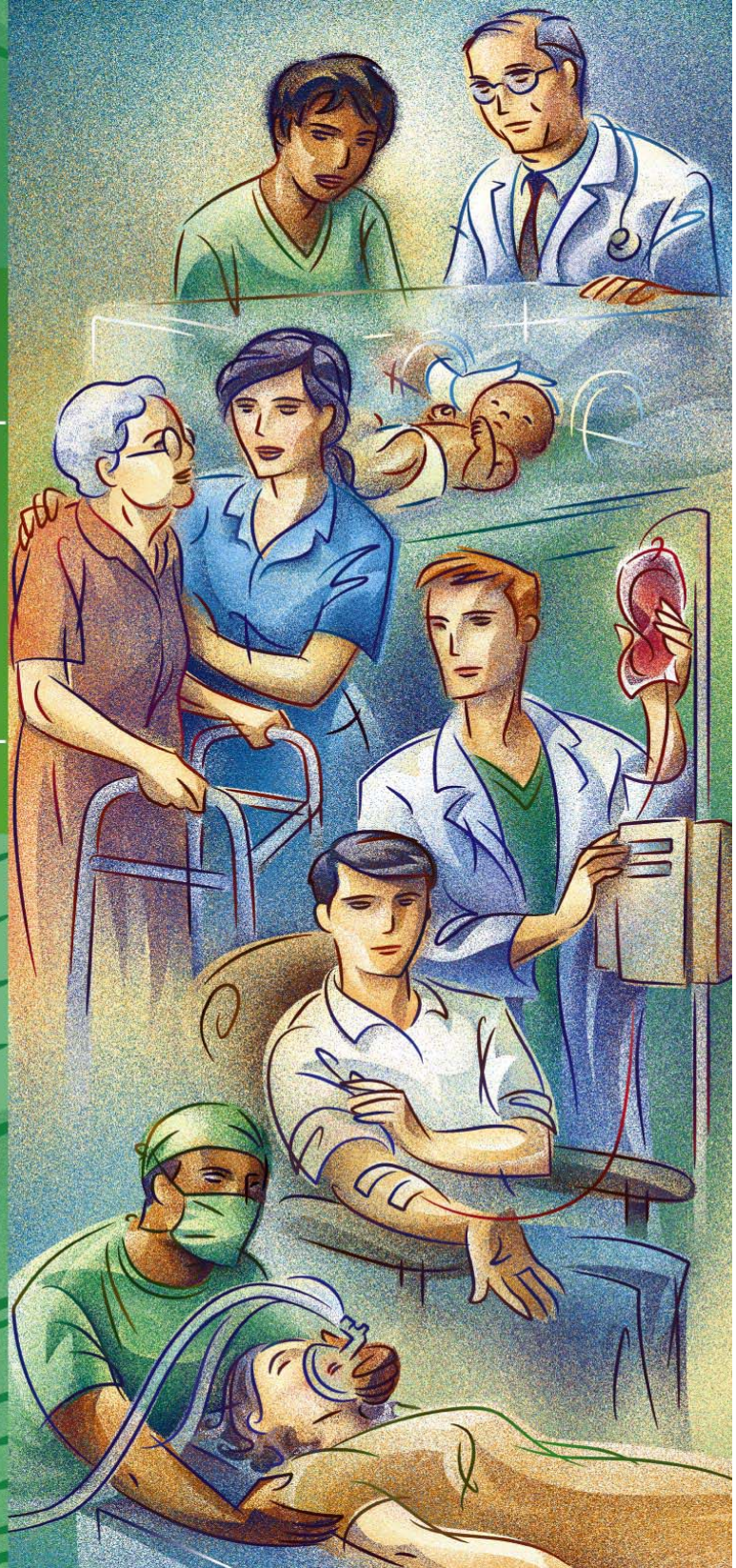![AHRQ]

AHRQ QUALITY INDICATORS

Patient Safety Indicators

SOFTWARE DOCUMENTATION

AHRQ Quality Indicators

Patient Safety Indicators:
SAS Software Documentation, Version 2.1

Citation

AHRQ Quality Indicators -- Patient Safety Indicators: Software Documentation, Version 2.1 - SAS. Rockville, MD: Agency for Healthcare Research and Quality, 2003. AHRQ Pub.03-R204

Abstract

The value of information on health care quality has never been so widely recognized; yet many organizations lack the resources and/or expertise to build a quality information program from the ground up. Recognizing this, the AHRQ Quality Indicators were developed specifically to meet the short-term needs for information on health care quality using standardized, user-friendly methods and existing sources of data.

This module of the AHRQ Quality Indicators was designed to capitalize on the availability of administrative data on inpatient stays to produce information for Patient Safety Indicators (PSIs). These indicators capture potentially preventable complications and iatrogenic events for patients treated in hospitals. They can be used as a screening tool for problems that patients experience as a result of exposure to the healthcare system and that are likely amenable to prevention by changes at the system or hospital level.

This document is the software documentation for the Patient Safety Indicators software Version 2.1, which is provided on the AHRQ Web site. The software was developed in SAS, for use on a personal computer. By making this tool available, we hope to assist others in producing information on health care quality more cost effectively.

Details on the development of the Inpatient Quality Indicators can be found in "Guide to Patient Safety Indicators."

Acknowledgments

This product is based on the work of many individuals who contributed to its development and testing.

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AHRQ Quality Indicators, SAS Software Documentation, Version 2.1: Patient Safety Indicators

Introduction

This documentation describes the software for implementing the Patient Safety Indicator (PSI) module of the AHRQ Quality Indicators Version 2.1 and highlights features of the analytic approach of particular interest to new users. Detailed information about the Patient Safety Indicators (PSI) is contained in the companion document "*Guide to Patient Safety Indicators*", which includes information about the development of the indicators and their definitions.

The software consists of a series of computer programs that:

▸ Assign and calculate PSIs from hospital discharge abstracts or UB (uniform billing) claims data.

▸ Print PSI results in SAS format or as an ASCII text file (comma delimited) that can be imported into word processing documents, spreadsheets, or graphics software, at the user's option.

▸ Create risk-adjusted rates that adjust for case mix differences.

▸ Create smoothed (i.e., reliability-adjusted) rates that reduce fluctuations over time due to random variation.

This documentation includes:

▸ A discussion of the data elements necessary to produce the AHRQ PSIs and the uniform coding conventions recommended for those elements.

▸ Descriptions of the PSI processing steps in non-technical language.

▸ Detailed descriptions of the functions of each PSI SAS program.

Critical user information is highlighted with this symbol: ☀

Components of the Patient Safety Indicators module

As shown in Table 3 on page 6, the Patient Safety Indicators module consists of six SAS programs and seven ASCII text files that contain auxiliary data. These programs and text files are described in the subsequent sections of this document. The programs were developed for use in Statistical Analysis System (SAS), version 6.12 or higher, on an IBM compatible computer.

A note on the naming conventions for the Patient Safety Indicators (PSI) module programs. Most programs have names of the form PSSASi, PSSASAi, or PSSASPi. The first two characters "PS" of the program name indicates a Patient Safety Indicators program, to distinguish it from other modules that have been or will be released from AHRQ. The next three characters of the program name are "SAS" and are present to distinguish the program from future SPSS versions of the software. In the programs that are specific to either Area or Hospital runs, the sixth character of the program name is either "A" or "P". The sixth character is an "A" if it is for the production of Area indicator rates that use county and Metropolitan Statistical Area (MSA) area populations as denominators. The sixth character is a "P" if it is a program that is for the production of Hospital indicator rates that use subsets of the hospitalized population. The last character (i) of the variable name designates the number of the specific program.

Quick Reference

The subsequent four pages are intended to serve as a quick reference to assist in reading this documentation and in reviewing the Patient Safety Indicator (PSI) module outputs. Processing steps (Figures 1 and 2) are shown first followed by a listing of the module indicator variables (Table 1), variable prefixes (Table 2), and module contents (Table 3). One suggestion is to print these pages in duplex mode on two sheets of paper so that they can then be easily referred to as the need arises.

Figure 1. Processing Steps for the Patient Safety <u>Hospital</u> Indicators

LEGEND:

SAS Data file

Program

Text file (supplied)
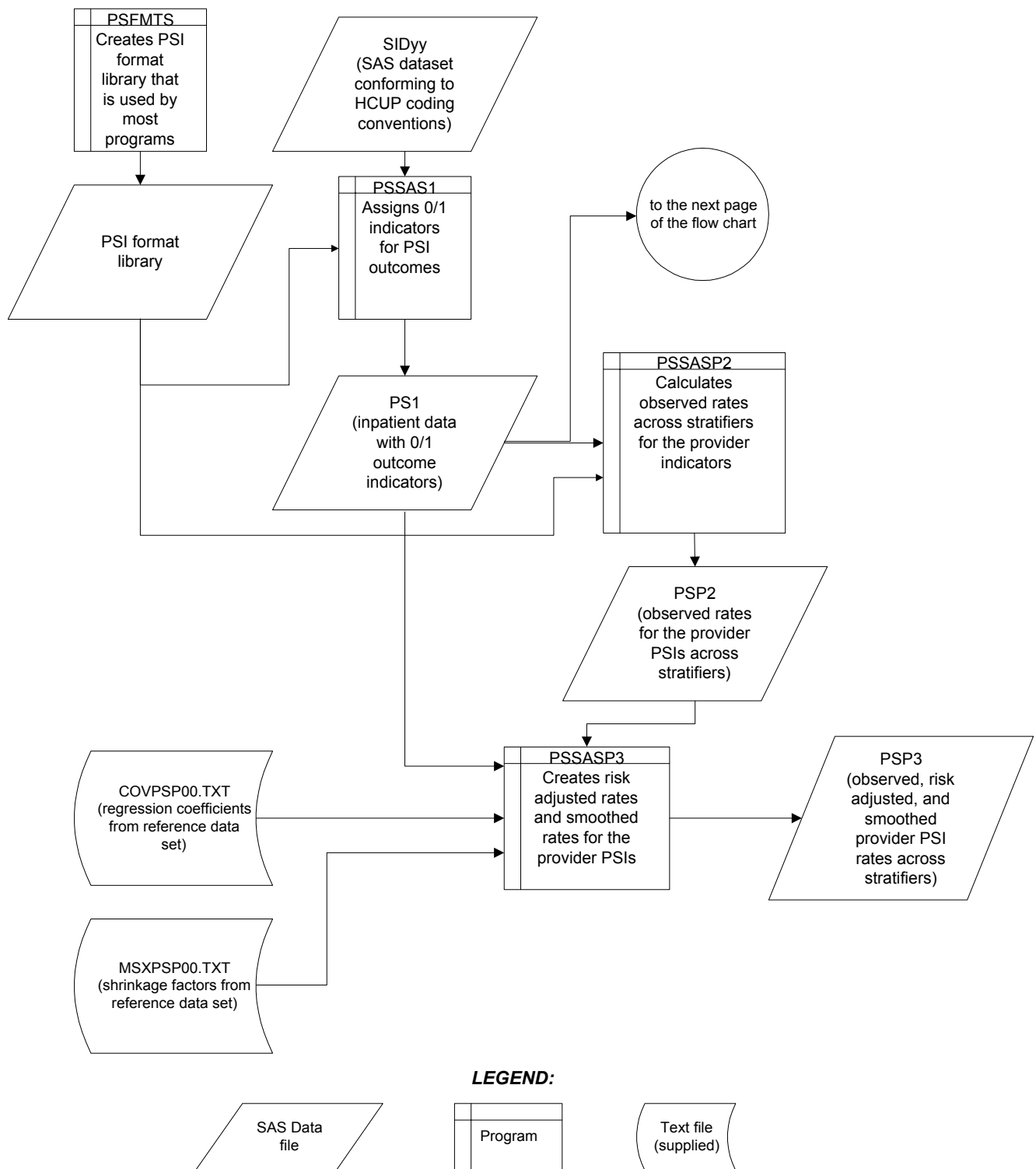
Note: There is another version of PSSAS3 that is available for calculating confidence intervals around each Patient Safety Indicator. This syntax, PSSAS3CI is available upon request. Please send an email to QI support at support@qualityindicators.ahrq.gov with "PSI Confidence Interval Syntax Request" as the subject line and indicate in the body of the e-mail you would like the SAS syntax.

Figure 2. Processing Steps for the Patient Safety <u>Area</u> Indicators
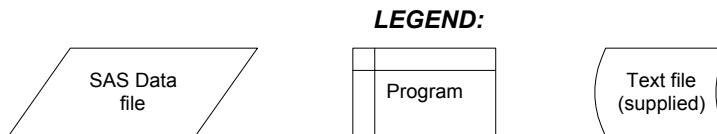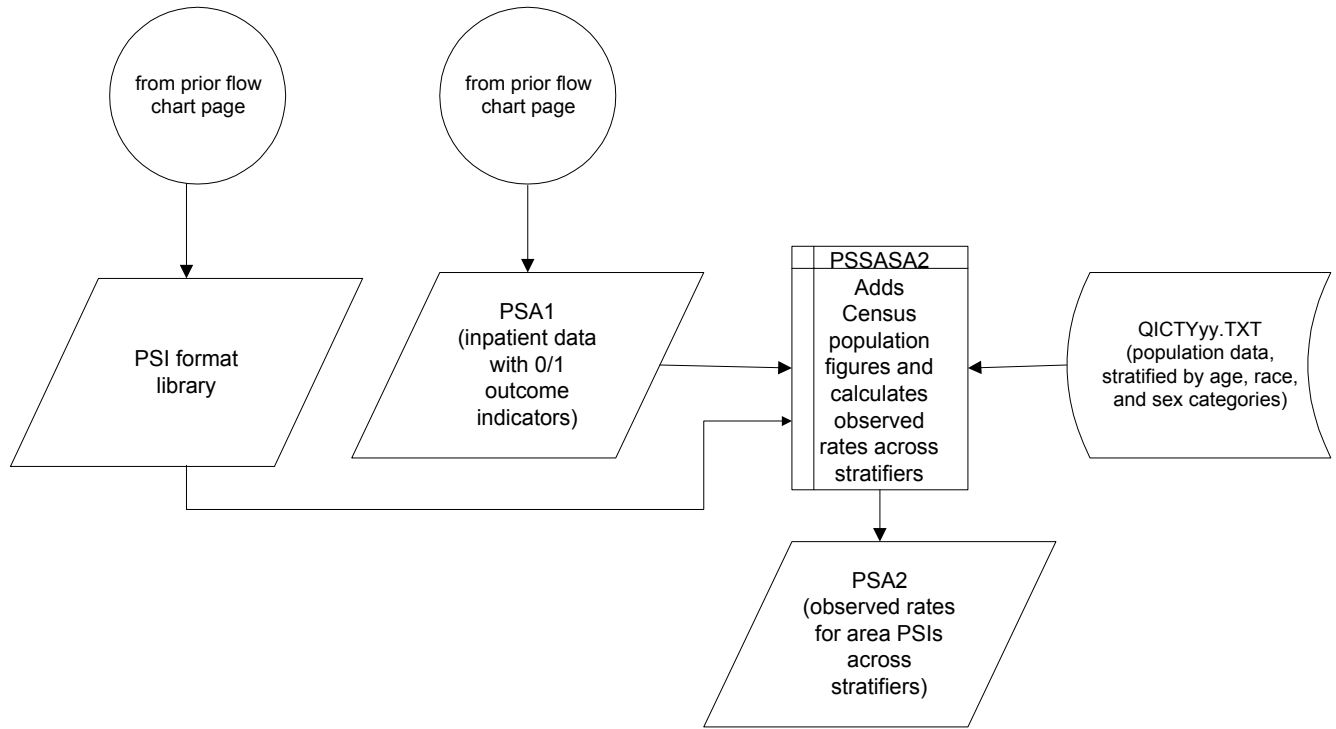
Patient Safety Indicator Module Details

		Table 1. Patient Safety Indicator (PSI) Variables

Type	PSI number	Indicator
Hospital	1	Complications of anesthesia
	2	Death in low mortality DRGs[a]
	3	Decubitus ulcer
	4	Failure to rescue
	5	Foreign body left during procedure
	6	Iatrogenic pneumothorax
	7	Selected infections due to medical care
	8	Post-operative hip fracture
	9	Post-operative hemorrhage or hematoma
	10	Post-operative physiologic and metabolic derangements
	11	Post-operative respiratory failure
	12	Post-operative pulmonary embolism or deep vein thrombosis
	13	Post-operative sepsis
	14	Post-operative wound dehiscence
	15	Accidental puncture or laceration
	16	Transfusion reaction
	17	Birth trauma
	18	Obstetric trauma – vaginal with instrument
	19	Obstetric trauma – vaginal without instrument
	20	Obstetric trauma – cesarean section
Area	21	Foreign body left during procedure
	22	Iatrogenic pneumothorax
	23	Selected infections due to medical care
	24	Post-operative wound dehiscence
	25	Accidental puncture or laceration
	26	Transfusion reaction

[a] The second indicator is reported as a single measure, but is also stratified into medical (adult and pediatric), surgical (adult and pediatric), obstetric and psychiatric DRGs.

Table 2. Prefixes for the Patient Safety Indicator (PSI) Variables			
		Examples	
Prefix	**Contents**	**Hospital indicator # 8, Post-operative Hip Fracture**	**Area indicator # 23, Infection Due to Medical Care**
T	Inpatient numerator (top)	TPPS08	TAPS23
P	Population denominator (pop)	PPPS08	PAPS23
O	Observed Rate	OPPS08	OAPS23
R	Risk-adjusted Rate	RPPS08	RAPS23
S	Smoothed Rate	SPPS08	SAPS23

Table 3. Patient Safety Module Contents	
SAS programs	**ASCII text files †**
CONTROL.SAS	QICTY97.TXT
PSFMTS.SAS	QICTY98.TXT
PSSAS1.SAS	QICTY99.TXT
PSSASP2.SAS	QICTY00.TXT
PSSASP3.SAS	QICTY01.TXT
PSSASA2.SAS	COVPSP00.TXT
	MSXPSP00.TXT

† The ASCII text files are data files provided with the Patient Safety module and are necessary for the programs to run. There is no need to convert these files to SAS format for use with the software.

Background

The Patient Safety Indicator module contains 26 indicators that reflect the quality of care inside hospitals. These indicators serve as flags for potential quality problems rather than definitive measures of quality of care. The indicators include two groups of measures based on hospital stays.

1. There are 20 hospital-based patient safety indicators for medical conditions and surgical procedures that have been shown to have complication/adverse event rates that vary substantially across institutions and for which evidence suggests that high complication/adverse event rates may be associated with deficiencies in the quality of care. These indicators are measured as rates -- number of complications / adverse events divided by the number of admissions for the procedure or condition. The hospital-based indicators include only those cases where a secondary diagnosis code flags a potentially preventable complication.

   Eight of these indicators are for surgical discharges, eight are for either medical or surgical discharges, and four are for obstetric discharges. Two of the hospital-based patient safety indicators, Post-operative hemorrhage or hematoma (#9) and Post-operative pulmonary embolism or deep vein thrombosis (#12), will incorporate information about when procedures were performed (relative to the admission date) if this information is available. Note, however, that if the day of procedure information is missing, the computed rates for post-operative hemorrhage or hematoma will be slightly higher and the computed rates for post-operative pulmonary embolism or deep vein thrombosis will be slight lower than if the information was available. Admission type is used by four of the PSIs: Post-operative physiologic and metabolic derangements, Post-operative respiratory failure, Post-operative sepsis, and Birth trauma (#s 10, 11, 13, and 17), to identify elective surgeries and newborn admissions.

2. There are six area-based patient safety indicators, where geographic areas can be defined at the MSA (Metropolitan Statistical Area) level for urban areas and at the county level for rural areas or by county for all areas. MSAs are defined in terms of entire counties, which include the county (or counties) that contain the largest city and any adjacent counties that have at least 50 percent of their population in the urbanized area surrounding the largest city. In New England, the MSAs are defined in terms of cities and towns rather than counties. The MSA definitions in this software are based on the standards effective June 30, 1999.

   These indicators are identical to hospital-based indicators, except that the numerator uses principal diagnosis in addition to secondary diagnoses in order to capture all cases of the complication, and not only those that develop during a given hospital admission.

The 26 indicators in the PSI module are listed in Table 1 on page 5. See also Appendix A of the "*Guide to Patient Safety Indicators"* for the definition of each indicator. Note that the second indicator (for death in low mortality DRGs) is reported as a single measure, but also has seven sub-indicators for medical (adult and pediatric), surgical (adult and pediatric), obstetric and psychiatric DRGs.

The data required for measuring these indicators come from hospital discharge abstracts or billing claims (administrative data) which are readily available in many states. The residential population data for the six area-based utilization indicators are from the Bureau of Census.

The software generates observed rates for the area-based patient safety indicators and observed, risk-adjusted, and smoothed (i.e., reliability-adjusted) rates for all hospital based indicators. Observed rates are the raw rates. Risk-adjusted rates are derived from applying the average case mix of a baseline file that reflects a large proportion of the U.S. hospitalized population. Smoothed rates are estimates with removal of fluctuations over time due to random variation. The observed rates for the area PSI are extremely low, and as a result age-sex adjustments are not necessary.

For information about how these indicators were identified, see the "*Guide to the Patient Safety Indicators."*

Data elements and coding conventions

Input for the AHRQ Quality Indicators

The PSI software was written to process data from discharge data abstracts that contain information about hospital stays. The specific data elements that are needed for the PSI software are listed in Table 4. The PSI module was tested on data from the Healthcare Cost and Utilization Project (HCUP). HCUP is an ongoing Federal-State-private collaboration to build uniform databases from administrative hospital-based data collected by State data organizations and hospital associations.

- *The input data files for the Patient Safety Indicators software must be in SAS.*

- *We recommend that users recode data elements in their input files to be consistent with the coding expected by the software. This will minimize the number of internal changes that will be necessary in the Patient Safety Indicators software. For example, recoding the SEX data element in the input file to be consistent with the coding described in Table 4 (i.e., 1 for male and 2 for female) is easier than modifying all uses of the Sex data element in the PSI programs.*

- *Not every value for every data element is referenced by the PSI software. For example, admission source (ASOURCE) values are used to identify transfers. However, we include the complete set of HCUP values to assist users of the uniform HCUP data files.*

- *Four of the PSIs (#s 10, 11, 13, and 17) use admission type (ATYPE) to identify elective surgeries and newborn admissions. If admission type (ATYPE) is not available in the user's data, the user may want to evaluate other data in the file to create a proxy to identify emergency, urgent and newborn admission types.*

- *To minimize internal changes to the software, all required elements should be present in the input data file. If a required element is not available, a dummy element should be provided. Failure to provide a dummy element will result in errors during the execution of the PSI programs.*

The data elements listed in Table 4 are those required for the input files of both SAS and SPSS. When a variable is not required for the SAS program the notation "Not used by the QI program" will be present in the Comments column. The SAS program will still run if these variables are not present, however, the SPSS program will not run correctly. Standardizing the variables and data values in the input data file will be helpful for users who have access to both statistical software packages.

The data element HOSPSTCO provides flexibility for users to calculate the area PSIs by hospital location or by patient residence. If the user wants to calculate the PSIs using the population associated with the hospital location as the denominator, the values for this variable should be the individual hospital FIPS[1] state/county codes. If the user wants to calculate the area PSIs based on the population of the MSA region or county associated with the patient residence, the values for this variable should be the FIPS state/county code associated with each individual patient's place of residence.

- *If the hospital FIPS code is used in HOSPSTCO, users should be aware that rates may be biased for hospitals which serve as regional referral centers. These hospitals are likely to treat patients from outside the MSA, county or even the state in which the facility is located.*

- *Using the patient FIPS state/county code for analysis may more accurately reflect the true population at risk.*

- *It is possible that some records in the input data file may be missing the patient FIPS code. Users should be aware that any records with missing values (in the HOSPSTCO data field) are excluded from the calculations*

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1 Federal Information Processing Standard, as defined by the U.S. Department of Commerce, National Institute of Standards and Technology (formerly National Bureau of Standards).

of observed, risk-adjusted and smoothed PSI area rates. They will be included in the output from the third program (PSSAS1.SAS).

☼ *The software will generate area PSI rates for each county included in the HOSPSTCO data field. Users are encouraged to limit cases in their input file to those patients discharged from the geographic area of interest. For example, if you are using data from the state of Wisconsin and are interested in generating a rate for Wisconsin, you should remove the cases where the patient's county of residence (FIPS code) is from another state. Otherwise the total or overall rate will include the population of the counties outside Wisconsin.*

The software provides the user with the option of producing output by MSA or by county. When MSA is selected, urban areas are always defined by MSAs. When county is selected urban areas will be defined by county.   Rural areas are always defined by county.

☼ *In the software programs, the MSALEVL parameter indicates whether MSA codes should be created from the FIPS state/county codes in the input dataset. If the user wishes to analyze data at the MSA level, this parameter should be set to 1. If the user wishes to analyze data at the county level, this parameter should be set to 0.*

Coding of diagnoses, procedures, and DRGs

Diagnoses and procedures must be coded using the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)

☼ *Significant modifications to ICD-9-CM codes occurred in the early 1990s. PSI definitions only reflect codes valid after October 1, 1997, and therefore may not accurately analyze data collected before 1997.*

♦ Diagnoses and procedure codes should be in character strings.

♦ Diagnosis and procedure codes should not contain any decimal points.

♦ Diagnosis and procedure codes should be left justified. Diagnosis codes with fewer than five digits should be padded with spaces (not zeros) on the right. Procedure codes with fewer than four digits should be padded with spaces (not zeros) on the right.

☼ *The PSI programs assume accurate and specific coding of ICD codes. If an ICD code is specified using 5 digits, the software recognizes only 5-digit versions of that code and not truncated versions at 3 or 4 digits. Similarly, if an ICD code is specified using 4 digits, the software recognizes only 4-digit versions of that code and not truncated versions at 3 digits. For example, 4281 is the ICD-9-CM diagnosis code for left heart failure. If your data are coded less specifically (i.e., 428 is used to designate "heart failure"), these less specific codes are not recognized by the software and will result in undercounting cases.*

♦ This software has ICD-9-CM codes updated through FY2003 changes.

♦ Diagnosis-related groups (DRGs) are those derived from the Centers for Medicare & Medicaid Services (previously Health Care Financing Administration) Medicare grouper. The software expects that you will be using the DRG effective on the discharge date. The software now refers to data elements DRG and MDC. Your data should be coded accordingly. The software may be modified at the user's option to use other types of DRGs. However, the impact of using other types of DRGs should be evaluated carefully before making such a change.

☼ *Version 2.1 of the software accounts for ICD-9-CM and DRG coding effective through September 30, 2003.*

Use of External Cause of Injury Codes

External cause of injury codes - E-codes – are used to classify environmental events, circumstances, and conditions as the cause of injury, poisoning, or other adverse events. The use of E-codes is not always required by a state uniform billing committee or a state data organization. Users should be knowledgeable of the E-code requirements and practices of hospitals represented in the input data file. Several of the indicators use E-codes in their numerator or denominator definitions. See the "*Guide to the Patient Safety Indicators"* for additional information*.*

Missing values

☼ *The PSI programs do not distinguish among different types of missing values.*

Data files of hospital discharge abstract data may have numeric data elements coded using special SAS missing "dot" values. For example, besides the standard SAS value of "." for missing data, there might also be present values of ".A" for invalid data, ".B" for data unavailable from a particular source, ".C" for inconsistent data. However, the PSI programs do **not** distinguish among the different types of missing codes. Therefore, all types of missing values in the input data to the PSI module can be represented by a single value - missing data (.) for numeric variables and blank (' ') for alphanumeric (or character) variables.

Table 4. Data Elements and Coding Conventions

Variable name	Description	Format	Value description	Comments
KEY	Sequence number. Unique case identifier.	Numeric	User defined unique numeric identifier for each discharge record	Not used by the PSI programs, but should be present to facilitate possible exploration and trouble shooting.
AGE	Age in years at admission	Numeric	Age in years	If missing, excluded from the analysis.
RACE	Race of patient.	Numeric 1 2 3 4 5 6	 White Black Hispanic Asian or Pacific Island Native American Other	The values 1,2, and 3 are used directly in the QI software. All other ethnicity codes are mapped to an 'other' category.
SEX	Sex of patient	Numeric 1 2	 Male Female	If missing, excluded from the analysis.
PAY1	Expected primary payer	Numeric 1 2 3 4 5 6	 Medicare Medicaid Private, incl. HMO Self-pay No charge Other	The values 1,2,3, and 4 are used directly in the QI software. All other payer codes are mapped to an 'other' category. Used to stratify only the Hospital-level PSIs (PSI01-PSI20).
HOSPSTCO	Hospital location or location of patient residence (FIPS State/county code)	Numeric ssccc	Modified Federal Information Processing Standards State/county code	Available at: http://eire.census.gov/popest/archives/files/fips.txt
HOSPID	Data Source hospital number	Numeric	Hospital identification number	Used to facilitate data exploration and possible trouble shooting.
DISP	Disposition of patient	Numeric 1 2 3 4 5 6 7 20	 Routine Short-term hospital Skilled nursing facility Intermediate care Another type of facility Home health care Against medical advice Died in the hospital	The values 2 and 20 are referenced by the PSI code (to identify transfers to another short-term hospital and patients who died in the hospital).
ATYPE	Admission Type	Numeric 1 2 3 4 5 6	 Emergency Urgent Elective Newborn Delivery Other	The values 3 and 4 are referenced by the PSI code (to identify elective surgeries and newborn admissions). PSIs 10, 11, 13, and 17 will be affected if ATYPE values are missing.
ASOURCE	Admission Source	Numeric 1 2 3 4 5	 ER Another hospital Another facility incl LTC Court/law enforcement Routine/birth/other	The values 2 and 3 are referenced by the PSI code (to look for transfers from another hospital or facility)
LOS	Length of Stay	Numeric	Number of days from admission to discharge	
DRG	Diagnosis Related Group	Numeric	DRG from CMS DRG Grouper	

Variable name	Description	Format	Value description	Comments
MDC	Major Diagnostic Category	Numeric	MDC from CMS DRG grouper	
DX1 – DX30	Diagnoses ICD-9-CM codes. DX1 is the principal diagnosis, DX2-DX30 are secondary diagnoses. Note: If e-codes are separated from secondary diagnoses in the input data file, the variable should be renamed and included as a secondary diagnosis variable (e.g., e-codes would be labeled as DX10 in a data file where the last secondary dx field is DX9).	String, 5 character	Diagnosis codes	Users must specify the number of diagnosis variables as the parameter in the CONTROL.SAS program.
NDX	Count of the number of diagnoses (Dx) on the discharge record.	Numeric	Count of Diagnoses	If the 1st discharge record has 5 Dx and the 2nd has 10, NDX would be 5 on the 1st and 10 on the 2nd. Not used by the SAS program.
PR1 – PR30	Procedure ICD-9-CM codes. PR1 is the principal procedure, PR2-PR30 are secondary procedures.	String, 4 character	Procedure codes	Users must specify the number of procedure variables as a parameter in the CONTROL.SAS program.
NPR	Count of the number of procedures (Pr) on the discharge record.	Numeric	Count of Procedures	If the 1st discharge record has 1 Pr and the 2nd has 2, NPR would be 1 for the 1st record and 2 for the 2nd. Not used by the SAS program.
PRDAY1 – PRDAY30	Days from admission to procedure. PR1 is the principal procedure, PR2-PR30 are secondary procedures.	Numeric	Days from Admission to Procedure	Necessary variables if the user sets the &PRDAY parameter in CONTROL.SAS to equal one. In this case, it is expected that the number of PRDAY variables agrees with the number of Procedure codes present.

These variables are not needed if the user sets the &PRDAY parameter in CONTROL.SAS to equal zero, indicating that there is no procedure day information available. |

User options

The PSI software reflects the development and implementation of the software using data available to AHRQ. Our goal was to develop the tools, illustrate their use, and then encourage others to adopt and use the tools for their own applications. As a result, we expect and encourage users of the software to consider whether and how to modify the PSI software to better serve their local conditions or interests.

☼ *Modifications to the definitions of outcomes of interest (numerators) or populations at risk (denominators) are possible but not desirable. Maintaining consistent definitions is important. Once definitions are altered, the ability to make comparisons of PSIs based on original definitions is lost. We encourage users to identify ways to improve the PSI methodology and to share their suggestions with us for future updates.*

AHRQ is planning to provide national PSI estimates through its web-based query system, HCUPnet (http://hcup.ahrq.gov/HCUPnet.asp). If users change definitions of the PSIs, it will not be possible to compare users' results to the national estimates in HCUPnet.

Processing steps

Each Patient Safety Indicator (PSI) expressed as a rate, is simply defined as:

Outcome of interest / Population at risk

(or)

Numerator / Denominator

Conceptually, five steps are necessary to produce the PSI rates. The following describes the steps and how the software performs them.

1. Identify outcomes in inpatient records

Inpatient records are marked to indicate whether they contain the outcome of interest (numerator or "top") for each of the AHRQ PSI measures.

This is done by setting a series of flag variables, each of which corresponds to the numerator for a particular PSI. For example, if the inpatient record meets the conditions for inclusion in the outcome for PSI #1, then the outcome indicator for PSI #1 is set to one.

This step requires one pass through the discharge-level data and outputs a discharge-level data file containing the flag indicator variables for the outcomes for each PSI.

2. Identify populations at risk

For the Hospital PSIs, the populations at risk (the denominators for calculating the PSI rates, or "pop") are derived from the hospital discharge records.

For the Area PSIs, the populations at risk (the denominators for calculating the PSI rates) are derived from Census population figures.

3. Calculate observed (raw) Patient Safety Indicator rates

Using the output data from step 1 and either hospital discharge or Census population data from step 2, the PSI rates are calculated for user-specified combinations of stratifiers. These stratifiers include hospitals, age groups, race/ethnicity categories, sex, and payer categories for the Hospital PSIs, and areas (MSAs/counties), age groups, race/ethnicity categories, and sex for the Area PSIs.

> ☼ *The programs calculate observed PSI rates regardless of the number of cases available. However, PSI rates based on only a few cases should be interpreted with caution.*

In work at AHRQ, we do not report rates based on fewer than 30 cases in the numerator or the denominator. This exclusion rule serves two purposes:

- It eliminates unstable estimates based on too few cases.

- It helps protect the identities of hospitals and patients.

This step outputs the observed rates for user-specified categories, alone or in combination. For example, Hospital PSI observed rates could be output at the hospital level, at the payer level, or at the hospital level by payer.

4.   *Risk adjust the Patient Safety Indicator rates. Hospital PSIs only.*

Regression coefficients from a baseline database (reflecting a large proportion of the U.S. population) are applied to the observed rates to risk-adjust the rates observed in the user's data. These baseline file regression coefficients are provided as part of the PSI module. The risk-adjusted rates will then reflect the age, sex, DRG and comorbidity distribution of data in the baseline file rather than the distribution for the hospitals present in the users' data. This will allow risk-adjusted rates produced by various users to be compared directly to one another. The regression coefficients were derived from AHRQ's State Inpatient Databases (SID) for 29 states. The code to generate these baseline coefficients are not part of the PSI module.

> 🔔 *For the hospital indicators, if there are fewer than three discharges for the particular PSI within a stratification cell, the risk-adjusted rate for that combination of stratifiers is set to missing.*

5.   *Create MSX smoothed rates. Hospital PSIs only.*

Shrinkage factors are applied to the risk-adjusted rates for each PSI in a process called multivariate signal extraction (MSX). These shrinkage factors were calculated from the SID database of 29 states. For each PSI, the shrinkage estimate reflects a 'reliability adjustment' unique to each indicator. The less reliable the PSI over time and across hospitals, the more the estimate 'shrinks' the PSI toward the overall mean. The resulting rate will appear "smoother" than the raw rate, meaning the year-to-year fluctuations in performance are likely to be reduced. More information on interpreting smoothed rates is contained in the interpretation section of this document. The shrinkage factors are provided as part of the PSI software and do not need to be calculated by users.

These five steps reflect the PSI module production in a nutshell. The next section of this document describes the specifics of each software component of the PSI module software.

Program descriptions

This section describes the six SAS programs that assign, calculate, and print the Patient Safety Indicators.

For each program there is a description, a list of input and output files, and an explanation of changes to the program that may be required. The flow of data through the PSI module programs is shown in the flowcharts in Figures 1 and 2 that begin on page 3.

If you desire to create and examine observed PSI rates, then the PSFMTS, CONTROL, and the PSSAS1 programs will need to be used, followed by PSSASP2 (for Hospital observed rates) and/or PSSASA2 (for Area observed rates). If you also wish to create Hospital risk-adjusted and smoothed PSI rates, then you will also need to run the PSSASP3 program. Risk-adjusted and smoothed rates are not calculated for the Area PSIs.

Program 1: modify statements in the CONTROL.SAS code

The CONTROL.SAS code contains all of the SAS statements that you need to modify in order to run the remaining PSI module programs (with one exception noted below). This is where you specify, for example, the path names or locations of all your input and output data sets. There is also a TITLE line that the user can fill in. The items that need to be changed in order to run the PSSAS1, PSSASP2, PSSASP3, and PSSASA2 programs are described below under each program.

- 🔔 *The CONTROL.SAS code is automatically inserted into the remaining programs when they are executed. You do **not** need to run CONTROL.SAS as a separate program.*

- 🔔 *All of the changes needed for the CONTROL.SAS code are listed in the following descriptions for programs 2 – 6. Each program description contains a section labeled "Changes:" that enumerates the modifications for CONTROL.SAS that are associated with that particular program.*

- 🔔 *Lines of code to be modified are identified by the phrase "<===USER MUST modify" which means the user **must** make the change or by "<===USER MAY modify" which means the modification is optional.*

In all of the remaining programs included with the PSI module, there is one line of code near the beginning of each program that needs to be modified. This line of code starts with the phrase "FILENAME CONTROL". You **must** modify this line to point to the path name where you stored your modified copy of the CONTROL.SAS file.

CONTROL.SAS has a collection of parameters that allow you to read in data from and write out data to different locations or pathnames. For example, "LIBNAME1 IN1" points to the location of your input data set for program PSSAS1 and "LIBNAME OUT1" points to the location of the output data set created by the PSSAS1 program. The parameters allow these locations to be different from one another. However, if you wish to read in and write out all of the data to the same location, it is easiest to just make a global change in CONTROL.SAS changing "C:\pathname" to the single directory location that you wish to use.

There is a global PRINT parameter in CONTROL.SAS that as a default prints all of the output summary records at the end of the PSSASP2, PSSASP3, and PSSASA2 programs. These printouts may be quite large if you have a large database with a large number of hospitals and if you choose the results to be finely stratified. If you wish to turn these prints off, set PRINT to have a value of zero in CONTROL.SAS

Program 2: run PSFMTS

The PSFMTS program defines a format library, which contains the diagnosis and procedure screens necessary for assigning the outcomes of interest. This format library is used by most of the succeeding programs. Formats are defined in the following order in the program:

- Sex, age, race, and payer categories used as stratifiers in PSSAS1
- Hospital and area level indicators. These are the formats used with procedure and diagnoses codes to identify the outcomes of interest and set the Patient Safety Indicators in the PSSAS1 program
- Area formats that map FIPS state and county codes to MSAs
- Age categories used in the risk adjustment process implemented in PSSASP3
- DRG categories or stratifiers used in PSSASP3
- Comorbidity stratifiers

The MSA definitions are from June 30, 1999 according to the federal Office of Management and Budget (OMB) circular 99-04. The mapping is from county to MSA, except in New England where counties are assigned to NECMAs (New England County Metropolitan Area). OMB defines NECMAs as a county-based alternative to the city- and town-based New England MSAs and CMSAs (Consolidated MSAs).   For example, Hampden and Hampshire counties in Western Massachusetts are assigned to the Springfield MA NECMA, even though Holland town in Hampden County is part of the Boston MSA.

The PSI module version 2.1 contains formats that incorporate ICD-9-CM and DRG coding through September 30, 2003.

Input: None.

Output: Permanent SAS format library (FMTLIB).

Changes:
1. You must modify the "FILENAME CONTROL" statement at the beginning of the program to change the path so that it points to your location of the CONTROL.SAS code.

2. In CONTROL.SAS, specify the location (path) of the format library in the "LIBNAME LIBRARY" statement.

Program 3: run PSSAS1

The PSSAS1 program processes hospital discharge abstract data, sets comorbidity indicators, and flags inpatient records if they contain outcomes of interest. Outcome indicator names have prefix of "T" (Top). Stratifier variables are constructed at the beginning of the program.

This program assumes that the input data file (consisting of inpatient discharge abstract data) conforms to specific variable names, attributes, and coding conventions. See Table 4 on page 11 for variable names and attributes for the input data file.

Partial definitions of the Patient Safety Indicators are given in Table 1 on page 5. This table is presented to assist those individuals who desire to examine the software source code statements. Complete definitions of the indicators are given in Appendix A of the "*Guide to Patient Safety Indicators".*

The AHRQ Comorbidity Analysis Program (comoanaly.sas), available at http://www.ahrq.gov/data/hcup/comorbid.htm , has been included as part of program PSSASS1. This code adds the comorbidity indicators to each discharge record. The user does not need to access the AHRQ Comorbidity Analysis Program. The AHRQ Comorbidity Format Program is part of the PSI module. Instead, the appropriate formats (modified for used with the PSI) are included in the PSFMTS program.

<u>Input</u>:
1. User supplied SAS inpatient data set consisting of administrative hospital discharge abstract data. This data set is a discharge level file with an array of diagnosis and procedure codes, among other data elements.

2. SAS format library (FMTLIB) created from the PSFMT program.

<u>Output</u>:
1. SAS dataset containing inpatient records with input variables, stratifiers, comorbidity variables, and flag indicators (TPPSxx and TAPSxx) for the outcomes of interest that will later form the numerators for the PSI rates.

2. PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of all of the numeric variables in the output data file and a PROC CONTENTS of the output data file are output to hardcopy.

3. A PROC PRINT of the first 24 observations in the output data file is output to hardcopy.

<u>Changes</u>:
1. The "FILENAME CONTROL" statement at the beginning of the program must be changed to reflect the location of the CONTROL.SAS code.

2. In CONTROL.SAS, specify the locations (paths) of the input and output files in the "LIBNAME IN1" and "LIBNAME OUT1" statements.

3. In CONTROL.SAS, specify the names of the input and output files in the "INFILE1" and "OUTFILE1" statements.

   The PSI module assumes that your starting SAS data set contains 30 diagnoses and 30 procedures. If these numbers are different in your input inpatient data, then modify the NDX and NPR parameters in CONTROL.SAS.

   If your variables are named differently from those used in the PSI software (see table 4 on page 11), you MUST either rename those variables prior to running this program or modify PSSAS1 to include the renaming of your variables to match those expected by the software. Similarly, if your variables are not the same type, i.e., character or numeric, as those expected by the software (see Table 4), you MUST modify your variables prior to running this program.

Program 4: run PSSASP2

The PSSASP2 program calculates the observed or raw rates for the hospital-level Patient Safety Indicators, using the data derived in a previous step (PSSAS1). These observed rates are stratified by combinations of hospitals, sex, age, race, and payer categories. The program first totals the indicator flags created by the PSSAS1 program and then for each of the desired stratifiers divides these totals by the hospital discharges in the universe for the indicator. The population denominators are stored in variables with names that have a prefix of "P" (<u>P</u>op). The <u>O</u>bserved rates are stored in variables that have a prefix of "O".

<u>Input</u>:
1. The SAS dataset that was created in the PSSAS1. This is a discharge-level file that contains inpatient records with input variables, stratifiers, and the 20 new flag indicators for the PSI Hospital outcomes of interest.

2. SAS format library (FMTLIB) created from the PSFMT program.

<u>Output</u>:

1. SAS dataset with summary records that contain observed rates (OPPSxx variables where xx refers to the indicator number), the counts of outcomes that formed the numerators of the rates (TPPSxx variables), and the hospital discharge totals that formed the denominators of the observed rates (PPPSxx variables). The output file has records summarized to the various combinations of stratifiers specified in the TYPELVLP parameter that is described in item 4 in "Changes" below.

2. An optional ASCII (comma delimited) text file that the user can then import into a spreadsheet. This text file contains the same information as the SAS output dataset. The text file will contain the OPPSxx observed rates, the TPPSxx counts of outcomes that formed the numerators of the rates, and the PPPSxx counts of outcomes that formed the denominators of the rates. The different records/rows in the text file will correspond to the different TYPELVLP stratification combinations

3. A PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of the hospital-level summary records that shows statistics for the OPPSxx observed rates, the TPPSxx counts of outcomes that formed the numerators of the rates, and the PPPSxx counts of outcomes that formed the denominators of the rates. These means will only be generated if the user included a value of 16 for the TYPELVLP parameter discussed in item 4 in the "<u>Changes</u>" section below.

4. A PROC CONTENTS of the output SAS summary dataset is output to hardcopy.

5. A PROC PRINT of the output summary dataset is provided at the end of the hardcopy printout. This printout may be quite large depending on the number and the types of stratifications that the user requests with the TYPELVLP parameter discussed in item 4 in the "<u>Changes</u>" section below. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL.SAS code should be set to zero.

<u>Changes</u>:

1. The "FILENAME CONTROL" statement at the beginning of the program must be changed to reflect the location of the CONTROL.SAS code.

2. In CONTROL.SAS, specify the locations (paths) of the input and output SAS files in the "LIBNAME INP2" and "LIBNAME OUTP2" statements.

3. In CONTROL.SAS, specify the names of the input and output files in the "INFILEP2" and "OUTFILP2" statements. The name that you specify with INFILEP2 should be for the file that you created using the PSSAS1 program.

4. In CONTROL.SAS, specify the levels of aggregation for the observed rates. This is done by specifying numbers between 0 and 31 in the "%LET TYPELVLP =" statement. Each number from 0 to 31 corresponds to a different level or combination of levels as show in Table 5. The default values of 0 and 16 will provide an overall total and hospital-level totals.

If TYPELVLP includes the value 0, then the first observation in the output summary datafile will contain the overall totals and observed rates for the entire database created with the PSSAS1 program.

TYPELVLP	Stratification				
0	Overall				
1					Race
2				Payer	
3				Payer *	Race
4			Sex		
5			Sex *		Race
6			Sex *	Payer	
7			Sex *	Payer *	Race
8		Age			
9		Age			Race
10		Age *		Payer	
11		Age *		Payer *	Race
12		Age *	Sex		
13		Age *	Sex *		Race
14		Age *	Sex *	Payer	
15		Age *	Sex *	Payer *	Race
16	**Hospital**				
17	Hospital *				Race
18	Hospital *			Payer	
19	Hospital *			Payer *	Race
20	Hospital *		Sex		
21	Hospital *		Sex *		Race
22	Hospital *		Sex *	Payer	
23	Hospital *		Sex *	Payer *	Race
24	Hospital *	Age			
25	Hospital *	Age *			Race
26	Hospital *	Age *		Payer	
27	Hospital *	Age *		Payer *	Race
28	Hospital *	Age *	Sex		
29	Hospital *	Age *	Sex *		Race
30	Hospital *	Age *	Sex *	Payer	
31	Hospital *	Age *	Sex *	Payer *	Race

Table 5. PSSASP2 aggregation possibilities

0 and 16 TYPELVLP (overall and hospital) are default values for the level of computation in the software.

For example, if you are using a state inpatient hospital database, you might specify the following TYPELVLP values:

0 – provides overall rates for your entire state
8 – provides overall rates for your state, broken down by age groups
16 – provides rates for hospitals within your state
24 – provides rates for age groups within these hospitals

5. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then set the TEXTP2 parameter to 1. Otherwise, the default value of zero for TEXTP2 will skip around the code that would generate this file.

6. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then specify the path (including the file name) for this ASCII text file in the "FILENAME PSTEXTP2" statement.

Program 5: run PSSASP3

The PSSASP3 program calculates age, sex, DRG and comorbidity risk-adjusted rates for each PSI and then calculates smoothed rates.

☼ *If you are interested in calculating confidence intervals for each PSI, you may request a supplementary module (PSSASP3CI.SAS) to calculate a 95% CI for each PSI and hospital (see the Interpreting the Results, Confidence Intervals section for additional information). You would run this program in place of PSSASP3. The user needs to run only PSSASP3 or PSSASP3CI, it is not necessary to run both these programs.*

☼ *When there are fewer than three discharges within a stratification cell, the risk-adjusted rates are set to missing. The smoothed rates that are based on these risk-adjusted rates are also set to missing.*

The output file has records summarized to the various combinations of stratifiers that were specified in the TYPELVLP parameter of the preceding QISASP2 program. See table 5 on page 20.

Input:
1. SAS format library (FMTLIB) created from the PSFMT program.

2. The discharge-level file that was created with the PSSAS1 program.

3. The SAS dataset with summary records that was created with the PSSASP2 program.

4. A text file (COVPSP00.TXT) containing regression coefficients from a regression that was run on a reference SID dataset. These coefficients will be used in the risk adjustment process. This file is provided to you as part of the PSI module. The text file does not need to be converted to a SAS file for use with the software.

5. A text file (MSXPSP00.TXT) containing three arrays for use in the smoothing process. The arrays contain noise estimates, signal estimates, and mean rates for each PSI. This file is provided to you as part of the PSI module. The text file does not need to be converted to a SAS file for use with the software.

Output:
1. A SAS dataset with an overall summary record and with hospital-level summary records that contain the three types of indicator rates, along with the components of the initial raw rates. Specifically, the file contains the observed rates (OPPSxx variables), the risk-adjusted rates (RPPSxx variables), the smoothed rates (SPPSxx variables), the counts of outcomes that formed the numerators of the observed rates (TPPSxx variables), and the hospital discharge totals that formed the denominators of the observed rates (PPPSxx variables).

2. An optional ASCII (comma delimited) text file that the user can then import into a spreadsheet. This text file contains the same information as the SAS output dataset. The text file will contain the OPPSxx observed rates and their TPPSxx and PPPSxx numerator and denominator components, the RPPSxx risk-adjusted rates, and the SPPSxx smoothed rates. Each record or row in the text file will correspond to a specification group.

3. A PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of the hospital-level summary records that shows statistics for the observed, risk-adjusted and smoothed rates, and statistics for the counts of outcomes that formed the numerators and denominators of the observed rates. These means will only be generated if the user included a value of 16 for the TYPELVLP parameter of the preceding QISASP2 program. See table 5 on page 20.

4. A PROC CONTENTS of the output SAS summary dataset is output to hardcopy.

5. A PROC PRINT of the output summary dataset is provided at the end of the hardcopy printout. This printout may be quite large depending on the number and the types of stratifications that the user

requested with the TYPELVLP parameter of the preceding PSSASP2 program. See table 5 on page 20. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL.SAS code should be set to zero.

Changes:
1. The "FILENAME CONTROL" statement at the beginning of the program must be changed to reflect the location of the CONTROL.SAS code.

2. In CONTROL.SAS, specify the locations (paths) of the input and output SAS files in the "LIBNAME INP3" and "LIBNAME OUTP3" statements.

3. In CONTROL.SAS, specify in the "INFILP3X" statement the name of the discharge-level file that you created with the PSSAS1 program.

4. In CONTROL.SAS, specify in the "FILENAME COVARP" statement the path (including the file name) for the ASCII text file that contains regression coefficients from a regression that was run on the reference SID dataset. This file is provided as part of the PSI module. The name of the file is COVARP00.TXT.

5. In CONTROL.SAS, specify in the "FILENAME MSXP" statement the path (including the file name) for the ASCII text file that contains the estimates to smooth the indicator rates. This file is provided as part of the PSI module. The name of the file is MSX00.TXT.

6. In CONTROL.SAS, specify in the "INFILP3Y" statement the name of the summary file that you created with the PSSASA2 program.

7. In CONTROL.SAS, specify in the "OUTFILP3" statement the name that you wish the output file to have.

8. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then set the TEXTP3 parameter to 1. Otherwise, the default value of zero for TEXTP3 will skip around the code that would generate this file.

9. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then specify the path (including the file name) for this ASCII text file in the "FILENAME PSTEXTP3" statement.

Program 6: run PSSASA2

The PSSASA2 program calculates the observed or raw rates for the area-level Patient Safety Indicators, using the data derived in a previous step (PSSAS1). These observed rates are stratified by combinations of area, sex, age, and race categories. The program first totals the six area indicator flags created by the PSSAS1 program, and then for each of the desired stratifiers divides these totals by the pertinent residential population. The population denominators are stored in variables with names that have a prefix of "P" (Pop). The Observed rates are stored in variables that have a prefix of "O".

Input:
1. The SAS dataset that was created in the PSSAS1. This is a discharge-level file that contains inpatient records with input variables, stratifiers, and the six new flag indicators for the PSI Area outcomes of interest.

2. A text file with Census area residential populations, stratified by area, age, sex, and ethnicity categories. Five such files are currently provided along with the PSI module software. The files are QICTY97, QICTY98, QICTY99, QICTY00, and QICTY01. The user should select the file for the year that best matches the user's discharge datafile.

☼ *Users do **not** need to convert the ASCII text file to a SAS dataset for use with the software.*

3. SAS format library (FMTLIB) created from the PSFMT program.

Output:

1. SAS dataset with summary records that contain observed rates (OAPSxx variables where xx refers to the indicator number), the counts of outcomes that formed the numerators of the rates (TAPSxx variables), and the residential population totals that formed the denominators of the observed rates (PAPSxx variables). The output file has records summarized to the various combinations of stratifiers specified in the TYPELVLA parameter that is described in item 5 in "Changes" below.

2. An optional ASCII (comma delimited) text file that the user can then import into a spreadsheet. This text file contains the same information as the SAS output dataset. The text file will contain the OAPSxx observed rates, the TAPSxx counts of outcomes that formed the numerators of the rates, and the PAPSxx residential population totals. The different records/rows in the text file will correspond to the different TYPELVLA stratification combinations.

3. A PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of the area-level summary records that shows statistics for the OAPSxx observed rates, the TAPSxx counts of outcomes that formed the numerators of the rates, and the PAPSxx residential populations totals. These means will only be generated if the user included a value of 8 for the TYPELVLA parameter discussed in item 5 in the "<u>Changes</u>" section below.

4. A PROC CONTENTS of the output SAS summary dataset is output to hardcopy.

5. A PROC PRINT of the output summary dataset is provided at the end of the hardcopy printout. This printout may be quite large depending on the number and the types of stratifications that the user requests with the TYPELVLA parameter discussed in item 5 in the "<u>Changes</u>" section below. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL.SAS code should be set to zero.

Changes:

1. The "FILENAME CONTROL" statement at the beginning of the program must be changed to reflect the location of the CONTROL.SAS code.

2. In CONTROL.SAS, specify the locations (paths) of the input and output SAS files in the "LIBNAME INA2" and "LIBNAME OUTA2" statements.

3. In CONTROL.SAS, specify the names of the input and output files in the "INFILEA2" and "OUTFILA2" statements. The name that you specify with INFILEA2 should be for the file that you created using the PSSAS1 program.

4. In CONTROL.SAS, specify the path (including the file name) for the ASCII population text file in the "FILENAME POPFILA2" statement. The file name will be QIPOP97.TXT, QIPOP98.TXT, QIPOP99.TXT, QIPOP00.TXT, or QIPOP01.TXT. These files are provided to you as part of the PSI module. The file used should be the one that is closest to the year associated with your particular data.

5. In CONTROL.SAS, specify the levels of aggregation for the observed rates. This is done by specifying numbers between 0 and 15 in the "%LET TYPELVLA =" statement. Each number from 0 to 15 corresponds to a different level or combination of levels as show in Table 6. The default values of 0 and 8 will provide an overall total and area-level totals.

☼ *If TYPELVLA includes the value 0, then the first observation in the output summary datafile will contain the overall totals and observed rates for the entire database created with the PSSAS1 program.*

<table>
<tr><td colspan="8">Table 6. PSSASA2 aggregation possibilities</td></tr>
<tr><td>TYPELVLA</td><td colspan="7">Stratification</td></tr>
<tr><td>0</td><td>Overall</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Race</td></tr>
<tr><td>2</td><td></td><td></td><td></td><td></td><td>Sex</td><td></td><td></td></tr>
<tr><td>3</td><td></td><td></td><td></td><td></td><td>Sex</td><td>*</td><td>Race</td></tr>
<tr><td>4</td><td></td><td></td><td>Age</td><td></td><td></td><td></td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>Age</td><td>*</td><td></td><td></td><td>Race</td></tr>
<tr><td>6</td><td></td><td></td><td>Age</td><td>*</td><td>Sex</td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td>Age</td><td>*</td><td>Sex</td><td>*</td><td>Race</td></tr>
<tr><td>8</td><td>Area</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>9</td><td>Area</td><td>*</td><td></td><td></td><td></td><td></td><td>Race</td></tr>
<tr><td>10</td><td>Area</td><td>*</td><td></td><td></td><td>Sex</td><td></td><td></td></tr>
<tr><td>11</td><td>Area</td><td>*</td><td></td><td></td><td>Sex</td><td>*</td><td>Race</td></tr>
<tr><td>12</td><td>Area</td><td>*</td><td>Age</td><td></td><td></td><td></td><td></td></tr>
<tr><td>13</td><td>Area</td><td>*</td><td>Age</td><td>*</td><td></td><td></td><td>Race</td></tr>
<tr><td>14</td><td>Area</td><td>*</td><td>Age</td><td>*</td><td>Sex</td><td></td><td></td></tr>
<tr><td>15</td><td>Area</td><td>*</td><td>Age</td><td>*</td><td>Sex</td><td>*</td><td>Race</td></tr>
</table>

0 and 8 TYPELVLA (overall and area) are default values for the level of computation in the software.

For example, if you are using a state inpatient hospital database, you might specify the following TYPELVLA values:

0 – provides overall rates for your entire state
4 – provides overall rates for your state, broken down by age groups
8 – provides rates for areas within your state
12 – provides rates for age groups within these areas

6. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then set the TEXTA2 parameter to 1. Otherwise, the default value of zero for TEXTA2 will skip around the code that would generate this file.

7. In CONTROL.SAS, if you wish to create an ASCII (comma delimited) text file that you can import into a spreadsheet, then specify the path (including the file name) for this ASCII text file in the "FILENAME PSTEXTA2" statement.

Reviewing the printed output.

This section contains tips for reviewing some of the printed output from the PSI module. These tips are oriented toward explaining the interrelationships between printout items from different programs and hopefully will help to reveal the nature and structure of the module outputs. For guidance in interpreting the results, see the next section which begins on page 30.

🔔 *The final output of the PSI module is a PROC PRINT from PSSASP3 (for hospital-level indicators) and PSSASA2 (for area-level indicators). All interim printouts are for checking and trouble-shooting. However, if you have elected to refrain from risk adjusting and smoothing the hospital indicators, then the final hospital indicator output will be the PROC PRINT at the end of the PSSASP2 program. Risk-adjusted and smoothed rates are not calculated for the area-level PSIs.*

PSSAS1

The initial printout from the PSSAS1 program contains **PROC MEANS** output for all of the numeric variables (including the comorbidity indicators) in the output discharge-level dataset. It will contain information for the newly constructed TAPSxx and TPPSxx flag variables that will later form the numerators for the indicator rates. For each TAPSxx and TPPSxx flag variable:

- The SUM will contain the total number of observations in the dataset that were found to have the particular outcome of interest.

- The Hospital indicator numerators (TPPS01-TPPS20) and the Area indicator numerators (TAPS21-TAPS26) will all have a value of one, zero, or missing ('.'). For these indicators, a value of zero was assigned to the TAPSxx/TPPSxx flag if a particular observation was part of the population at risk for a particular indicator but did not have the particular outcome of interest. For example, TPPS20 = 1 indicates a patient who had an obstetric trauma from a Cesarean section, while TPPS20 = 0 identifies a patient who had a C-section but no trauma complication.

- The MEANs will contain a close approximation of the eventual overall observed indicator rates. The values will change slightly after PSSASA2/PSSASP2 has applied additional parts of the indicator definitions.

- N lists the number of observations in the dataset with non-missing values. N will contain the denominator for the observed indicator rate.

The PSSAS1 printout also contains a **PROC CONTENTS** that lists all of the variables in the output dataset, including the character variables that are present, and a PROC PRINT of the first 24 observations in the output dataset.

PSSASP2

The purpose of this printout is to provide the observed rates for all hospital-level indicators. The default printout shows results by hospital, but other levels of output (as shown in Table 5) can be specified as well. Note that risk-adjusted and smoothed rates are shown in the output from the next program.

The printout from the PSSASP2 program contains **PROC MEANS** on the hospital-level summary records for all of the numeric variables in the output summary dataset. It will contain information for the newly constructed OPPSxx rates, the PPPSxx denominators, and the TPPSxx numerators.

- The _TYPE_ variable described in the MEANS table identifies the stratification level for the records in the output data set. The _TYPE_ variable corresponds to the TYPELVLP parameter values that were specified (see item 4 in "Changes" under the PSSASP2 program). In this case, _TYPE_ always assumes the value of 16, since only the hospital-level records are selected.

- The N statistic for _TYPE_ contains the number of records in the output summary data set. A TPPSxx numerator variable with a value for N that is lower than the N value for _TYPE_ indicates that there were no outcomes of interest in some of stratification cells. Similarly, a PPPSxx denominator variable with a lower value for N than _TYPE_ indicates that for some stratification cells, there were no hospital discharges with the outcome of interest.

- The MINIMUM value for the TPPS01-TPPS20 numerators will be zero since values of zero were assigned for observations that were part of the population for the rate denominator but did not have the particular outcome of interest to be included in the rate numerator.

⌘ *For the observed rates, the User should **NOT** report the MEANS displayed here, but instead should refer to the overall means in the output dataset that are also present in the subsequent PROC PRINT. The MEANS given here are means of hospital means; i.e., all hospitals are given equal weight, regardless of the number of discharges in the different hospitals.*

- The SUMs for the counter variables TPPSxx and PPPSxx will contain overall file totals for these data elements. The SUMs for the observed rates have no intuitive meaning.

If the "PRINT" parameter in the CONTROL.SAS program is set to one, the subsequent **PROC PRINT** output contains a complete dump of the output summary file. Listed for each record are the stratification values, the PPPSxx population denominators for the 20 indicators, the TPPSxx outcome numerators for the 20 indicators, and the 20 OPPSxx observed rates.

PSSASP3

⌘ *The **PROC PRINT** at the end of this program provides your **final output**. (This printout appears if the "PRINT" parameter in the CONTROL.SAS program is set to one – the default setting.) It lists the numerator and the denominator, along with the observed, risk-adjusted, and smoothed rates for all indicators, as shown in the following example.*

```
                                    SAMPLE DATA
                                 PROGRAM P3 PART III
                 AHRQ PATIENT SAFETY INDICATORS: HOSPITAL-LEVEL MERGED FILES
                                   FINAL OUTPUT
                          Indicator # 04: FAILURE TO RESCUE

                                  TPPS04      PPPS04       OPPS04      RPPS04      SPPS04
    OBS HOSPID AGECAT SEXCAT PAYCAT RACECAT (Numerator)(Denominator) (Observed) (Risk Adj) (Smoothed)

     1    .                                    3051       18021     0.169302   0.171598   0.171589
     2 12004                                     38         182     0.208791   0.218282   0.197431
     3 12006                                      1          11     0.090909   0.087498   0.164362
     4 13015                                      4          32     0.125000   0.174602   0.171170
     5 13022                                    151        1148     0.131533   0.162518   0.163375
     6 13031                                     42         188     0.223404   0.180822   0.176362
     7 13042                                     25         249     0.100402   0.113107   0.133753
     8 13060                                      7          38     0.184211   0.190012   0.174569
     9 13076                                     34         182     0.186813   0.178394   0.174908
    10 13084                                     16         168     0.095238   0.097523   0.130686
    11 13088                                     72         423     0.170213   0.133663   0.142811
    12 13093                                     47         305     0.154098   0.173130   0.172266
    13 13096                                     33         328     0.100610   0.128792   0.141256
    14 13097                                    123        1009     0.121903   0.118205   0.124576
    15 13100                                      2          21     0.095238   0.034538   0.152704
    16 14002                                    130         843     0.154211   0.195720   0.192105
    17 14003                                     14         109     0.128440   0.131110   0.153216
    18 14008                                      9          88     0.102273   0.103876   0.144754
    19 14031                                     72         413     0.174334   0.196287   0.189719
    20 14034                                     61         406     0.150246   0.169017   0.169369
    21 14044                                    102         469     0.217484   0.217232   0.206444
    22 15049                                     95         608     0.156250   0.152693   0.156011
    23 15050                                    131         603     0.217247   0.202397   0.196354
    24 15054                                     10          67     0.149254   0.131847   0.157933
    25 15071                                     18         128     0.140625   0.144376   0.157979
    26 15074                                     54         370     0.145946   0.165906   0.167139
    27 15080                                     12         128     0.093750   0.100078   0.136848
    28 15097                                     34         157     0.216561   0.244424   0.209481
    29 15098                                     61         309     0.197411   0.184295   0.179952
    30 15123                                    126         644     0.195652   0.187238   0.184223
    31 15136                                    104         553     0.188065   0.164413   0.165623
    32 15143                                     47         262     0.179389   0.168238   0.168988
    33 15145                                      5          47     0.106383   0.133684   0.161179
    34 15149                                     58         399     0.145363   0.143799   0.150717
    35 15150                                      3          31     0.096774   0.093100   0.156403
    36 15163                                     30         171     0.175439   0.184905   0.178361
    37 15173                                     23         107     0.214953   0.207813   0.186578
    38 15182                                     78         416     0.187500   0.157560   0.160796
    39 15188                                     29         123     0.235772   0.153952   0.162710
    40 15193                                    124         818     0.151589   0.165210   0.165968
    41 15195                                      8          43     0.186047   0.233235   0.185128
    42 15197                                      .           0     .          .          .
    43 15223                                    167         879     0.189989   0.192694   0.189623
    44 15230                                     10         107     0.093458   0.112351   0.145279
    45 15239                                    103         510     0.201961   0.199198   0.192981
    46 15241                                     40         154     0.259740   0.238155   0.205845
    47 15249                                     10          47     0.212766   0.216202   0.181882
    48 15253                                     43         296     0.145270   0.134759   0.146218
    49 15255                                     90         394     0.228426   0.216462   0.204361
    50 15256                                     62         328     0.189024   0.157658   0.161473
    51 15276                                    161        1002     0.160679   0.161331   0.162444
    52 15284                                    140         863     0.162225   0.168232   0.168533
    53 15288                                     41         226     0.181416   0.185729   0.179852
    54 15295                                     94         375     0.250667   0.266884   0.240607
    55 15296                                     57         244     0.233607   0.232630   0.209903
```

In this example printout, observation 1 (with HOSPID = .) is the overall average for the entire dataset (TYPELVL = 0). The remaining observations are individual hospitals, or hospitals (TYPELVL = 16). Data will appear under the column headers, AGECAT, SEXCAT, PAYCAT, and RACECAT, if you specify these levels of aggregation (shown in Table 5).

You may wish to express the results in more understandable terms:
- Multiply the rates by 100 to express them as a percentage (e.g., 0.0338 * 10 = 3.4%)
- To create standardized rates or rates per 1,000 discharges, multiple the output by 1,000.

The MEANS table is generated from the permanent hospital-based output file and is provided for trouble-shooting and understanding your data, but not for reporting. The means are provided just for the hospital level summary records.

- The N for all but the TPPSxx counter variables should contain the number of hospitals in the users database.

- The MEANS, MINIMUMs, and MAXIMUMs have their normal meaning and provide comparisons among the different hospitals or hospitals in your database.

- ☼ *For the (observed, risk-adjusted, or smoothed) rates, the User should **NOT** report the MEANS displayed here, but instead refer to the overall means in the output dataset in the PROC PRINT labeled "FINAL OUTPUT." The MEANS given here are means of hospital means; i.e., all hospitals are given equal weight, regardless of the number of discharges in the different hospitals.*

- If the "PRINT" parameter in the CONTROL.SAS program is set to one, at the end of the printout is a **PROC PRINT** on the final hospital-based output file. Listed for each level of stratification are the stratifiers, the numerator and denominator totals for the observed rates, and the observed, risk-adjusted, and smoothed rates.

PSSASA2

The purpose of this printout is to provide the observed rates for all area-level indicators. The default printout shows overall results and results by area, but other levels of output (as shown in Table 6) can be specified as well.

- The printout from the PSSASA2 program contains **PROC MEANS** for all of the numeric variables in the output summary dataset. It will contain information for the newly constructed OAPSxx rates, the PAPSxx denominators, and the TAPSxx numerators. The MEANS table is generated from the permanent area-based output file. The means are provided just for the area-level summary records.

- The _TYPE_ variable described in the first row of the MEANS table identifies the stratification level for the records in the output data set. The _TYPE_ variable corresponds to the TYPELVLA parameter values that were specified (see item 6 in "Changes" under the PSSASA2 program). In this case, _TYPE_ always assumes the value of 8 since only the area-level records are selected.

- The N statistic for _TYPE_ contains the number of records in the output summary data set. A TAPSxx numerator variable with a lower value for N than _TYPE_ indicates that there were no outcomes of interest in some of stratification cells. Similarly, a PAPSxx denominator variable with a lower value for N than _TYPE_ indicates that for some stratification cells, the Census residential population estimate was zero.

- The N for all but the TAPSxx counter variables should contain the number of different areas (MSAs and counties) in your database.

- The MEANs, MINIMUMs, and MAXIMUMs have their normal meaning and provide comparisons among the different areas in your database.

- The MINIMUM value for the TAPSxx numerators will be one or higher.

- The SUMs for the counter variables TAPSxx and PAPSxx will contain overall file totals for these data elements. The SUMs for the observed rates have no intuitive meaning.

☼ *For the observed rates, the User should **NOT** report the MEANS displayed here, but instead should refer to the overall means in the output dataset that are also present in the subsequent PROC PRINT. The MEANS given here are means of the area means; i.e., all areas are given equal weight, regardless of the population in the different areas.*

☼ *The **PROC PRINT** at the end of this program provides your **final output**. (This printout appears if the "PRINT" parameter in the CONTROL.SAS program is set to one – the default setting.) It lists the numerator and the denominator, along with the observed, risk-adjusted, and smoothed rates for all indicators, as shown in the example output below.*

```
                            SAMPLE PROGRAM
                       1997 NIS ONE-QUARTER SAMPLE
                             PROGRAM A2
            AHRQ PATIENT SAFETY INDICATORS: CALCULATE OBSERVED AREA RATES
                             FINAL OUTPUT
                Indicator # 25: TECHNICAL DIFFICULTY WITH PROCEDURE


                                        TAPS25        PAPS25        OAPS25
        OBS   AREA  AGECAT SEXCAT RACECAT (Numerator) (Denominator) (Observed)

         1                             1,354      34,797,250    0.000039
         2   0401                          2          69,450    0.000029
         3   0403                          1         111,652    0.000009
         4   0407                         14          94,705    0.000148
         5   0602                          6         122,639    0.000049
         6   0603                          9         142,155    0.000063
         7   0604                          7          18,273    0.000383
         8   0605                          8          54,842    0.000146
         9   0609                         11          44,264    0.000249
        10   0681                         38         624,577    0.000061
        11   2630                         28         119,795    0.000234
        12   2850                         30         863,080    0.000035
        13   5120                         14       1,260,307    0.000011
        14   5472                        309      15,562,781    0.000020
        15   7200                        217       2,841,395    0.000076
        16   7922                        178       1,679,321    0.000106
        17   8320                        215       2,722,060    0.000079
        18   9362                        240       6,718,863    0.000036
        19   9460                         15         231,426    0.000065
        20   9480                          9         386,789    0.000023
        21   9520                          3         778,684    0.000004
        22   9780                          0         350,192    0.000000
```

Observation 1 (with AREA = *blank*) is the overall average for the entire dataset (TYPELVL = 0). The remaining observations are individual areas (TYPELVL = 8).

You may wish to express the results in more understandable terms:
- Multiply the rates by 100,000 to express them as a rate per 100,000 population (e.g., 0.000039 * 100,000 = 3.9 technical difficulties with procedure per 100,000 population).

Interpreting the results

After performing all of the steps as previously outlined, users will have a set of observed estimates of performance for each Area PSI and three estimates of performance for each Hospital PSI – observed, risk-adjusted, and MSX smoothed (i.e., reliability-adjusted) estimates. This section will outline how the different types of estimates can be used.

The Patient Safety Indicators are not intended as definitive quality measures. Many factors can and do influence performance on quality indicators. Some of these factors are independent of quality. From our empirical analyses we estimated that generally less than 1 percent (range 0.2-15%) of total patient level variation for each QI is attributable to actual hospital-level differences. Though this number appears low, we also estimated that often most of this remaining hospital-level variation reflects true signal; that is, the observed performance is not likely the result of random variation. We also noted that these true differences in hospital performance are potentially clinically important, in that they involve severe and potentially preventable complications and adverse events. Thus, though these indicators are not intended and should not be used as definitive measures of quality, they are useful low-cost screens that can potentially illuminate differences between hospitals that may be addressable using quality and patient safety improvement techniques.

While very high rates may indicate quality problems, it is often best to compare hospital rates with other similar hospitals. These "peer groups" would ideally be as similar as possible in potentially important factors, such as case mix, socioeconomic status and other demographics. Similar hospitals should perform similarly on PSIs. Potential

characteristics that have been used to define peer groups have been teaching status, bed capacity, socioeconomic status of the population, and urban or rural location.

Performance on a single PSI often cannot reliably indicate actual quality differences. Examining all the indicators together is likely to produce a more complete picture of overall quality of care. Hospitals that perform better (or worse) than average on one measure tend to perform better (or worse) on others. In other words, performance on indicators is often related, and performance on multiple similar indicators could also be examined as summary indicators for an overall picture of quality.   Similarly, indicators may be related across indicator types. *Groups of indicators have not been validated as sets, but using them as such may be useful for exploration purposes.*

Observed means.

The interpretation of the observed (raw) PSI rates may be complicated by concerns over noise and bias. However, the observed rates do not require complex statistical methods as do the risk-adjusted and MSX smoothed rates. For this reason, they are the most intuitive estimates of PSI performance. Observed rates can be used as a baseline measure when comparing to risk-adjusted and MSX smoothed rates, to determine the impact of risk adjustment/smoothing.

Observed rates may fluctuate for some hospitals from year to year. While some of these fluctuations may indicate true differences in performance, others are due only to random chance (i.e., non-systematic differences among hospitals s in patient characteristics that are not observed, and therefore cannot be adjusted for). For this reason, it is often beneficial to examine observed rates for a given hospital over several consecutive time periods. This will help to diminish the chance of inaccurately judging poorer than average or better than average performance during one year as true performance.

Risk-adjusted rates. Hospital PSIs only.

Simply put, risk-adjusted rates are the estimated performance of hospitals on the PSIs if those hospitals had an 'average' case mix. This average case mix is estimated and included in the software using estimates from 29 States in the SID databases. Estimates of the average case mix do not reflect only the hospitals in the dataset being analyzed, but rather the distribution in age, sex, DRG and co-morbidity categories among the hospitals in the SID data.

Most hospital indicators are risk adjusted using age, sex, DRGs and co-morbidities. A few hospital indicators cannot be adjusted using DRGs since the population at risk is characterized by a few DRGs. These are the OB related indicators.

For Transfusion reaction (PSI #16) the outcome of interest is a relatively rare event and the observed rates will be extremely low. No risk-adjustment or smoothing is performed for this indicator.

> ☼ *The output will not include any risk-adjusted or smoothed rates for PSI #16, Transfusion reaction. The software will generate observed rates only.*

Users should compare risk-adjusted rates with the observed rates. This will indicate the impact of risk adjustment and presumably case mix on indicator performance. Hospitals with large changes in performance between observed and risk-adjusted rates presumably have a more or less complex case mix.

Additional information on the risk-adjustment methodology is available in the *Guide to Patient Safety Indicators*. In summary, all indicators were examined empirically by developing and conducting statistical tests for precision, bias, and relatedness of indicators. For each indicator, the project team calculated five different estimates of hospital performance:

1. The raw indicator rate was calculated using the number of adverse events in the numerator divided by the number of discharges in the population at risk by hospital. For the area indicators, the denominator is the population of the Metropolitan Statistical Area (MSA), New England County Metropolitan Area (for the New England States) or county (for non-MSA areas) of the hospital.

2. The raw indicator was adjusted using a logistic regression to account for differences among hospitals (and areas)

in demographics (specifically, age and gender). Age was modeled using a set of dummy variables to represent 10-year categories except for young children, whose age categories are narrower (i.e., less than 1, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, and 85 or more years), along with a parallel set of age-gender interactions. Because of sparse cells, certain age categories were combined or omitted for selected indicators, such as the obstetric indicators.

3. The raw indicator was adjusted to account for differences among hospitals in age, gender and modified DRG category.

4. The raw indicator was adjusted to account for differences among hospitals in age, gender, modified DRG, and comorbidities (defined using an adaptation of the AHRQ comorbidity software) of patients.

5. Multivariate signal extraction (MSX) methods were applied to adjust for reliability by estimating the amount of "noise" (i.e., variation due to random error) relative to the amount of "signal" (i.e., systematic variation in hospital performance or the 'reliability') for each indicator. This or similar "reliability adjustment" has been used in the literature for similar purposes. Multivariate methods (taking into account correlations among indicators to extract additional signal) were applied to most of the accepted indicators. The exceptions were Death in Low Mortality DRGs and Failure to Rescue. Only univariate signal extraction methods (smoothing) were applied to these two indicators and to the experimental indicators, because these indicators possibly cover broader clinical concepts. Correlations between these indicators and other indicators may not reflect correlations due to quality of care, and thus inclusion of these indicators may adversely affect the MSX approximations.

In our risk-adjustment models, we calculated hospital fixed effects using the standard method with logistic models of first estimating the predicted value for each discharge, then subtracting the actual outcome from the predicted, and averaging the difference for each hospital (and adding in the overall rate) to get the hospital fixed effect estimate. The logistic model was appropriate given the rare occurrence of many of the PSIs and the dichotomous outcomes. The risk-adjustment model for each PSI accounts for patient demographics (age, sex) and DRG/co-morbidity category. The risk-adjusted rates reflect the estimated performance on the PSI for each hospital if that hospital had the 'average' case mix among all hospitals in the estimation sample.

Second, because the fixed effects are calculated indirectly with a logistic model, the estimated risk-adjusted rates may be negative (that is, the model does not require the rates to be between zero and one). This might happen, for example, if the observed rate is close to zero, and the hospital has a more severe than average case mix. The model would predict that the hospital's performance with an 'average' case mix would be less and subtract some adjusted amount from the observed rate. If that observed rate is already nearly zero, the adjusted rate may be negative. A negative rate means that the observed rate is close to zero, and that the hospital has a less-severe-than-average case mix. In order to facilitate the interpretation of the estimates, the PSI module imposes a lower bound of zero; i.e., negative values are set to zero.

MSX smoothed rates. Hospital PSIs only.

The PSSASP3 program also yields the estimated MSX smoothed (i.e., reliability-adjusted) rates for each Hospital PSI. These smoothed rates are estimated using multivariate signal extraction (MSX). MSX is a Bayesian smoothing technique. Generally, indicators defined on relatively small populations per hospital or for relatively rare events are very noisy measures. In other words, many other factors other than quality can influence the observed rate. For factors that we can observe, such as the patient's age or gender or DRG, risk adjustment can account for their influence. There are many other clinical and non-clinical factors that we cannot observe. However, the MSX method estimates how much of an impact random differences in these factors have on the observed rate. The SAS program accomplishes this by adjusting toward the overall mean according to the degree of reliability of the specific hospital indicator.

The MSX method estimates reliability by looking at hospital performance among multiple indicators and across multiple years for a single indicator. If hospitals that perform high in one year also tend to perform high in the next, and hospitals that are low in one indicator tend to perform low in other related indicators, then the methods incorporate this information in forming an estimate of how much of a hospital's performance on a single indicator in a single year is "signal" and how much is "noise". PSSASP3 reports the "signal" estimate, after removing the "noise".

These estimates are referred to as "smoothed" estimates because when the raw data is reported annually on a graph, for example, the line connecting the points may show massive fluctuations, seemingly with no apparent pattern. Some of these fluctuations are due to random differences in factors that influence performance, so once the impact of these factors is removed, fluctuations are reduced, or smoothed out. Improvements in performance will still be observed, however, they will only be observed when it is likely that these improvements are actually true differences, and not simply random variation.

The estimates of how related the Patient Safety Indicators are among measures and over time for a typical hospital are based on estimates using the 29 states in the SID database. Therefore, PSSASP3 does not require multiple hospitals, measures, and years of data to operate. Instead shrinkage estimates were calculated from the combination of 29 statewide HCUP datasets to which the MSX had been applied. These shrinkage estimates are the best estimates of the impact that MSX smoothing would have on a particular PSI if MSX could be applied to the dataset being analyzed. These shrinkage estimates are then applied to the adjusted rates for each PSI, giving 'smoothed' estimates of the rates.

The smoothed estimates represent the best guess of what the hospital performance would be for any given PSI if the data contained only a minimal amount of noise. This has several implications. First, users can be more certain that changes observed over time represent true differences in performance, rather than random variation. Second, in any given year, users can be more certain that the rate does not reflect only random noise. This can best be seen by comparing the smoothed estimates with the observed raw rates, which will indicate the impact of MSX on that indicator. A large impact means that the observed rate of the indicator is less precise, meaning it contains more noise relative to other indicators sustaining less impact. Low precision can result from small numbers of observations, or for relatively rare events. Therefore, the impact of the MSX estimate will in general be greater for small hospitals and for infrequent events. Plotting the MSX estimates over time will reflect more persistent performance from year-to-year, and the correlations among indicators will generally be stronger.

Comparing observed, risk-adjusted and smoothed rates. Hospital PSIs only.

The purpose of the analysis determines which rates the user should look at in evaluating the performance of a hospital. If the user's primary interest is to focus on a particular hospital without any comparisons to other hospitals, simply examine the overall observed rate for the entire hospital, as well as further breakdowns by age, sex, payer, and race/ethnicity which are the output created by the PSSASP2 programs. Trend data are recommended for identifying changes over years.

If the purpose of the analysis is to compare the performance of a particular hospital with national, state, or regional averages or performance of other selected hospitals, then both observed and risk-adjusted rates should be examined. Variation in observed rates across hospitals is attributable to a variety of factors including differences in patient case mix or population demographics, disparity in access to and quality of care, and other hospital characteristics ('systematic factors'), and random factors (non-systematic factors or 'noise'). Comparing observed and risk-adjusted rates can reveal if there is any difference between the hospital's population and the population of other hospitals. If the difference is minimal, one can compare the observed rate with the overall average across all hospitals . However, to account for differences in patient case mix or population demographics among different hospitals, risk-adjusted rates should be used for hospital comparisons.

After removing the impact of patient case mix or population demographics, if users want to examine potential existence of random factors, comparisons can be made between the risk-adjusted rates and the smoothed rates to determine if the differences in risk-adjusted rates across hospitals are due to systematic, as opposed to random, factors. The following two tables provide guidance on how to interpret differences in observed, risk-adjusted, and smoothed rates.

Comparing Observed Rates with Risk-adjusted Rates
Purpose: To identify if there is any difference in the patient case mix of the hospital relative to that of all hospitals combined

Observed rate **>** Risk-adjusted rate	The hospital's patient population for the condition or procedure has a *higher* risk of complication/adverse event due to its case mix (for example, older or a greater proportion of a higher-risk DRG/ comorbidity).
Observed rate **<** Risk-adjusted rate	The hospital's patient population for the condition or procedure has a *lower* risk of complication/adverse event due to its case mix (for example, younger or a greater proportion of a lower-risk DRG/comorbidity).
Observed rate **=** Risk-adjusted rate	Mortality indicators: The hospital's patient case mix for the condition or procedure is similar to other hospitals', suggesting that patient composition is not a contributing factor to the hospital's performance for the complication/adverse event indicator.

Comparing Risk-adjusted Rates with Smoothed Rates (optional)
Purpose: To determine if differences in risk-adjusted rates across hospitals are due to systematic or random factors after patient case mix or demographic composition is taken into account.

Risk-adjusted rate *similar to* Smoothed rate	The hospital's risk-adjusted rate is more precise, an accurate reflection of the hospital's systematic ('true') rate. If there is any difference between the risk-adjusted rate and the overall average[1], such difference is likely to be due to systematic factors.
Risk-adjusted rate *different from* Smoothed rate	The hospital's risk-adjusted rate is less precise[2]; that is, some of the difference between the risk-adjusted rate and the overall average is due to random ('noise') factors. The smoothed rate is thus a more accurate estimate of the systematic rate than the risk-adjusted rate. Comparing the smoothed rate to the overall hospital average reveals more accurately the 'true' performance of the hospital.

Notes: 1. The overall hospital average refers to the weighted average risk-adjusted rates across all hospitals.
        2. The risk-adjusted rates for hospitals with small population are generally less precise.

Confidence Intervals.

The software does not include a procedure for calculating confidence intervals for the PSIs. Any such procedure should be evaluated for robustness depending on the hospital's denominator and rate. User's may request a supplementary module to calculate a 95% CI (PSSASP3CI.SAS) for each PSI and hospital using a procedure based on a normal approximation that is generally appropriate. The module can be requested by sending an e-mail to support@qualityindicators.ahrq.gov and specify "PSI Confidence Interval Syntax Request" in the subject line and indicate in the body of the e-mail you would like the SAS syntax.

Benchmark timings

The benchmark runtimes given below are from runs made on a Microsoft Windows 95 workstation, with an Intel Celeron, MMX, 500 MHZ processor, and 128MB of RAM. The dataset used contained 500,494 observations with 15 diagnosis fields and 15 procedure fields.

Step	Run time (in seconds)
Run PSFMTS to create the format library	001
Run PSSAS1	926
Run PSSASP2	029
Run PSSASP3	470
Run PSSASA2	012

User Support and Information

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We offer a listserv to keep you informed on the Quality Indicators. We encourage you to sign up for this free service. All you need is a computer, Internet access, and an E-mail address. It works just like other electronic distribution lists.

Here's how to register:

1. Send an E-mail message to: listserv@qualityindicators.ahrq.gov.

2. On the subject line, type: Subscribe. For example:

    Subscribe

3. In the body of the message type: sub Quality_Indicators-L and your full name. For example:

    sub Quality_Indicators-L John Doe

4. You will receive a message confirming that you are signed up.

If you have any questions, contact AHRQ QI Support at the e-mail noted above. If you do not receive an e-mail message confirming receipt of your e-mail, call (888) 512-6090.