

Fourteen-Year Trends in Pacemaker Implantation in the United States

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Introduction

- The World Survey¹ reported that US patients receive more dual chamber (DDD) pacemakers (PM) compared to Canada and most European nations
- DDD PM, as a % of total PM volume, increased from 1997-2001
- BiV PM began to be implanted in 2002
- We studied the national annual PM implantation rate from 1993-2006

Research Questions

- How has the epidemiology of PM utilization evolved over the past 14 years?
- How has hospital resource utilization for PM procedures evolved?
- What are the future implications of historical pacemaker trends?

Hypothesis

- There would be continued growth in DDD and biventricular (BiV) PM, as compared to single chamber (VVI and AAI) PM in the US

Methods – Historical Trends I

- The Nationwide Inpatient Sample (NIS) was queried to identify PM implants from 1993-2006 using the following ICD-9-CM procedure codes:
 - Dual chamber (DDD) PM: 37.83
 - Single ventricular (VVI) PM: 37.81-82+37.71
 - Single atrial (AAI) PM: 37.81-82+37.73
 - Biventricular (BiV) PM: 00.50*

*New code in 2002

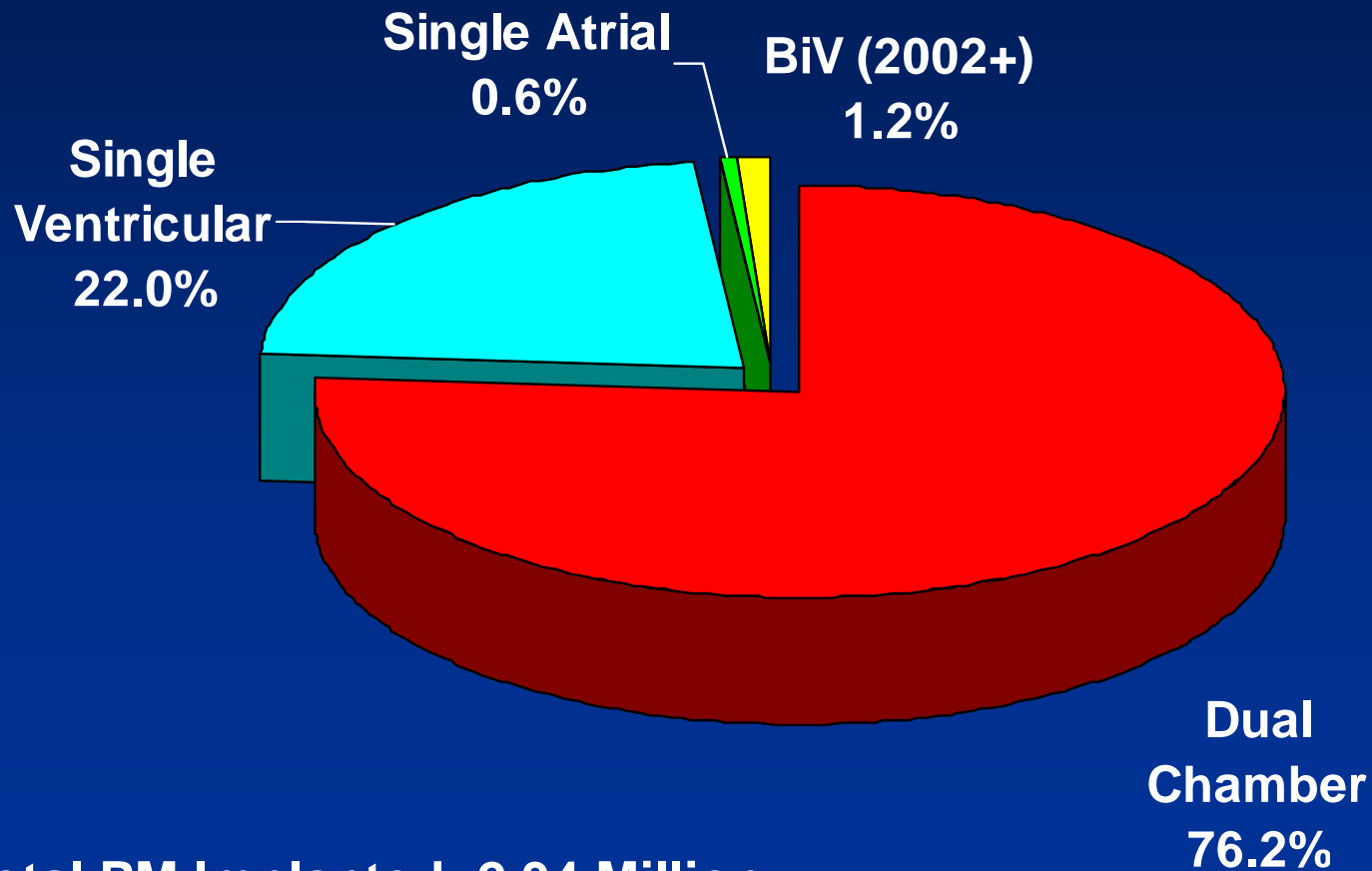
Methods – Historical Trends II

- The NIS is an annual statistically valid survey of ~1,000 hospitals and contains ~20% of hospitalizations within the US regardless of payment source
- Annual PM implantation rates, changes over time, and patient/procedure attributes were calculated
 - Mortality
 - Length of stay
 - Inpatient charges/cost (in \$2008)

Statistical Methods

- Rate of PM implantation indexed by: calendar year, age, sex, & Census regions
- Number of implants in each sub-group assumed to follow a Poisson distribution
- Population in each sub-group was obtained from the US Census Bureau
- Implant rate was modeled by a Poisson regression, adjusting for demographic and temporal differences

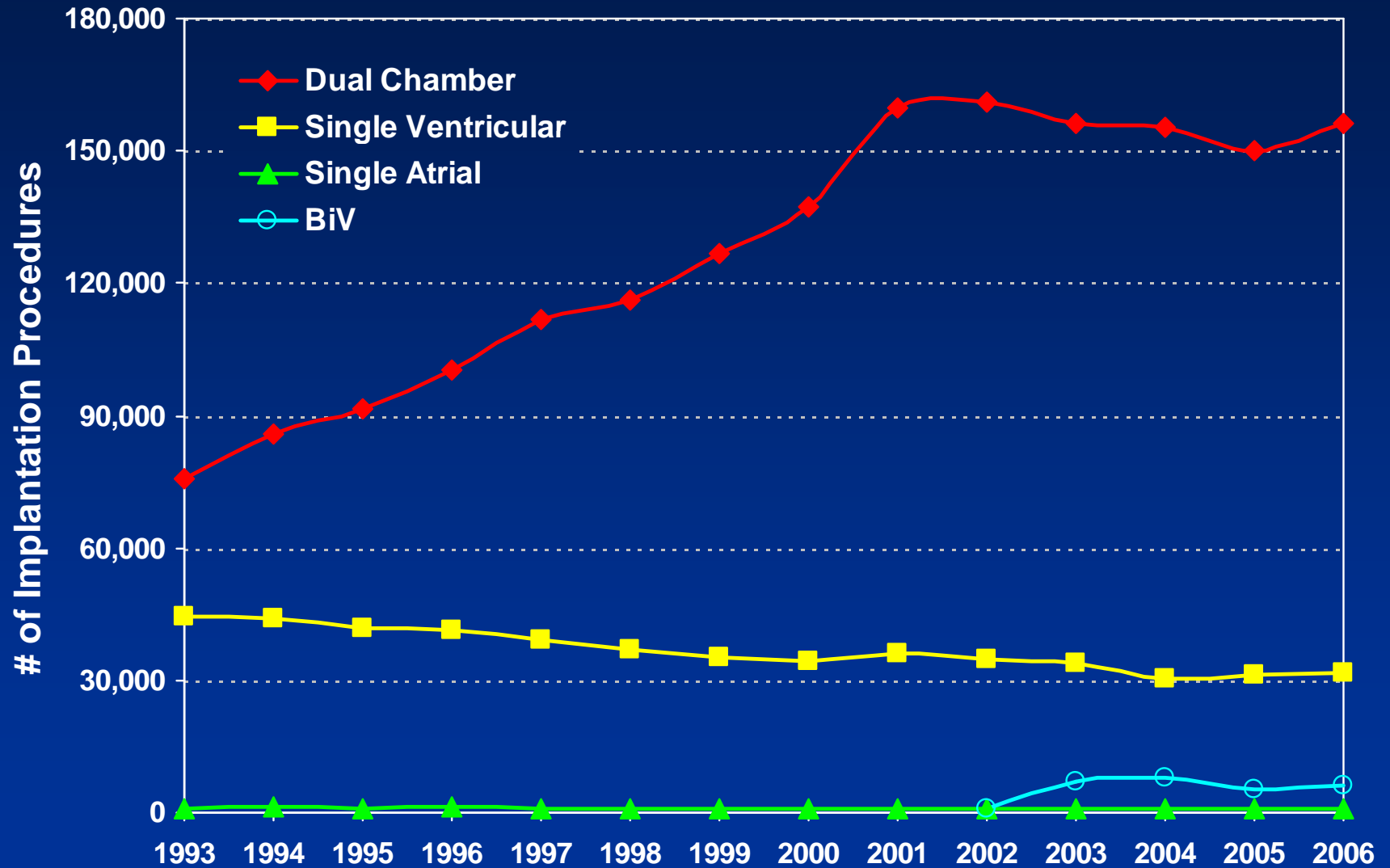
Pacemaker Implantations in the United States: 1993-2006



Total PM Implanted: 2.34 Million

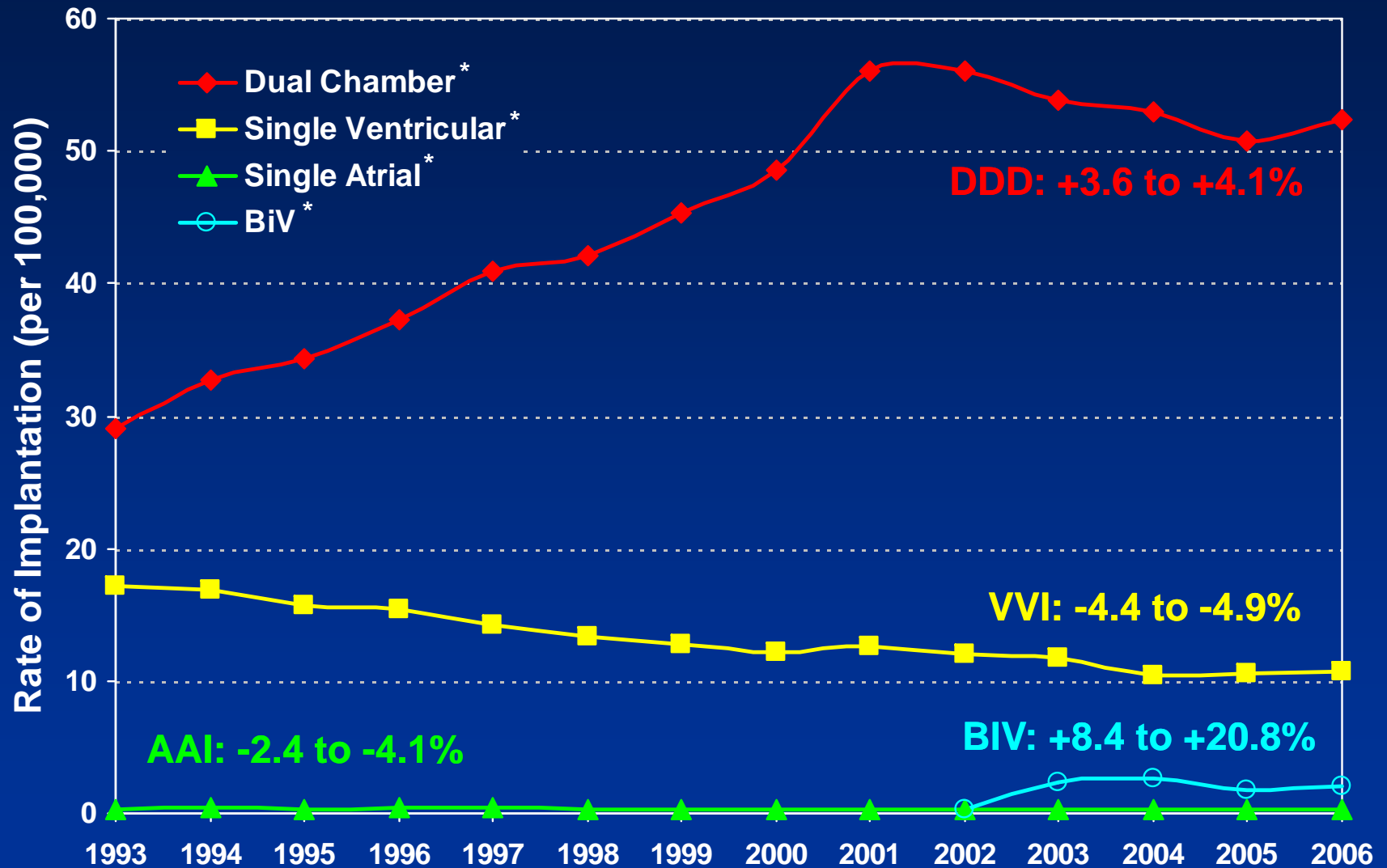
Incidence of Pacemaker Implantation

HCUP NIS Data, 1993-2006



Rates in Pacemaker Implantation

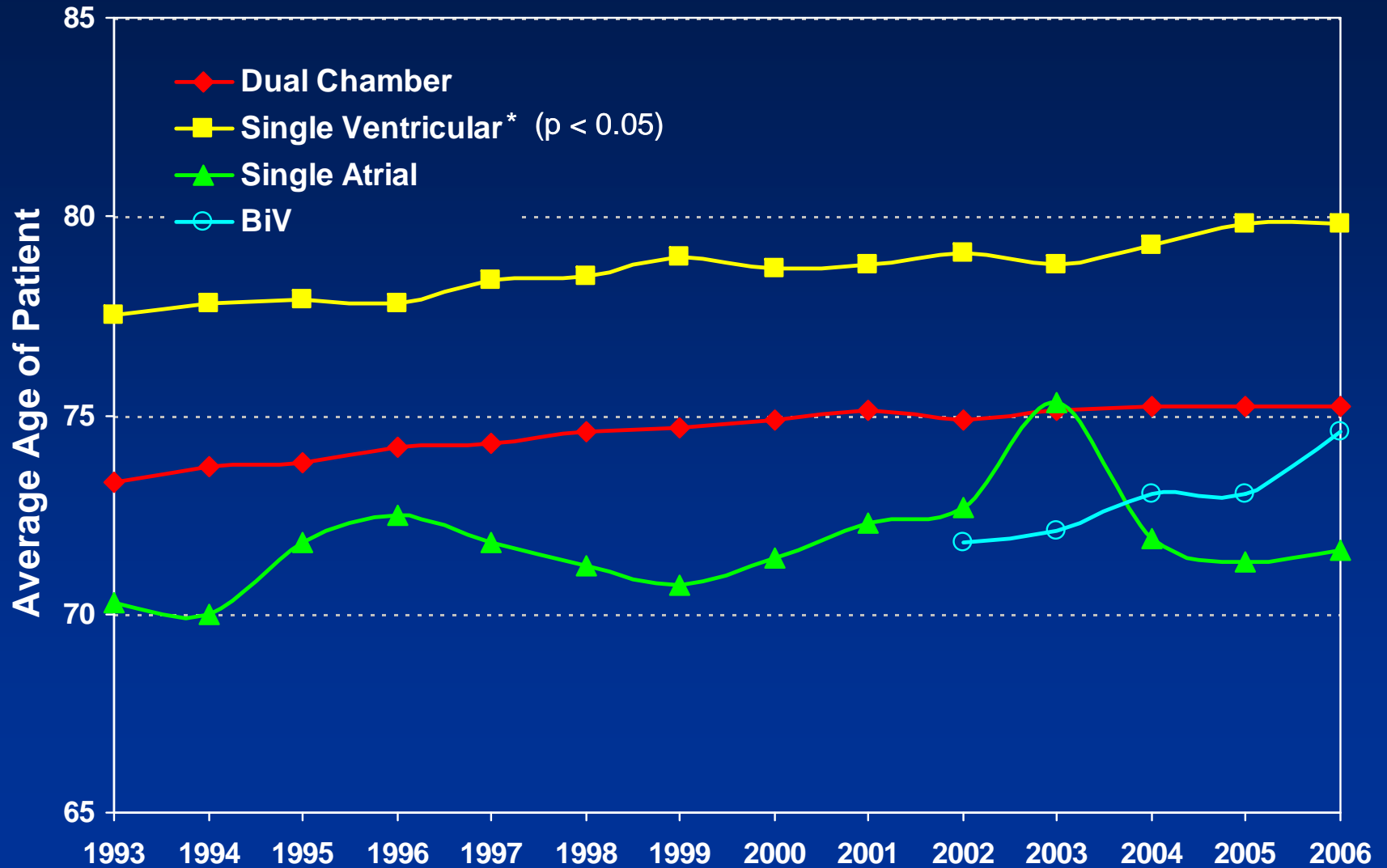
HCUP NIS Data, 1993-2006



*Temporal Trend Significant: $p < 0.0001$

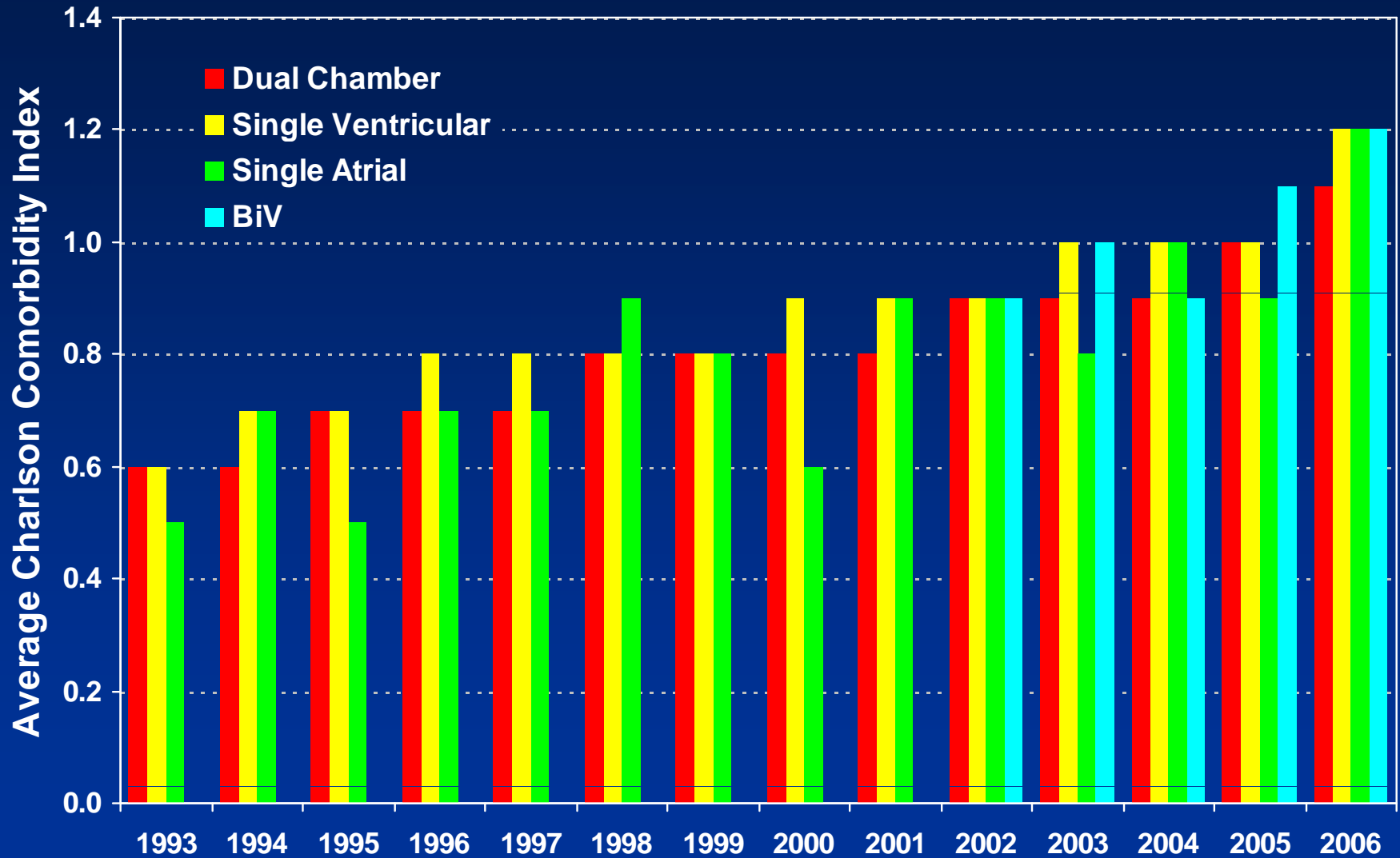
Trends in Pacemaker Patient Age

HCUP NIS Data, 1993-2006



Trends in Patient's Level of Comorbidity

HCUP NIS Data, 1993-2006

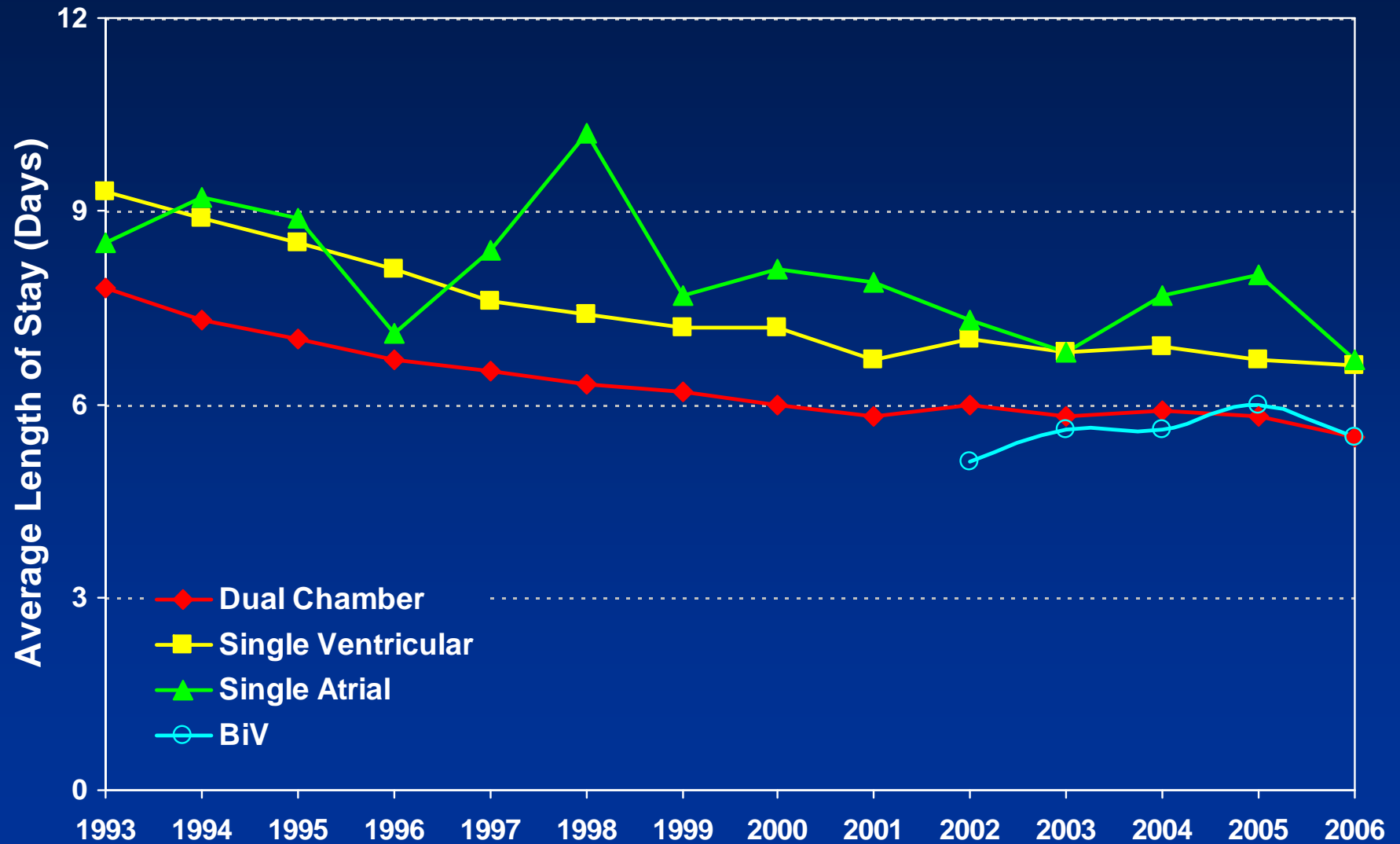


Hospital Trends

- VVI PM were implanted more often in teaching hospitals (51.5%)
- DDD (52%), BiV (65%) and AAI (57.4%) PM were implanted more often in urban non-teaching or rural hospitals ($P < 0.001$)
- In hospital survival was 98.6% for DDD patients, similar with BiV (98.3%, $P > 0.05$) and higher than VVI (97.8%, OR=1.64, $P < 0.001$) and AAI (97.8%, OR=1.71, $P < 0.001$)

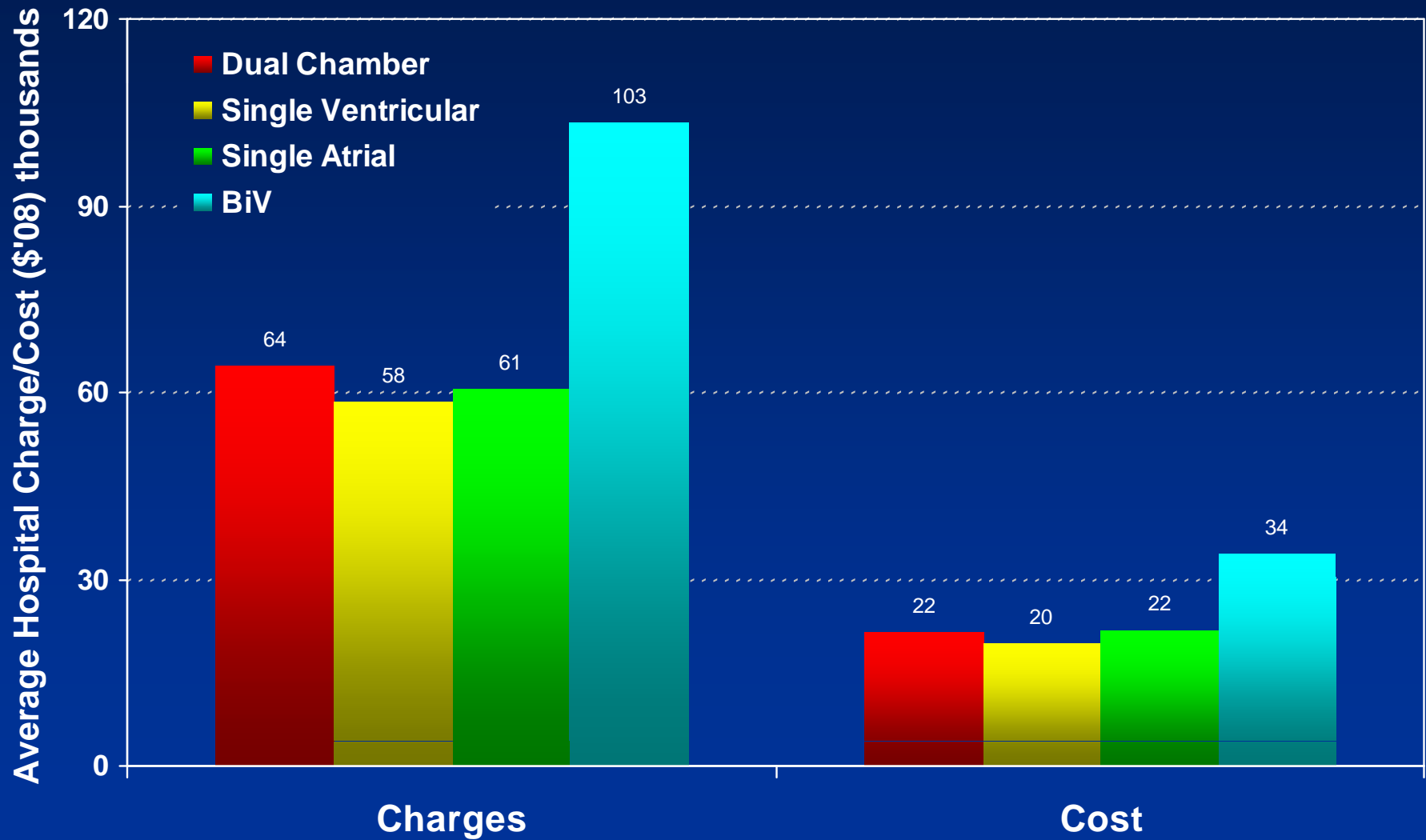
Trends in Length of Stay in Pacemaker Surgery

HCUP NIS Data, 1993-2006



Inpatient PM Charges v. Costs in 2006

Average Hospital Charge & Cost (HCUP Cost-to-Charge Conversion)



Discussion

- Plateau in DDD PM between 2003-2006, and decrease in % of DDD PM from 2000 to 2006
 - Increased utilization of BiV PMs and implantable cardioverter defibrillators (ICDs)¹
- Strengths
 - Largest nationally representative database
 - Covers all patient ages, payers, hospital types
- Limitations
 - Administrative data
 - Hospitalization only

Future Implications?

- Although overall totals were presented, historical analysis of surgery rates in sub-populations would provide additional insight
- Projected sub-population growth
 - US Census
- Projection analysis of surgery rates in sub-populations
 - Poisson regression
 - Point estimates and 95% CI

Future Demand: Projection Methods

- Subpopulation projection =
 - (projected sub-population_{year}) X (projected rate_{year})



- National projection
 - Sum of projections for sub-populations



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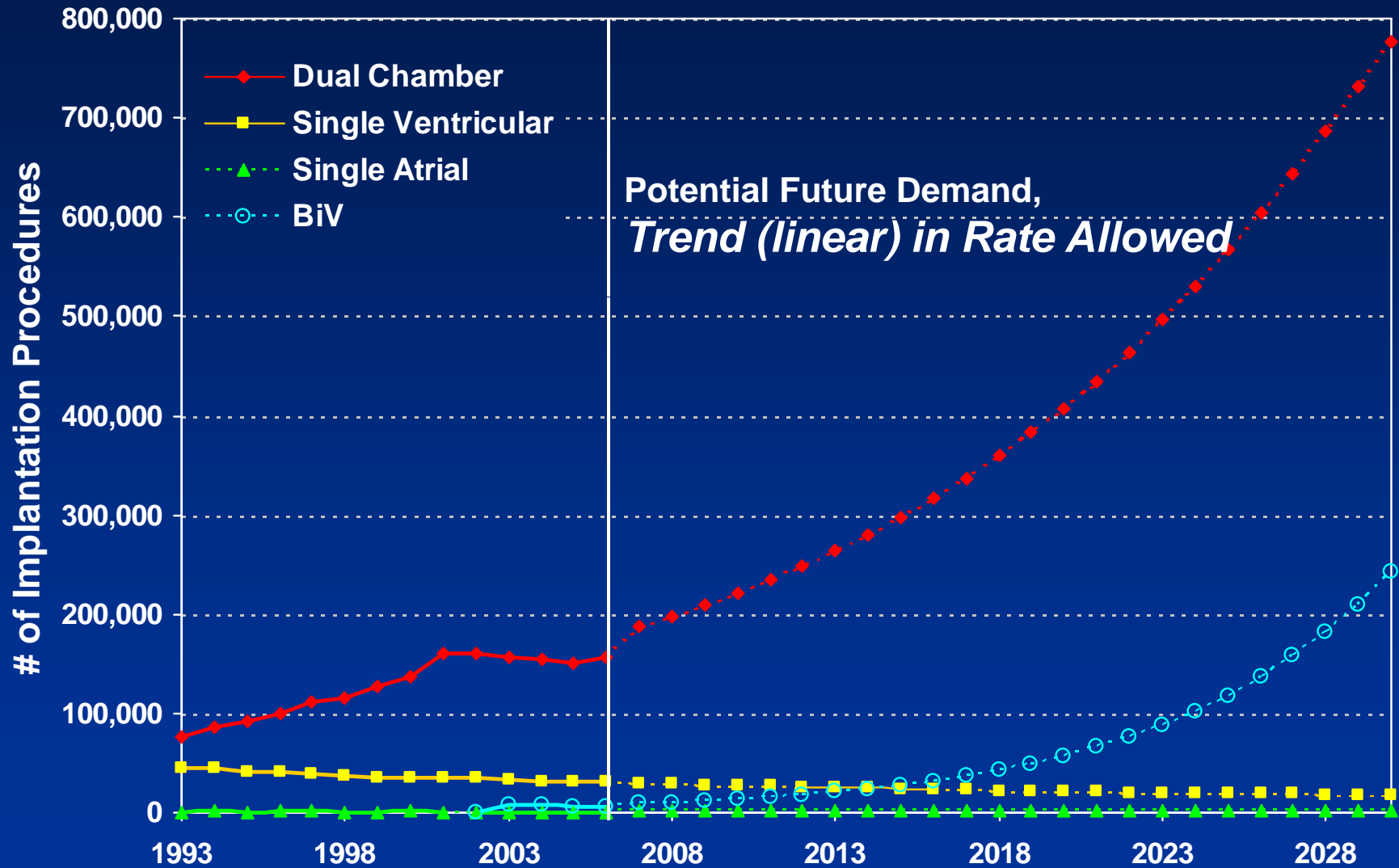


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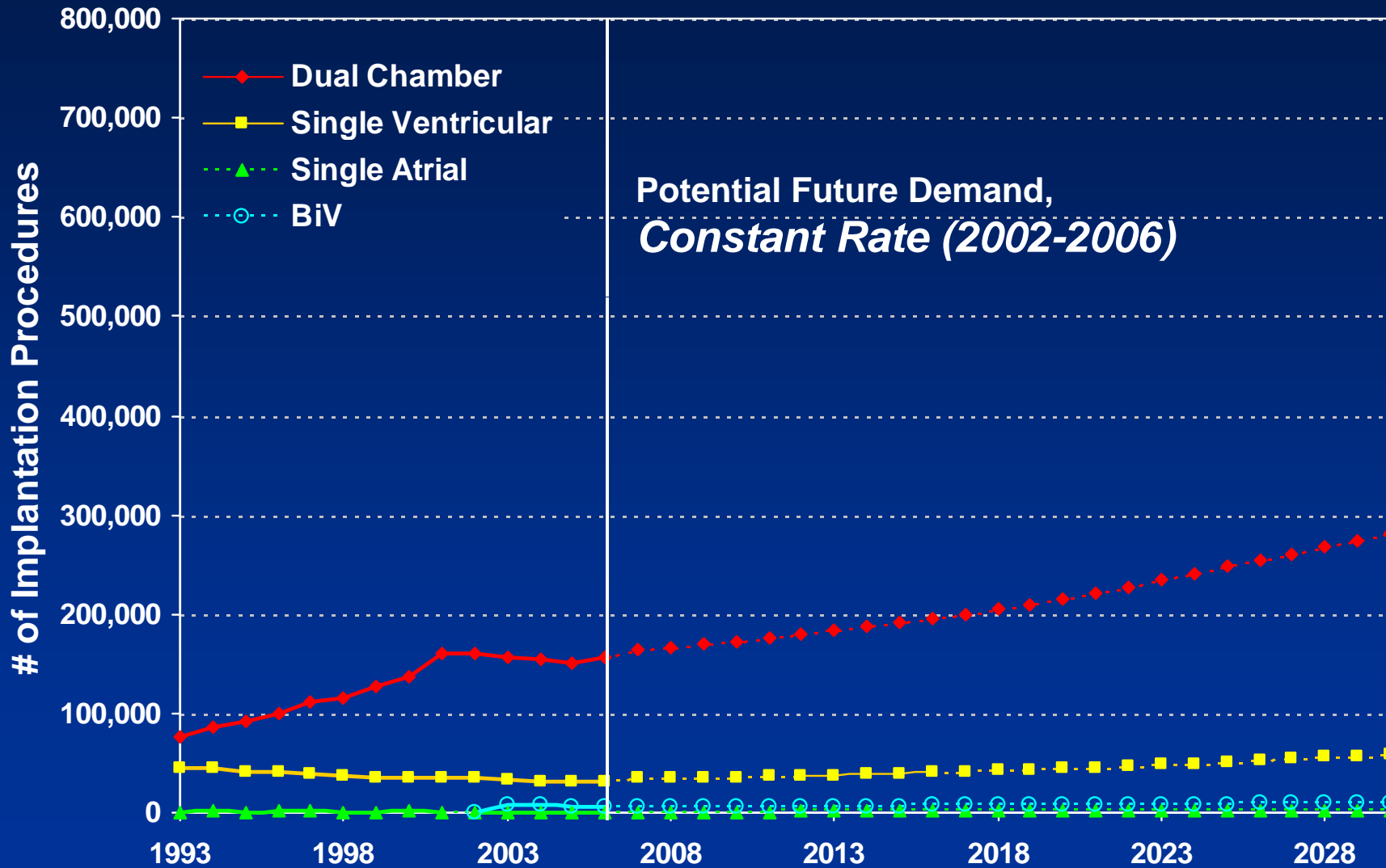
Future Demand for Pacemaker Implantation

HCUP NIS Data, 1993-2006



Future Demand for Pacemaker Implantation

HCUP NIS Data, 1993-2006



Conclusions - I

- DDD PM constitute the vast majority of US implants
- There was a steady growth in DDD PM implantation in the US from 1993 to 2002, followed by a decline from 2003-2006.
- This decline in DDD PM was associated with an increase in BiV PM (and ICD) implantation rates over the same period

Conclusions - II

- The decline in VVI PM implantation may be partly due to increasing recognition of harmful effects of RV pacing, although teaching hospitals implanted more VVI PM
- These trends justify scrutiny and periodic updates, and may shed light on future PM implantation rates

Thank You!

- Questions?
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