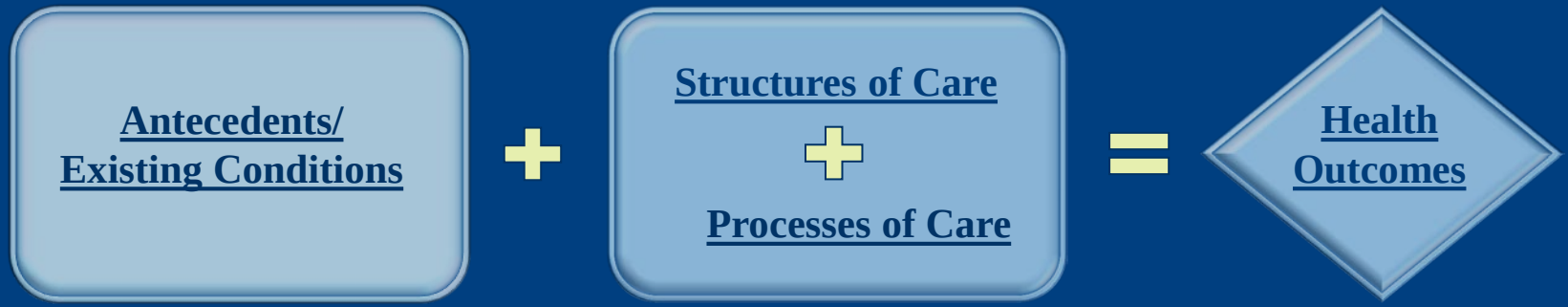
Risk Adjustment for CABG Surgery Outcomes – The Basics

- Purpose: Adjust hospital observed outcome rates so that they reflect the average illness severity of a hospital's patients.
- Theoretically, this allows us to produce risk-adjusted mortality rates that reflect what the hospital's observed rate would have been if it treated the average California hospital's patient case mix severity (expected mortality rate).
- Caveat: Only things that can be measured can be risk-adjusted and risk-adjustment can never be perfect – it can only be accurate to a measurable degree.

How is Risk Adjustment for Operative Mortality Done?

- Identify all measurable, prognostically important patient risk factors existing prior to surgery (use STS dataset).
- We do NOT adjust for hospital characteristics (DaVinci, case volume, nurse-patient ratio, etc.), things done to the patient before (IABP, carotid screening) or after surgery (therapy, discharge planning), even though these likely influence mortality, because these are under the control of the provider.



How is Risk Adjustment for Operative Mortality Done? (cont.)

- Enter CCORP registry data from all CA patients into a logistic regression model that predicts operative mortality and assess the independent contribution of each risk factor to mortality.
- Generate **expected mortality** for each patient and aggregate at hospital level.
- **Expected Mortality ≅ Case Mix ≅ Probability of Death ≅ Avg. Illness Severity**
- Create a ratio of each hospital's Observed mortality over it's Expected mortality (O/E Ratio).
- Multiply the O/E Ratio by the CA state average observed mortality rate to get the hospital's Risk-Adjusted Mortality Rate.
- ***A simplified example of how this is done ……***

Logistic Regression Model for Operative Mortality, 2007-2008

Risk Factors		N/Mean	Prevelance	Coeff.	p-value	OR
Intercept				-8.8951	**0.0001**	
Patient Age		65.7		0.0505	**0.0001**	1.052
Patient Gender	Female	6,856	25.7%	0.336	**0.0003**	1.399
	Male	19,800	74.3%		Reference	
Patient Non-White	Non-White	9,826	36.9%	0.158	0.0815	1.171
	White	16,830	63.1%		Reference	
BMI	0: Normal (18.5-40.0)	25,393	95.3%		Reference	
	1: Extremely Low (< 18.5)	231	0.9%	0.6353	**0.0267**	1.888
	2: Extremely High (> 40.0)	1,032	3.9%	0.7329	**0.0001**	2.081
Status of Procedure	1: Elective	9,416	35.3%		Reference	
	2: Urgent	15,894	59.6%	0.263	**0.0280**	1.301
	3: Emergent	1,346	5.0%	0.8639	**0.0001**	2.372
Pre-Op Creatinine (mg/dl)		1.30		0.9263	**0.0001**	2.525
Hypertension		22,736	85.3%	-0.0983	0.4407	0.906
PVD		3,555	13.3%	0.2649	**0.0112**	1.303
CVD		3,590	13.5%	0.2424	**0.0211**	1.274
Diabetes		11,693	43.9%	-0.0377	0.6784	0.963
Chronic Lung Disease	1: None/Mild	24,435	91.7%		Reference	
	2: Moderate	1,316	4.9%	0.4444	**0.0032**	1.560
	3: Severe	905	3.4%	0.7542	**0.0001**	2.126
Immunosuppressive Treatment		555	2.1%	0.0595	0.8074	1.061
Dialysis		926	3.5%	0.3686	0.0934	1.446
Arrhythmia: Afib/Aflutter		1,686	6.3%	0.4709	**0.0001**	1.601
Arrhythmia: Third Degree HB		251	0.9%	0.3967	0.1471	1.487
Arrhythmia: Vtach/Vfib		594	2.2%	0.1929	0.3351	1.213

Logistic Regression Model for Operative Mortality, 2007-2008 (continued)

Risk Factors		N/Mean	Prevelance	Coeff.	p-value	OR
Timing of MI	0: No MI	13,395	50.3%		Reference	
	1: 21+ days ago	4,663	17.5%	0.126	0.343	1.134
	2: 8-21 days ago	1,243	4.7%	0.2712	0.1239	1.312
	3: 1-7 days ago	6,204	23.3%	0.3122	**0.0073**	1.366
	4: <24 Hours	1,151	4.3%	0.5746	**0.0017**	1.776
Cardiogenic Shock		455	1.7%	0.9415	**0.0001**	2.564
Heart Failure		4,645	17.4%	0.14	0.1894	1.150
NYHA Class IV		5,357	20.1%	0.2642	**0.0148**	1.302
Prior Cardiac Surgery	1: First operation	25,646	96.2%		Reference	
	2+: Second or later op	1,010	3.8%	0.6712	**0.0001**	1.957
Interval from PCI to Surgery	No prior PCIs	20,638	77.4%		Reference	
	Prior PCI > 6 HRS	5,703	21.4%	0.141	0.1747	1.151
	Prior PCI <= 6 HRS	315	1.2%	0.2776	0.2806	1.320
Ejection Fraction		52.97		-0.0185	**0.0001**	0.982
Left Main Stenosis (%)		57.10		0.00367	0.1884	1.004
# of Diseased Coronary Vessels	None, One, or Two	5,940	22.3%		Reference	
	3 or more	20,716	77.7%	0.1047	0.3419	1.110
Mitral Insufficiency	None, Trival, Mild	25,371	95.2%		Reference	
	Mod/Severe	1,285	4.8%	0.1595	0.2571	1.173
Resuscitation		176	0.7%	0.456	0.1034	1.578
Year of Data Collection	2007	14,128	53.0%		Reference	
	2008	12,528	47.0%	0.0757	0.4039	1.079
Source: 2007-2008 CCORP data (salvage cases excluded)						
Number of Iso CABGs: 28,715	Number of Iso CABGs in ar	26656				
Incidence among cases in model: 2.36%						
Model-Statistics:	R^2: 15.58% - C-Statistic: 0.8006 - HL p-value: 0.0882					

Calculating Patient Expected Mortality

Patient	Emergent	Shock	BMI > 40	Dialysis	.. Other	Total (%)
A	0*.86 +	0*.94 +	1*.73 +	1*.37 +	2.0 =	3.1
B	0*.86 +	0*.94 +	1*.73 +	1*.37 +	6.5 =	7.6
C	1*.86 +	1*.94 +	1*.73 +	1*.37 +	9.0 =	11.9
D	1*.86 +	0*.94 +	1*.73 +	0*.37 +	2.1 =	4
E	0*.86 +	0*.94 +	1*.73 +	0*.37 +	5.0 =	5.73
F	0*.86 +	0*.94 +	0*.73 +	0*.37 +	1.5 =	1.5
	0="No", 1="Yes"			**Average:**		**5.64**

Calculating Hospital Risk Adjusted Mortality Rate

Hospital	CA Avg. Mortality	Observed	Expected	O/E*(2.0)=	Risk-Adjusted
A	2.0	2.0	2.0	2/2*(2.0)=	2.0%
B	2.0	5.6	5.6	5.6/5.6*(2.0)=	2.0%
C	2.0	2.0	4.0	2/4*(2.0)=	1.0%
D	2.0	6.0	3.0	5/3*(2.0)=	4.0%
E	2.0	0.0	8.0	0/8*(2.0)=	0.0%
F	2.0	5.0	0.5	5/.5*(2.0)=	20.0%

Are You Accurately Capturing Patient Risk?

- Review your Hospital Data Quality Report to see if you report much lower or higher rates of each risk factor compared to the California average.
- If you've been audited, review your audit report for risk factors with high disagreement between you and auditors.
- In the CCORP preliminary or final report, compare your hospital/surgeon's expected mortality to the expected mortality of other hospitals/surgeons you believe serve similar patients. Very different expected mortality rates won't prove there's a problem, but it's a reason to dig deeper.
- Consult the CCORP data definitions, clarifications, and Q&A.
- Contact us via email or phone with any questions.