



# Surveillance of nosocomial infections in ICU:

*results from the national surveillance network, 1997-2002*

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# Introduction

- National surveillance of nosocomial bacteremia and pneumonia in the ICU (in coll. with SIZ, since 1996)
  - objective: to provide standardized tool for inter-ICU comparison of infection rates and patient profiles
  - participation min. 3 months
  - patient-based surveillance: risk factors (at admission and day-by-day) for all ICU patients (infected and non-infected)
  - data entered on software in hospitals (Sinergiz/NSIHwin) and sent to IPH for analysis and feedback (benchmarking)

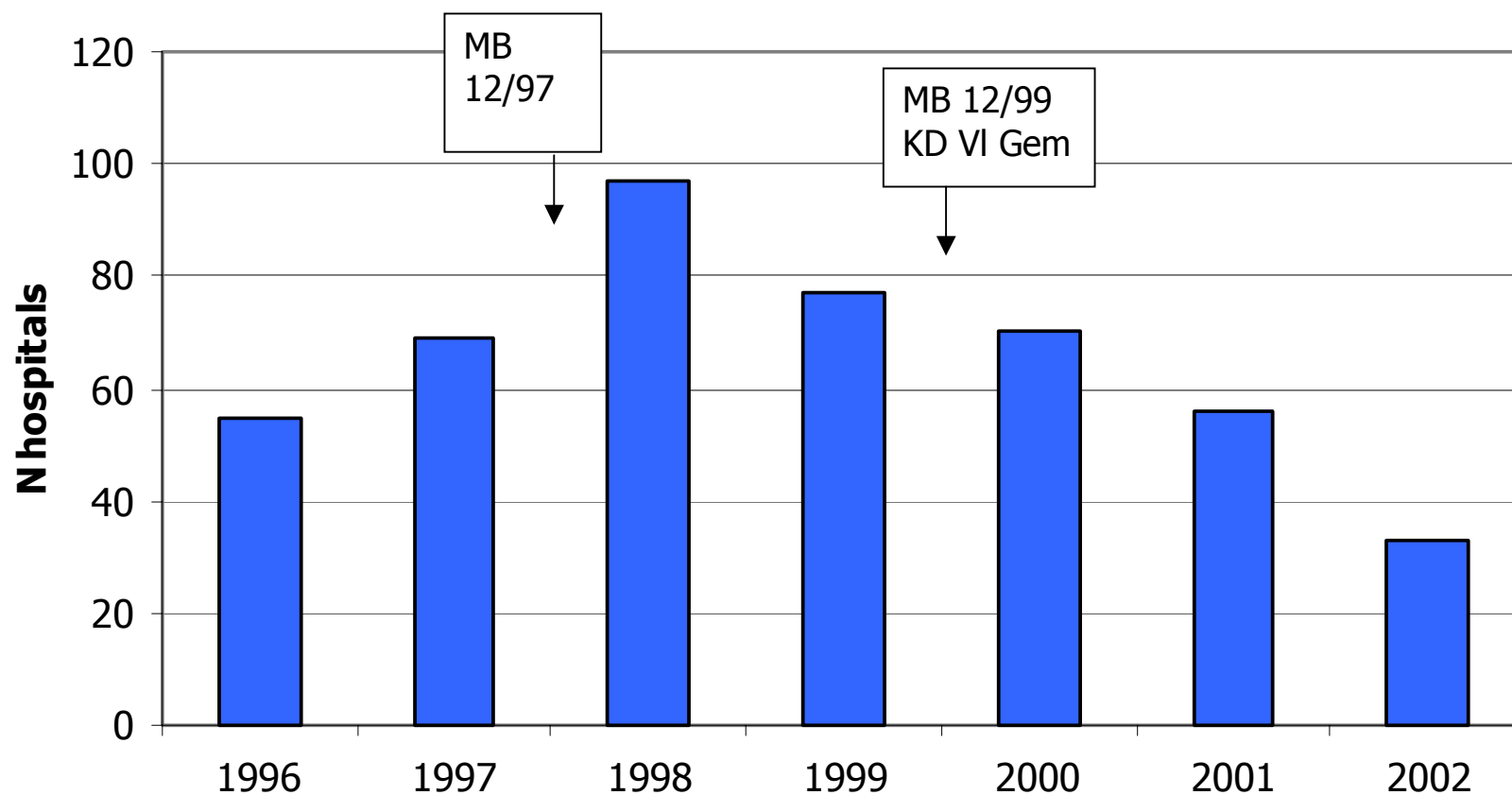
# Methods: case definitions

- Nosocomial = infection >2 days ICU-stay
- Pneumonia: major (treatment, pos RX, new purulent sputum) and other criteria
- Bacteremia : definition modified in 2000 because of Flemish KD (Coag.-neg. Staph.)
- Definition of « device-associated » infection: device use in 48 hours before onset

# Methods – data quality

- 16.8% of patients excluded from analysis:
  - < 50% of total infections had corresponding infection file (DBD + infection file)
  - Hospitals with quality score  $\leq$  P10
  - Quarters < 50 patients
  - Data input with test version NSIHwin 1.0.
  - Patients < 2 days ICU stay (=not at risk)
- ongoing validation study

# Participation to NSIH-ICU surveillance, 1997 - Sep 2002

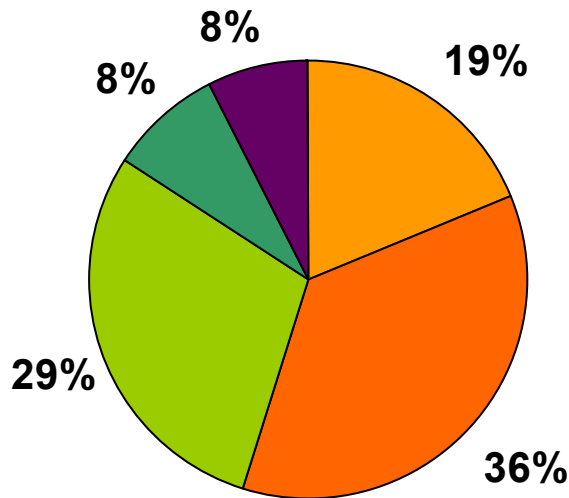


# Results- Description of patients (N=59.040, 94 hospitals)

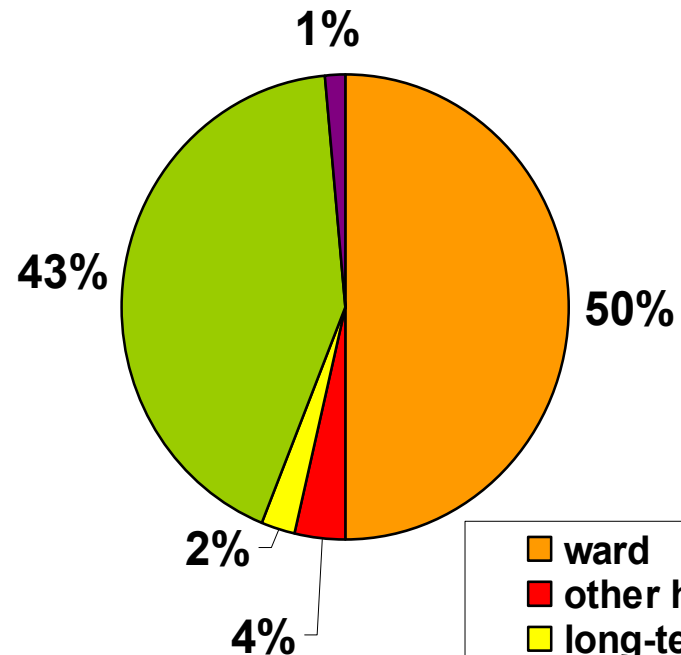
- Sex ratio M:F 1.4
- Mean age: M 64 y , F 68 y
- 8.2% deceased in ICU;
  - SAPS II < 20 : 0.6%
  - SAPS II ≥ 60 : 36.6%
- Mean LOS: 6.7 d (median 4 d)
- 8% stayed > 2 weeks

# Description of patients (2)

- Type of admission

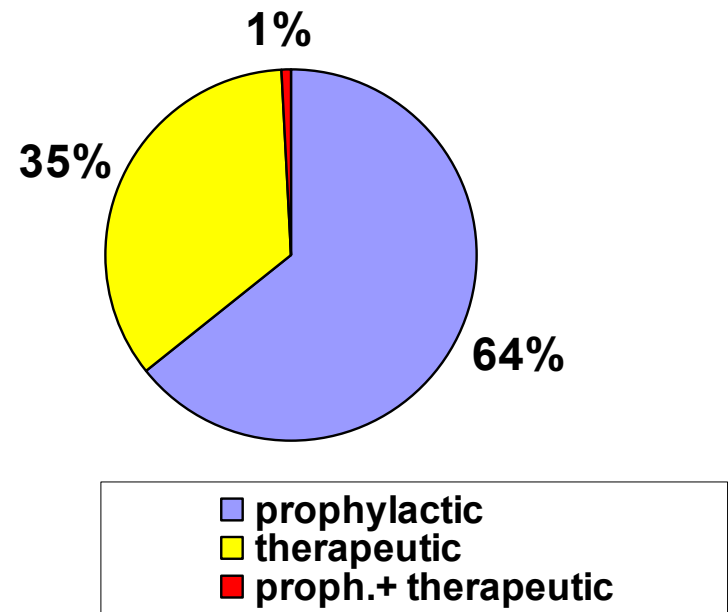
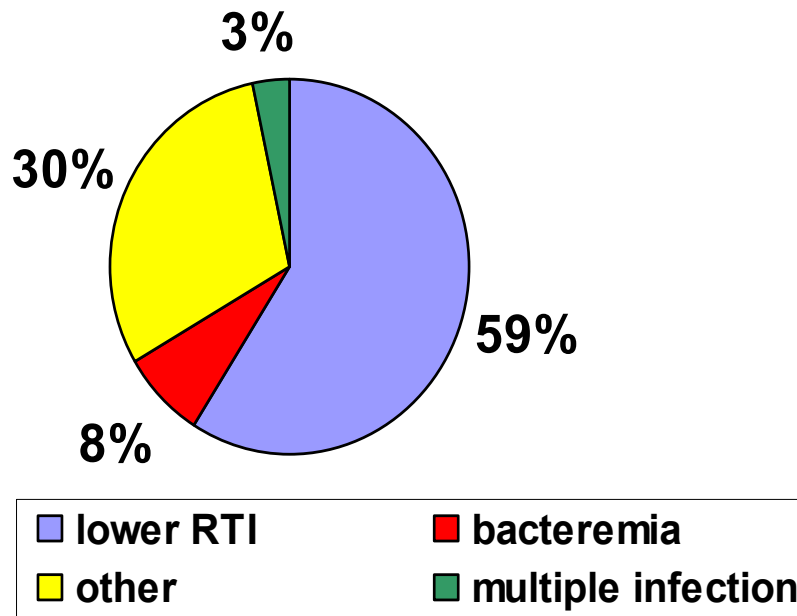


- Origin of patient



# Description of patients (3)

- Infection at entry (23%)
- AB at admission



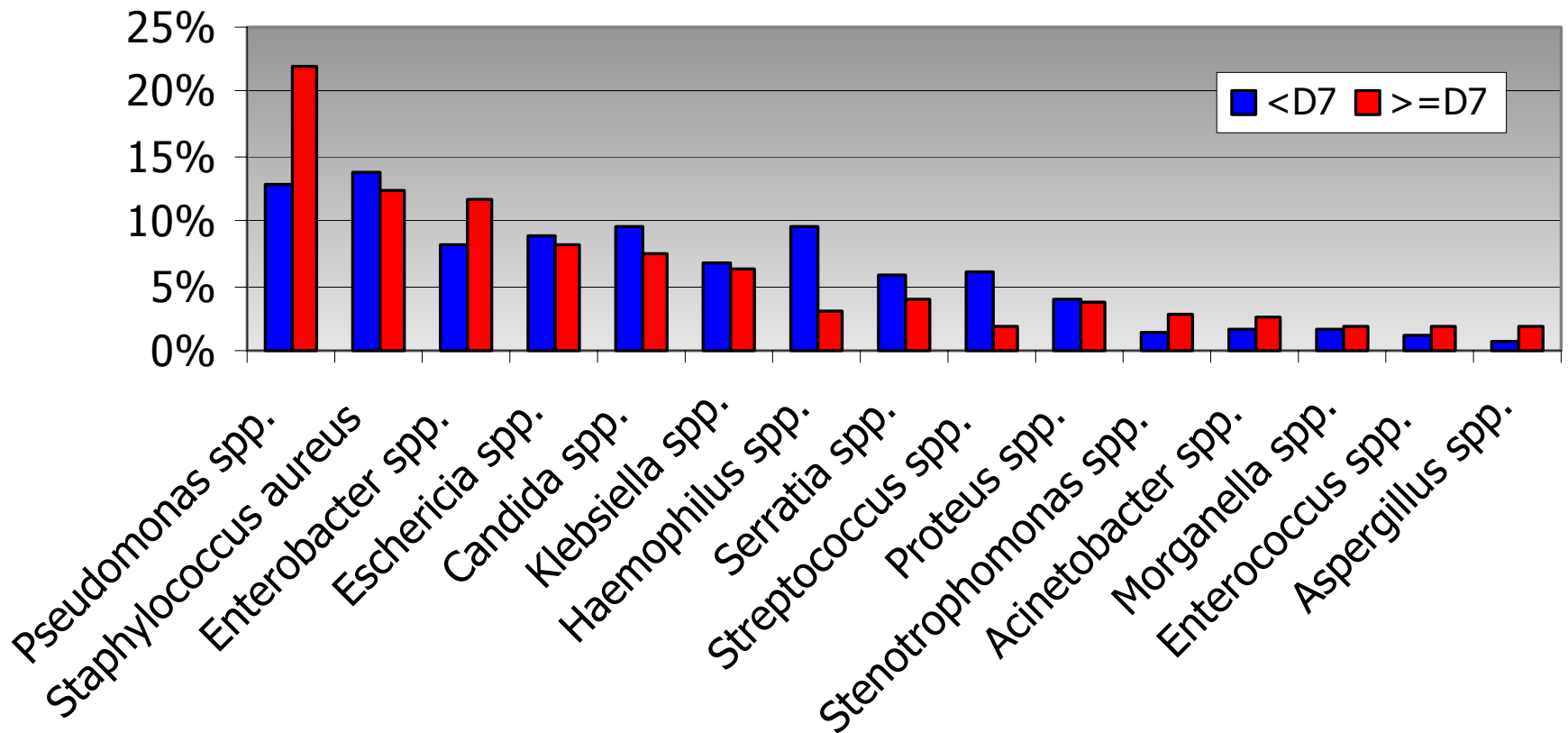
# Risk factors

- $\geq 1$  day central catheter: 65% (695 catheter days /1000 pd)
- $\geq 1$  day ventilation: 41% (352 invasive vent. days /1000 pd)
- AB Use in ICU :
  - Prophylactic : 35.0% (132 proph ABdays/1000 pd)
  - Therapeutic: 34.9% (416 tt ABdays/1000 pd)
  - SDD: 0.7% (8 SDD days/1000 pd)
- Feeding:
  - 211 enteral feeding days/1000 pd
  - 178 parenteral feeding days/1000 pd

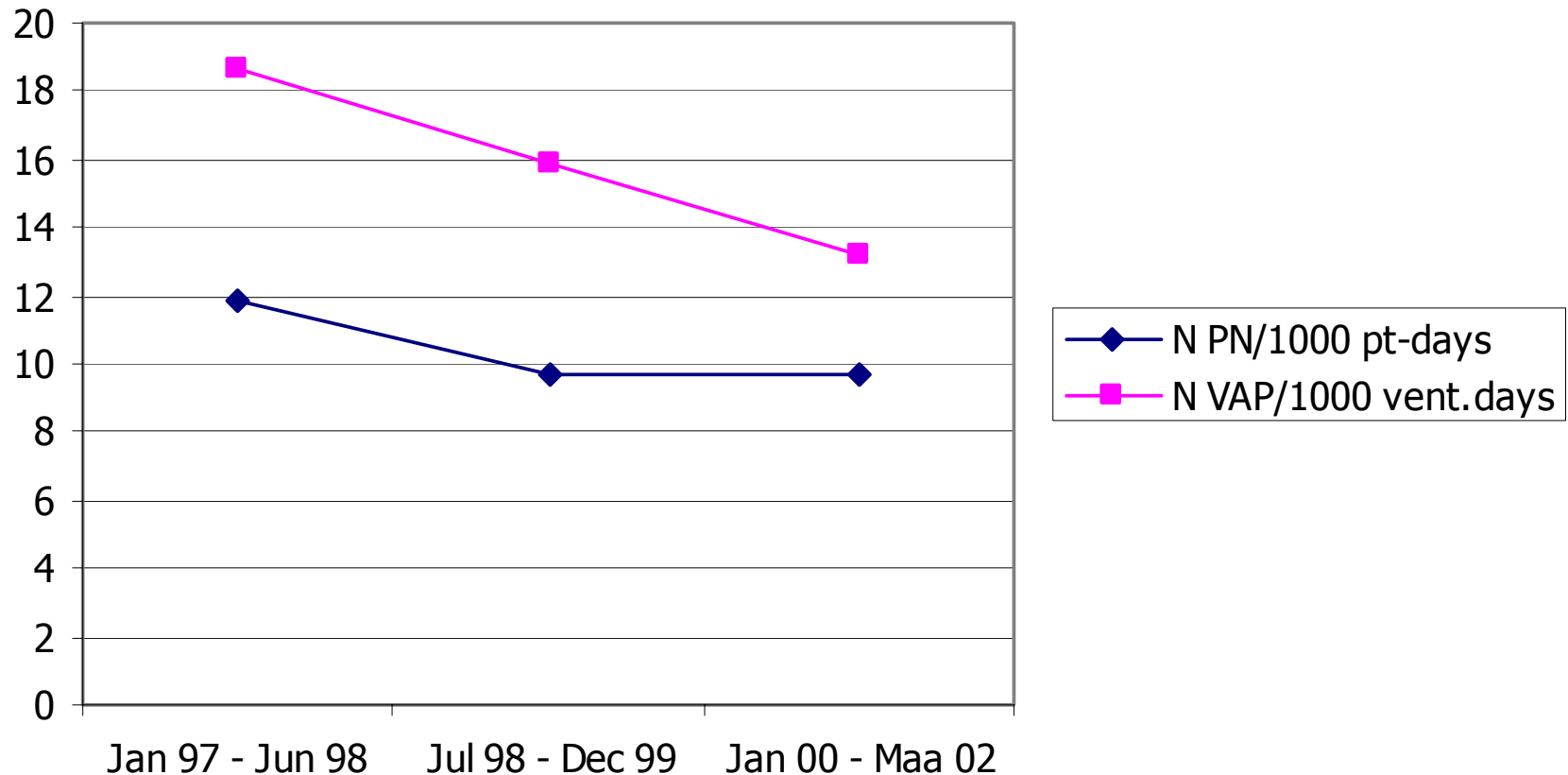
# Results - Pneumonia

- 7% acquired a pneumonia in ICU (P90=12%)
- 81% of nosocomial PN are VAP
- 40% endotracheal asp, 8% invasive method
- 19.2 VAP/1000 ventilation-days (P50: 17.8)
- Length of stay x 2.9 (20 vs 7 days)
- Mortality x 3.7 (26% vs 7%) (SAPS 1.4x worse)

# Most frequently isolated micro-organisms in early (<D7) and late (≥D7) nosocomial pneumonia, 1997-2002 (n=5119)

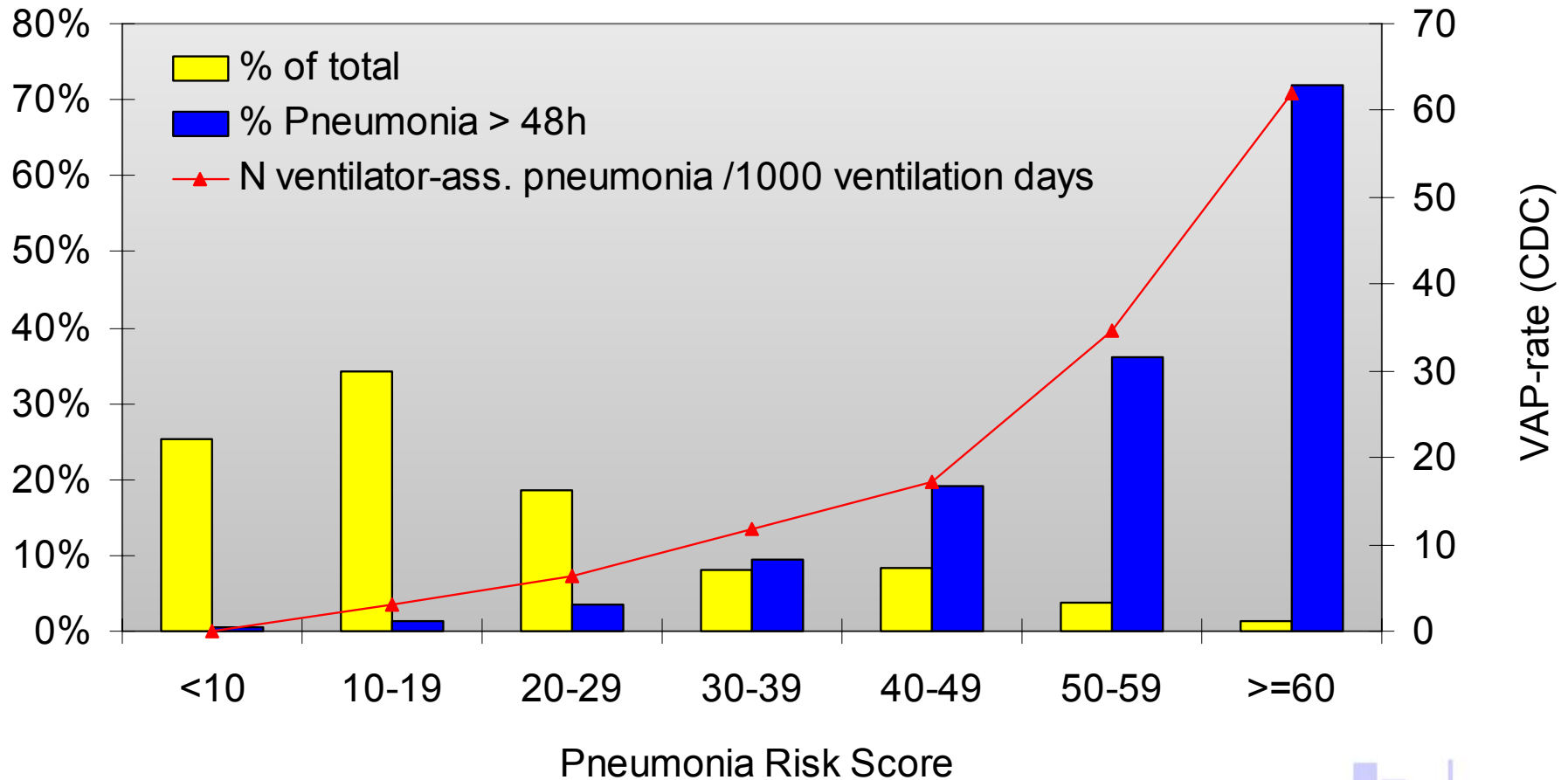


# Evolution of VAP rate and pneumonia incidence density, n=33 « regular » hospitals, 1997-2002



# Risk score for « prediction » of ICU-acquired pneumonia, n=15838, 67 ICUs

**% ICU-acquired pneumonia and ventilator-associated pneumonia rate by Pneumonia risk score**



# Development of risk scores for icu-acquired pneumonia and bacteremia, NSIH 1997-2001

Multiple logistic regression models for the prediction of ICU-acquired pneumonia and bacteraemia		
	Adj. OR (95%CI) PNEUMONIA	Adj. OR (95%CI) BACTERAEEMIA
SAPSII		
<15	1	1
15-24	1.6 (1.0 -2.5)	1.8 (0.8 -4.0)
25-34	2.2 (1.5 -3.4)	2.0 (0.9 -4.5)
35-64	2.9 (1.9 -4.4)	2.1 (0.9 -4.7)
65-74	2.5 (1.5 -4.1)	1.9 (0.7 -4.6)
>=75	1.9 (1.1 -3.2)	1.9 (0.8 -4.9)
Gender (male)	1.5 (1.3 -1.7)	-
Age>=80 yrs	-	0.6 (0.4 -0.8)
Admission type		
medical coronary	0.7 (0.5 -0.9)	0.7 (0.5 -1.0)
medical - trauma	1.8 (1.2 -2.5)	-
scheduled surgery	-	0.7 (0.5 -0.9)
thoracic non-card.surgery	3.0 (2.1 -4.2)	-
neurosurgery	-	0.5 (0.2 -0.8)

## Multiple logistic regression models for the prediction of ICU-acquired pneumonia and bacteraemia (cont'd)

	Adj. OR (95%CI) PNEUMONIA	Adj. OR (95%CI) BACTERAEamia
Mechanical ventilation		
0-1 d	1	1
2 d -ABT peri-adm.	1.3 (1.0 -1.8)	1
+ABT peri-adm.	1.1 (0.7 -1.9)	1
3-4d -ABT peri-adm.	9.8 (7.6 -12.7)	4.3 (2.7 -6.8)
+ABT peri-adm.	2.5 (1.8 -3.6)	1.7 (0.9 -3.1)
5-6d -ABT peri-adm.	22.2 (15.5 -31.7)	8.1 (4.6 -14.1)
+ABT peri-adm.	7.2 (4.9 -10.6)	2.9 (1.5 -5.5)
7-13d -ABT peri-adm.	24.2 (16.3 -35.8)	11.8 (6.9 -19.9)
+ABT peri-adm.	14.6 (10.1 -21.2)	8.3 (5.0 -14.0)
>=14d	25.9 (15.8 -42.6)	11.1 (6.1 -20.4)
Gastric tube without feeding	1.3 (1.1 -1.6)	-
Enteral feeding	2.1 (1.7 -2.6)	1.4 (1.0 -1.8)
Parenteral feeding	1.9 (1.6 -2.2)	2.0 (1.6 -2.5)
Central venous catheter		
0 d	1	1
1-2 d	24.5 (18.0 -33.4)	23.1 (12.7 -41.9)
3-4 d	2.4 (1.8 -3.2)	2.6 (1.5 -4.5)
5-6 d	1.6 (1.2 -2.2)	4.6 (2.7 -8.1)
7-13 d	0.6 (0.5 -0.9)	2.2 (1.2 -3.9)
>=14 d	0.3(0.2 -0.4)	1.2 (0.6 -2.4)
Pneumonia bef. bacteraemia	-	3.1 (2.4 -4.1)



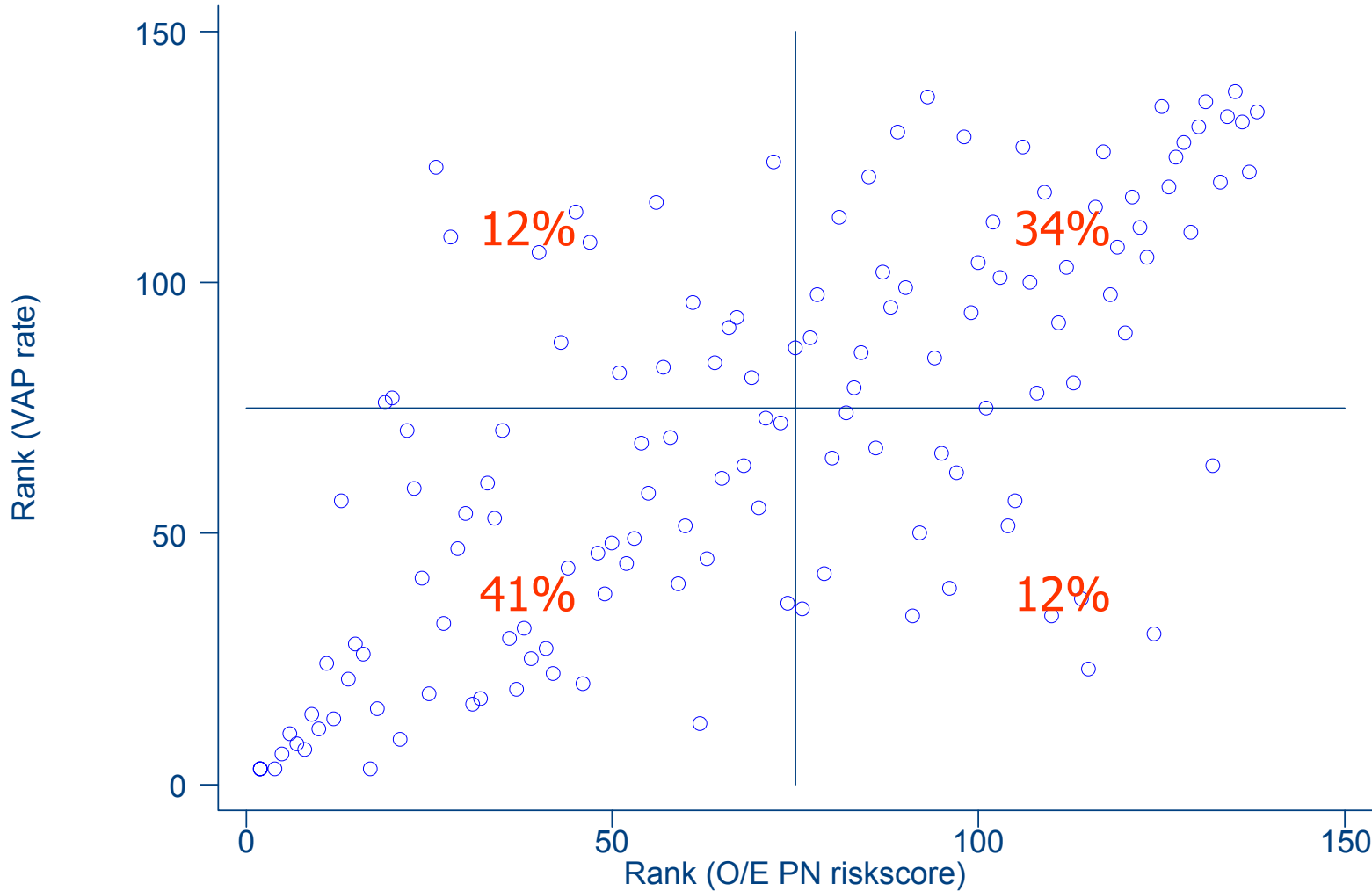
# Risk score performance

- Pneumonia risk score (PRS) : 10 variables (5 intrinsic, 5 extrinsic)
- Bacteremia risk score (BRS) : 10 variables (6 intrinsic, 4 extrinsic)
- **Score performance:**

	<b>AUC<sub>dev</sub></b>	<b>GOF<sub>dev</sub></b>	<b>AUC<sub>val</sub></b>	<b>GOF<sub>val</sub></b>
○ <b>PRS</b>	0.871	0.22	0.886	0.21
○ <b>BRS</b>	0.885	0.24	0.867	0.47

- *Development sample : NSIH 1997-1999; Validation sample NSIH 2000-2001*

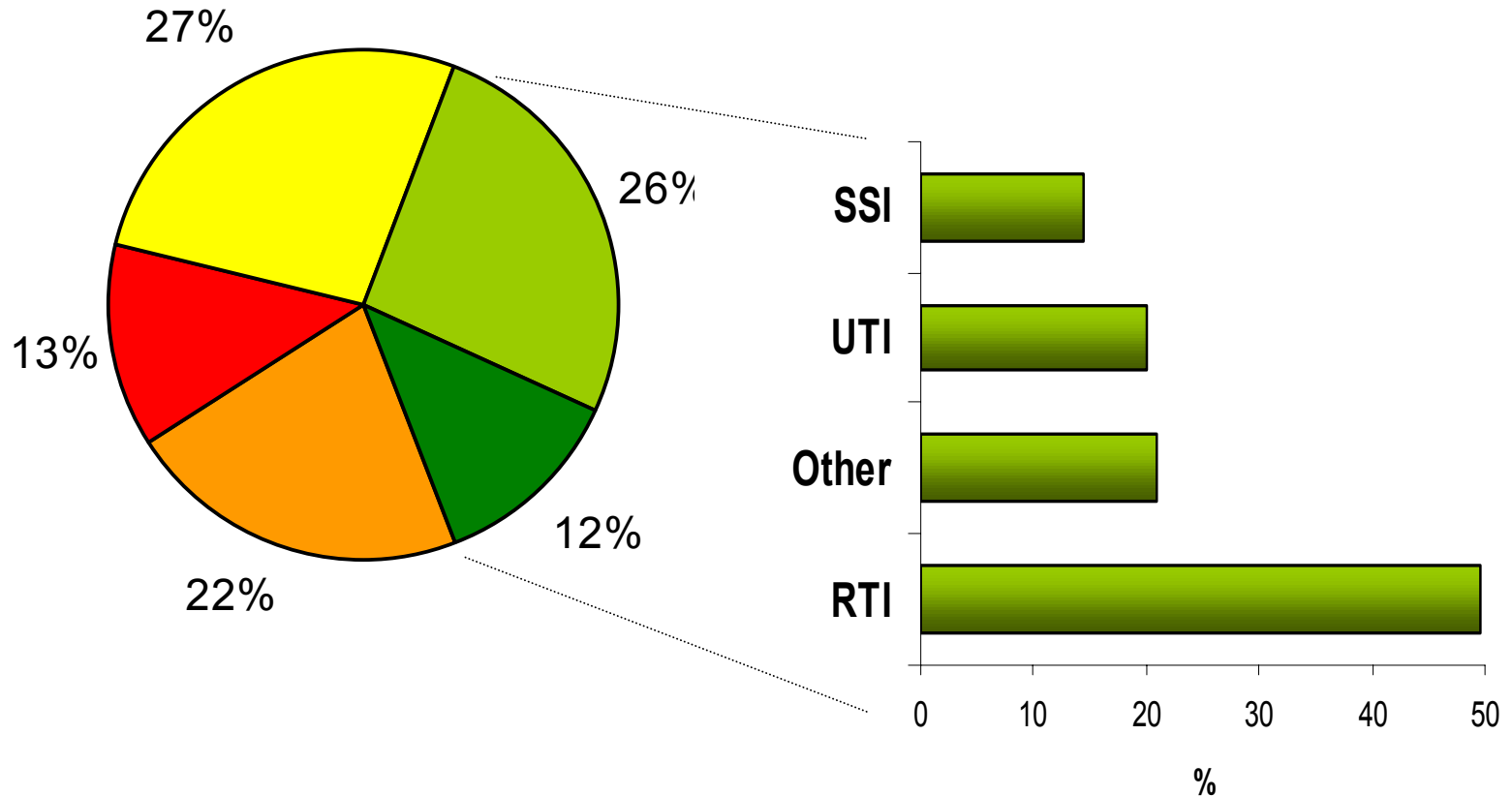
# Changes in ICU rank when compared according to VAP rate (#VAP/1000 vd) vs. Observed # PN/ Expected # PN (PN risk score)



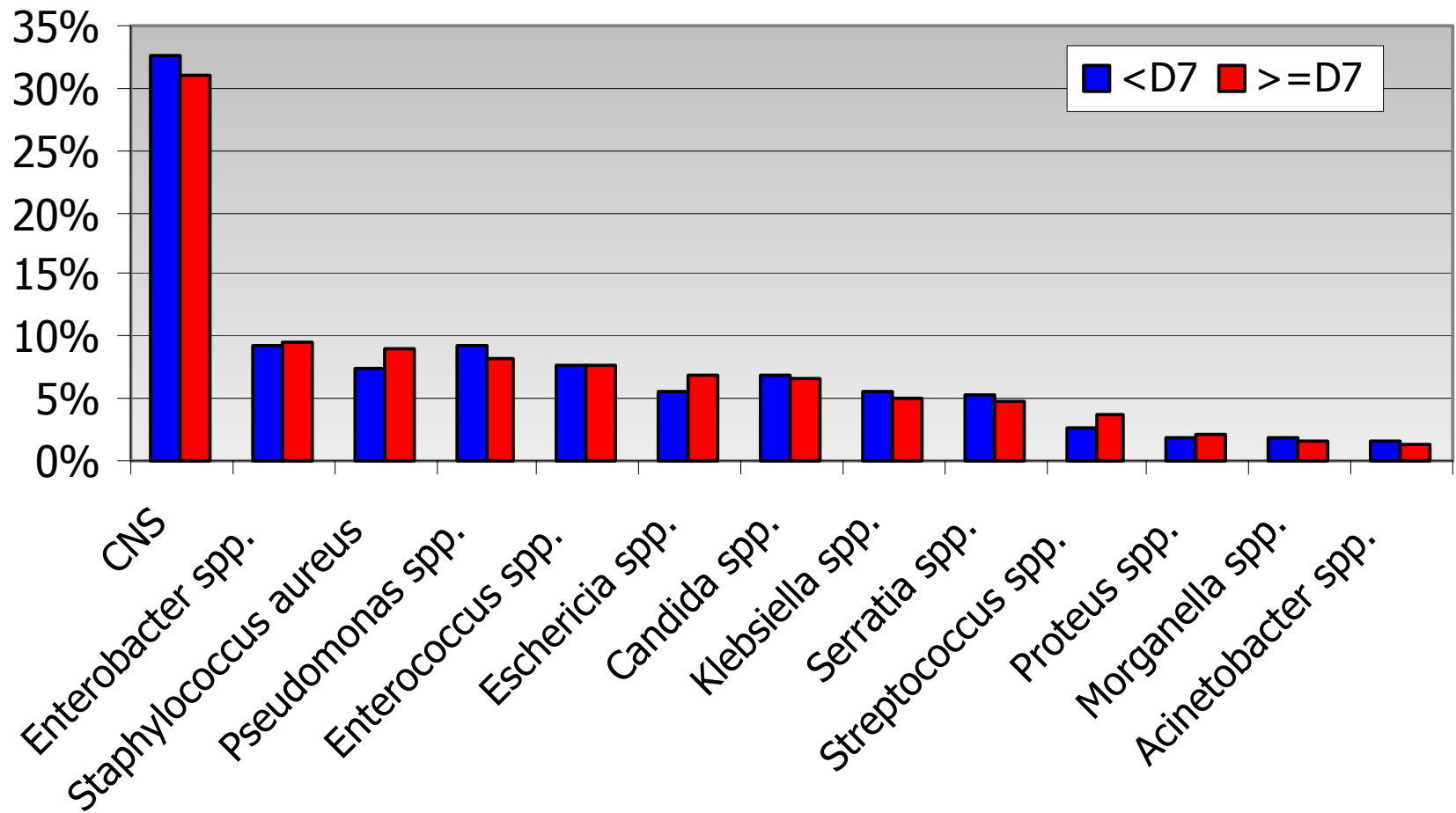
# Results - Bacteremia

- 2.5% patients acquired BAC in ICU (P90=5%)
- 3.9 BAC episodes/1000 pat days (P50 3.4)
- Length of stay x 3.5 (24 vs 7 days)
- Mortality x 3.9 (31% vs 8%) (SAPS 2x worse)

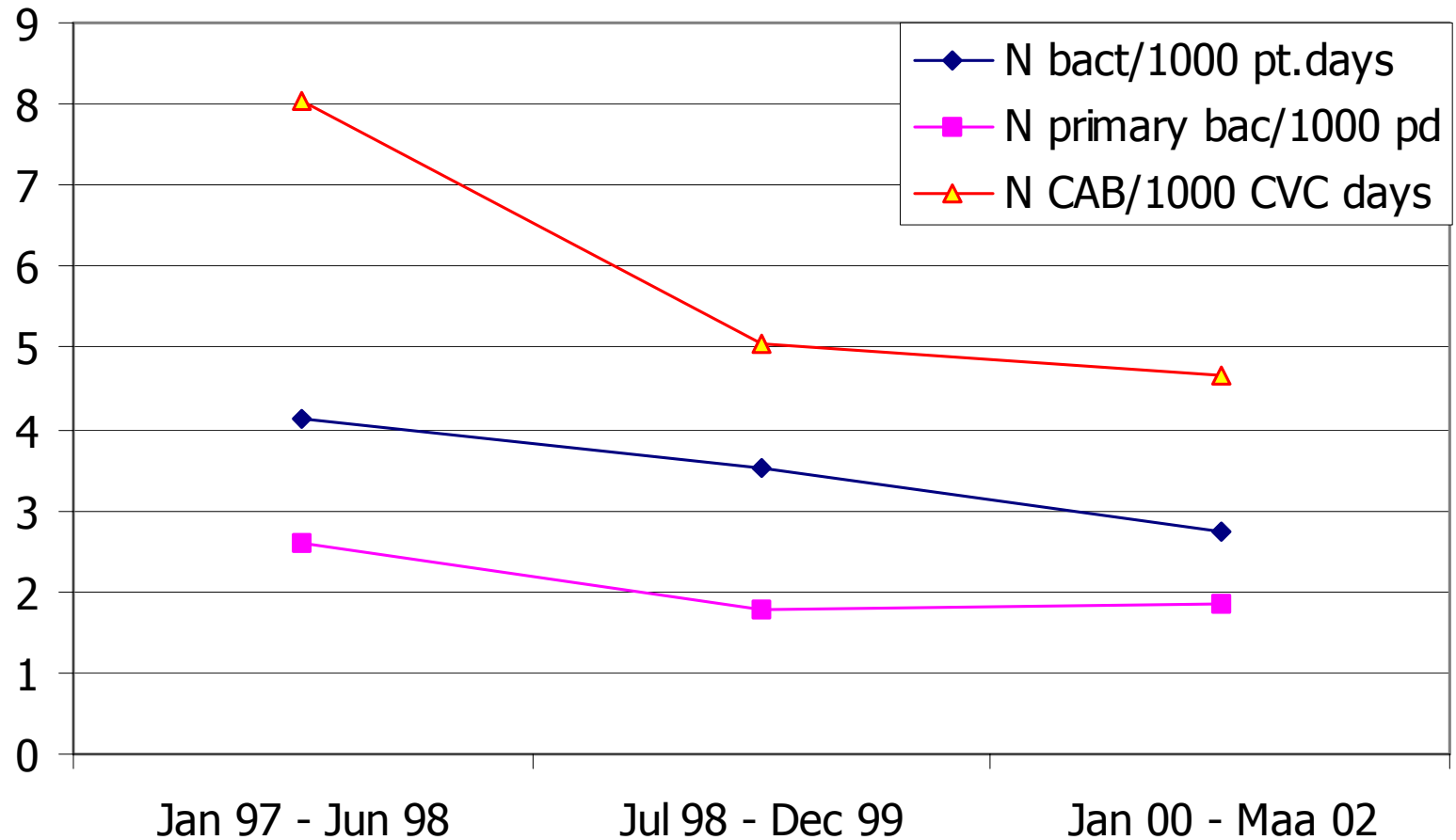
# Origin of Bacteremia



# Most frequently isolated micro-organisms in early and late ICU-acquired bacteremia, 1997-2001 (n=1544)

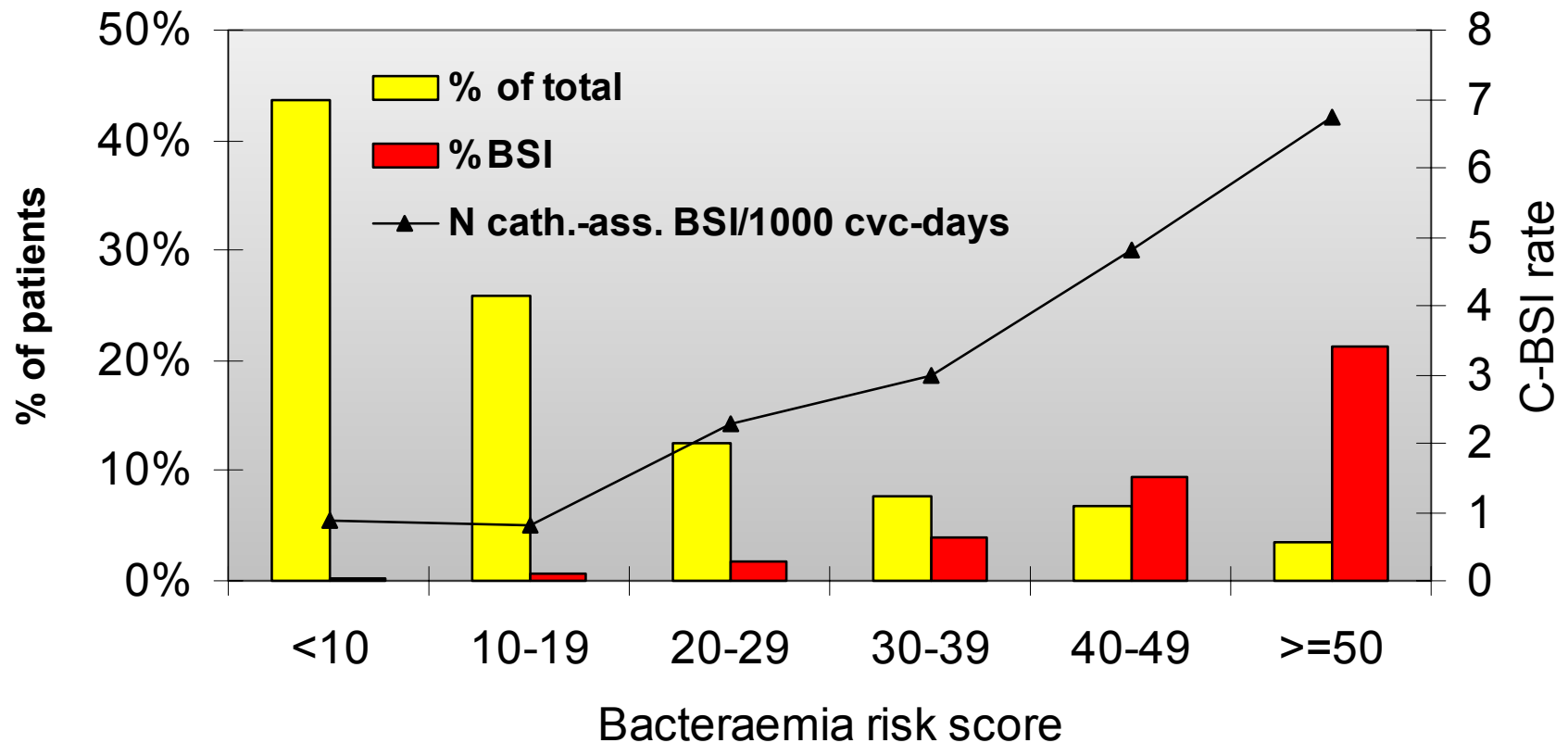


# Evolution of ICU-acquired bacteremia rates, n=33 « regular » hospitals, 1997-2002



# Risk score for « prediction » of ICU-acquired bacteremia, n=15838, 67 ICUs

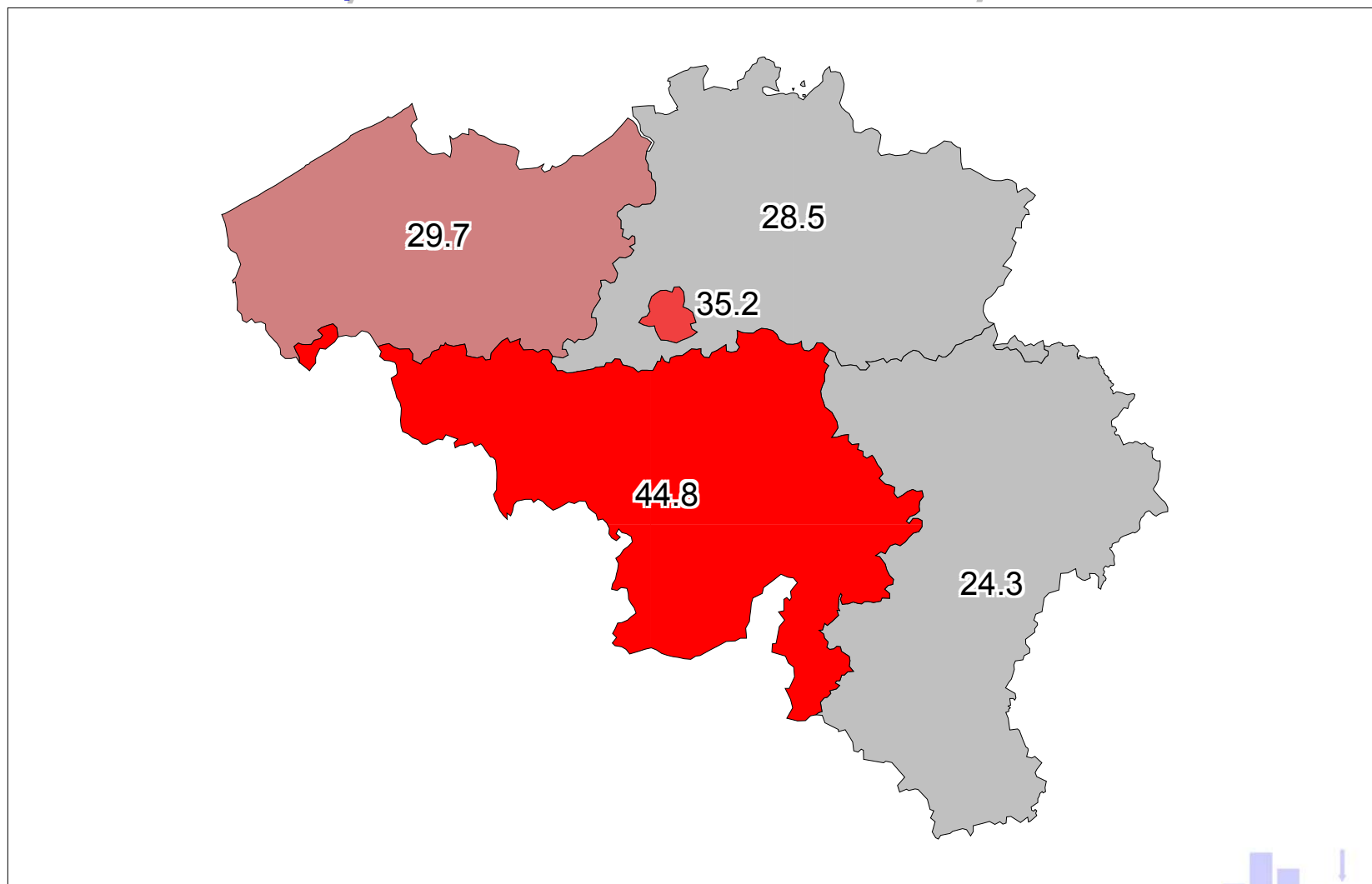
## % Bacteremia and cath.ass. BSI rate by Bacteraemia risk score



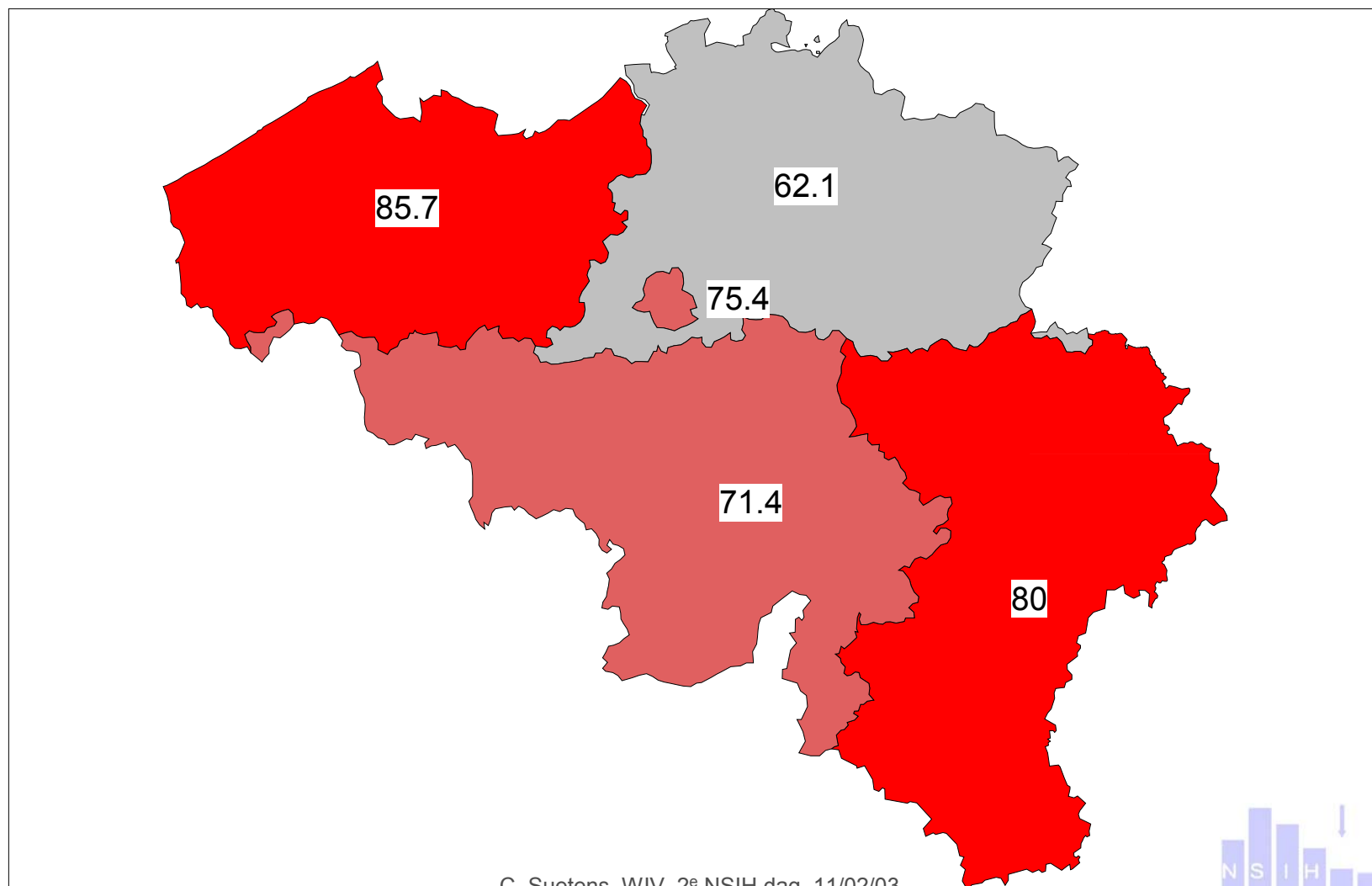
# Results – Antibiotic resistance in ICU-acquired PN & BAC (n=74 hospitals), 1997-2002

	N determined (%)	% not sensitive
<i>S. aureus</i> oxa-R (MRSA)	796/888 (90%)	34.6%
+genta-R		41.4%
CNS oxa-R	481/740 (65%)	79.6%
<i>Enterococcus</i> sp. ampi-R	168/230 (73%)	14.9%
<i>E. aerogenes</i> C3-R	294/389 (76%)	62.9%
+imi-R		7.4%
<i>P. aeruginosa</i> CAZ-R	819/1030 (80%)	19.2%
+imi-R		40.9%

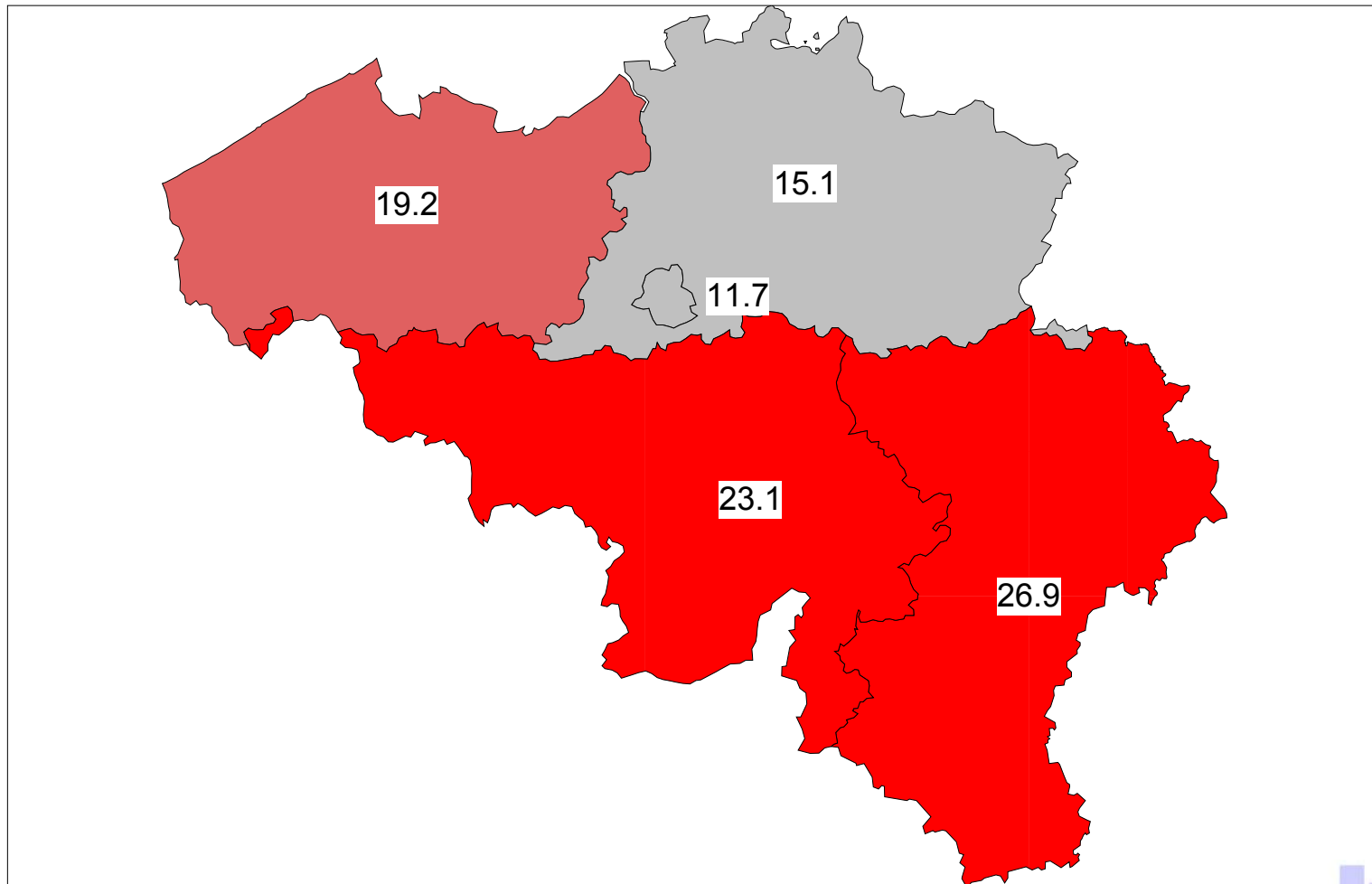
# Regional differences in antibiotic resistance in the ICU, 1997-2002 : MRSA/SA%



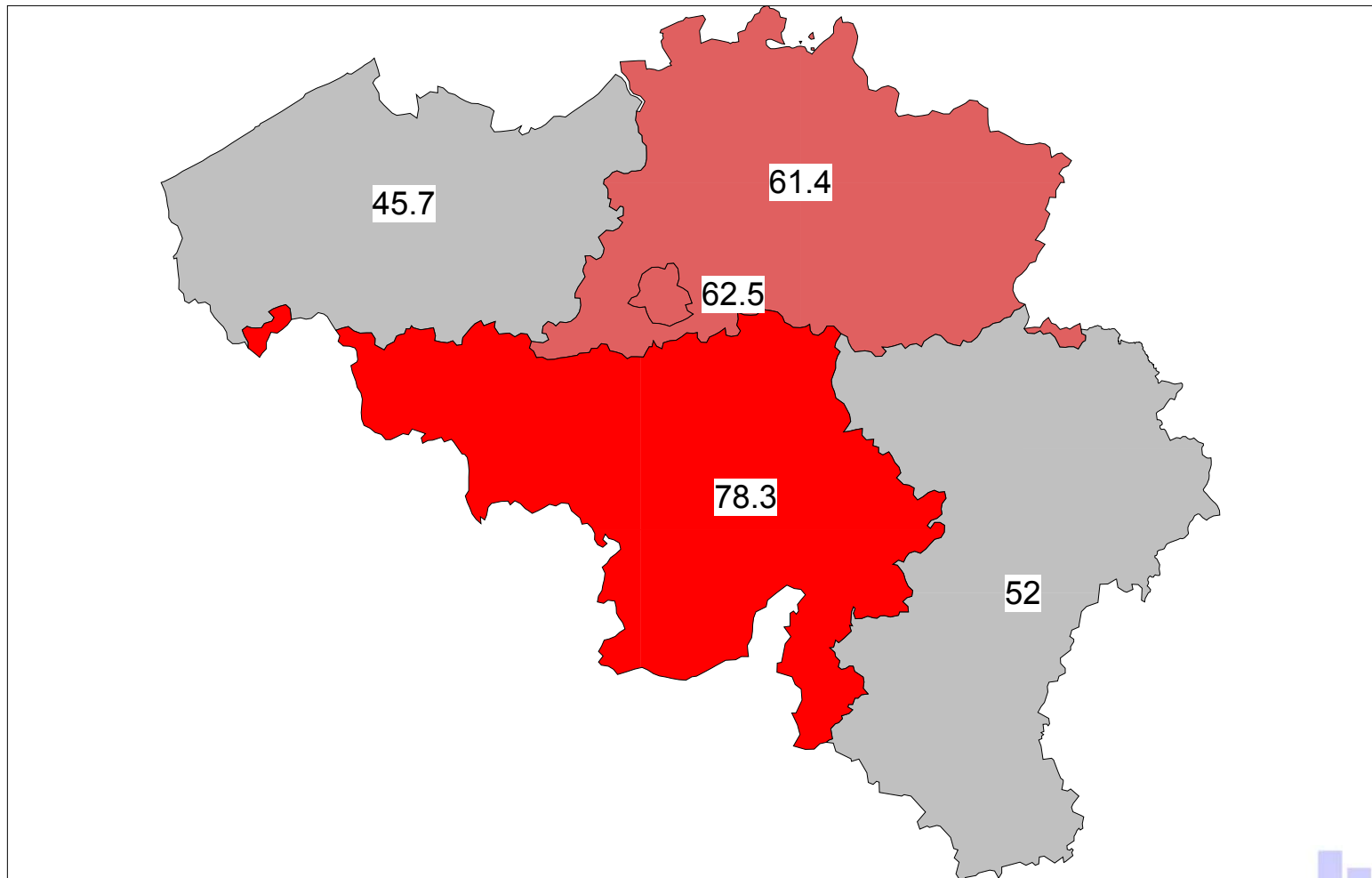
# Regional differences in antibiotic resistance, 1997-2001 : *CNS oxa-R*



# Regional differences in antibiotic resistance in the ICU, 1997-2002 : PSE CAZ-R%



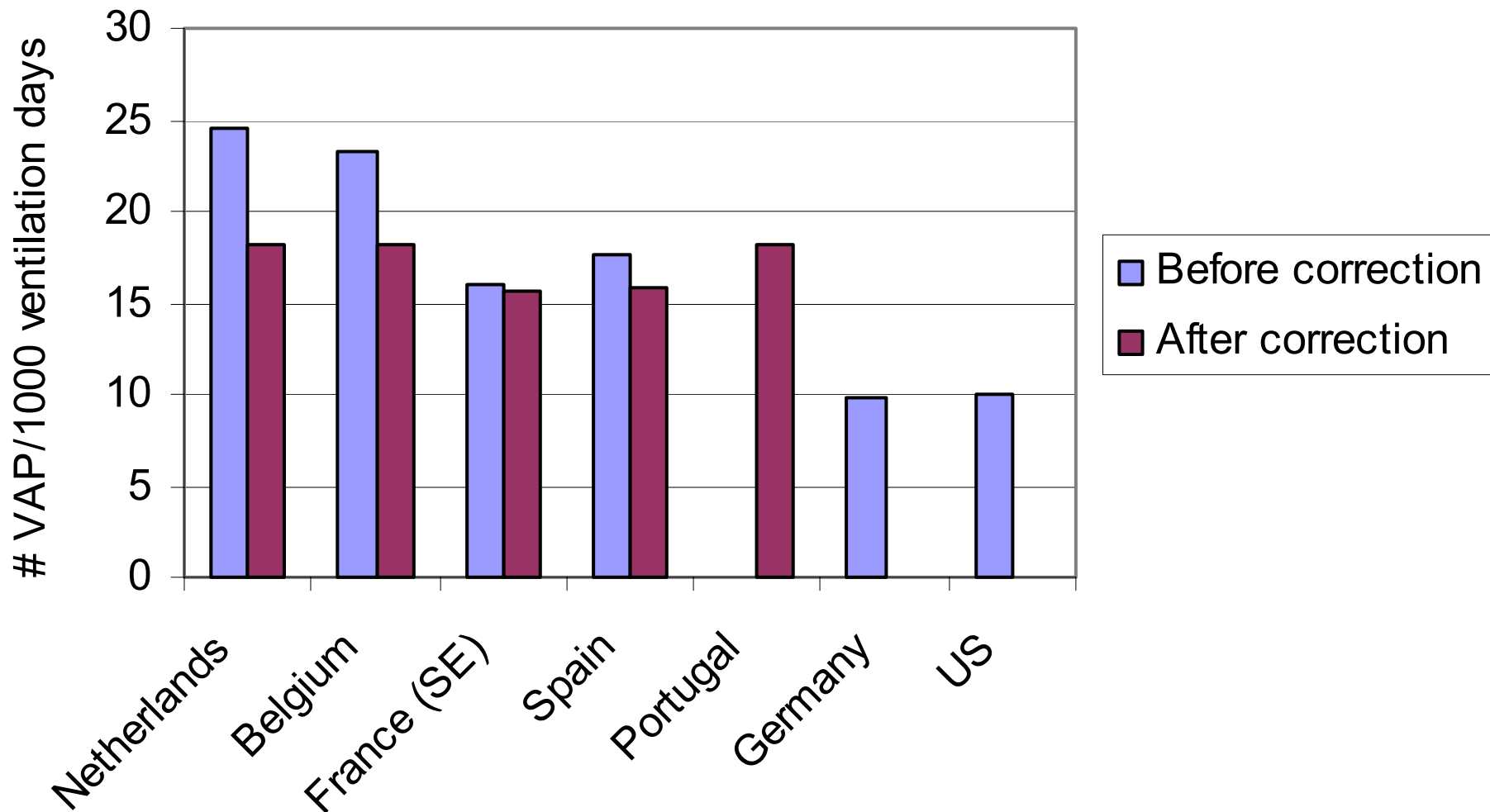
# Regional differences in antibiotic resistance in the ICU, 1997-2002 : *E. aerogenes* C3-R%



# Discussion

- Participation: 85%  $\geq 1$  participation since 1996; 50% participate each year
- Reasons for non-participation: workload, non-significant incentive, non-participation of ICU staff, other surveillance in place...
- Data quality:
  - 1/3 of data of high internal quality  $>$  used for risk score development
  - correlation external (preliminary results)  $\sim$  internal validity

# Comparison of ventilator-associated pneumonia rates before and after maximal correction, surveillance of NI in the ICU in Europe



Source: HELICS 3, 2001

# Proportional distribution of pathogens isolated in ICU-acquired pneumonia (HELICS-ICU - corrected)

	GE	NL	BE	FR	SP	PO	USA
<i>Staphylococcus aureus</i>	17.6%	11.0%	12.7%	19.8%	20.3%	36.6%	20.0%
<i>Pseudomonas spp</i>	11.1%	15.9%	17.8%	19.5%	15.4%	28.2%	21.0%
<i>Klebsiella spp</i>	9.5%	11.7%	6.4%	4.6%	5.1%	2.8%	8.0%
<i>Enterobacter spp</i>	6.0%	8.5%	9.6%	6.0%	6.4%	1.4%	9.0%
<i>Escherichia spp</i>	7.4%	10.0%	8.7%	7.5%	6.7%	7.0%	4.0%
<i>Acinetobacter spp</i>	3.7%	3.1%	2.1%	3.1%	10.8%	1.4%	6.0%
<i>Candida spp</i>	9.8%	6.8%	8.8%	6.2%	2.8%	7.0%	6.2%

# Discussion - 2

- Real decrease of infection rates in cohort of 33 hospitals ?:
  - risk factors remained stable in 3 periods
  - partic. on average 11 quarters (vs. 4 in others)
  - lower MRSA/SA % : 28.4% (vs. 46.7%)
  - quantitative (?) cultures in pneumonia: 53% vs 40%

Tabel 1. Evolutie van infectiecijfers en risicofactoren in een cohorte van 33 fusieziekenhuizen\*, januari 1997-maart 2002, nationale surveillance van nosocomiale infecties op intensieve zorgen

	Jan 97 - Jun 98	Jul 98 - Dec 99	Jan 00 - Maa 02	p waarde
Aantal ziekenhuizen	33	33	33	
Mortaliteit	7.2%	6.7%	7.3%	NS
Ligduur (dagen)	6.3	6.5	6.8	NS
Mediane SAPS II score	29.0	28.0	29.0	NS
N pneumonieën/1000 ligdagen	12.0	10.2	10.1	NS
N VAP/1000 ventilatiedagen	22.2	19.0	16.6	0.044
N ventilatiedagen/100 ligdagen	32.1%	30.9%	33.4%	NS
N bacteriëmieën/1000 ligdagen	4.6	3.8	2.5	<0.001
N primaire bac./1000 ligdagen	2.8	1.8	1.7	0.06
N Catheter-bac./1000 catheterdagen	3.9	2.7	2.7	0.03
N CVC dagen/100 ligdagen	75.1%	68.4%	69.1%	NS

# Perspectives

- adaptation of national protocol(s) to EU standard methods (Decision 2119/98 EC  $\Rightarrow$  HELICS) in 2003
  - level 1: infections + unit-based patient-days
  - level 2: NI risk score (patient-based)
  - pilot projects electronic surveillance
- collaboration:
  - « college intensieve zorgen »: quality of diagnosis of pneumonia
  - regional « platforms » for hospital hygiene: inter-regional comparisons, intra-regional reference data

# New HELICS-ICU protocol

## *Level 1*

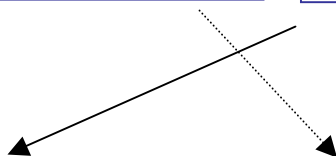
*Unit-based component  
(patient-days + ICU characteristics)*

Continuous surveillance

## *Level 2*

*Patient-based component :  
(NI Risk score, device-days)*

Min 3 months



*All NI/1000 pt-days  
Site specific incidence rates  
Pathogen-specific incidence rates  
% infected patients*

*Device-  
adjusted  
infection  
rates*

*Standardized  
infection ratio  
Stratification*

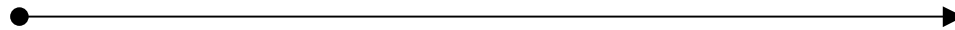
# Common to 2 levels

Only include patients that stay more than 2 calendar-days in the ICU

1/1 2/1 3/1



*Infections > D2*



D1 D2 D3

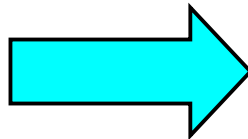




# (Near?) future: electronic surveillance

## Computer

- Administrative data:
  - dates, sex, age
- Microbiology:
  - sampling date, m-o, Abgram, site
- Antibiotic use
  - dates, molecule



## Validation by clinician

- Nosocomial infection Y/N
- Site
- Match definition? Y/N

# Unit-based component (level 1) = Minimal data

= data every national/regional surveillance network should be able to provide

- objective=follow-up trends in time
- limited comparison possibilities: pathogen-specific incidence rates

(e.g.  $\#BSI_{MRS A}/1000$  patient-days)

# ICU characteristics

- Hospital size (n beds) & type (Univ., general)
- ICU type: mixed, medical, surgical, pediatric, neonatal, ...
- Number of ICU beds & staff (MD's, nurses)
- mean LOS, % deaths, % surgical patients, % ventilated patients over last year
- criteria for blood sampling ( $> ?$  °C)
- diagnostic procedures for pneumonia

# Surveillance of ICU-acquired infections – Patient-based level (level 2)



**Hospital code:** \_\_\_\_\_ **Unit:** \_\_\_\_\_ **Patient number:** \_\_\_\_\_  
**Gender:**  M  F **Age:** \_\_\_\_\_ **Admission date in hospital:** \_\_\_\_-\_\_\_\_-\_\_\_\_ (dd/mm/yyyy)  
**Date ICU admission:** \_\_\_\_-\_\_\_\_-\_\_\_\_ **Date ICU discharge:** \_\_\_\_-\_\_\_\_-\_\_\_\_ (INCLUSION DATE)  
**Discharge status**  alive  death in ICU  DNR/withdrawal

SAPS II score  and/or APACHE II score

<b>Glasgow coma score</b>	<input type="radio"/> <6	<input type="radio"/> 6-8	<input type="radio"/> 9-10	<input type="radio"/> 11-13	<input type="radio"/> 14-15
<b>Type of admission</b>	<input type="radio"/> medical		<input type="radio"/> scheduled surgical		<input type="radio"/> unscheduled surgical

**Trauma**  Yes  No **Acute coronary care**  Yes  No **Antimicrobial therapy at admission(± 48h)**  Yes  No

**Surgery before admission (within last 30 days) :**  Yes  No

coronary surgery  other cardiac  other thoracic  neurosurgery  other

**Naso/oro-intestinal tube without feeding in ICU**  Yes: date start \_\_\_\_-\_\_\_\_-\_\_\_\_ (dd-mm-yyyy)  No

**Enteral feeding in ICU**  Yes: date start \_\_\_\_-\_\_\_\_-\_\_\_\_ (dd-mm-yyyy)  No

**Parenteral nutrition in ICU**  Yes: date start \_\_\_\_-\_\_\_\_-\_\_\_\_ (dd-mm-yyyy)  No

	day date	Adm /	2 /	3 /	4 /	5 /	6 /	7 /	8 /	9 /	10 /	11 /	12 /	13 /	14 /
Number of central venous catheters															
Mechanical ventilation															
- invasive		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
- non-invasive*		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Urinary catheter		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

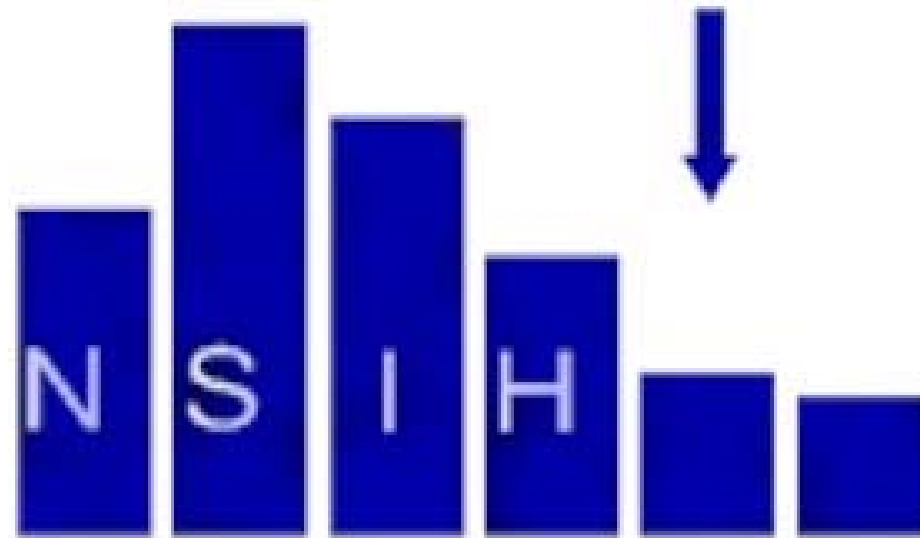
**Infected patient (if yes please fill out infection sheet):**

Yes  No

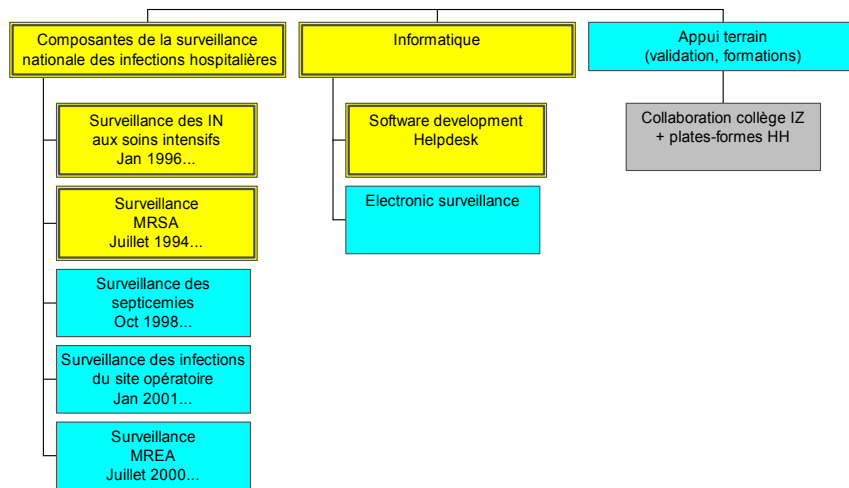


# Perspectives

- adaptation of national protocol(s) to EU standard methods (Decision 2119/98 EC  $\Rightarrow$  HELICS) in 2003
  - level 1: infections + unit-based patient-days
  - level 2: NI risk score (patient-based)
  - pilot projects electronic surveillance
- collaboration:
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*Thanks to all participating hospitals !*

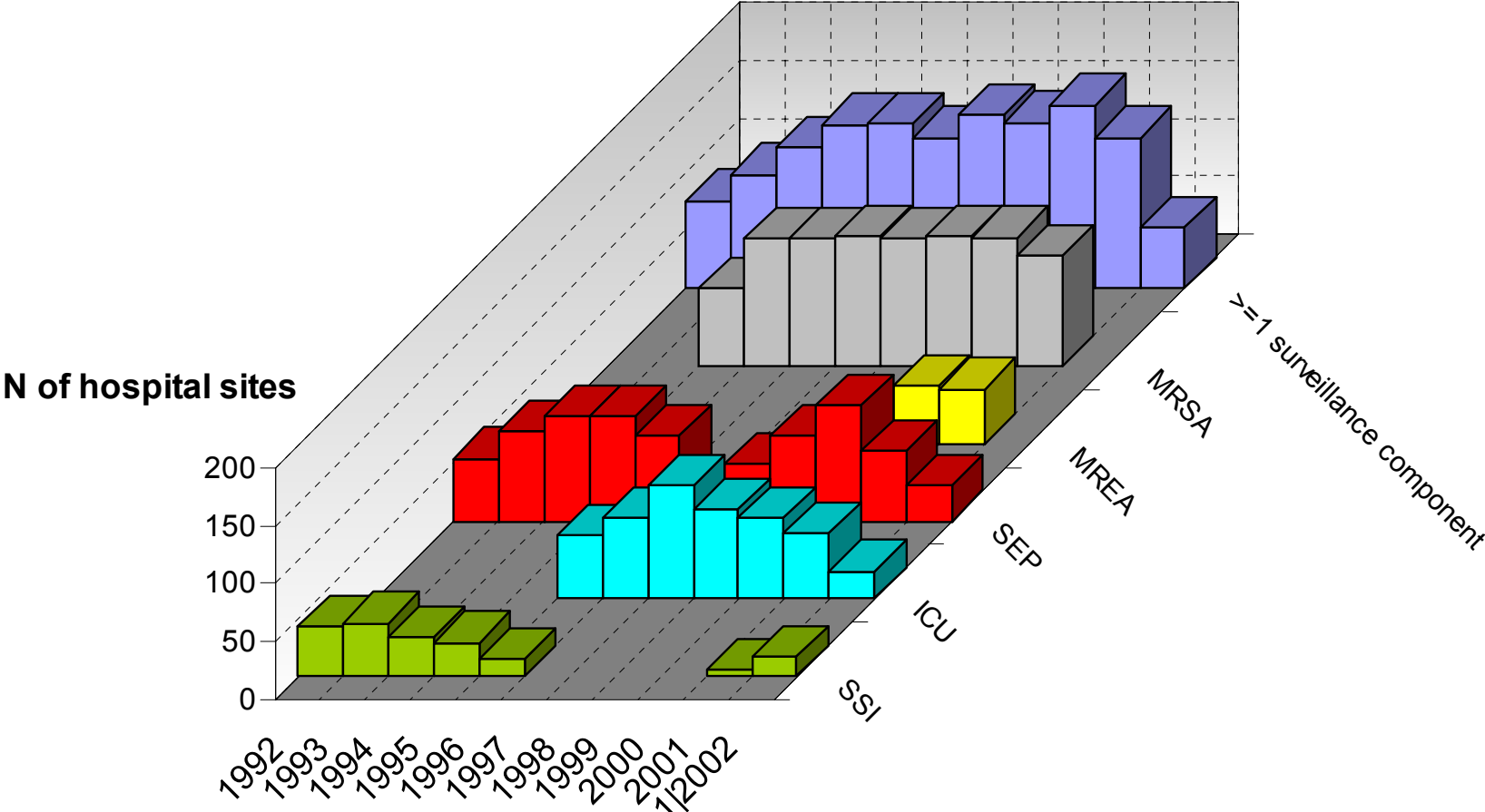


# Methods: case definitions

## Bacteremia

- Before 2000
  - 1 positive blood culture for recognised pathogen OR
  - 2 pos. blood cultures with skin contaminant (within 72 hours) + clinical symptoms:
  - skin cont= *CNS, micrococcus sp., propionibacterium acnes, bacillus sp., corynebacterium sp., streptococci viridans, acinetobacter sp., clostridium sp.*
- From Jan 2000 (CDC)
  - idem +
  - 1 pos blood culture with skin contaminant in patient with clinical symptoms, central catheter, AB therapy
  - skin cont= *CNS, micrococcus sp., propionibacterium acnes, bacillus sp., corynebacterium sp.*
  - + pos. Ag test blood

# Participation to the national surveillance of hospital infections and antibiotic resistance, IPH-NSIH, 10/1992-3/2002



# Proportional distribution of pathogens isolated in ICU-acquired pneumonia (corrected)

	GE	NL	BE	FR	SP	PO	USA
<i>Staphylococcus aureus</i>	17.6%	11.0%	12.7%	19.8%	20.3%	36.6%	20.0%
<i>Pseudomonas spp</i>	11.1%	15.9%	17.8%	19.5%	15.4%	28.2%	21.0%
<i>Klebsiella spp</i>	9.5%	11.7%	6.4%	4.6%	5.1%	2.8%	8.0%
<i>Enterobacter spp</i>	6.0%	8.5%	9.6%	6.0%	6.4%	1.4%	9.0%
<i>Escherichia spp</i>	7.4%	10.0%	8.7%	7.5%	6.7%	7.0%	4.0%
<i>Acinetobacter spp</i>	3.7%	3.1%	2.1%	3.1%	10.8%	1.4%	6.0%
<i>Candida spp</i>	9.8%	6.8%	8.8%	6.2%	2.8%	7.0%	6.2%