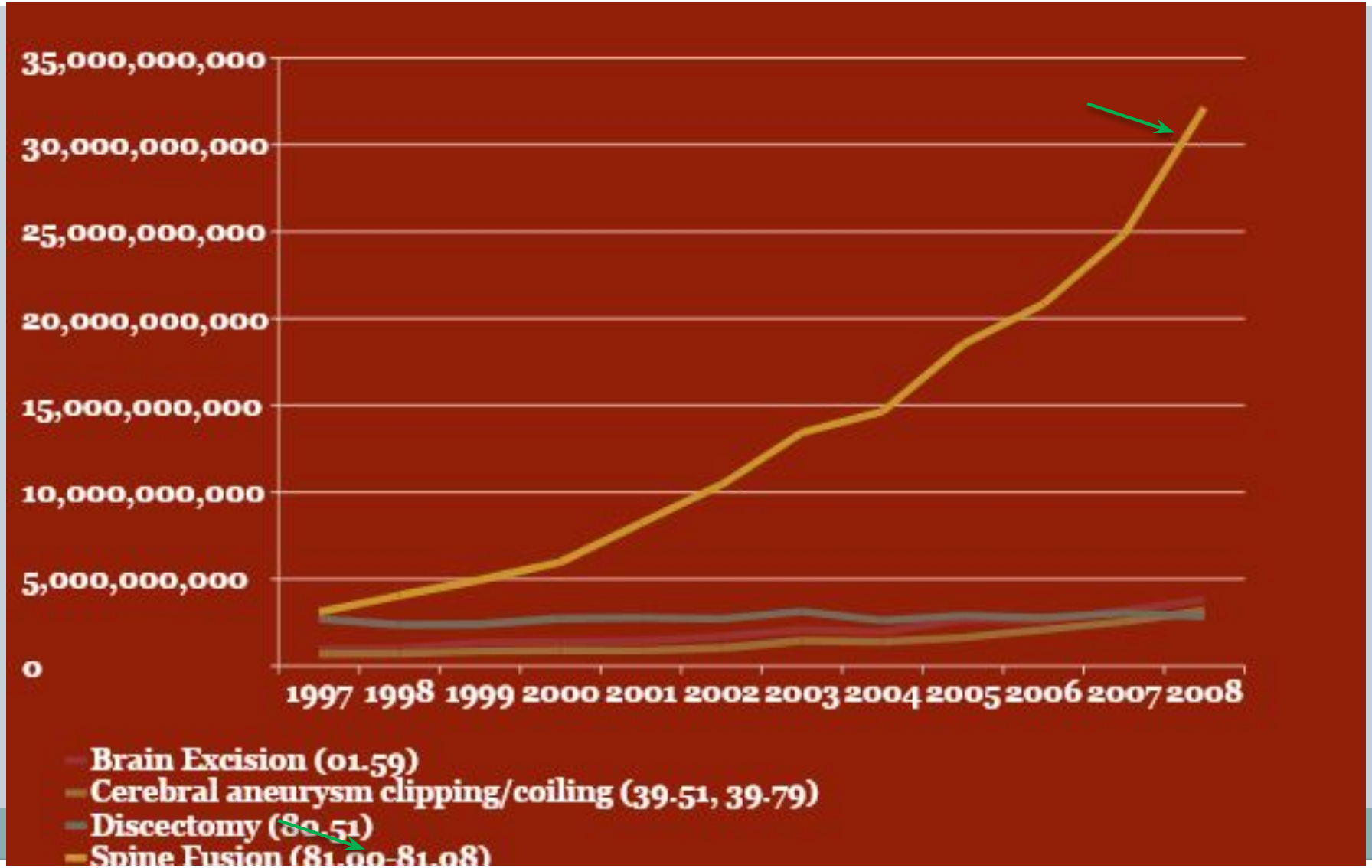
Neurosurgeon's salary makes 20% of all personnel expenditures

- Thus, total personnel expenditure is - $15.310.425.400

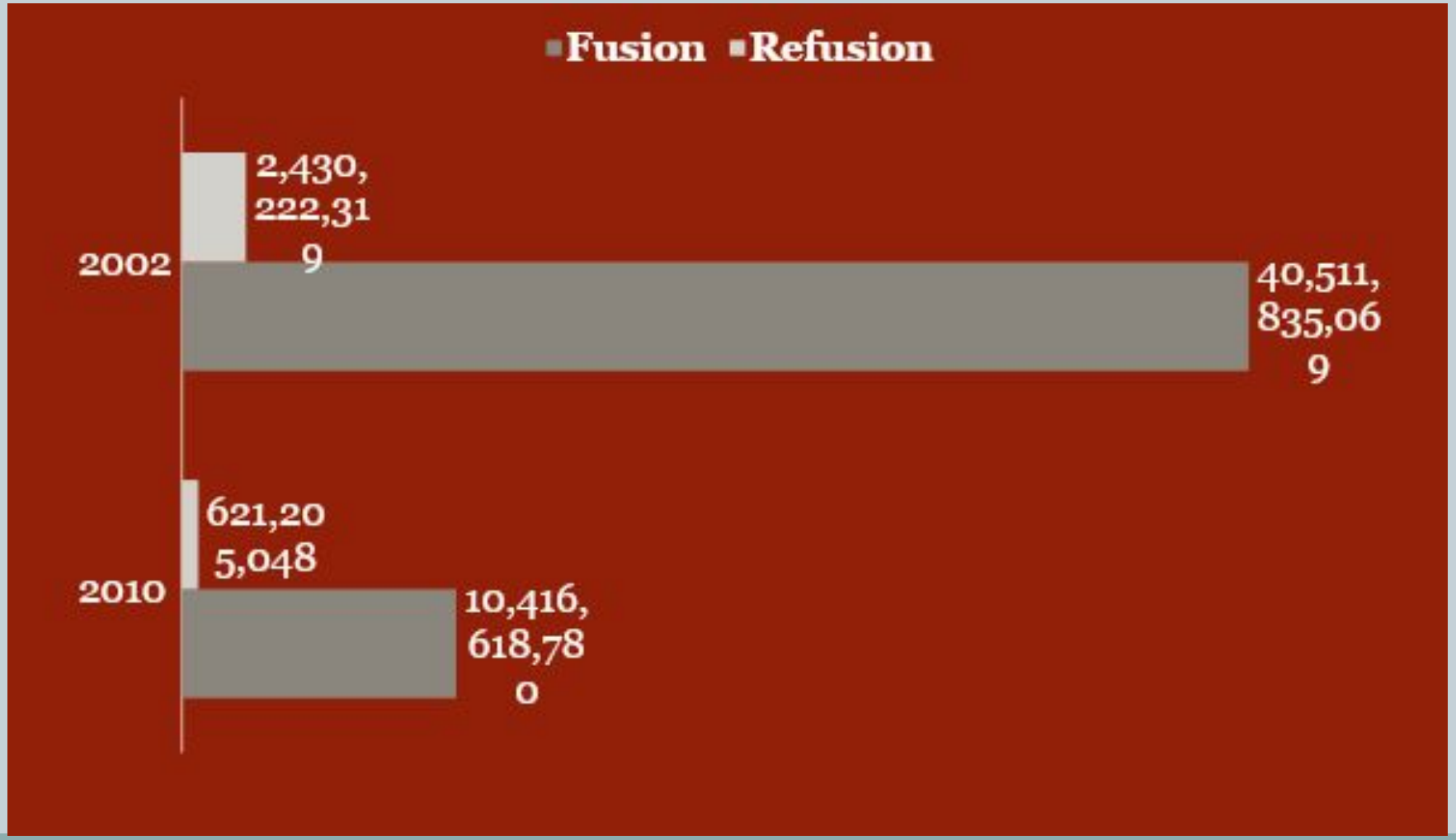
Insurance makes 74% of total health expenditures

- Thus, total Neurosurgeon Salary in US - $20.6 billion
- Salaries make 20% of total Health expenditure
- Thus, total Neurosurgery expenditure in US **- $103 billion (1% of world health expenditure)**

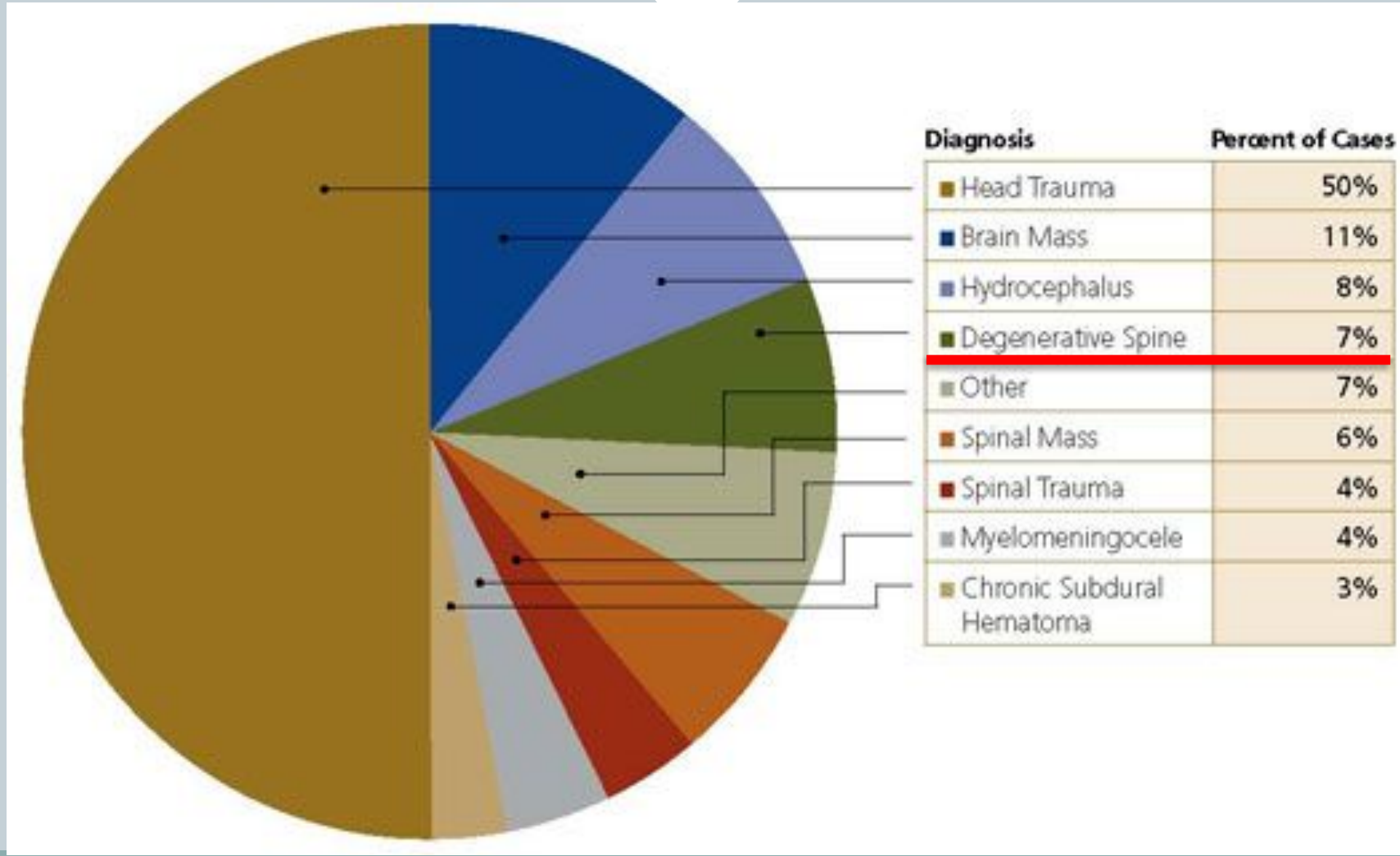
ii. Aggregate Hospital Charges for Neurosurgical Procedures in the United States



iii. The "National Bill"
of All Spine De Novo Fusions and Refusions



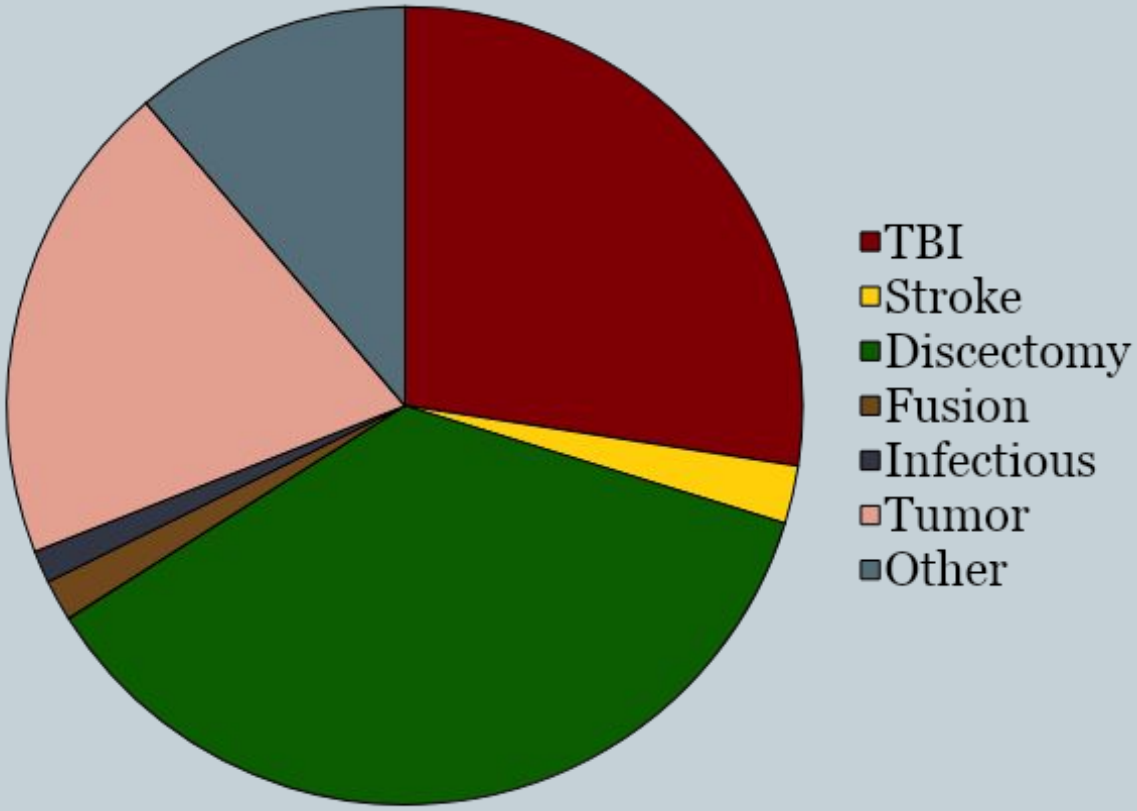
iv. Neurosurgical Procedures in Ethiopia



Diagnosis	Percent of Cases
Head Trauma	50%
Brain Mass	11%
Hydrocephalus	8%
Degenerative Spine	7%
Other	7%
Spinal Mass	6%
Spinal Trauma	4%
Myelomeningocele	4%
Chronic Subdural Hematoma	3%

v. Neurosurgery expenditures in Armenia

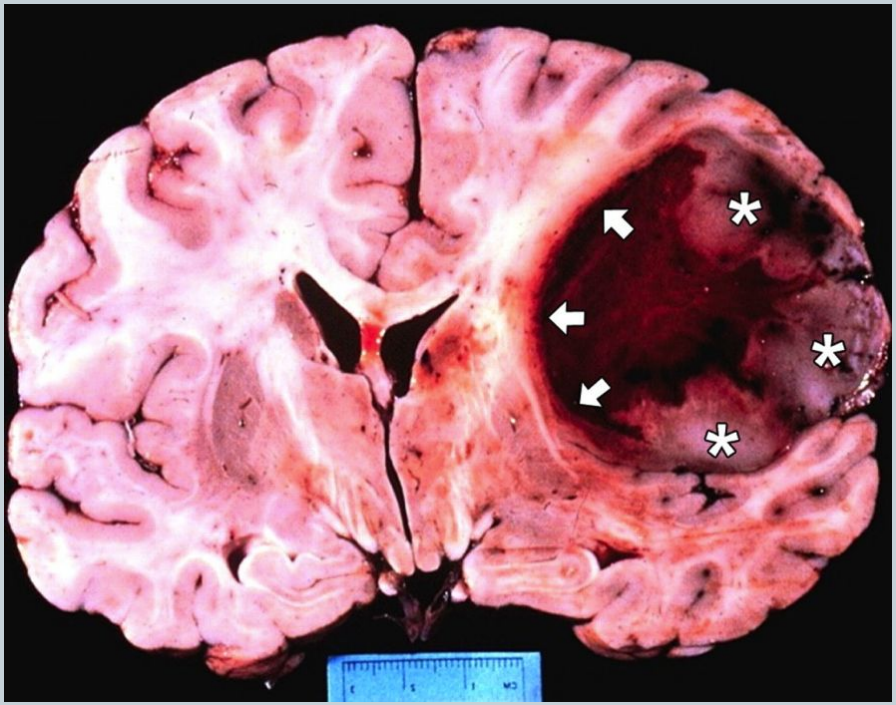
- $2.8 million total neurosurgery expenditure in 2015*
  *there are substantial direct unregistered payments to doctors
- 3.101 Neurosurgical procedures in 2015

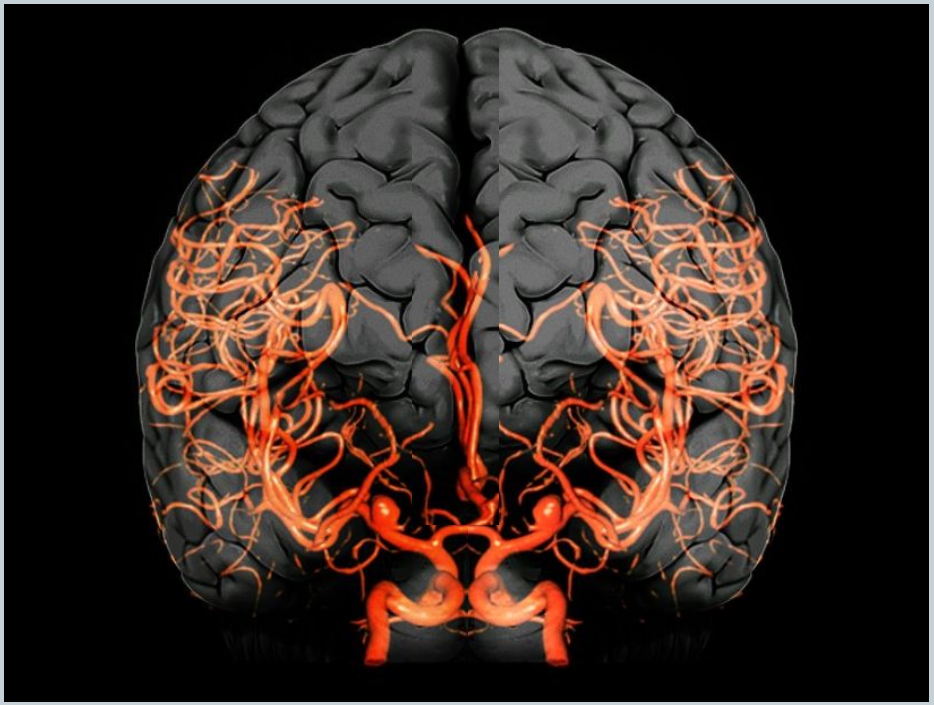


III. THE VIEW FROM MT. OLYMPUS

-Resource reallocation – a comparative exercise

Glioblastomas vs ruptured intracranial aneurysms

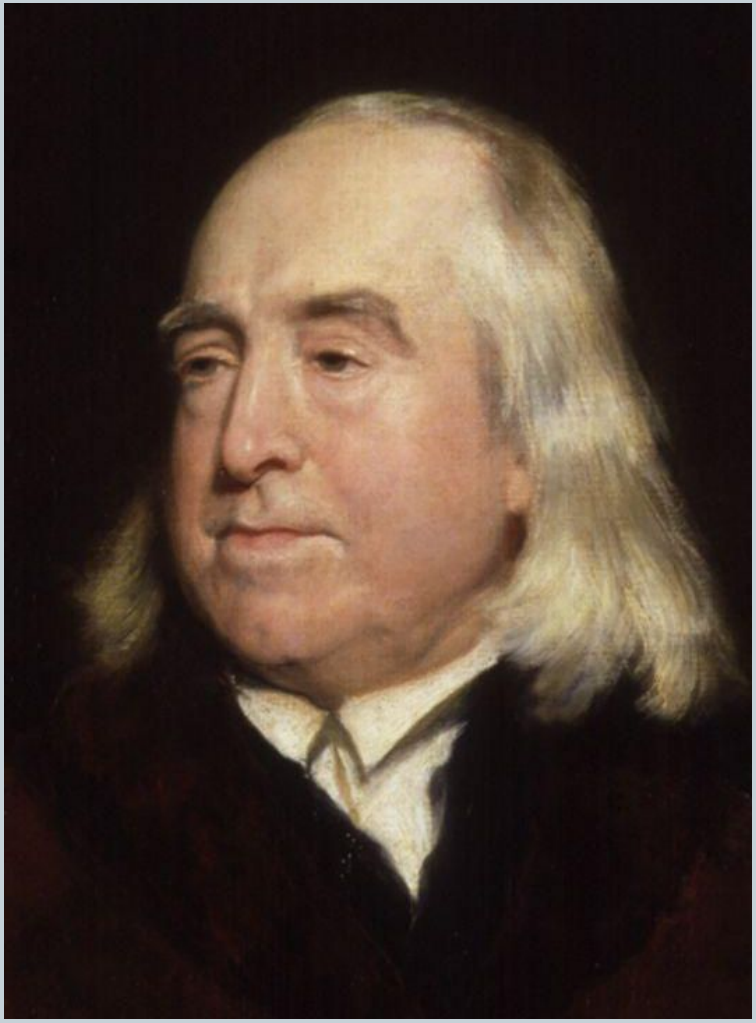




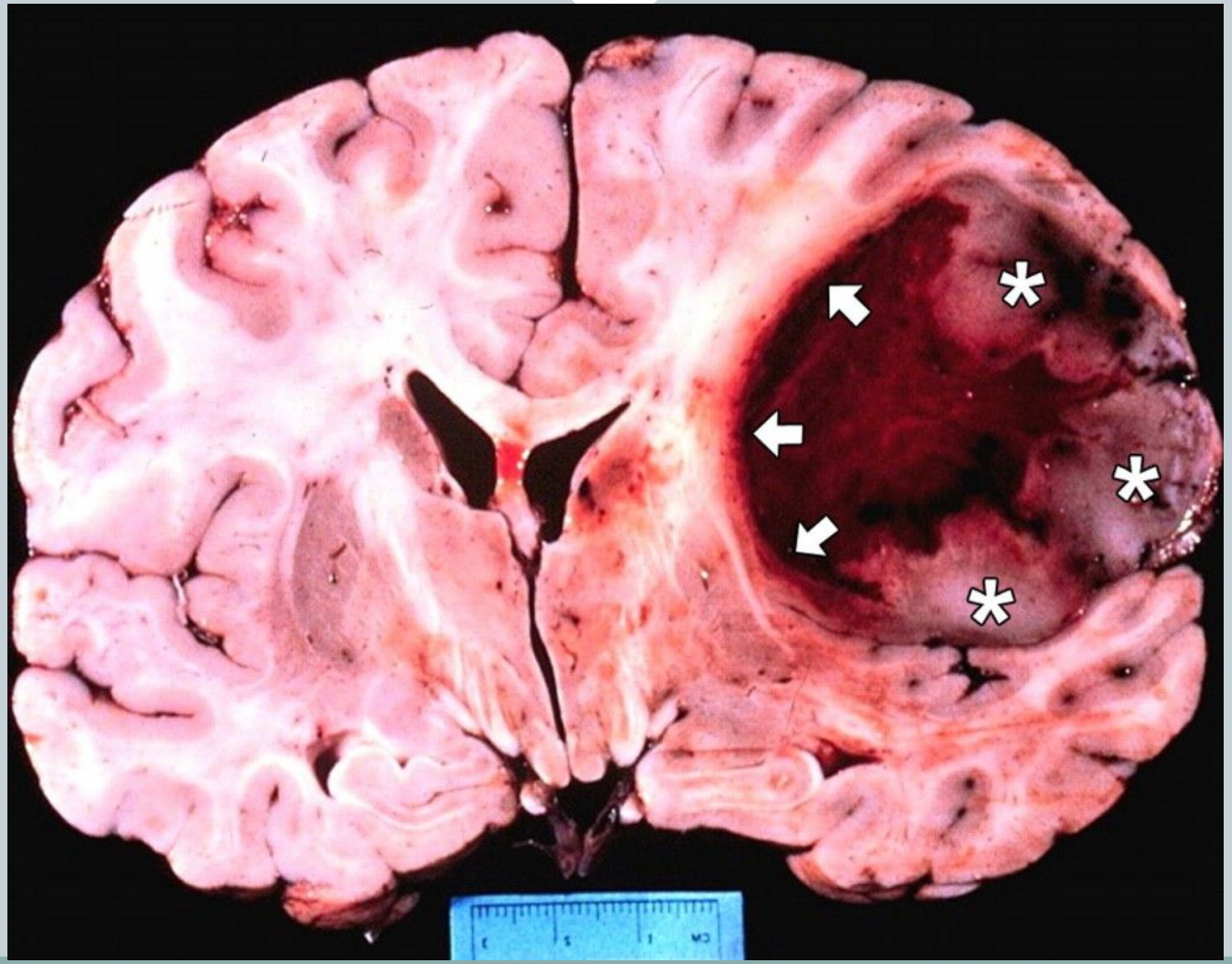
Jeremy Bentham

Greatest good for the greatest number

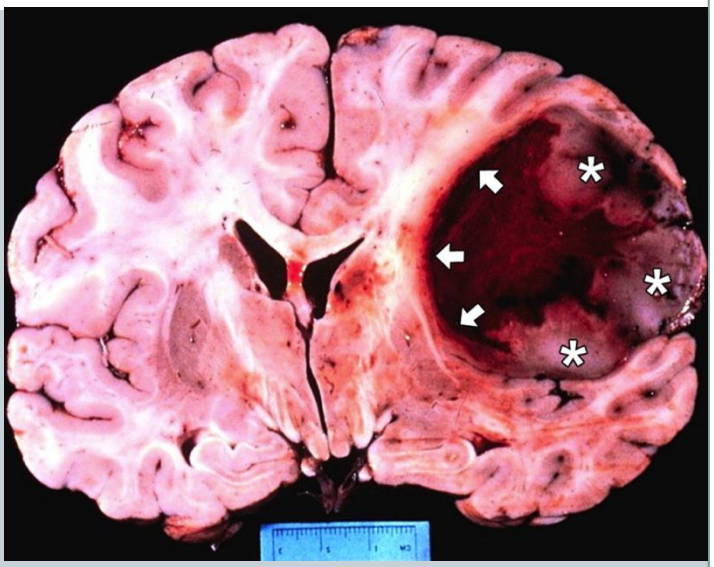
1748 - 1832



III.a. Glioblastomas

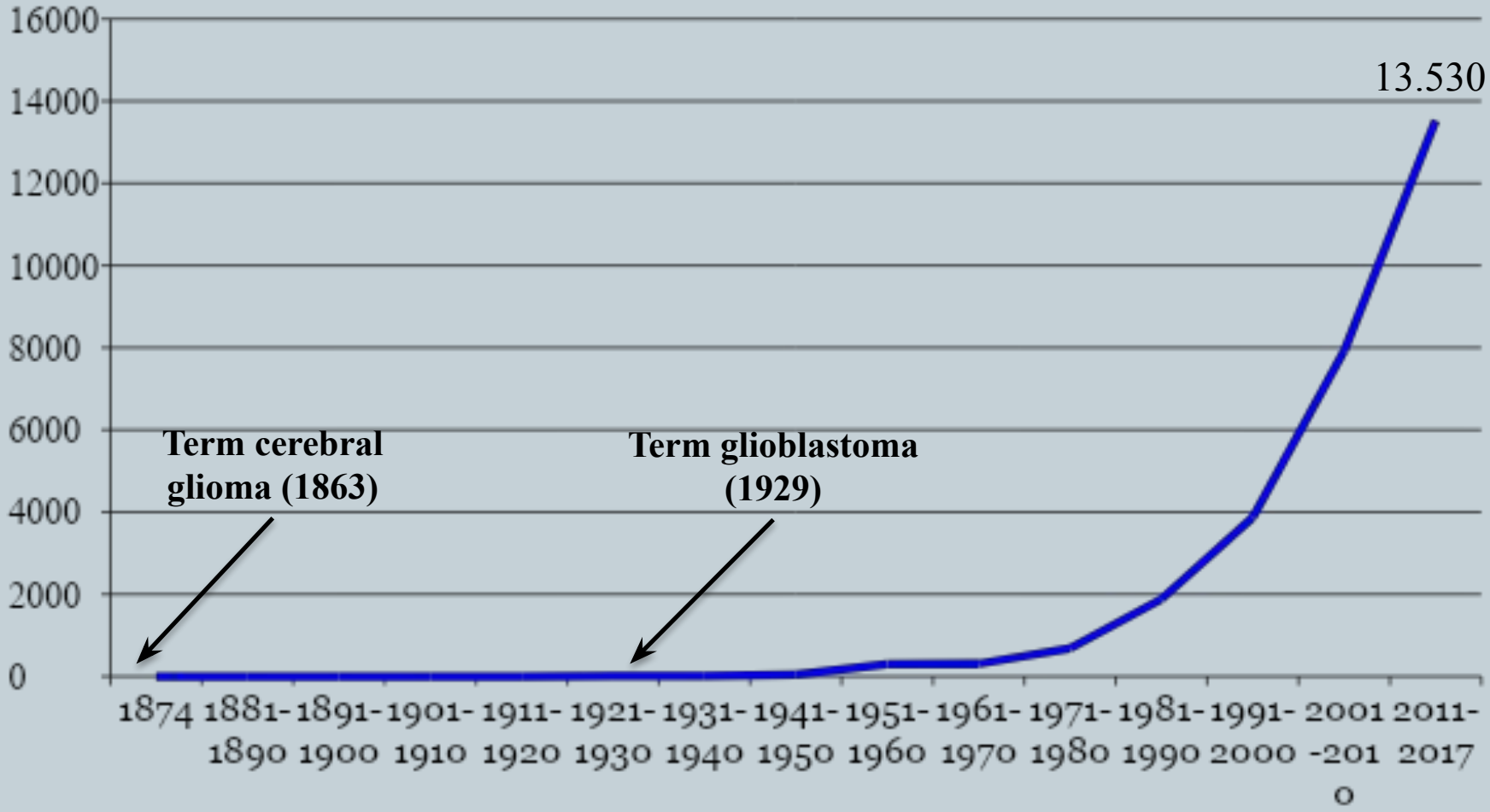


III.a. Glioblastomas

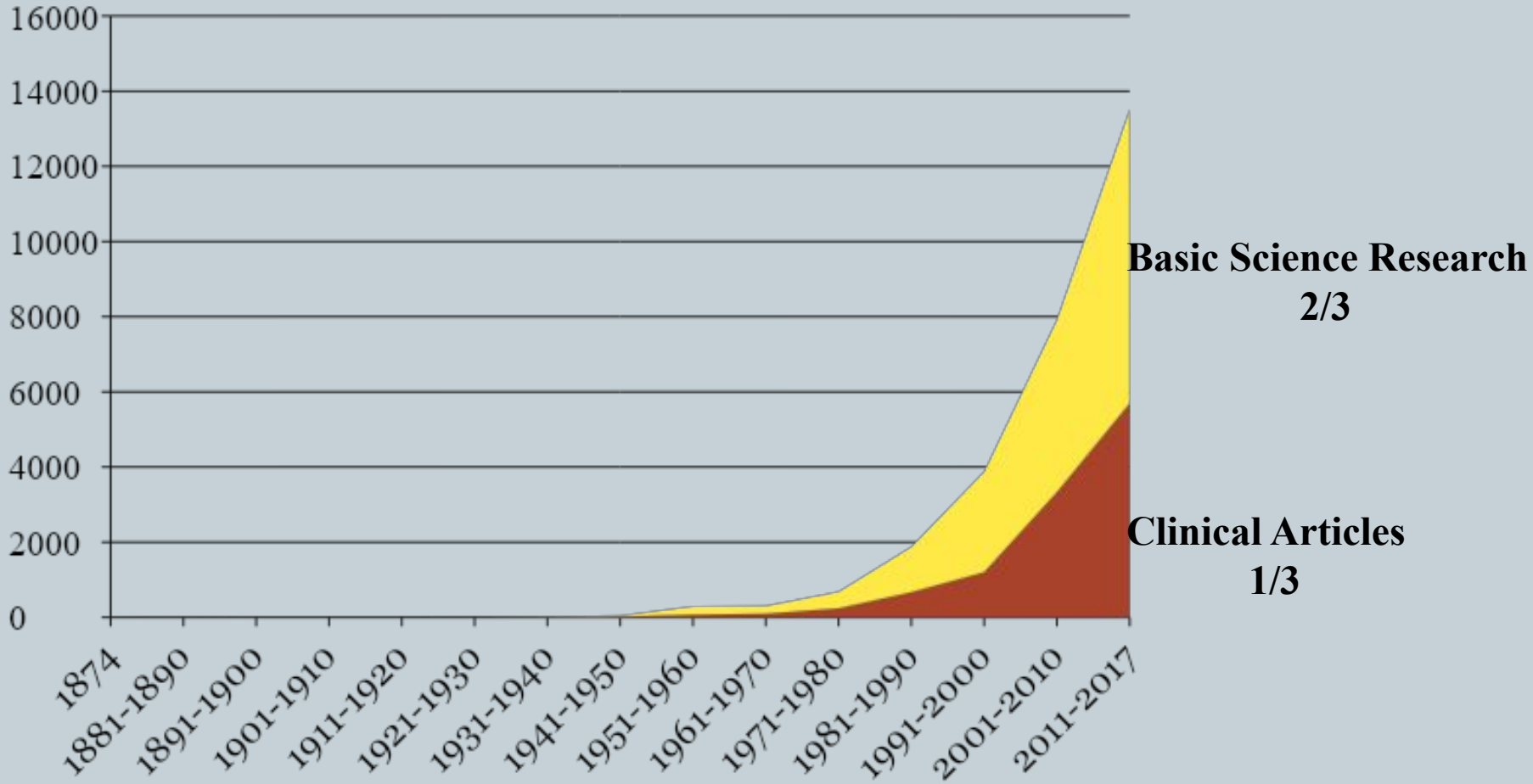


i. Published articles
ii. Types of published articles
iii. Clinical Guidelines/ Standard of care
iv. Main countries publishing guidelines
v. Most recent guidelines
vi. Summary of guidelines
vii. Guideline limitations
viii. A little math….
    1) Number of Glioblastoma cases in the world
    2) How many people with Glioblastoma are NOT receiving the standard of care?

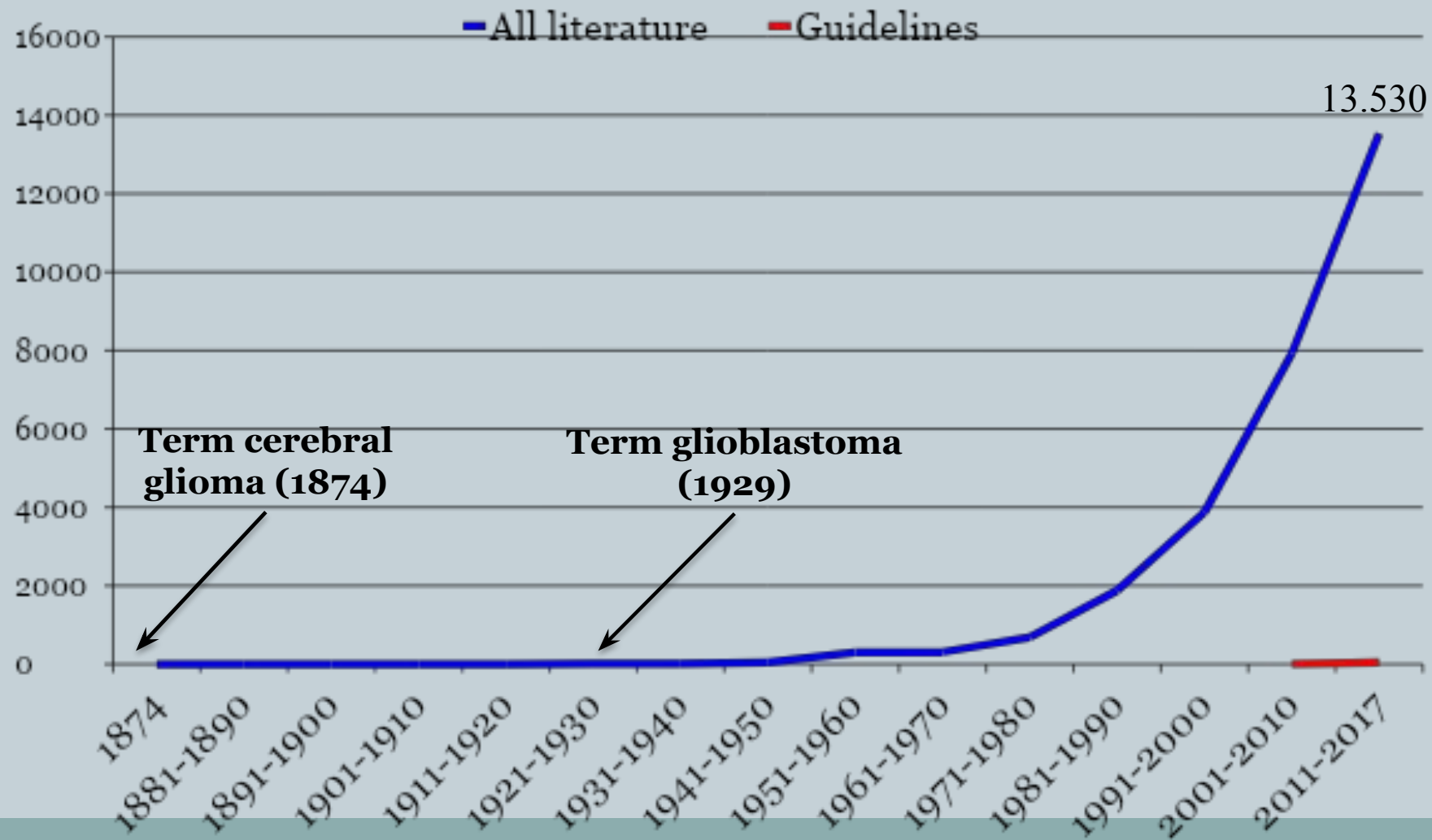
i. Cited articles related to cerebral gliomas or glioblastomas – 28.577



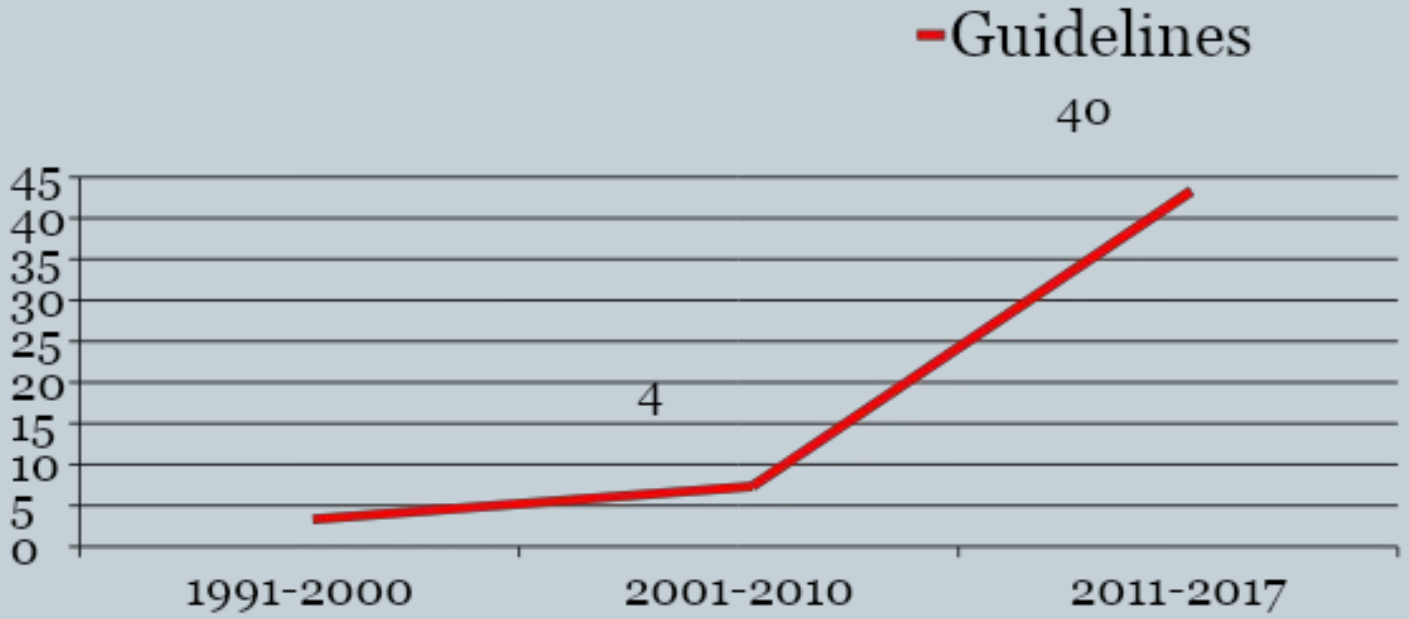
ii. Cited articles by type of research



iii. Articles related to cerebral gliomas or glioblastomas – 28.577



iii. Articles related to clinical guidelines for treatment of gliomas or glioblastomas – 40



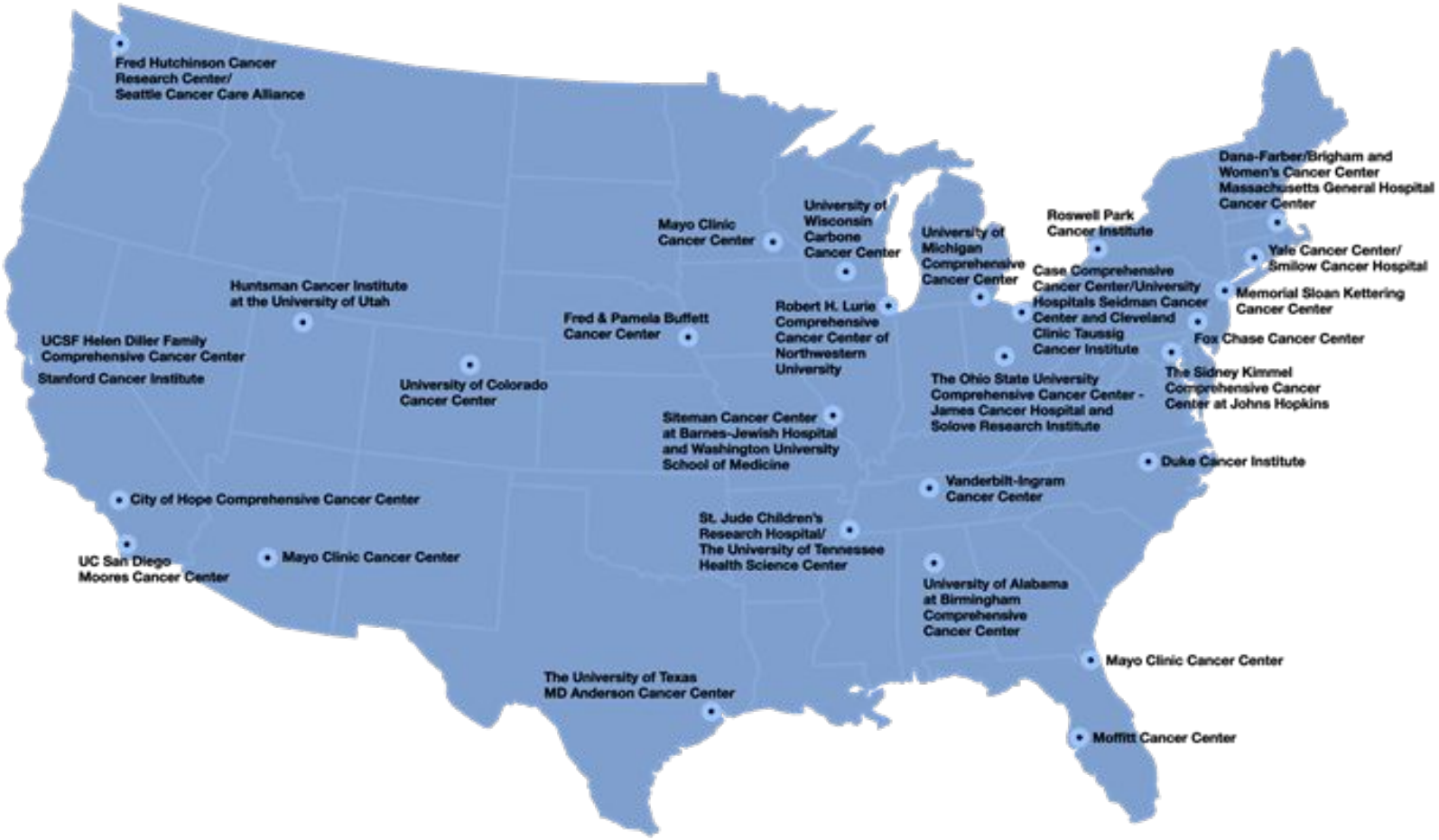
iv. Most published guidelines for GBM are from US or Western Europe

	USA	UK	Switzerland	Germany	Netherlands	Spain	Belgium
2006	1						
2007		1	1				
2008		1					
2009							
2010		1				1	
2011	1						
2012	5	1					1
2013	2						
2014	9		1	1	1		
2015	7	1	1				
2016	3			1	1		
2017	1						

National Comprehensive Cancer Network

Your Best Resource in the Fight Against Cancer®

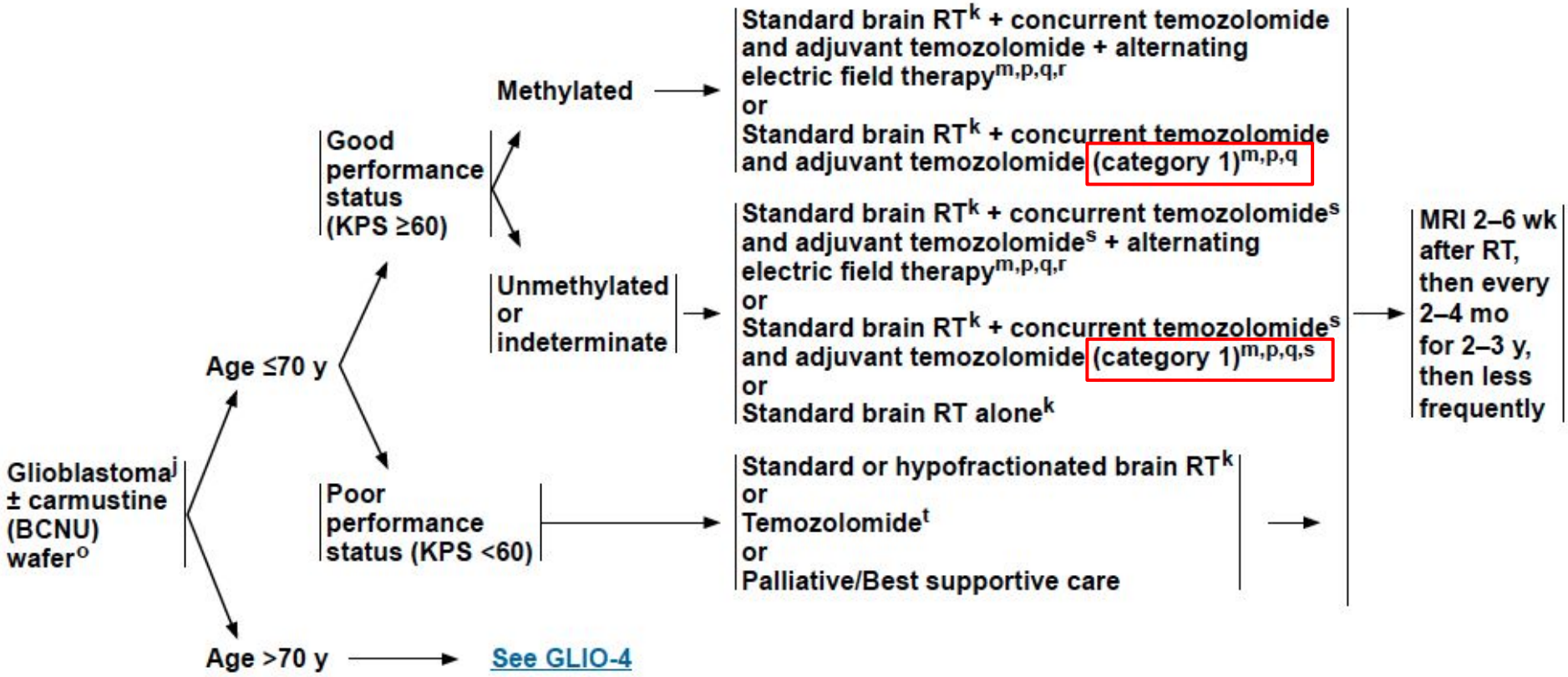
National Comprehensive Cancer Network (NCCN) is an alliance of 27 cancer centers in the United States, most of which are designated by the National Cancer Institute as comprehensive cancer centers.



v. GBM Guidelines – Adjuvant Treatment (Age <70)

National Comprehensive Cancer Network®

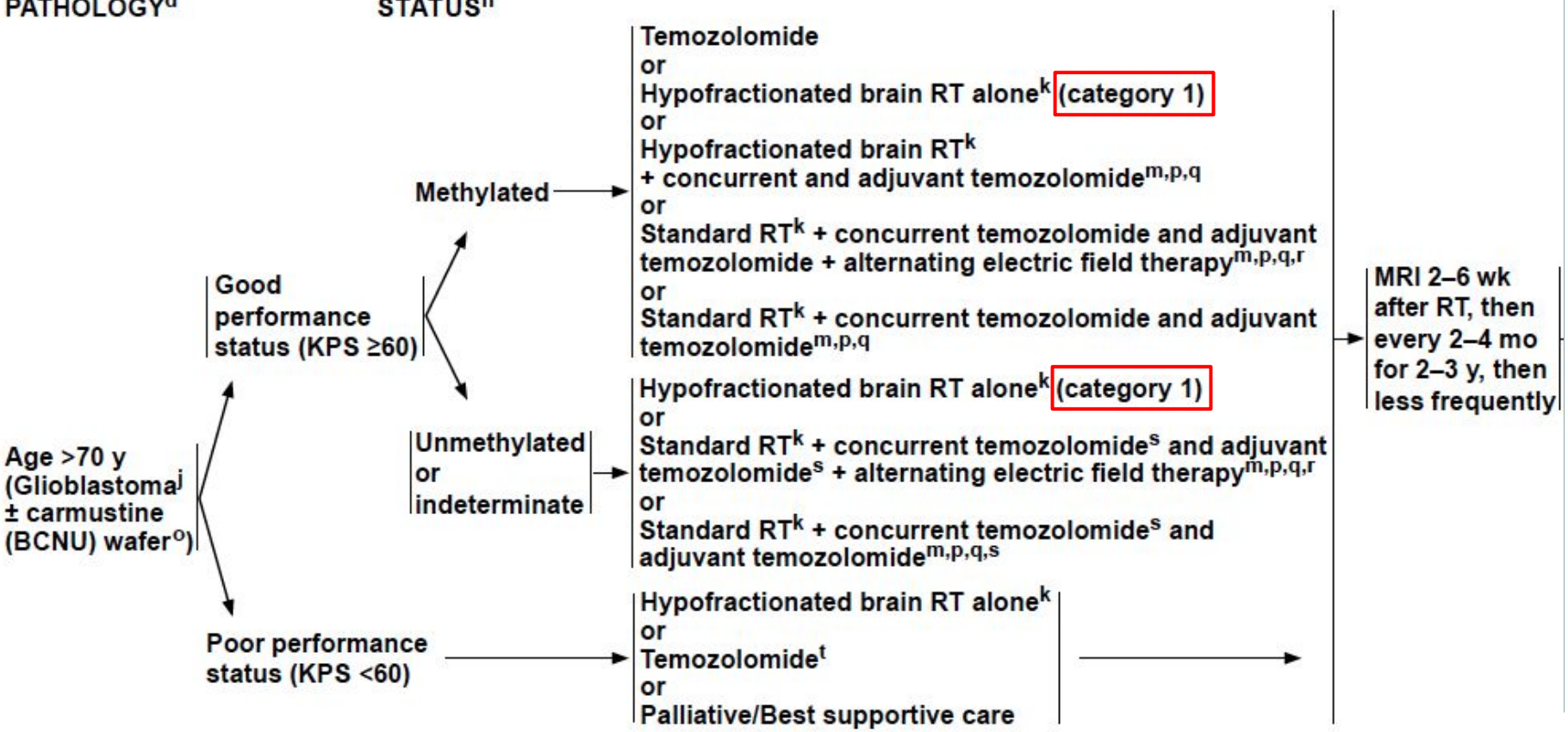
NCCN Guidelines Version 1.2016
Anaplastic Gliomas[a]/Glioblastoma



v. GBM Guidelines – Adjuvant Treatment (Age >70)

National Comprehensive Cancer Network®

NCCN Guidelines Version 1.2016
Anaplastic Gliomas[a]/Glioblastoma



vi. Summary of published clinical guidelines

Generally addressed issues

- Who to treat?
- Role of surgery
- Role of chemotherapy
- Role of radiation
- Management of recurrence

vii. Guideline limitations

- Applicable only to developed countries (Western world)
- Only 3 out of 40 guidelines support any of the recommendations with partial Grade I evidence
- No Grade I evidence before 2014
- There is no any reference to cost
- Often incompletely address treatment algorythm

viii. And now a little math…

- The question we ask: How many people in the world are actually getting the standard of care?
- If not, why so?

(1) Number of Glioblastoma cases in the world

- Even in developed places there are limitations to access

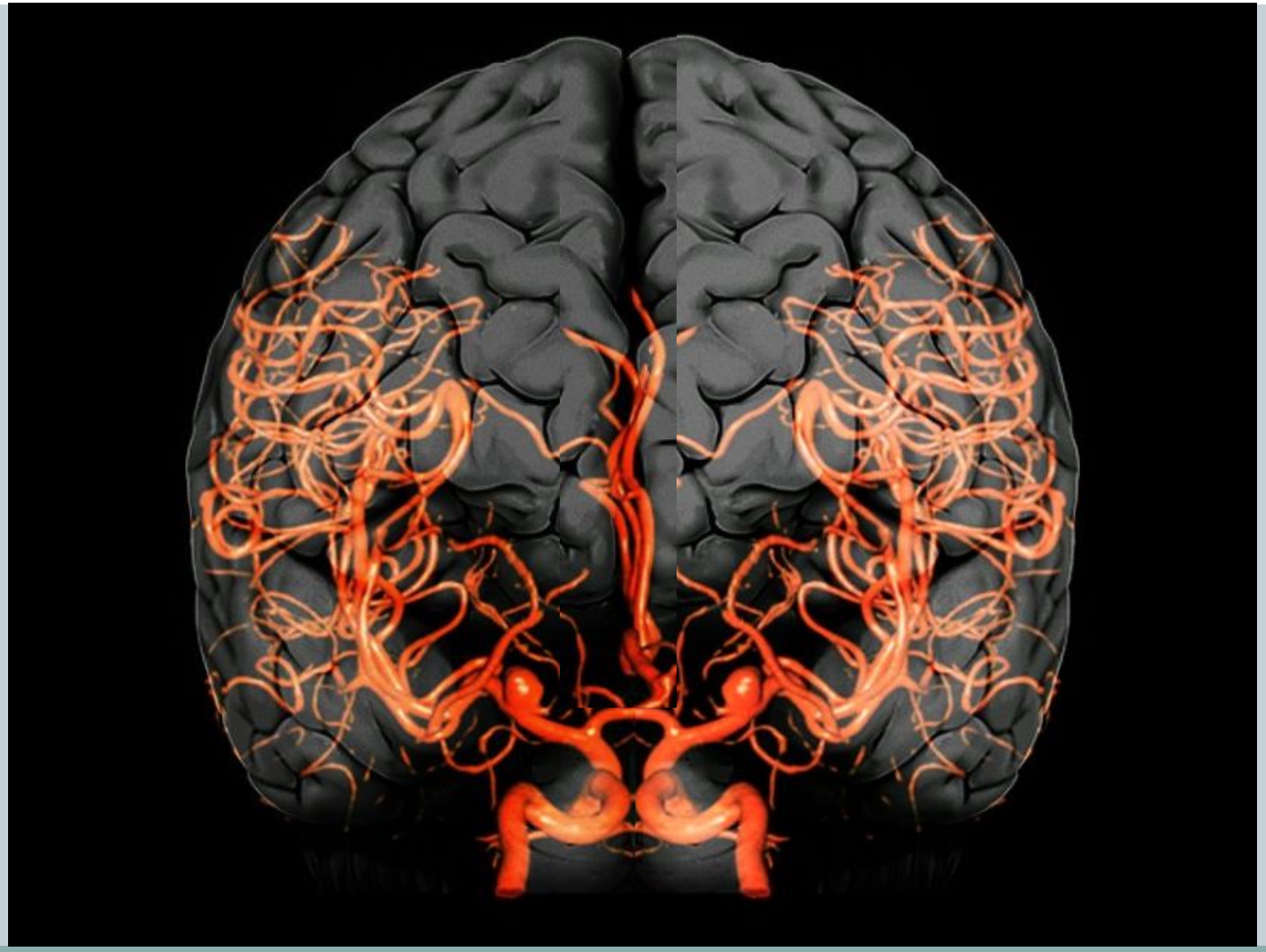
- US 13,000 new GBM cases
- US population 320,000,000
- Number of people over 40 is about 130,000,000
- Incidence per older person in the US is 1/10,000
- More or less the world population is about 7.5 billion
- World population over 40 is about 2.8 billion

- Thus if the incidence is 1/10,000 - **280,000 people** in the world that will be yearly affected by GBM

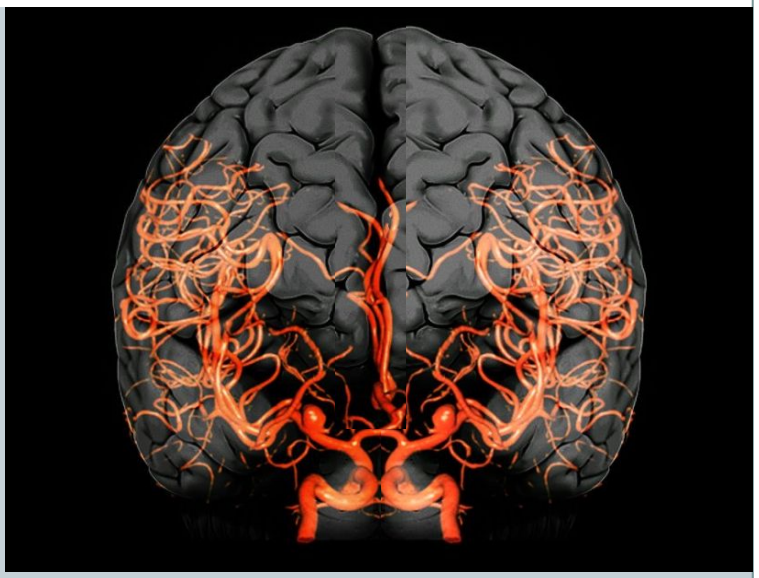
(2) How Many People are NOT Receiving the "Standard of Care"/treatment for Glioblastomas

- How many people are receiving standards of care world wide at the present?
- Estimated yearly incidence of GBM worldwide is 280,000
- 280,000 - 13,000(US) - 41,000 (EU) = 226,000
- About 5% of the remainder of world's population is getting appropriate treatment, which is 11,500
- 226,000 - 11,500 = **214,500**

III.b. Ruptured intracranial aneurysms

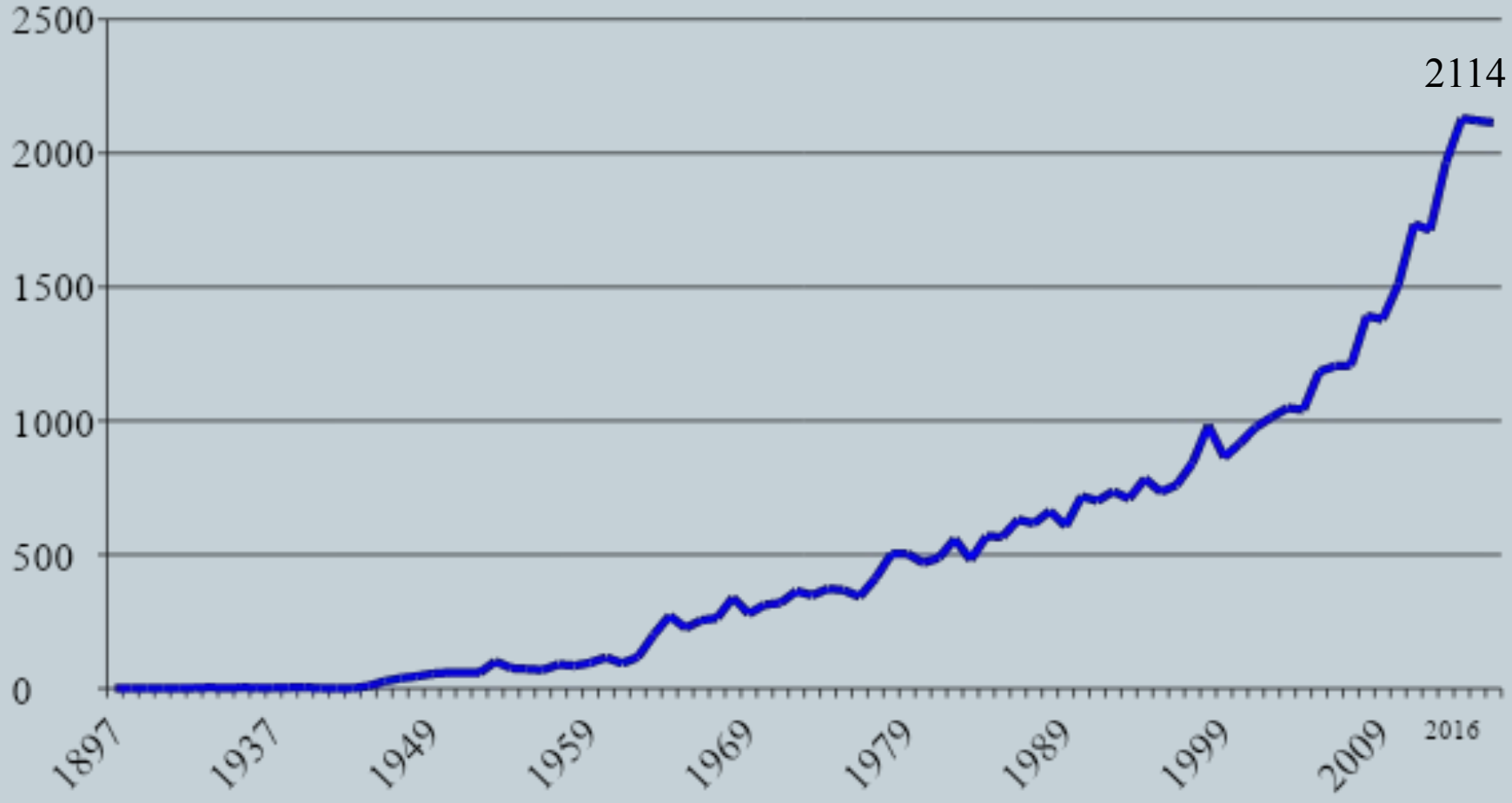


III.b. Ruptured Intracranial Aneurysms

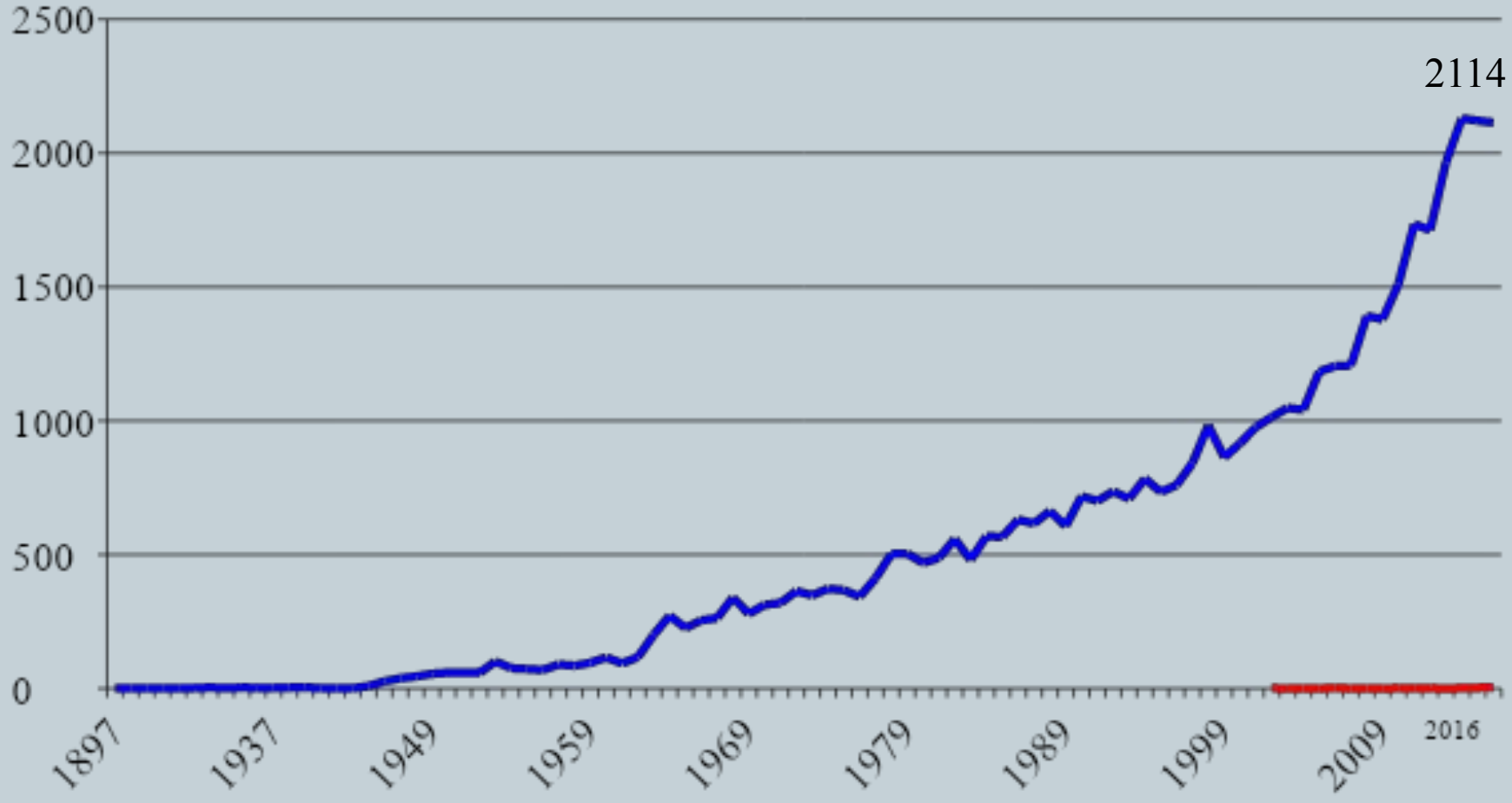


i. Published articles
ii. Clinical Guidelines/ Standard of care
iii. Main countries publishing guidelines
iv. Summary of guidelines
v. Guideline limitations
vi. A little more math….
    1) Number of Ruptured Aneurysms worldwide
    2) How Many People are NOT Receiving the Standard of Care?

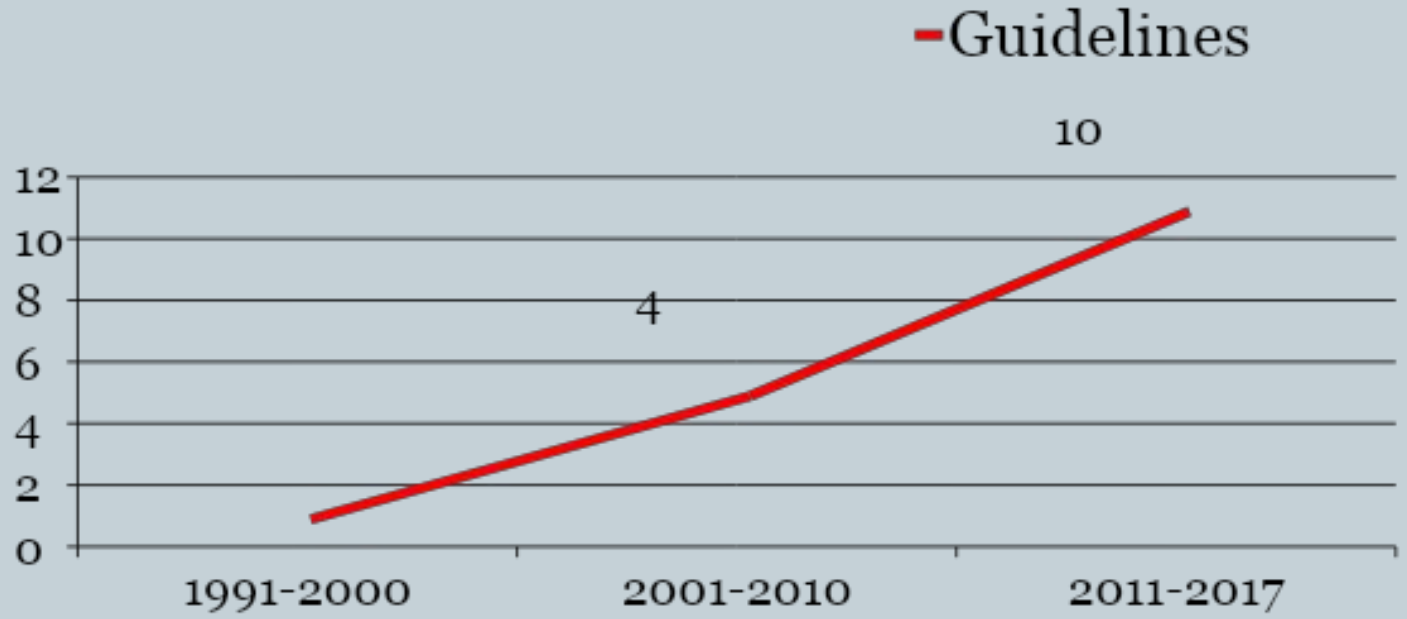
i. Cited articles related to ruptured intracranial aneurysms - 26.742



ii. Cited articles related to ruptured intracranial aneurysms (26.742) and Clinical Guidelines (14)



ii. Articles related to clinical guidelines for treatment of ruptured intracranial aneurysms - 12



iii. Most published guidelines for ruptured aneurysms are from US

	USA	UK	Australia	South Korea	Spain	Japan
2002						1
2006	1				1	
2010					1	
2011					1	
2012	1					
2014				1		
2015	2		1			
2016	2	1				1

iv. Summary of published clinical guidelines

Generally addressed issues

- Risk factors for and prevention of aSAH
- Natural history and outcome of aSAH
- Clinical manifestations and diagnosis of aSAH
- Medical measures to prevent rebleeding after aSAH
- Surgical and endovascular methods of treatment of ruptured cerebral aneurysms
- Hospital characteristics and systems of care
- Anesthetic management during surgical and endovascular treatment
- Management of cerebral vasospasm/ hydrocephalus/ seizures/ medical complications after aSAH

v. Guideline limitations

- 2 out of 52 recommendations have Level A evidence
- There is no any reference to cost
- Based on a single large clinical trial
- Not all treatment algorithms are included

vi.1. Number of Ruptured Aneurysms worldwide

- Incidence – 9.1/100.000
- Calculated number of new cases/year worldwide – **673.849**
- How many people are receiving standards of care world wide at the present?
- 673.849 – 29.500(US) - 47,000 (EU) ≈ 600,000
- About 5% of the remainder of world's population is getting appropriate treatment, which is 30.000
- 600,000 -30,000 = **570.000**

vi.2. How Many People are NOT Receiving the Standard of Care for Glioblastoma and Ruptured Aneurysms worldwide

- Glioblastomas – 214.500
- Ruptured intracranial aneurysms – 570.000

IV

- Why not worldwide access to standard of care/ clinical guidelines/ treatment of Glioblastomas and Ruptured Aneurysms?

Supply?

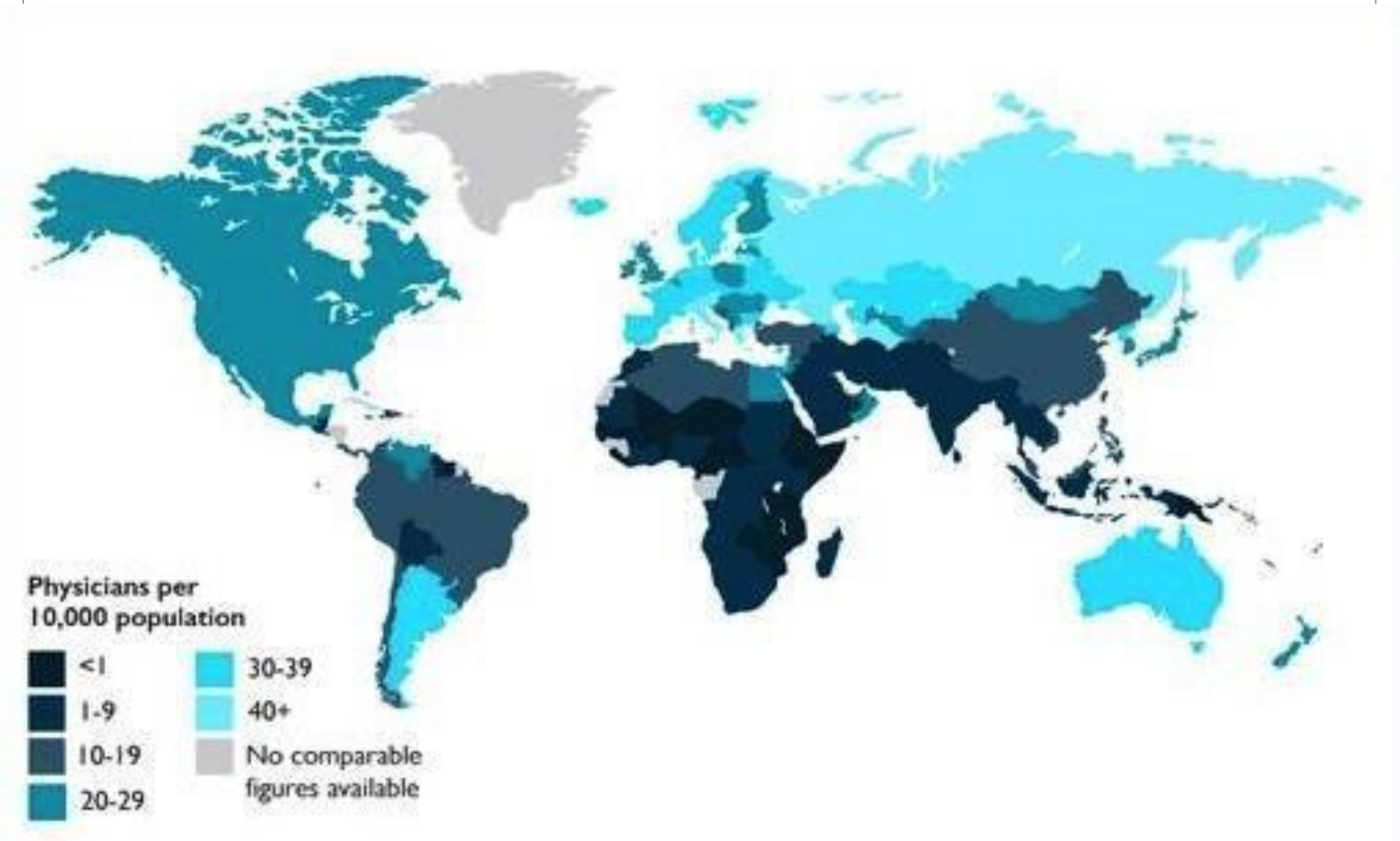
Cost?

SUPPLY

IV.a. Worldwide general supply difficulties…

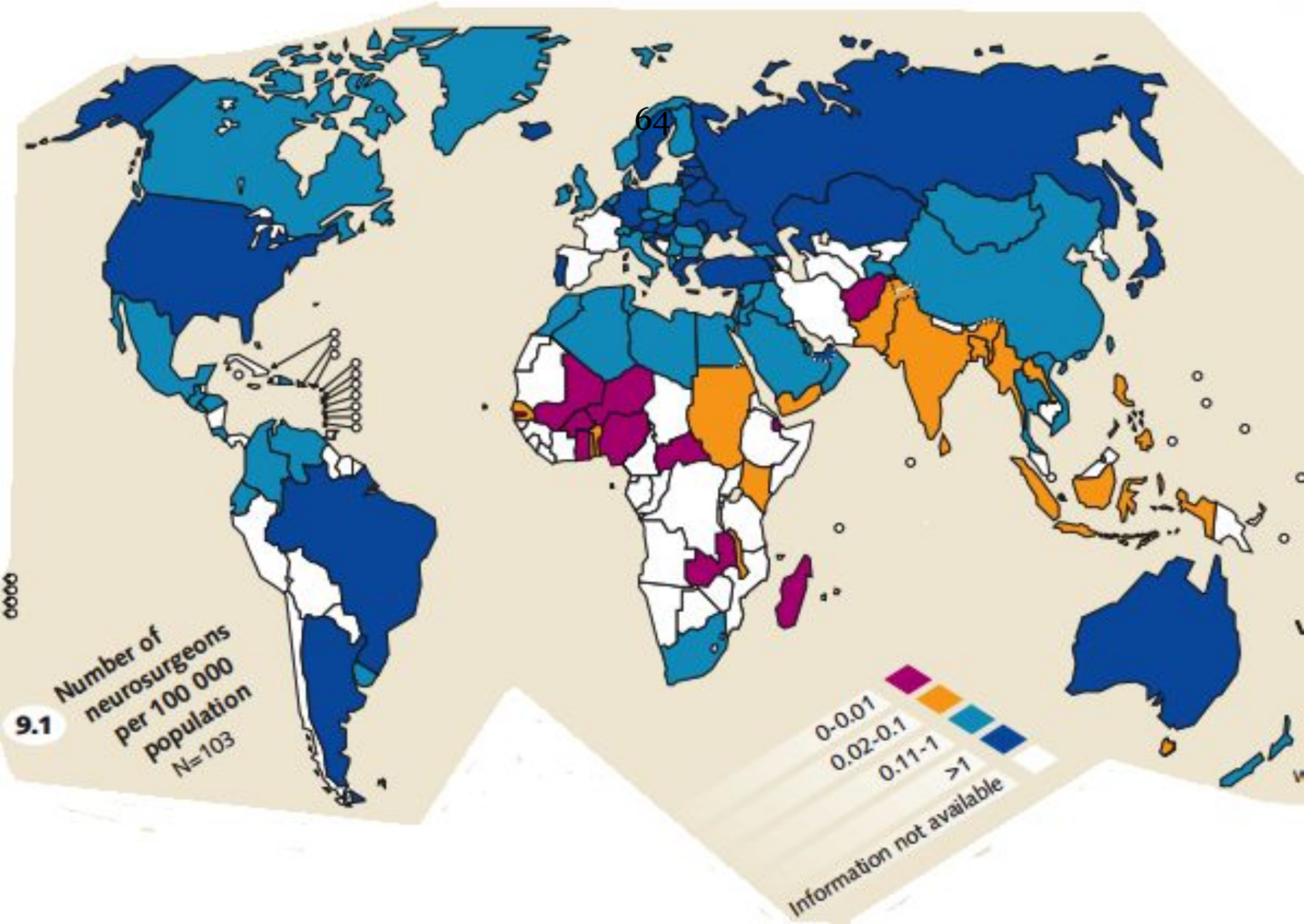
i. Mal-Supply of Physician Work-force
ii. Neurosurgeons Around the World
iii. Thailand - a personal story
iv. Absence of radiographic diagnostic facilities
v. Tertiary Care: China

i. Mal-Supply of Physician Work-force



ii. Supply: Neurosurgeons Around the World

- A total of 33 193 neurosurgeons are reported to be available in 103 countries in 2004.
- The median number of neurosurgeons per 100 000 population is:
- 0.01 in Africa
- 0.76 in the Americas
- 0.03 in South-East Asia
- 0.37 in the Eastern Mediterranean
- 1.02 in Europe


9.1
Number of neurosurgeons per 100 000 population
N=103
0-0.01
0.02-0.1
0.11-1
>1
Information not available

iii. Thailand - a personal story

iv. Absence of radiographic diagnostic facilities

Table 123 (page 1 of 2). Number of magnetic resonance imaging (MRI) units and computed tomography (CT) scanners: Selected countries, selected years 1990–2009

Updated data when available, Excel, PDF, and more data years: http://www.cdc.gov/nchs/hus/contents2011.htm#123.

[Data are based on reporting by Organisation for Economic Co-operation and Development (OECD) countries]

Country	1990	1995	2000	2007	2008	2009	1990	1995	2000	2007	2008	2009
	Number of MRI units per million population						Number of CT scanners per million population					
Australia[1]	0.6	2.9	†3.5	5.1	5.6	5.9	13.8	††20.5	††26.1	---	---	††38.7
Austria	---	---	11.0	17.7	18.0	18.4	---	---	26.1	30.0	29.6	29.3
Canada[2]	0.7	1.4	2.5	6.7	---	8.0	7.2	8.0	---	12.7	---	13.9
Czech Republic[3]	---	1.0	1.7	4.4	5.0	5.7	---	6.7	9.6	12.9	13.3	14.1
Denmark	---	---	5.4	---	---	15.4	---	---	11.4	18.5	21.5	23.7
Estonia	---	---	---	5.2	8.2	7.5	---	---	---	11.2	14.9	14.9
Finland	1.8	4.3	9.9	15.3	16.2	16.9	9.8	11.8	13.5	16.5	---	20.4
France	---	---	1.7	5.5	6.1	6.5	---	---	7.0	10.4	10.9	11.1
Greece	---	---	---	17.9	19.6	21.7	---	---	---	29.0	30.6	33.8
Hungary[4]	0.1	1.0	1.8	2.8	2.8	2.8	1.9	4.6	5.7	7.3	7.1	7.2
Iceland	3.9	7.5	10.7	19.3	18.8	21.9	11.8	18.7	21.3	32.1	31.3	34.5
Ireland	---	---	---	8.5	9.0	†11.9	4.3	---	---	14.3	14.5	15.3
Israel[5]	---	0.9	1.4	2.0	2.1	1.9	---	1.6	5.7	8.5	8.8	9.4
Italy[6]	---	---	7.8	18.5	20.1	21.6	---	---	21.1	30.1	30.9	31.7
Japan[7]	6.1	---	---	---	43.1	---	55.2	---	---	---	97.3	---
Luxembourg	2.6	2.5	2.3	10.4	12.4	14.2	5.2	26.9	25.2	27.1	26.9	26.3
Mexico	---	---	---	1.5	1.7	1.9	---	---	---	4.0	4.2	4.3
Netherlands[8]	0.9	3.9	---	7.6	10.4	11.0	7.3	---	---	7.8	10.3	11.3
New Zealand	---	---	---	8.8	9.6	9.7	3.5	---	8.8	12.3	12.4	14.6
Poland	---	---	---	2.7	2.9	3.7	---	---	4.4	9.7	10.9	12.4
Portugal[9]	---	---	---	8.9	---	---	---	---	---	26.0	---	---
Republic of Korea	---	3.9	5.4	16.0	17.6	19.0	---	15.5	28.4	37.1	36.8	37.1
Slovak Republic[10]	---	---	1.1	5.7	6.1	6.1	---	---	---	13.7	13.7	13.3
Slovenia	---	---	---	3.5	4.5	4.5	---	---	---	10.9	12.4	11.9
Switzerland	---	---	---	---	---	---	---	---	---	††31.4	††32.0	††32.8
Turkey	---	---	---	5.4	†7.2	8.9	1.6	---	---	7.7	†10.6	11.6
United Kingdom[11]	---	---	††5.6	---	††5.6	---	---	---	††5.3	---	††7.4	---
United States[12]	---	12.3	---	25.9	---	---	---	---	---	34.3	---	---

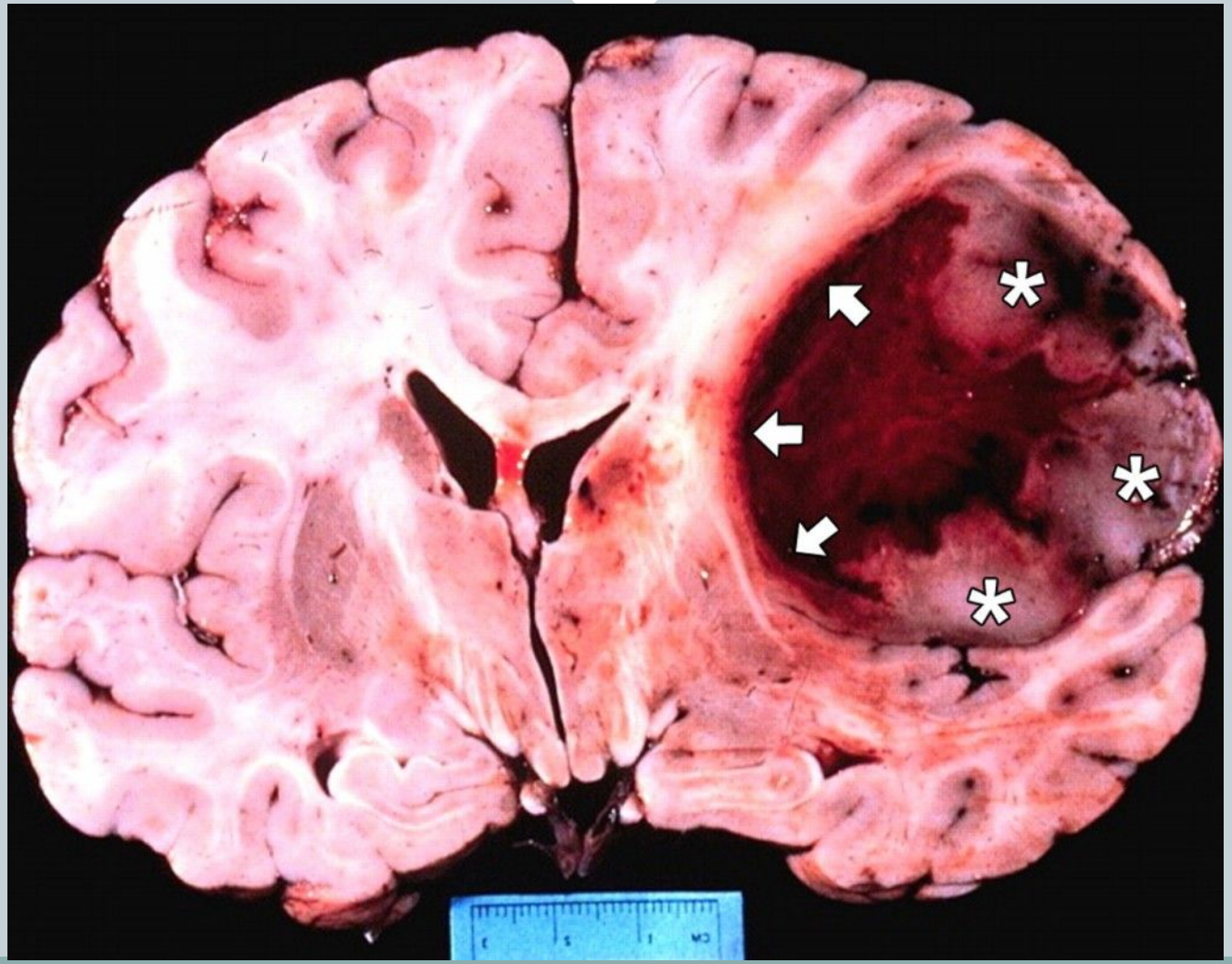
v. Tertiary Care: China

v. China: Tertiary Hospital Care Imbalanced

	Name of Hospital	Total Score	Research Score	Total Score
1	Beijing Union hospital	80.00	10.95	90.95
2	Sichuan Huaxi hospital	69.42	20.00	89.42
3	PLA General hospital	58.16	14.52	72.68
4	Ruijin Shanghai Jiaotong Univ.	42.92	11.90	54.83
5	Xijing 4th Military Medical Univ.	33.99	12.99	46.98
6	Zhongshan, Fudan Univ.	32.83	13.66	46.48
7	Huashan, Fudan Univ.	34.70	10.23	44.93
8	First hospital, Peking Univ.	32.43	9.10	41.53
9	People's Hospital, Peking Univ.	29.25	8.88	38.13
10	Tongji hospital,	26.43	11.13	37.56
11	First Hospital, Zhongshan Univ.	25.15	12.26	37.41
12	Peking Univ. 3rd Hospital,	18.42	9.29	27.72
13	Union hospital, Tongji Med. College	15.61	10.85	26.45
14	First hospital, Zhejiang Univ.	13.13	13.09	26.22
15	Changhai, 2nd Military Med. Univ.	14.35	11.25	25.60
16	First hospital, China Med. Univ.	15.05	10.17	25.21
17	Fuwai Heart-Vascular Disease Hospital	12.75	12.43	25.16
18	Xiangya 2nd hospital. Zhongnan Univ.	13.53	9.06	22.59
19	Renji hospital, Jiaotong Univ.	12.82	9.64	22.46
20	Southern Hospital, Southern Medical Unv.	12.98	9.32	22.29

Table 6. Top 20 hospitals in China (2011)

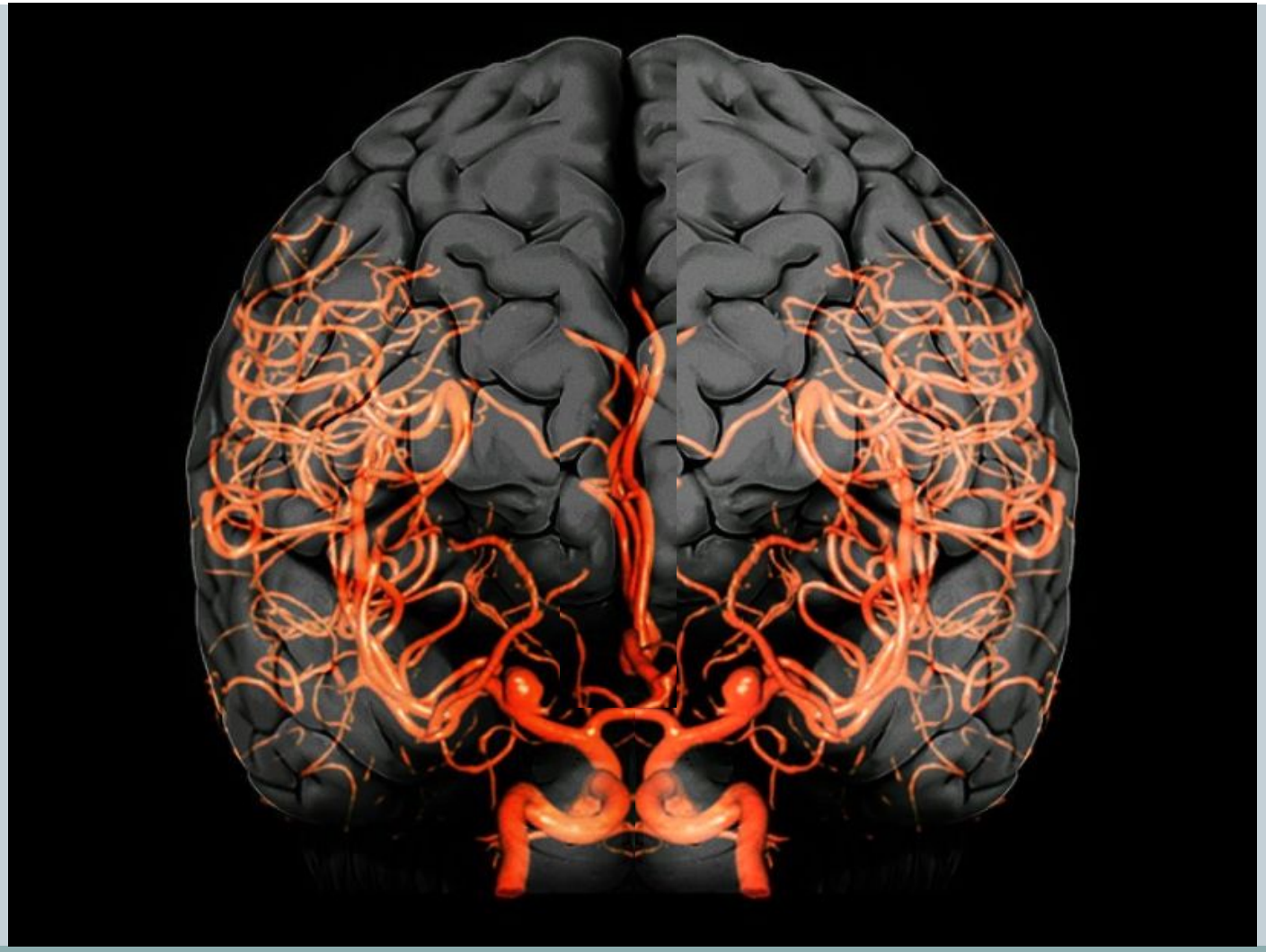
IV.b. Supply difficulties for Glioblastomas



i. Neuropathologists around the world

- American Associaton of Neuropathologists has 800 members from around the world
- Number of neuropathologists in UK: 98

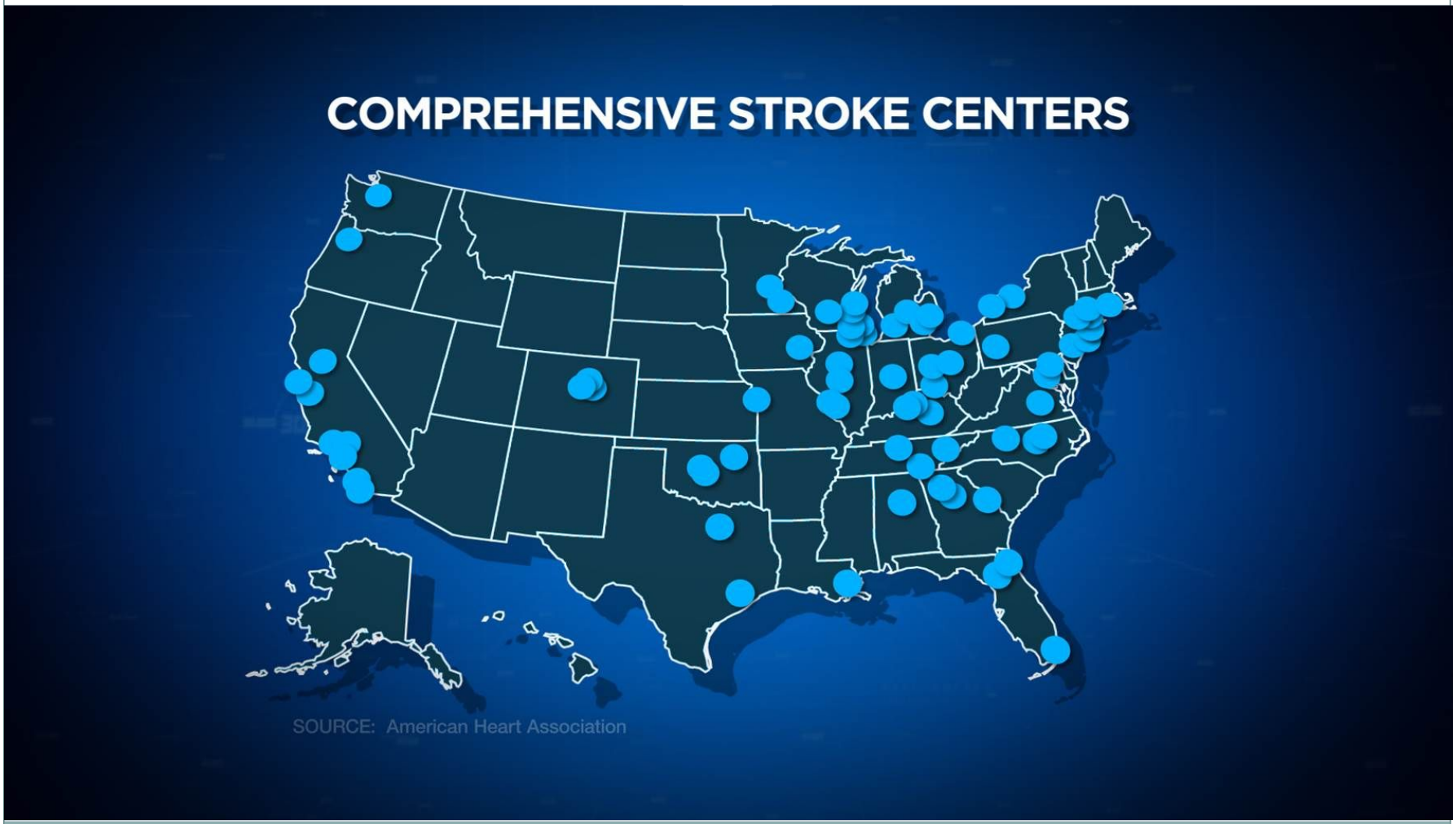
IV.c. Supply difficulties for ruptured aneurysms



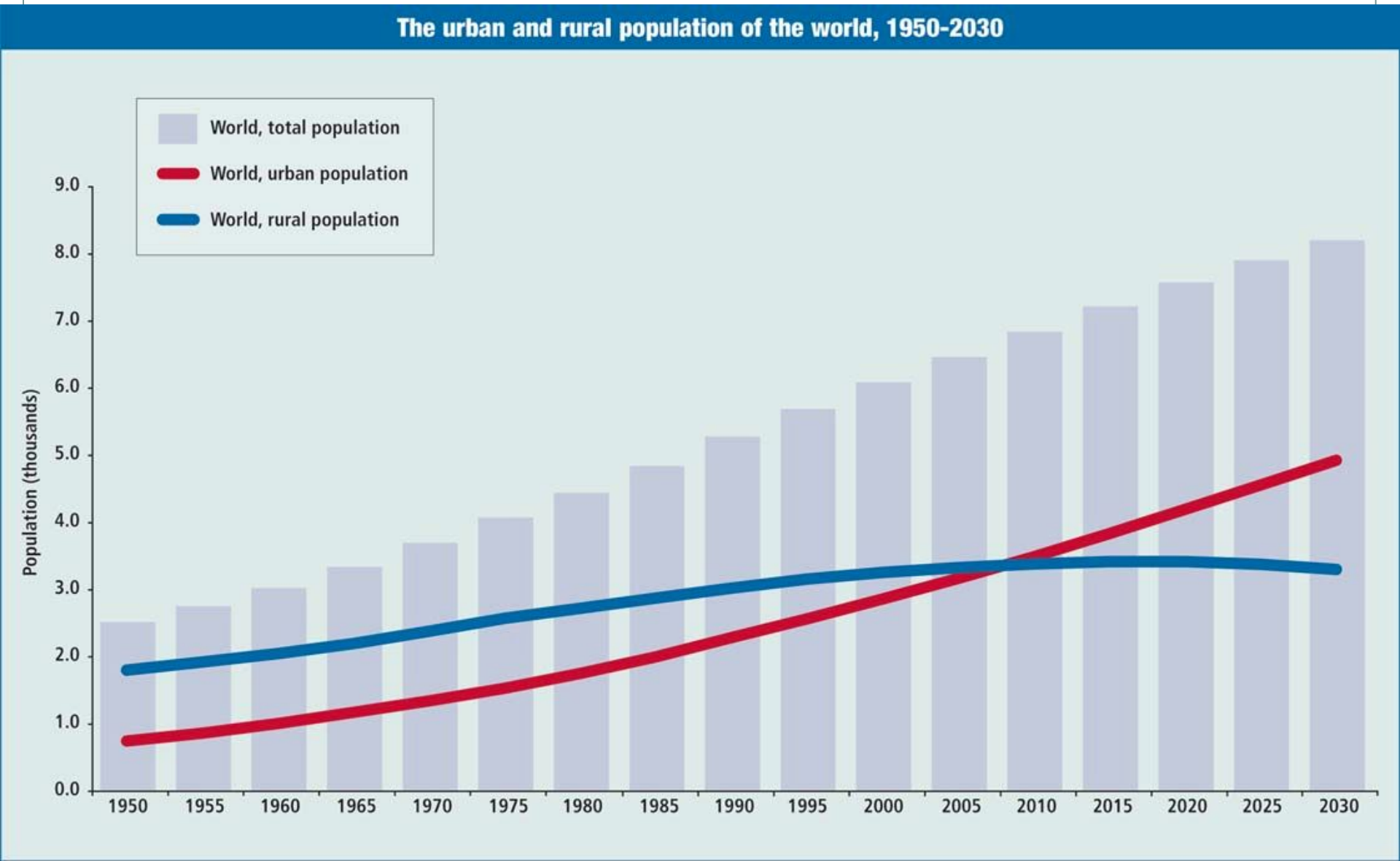
i. Interventional Neuroradiologists

- The number of physicians in the United States with an active interest and special competency in this field is estimated to be around 600

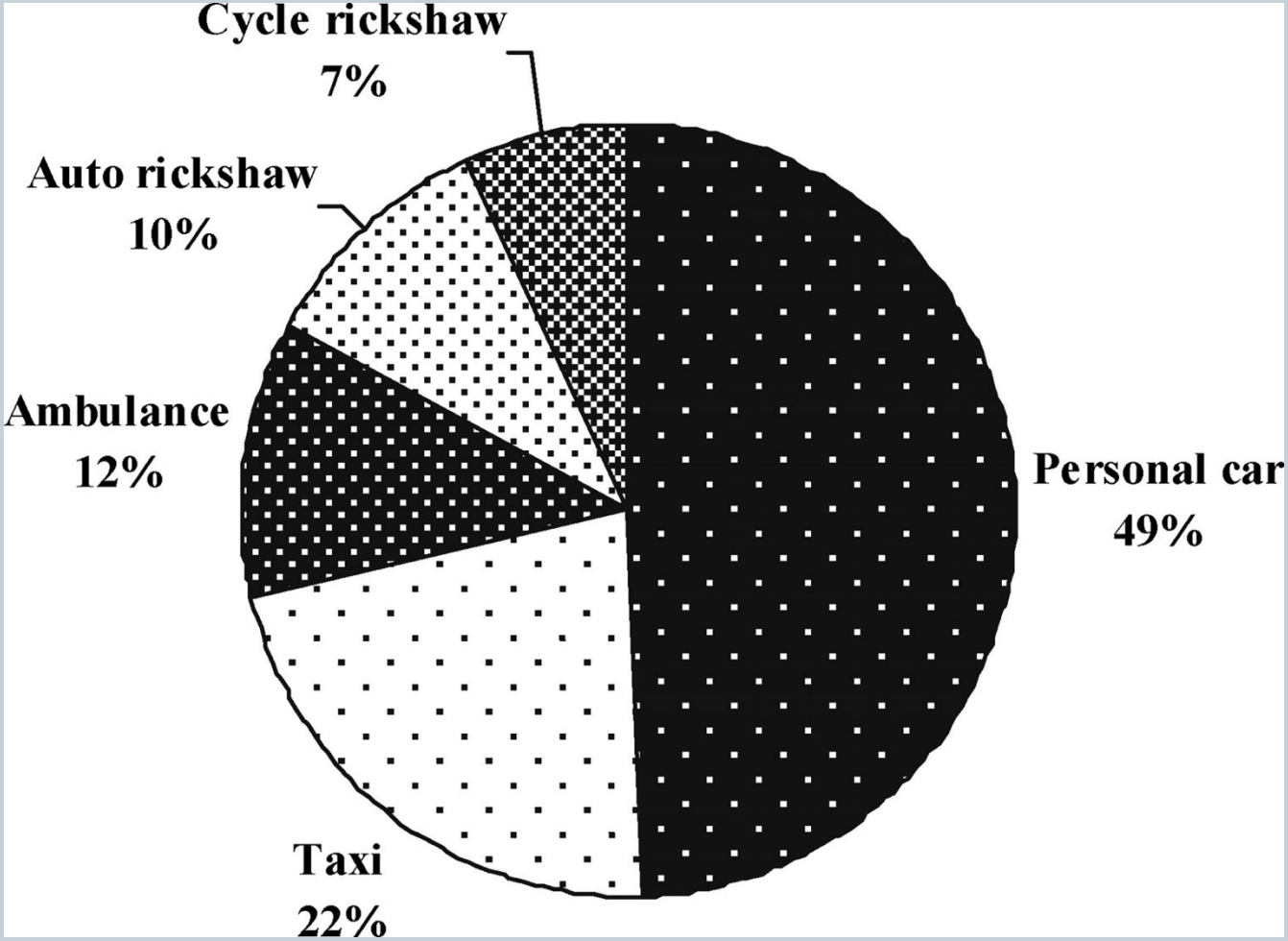
ii. 103 Comprehensive Stroke Centers in US



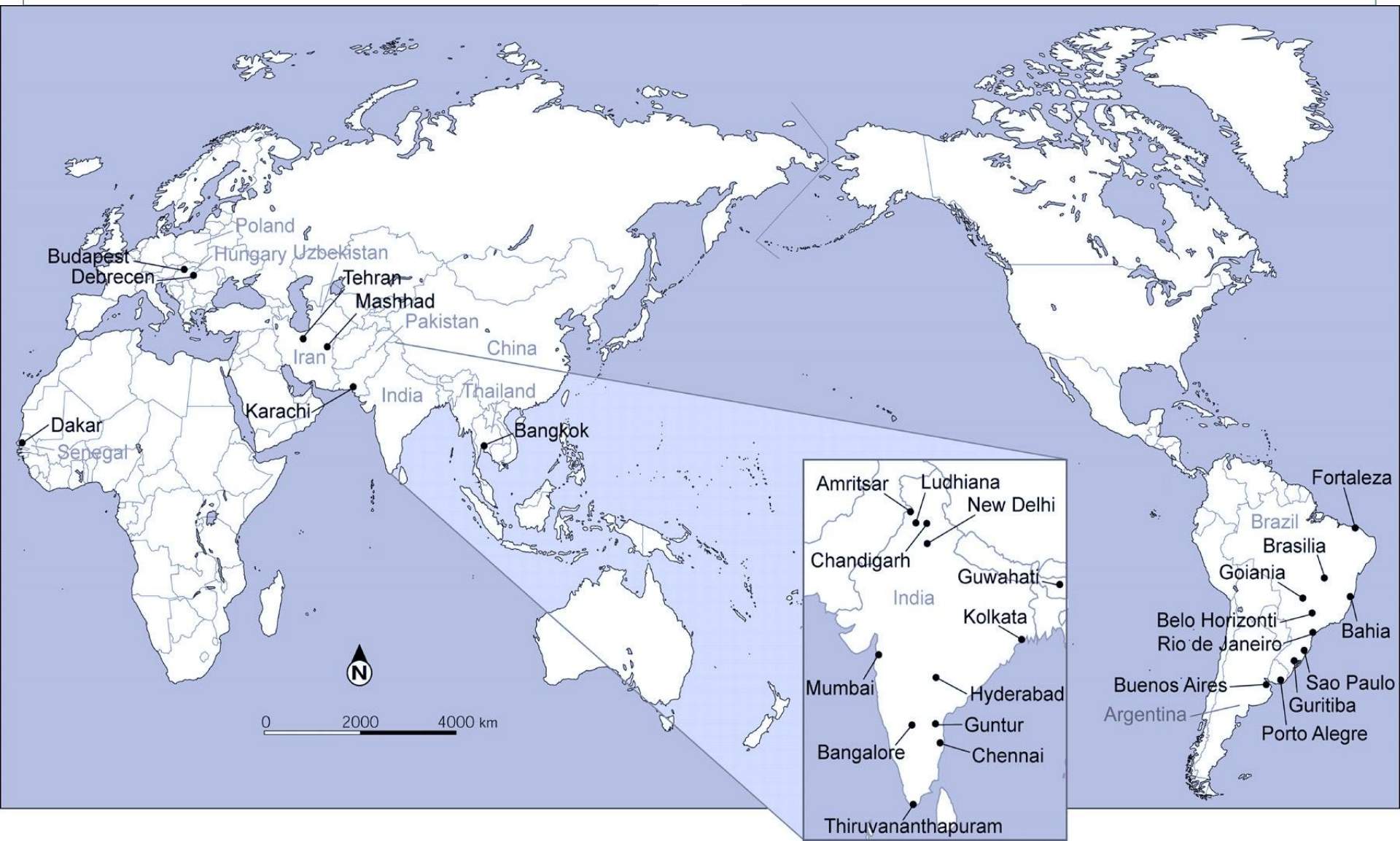
iii. World Urbanization (United Nations)



iv. Modes of transport of stroke patients in India

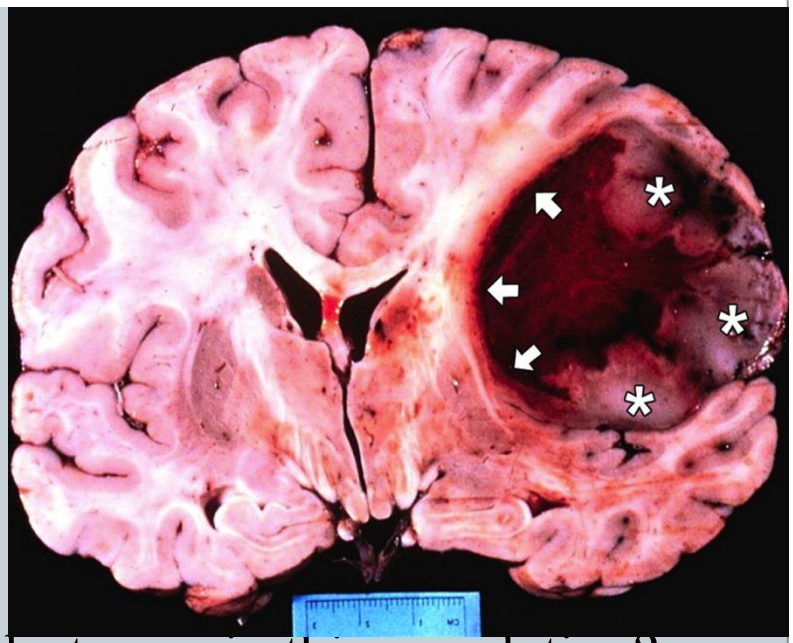


v. Stroke centers in developing world



COST

IV.d. Cost issues for Glioblastomas*



i. US Cost data

ii. EU Cost data

iii. Amount of GNP spent on healthcare

iv. Developing world cost data

v. How much would it cost to treat Glioblastomas in this population?

vi. % of people who can independently pay for reduced costs of GBM

*Supply costs are not included in this section

i. US Cost data

- Currently in the U.S., the cost of temozolomide (Temodar, Temodal) treatment is over $10,000 per month. If you add in Gliadel Wafers, it adds another $10,000 to your initial resection surgery. And treatment with Avastin + CPT-11 can be over $50,000 per year.

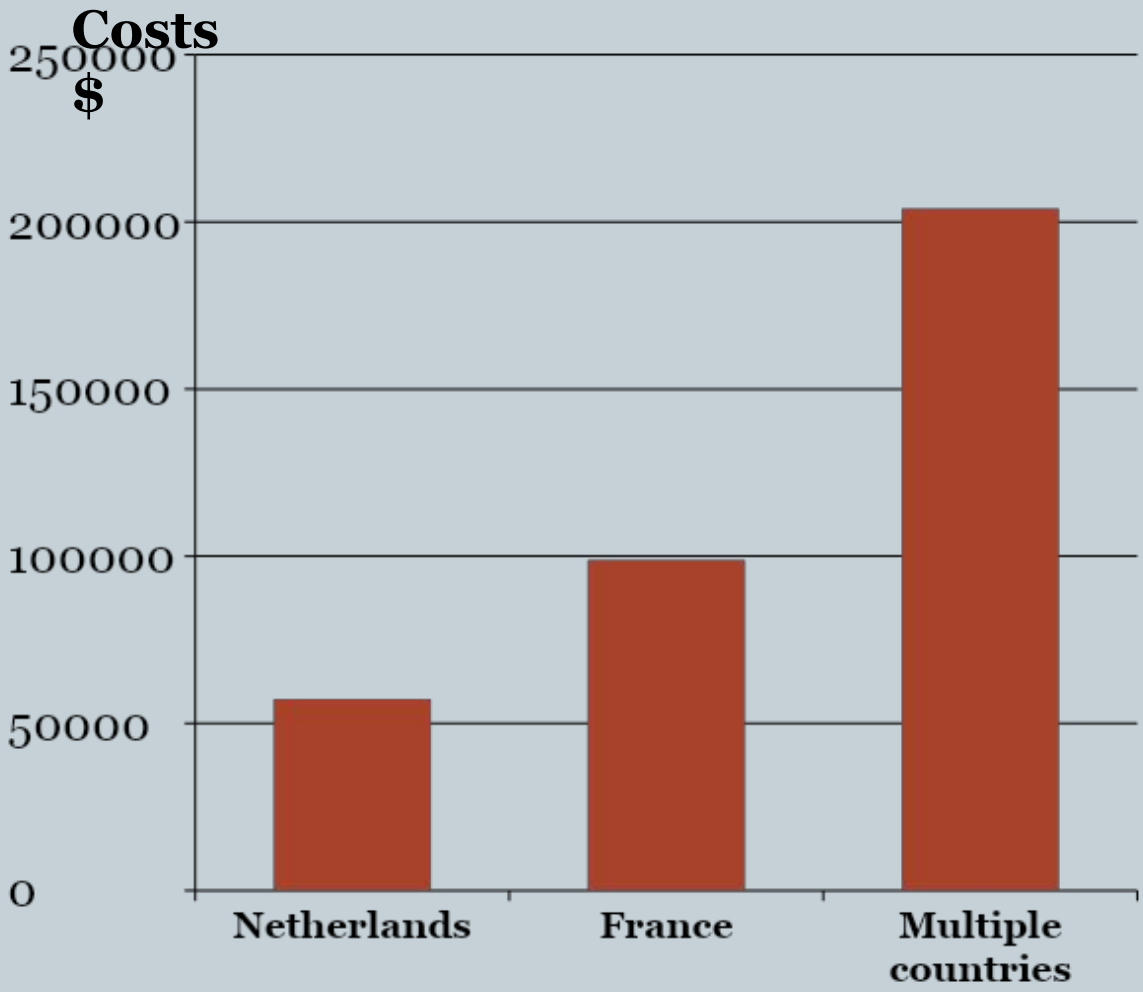
Cost data in the USA :

- Dx
  - MRI/CT-Scan
  - $1200
  - Biopsy
- Neuropathology
- Craniotomy
  - $50,000-$70,000
- Radiation
  - $7,000-$20,000

ii. US Cost data, cont.

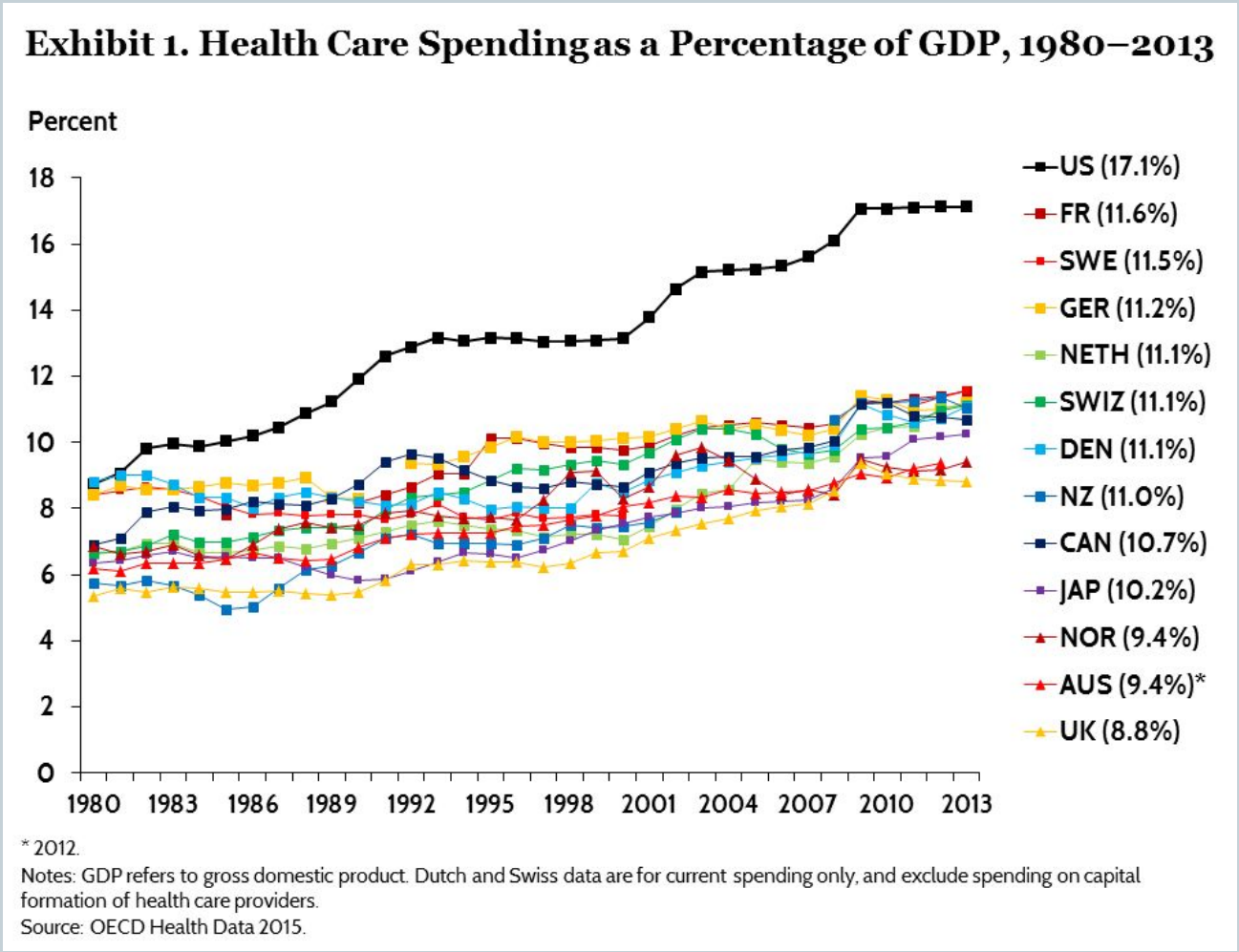
- Chemotherapy with the drug temozolomide is the current standard of treatment for GBM
  - $51/5 capsules (6 times treatment)
- Hospice
  - $150/day
- Meds
  - Seizure meds
  - Steroids
- Follow up scans
- Hospice Care
- Pain Management

ii. Average Glioblastoma Treatment Costs in Europe



Average Cost Glioblastoma treatment in Europe: $125.000

ii. Amount of GNP Spent on Healthcare



ii. EU Cost data

- Thus we estimate the cost of GBM treament in the United States would be $250,000
- Estmated cost of GBM treatment in EU is $125.000

iii. Developing world cost data

USA

1. Neurosurgery consultation - $378
2. Labs - $400
3. Imaging (MRI) – 6 x $600
4. Hospital costs - $8.813
5. Surgery costs - $25.204
6. BCNU costs - $10.000
7. Genetic study - $550
8. Immunohistology - $416
9. Radiation costs - $11.520
10. TMZ (initial) - $12.136
11. TMZ (maintenance) - $2.041/month
12. Electric field therapy - $21.000/month
13. Other medications - $300/month
14. Hospice - $4.500/month

Total: $73.017 + $23.341/month + Hospice

INDIA

1. Neurosurgery Consultation - $11
2. Labs - $119
3. Imaging (MRI) – 6 x $400
4. Hospital costs - $467
5. Surgery costs - $3.500
6. BCNU costs - $4.285
7. Genetic study - $243
8. Immunohistology - $124
9. Radiation costs - $6.898
10. TMZ (initial) - $1.410
11. TMZ (maintenance) - $365/month
12. Electric field therapy - NA
13. Other medications – $180/month
14. Hospice – NA

Total: $19.457 + $545/month + Hospice

iv. How much would it cost to treat Glioblastomas in this population?

For typical patient with an average length of survival net calculated cost will be:

- **US** – 220,000 X $250,000 = $55 billion

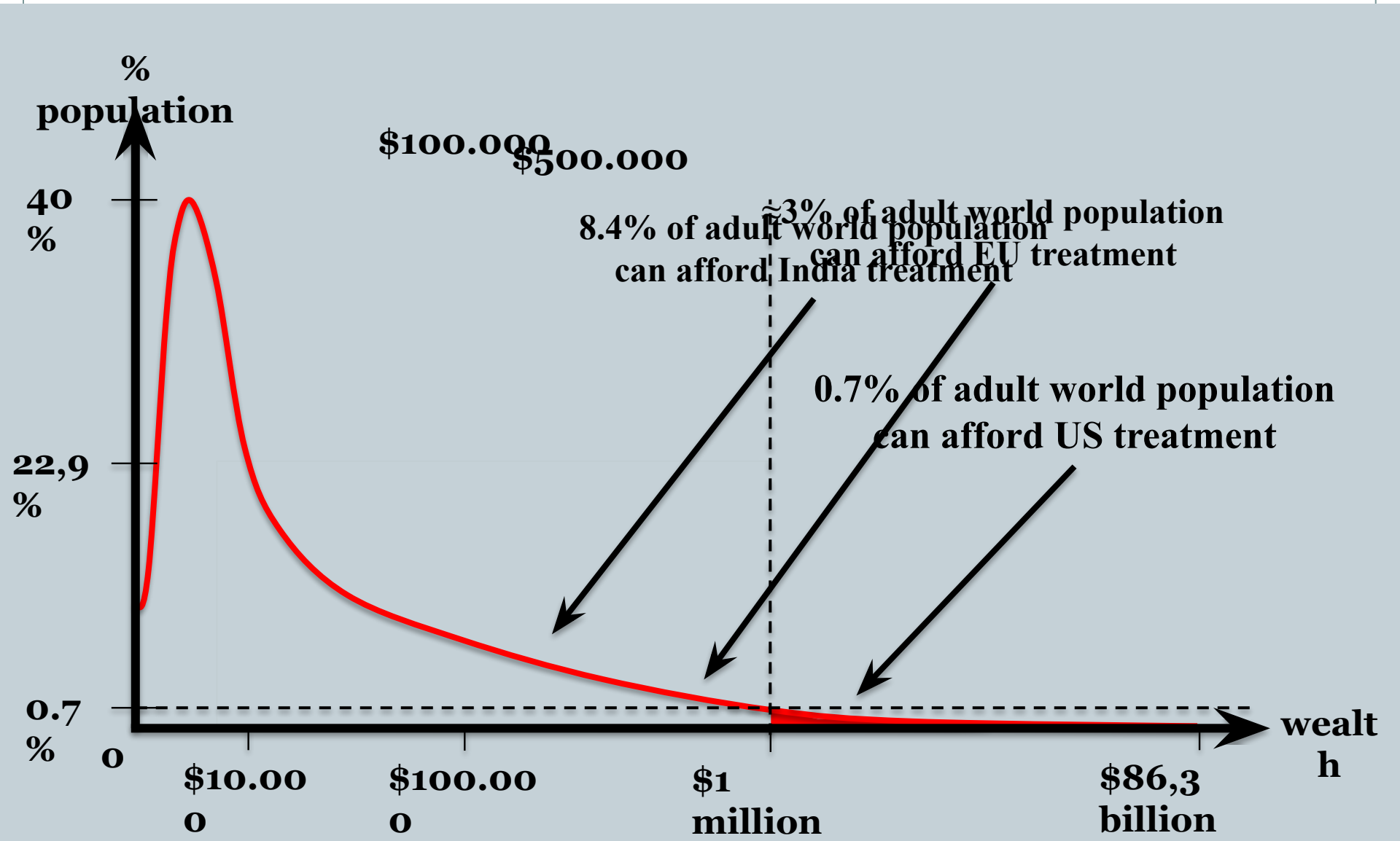
VS

- **EU** – 220,000 x $125,000 = $27.5 billion

VS

- India - 220,000 x $27.414 = $6 billion

v. % of people who can independently pay for reduced costs of GBM

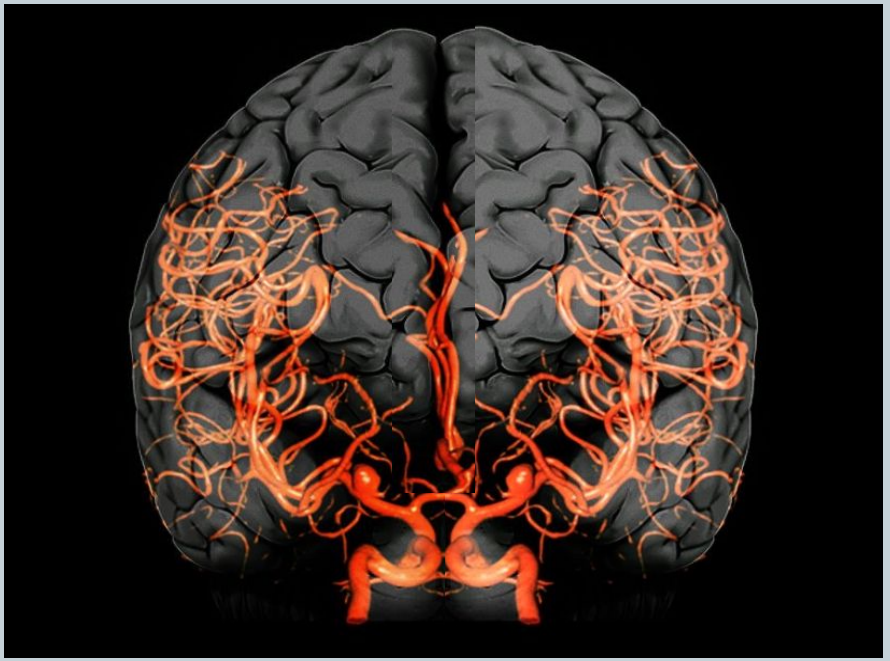


IV.e. Cost issues for ruptured aneurysms*

i. Costs of aneurysm treatment

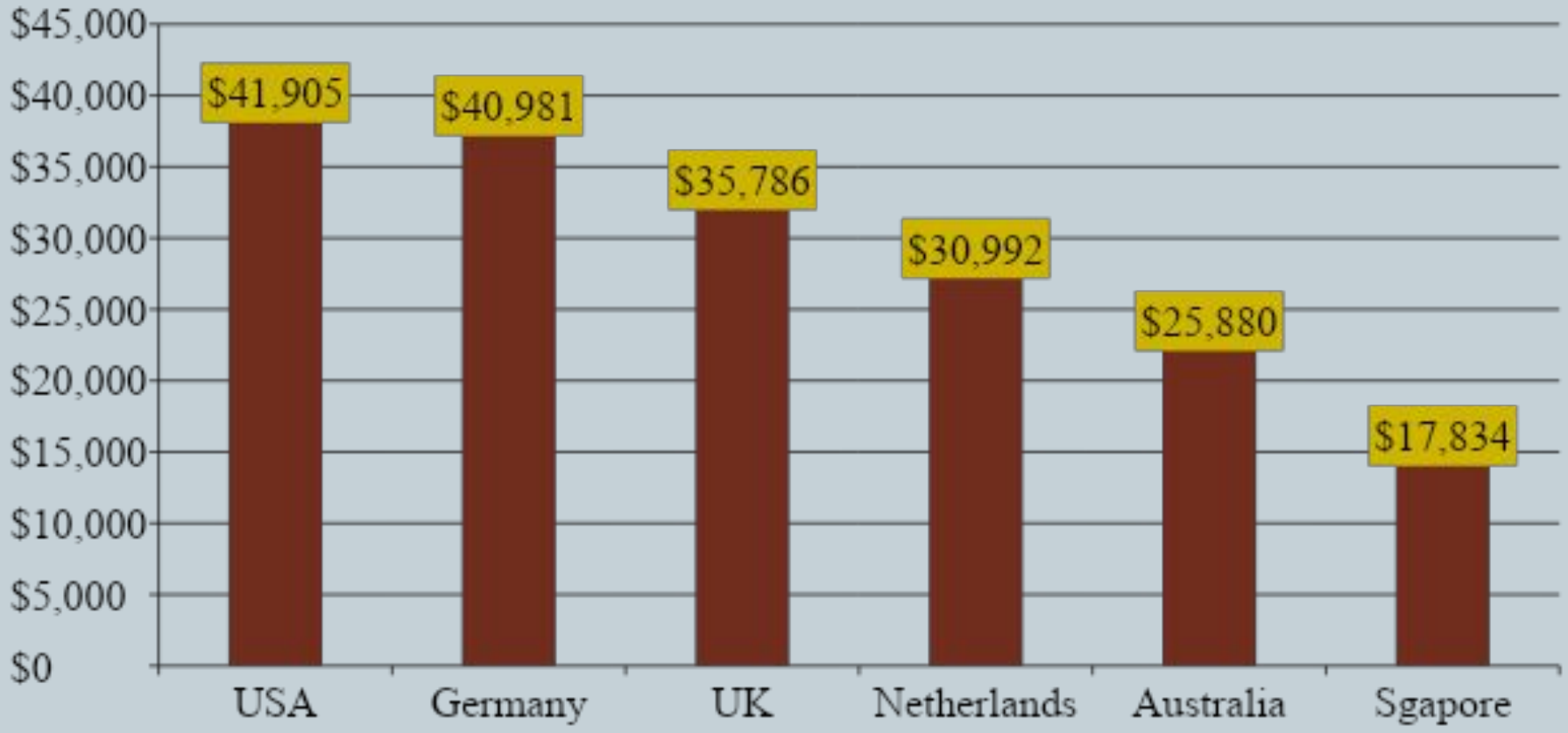
ii. How much would it cost to treat ruptured aneurysms in this population?

iii. % of people who can independently pay for reduced costs of aneurysm treatment



*Supply costs are not included in this section

i. Costs of treatment of aneurysms are relatively well investigated



Richard Dodel et al., Stroke. 2010;41:2918-2923

i. Costs of aneurysm treatment

- US cost - $42.000
- Averag EU cost - $36.000
- India cost - $6.000[1]

1.http://medicureassist.com/: Website of Medical Tourism in India

ii. How much would it cost to treat ruptured aneurysms in this population?

- **US** – 570,000 X $42,000 = $24 billion

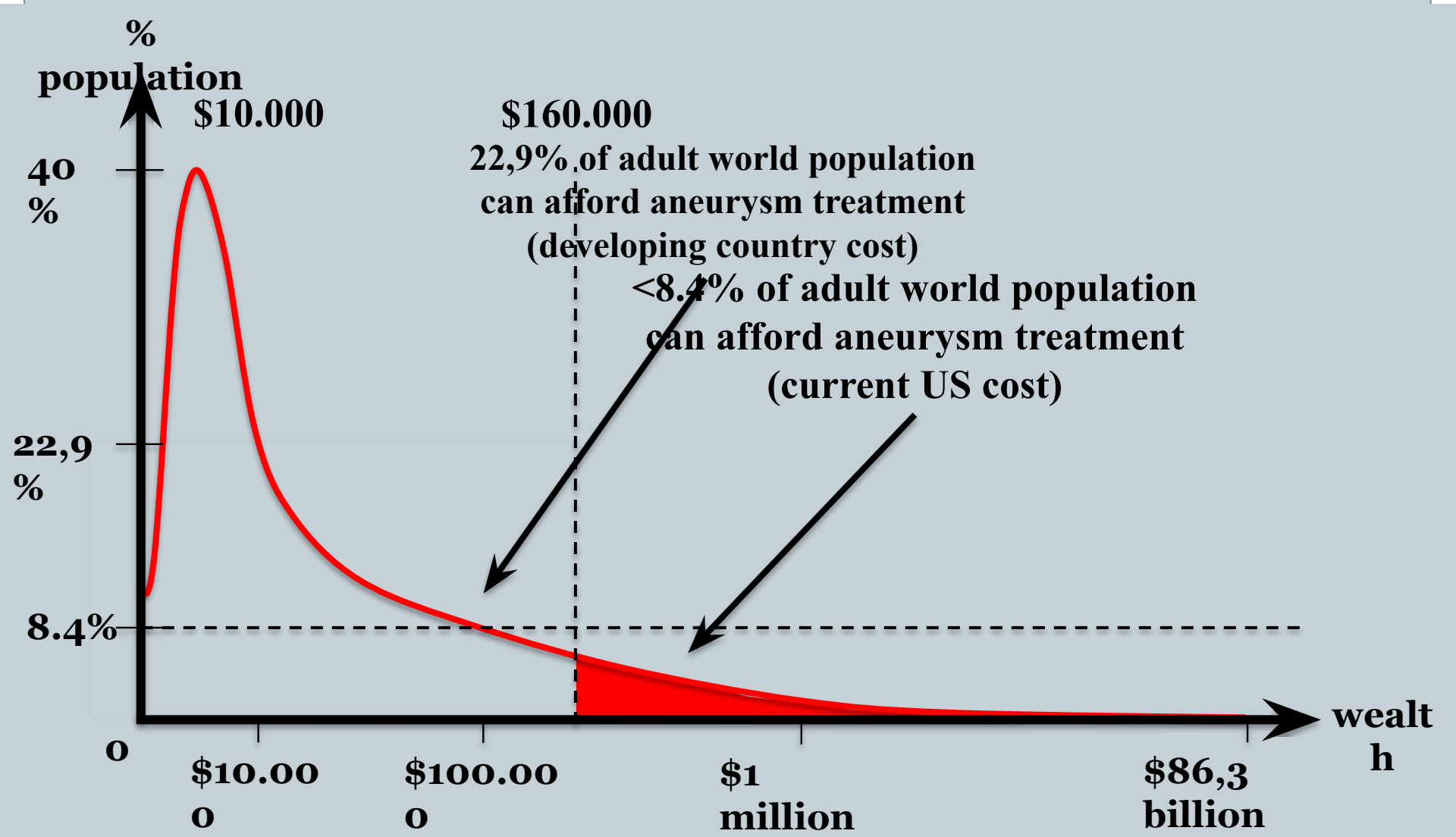
VS

- **EU** – 570,000 x $36,000 = $20.5 billion

VS

- India - 570,000 x $6,000 = $3.4 billion

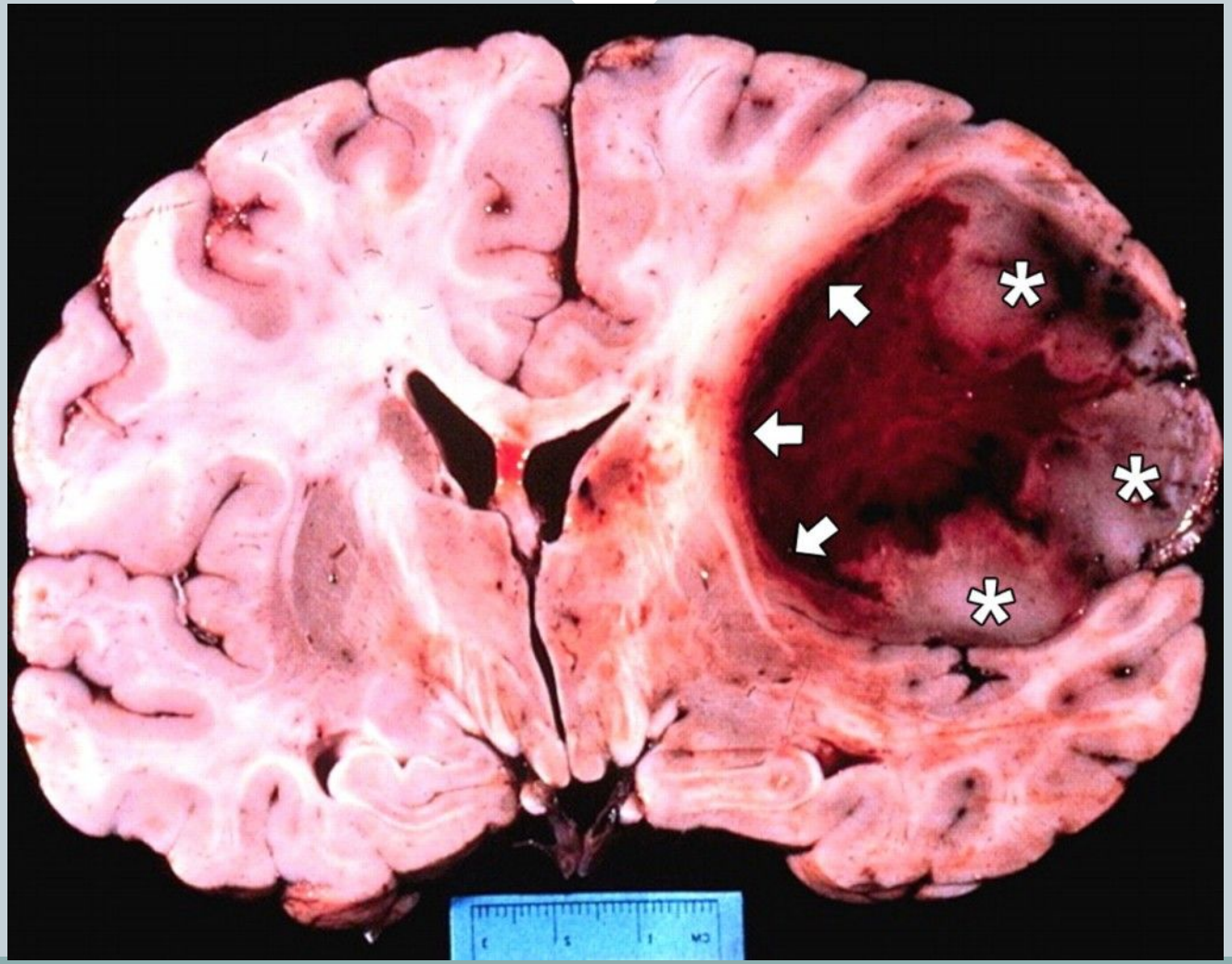
iii. % of adult population who can independently pay for aneurysm treatment



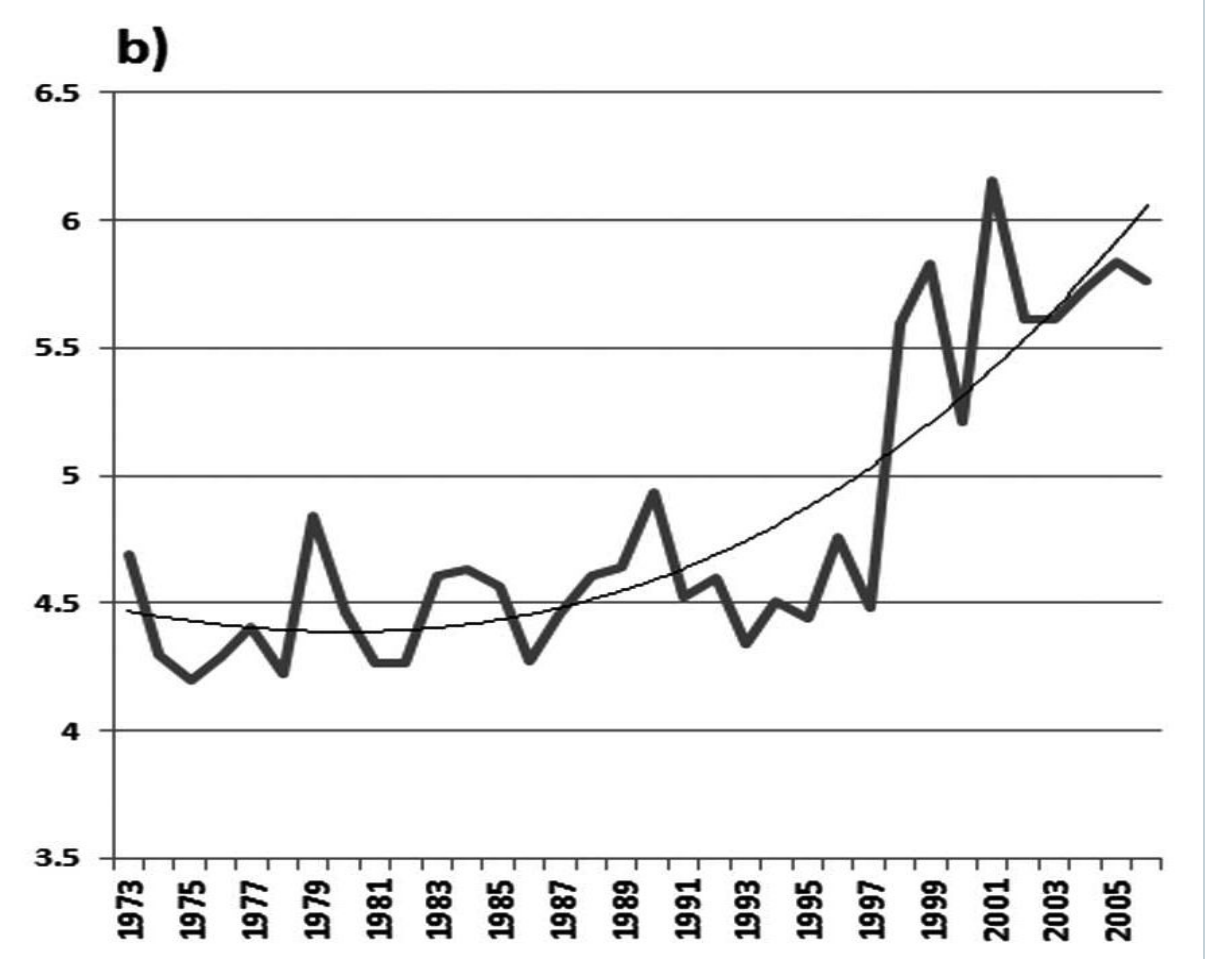
IV.f.

- What is the comparative benefit of world standards for each disease process?

i. Benefit of clinical guidelines - Glioblastomas



Benefit of clinical guidelines: Survivability in GBM



Kaplan-Meier plot, 21,783 GBM patient yearly median survival development over time

Pascal O. Zinn et al., 2013

Outcome (GBM)

Median survival without treatment is 3 months[1]

Median survival with maximal treatment is 14.6 months[2]

Treatment adds 11,6 months or about 1 year of life

1. Schapira, Anthony H.V. (2007). Neurology and clinical neuroscience. Philadelphia: Mosby Elsevier. p. 1336. ISBN 9780323070539.

2. World Cancer Report 2014. World Health Organization. 2014. pp. Chapter 5.16. ISBN 9283204298.

Outcome (GBM)

Median survival without treatment is 3 months

Median survival with maximal treatment is 14.6 months

Treatment adds 11,6 months or about 1 year of life

- ✔ Number of patients/year – 214.500
- ✔ 214.500 years of life gained thanks to treatment
- ✔ Amount of money needed to treat these people in

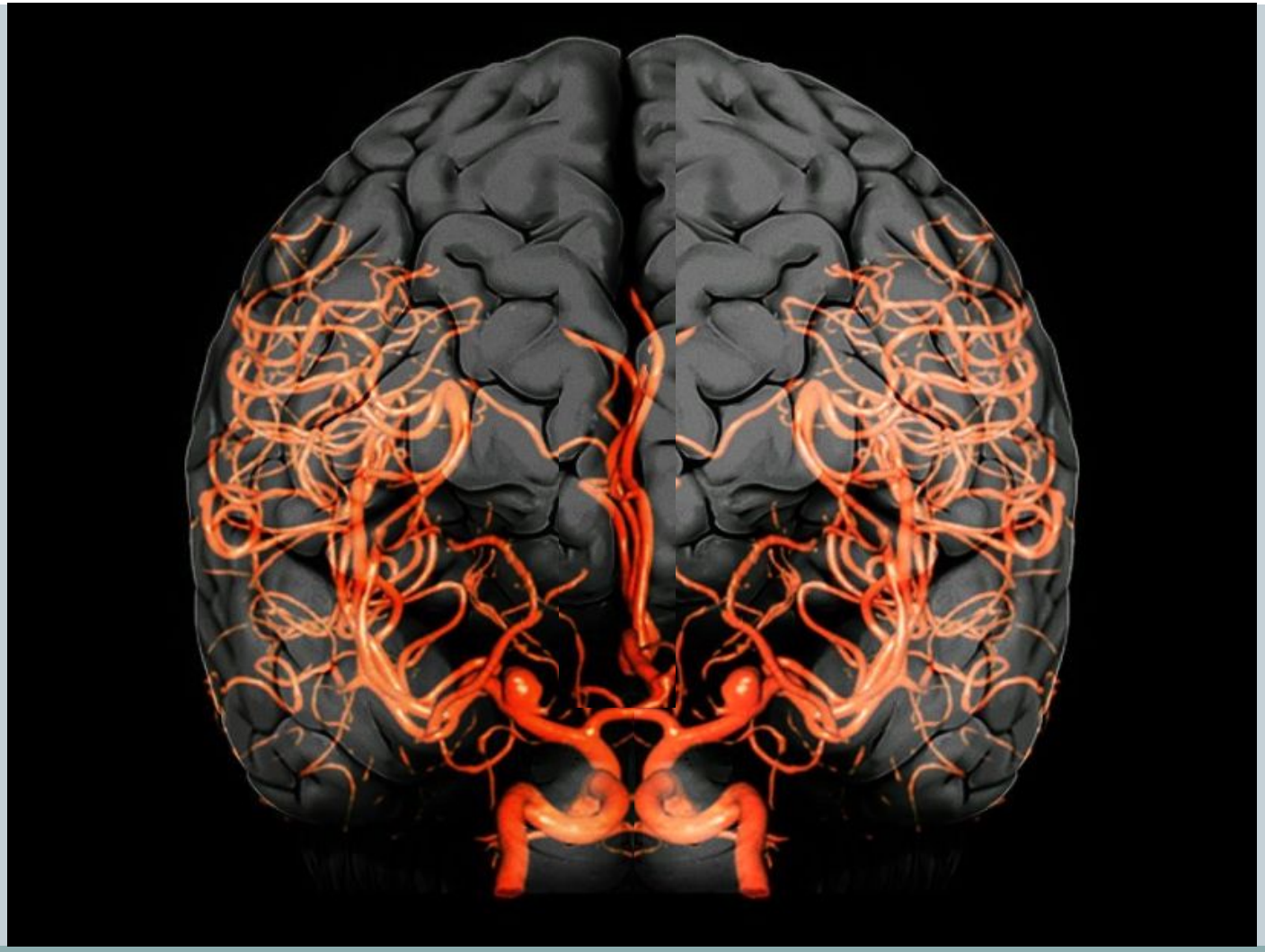
US - $55 billion vs in India - $6 billion

or

$256.500 per year of life gained (US cost)

$28.000 per year of life gained (India cost)

ii. Benefit of clinical guidelines – ruptured aneurysms



Benefit of Guidelines
Natural history of ruptured aneurysms w/wo treatment

Natural History of Ruptured, but Untreated Intracranial Aneurysms (Stroke, March 1, 2017)

Stroke. 2017 Mar 1. pii: STROKEAHA.116.015933. doi: 10.1161/STROKEAHA.116.015933. [Epub ahead of print]

Natural History of Ruptured but Untreated Intracranial Aneurysms.

Korja M[1], Kivisaari R[2], Rezai Jahromi B[2], Lehto H[2].

Author information

[1]From the Department of Neurosurgery, University of Helsinki and Helsinki University Hospital, Finland. miikka.korja@hus.fi.
[2]From the Department of Neurosurgery, University of Helsinki and Helsinki University Hospital, Finland.

Abstra

BACK

The 1-year mortality rate was 75% for good-grade patients

cohort

relatively large hospital cohort.

METHODS: Patients admitted to the study hospital between 1968 and 2007 with saccular but untreated ruptured intracranial aneurysms were identified from the hospital aneurysm registry of 6850 patients. The study cohort included only patients who were followed up until death and for whom the date of symptom onset and the date of hospital admission were available.

RESULTS: For 510 patients identified, the median survival time from symptom onset to death was 20 days. The 1-year mortality rate was 65%, but varied substantially by admission delays and clinical status on admission, being lowest (13%) for patients admitted later than a month after symptom onset and highest (89%) for poor-grade patients. The 1-year mortality rate was 75% for good-grade patients admitted within a week.

CONCLUSIONS: Mortality rates for patients with untreated ruptured intracranial aneurysms are even worse than presented in the historical study. When discussing with subarachnoid hemorrhage patients and their relatives about treatment options, the presented natural history figures are of use.

KEYWORDS: aneurysm, ruptured; cohort studies; intracranial aneurysm; natural history; subarachnoid hemorrhage

Benefit of Guidelines: Natural history of ruptured aneurysms w/wo treatment

Natural History of Ruptured and Treated Intracranial Aneurysms (ISAT)

AHA/ASA Guideline

Guidelines for the Management of Aneurysmal Subarachnoid Hemorrhage

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Natural History and Outcome of aSAH

Although the case fatality of aSAH remains high worldwide,[5] mortality in industrialized One study in the per year from 19 1994.[5] Others have shown that case fatality rates decreased from 57% in the mid-1970s to 42% in the mid-1980s,[11] whereas rates from the mid-1980s to 2002 are reported to be anywhere from 26% to 36%.[6,12,13,18,20,61,62] Mortality rates vary widely across published epidemiological studies, ranging from 8% to 67%.[59] Regional variations become apparent when numbers from different studies are compared. The median mortality rate in epidemiological studies from the United States has been 32% versus 43% to 44% in Europe and 27% in Japan.[59] These numbers are based on studies that

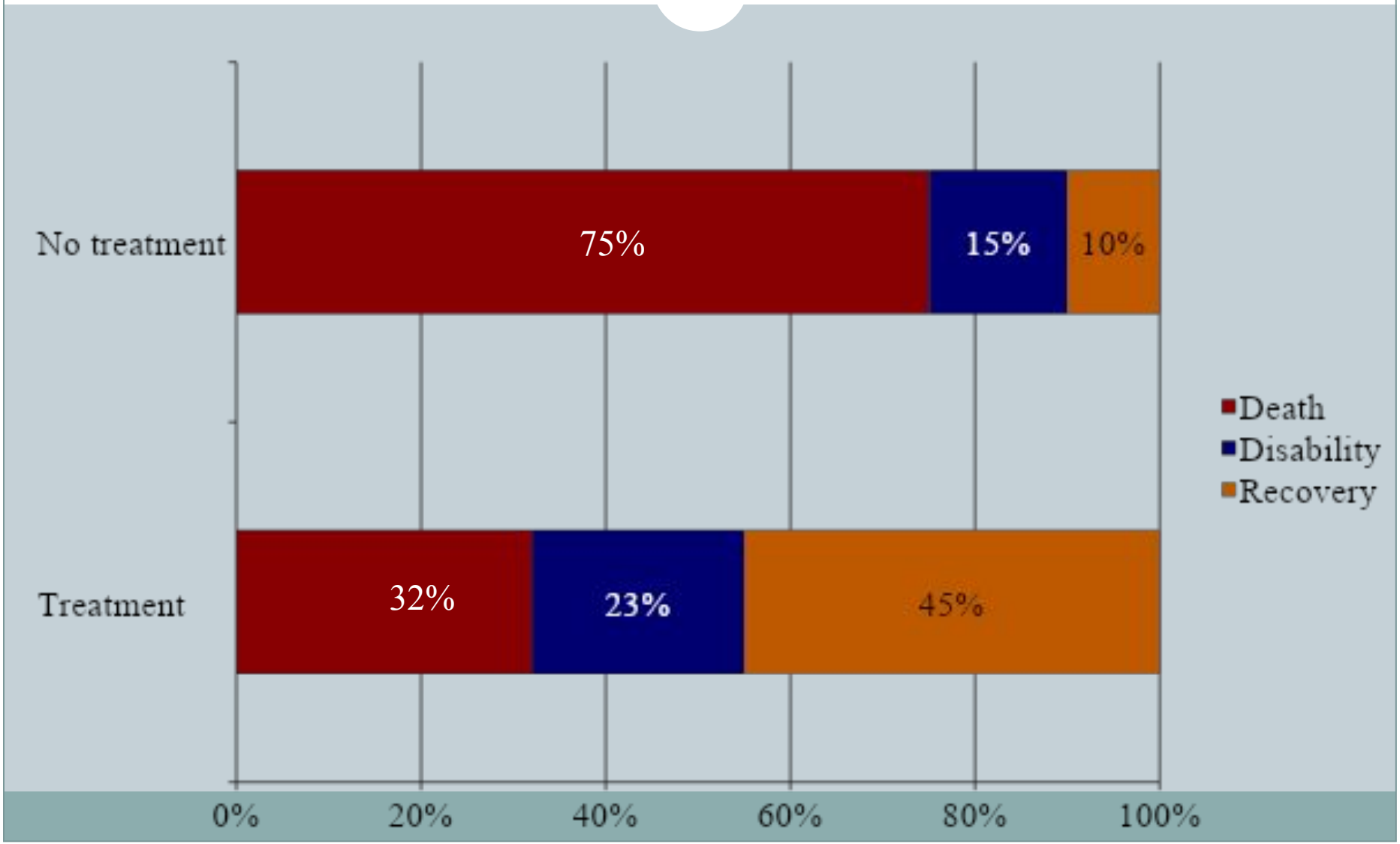
mortality rate in epidemiological studies from the United States has been 32% versus 43% to 44% in Europe and

ified Rankin Scale 3) and 6.5% being functionally dependent (modified Rankin Scale score of 4–5) 1 year after aSAH. Furthermore, scales that are relatively insensitive to cognitive

present in ≈20% of aSAH patients and is associated with poorer functional recovery and lower quality of life.[65] Cog-

demonstrated that intellectual impairment is very prevalent after aSAH. Although cognitive function tends to improve over the first year,[64] global cognitive impairment is still present in ≈20% of aSAH patients and is associated with poorer functional recovery and lower quality of life.[65] Cognitive deficits and functional decline are often compounded by mood disorders (anxiety, depression), fatigue, and sleep disturbances.[66] Therefore, scales assessing well-being and quality of life can be particularly useful in the integral assessment of patients with aSAH, even among those who regain functional independence.[67,68] Behavioral and psychosocial difficulties, as well as poor physical and mental endurance, are some of the most commonly encountered factors accounting for the inability of otherwise independent patients to return to their previous occupations.[66,68]

Benefit of Guidelines: Natural history of ruptured aneurysms w/wo treatment



Outcome (Ruptured aneurysms)

Primary impact

1. Decrease in mortality – 43% (289.755/year)
2. Increase in disability – 8% (53.907/year)
3. Increase in recovery – 35% (235.847/year)

- ✔ Mean age at presentation – 55.74
- ✔ Proper treatment can add about 20 years of productive life
- ✔ 289.775 X 20 = 5.8 mln years of life gained thanks to treatment

or

$4.862 per year of life gained (US cost)

$690 per year of life gained (India cost)

✔ Conclusion N1

- The cost and supply shortfalls prevent universal applications of clinical guidelines across the world

✔ Conclusion N2

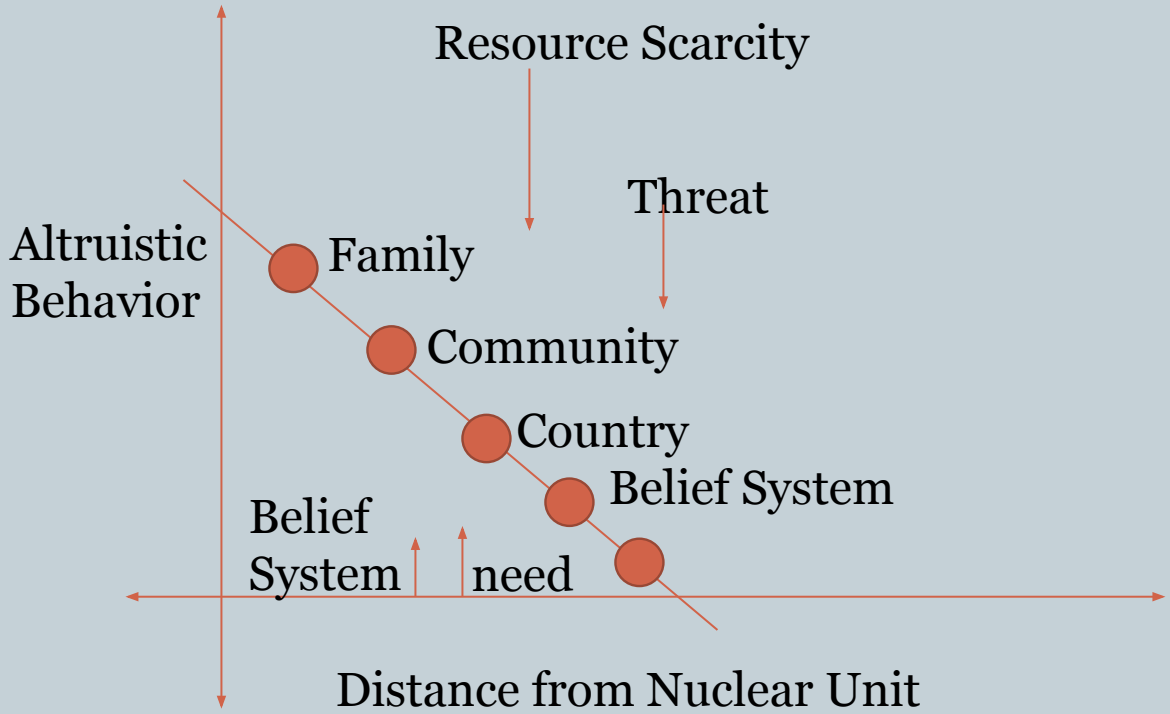
- Thus, treating ruptured aneurysms is about 50 times more cost-effective than treating Glioblastomas

VS

V. THE VIEW FROM MT. OLYMPUS

-How can worldwide healthcare resource dysfunction be improved?
(diminish cost/ increase supply/ better resource reallocation/
combined efforts to improve clinical outcomes)

V.a. Altruistic coefficient graph



V.b. A COLLABORATIVE ARRANGEMENT BETWEEN THE DEVELOPED AND DEVELOPING WORLD

V.c. The developed world's efforts

V.c. The developed world's efforts

i. Better resource allocation
ii. Income transference
    1) Direct Cash transference
    2) Charity
    3) Universal Insurance
    4) Government mandated
iii. Transference of Technology
iv. Profit motive
v. Used Equipment

V.c. The developed world's efforts (continued)

vi. Members of the International Patent System

vii. MD Anderson Cancer Center

viii. Establish Institutions in Developing Countries to Deal with Tertiary Neurosurgical Problems

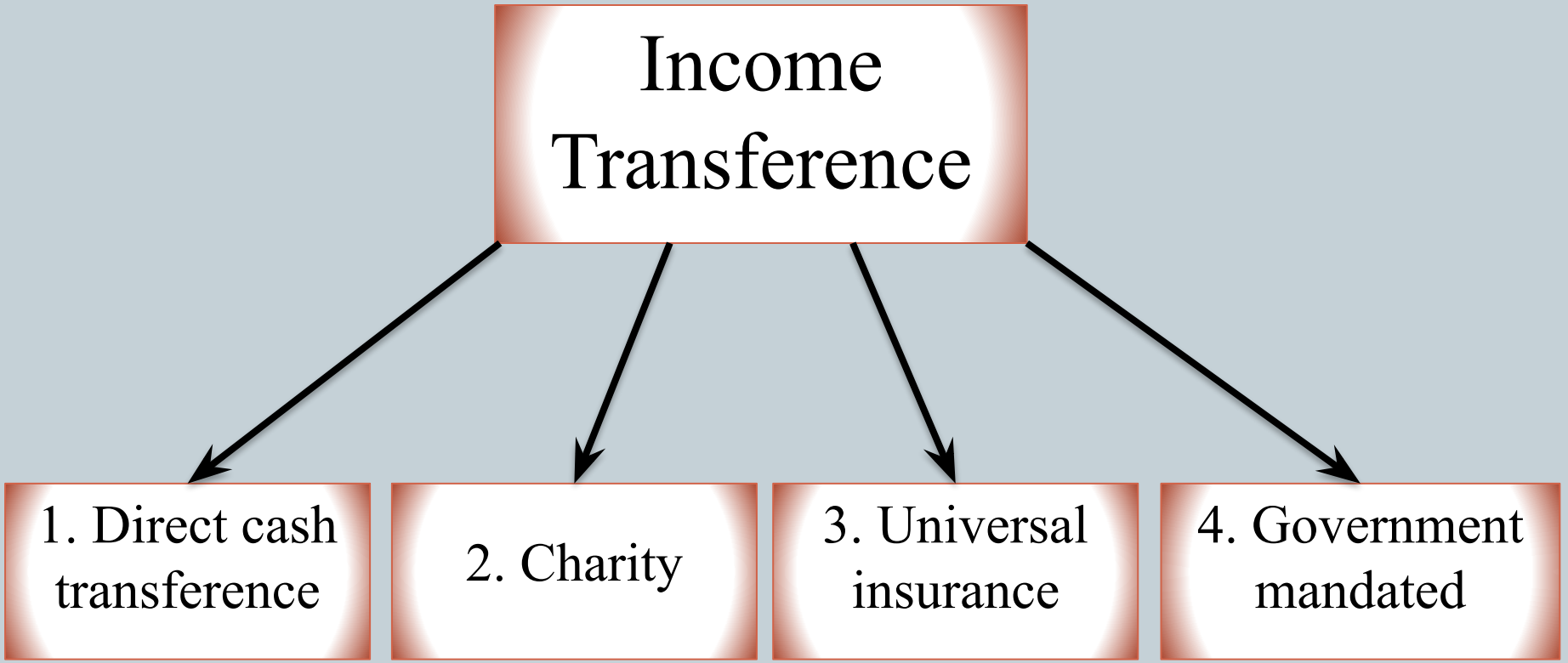
ix. Advanced Medical Technology in Full Time Use

x. Technology around the world

xi. Telemedicine

i. Better resource allocation with development of appropriate methodological system

ii. Income Transference



1) Direct Cash transference – Glioblastomas, ruptured aneurysms

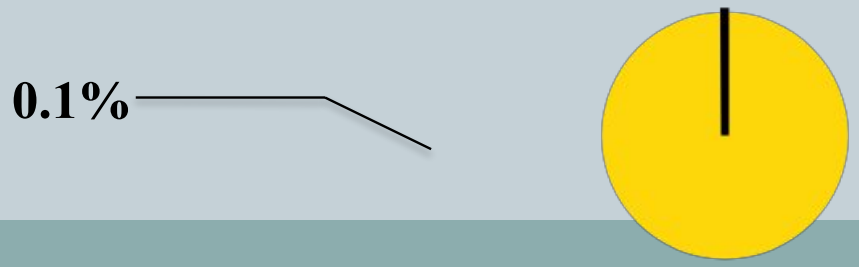
- US – $55 billion (0.6% of WHE)
- EU – $27.5 billion (0.3% of WHE)
- India – $6 billion (0.06% of WHE)

} Glioblastomas

- US – $24 billion (0.25% of WHE)
- EU – $20.5 billion (0.2% of WHE)
- India – $3.4 billion (0.035% of WHE)

} Ruptured aneurysms

- Combined amount: $9.4 – $79 billion
- A relatively trivial amount considering the world's GNP of $77.9 trillion and the amount the world spends on healthcare approximately $9.5 trillion

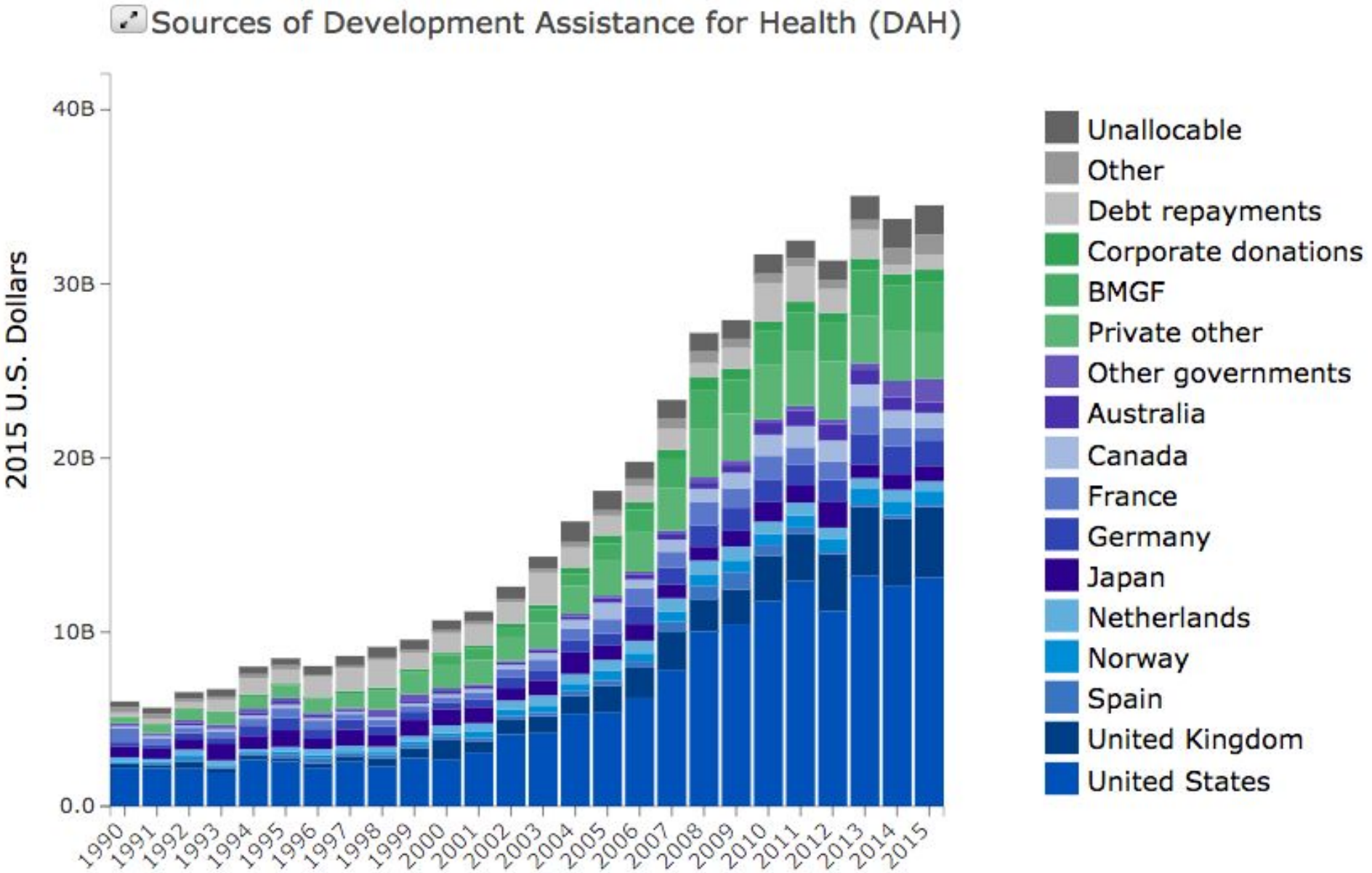


2) Charity in the world

- Total amount of charity in the world
  - $998.3 billion
  - Gross amount of charity money on world healthcare - $40 billion
- US charity
  - $29.8 billion out of $373.2 billion is allocated to world health

Source: www.charitynavigator.org

2) Charity

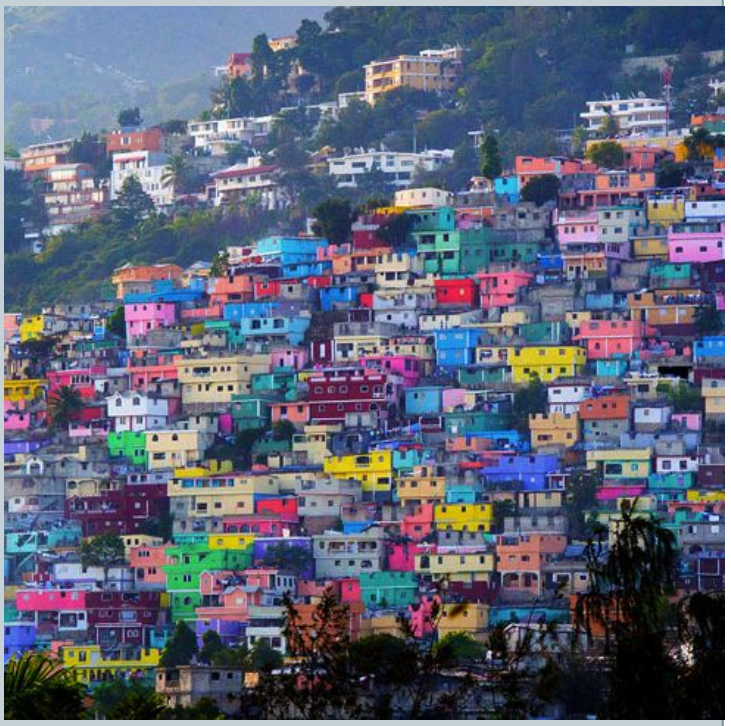

Sources of Development Assistance for Health (DAH)
2015 U.S. Dollars
40B
30B
20B
10B
0.0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Unallocable
Other
Debt repayments
Corporate donations
BMGF
Private other
Other governments
Australia
Canada
France
Germany
Japan
Netherlands
Norway
Spain
United Kingdom
United States

3) Universal insurance

- Health expenditure per capita in US is $9.000/year
- For a family of four will be $36.000/year
- Thus, developing countries cannot afford it.

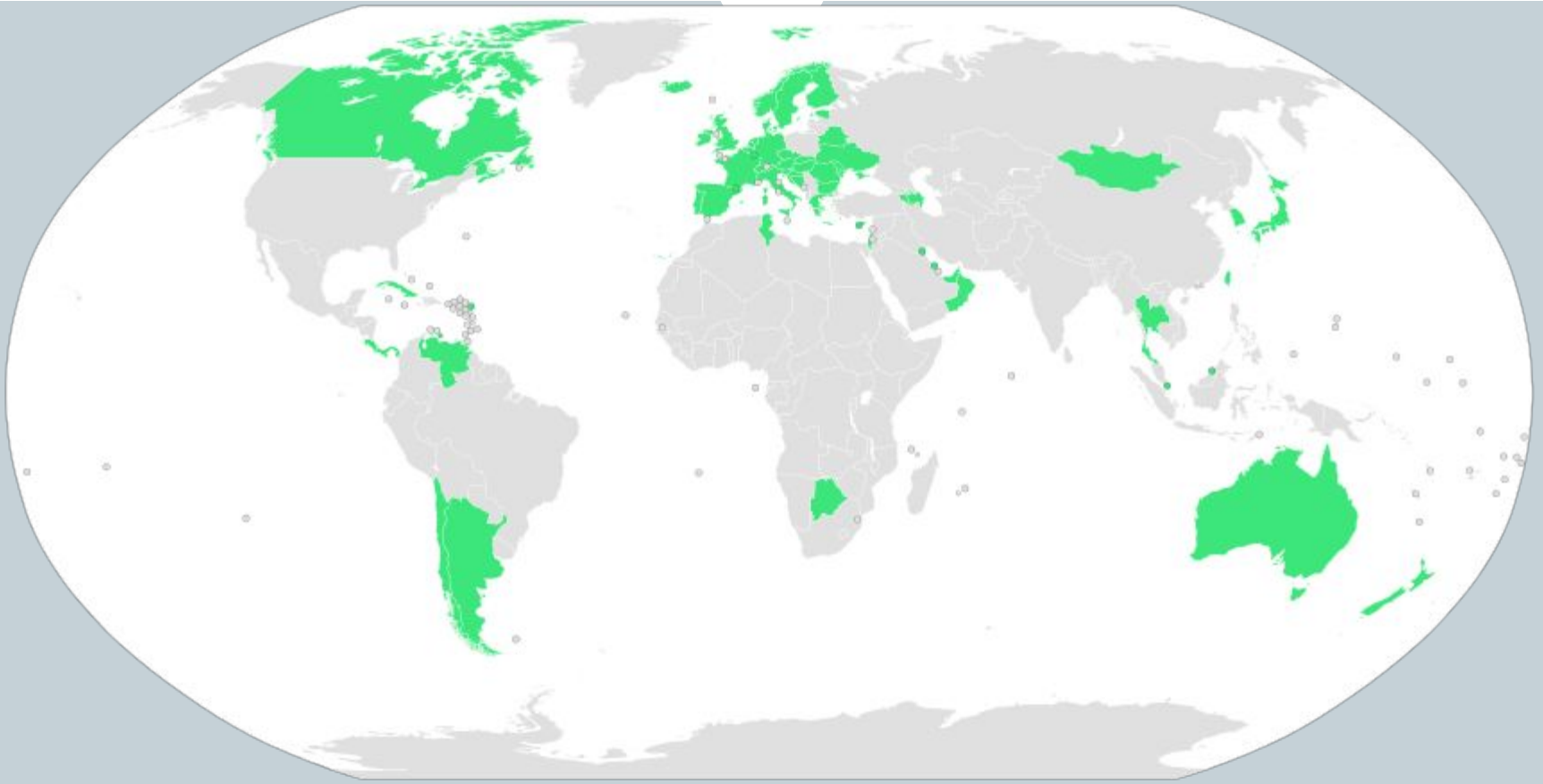
Haiti

- Population: 10.711.000(World bank)
- GDP: 8.765 billion(World bank)
- GNI per capita: $810(World bank)
- Population older than 40: 2.5 million (23%)(Wikipedia)
- Calculated number of GBM per year: 250
- Treatment cost: $62.5 million
- Even if we treat GBM 10 times cheaper, it will still be impossible in Haiti.



Capital of Haiti
Port-au-Prince

4) Government mandated: Universal healthcare, but not across borders



58 countries with universal health care in 2009.
58 countries with legislation mandating universal health care, along with > 90% health insurance coverage, and > 90% skilled birth attendance.

iii. Transference of Technology

iii. Transference of Technology, cont.

- Mercer university in Vietnam:

  Manufacturing prosthetic limbs for landmines victims in Vietnam

- $200 in Vietnam vs $10,000 in US

iv. Profit motive

v. Used Equipment

v. Used Medical Equipment

- Mexico imports medical equipment, instruments, disposable and dental products totaled US $10.58 billion in 2015.
- This represented about 80 %of the medical equipment and instrument market and approximately 40 % of the disposable products and dental materials.
- Information on import regulations for pre-owned medical devices was available for 106 markets.
- Of 106 markets, 85 markets appear to permit the unrestricted importation of used or refurbished medical equipment on the same terms as new.
- In 2005 India lifted its restrictions, and Niger and Slovak Republic submitted reports in 2005 and 2007 respectively for the first time and indicated that there are no restrictions. Sixteen markets impose restrictions. Five generally prohibit the importation of pre-owned devices.

vi. Members of the International Patent System

vii. MD Anderson Cancer Center

viii. Establish Institutions in Developing Countries to Deal with Tertiary Neurosurgical Problems

ix. Advanced Medical Technology in Full Time Use Expensive Technology around the Clock

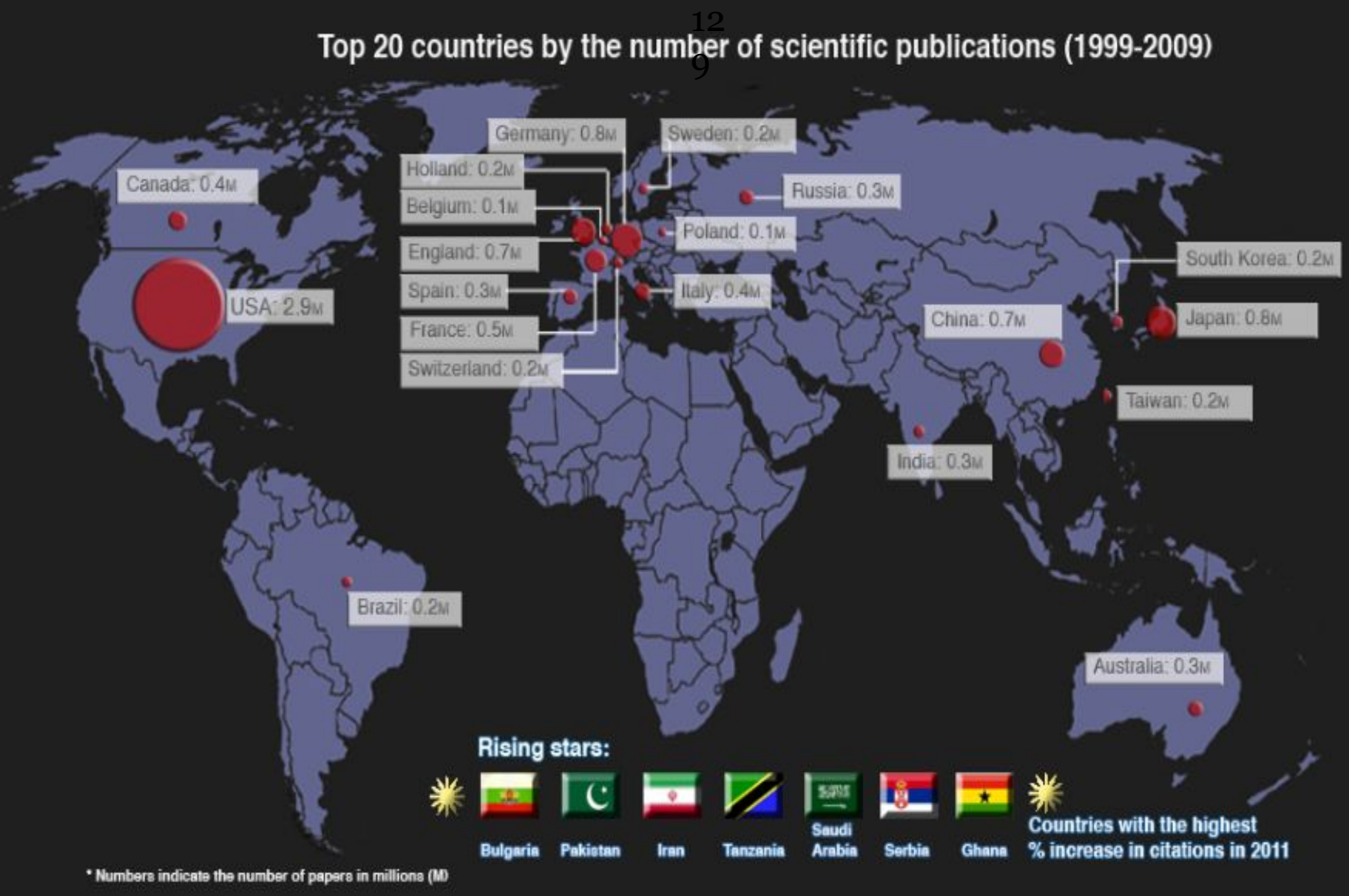
x. Technology around the world

Top 20 countries for scientific output are first world countries with the USA publishes twice as much as the 2 countries after it in the list

(Japan, Germany)

The top 20 countries for scientific output

12
9



- However, in regards to healthcare inquiries there needs to be higher grade clinical research studies with better demarcation of clinical expenditures.

xi. Telemedicine

V.d. What Can Developing Countries do?

V.d. What Can Developing Countries do?

i. Become more prosperous

ii. Develop cheaper technology exportable to the 1st world

iii. Become innovators

iv. Discover outrider operative variables

1) Discover unusual disease presentations
2) Human genome variability
3) Discover possible environmental causable agents
4) T cell & variability of the immune system
5) Differing successful treatment modalities

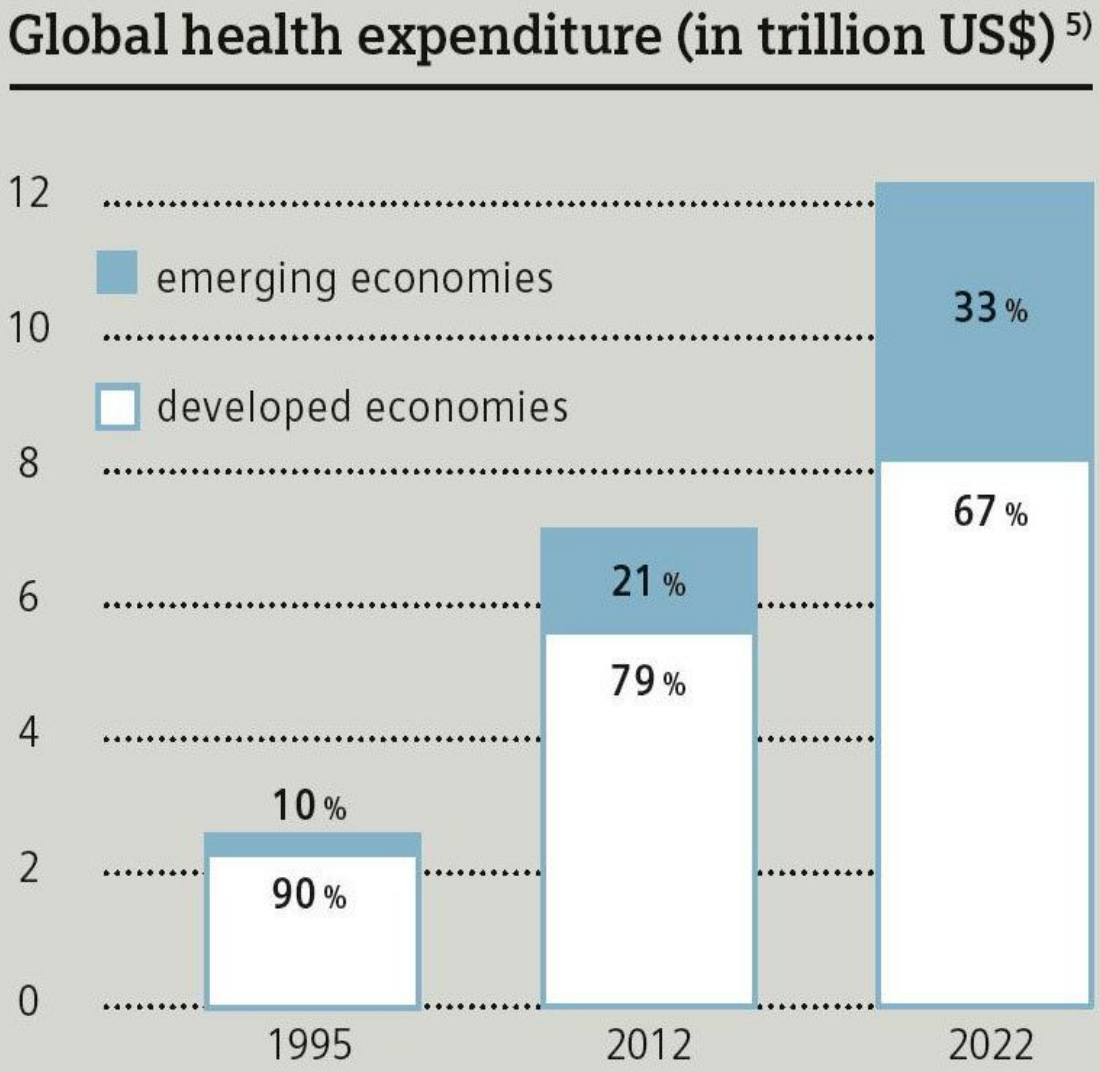
V.d. What Can Developing Countries do? (continued)

v. Participate in Clinical Trials

vi. Western trained physicians from developing countries serving as a conduit for tertiary technology

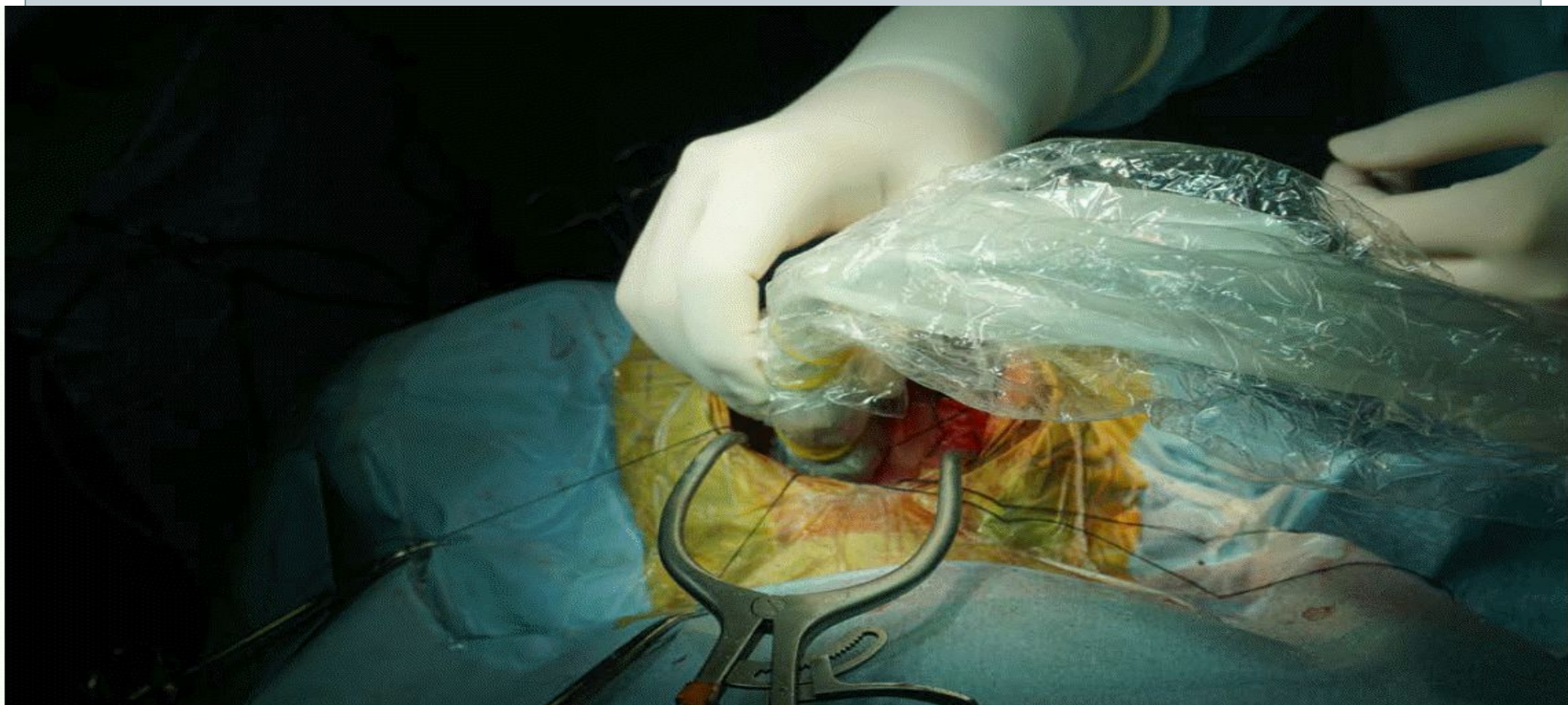
vii. Better statistics

i. Become more prosperous

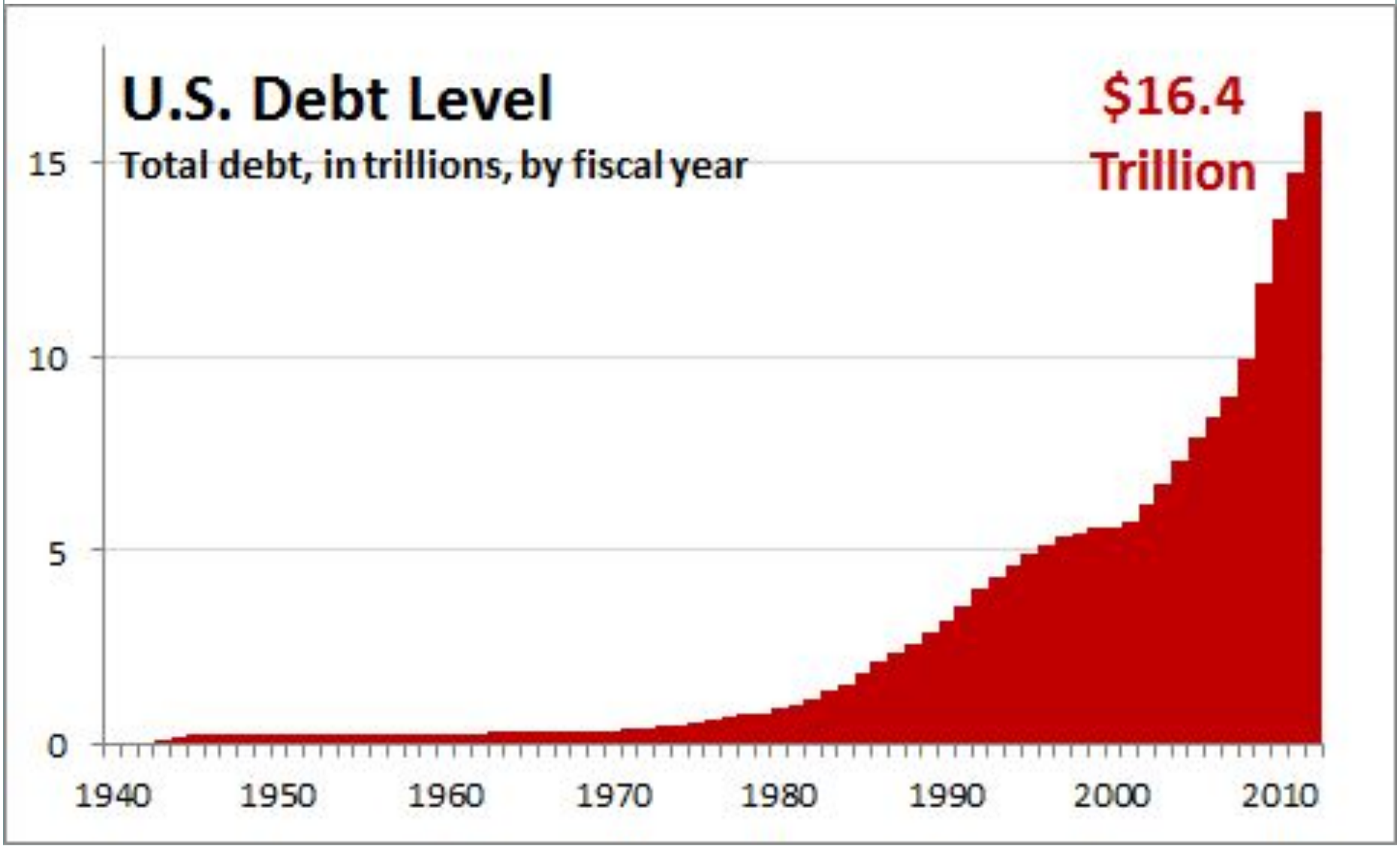


ii. Burr hole with ultrasound

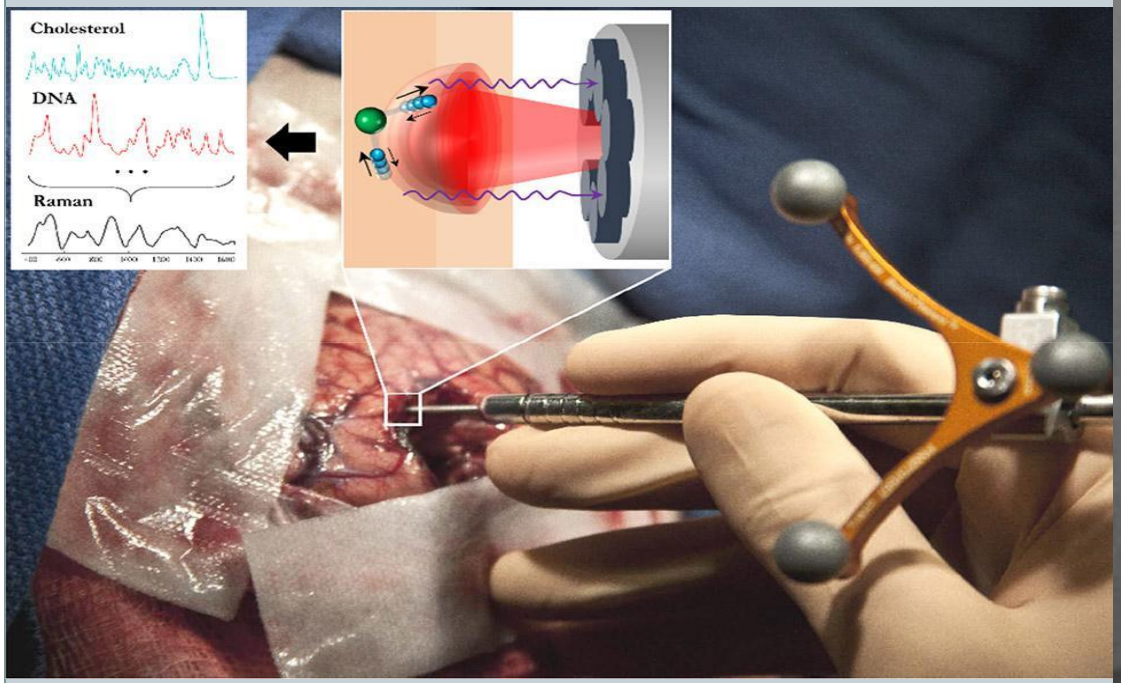
- They can experiment with less expensive options and see if they work, which could not be done in the US
- Ultrasound ($200) vs CT-Scan ($1200)

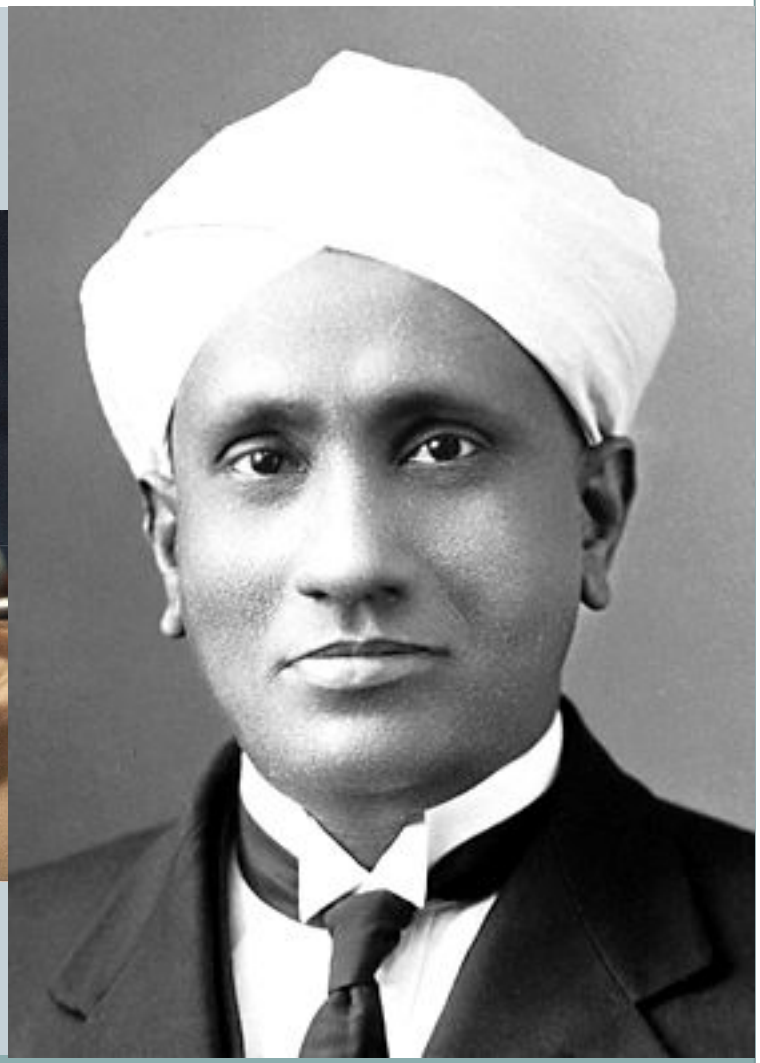


US National Debt



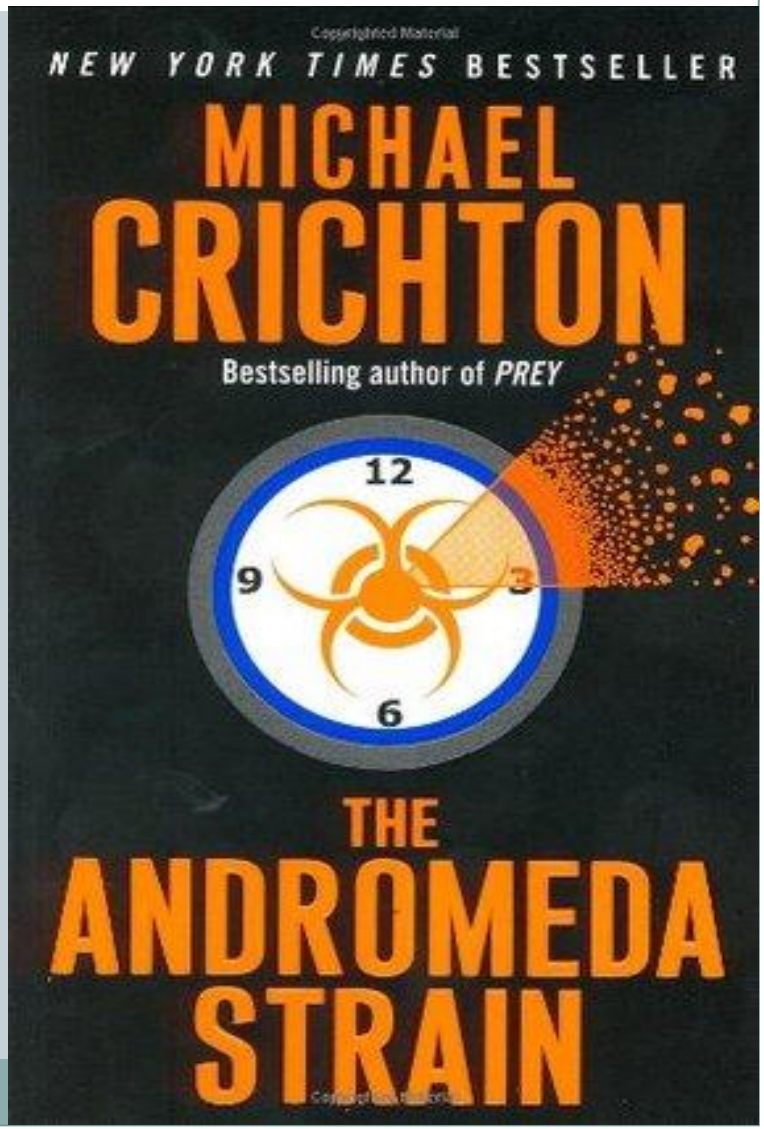
iii. Become Innovators-Raman technique





iv.1. Discover Unusual disease Presentations And Treatment Patterns (find outrider operative variable)

- Maybe certain DNA protects against GBM/Glioma
- Maybe everybody has infections, can an infection lead to a GBM cure?

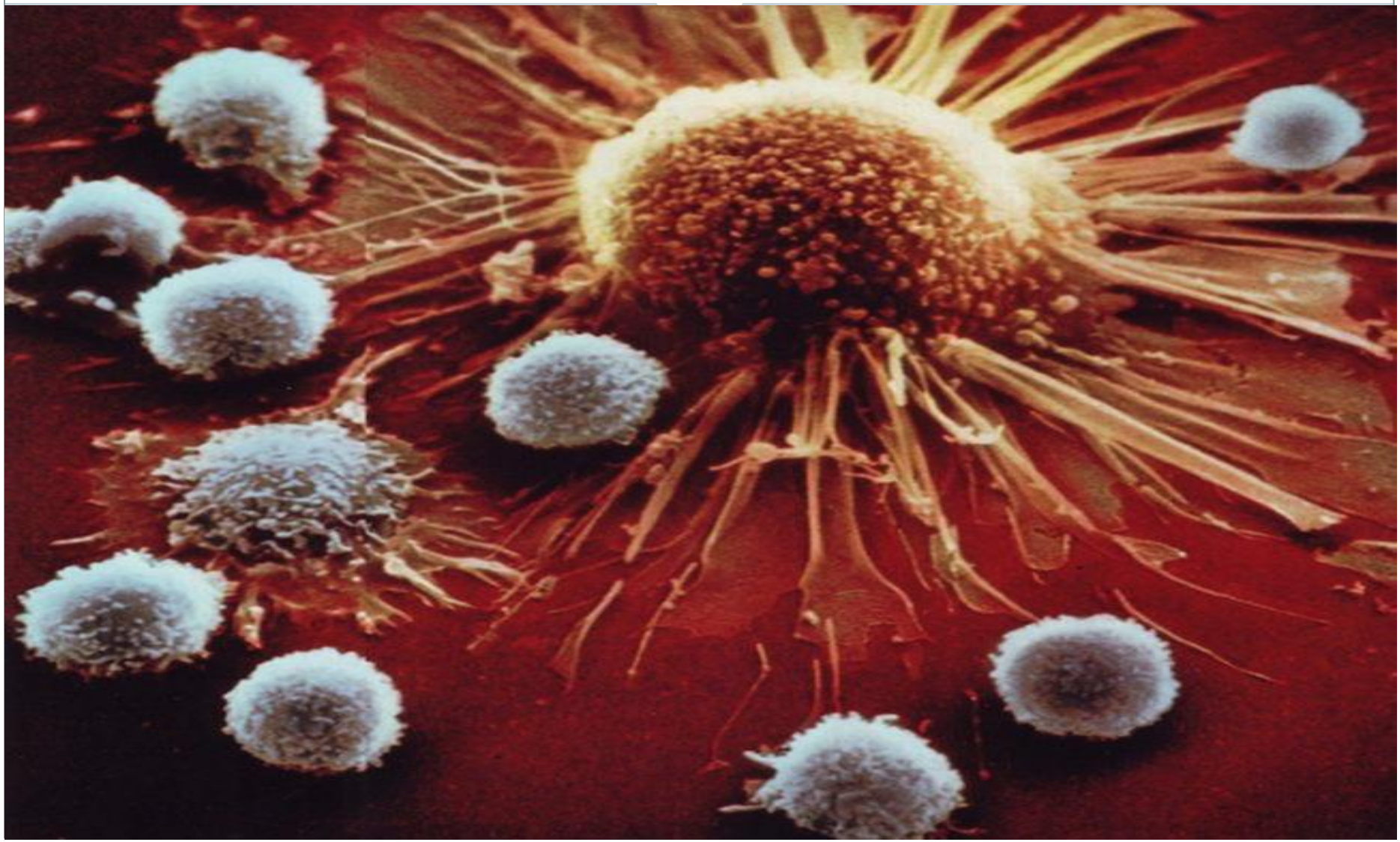


iv.2. The human genome variability

iv.2. African tribe (Massai warriors)

iv.3. Pollution and cancer

iv.4. T-cell & variability of the immune system



iv.5. 5 years survival rates in comparison to the USA

Glioblastoma	US[1]	1995–2010	4.7	4.4–5.0
	Korea[20]	1994–2004	8.9	
	US[154]	1997–2000	0.1	
	UK & Ireland[18] (EUROCARE)	1995–2002	2.2	1.6–2.9
	Northern Europe[18](EUROCARE)	1995–2002	1.9	1.2–2.9
	Central Europe[18] (EUROCARE)	1995–2002	4.4	3.2–5.9
	Eastern Europe[18] (EUROCARE)	1995–2002	2.2	1.0–4.4
ICD-O-3 morphology codes 9440–9442	Southern Europe[18](EUROCARE)	1995–2002	2.8	1.8–4.3

v. Participate in Clinical Trails - Avoid the mistakes made in The Tuskegee Studies of untreated syphilis

- The study was conducted between 1932 and 1972.The study initially involved 600 african american men – 399 with syphilis, 201 who did not have the disease. The study was conducted without the benefit of patients' informed consent.

The Constant Gardner

- Unethical clinical trials in Africa for financial gain

vi. Such physicians could pioneer technology and improve care arrangements for their home countries

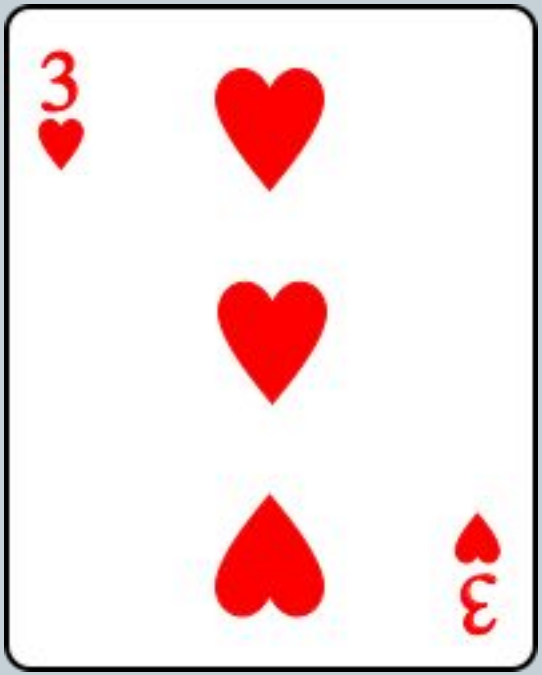
- 14% of the approximately 20,000 new residents and interns in the US are not US citizens

- Those physicians in western countries that come from developing countries could have the responsibility to their countries of origin to facilitate treatment of GBM

vii. Better Statistics/Incidence is poorly established world wide…

- Canada
  - "Currently, the Canadian medical system does not track statistics on primary brain tumors. Complete and accurate data is needed to facilitate the research that will lead to a better understanding of this disease and improved diagnosis and treatment."
- Korea
  - Despite its importance, there are no accurate statistics on primary CNS tumors in Korea.
- Sudan
  - The reason there are few statistics on glioma incidence by country is because it is so expensive to diagnose
  - We believe world statistics are greatly understated do to lack of available diagnostic medicine
  - Furthermore, the world's population is younger than the typical age of diagnosis for Glioma/GBM, causing under-reported numbers.

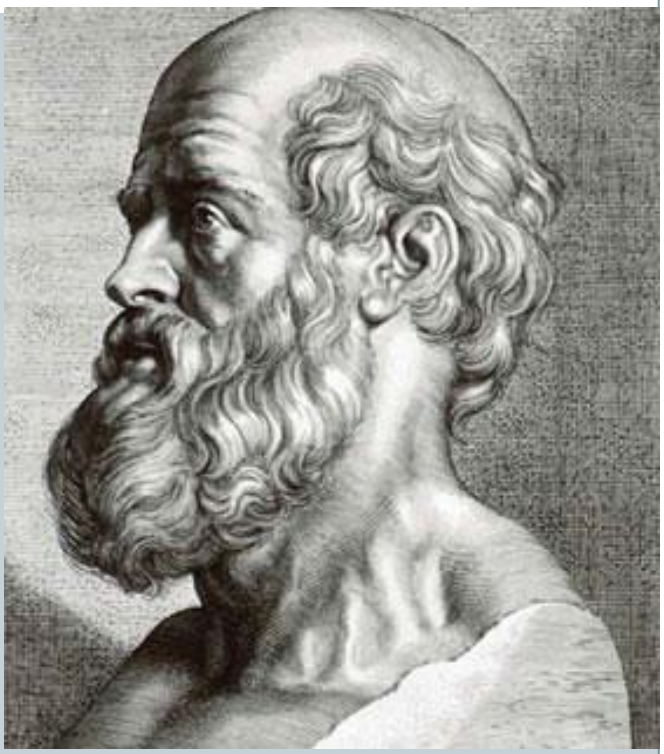
V.e. A third solution



Physician Responsibility

ii. Various Physician oaths

- The Oath of Hippocrates of Kos, 5th century BC
- Declaration of Geneva of the World Medical Association
- An Oath that "Bears the Name of Hippocrates"
- American Medical Association Code of Ethics (post-1980)



iii. Responsibilities in the Hippocratic Oath

- I swear to fulfill, to the best of my ability and judgment, this covenant:...
- I will respect the hard-won scientific gains of those physicians in whose steps I walk, and gladly share such knowledge as is mine with those who are to follow.
- I will apply, for the benefit of the sick, all measures which are required, avoiding those twin traps of overtreatment and therapeutic nihilism.
- I will remember that there is art to medicine as well as science, and that warmth, sympathy, and understanding may outweigh the surgeon's knife or the chemist's drug.
- I will not be ashamed to say "I know not," nor will I fail to call in my colleagues when the skills of another are needed for a patient's recovery.
- I will respect the privacy of my patients, for their problems are not disclosed to me that the world may know. Most especially must I tread with care in matters of life and death. Above all, I must not play at God.
- I will remember that I do not treat a fever chart, a cancerous growth, but a sick human being, whose illness may affect the person's family and economic stability. My responsibility includes these related problems, if I am to care adequately for the sick.
- I will prevent disease whenever I can but I will always look for a path to a cure for all diseases.
- I will remember that I remain a member of society, with special obligations to all my fellow human beings, those sound of mind and body as well as the infirm.
- If I do not violate this oath, may I enjoy life and art, respected while I live and remembered with affection thereafter. May I always act so as to preserve the finest traditions of my calling and may I long experience the joy of healing those who seek my help.

iv. Suggested additions to the oath

1. The responsibility of health care expenses sharing
2. Responsibility of spread of new medical technology

- "We are **Doctors Without Borders**/Médecins Sans Frontières (**MSF**). We help people worldwide where the need is greatest, delivering emergency **medical** aid to people affected by conflict, epidemics, disasters, or exclusion from health care"
- Founded: December 20, 1971, Paris, France
- Headquarters: Geneva, Switzerland
- Number of employees: 36,482


HEART INSTITUTE

THANK YOU