

# **BIOMEDICAL BIBLIOMETRICS: VOLUME AND QUALITY OF RESEARCH IN DIFFERENT FIELDS**

**Nordic seminar on databases and analysis  
Göteborg, 14 December 2009**

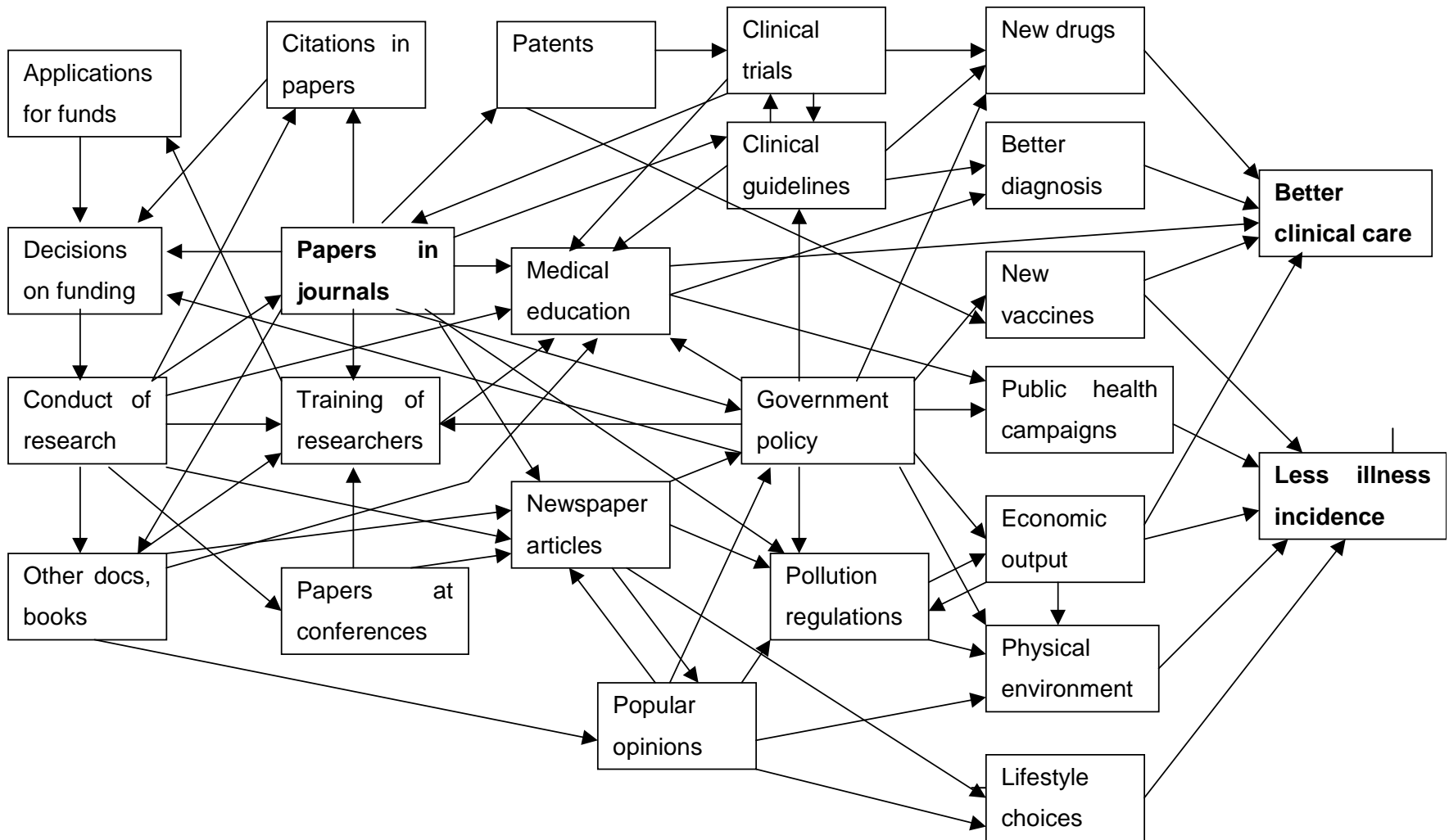
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# SYNOPSIS OF PRESENTATION

- **Putting biomedical research into practice**
- **Measures of research output – total and distribution – GDP and the burden of disease**
- **Measures of research “quality” – citation counts and their problems**
- **Citations on clinical guidelines**
- **Citations in the mass media**
- **Conclusions**

# PUTTING RESEARCH INTO PRACTICE (I)

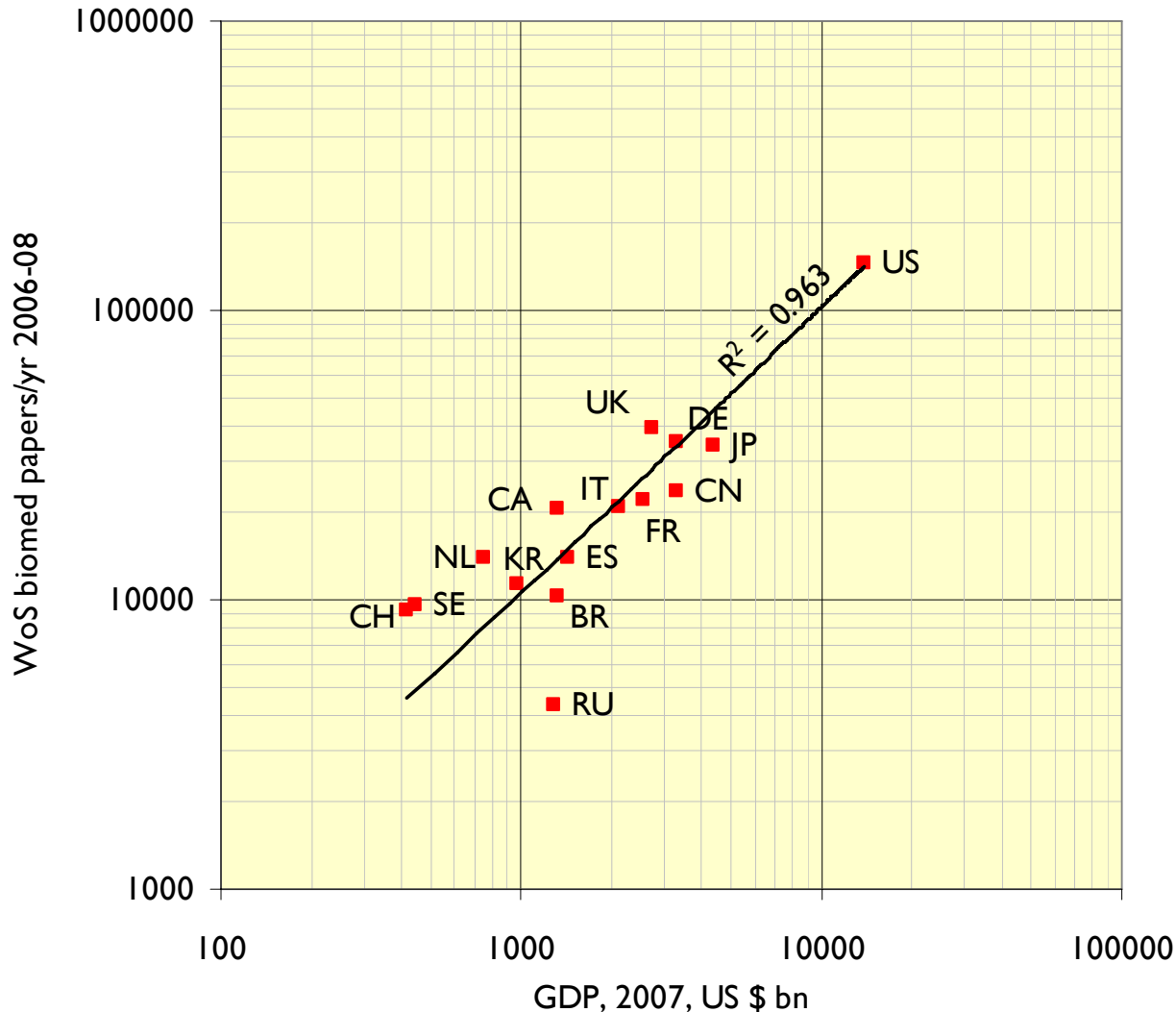


## **PUTTING RESEARCH INTO PRACTICE (2)**

- many different inputs to any given new medical practice, preventive measure or commercial innovation
- very hard to identify the amount of credit to be given to any single piece of research
- basic research has a long payoff time (perhaps decades) and benefit may be in unexpected areas
- but clinical work is often under-valued by conventional measures of esteem
- government plays a central role in shaping the process
- public reactions and mass media also play a role

# MEASURES OF RESEARCH OUTPUT (I)

## Biomedical research outputs correlate closely with GDP

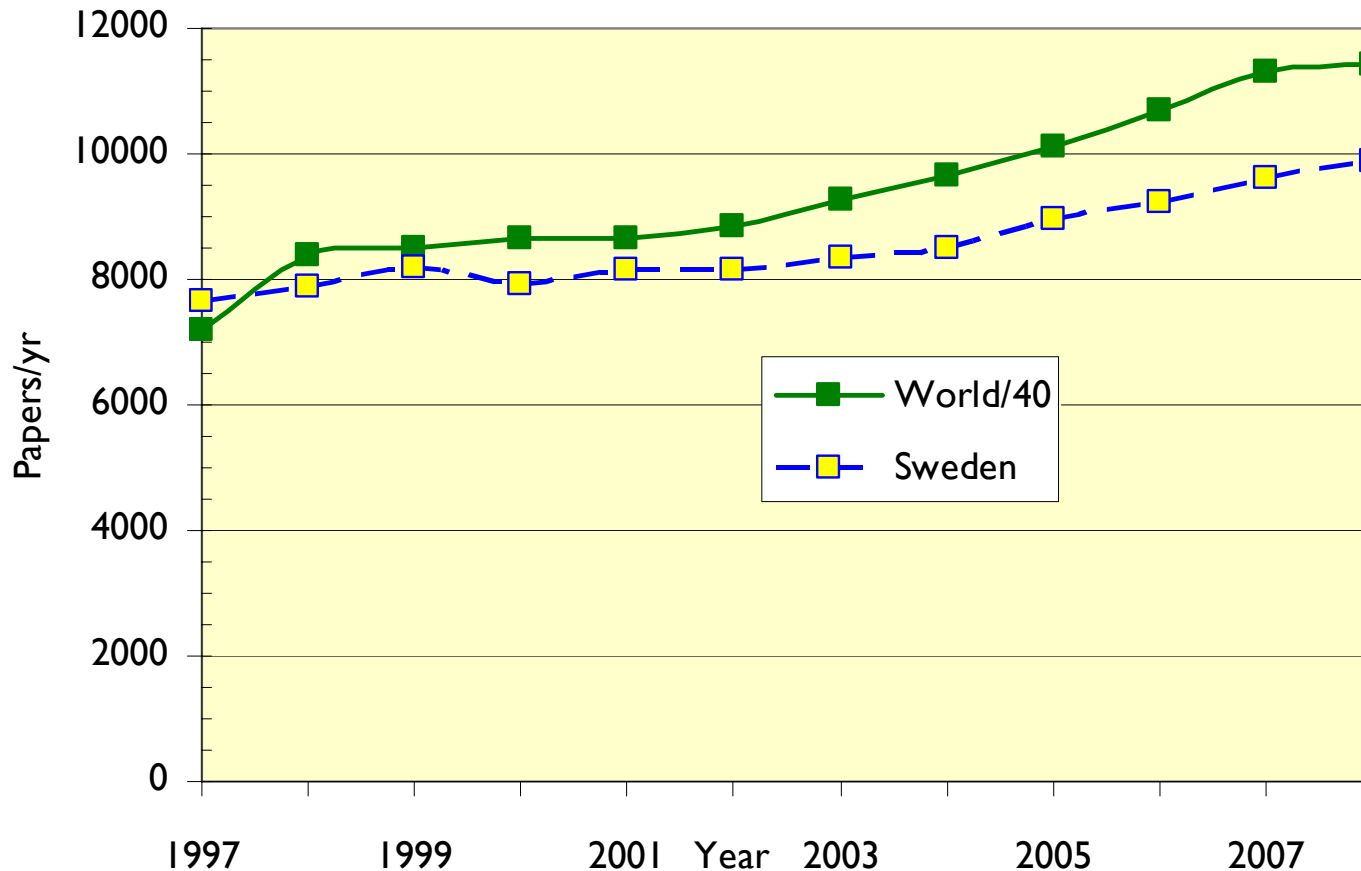


Log-log scale shows good correlation, with SE (Sweden) and CH (Switzerland) doing about twice as much biomedical research as would be expected for their wealth

*Biomedical research defined by multiple address words, e.g., ALLERG\*, BIOCHEM, CHILD, DIABET, EYE, FAMILY, GENET, etc.*

# MEASURES OF RESEARCH OUTPUT (2)

## Has Swedish biomedical research output been growing?



Yes, slowly, but not as fast as the world average. SE presence on integer count decreased from 2.7% in 1997 to 2.2% in last few years. But does this matter when it is already so large?

# MEASURES OF RESEARCH OUTPUT (3)

- how does Sweden's biomedical research portfolio compare with its disease burden?
- burden can be measured in deaths or DALYs – WHO data for 2002 and 2004 for all countries
- absolute performance: compare % of biomedical output in a disease area with % of disease burden
- relative performance: compare SE relative commitment to research in an area to SE disease burden wrt the world (or OECD member states)
- if a subject area appears under- (or over-) researched on both measures, then may need corrective action

# MEASURES OF RESEARCH OUTPUT (4)

## WHO DALY estimates for world and SE for 2004

Condition	SE	%	Wld	%	SE ratio
Total DALYs, k	1033		1521022		
Population, m	9.0		6425		
DALYs/caput	0.12		0.24		
<b>I Communicable, maternal, nutrit.</b>	<b>43</b>	<b>4.2</b>	<b>603464</b>	<b>39.7</b>	<b>0.10</b>
Poliomyelitis	0.14	0.0	34	0.0	6.00
<b>II Non-communicable</b>	<b>915</b>	<b>88.6</b>	<b>730346</b>	<b>48.0</b>	<b>1.84</b>
<b>III Injuries</b>	<b>75</b>	<b>7.3</b>	<b>187212</b>	<b>12.3</b>	<b>0.59</b>
Self-inflicted	23	2.2	19546	1.3	1.73
Road traffic accidents	16	1.5	41140	2.7	0.57

Sweden is very healthy, but relatively high incidence of polio and self-inflicted injuries; low rate of road traffic accidents

# MEASURES OF RESEARCH OUTPUT (5)

## Non-communicable diseases and disorders

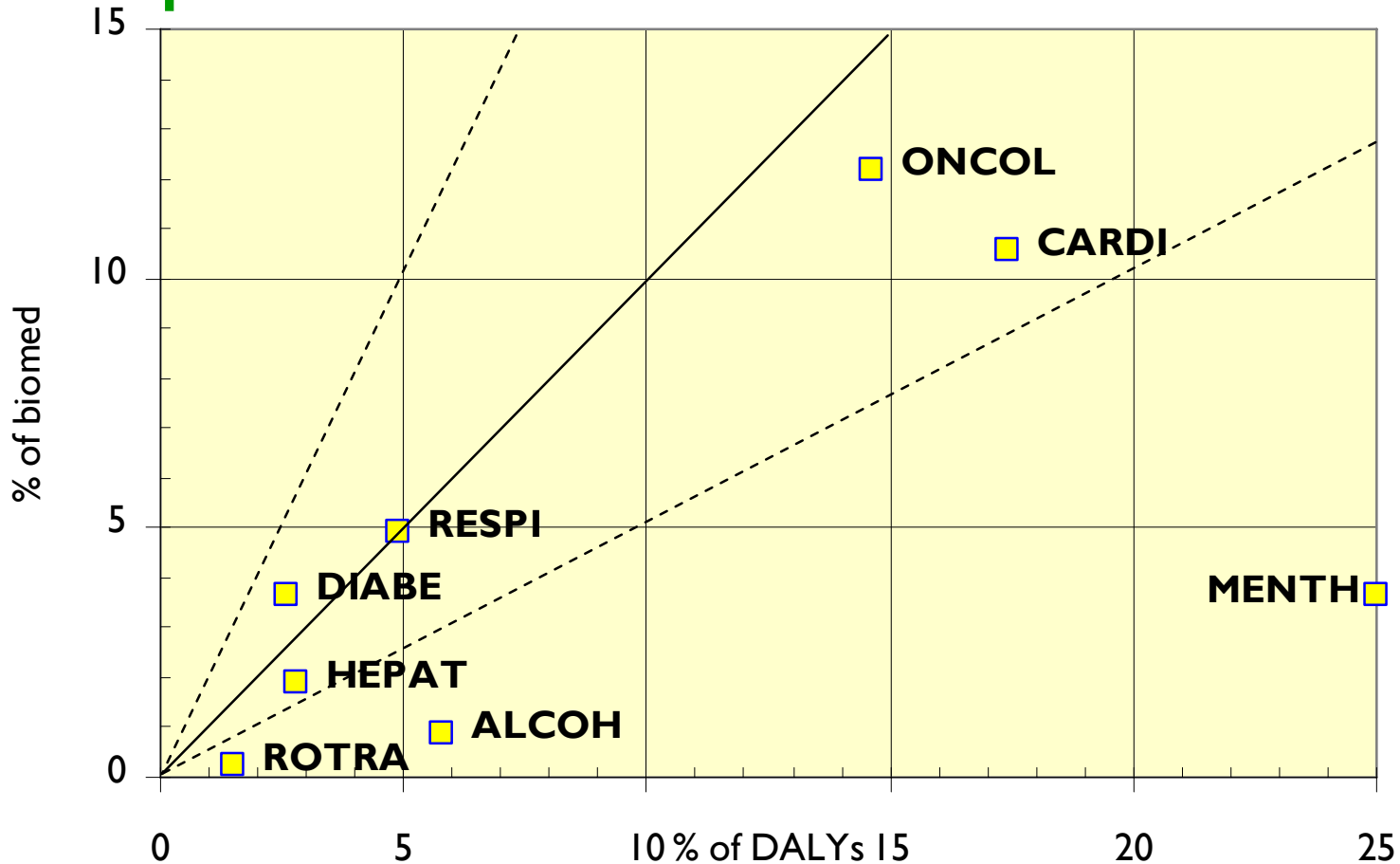
<i>Condition</i>	<i>SE</i>	<i>%</i>	<i>Wld</i>	<i>%</i>	<i>SE ratio</i>
<b>II Non-communicable</b>	<b>915</b>	<b>88.6</b>	<b>730346</b>	<b>48.0</b>	<b>1.84</b>
Mental disorders	258	25.0	158856	10.4	2.39
Depression	90	8.7	65363	4.3	2.03
Alcohol use	60	5.8	23731	1.6	3.72
Dementias	53	5.1	11135	0.7	7.01
Cardiovascular	180	17.4	151133	9.9	1.75
Cancer	151	14.6	77699	5.1	2.86
Sense organ diseases	84	8.1	86745	5.7	1.43
Respiratory diseases	51	4.9	58946	3.9	1.27
Musculoskeletal disorders	48	4.6	30811	2.0	2.29
Digestive disorders	29	2.8	42430	2.8	1.01
Diabetes mellitus	27	2.6	19651	1.3	2.02

# MEASURES OF RESEARCH OUTPUT (6)

- definition of sub-fields > creation of “filters” to identify papers in WoS
- these are based on specialist journals and title words and are calibrated to give precision and recall
- about 100 filters have been defined for most disease areas (e.g., cancer) and body parts (e.g., liver, kidney)
- for most sub-fields, large majority of papers are **NOT** in specialist journals
- disease-specific charities’ papers are typically only two thirds within their sub-field (others basic biology)

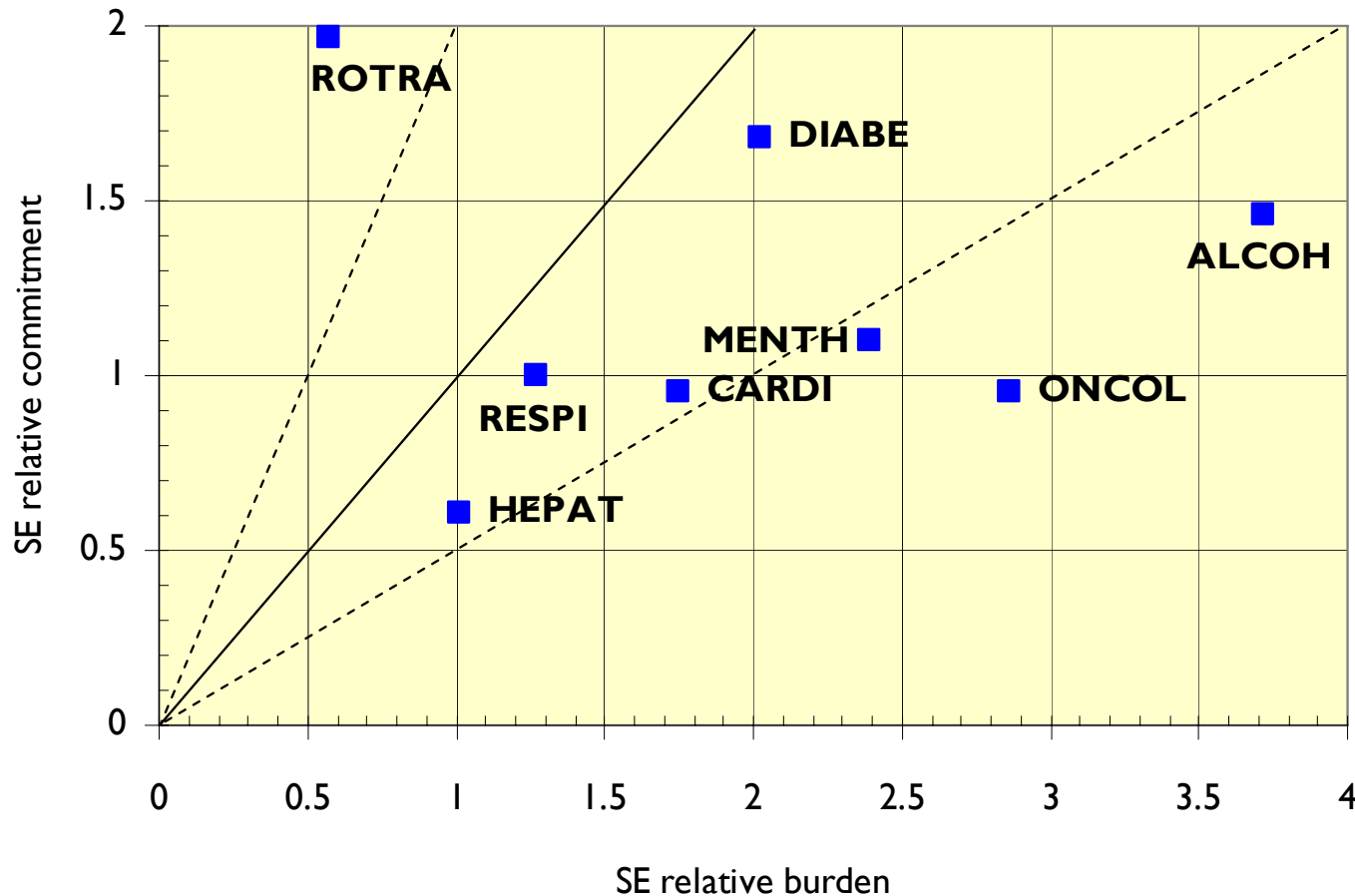
# MEASURES OF RESEARCH OUTPUT (7)

absolute performance: % of DALYs and % of biomed output



# MEASURES OF RESEARCH OUTPUT (8)

relative performance: rel. burden and RC to sub-field



Under-researched sub-fields are ALCOH, MENTH and CARDI on both criteria; ONCOL on relative perf. and ROTRA on absolute perf.

# MEASURES OF “QUALITY” (I)

- traditional measure is citations on other papers – still useful, but needs care: constant time window, and preferably based on fractional address counts, = **actual citation impact, ACI**
- can also use journal citation score (average for all papers), based on editors’ selection of papers, = **potential citation impact, PCI**
- % of papers receiving enough cites to put them in **top 5%, 10% or 20% of world = world-scale values**
- new measure, % of reviews, shows esteem in which **senior researchers are held by editors**

## MEASURES OF “QUALITY” (2)

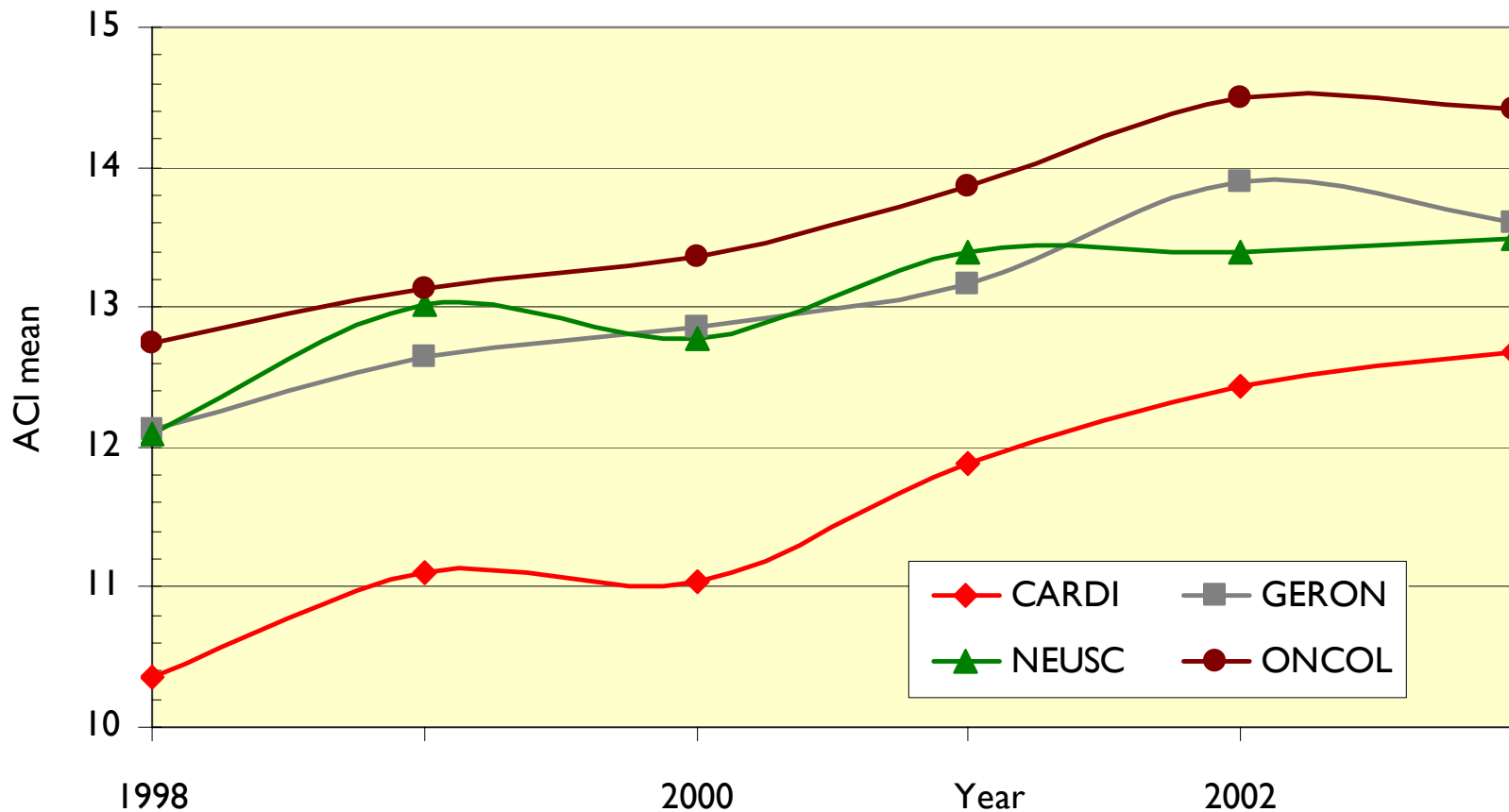
- **transnational collaboration, especially with US and leading European countries, shows visibility**
- **putting research into clinical practice measured from citations on clinical guidelines (even from UK)**
- **influence on medical education measured from citations in textbooks**
- **influence on the public from citations in the mass media (newspapers, broadcasters: example: BBC)**
- **influence on other researchers by publishing in highly visible and useful journals**

## MEASURES OF “QUALITY” (3)

- multiple indicators are needed to show different aspects of research output
- comparisons can be with totality of own country or with world standard (though this could be low)
- may need to take account of research level of papers as clinical ones usually less cited than basic, but not on clinical guidelines
- may also need to take account of subject area within sub-field (e.g., cancer manifestation) or approach to subject (e.g., epidemiology, diagnosis, treatment, prognosis, palliation)

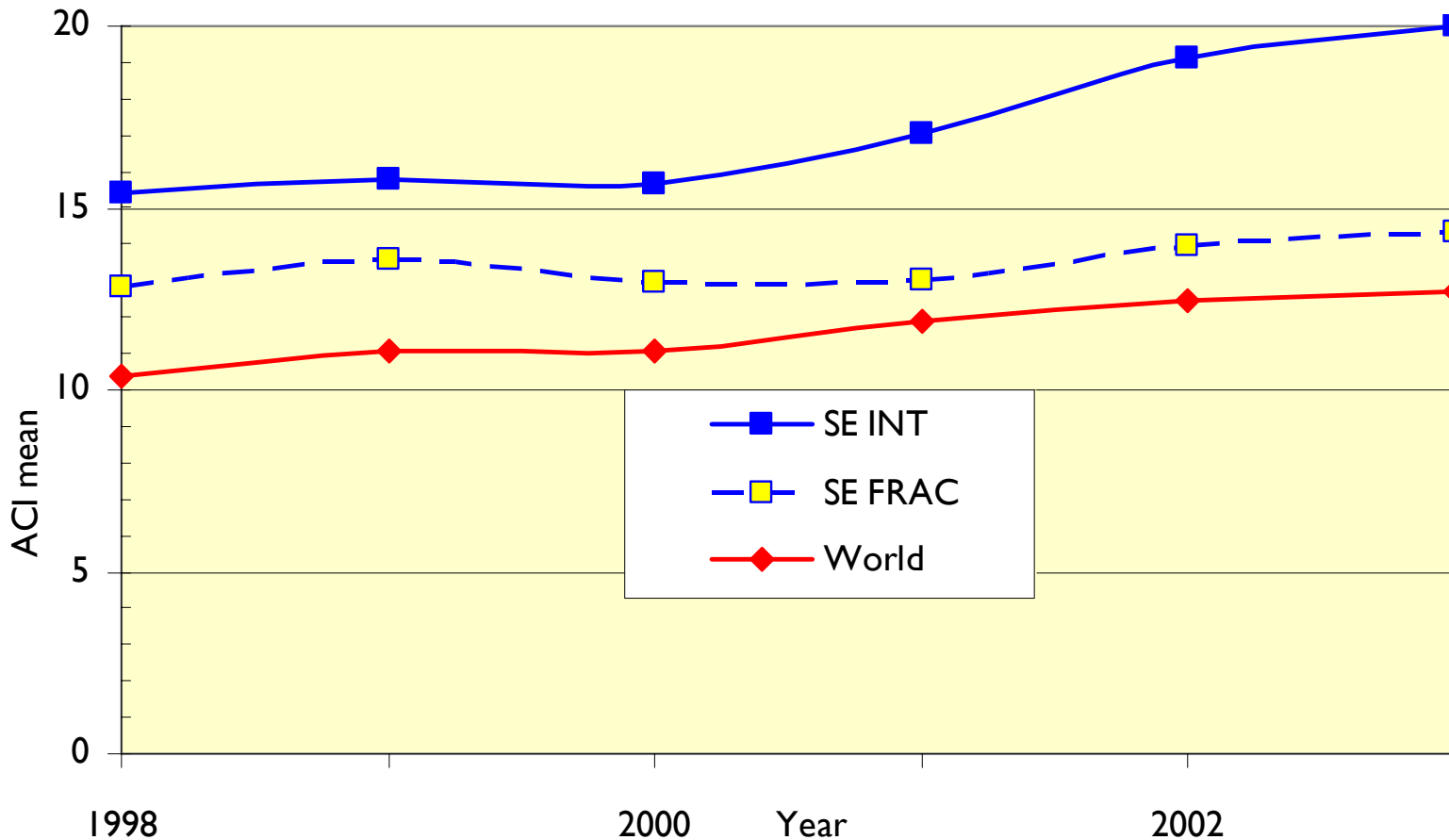
# MEASURES OF “QUALITY” (4)

Five-year citation scores (ACI) for world papers in four sub-fields (cardiology, gerontology, neuroscience, cancer) show a fairly steady increase with time



# MEASURES OF “QUALITY” (5)

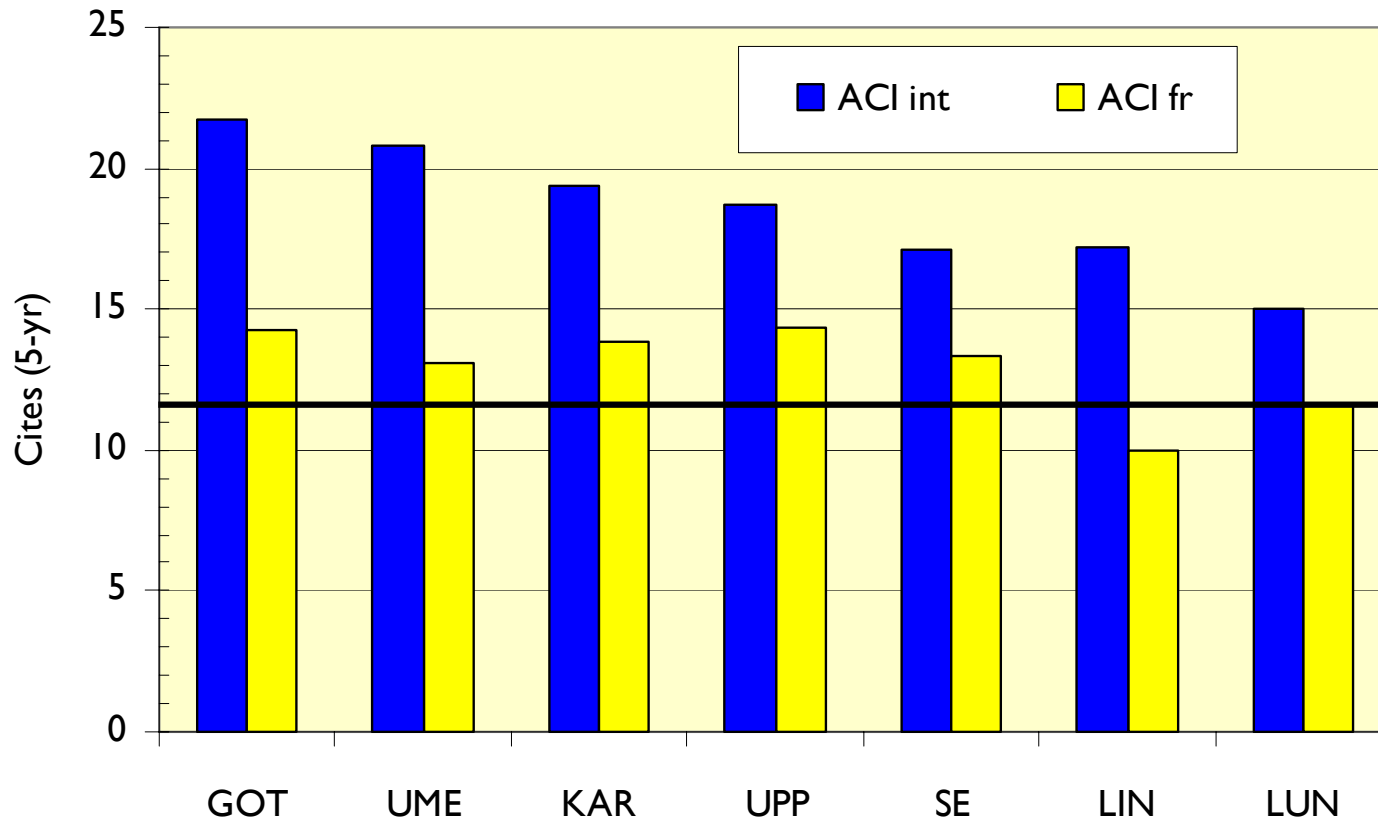
## ACI for cardiology papers, world and Sweden



On integer count basis, SE is improving but this is not so on a fractional count basis, although it is still 16% better than world average.

# MEASURES OF “QUALITY” (6)

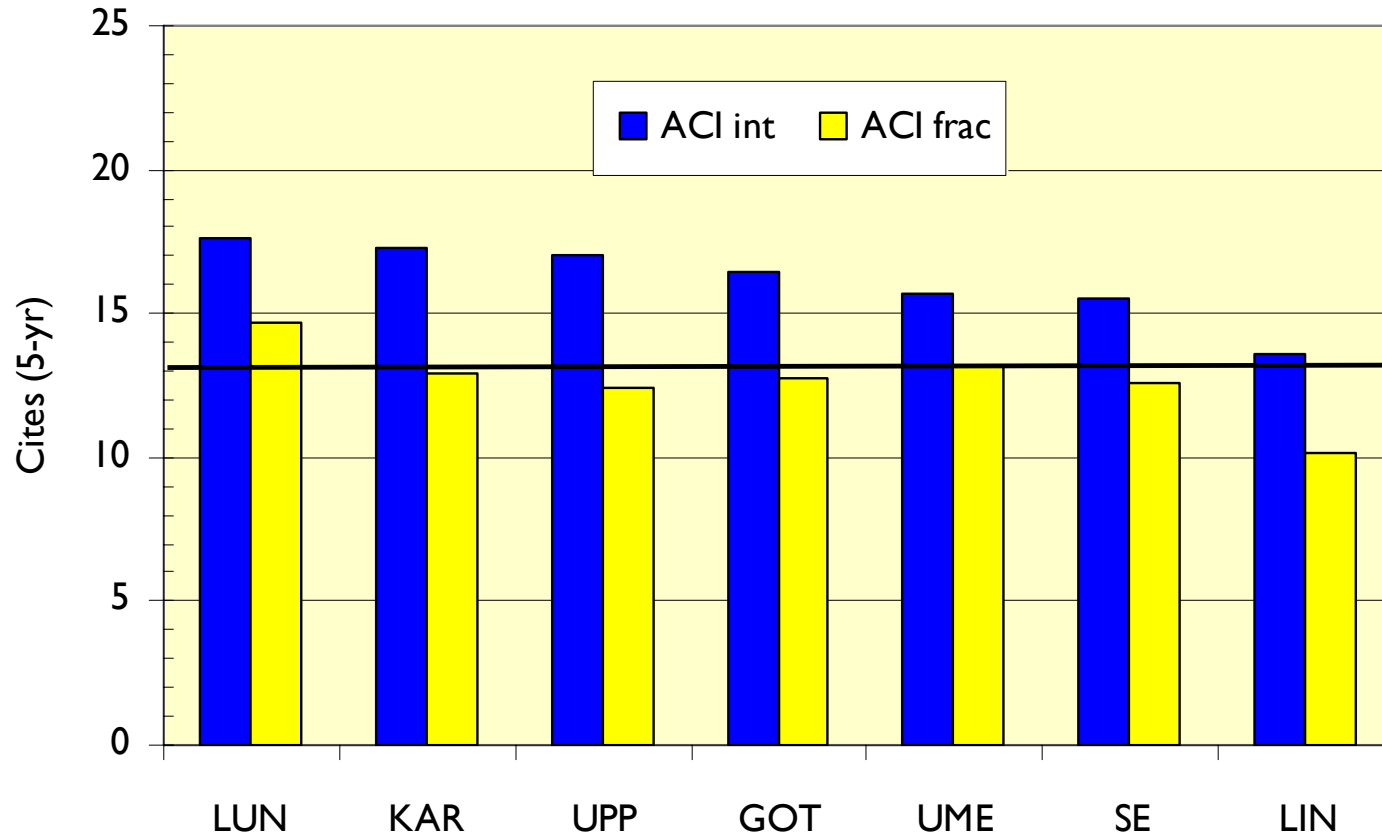
## ACI for cardiology 1997-2004, six SE med. schools



All six well above world avg (=11.6 cites) on int ct basis, and all but Linköping also on frac ct basis

# MEASURES OF “QUALITY” (7)

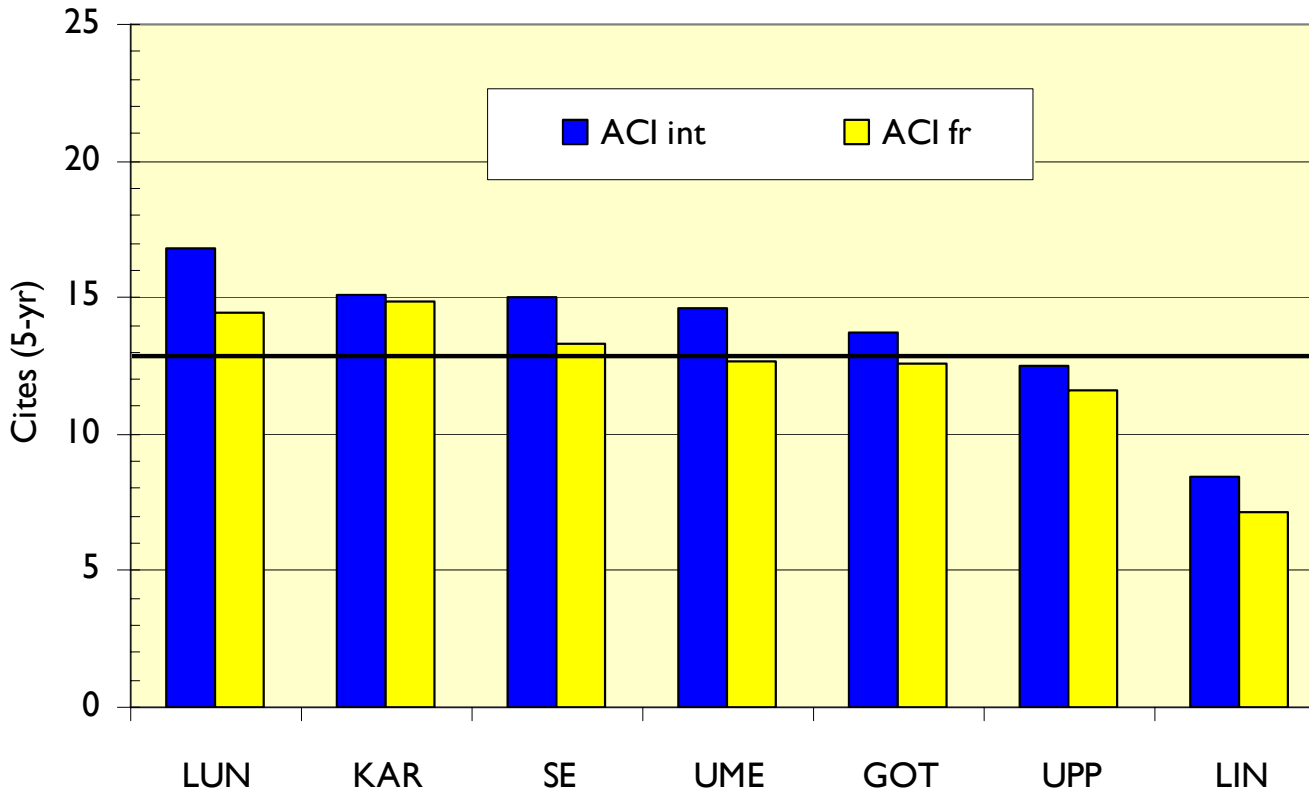
## ACI for gerontology 1997-2004, six SE med. schools



Less variation in ACI int than in CARDI; only Lund > world avg (13.1 cites) on frac ct basis – *cf.* its performance with that in CARDI where it was low

# MEASURES OF “QUALITY” (8)

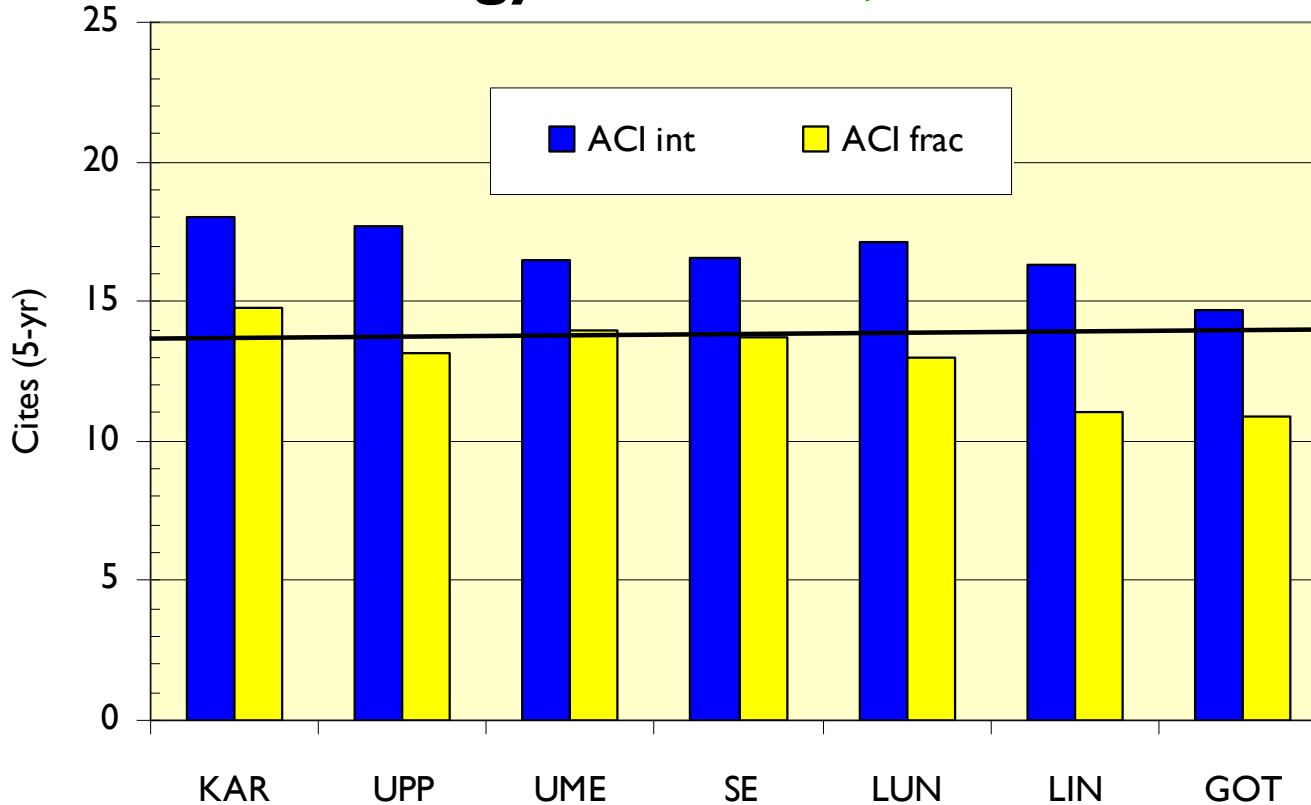
## ACI for neuroscience 1997-2004, six SE med. schools



World level = 13.0 cites; Lund scores highest overall but Karolinska highest on fractional count basis; Linköping output small and not well cited

# MEASURES OF “QUALITY” (9)

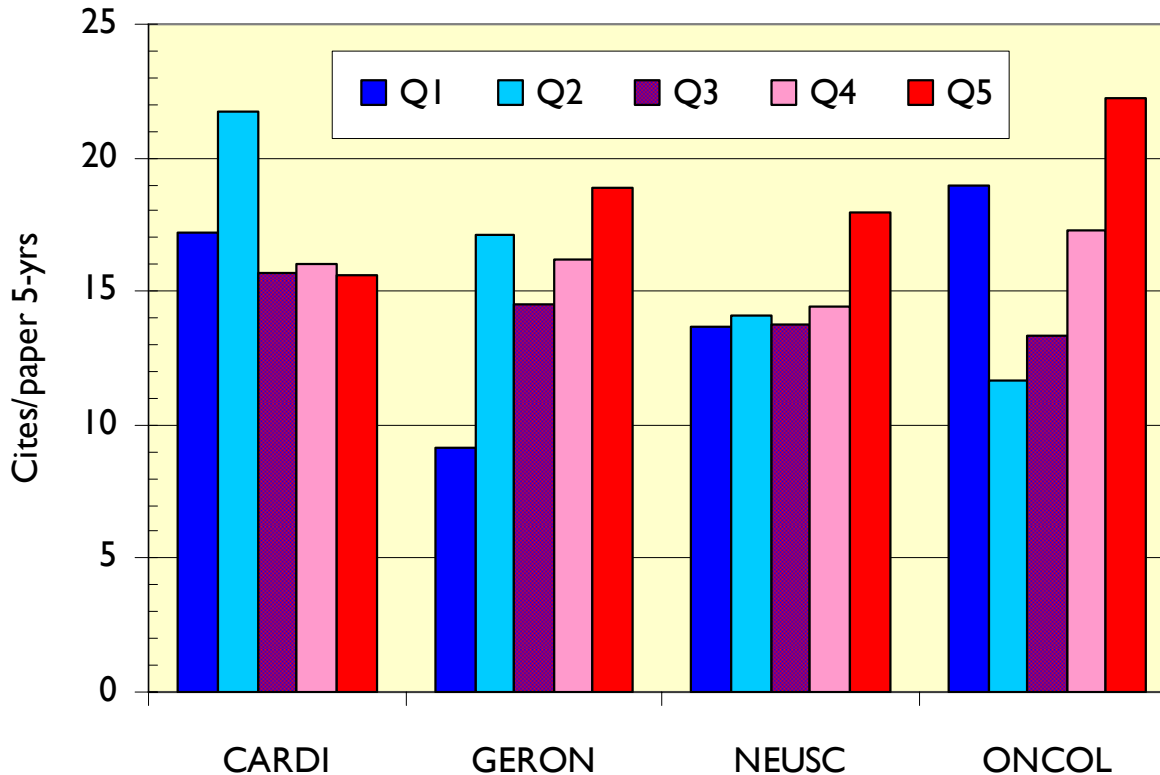
## ACI for oncology 1997-2004, six SE med. schools



All are > world level of 13.7 cites/paper on int. cts but Linköping and Göteborg are well below this level on frac. cts.

# MEASURES OF “QUALITY” (10)

ACI depends on the RL of the papers .....

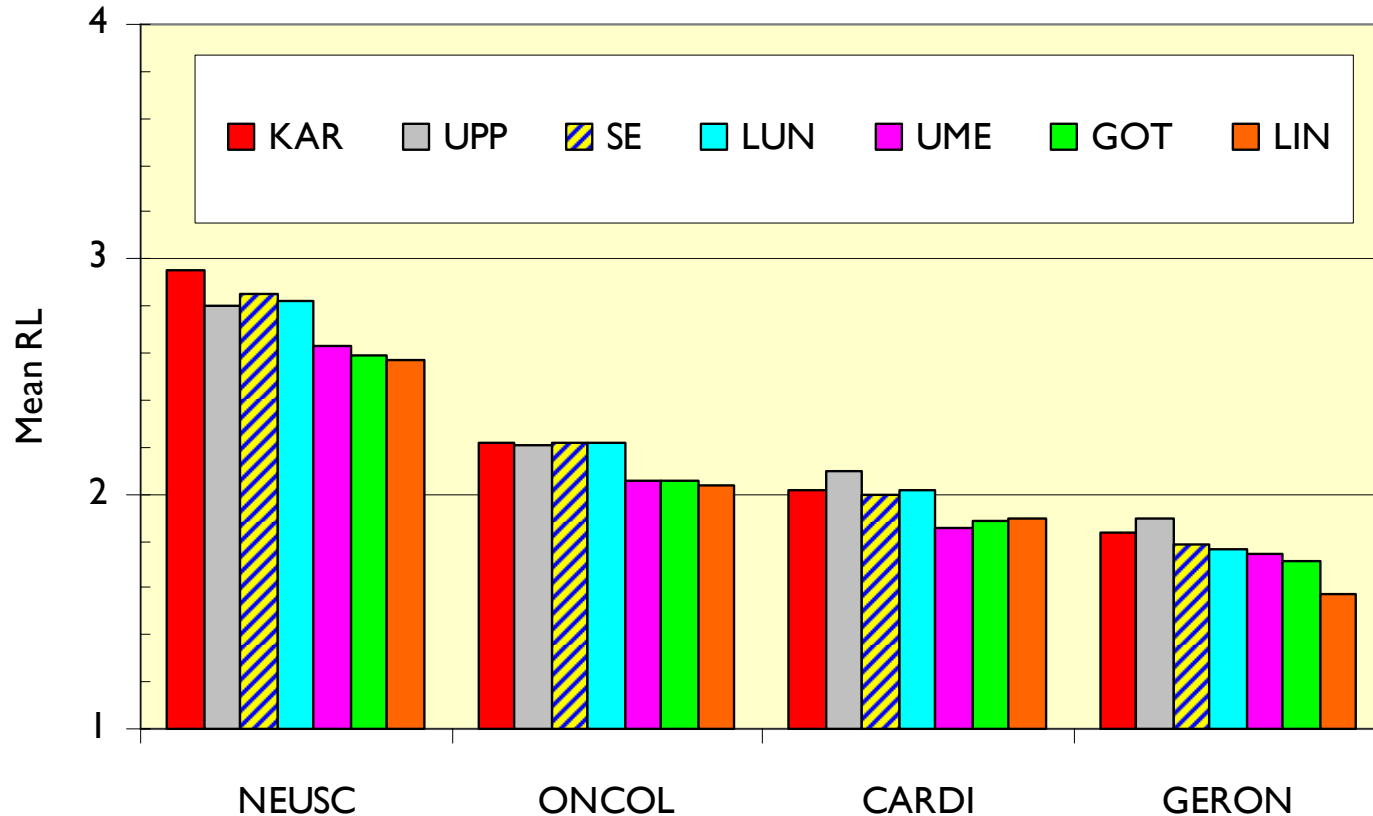


Papers with RL are divided into five quintiles: Q1 is the most clinical and Q5 the most basic.

Except for CARDI, in other sub-fields basic papers (Q5) are most cited, and clinical ones (Q1 and Q2) are less cited. This may affect ACI scores for the medical schools as some do more clinical, and some more basic, work

# MEASURES OF “QUALITY” (II)

...and the different schools vary in their mean RL



RL1 = clinical; RL4 = basic. Karolinska and Uppsala the most basic and Göteborg and Linköping the most clinical in most sub-fields

# MEASURES OF “QUALITY” (12)

## Percentage of reviews in four biomedical sub-fields

	<i>CARDI</i>	<i>GERON</i>	<i>NEUSC</i>	<i>ONCOL</i>
<b>SWEDEN</b>	<b>0.74</b>	<b>0.62</b>	<b>0.83</b>	<b>0.68</b>
<b>Göteborg</b>	<b>0.63</b>	<b>0.49</b>	<b>0.94</b>	<b>0.48</b>
<b>Lund/Malmö</b>	<b>0.69</b>	<b>0.58</b>	<b>0.87</b>	<b>0.54</b>
<b>Uppsala</b>	<b>0.82</b>	<b>0.51</b>	<b>0.79</b>	<b>0.76</b>
<b>Karolinska</b>	<b>0.70</b>	<b>0.69</b>	<b>0.85</b>	<b>0.75</b>
<b>Linköping</b>	<b>0.58</b>	<b>0.55</b>	<b>0.63</b>	<b>0.40</b>
<b>Umeå</b>	<b>0.26</b>	<b>0.37</b>	<b>0.52</b>	<b>0.41</b>
<b>Other</b>	<b>0.85</b>	<b>0.73</b>	<b>0.95</b>	<b>0.74</b>

Ratios to world mean values for 1997-2008 (respectively 6.1%, 7.8%, 6.8% and 8.1%). Values below 0.5 tinted rose, values below 0.71 tinted yellow.

# MEASURES OF “QUALITY” (13)

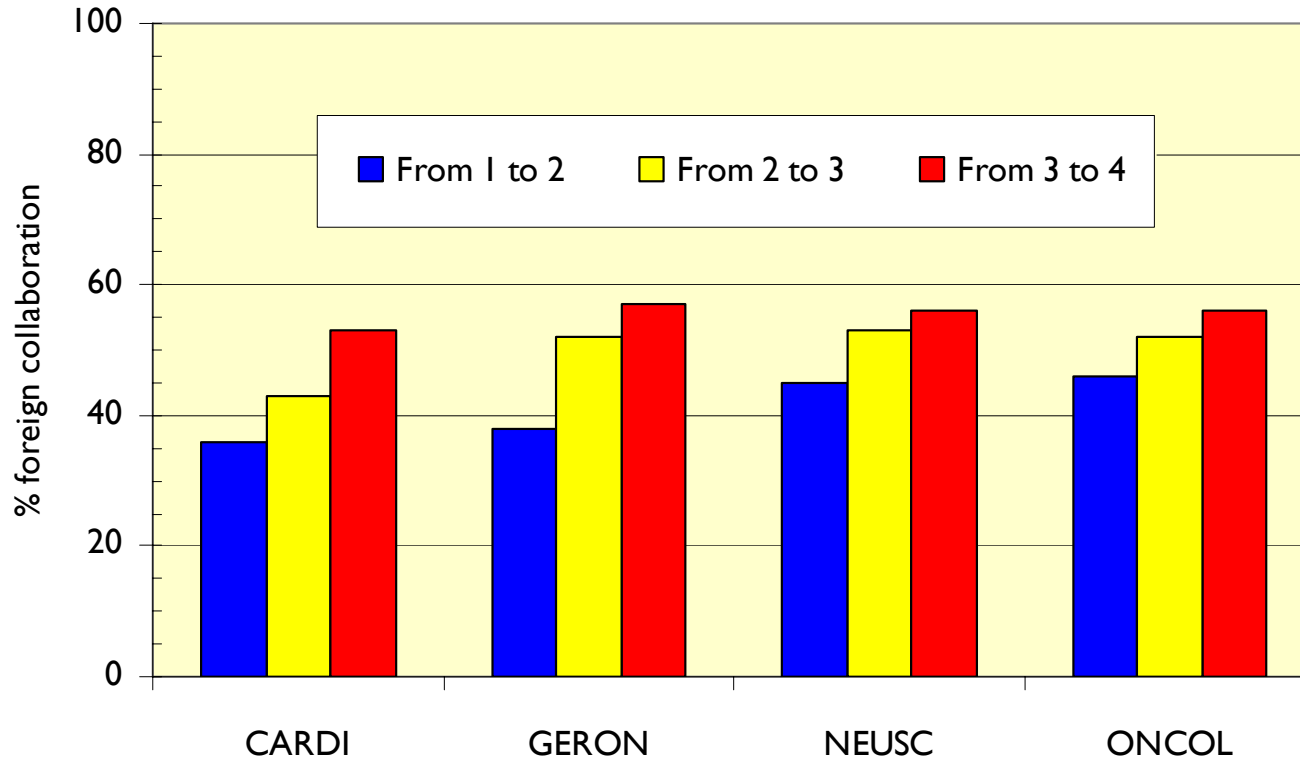
## Percentage of foreign collaboration in 4 sub-fields

	<i>CARDI</i>	<i>GERON</i>	<i>NEUSC</i>	<i>ONCOL</i>
<b>SWEDEN</b>	<b>40</b>	<b>42</b>	<b>53</b>	<b>50</b>
<b>Göteborg</b>	<b>43</b>	<b>39</b>	<b>43</b>	<b>43</b>
<b>Lund/Malmo</b>	<b>37</b>	<b>43</b>	<b>48</b>	<b>53</b>
<b>Uppsala</b>	<b>38</b>	<b>38</b>	<b>49</b>	<b>44</b>
<b>Karolinska</b>	<b>40</b>	<b>48</b>	<b>58</b>	<b>53</b>
<b>Linköping</b>	<b>27</b>	<b>27</b>	<b>32</b>	<b>38</b>
<b>Umea</b>	<b>34</b>	<b>33</b>	<b>47</b>	<b>45</b>
<b>Other</b>	<b>56</b>	<b>46</b>	<b>60</b>	<b>56</b>

“Other” and Karolinska collaborate the most, except for Göteborg in cardiology. Linköping trails in all four sub-fields.

# MEASURES OF “QUALITY” (14)

...but % foreign collaboration increases with RL



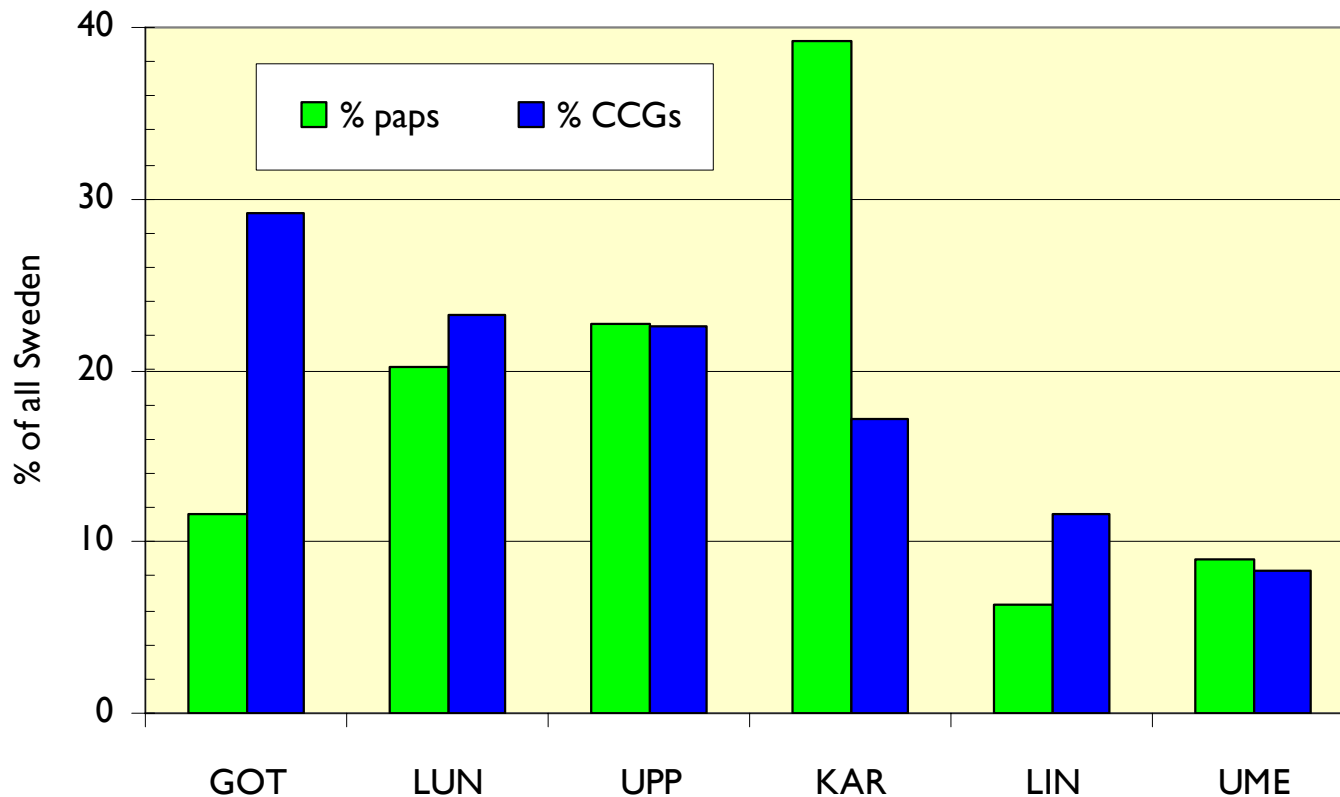
RL1 = clinical; RL4 = basic. Trend is uniform for all four sub-fields

# CITATIONS ON CLINICAL GUIDELINES (I)

- guidelines are increasingly popular, especially in Europe and Canada where health is mostly paid by state
- may be produced by professional bodies, by special institutes (on a national or regional basis), and by individual hospitals (e.g., in USA)
- usually a lot of references, mostly clinical, quite recent, with bias towards publishing country
- but sets of guidelines may nevertheless have enough citations to allow an evaluation of research in third countries

# CITATIONS ON CLINICAL GUIDELINES (2)

## UK cancer clinical guidelines citing SE med. schools



Cited papers mainly 1992-2001. Göteborg has 133 cites of 455 Swedish total but only 968 of 8351 Swedish papers and so performs much better than Karolinska on this measure

# CITATIONS IN THE MASS MEDIA (I)

- newspapers, radio and television show an increasing interest in medical research stories
- they are read, heard and seen by:
  - policy makers (politicians and senior officials)
  - health-care administrators and research trustees
  - medical staff (doctors, surgeons, nurses, AHPs)
  - biomedical researchers (paper by Phillips *et al.*)
  - general public and patient carers
- newspapers can be studied through own archives and commercial databases (e.g., Factiva)
- broadcasters often have searchable archives

# CITATIONS IN THE MASS MEDIA (2)

## BBC stories of cancer research

Story describes recent research (in the USA), and gives journal (*Cell*), location of researchers (MIT), and name of one of them (Eric Lander) so that paper can be identified from the journal archive (below). Also two commentators (from cancer charities)

**Identification of Selective Inhibitors of Cancer Stem Cells by High-Throughput Screening**  
*Cell*, 2009, Vol 138 (4), pp 645-659.

LIVE BBC NEWS CHANNEL

Page last updated at 11:23 GMT, Friday, 14 August 2009 12:23 UK

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### Drug 'attacks cancer stem cells'

A compound that appears to target the master cells which help breast cancers grow and spread has been discovered by US scientists.

In tests in mice, salinomycin killed breast cancer stem cells far more effectively than some existing drugs, and slowed tumour growth.

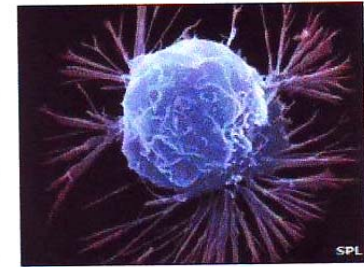
The drug, a farm antibiotic, has yet to be tested in humans, the journal *Cell* reports.

But UK experts warned a human version could be some years away.

The reasons why, even following powerful chemotherapy, some cancers can grow back, are not fully understood.

Many scientists believe a key role lies with stem cells, which can be resistant to conventional chemotherapy, remaining to 'seed' new tumours and drive their growth.

The drug's potential was identified by researchers at the Massachusetts Institute of Technology, who tested 16,000 existing chemical compounds against breast cancer stem cells in the laboratory.



Some 16,000 chemicals were tested by researchers

“ This is one of the biggest advances we have seen this year in this area of research ”

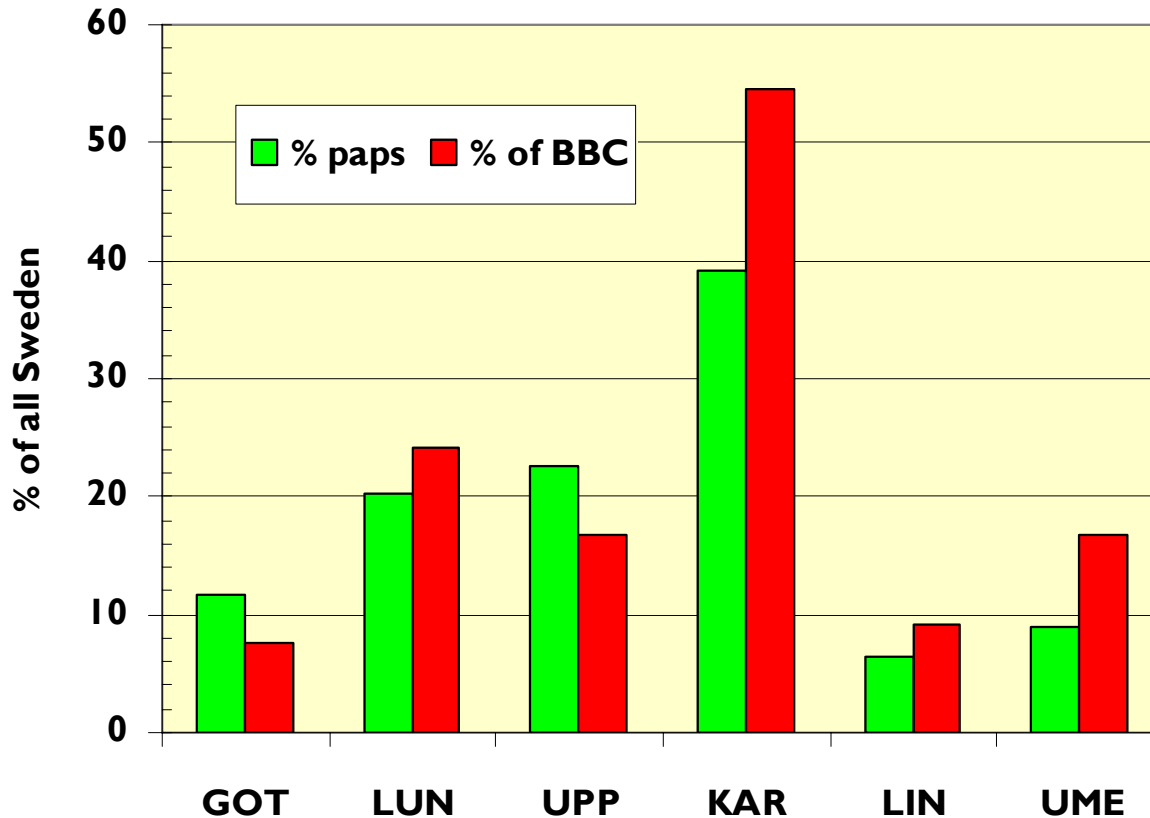
Dr John Stingl  
Cancer Research UK Cambridge Research Institute

## **CITATIONS IN THE MASS MEDIA (3)**

- **study of BBC's website for 10 years (1997-2006)**
- **about 260 stories/yr of which 170 reported research**
- **heavy focus on breast cancer compared to burden**
- **20% on new drugs and vaccines; very little on surgery**
- **most stories had commentators who put results in context – frequently from cancer charities**
- **cited papers from 60 countries, but UK over-cited x6**
- **US papers cited about fairly, but other countries were less cited, except for Sweden (66 cites)**

# CITATIONS IN THE MASS MEDIA (4)

## BBC cancer research stories citing SE med. schools



Citation rate is more nearly proportional to output, but on this measure Karolinska shows to advantage, as does Umea, both statistically significant at  $p < 5\%$

## CONCLUSIONS (I)

- **bibliometric measures can put both quantity and distribution of research in perspective wrt national wealth and burden of disease**
- **good estimates of disease burden are now available from the WHO for all countries and many disorders**
- **measures of “quality” or impact should not be confined to standard citations, and even these must be treated with great care to ensure fair comparisons**
- **multiple measures of “quality” should be determined and they may provide different messages**

## CONCLUSIONS (2)

- **new measures are needed to reflect the different ways that biomedical research is put into practice**
- **these require a data-gathering effort, and international co-ordination would be helpful to create a richer resource**
- **the mass media are of increasing importance as health-related research becomes of general and popular interest**
- **but bibliometrics should always be a complement to peer-review and be informed by expert knowledge**