COMMUNITY-ACQUIRED PNEUMONIA, HOSPITAL OUTCOMES FOR CALIFORNIA, 2002-2004:

A USERS' GUIDE FOR HOSPITALS

This Guide is designed for use by hospitals, to help them understand their mortality results for community-acquired pneumonia and to interpret their detailed statistics. Based on their results, hospitals may initiate programs to improve their patient discharge data coding or perform quality improvement analyses.

It explains how to interpret the quality ratings of all the California hospitals that cared for CAP patient during 2002-2004. It also explains how the statistical model was applied to patient data to obtain quality ratings for hospitals.

The measure of healthcare quality that is used in this report is the risk-adjusted death rate (RADR) for CAP patients. The measure is calculated for each hospital and compared with the statewide death rate. A death rate that is significantly higher than the statewide rate is considered "worse" and a death rate that is significantly lower is considered "better".

The results for all of the hospitals are shown in Chart 1, which is also available at this web site.

1. Chart 1: Community-acquired pneumonia (CAP) 30-day mortality rates, 2002-2004

The statewide 30-day mortality rate chart (see Chart 1) shows the healthcare quality rating of all hospitals with at least 30 CAP patients admitted between 2002 and 2004. The ”worse than expected” or “better than expected” quality rating is based on a statistical test using a 98% confidence interval (or 99% in a one-tailed test). It has been computed for (a) a statistical model that includes presence of a “Do Not Resuscitate” order (DNR) and for (b) a second statistical model that does not include DNR.

In Chart I the hospitals are grouped by county. Hospitals with mortality rates that are significantly lower or higher than the state overall rate are indicated by gray-shading the hospital name.

2. Hospitals with fewer than 30 CAP patients

Hospitals with fewer than 30 CAP patients during 2002-2004 are reported in Table 1. The Technical Advisory Committee that provides guidance to OSHPD determined that a risk-adjusted mortality rate should not be reported for these hospitals, given statistical considerations. No estimate is made in this report of the quality of care provided by these hospitals. Hospitals with no qualifying CAP admissions in the reporting period are not shown.

Table 1. Hospitals with 30 or fewer CAP patients: Number of admissions and number of deaths within 30 days, by county, 2002-2004

County	Hospital	# of CAP Patients	# Died within 30 Days
Alameda	Children's Hospital Med Ctr Of No Cal	10	0
Fresno	Fresno Heart Hospital	5	0
Fresno	Sanger General Hospital	12	0
Humboldt	General Hospital, The	21	0
Humboldt	Jerold Phelps Community Hospital	30	4
Inyo	Southern Inyo Hospital	19	2
Los Angeles	Avalon Municipal Hospital & Clinic	15	1
Los Angeles	Barlow Hospital	7	0
Los Angeles	Children's Hospital of Los Angeles	19	1
Los Angeles	Doctors Hospital of West Covina	17	1
Los Angeles	Earl & Loraine Miller Children's Hosp	5	0
Los Angeles	Lincoln Hospital Med Ctr	24	1
Los Angeles	Los Angeles Co Rancho Los Amigos Mc	12	0
Los Angeles	Orthopaedic Hospital	12	1
Los Angeles	Specialty Hospital of Southern California	1	0
Los Angeles	St. Luke Med ctr	12	1

Madera	Valley Children's Hospital	22	0
Merced	Dos Palos Memorial Hospital	3	0
Modoc	Surprise Valley Community Hospital	18	1
Mono	Mammoth Hospital	22	0
Orange	Children's Hospital of Orange County	3	0
Orange	College Hospital-Costa Mesa	7	0
Orange	Orange County Comm Hosp-Buena Park	24	4
Sacramento	Shriners Hospital-Northern Calif	1	0
San Diego	Children's Hospital-San Diego	9	0
San Diego	Sharp Mary Birch Hospital For Women	2	0
San Mateo	Seton Med Ctr-Coastside	2	1
Santa Clara	Lucile S Packard Chldrn Hosp At Stanford	6	0
Shasta	Patient's Hospital Of Redding	1	0

3. Understanding the model statistics

The risk-adjusted death rate (RADR) and associated lower and upper 90%, 95% and 98% confidence bounds can be used to compare a hospital's results with the statewide rate. If the statewide death rate is ***between*** the upper and lower confidence bounds, this means that the results are not significantly different from the overall state rate. If the upper confidence bound falls ***below*** the statewide death rate, the rate is significantly ***better*** than the state rate. If the lower confidence bound is ***above*** the statewide death rate, the death rate is significantly ***worse.***

The risk-adjusted death rate and the lower and upper confidence bounds can also be used to compare a hospital's observed and expected death rates. If the confidence bounds are ***below*** the expected death rate, the observed death rate is significantly ***better*** than expected. If confidence bounds are ***above*** the expected death rate, the observed death rate is significantly ***worse*** than expected based on the experience of all California hospitals with similar patients. (The observed and expected death rates are provided to hospitals for their own use, but are not included in the public report.)

If a hospital has a risk-adjusted death rate higher than the state rate with a significant *P-value*, that hospital may wish to explore possible reasons by reviewing the relevant medical records and checking how the discharge records were coded.

A hospital may appear significantly different from the state overall rate for a number of reasons, including:

1) Inadequate coding of medical data. Medical staff might have neglected to document important risk factors. All chronic diseases affecting evaluation and treatment should be coded on the discharge abstract.

2) Clinical risk factor(s) not included in model. In some cases there can be a clinical condition that is (a) more common among the patients at a particular hospital than at other hospitals and (b) omitted from the model. This would result in insufficient risk-adjustment for that hospital. Note that some important physiologic variables cannot be recorded using the ICD-9-CM codes and therefore are not included in the model.

3) Quality of care. Some aspects of the process of care at a hospital might differ from practices in other hospitals. For example, it was found in OSHPD's CAP validation study that hospitals with low risk-adjusted mortality rates were more likely to perform sputum cultures at admission.

4) Chance variation. If a hospital's mortality rate is found to be significantly different from the statewide rate, there is a small chance, less than 1%, that this result occurred by chance.

4. CAP patient selection

Patients are selected for inclusion in the CAP report if they meet the following criteria:

- A principal diagnosis of community-acquired pneumonia or a specified pneumonia-related principal diagnoses with a secondary diagnosis of community-acquired pneumonia.
- Age at admission of 18 years or greater.
- Source of admission is "Home".
- Date of discharge between 1-1-2002 and 12-31-2004 plus date of admission between 11-1-2001 (two months prior to 2002) and 12-1-2004.

In addition, several exclusion criteria were defined to eliminate patients that may not truly represent CAP. Cases with any of the following characteristics were excluded:

- One or more admissions within 10 days preceding the index CAP admission.
- Any diagnosis code on the index hospital record indicating trauma.
- Organ transplant patient.
- Any of the following indicated as the cause of the pneumonia: human immunodeficiency virus (HIV) or AIDS, cystic fibrosis, tuberculosis, post-operative pneumonia, or certain unusual pathogens.
- Data-related problem: Missing or invalid social security number, unidentified gender, date of death missing or preceding the date of admission, out-of-state zip code (making death information from the state vital statistics uncertain).

The original discharge data reported to OSHPD contained up to 25 diagnoses coded according to the ICD-9-CM. For each diagnosis there was also a field indicating whether the diagnosis was a "condition present at admission" (CPAA). These codes were translated into categorical risk factor variables. For example, if a patient had a diagnosis code of 428.x, indicating chronic congestive heart failure (CCHF) in any diagnosis field, and this was "present at admission", a value of 1 (yes, present) was recorded for the variable CCHF. Otherwise, the variable value was coded as 0 (no, absent). A complete list of variables, including variable names, descriptions, and valid values is shown in Table 2.

Table 2. Variables included in the CAP model: Description and coding

Column/ Variable	Description	Valid Values*
abstrec	abstract record number	as reported
admdate	index admit date	mm/dd/yyyy format
admtype	type of admission	1=scheduled, 2=unscheduled, 3=infant, 4=unknown
ageyrsa	age in years at admission	at least 18 years old
asthma	asthma-dx=493xx	1=yes, 0=no
birthdate	date of birth	ddmmyyyy text format for excel
blood	blood cancer	1=yes, 0=no
casthma	chronic asthma-dx=493xx	1=yes, 0=no
cblood	chronic blood cancer	1=yes, 0=no
cchf	chronic congestive heart failure	1=yes, 0=no
cchrenal	chronic renal failure	1=yes, 0=no
chf	congestive heart failure-dx=428xx 39891 40291 40401 40403 40413 40411 40491 40493 425	1=yes, 0=no
chrenal	chronic renal failure-dx=585 40391 40301 40311 40402 40412 40492 99673 v451	1=yes, 0=no
clcva	chronic lcva-dx=342,438	1=yes, 0=no
cliver	chronic liver disease	1=yes, 0=no
clung	chronic lung/heart cancer	1=yes, 0=no
coagdef	coagulation defects-dx=2874 2875 2866 2867 2869 2879	1=yes, 0=no
cpaa1-cpaa24	condition present at admission (other diagnoses)	y=yes, n=no, u=uncertain
cpaa_p	principal diagnosis present at admission	y=yes, n=no, u=uncertain
cparkins	chronic parkinsons disease	1=yes, 0=no
csolidnl	chronic solid nonlung cancer	1=yes, 0=no
cva	cerebrovascular disease-dx=430 431 432x 433x 434x 435x 436 4371	1=yes, 0=no
death30	death within 30 days of admission	1=yes, 0=no
deathdate	Date of death	mm/dd/yyyy format
diag1-diag24	other (secondary) diagnoses	icd-9-cm codes required if reported
diag_p	principal diagnosis	icd-9-cm code required
disdate	discharge date	mm/dd/yyyy format
disp	patient disposition: ltc=long term care, ama=against medical advice, hhs=home health svc	01=home, 02=acute care(same hosp), 03=other care(same), 04=ltc(same), 05=acute care(other hosp), 06=other, 07=ltc, 08=resident fac, 09=prison/jail, 10=ama, 11=died, 12=hhs, 13=other

dnrisk	Do not resuscitate order present within 24 hours of admission?	1=yes, 0=no
ethnic	hispanic ethnicity	1=hispanic, 2=non-hispanic, 3=unknown
gramneg	gram neg group-dx=4820 4821 48282	1=yes, 0=no
lcva	late effects cerebrovascular disease/hemiplegia-dx=438xx 342xx	1=yes, 0=no
liver	chronic liver disease-dx=571xx 572x 573x 07022 07032 07044 07054	1=yes, 0=no
los	length of stay	total days from admit date to discharge date
lung	lung cancer	lung
male	male gender	1=yes, 0=no
newsept	septicemia in primary	1=yes, 0=no
numdis	number of prior discharges within 6 mo	0- maximum number of prior discharges
oshpdid	6-digit hospital id	six digits: first two=01-58(valid county code), last four=unique
parkins	parkinsons disease-dx=332x	1=yes, 0=no
patcnty	patient county of residence	01-58=ca county; 00=unknown, outside ca, or homeless
patzip	patient zip code	xxxxx=unknown, yyyyy=outside us, zzzzz=homeless
pay_cat	payer category	01=medicare, 02=medi-cal, 03=private, 04=workers comp, 05=county indigent, 06=other govt, 07=other indigent, 08=self pay, 09=other payer, 10=not reported
probdeath	estimated probability of death without dnr as a risk factor	between 0-1
probdeath_dnr	estimated probability of death with dnr as a risk factor	between 0-1
proc_p	principal procedure	icd-9-cm codes required if reported
procdate	principal procedure date	mm/dd/yyyy format
race	race	1=white, 2=black, 3=native american, 4=asian, 5=other, 6=unknown
respirat	respiratory failure-dx=51881 51882	1=yes, 0=no
sex	patient sex	1=male, 2=female, 3=other, 4=unknown
solidnl	solid non-lung cancer	1=yes, 0=no
source	admission source	use only the first digit of this 3-byte field. First digit = 1 indicates admission source is “home”. (In other words, use only “131” and “132”)
ssnum	patient social security number	valid non-missing number required
staph	staphylococcus-dx=4824	1=yes, 0=no
typecare	type of care	1=acute care

* Missing numeric fields are indicated with periods (‘.’). Missing character (alphanumeric) fields are indicated with blanks (‘ ‘).

5. Risk model coefficients

Two models were utilized to estimate the expected death rate. One excluded the variable indicating whether there was a "Do Not Resuscitate" (DNR) order in place and a second model included this variable. Thus, there are two sets of coefficients in the tables, a set for each model (Table 3).

The CAP models reported here had C-statistics of 0.797 and 0.824 respectively for the models without DNR and with DNR respectively. The C-statistic indicates how well the model predicts the outcome (i.e., the discrimination of the model). A model that predicts no better than chance has a C-statistic of 0.50 while perfect prediction results in a C-statistic of 1.0.

Table 3. Comparison of Coefficients for Models with DNR Excluded and DNR Included as a Risk Factor

	Model Not Including DNR			Model Including DNR		
Risk Factor	**Coefficient Estimate**	**P-value**	**Odds Ratio**	**Coefficient Estimate**	**P-value**	**Odds Ratio**
Intercept	-6.0674	<.0001		-5.6516	<.0001	
ageyrsa	0.0442	<.0001	1.045	0.0347	<.0001	1.035
male	0.0930	<.0001	1.097	0.1428	<.0001	1.153
newsept	1.1106	<.0001	3.036	1.0380	<.0001	2.824
respirat	1.6468	<.0001	5.190	1.6457	<.0001	5.185
staph	0.4448	<.0001	1.560	0.4638	<.0001	1.590
cliver	0.6259	<.0001	1.870	0.6070	<.0001	1.835
clung	1.2146	<.0001	3.369	1.1229	<.0001	3.074
csolidnl	0.9322	<.0001	2.540	0.8678	<.0001	2.382
cblood	0.5907	<.0001	1.805	0.5918	<.0001	1.807
cchrenal	0.3489	<.0001	1.418	0.3853	<.0001	1.470
clcva	0.2298	<.0001	1.258	0.1577	<.0001	1.171
coagdef	0.7142	<.0001	2.043	0.7324	<.0001	2.080
gramneg	0.0381	0.4222	1.039	0.0444	0.3519	1.045
cchf	0.1794	<.0001	1.196	0.1864	<.0001	1.205
cparkins	0.2524	<.0001	1.287	0.1620	0.0002	1.176
cva	0.1677	0.0036	1.183	0.1927	0.001	1.212
casthma	-0.6696	<.0001	0.512	-0.6266	<.0001	0.534
numdis	0.1408	<.0001	1.151	0.1295	<.0001	1.138
dnrisk				1.4333	<.0001	4.193

6. Suggested quality improvement analyses

To make use of the findings of this report, facilities may perform follow-up assessments to guide improvements in their quality of care and/or data coding efforts. Examples of possible assessments include: reviewing records of patients who died after discharge,

reassessing the coding of certain clinical risk factors, comparing outcomes of the physicians providing CAP care, and examining the effect of data errors on the facility's rating.

7. How risk adjustment is performed

The risk-adjustment model is utilized by applying the coefficients calculated for each risk factor to each patient's data. This leads to calculation of the probability of death for each patient, as demonstrated in the following example.

Example A 67-year-old man with no prior hospitalizations and no chronic conditions was admitted in 2002 for community-acquired pneumonia with respiratory failure. For this patient the variables of interest are *male, ageyrsa),* and *respirat*.

In this example we use the coefficients from the model, excluding DNR. The variables *male, ageyrsa* and *respirat* are the only risk factors used for calculating this man's risk of death. The remaining risk variables are all zero and so are not shown.

To calculate his risk of death, first multiply the value of each risk factor by its parameter estimate (coefficient) and sum these values with the INTERCEPT:

INTERCEPT		=	-6.0674
MALE	(1 x 0.0930)	=	0.0930
AGEYRSA	(67 x 0.0442)	=	2.961
RESPIRAT	(1 x 1.6468)	=	1.6468
Sum (z)		=	-1.367

Then, use the following equation to obtain the expected probability of death:

$$\hat{p} = \frac{1}{1 + e^{-z}}$$

where:
e is a constant = 2.71828, and
z = the sum of the value of the intercept and the value of each parameter estimate multiplied by its risk-factor.

In the example, $\hat{p} = 1 / (1+ e^{-(-1.367)}) = 0.203$. The risk of death for this patient was .203 (or 20.3% if multiplied by 100). Our hypothetical patient had a 20.3% probability of death within 30 days of admission.

Next, the probabilities of death for all of the patients at a particular hospital are added together. The sum of the probabilities equals the hospital's expected number of deaths.

To calculate the final risk-adjusted death rate (RADR) the following steps are carried out:

1. The expected number of deaths for a hospital is divided by the total CAP case number to get the expected death rate.
2. The observed death rate is divided by expected death rate to get the O/E ratio.
3. Finally, the statewide death rate is multiplied by the hospital's O/E ratio to get risk-adjusted death rate.