3.12% in 1998 compared to 1.25% in 1994 and 0.27% in 1998 for the U.S. and the teaching hospital respectively. The 365-day mortality rates are 8.16% in 1994 and 8.77% in 1998 in the U.S. and 7.21% in 1994 and 6.15% in 1998 in the teaching hospital.

Conclusion

While this report in no way substitutes for a comprehensive evaluation of the major research and teaching hospital in this study, it does provide preliminary evidence that the hospital being reviewed exhibits many of the characteristics we would expect to find in a large, research-oriented teaching hospital. Patients admitted to the hospital were far more likely to undergo both PCI and CABG during their initial admission. Moreover, they were less likely to experience complications or to die during the initial admission. For the 365 days following the initial admission of patients to the hospital, these encouraging trends continued: IHD patients who received PCI following CAG were less likely to be readmitted, less likely to die and more likely to spend fewer days in the hospital. In addition to the positive patient outcomes and high procedure rates, the hospital was quicker to adopt new medical technology than the rest of the country. In the case of stents, the hospital introduced the new medical technology at a faster rate than the U.S. average during the first two years that the technology diffused into medical markets.

On the merit of these results, we are comfortable identifying this hospital as a leading research-oriented teaching hospital in the U.S. As such, we anticipate that a comparison with a leading Japanese hospital will be very interesting for researchers, clinicians and hospital administrators in both countries. We look forward to the next stage of this project and to the interesting research results that this project will produce.

Section III. Procedure Utilization Trends in a Major U.S. Research Hospital

Based on the promising results obtained from the preliminary analysis at the U.S. teaching hospital described in Section II, researchers in Japan and the United States have continued to refine the protocol for this project to optimize the comparability of the data available at the U.S. and Japanese hospitals. In Japan, where data is not collected systematically by the government, researchers and clinicians have developed clinically detailed data sets from individual hospitals that they use to assess the Japanese health care system. In the United States, where Medicare records have established the standardized format for data collection, few hospitals collect data that approaches the level of clinical detail available in the Japanese data set. To obtain detailed clinical data, researchers in the U.S. must undertake a time consuming and expensive chart review of the medical records for a hospital. This process is complicated by patient confidentiality concerns, a contentious issue widely debated in the U.S. at present.

As a result, rather than delve into the different clinical characteristics of the patients and attending physicians, it was decided that this project should focus on broader trends in outcomes by age and gender for procedure-based cohorts of patients at each hospital. We hope by undertaking such an analysis to accomplish several goals. First ***

We believe that this research represents a valuable step forward in understanding the differences in the ways that top medical facilities function within their national health care systems. We are appreciative for the opportunity to participate in this study and anticipate that we will be able to collaborate on many more projects in the years to come.

Data and Methodology

One of the major limitations of our pilot study was the absence in our analysis of patients from younger age groups, particularly those younger than 65. The reason for the exclusion of these patients was that our data was obtained solely from Medicare records, which, as the national insurance system for the elderly, only cover those 65 years of age and older. We have extended the scope of the analysis by incorporating data for patients under 65 years of age derived from inpatient claim records of all California hospital discharges from 1991-1996 reported to the

California Office of Statewide Health Planning and Development (OSHPD). The data for patients 65 years of age and older are identical to the data we used in the pilot study: the Medicare Provider Analysis and Review (MEDPAR) files for information on inpatient hospital care, the Outpatient Standard Analytic File for information on outpatient care, and HISKEW and Denominator records for information on patient demographic characteristics (age, gender) and date of death. We merged the Medicare files and linked them with population death registries to recreate the stays of patients over the age of 65 from 1994 through 1998. The data for a leading US teaching hospital were extracted from the Medicare data for patients 65 and older and from the OSHPD data for patients under 65. Using the unique hospital identification number for the hospitals to which a patient is admitted, we were able to identify all patients who were admitted to the teaching hospital for care from 1994 to 1998 (Medicare) or 1994-1996 (OSHPD).

Within each dataset, we constructed six procedure-based cohorts using International Classification of Diseases 9^{th} revision – clinical modification codes: 1) ICD-9-CM 36.01 and 36.02: patients who received percutaneous intervention (PCI) in a single vessel (SVD), 2) ICD-9-CM 36.05: patients who received percutaneous intervention (PCI) in multiple vessels (MVD), 3) ICD-9-CM 36.11: patients who received coronary artery bypass graft (CABG) surgery in one coronary artery, 4) ICD-9-CM 36.12: patients who received coronary artery bypass graft (CABG) surgery in two coronary arteries, 5) ICD-9-CM 36.13 and 36.14: patients who received coronary artery bypass graft (CABG) surgery in three or more coronary arteries, and 6) patients who received more than one procedure on the same day.

As in the preliminary analysis, the sample sizes for the teaching hospital's cohorts are problematic, especially since the disease-based cohorts are further disaggregated by age and gender. While this is not a problem at the national or state level, the small number of patients in a demographic cell at one hospital may cause sampling errors. In our single hospital sample, only 5 women under the age of 65 received percutaneous intervention (PCI) in multiple vessels in 1994 and 1995 combined, making our results vulnerable to outliers and natural fluctuations in the patient cohort. To enlarge the number of observations in each cohort, we collapsed years into two time periods, 1994-1995 and 1996-1998.

Using our six procedure-based cohorts, we calculated simple unadjusted means of the outcome rates (length of stay, hospital re-admissions, and mortality) by age-groups and gender for different time frames. In addition, we expanded the analysis to include information on costs of the initial admission. Unfortunately, in the United States, it is often difficult to determine the actual cost accrued by a patient during his or her stay because the charges claimed by the hospital for reimbursement from the payer (Medicare for those 65 and older, another insurance provider for those under 65) often are different from the amount the payer reimburses the hospital. Furthermore, OSHPD and Medicare report comparable charge data, but not reimbursement data. The OSHPD data set provides charge data during the first admission. The Medicare data set provides charge and reimbursement data for the first admission. The reimbursement data is calculated from the disease related groups (DRGs) into which a patient is grouped.

Our findings from this analysis are described below. Please note that we have not attempted to draw conclusions from the data, as conclusions at this stage are meaningless without the data from the Japanese teaching hospital for comparison. We will leave this task to our Japanese counterparts who will have access to data from both hospitals and both countries. Our aim is to provide a [descriptive framework] for reviewing the U.S. results, focusing particularly on differences in treatment and outcomes between demographic groups within the hospital.

Results

Make certain same general findings regarding US and hospital as reported in preliminary analysis – then sentence that same general trends hold as were earlier reported and instead will focus on trends just within the US hospital except when new results should be reported.

Changes in U.S. teaching hospital cohort over time:

- Table 3: sample size of procedure by age and gender (Delete?)

- Figure 12: Number of patients in a leading US hospital by procedure (Higher frequency for PCI SVD and CABG DVD so focusing more on these procedures in subsequent analysis.
- Figure 10: Share of Patients with Procedures by age and gender (1994-1995)
- Figure 11: Share of Patients receiving procedures " " " (1996-1998)

LOS:

Major results

1. LOS appears to be decreasing over time, for US, CA and hospital (although trend not a clear for hospital).
2. Larger LOS for women than men across the board for comparable agegroups, but decreasing for both genders, although by less for women
3. LOS different across US – US average>CA average>hospital
4. Longer LOS for more sever treatments (graph average for all age groups across treatments)

MORTALITY:

1. Increasing over longer range time periods for hosp, ca and US (use one age and gender and procedure to show), but overall decrease over time and US>CA overall (hard to tell for hosp)
2. Women have higher mortality rates than men for comparable age groups (use 1 year or 90 day) – rate of increase or decrease larger for women or men?
3. Mortality increases with age (

Crossover Rates

1. No CABG patients receive CABG subsequently at teaching hospital (with one exception) – less than 1% for all age groups in both US & CA receive subsequent CABG following CABG
2. Between 6%-0% of PCI patients subsequently receive any type of CABG – no consistent trends across CABG crossovers in terms of rates for men versus women or the elderly versus

other age groups over our time period. CABG crossover occurs more often among PCI SVD patients than PCI DVD patients, although this may be an artifact of the small sample sizes.

3. Of crossover procedures performed at the teaching hospital among our cohort of patients, PCI SVD was performed most frequently, followed by PCI MVD. Crossover PCI SVD rates slightly higher for all age and gender groups in teaching hospital than national or state average.
4.

Stent Use - is this following treatment, or included in the treatment

1. Large increase across all age groups and genders for stent use from 1994-1995 to 1996-1998 – not surprising considering that stents were introduced into medical practice around 1995.
2. Virtually no CABG patients received stents
3. For Men, clear increase use with age; for women, no clear trend by age – PCI MVD patients are less likely to receive stents with age, elderly PCI SVD patients more likely.

Charges and Reimbursement

1. Charges much higher at hospital than in nation – prices on par with CA prices
2.

Major teaching and research hospitals often service patients who cannot be treated by smaller, less well-equipped hospitals. Often, these larger hospitals serve as regional hubs that dispense care for certain pre-specified conditions because of their state-of-the-art facilities and specialists who perform these conditions. Because of this process of sorting patients by severity, we would expect to find that patients admitted to the teaching facility in this study to be less healthy than the national average and to exhibit more co-morbid conditions, to be older than the average and to have more severe diagnoses.

In order to determine whether sicker patients are transferred to the teaching hospital for cardiac care from the surrounding regions, we would need to compare the hospital's patient characteristics to the to a similar cohort created at the regional level. Undertaking a comparison of patient characteristics between one hospital and the national average is not helpful unless we can assume that the underlying populations are similar. As illustrated in Table 1, the cohorts from the teaching hospital tended to be older, have a larger percentage of men and be slightly less racially diverse, although this could be an artifact of the way Medicare reports race. Medicare records a patient's race as either black or non-black, combining Latinos/Hispanics, Asians and Caucasians into the "non-black" label.

In Table 2, IHD patients from the teaching hospital and in the U.S. exhibited similar rates of co-morbidities: the U.S. average of patients with co-morbidities of diabetes and chronic obstructive pulmonary disease (COPD) is slightly higher than the rates of these co-morbidities for the teaching hospital and patients in the teaching hospital had slightly higher rates of hypertension and peripheral vascular disease. As we can see in Table 1, patients in the U.S. cohort were more likely to have diseased vessels than patients at the teaching hospital. Interestingly, patients at the teaching hospital had higher rates of prior PCI and CABG, although since we did not investigate where patients received these procedures, we cannot use this information as an indication of higher procedure use at the teaching hospital. These general trends in patient characteristics are consistent across all three procedure based cohorts. However, as mentioned before, the significance of the cohort differences are best determined at the regional level.

Clearly, examining the patient cohort is not sufficient to determine whether a hospital can be classified as a high-tech research facility. More appropriate measures of a high-tech teaching hospital are 1) high rates of procedure utilization, 2) early treatment adoption rates for new treatments such as stents and statins, and 3) better outcomes. These measures should not be compromised by underlying heterogeneity to the same extent as the data on patient characteristics were. By comparing these three measures for the U.S. average and the average from the teaching hospital, it is possible to ascertain whether the teaching hospital conforms to our standards for a leading high-tech hospital. We will begin with comparison of the procedure utilization rates.

Looking at the treatment trajectories of patients after they receive CAG, we find significantly higher rates of procedure utilization at the teaching hospital compared to the national average. Of the patients who received CAG at the teaching hospital, approximately 70% received PCI within the same admission, approximately 17-11.5% received CABG and only 15% to 10% received no treatments. Compared to the national average, where of the patients who received CAG, only 3% to 4% received PCI, only 5.50% – 6.73% received CAGB, and most patients (74% - 71.5%) received no medical treatment at all during the first admission, the teaching hospital appears to be better equipped to respond quickly to the needs of patients during their stay at the hospital. The rates of procedure use by IHD patients within a year after CAG remain high in the teaching hospital (PCI: 69.11% in 1994 to 74.21% in 1998; CABG: 18.36% in 1994 to 12.70% in 1998; no treatment: 12.96% in 1994 to 9.13% in 1998) while the U.S. average increased for PCI to 34% in 1994 and 43% in 1998, decreased for CABG (29.13% in 1994 to 26.17% in 1998) and for patients who received no treatments (28.82% in 1994 to 22.33% in 1998). Please see Chart 1 and Chart 2 for graphical illustration of these trends for all years. Part of the increase in treatment rate for the U.S. average in the year following CAG can probably be account for by the fact that many patients who received CAG were subsequently transferred to a facility like the teaching hospital that had the equipment necessary to perform the requisite procedures. Likewise, the high rates of procedure utilization of patients admitted to the hospital during their initial stay probably reflects the fact that many patients were transferred to the hospital specifically to receive PCI or CABG.

Another characteristic of leading research teaching hospitals is the early adoption of state-of-the-art medical technology. Though it can be difficult to identify patterns of early technology adoption, the introduction of stents, a mesh-like device inserted into diseased arteries to maintain blood flow, in the mid 1990's make it possible to study this effect. In Chart 3, our data shows that stents were not used in PCI surgery in the U.S. or in research hospital in 1994. Beginning in 1995, stents started to be used across the United States at a rate of 7.23% in IHD patients who had received CAG. Comparatively, in the same year, doctors in the research hospital used stents at a rate of 10.80%. The following year revealed another large increase in the use of stents, 41.67% in the U.S., and 47.65% at the research hospital. In 1997 and 1998, the U.S. rate surpassed the rate of stent use in the research facility, however, we can speculate that the slowing rate of increase in the teaching hospital reflects changing physician practice patterns rather than the unavailability of the technology. In the first two years of stent usage, the data do seem to indicate a pattern of earlier adoption as seen in the more rapid increase of stent utilization rates.

Finally, by comparing patient outcomes, we gain a sense of the relative quality of care available at the teaching hospital and in the U.S. as a whole. In general, we will be looking at the outcomes associated with PCI following CAG, since the small sample size for patients receiving CABG following CAG is potentially biased by random fluctuations in the patient cohort from year to year. On the whole, we find that patients treated in the teaching hospital had fewer complications and better outcomes than did the average IHD patient in the United States. First, the time from admission to PCI has steadily decreased for both cohorts; however, the absolute time frame is shorter for patients in the teaching hospital. In 1994, the mean wait was 0.73 days, decreasing to 0.41 days in 1998 at the teaching hospital. A similar patient in the U.S., on the other hand, waited 1.85 days in 1994 for the procedure, down to 1.24 days in 1998. Perhaps because of this difference, patients who received PCI at the teaching hospital spent approximately 1.5 to 2 fewer days in the hospital during their original hospital stay (4.01 days in 1994; 2.14 days in 1998) than the national average (5.76 days in 1994; 4.02 day in 1998). This trend of decreasing length of stays for patients receiving PCI continued for the first 30 days after the initial hospitalization (U.S. average: 6.51 days in 1994; 5.12 day in 1998; hospital average: 4.60 days in 1994; 2.54 days in 1998) and for the year after the initial hospitalization (U.S. average: 9.47 days in 1994; 8.71 days in 1998; hospital: 6.23 days in 1994: 4.43 days in1998). The shorter length of stay in the teaching hospital could be attributed to many factors: governmental policies that reward physicians and hospitals for decreasing patient stays, the high levels of managed care in the area surrounding the hospital, a healthier patient cohort, fewer procedure related complications and a lower readmission rate, among other factors. While it is not within the scope of this study to explore how the first three factors affect patient length of stay, it is possible to review rates of procedure-related complications and re-admissions.

The 30-day complication rates were relatively similar in the U.S. and the teaching hospital; less than 1% of patients from either cohort had complications within 30 days of their procedure. We see more of a difference in the 365-day complication rates, although the rates are still low for both cohorts. Post-operative MI occurs slightly more frequently in the average U.S. IHD patient (5.30% in 1994; 7.48% in 1998) than in a patient at the research hospital (4.70% in 1994; 4.01% in 1998). Rates of acute occulusion for the U.S. are between 0.85% in 1994 and 1.37% in 1998. In the teaching hospital, these rates seem to be dropping rather than rising (0.63% in 1994; 0.27% in 1998). While it is probable that the lower complication rates at the research hospital play a part in the lower length of stays that we describe above, re-admission rates may have a more direct impact on length of stays. At the teaching hospital, there is a decreasing rate of readmission due to cardiac-related incidents for both 30-day and 365-day re-admissions. In 1994, 2.51% of the IHD patients who received PCI following CAG were readmitted within 30 days and 7.21% were readmitted within 365 days. Comparatively, in the same year, 2.69% of U.S. IHD patients who received PCI following CAG were readmitted within 30 days and 9.16% within one year. These rates are not too different, but looking forward four years to 1998, we see that while the readmission rates have decreased or stayed approximately level in the teaching hospital, they have increased in the country as a whole. In the teaching hospital, the 30-day readmission rate decreased to 1.60% and the 365-day rate basically remained level at 7.47%. For the U.S. IHD patients, 30-day re-admissions increased to 4.19%, and 365-day re-admissions to 11.22%.

Finally, comparing mortality rates, we find that the rates remained more or less level for the U.S. patients and decreased in the teaching hospital's patients, making the differences in mortality rates more pronounced over time. The 30-day mortality rate is 3.22% in 1994 and 3.12% in 1998 compared to 1.25% in 1994 and 0.27% in 1998 for the U.S. and the teaching hospital respectively. The 365-day mortality rates are 8.16% in 1994 and 8.77% in 1998 in the U.S. and 7.21% in 1994 and 6.15% in 1998 in the teaching hospital.

Notes:

- Here and in subsequent figures, rates are adjusted to the 1995 demographic composition of the AMI population. Because the demographic composition of AMI patients in the United States has not changed much during the time period (the average age and proportion female have increased slightly), these adjustments have little effect on the results.
- Because reliable longitudinal data for California residents is only available beginning in 1991, we are unable to exclude all cases of recurrent AMI in 1991. Approximately 6 percent of patients in subsequent years had prior AMI admissions within one year, and including these patients in our trend analysis did not substantially alter our results. The estimates for 1996 reflect AMI cases in the first three quarters of the year.
- Comparisons of the California elderly population to the remainder of the US elderly population suggest that the trends for California are likely to be representative of the entire US. In any given year, rates for the California elderly are somewhat higher than for the overall U.S. elderly, but the growth rates are similar.

Figure 1: 90-Day Intensive Procedure Rates, US Elderly AMI Patients

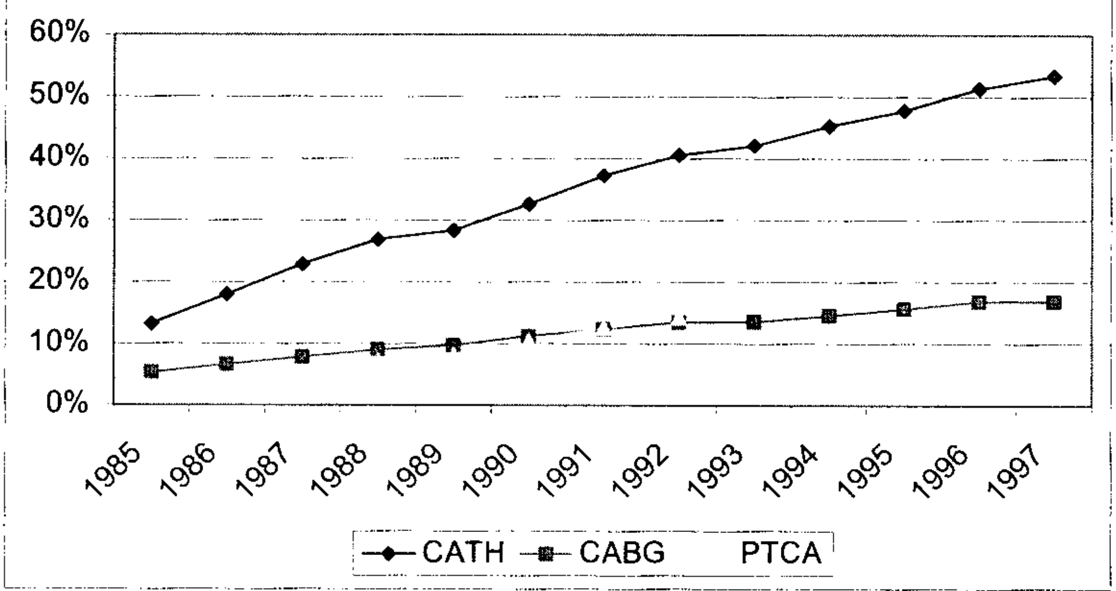
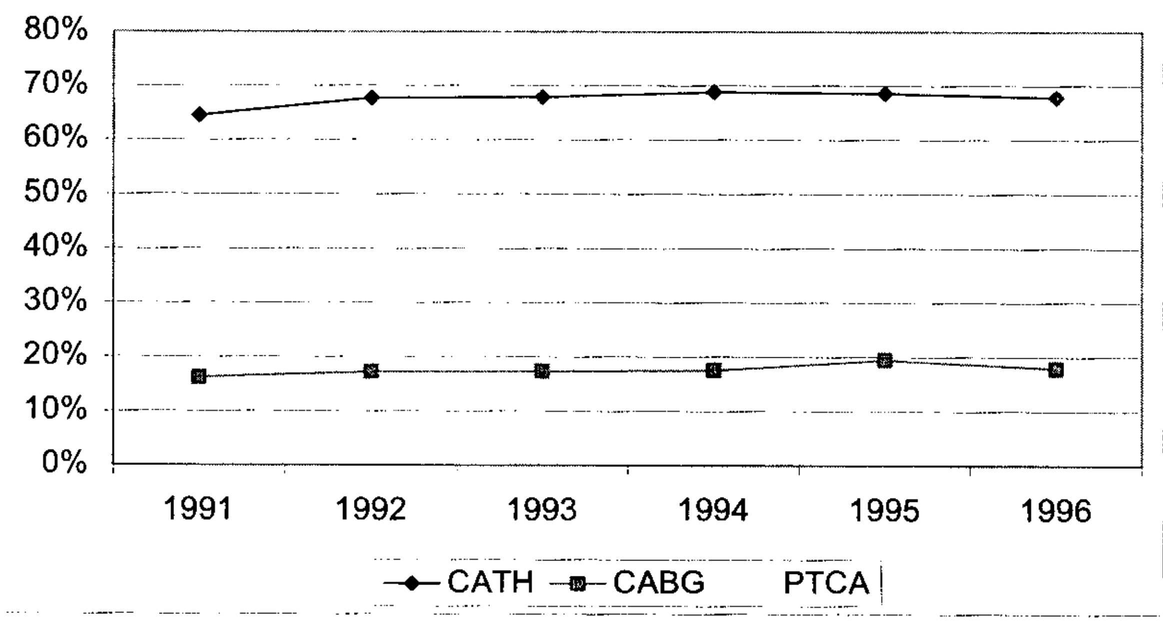


Figure 2: 90-Day Intensive Procedure Rates, California Non-Elderly AMI Patients



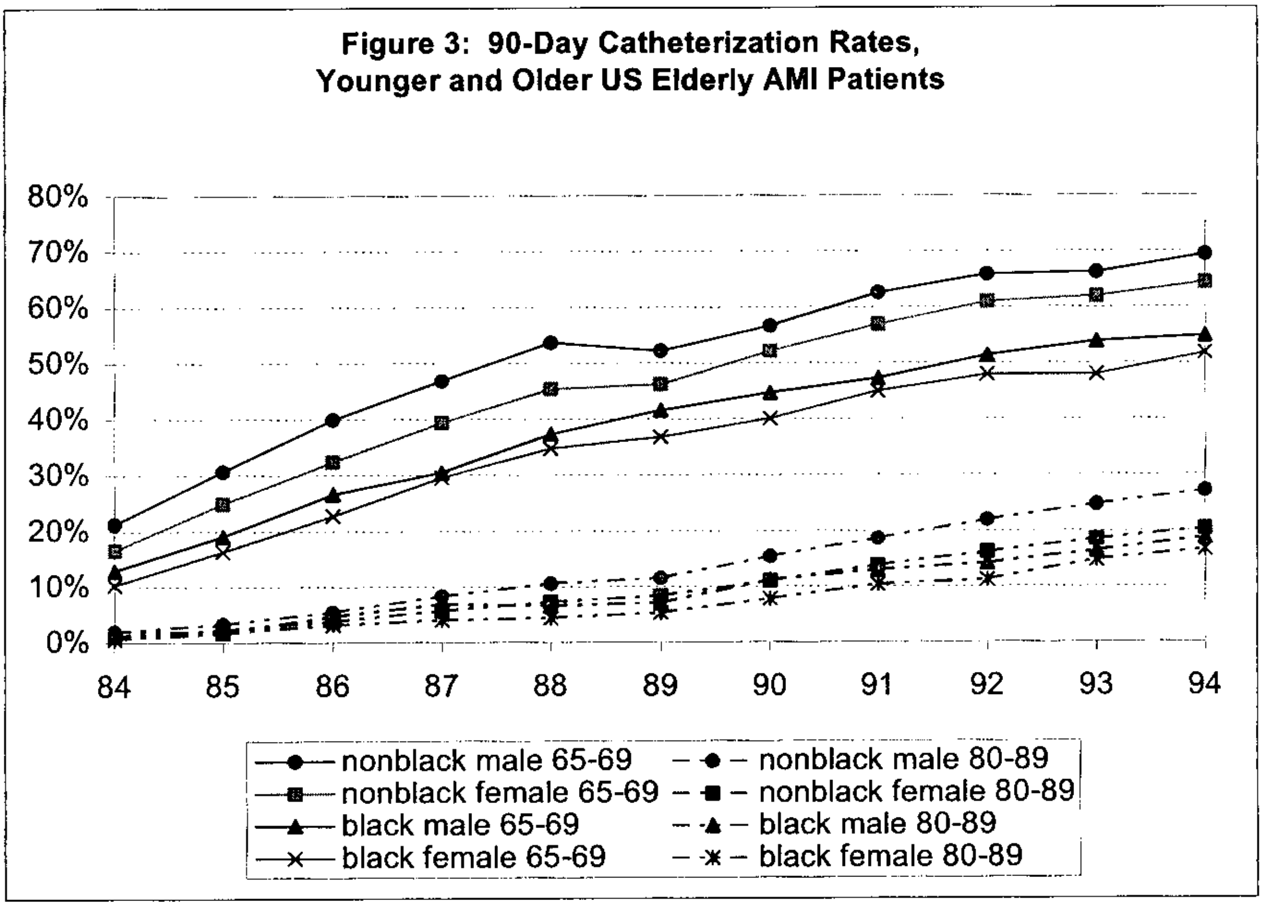


Figure 3: 90-Day Catheterization Rates,
Younger and Older US Elderly AMI Patients
80%
70%
60%
50%
40%
30%
20%
10%
0%
84
85
86
87
88
89
90
91
92
93
94
nonblack male 65-69
nonblack female 65-69
black male 65-69
black female 65-69
nonblack male 80-89
nonblack female 80-89
black male 80-89
black female 80-89

Figure 4: One-Day Angioplasty Rates, US Elderly and California Nonelderly AMI Patients

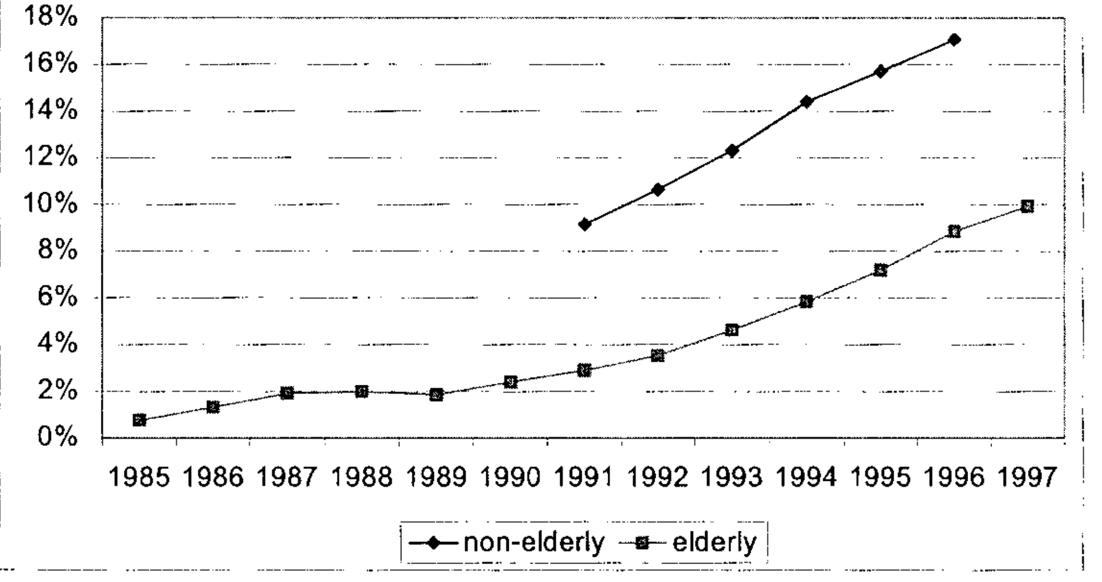


Figure 5: 90-Day Stent Rates, US Elderly and California Nonelderly AMI Patients

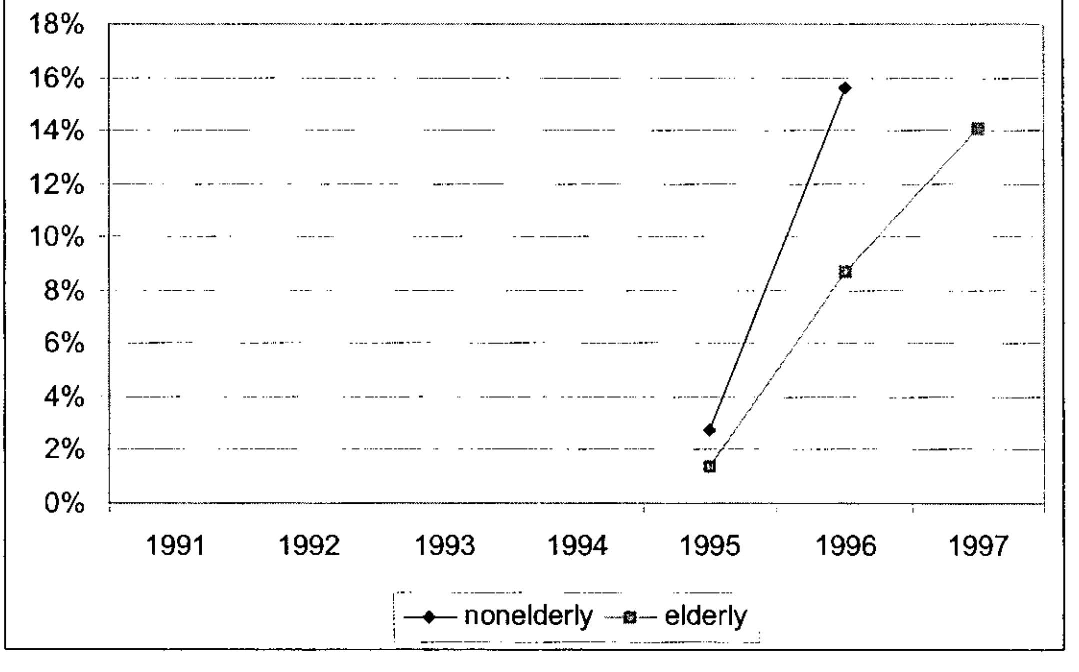


Figure 6: Share of US Elderly AMI Patients by Hospital Types

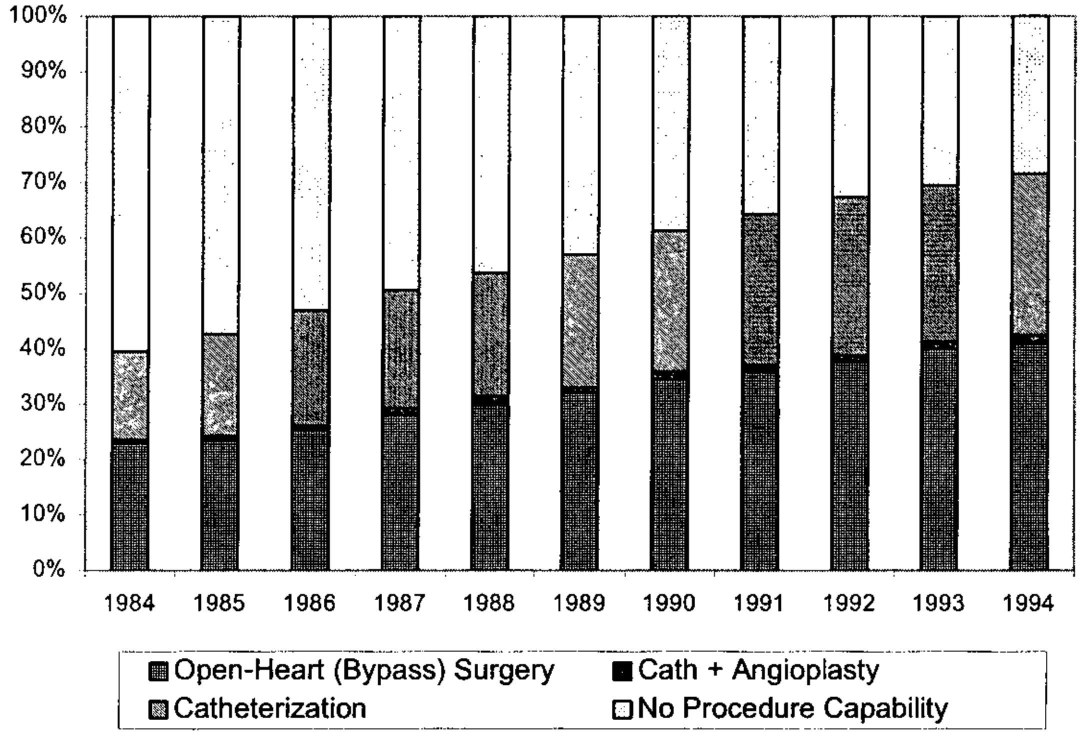


Table 1: Characteristics of IHD patients receiving CAG in 1996

	Demographic Characteristics				*Previous Interventions*		*Disease Severity*			
	Age	Gender (% Male)	Non-black	Black	Prior PCI	Prior CABG	single vessel disease	double vessel disease	triple vessel disease	> triple vessel disease
US	73.8	57.1%	95.0%	5.0%	5.0%	1.0%	2.2%	6.5%	8.0%	5.5%
Hospital	74.8	61.7%	97.5%	2.5%	10.1%	1.1%	2.3%	3.7%	3.9%	0.9%

Table 2: Comorbidities of IHD patients receiving CAG in 1996

	Diabetes	Hyper-tension	Hyper-lipidemia	COPD	Peripheral Vascular Disease	Stroke	Renal disease	hematological disorder	Others
US	26.0%	57.0%	10.6%	15.0%	10.6%	5.8%	1.5%	0.0%	98.5%
Hospital	20.4%	61.5%	9.9%	8.9%	15.1%	5.5%	0.7%	0.0%	98.6%

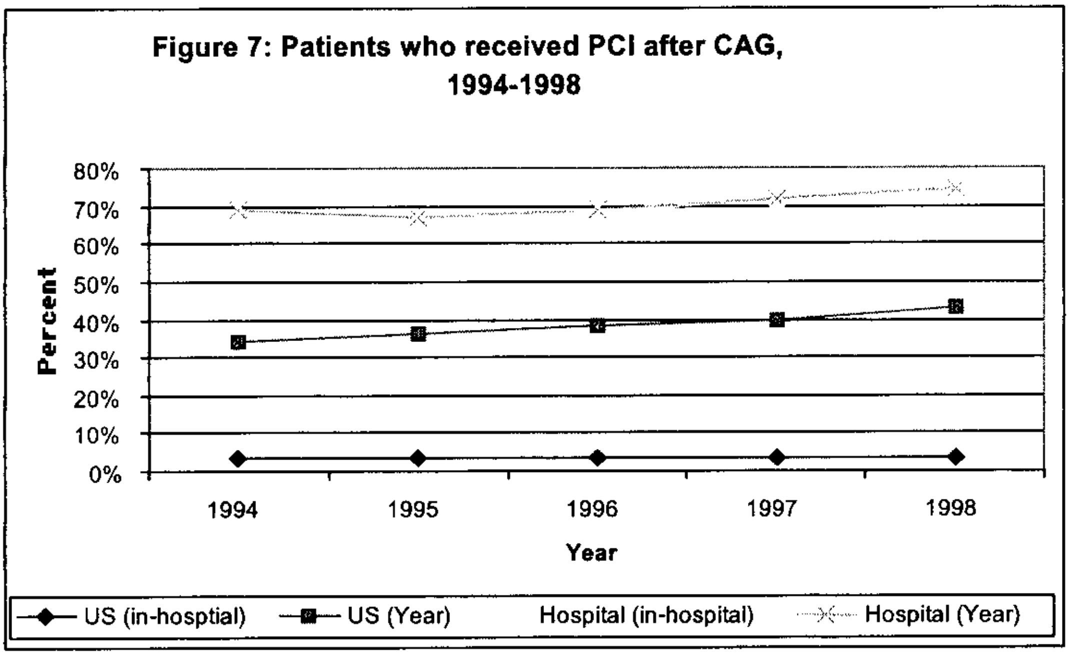


Figure 7: Patients who received PCI after CAG,
1994-1998
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent
1994
1995
1996
1997
1998
Year
US (in-hosptial)
US (Year)
Hospital (in-hospital)
Hospital (Year)

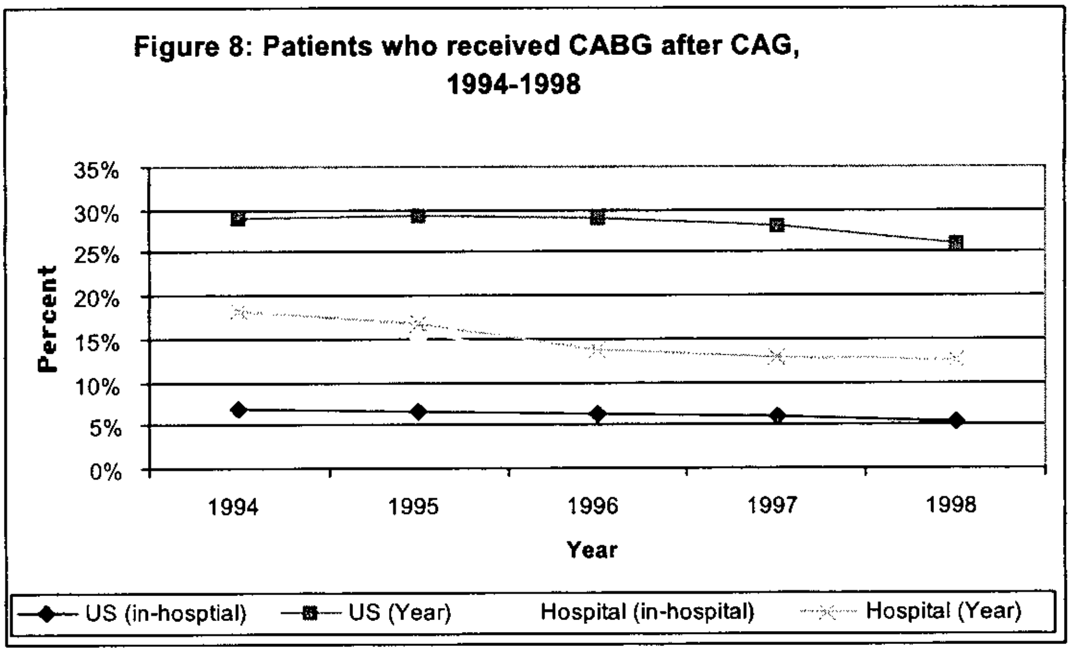


Figure 8: Patients who received CABG after CAG,
1994-1998
35%
30%
25%
20%
15%
10%
5%
0%
Percent
1994
1995
1996
1997
1998
Year
US (in-hosptial)
US (Year)
Hospital (in-hospital)
Hospital (Year)

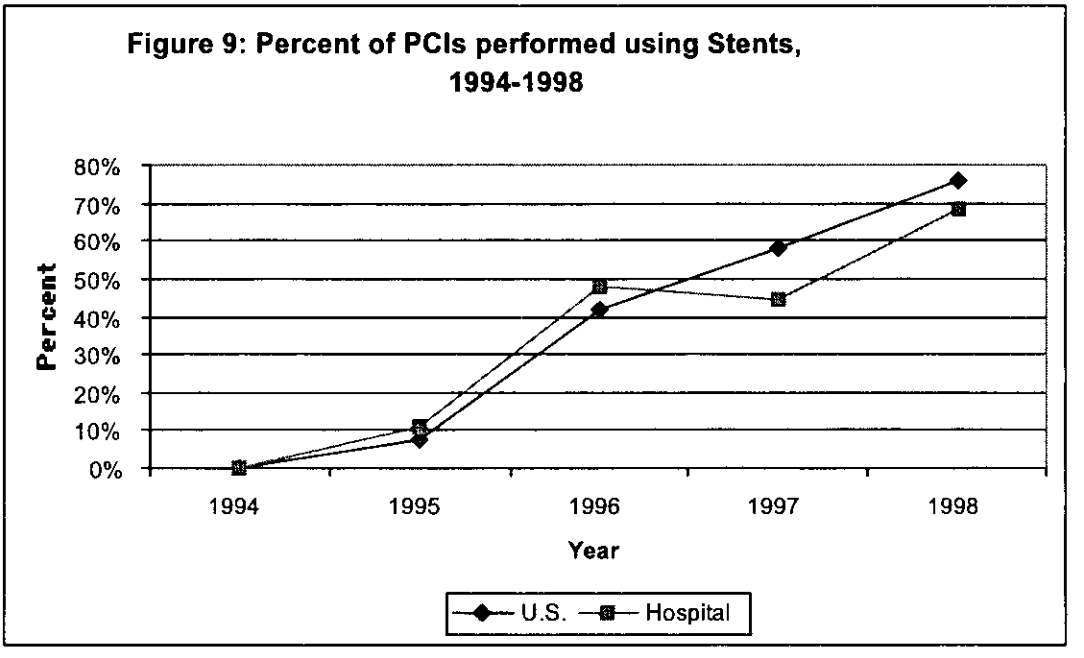


Figure 9: Percent of PCIs performed using Stents, 1994-1998
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent
1994
1995
1996
1997
1998
Year
U.S.
Hospital

Figure 10: Share of Patients with Procedures by Age and Gender in 1994-1995 in a leading U.S. Hospital

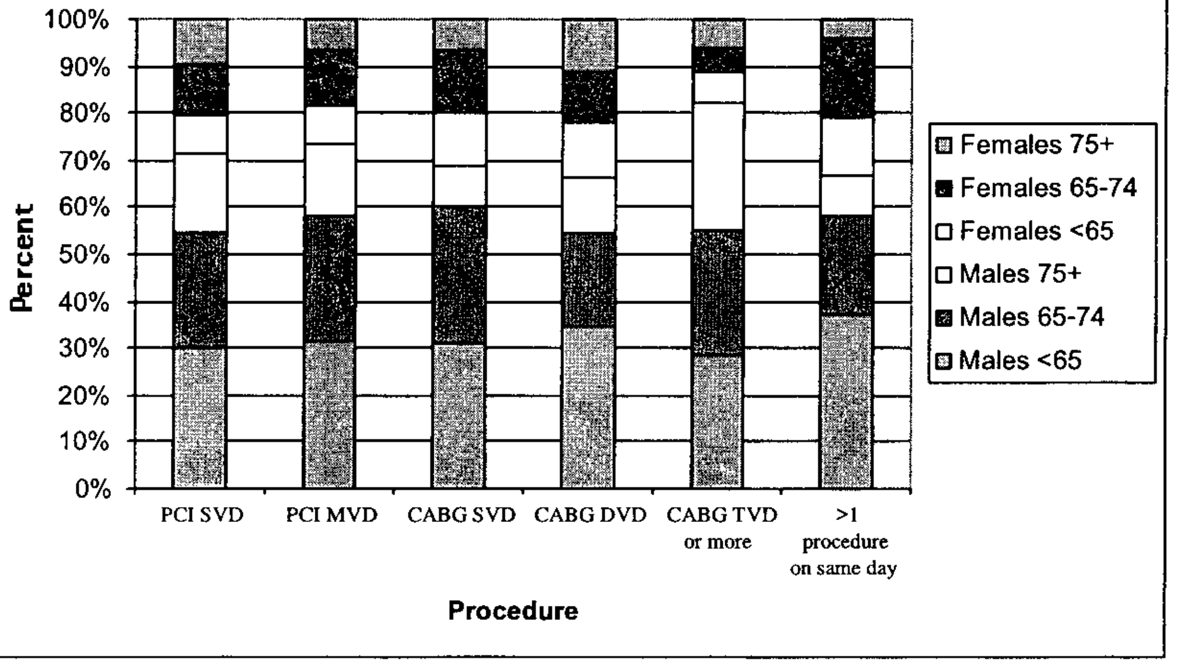


Figure 11: Share of Patients Receiving Procedures by Age and Gender in 1996-1998 in a leading U.S. Hospital