THE ECONOMIC BURDEN OF ANTIBIOTIC RESISTANCE – EVIDENCE FROM THREE RECENT STUDIES

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Roadmap of presentation

- Cost concepts
- Data on cost of AMR
  - Massachusetts hospital discharge study
  - Chicago Cook County (Stroger) Hospital (CARP extension) study
  - Study of experience of patients with MRSA
- Overall estimate of cost of AMR for the United States

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The direct costs of drug resistance

- longer medical treatment
- costly second- and third-line therapies
- development of replacement drugs for those that no longer work, and
- screening and diagnostics to detect and prevent the spread of resistant strains

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The indirect economic costs

- poor patient health
- longer term disability
- excess mortality
- economic burden on patients and families
- loss of drug effectiveness
- expensive risk-reduction efforts to limit the spread of the resistant pathogens
  - adapted from Center for Global Development

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The Massachusetts Hospital Discharge Study

- Uses Massachusetts hospital discharge data from 2000-2007
- based on presence of ICD-9 V09 codes in discharge dataset
- Data on number of cases with reported resistance, including demographics
  - Age, sex, payer
- Allows us to see trends over time
- Permits a lower-bound estimate of the cost to Massachusetts to be made

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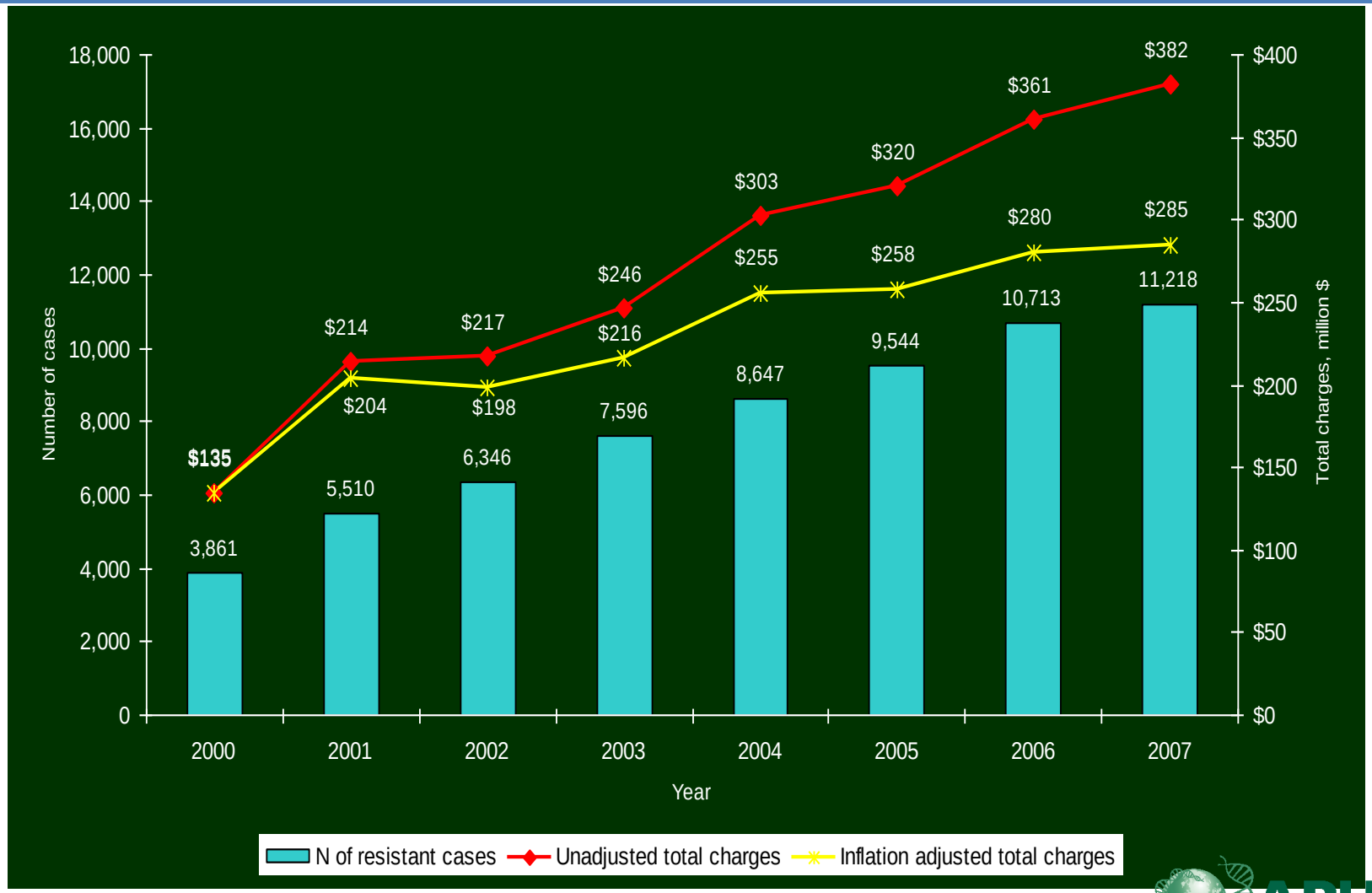
Trends in hospital discharges reporting antibiotic resistance and total hospital charges in Massachusetts, 2000-2007



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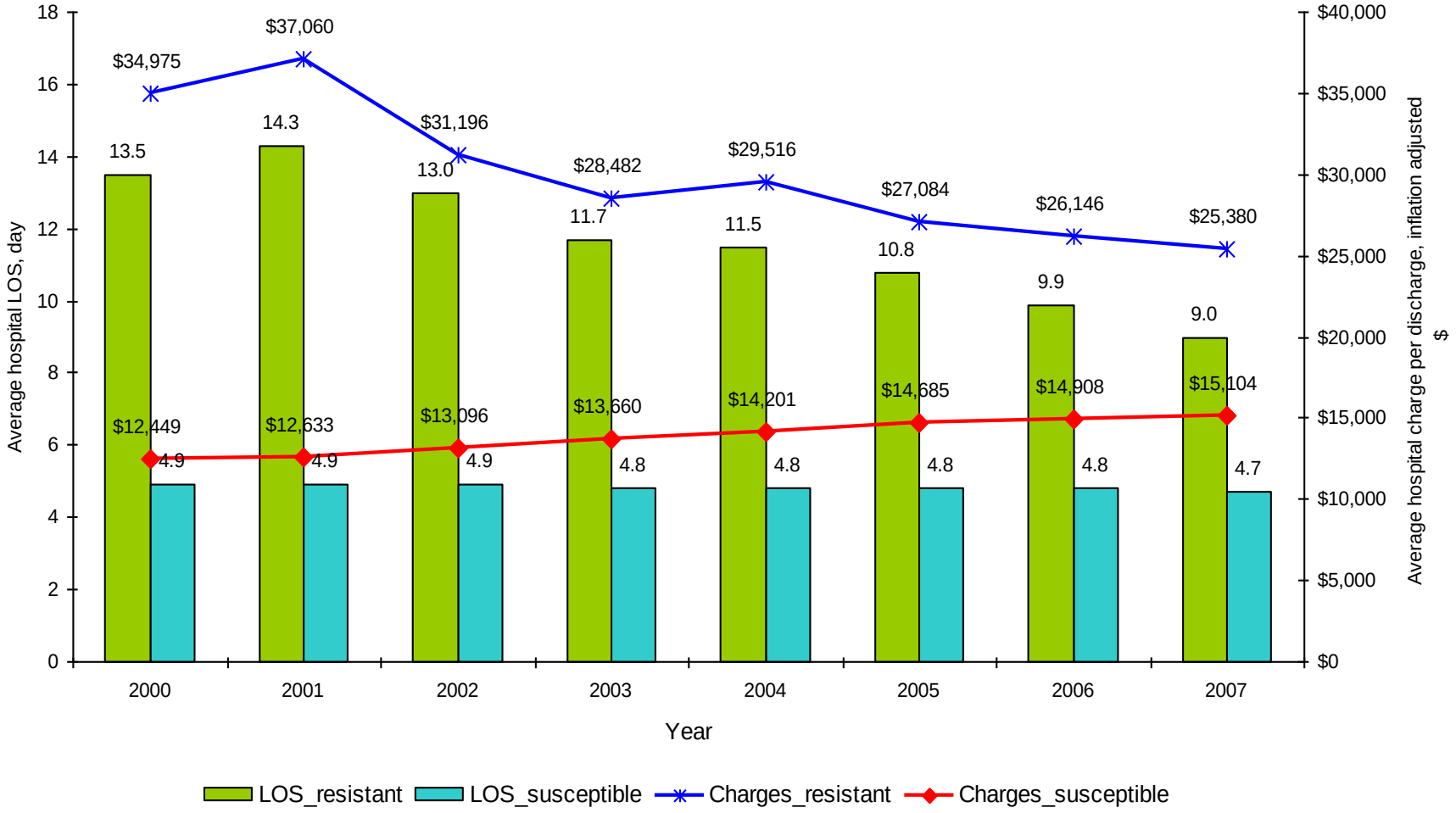
Average hospital LOS and hospital charge per discharge (inflation adjusted) for drug-resistant infections and drug-susceptible infections in Massachusetts, 2000-2007



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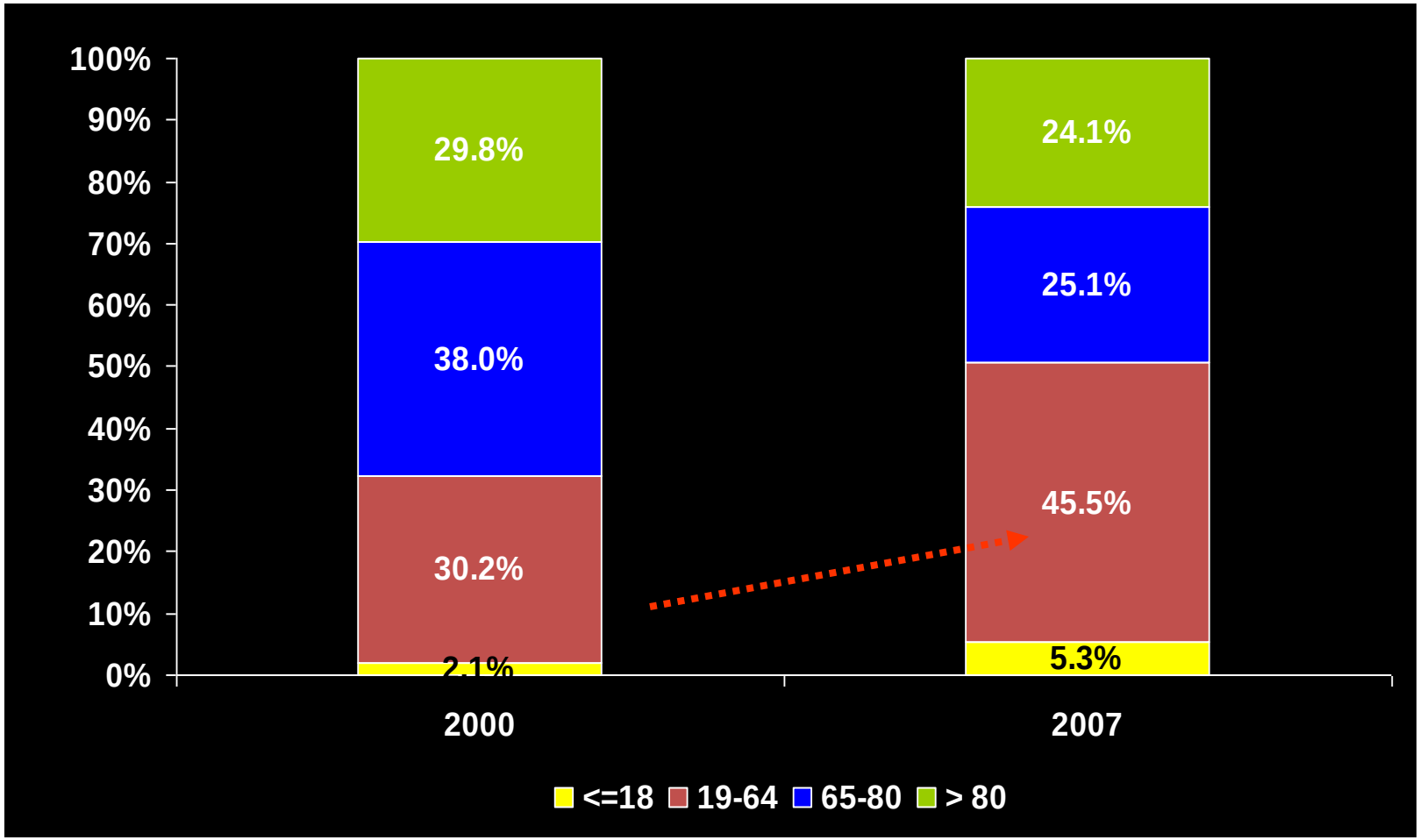
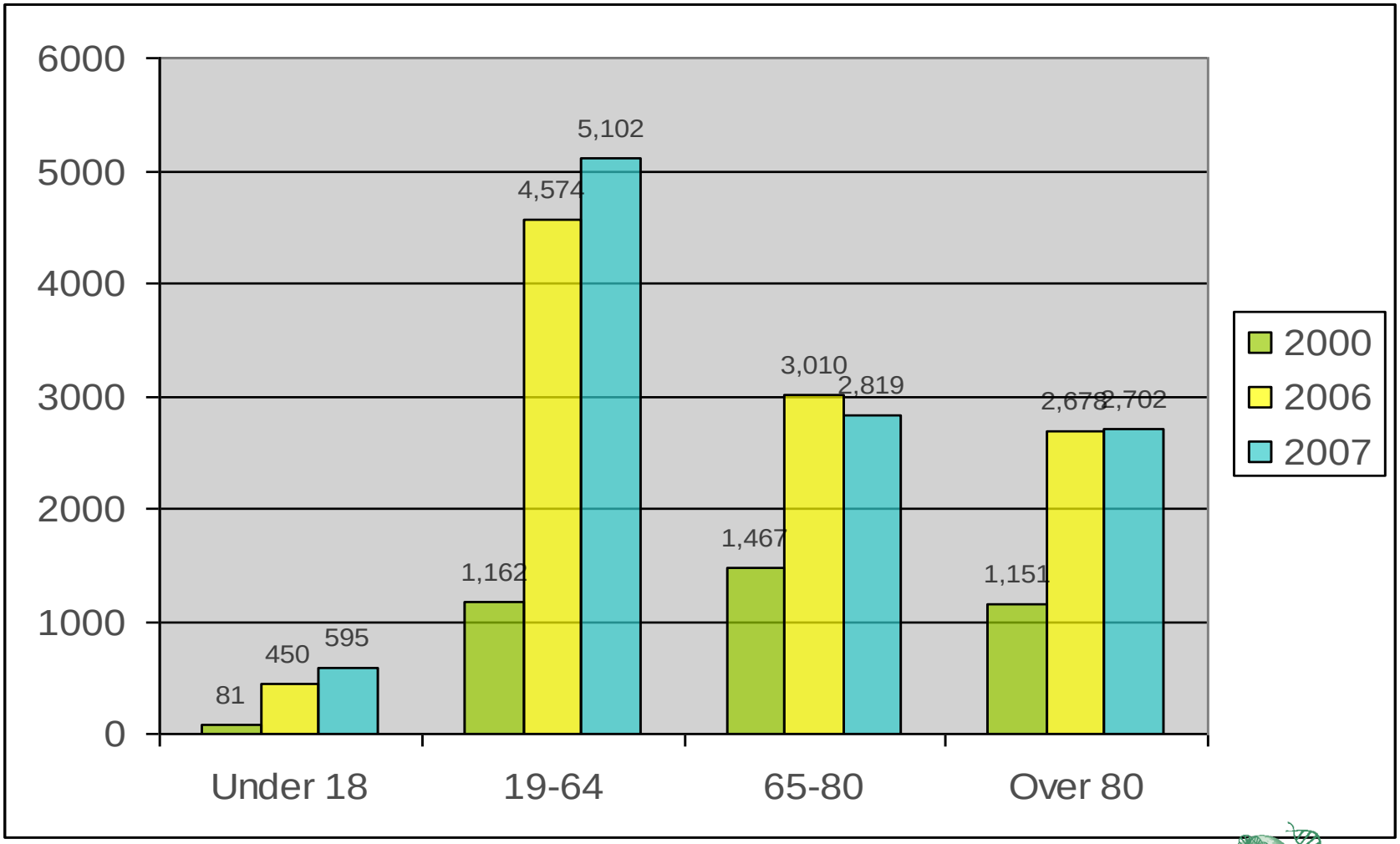
Age Distribution of Hospital Discharges with Drug-Resistant Infections in Massachusetts, 2000 and 2007



Age distribution of cases in Massachusetts, 2000, 2006 and 2007



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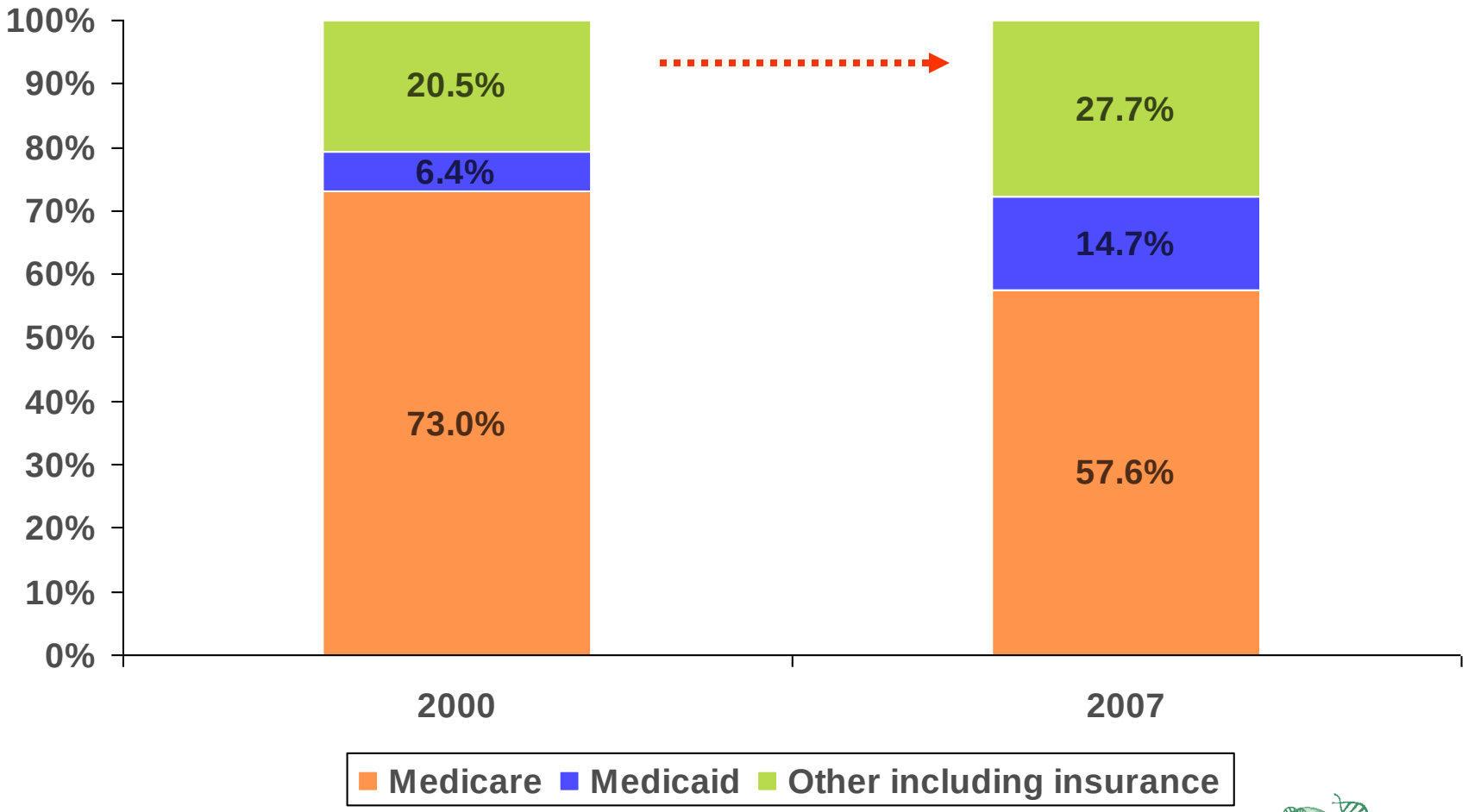
Payer Distribution of Hospital Discharges with Drug-Resistant Infections in Massachusetts



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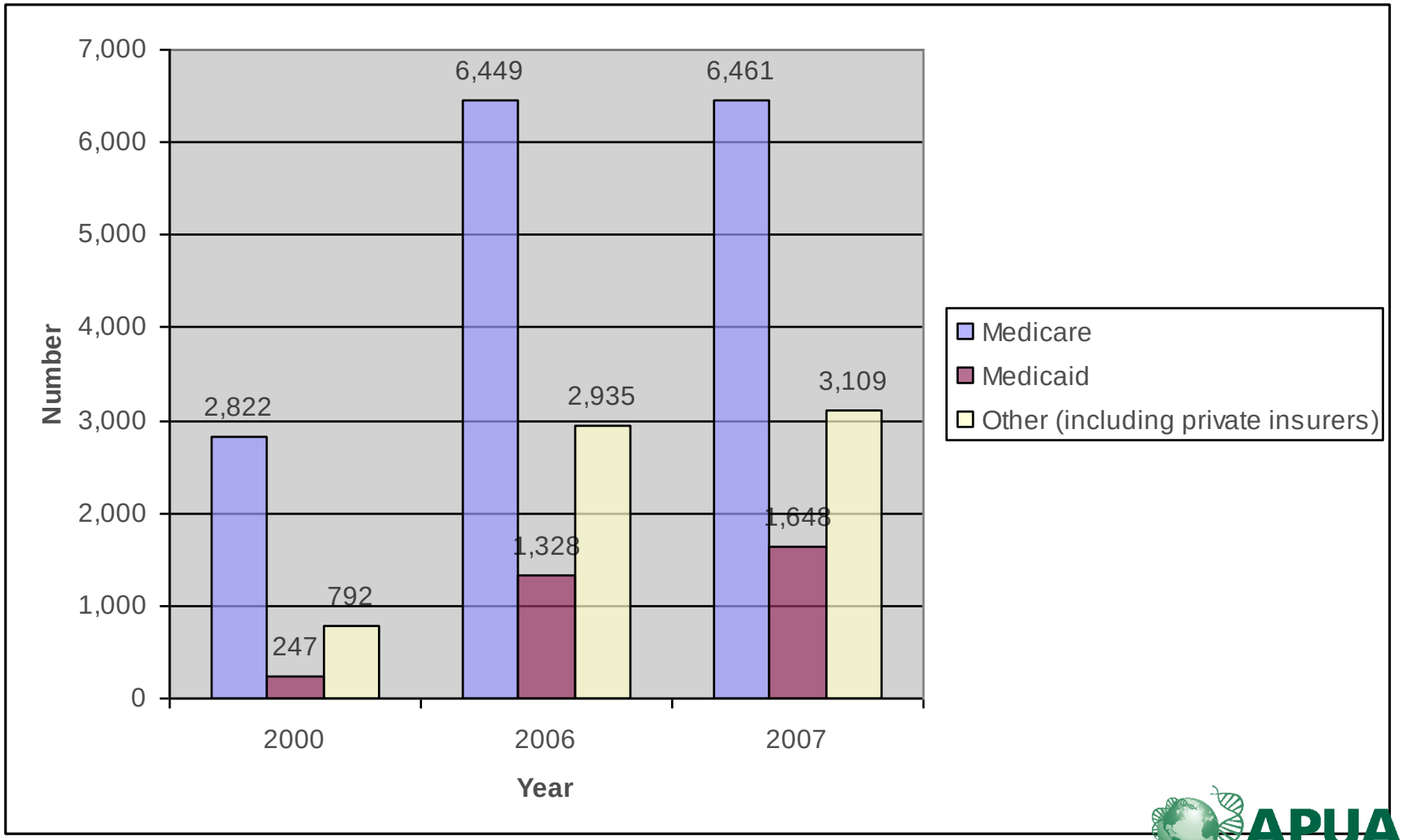
Drug resistant cases by payer, Massachusetts, 2000-2007



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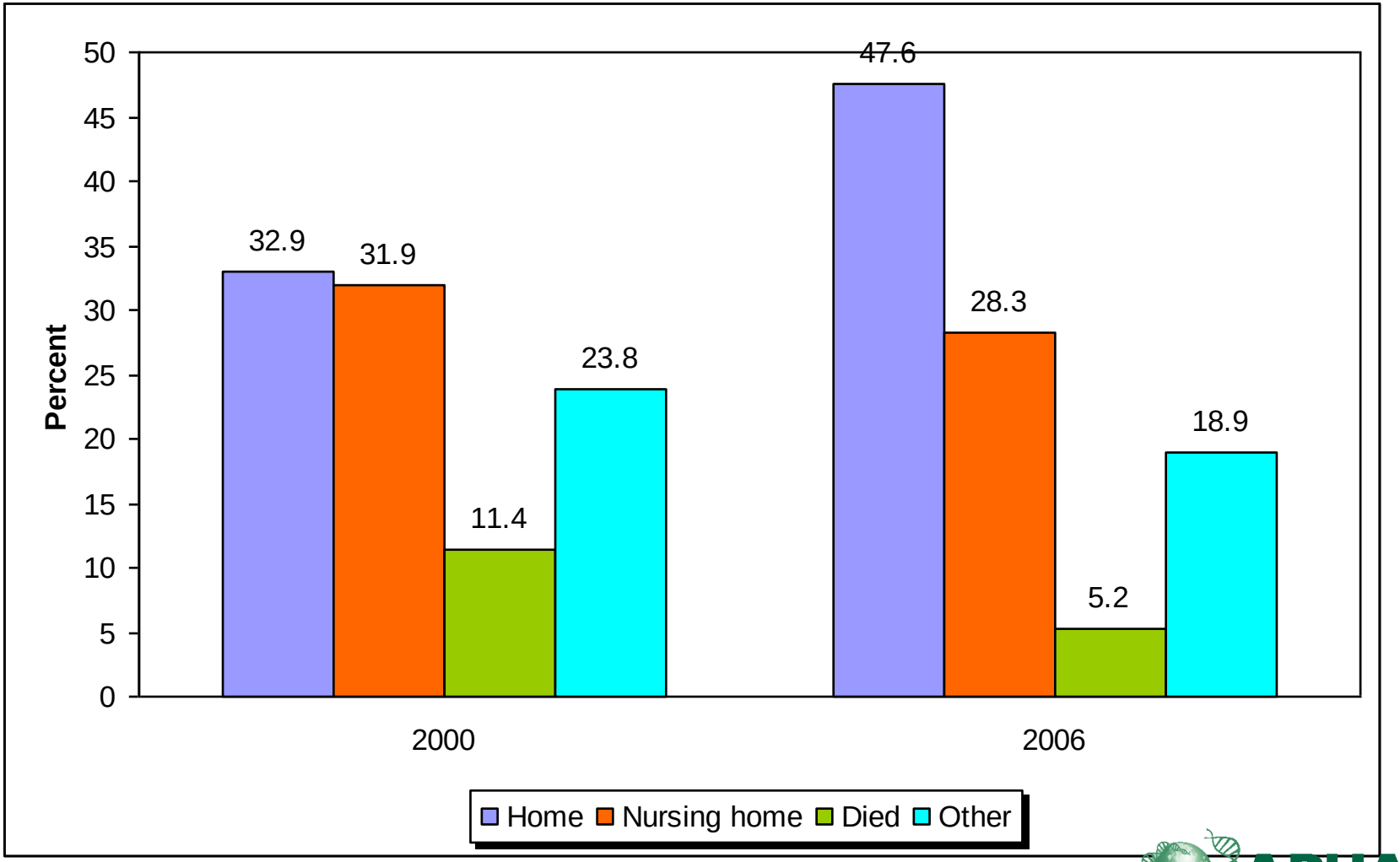
Destination of discharges, 2000 and 2006



The Chicago Cook County (Stroger) Hospital Study

- Based on Chicago Antimicrobial Resistance Project (CARP) dataset, expanded to include all resistant infections to measure costs attributable to ARI
  - Random sample, age>17 years, and >5 ICD9 codes at discharge
  - Exclusion for trauma, burn, or obstetrical care
- Detailed chart review and costing of 1391 patients, of whom 188 (13.5%) had an ARI
- Excess LOS was 6.4-12.7 days
- Attributable mortality was 6.5%
- Societal costs estimated at $10.7-15 million in this hospital for this year (2000)
- Total cost estimated at $13.35 million in 2008 $

Characteristics of the patient sample

Characteristic	ARI patients	Non-ARI patients
All patients (n=1391)	188 (13.5%)	1203 (86.5%)
Age (years)	53.0	54.5
Male sex (%)	64.9	57.1
APACHE III Score *	54.8	40.1
Duration of stay (d) *	24.2	8.0
HAI *	135 (71.8%)	125 (10.4%)
Cost per day, US$ *	2,098	1,581
Total cost, US$ *	58,029	13,210
Death *	34 (18.1%)	36 (3.0%)
* P < .001		

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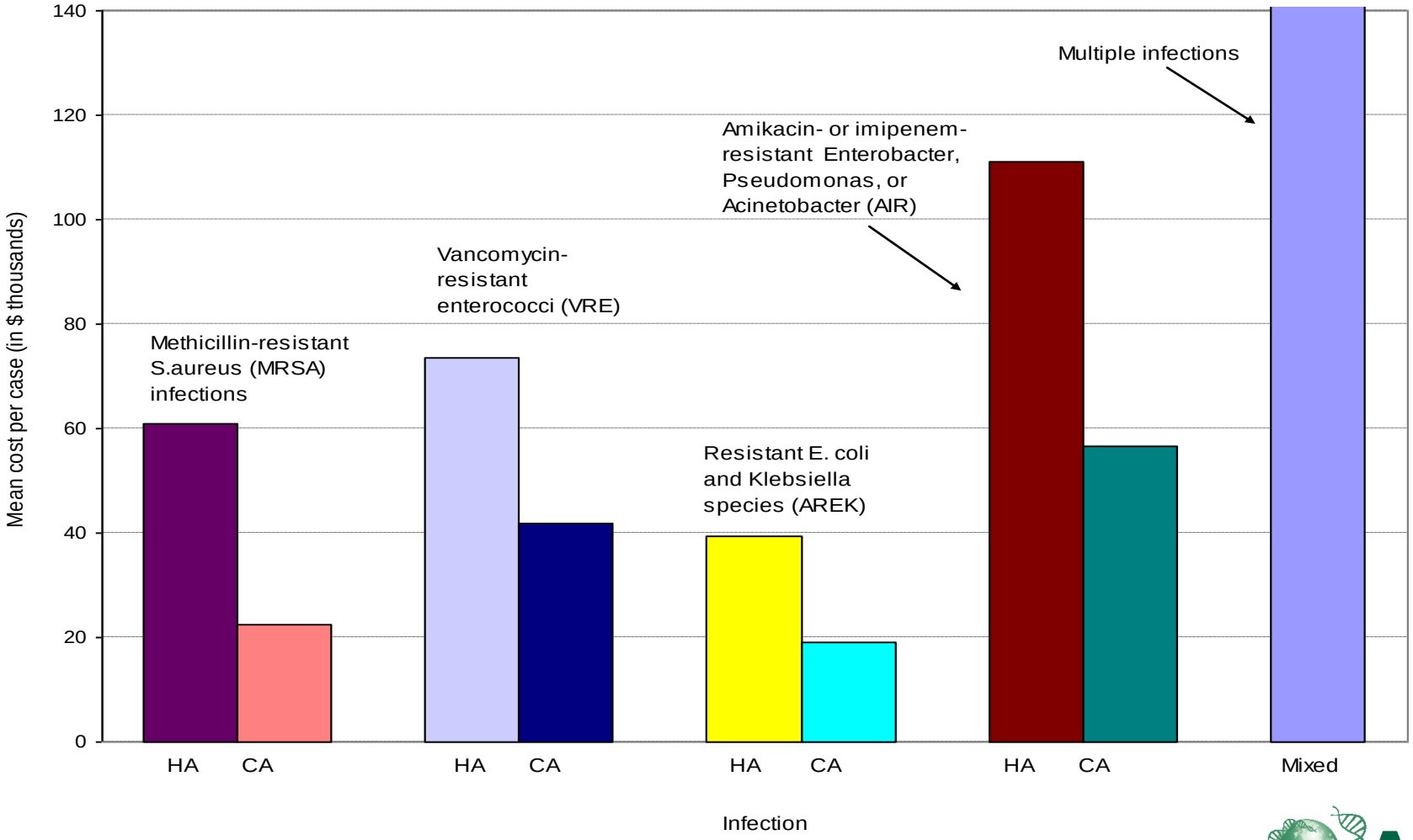
Costs of different infections: Chicago Cook County Stroger Memorial Hospital (hospital vs community acquired)



Source: RR Roberts et al, CID 2009:49, 1175-1184 (15 October 2009)

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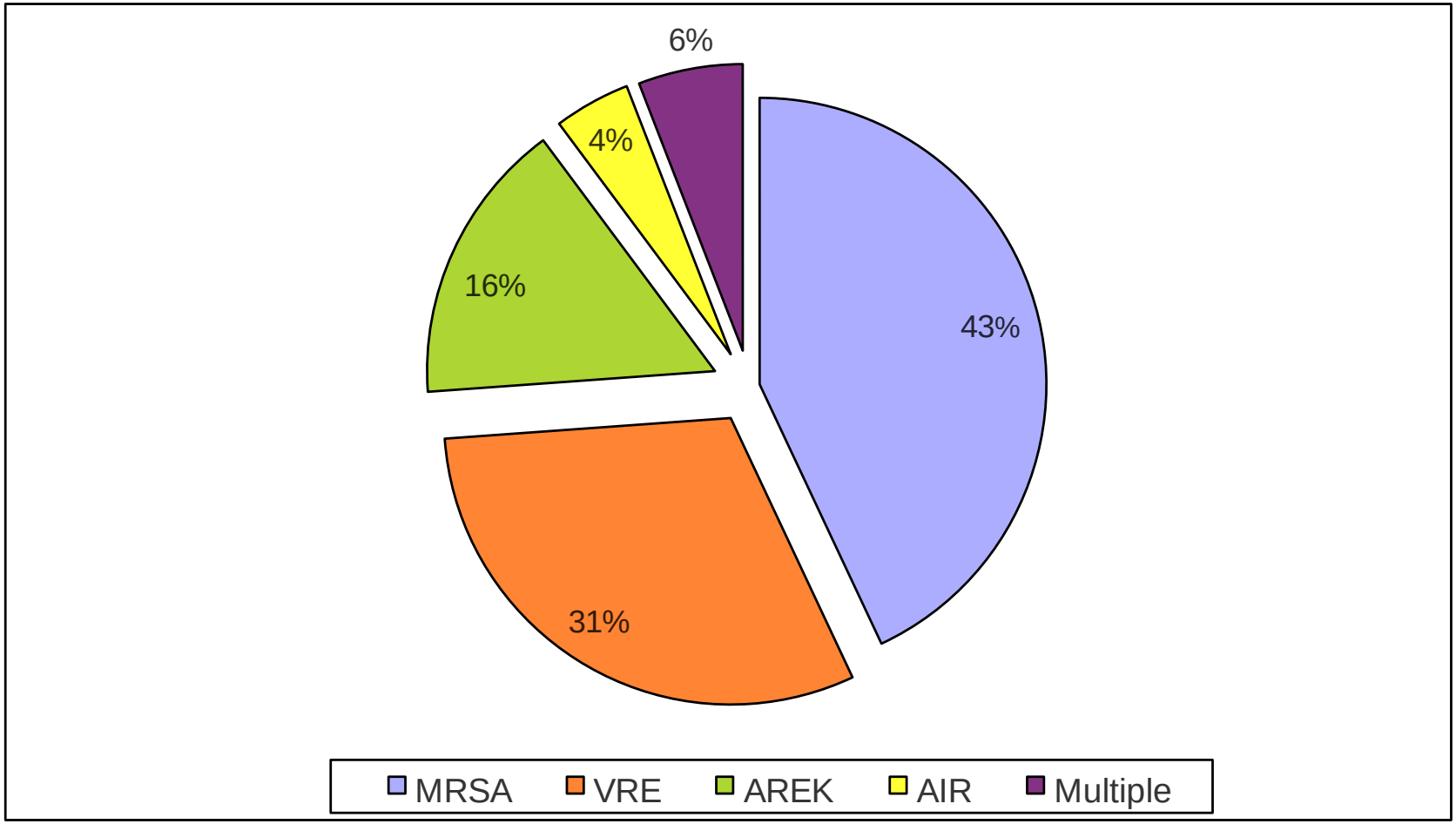
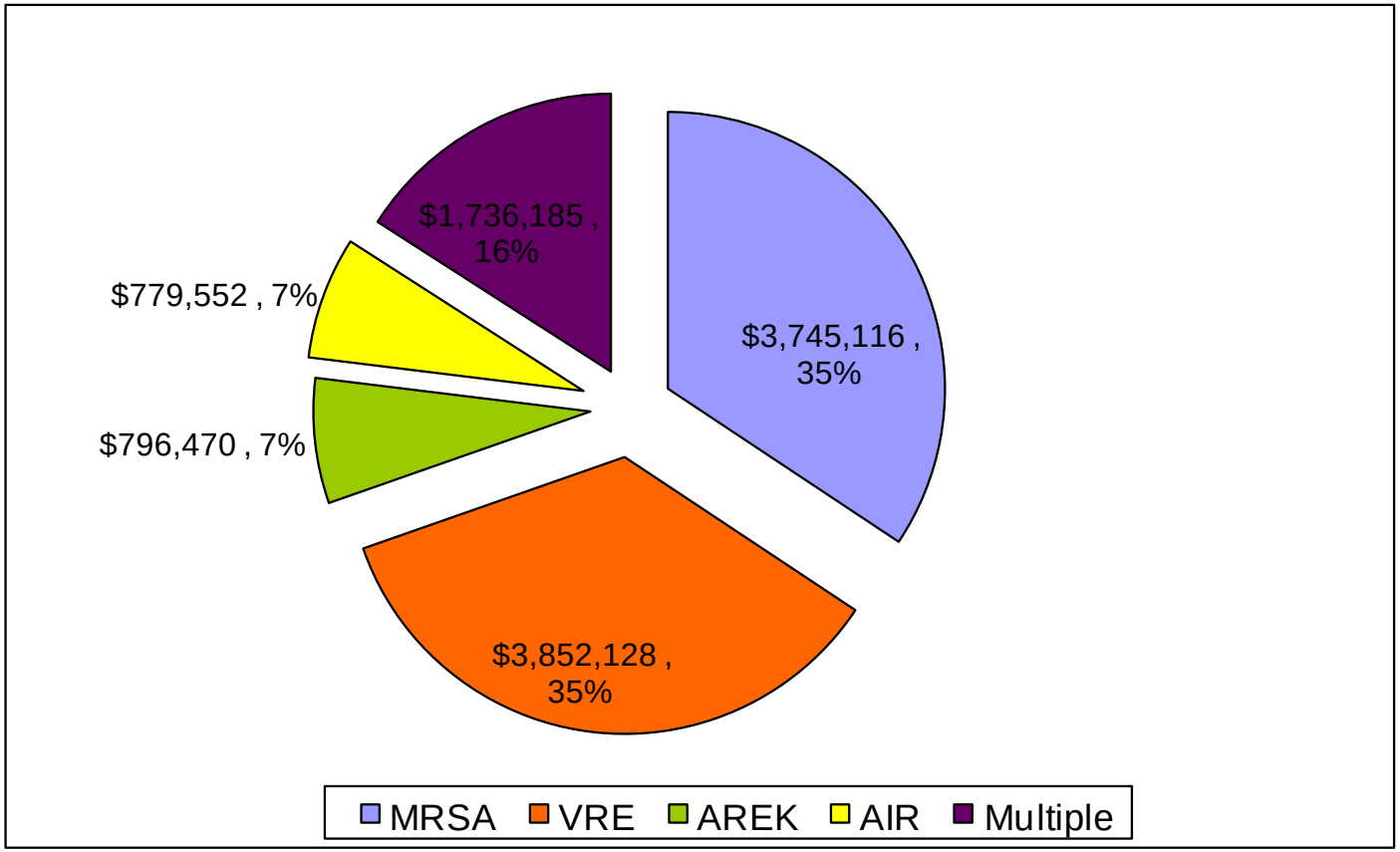
Overall resistant infections by type, Chicago Cook County Hospital (2000)



Contribution to total cost by infection, Chicago Cook County Hospital (2000)



Impact of infection on surgery charges

Engemann et al (CID 2003) found that

- Charges for surgeries: $29,455
- Non- AB resistant SSIs: $52,791
- AB resistant SSIs: $92,363
- Surgeries with AB resistant infections resulted in charges **3.1 times** those of surgeries with no infection
- Charges for surgeries with resistant infections were **1.75 times** those of AB susceptible infections
  - Engemann et al, CID 2003; 26:592-8.

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What does resistance add to costs?

Pathogen	Susceptible	Resistant	Difference
ESBL (Schwaber MJ, Antimicrob Agents Chemother 2006)	$16,877 LOS 5 days Mortality 35%	$46,970 LOS 11 days Mortality 18%	Cost: **2.8** x LOS: **2.2** x Mortality: **1.94** x
P. aeruginosa (Harris A et al, CID 1999)	$22,116	$54,081	Cost: **2.44** x
Various pathogens, Massachusetts, 2007	$15,104 LOS 4.7 days	$25, 380 LOS 9 days	Cost: **1.9** x LOS: **1.7** x

Source: cited in Slama TG, Critical Care 2008, 12(suppl 4):S4 and author's data from Massachusetts Hospital Discharge Database.

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The national burden

- Extrapolating to the US on the basis of Chicago data:
- In 2000, there were 900,000 admissions with same criteria as used in study
- Applying costs found at Cook County Stroger gives $16.6 - 26 billion additional healthcare costs (year 2000 costs)
- Updating the figure to 2009 costs gives approximately $21 - $34 billion using the CPI
- Using medical inflation rates the cost might be as high as $24 - 38 billion

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Study of impact of MRSA on patients and households

- Internet-based study of 300+ respondents
- Recruited through MRSA chatrooms and listservs, Google adwords
- Filters to screen out carriers and proxies
- Limitations of internet-based surveys
  - Computer access needed to learn about study and to complete it
  - Draws those most concerned -- linking through keywords, Google ads, chat groups
  - Biased towards those who are well enough to complete survey, and probably towards younger respondents

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Impact of MRSA on individuals

- *"I have been isolated/alienated from near everyone and everything; including being with my 2 small grandchildren. I had infected my father and two co-workers at my last job. I cannot be in the heat or any sunlight due to the antibiotics. I have no social life anymore, whatsoever. I am 52, single, no income, no insurance and scared to death…"*
  - 52 year old woman respondent

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Impact on individuals: another example

- *"It has destroyed my life. I cannot use my pool, maintain my house, earn a living, go anywhere for more than a few hours, and I've had to rehome 4 of my beloved birds. It is DEVASTATING! I can only stand for a few minutes at a time (I had a hip replacement that got infected and I currently have NO left hip.) I no longer go anywhere and have become a burden on my family. I hate my life."* – 59 year old woman

Reported out of pocket expenditures by MRSA patients (preliminary data)

Patients report a mean out of pocket expenditure of **$2251:**

Cost Item	Mean ($)	Median ($)
Outpatient visits (incl. co-pays)	588	222
Prescription drugs	222	100
Hospital stay	536	0
Wound care supplies	212	50
Non-prescription drugs	53	12
Home medical care	603	0
Mental health care	37	0

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Insurance status of respondents

Medicare	9%	28
Medicaid	6.1%	19
Private insurance, HMO, or PPO	68.6%	214
Uninsured	13.8%	43
Not sure	1.6%	5
Prefer not to say	1.6%	5
Other	9.6%	30

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Conclusion

- Burden of antibiotic resistance is rising steadily, although costs per patient may be declining
  - MRSA effect? Younger, healthier patients?
- Affecting younger age groups and consequently more with private insurance and uninsured
- Overall cost burden of hospital care may be as high as $38 billion
  - No good estimates seem to exist of cost in outpatient settings
- Individuals and households affected by drug resistance bear a large uncompensated burden in terms of out of pocket expenses and lost wages

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ICD9 V09 Codes for Drug-Resistant Infections

ICD9 Code	Full_Description
V090	Infection with microorganisms resistant to penicillins
V091	Infection with microorganisms resistant to cephalosporins and other B-lactam antibiotics
V092	Infection with microorganisms resistant to macrolides
V093	Infection with microorganisms resistant to tetracyclines
V094	Infection with microorganisms resistant to aminoglycosides
V0950	Infection with microorganisms resistant to quinolones and fluoroquinolones without mention of resistance to multiple quinolones and fluoroquinolones
V0951	Infection with microorganisms resistant to quinolones and fluoroquinolones with resistance to multiple quinolones and fluoroquinolones
V096	Infection with microorganisms resistant to sulfonamides
V0970	Infection with microorganisms resistant to other specified antimycobacterial agents without mention of resistance to multiple antimycobacterial agents
V0971	Infection with microorganisms resistant to other specified antimycobacterial agents with resistance to multiple antimycobacterial agents
V0980	Infection with microorganisms resistant to other specified drugs without mention of resistance to multiple drugs
V0981	Infection with microorganisms resistant to other specified drugs with resistance to multiple drugs
V0990	Infection with unspecified drug-resistant microorganisms, without mention of multiple drug resistance
V0991	Infection with unspecified drug-resistant microorganisms, with multiple drug resistance