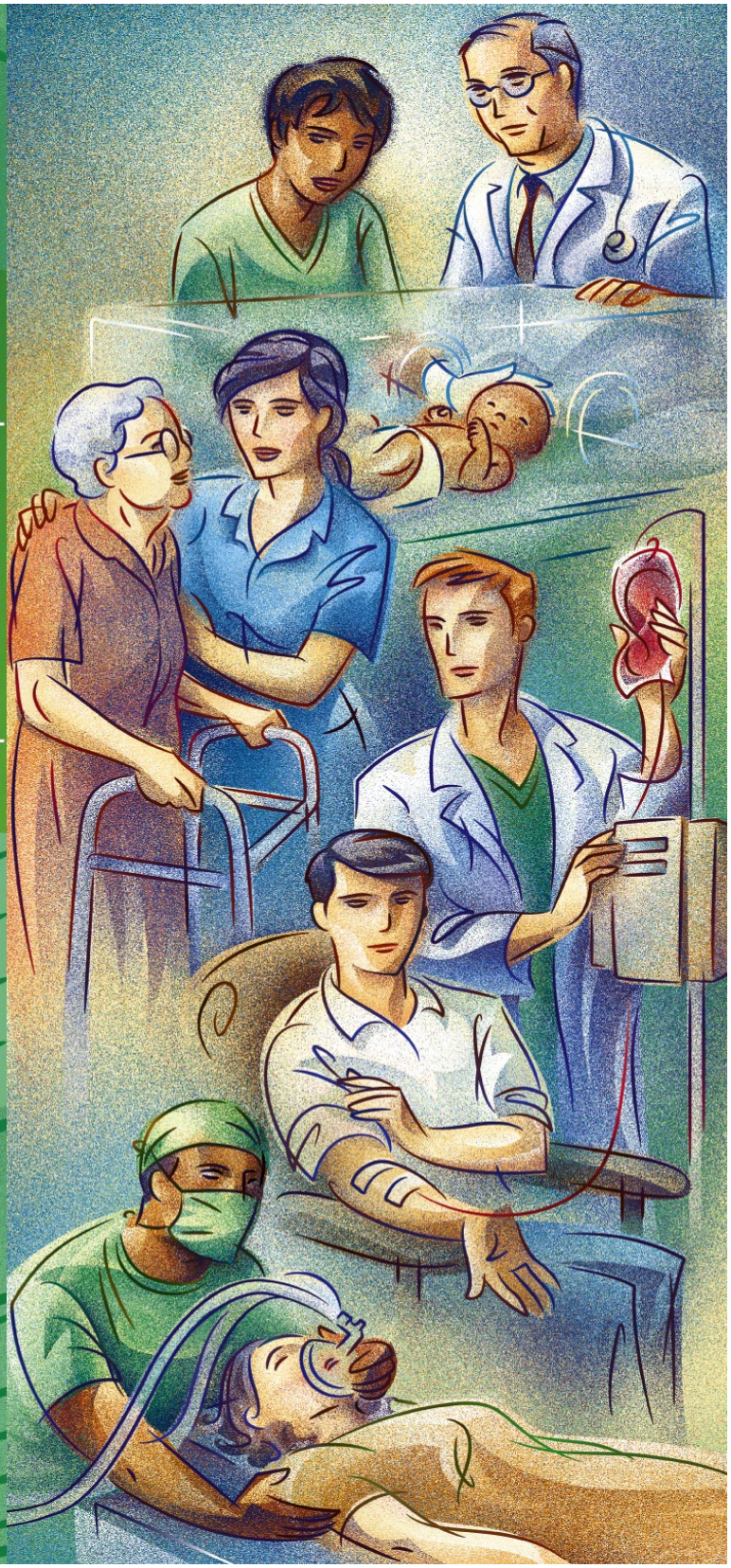
AHRQ

AHRQ QUALITY INDICATORS

Patient Safety Indicators

SOFTWARE DOCUMENTATION



AHRQ Quality Indicators

Patient Safety Indicators: Software Documentation, Version 3.0a SAS

Department of Health and Human Services
Agency for Healthcare Research and Quality
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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 provider level.

This document is the software documentation for the Patient Safety Indicators software Version 3.0, 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 Patient Safety Indicators can be found in *Guide to Patient Safety Indicators*. See Appendix A for links to documents and tools.

Acknowledgments

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AHRQ Quality Indicators, SAS Software Documentation, Version 3.0a: Patient Safety Indicators

1.0 Introduction

This documentation describes the software for implementing the Patient Safety Indicator (PSI) module of the AHRQ Quality Indicators Version 3.0a and highlights features of the analytic approach of particular interest to new users. Detailed information about the PSIs is contained in the companion document *Guide to Patient Safety Indicators*, which includes information about the development of the indicators and their definitions. Detailed definitions, including all ICD-9-CM codes included in or excluded from the numerator and denominator for each indicator, are contained in a separate document *Patient Safety Indicators Technical Specifications.* See Appendix A for links to documents and tools.

The section called "Interpreting the Results" has been removed from this document. The *Guide to Patient Safety Indicators* contains a new section, "Using Different Types of QI Rates."

The PSI SAS software no longer incorporates the AHRQ Comorbidity software. Before running the PSI software, the user will need to download and run the standalone program available at http://hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp. That program will create the comorbidity variables in the user's data file. These variables are only needed if the user intends to calculate risk-adjusted rates using PSSASP3.

The software consists of a series of computer programs that perform the following functions:

- 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 and expected rates that adjust for performance 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:

2.0 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 three 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)[1], version 6.12 or higher, on a Windows personal computer.

A note on the naming conventions for the PSI module programs. Most programs have names of the form PSSASi, PSSASAi, or PSSASPi. The first two characters "PS" of the program name indicate 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 SPSS versions of the software. In the programs that are specific to either Area or Provider Indicators, 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 or Office of Management and Budget (OMB) defined metropolitan or micropolitan area (Metro Area) populations as denominators. The sixth character is a "P" if it is a program that is for the production of Provider Indicator rates that use subsets of the hospital discharge population. The last character (i) of the variable name designates the number of the specific program.

3.0 Quick Reference

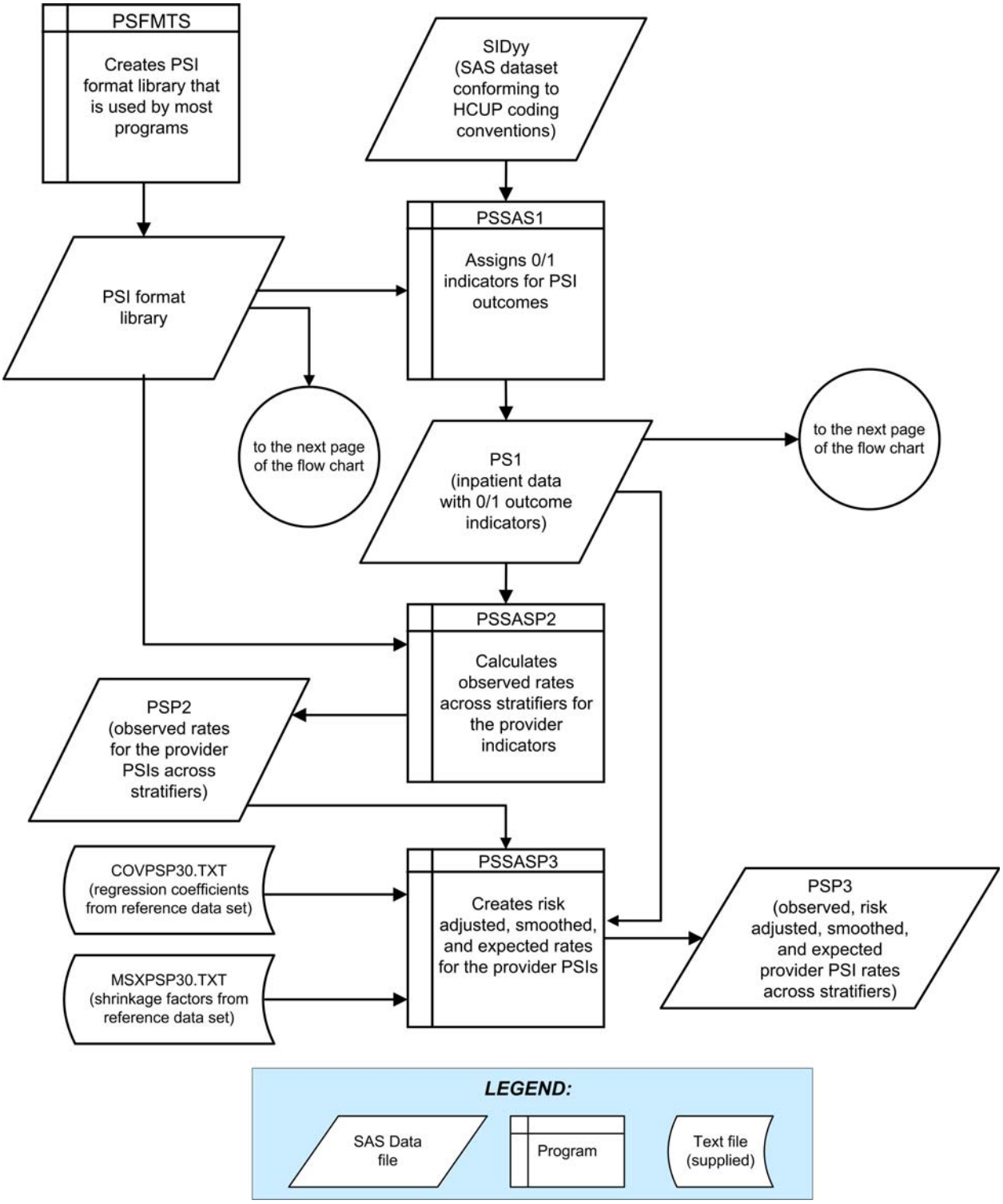
The subsequent four pages are intended to serve as a quick reference to assist in reading this documentation and in reviewing the PSI module outputs. Processing steps are shown first (Figure 1 and Figure 2) followed by a listing of the module indicator variables (Table 1), variable prefixes (Table 2), 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.

3.1 Processing Steps

Figure 1 shows processing steps for the Patient Safety Indicators - Provider, while Figure 2 shows steps for the Patient Safety Indicators - Area.

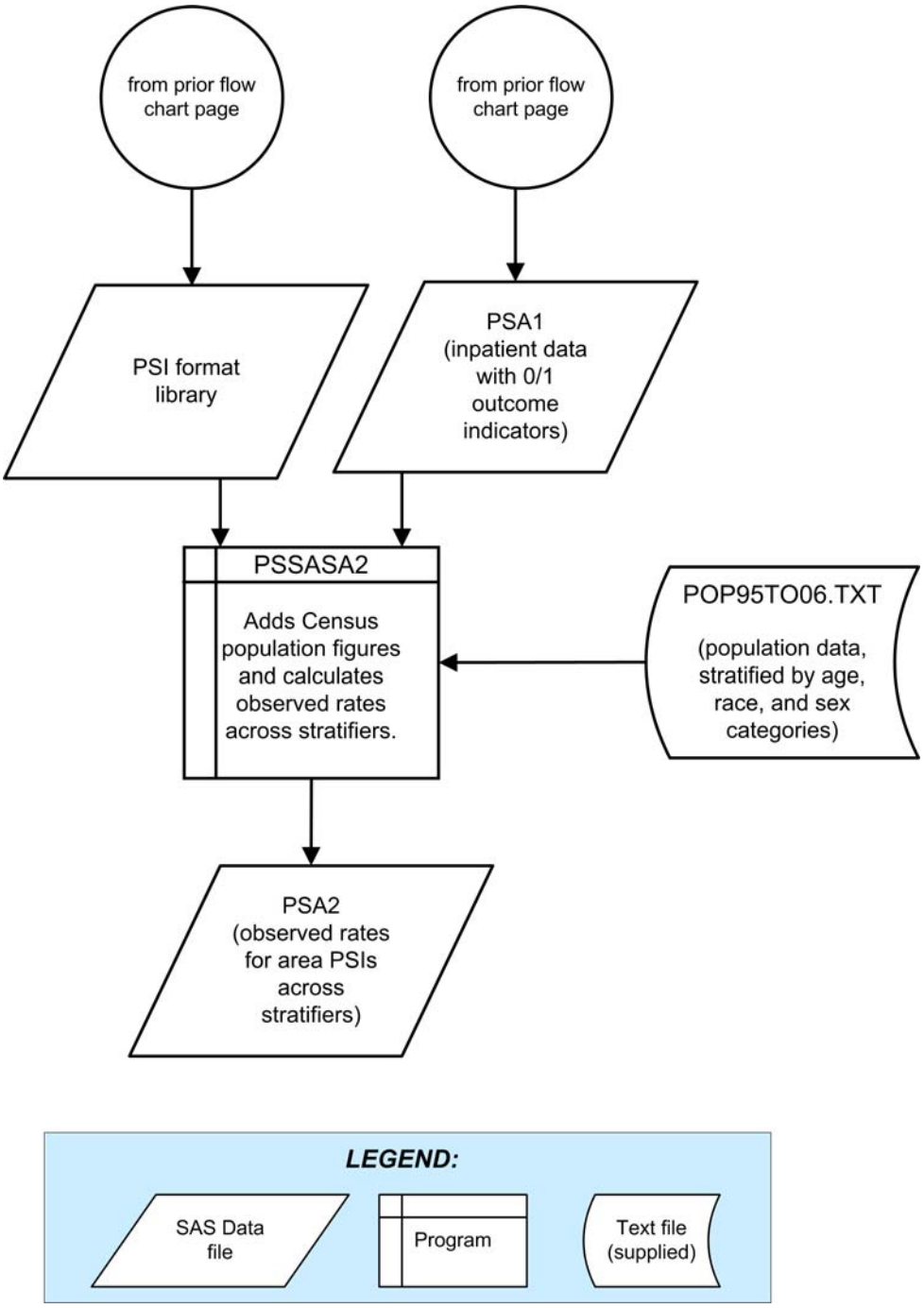
[1] SAS is a statistical program distributed by the SAS Institute, Inc. (http://www.sas.com). The company may be contacted directly regarding the licensing of their products. The SAS Institute, Inc. does not have any affiliation with AHRQ nor involvement in the development of the AHRQ QIs.

Figure 1. Processing Steps for the Patient Safety Indicators - Provider



NOTE: Each of the SAS Programs in Figure 1 incorporates the CONTROL_PSI.SAS program, which contains code the user **must** modify in order to run the PSI software. The **modifications** include such items as specifying the name and location of the input data set, the population data set, and the output data set.

Figure 2. Processing Steps for the Patient Safety Indicators - Area



3.2 Patient Safety Indicator Module Details

The following tables list the module indicator variables (Table 1), variable prefixes (Table 2), and module contents (Table 3).

Table 1. Patient Safety Indicator (PSI) Variables

PSI Number	Indicator
	Patient Safety Provider Indicators
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	Postoperative hip fracture
9	Postoperative hemorrhage or hematoma
10	Postoperative physiologic and metabolic derangements
11	Postoperative respiratory failure
12	Postoperative pulmonary embolism or deep vein thrombosis
13	Postoperative sepsis
14	Postoperative wound dehiscence
15	Accidental puncture or laceration
16	Transfusion reaction
17	Birth trauma – injury to neonate
18	Obstetric trauma – vaginal with instrument
19	Obstetric trauma – vaginal without instrument
20	Obstetric trauma – cesarean section
	Patient Safety Area Indicators
21	Foreign body left during procedure
22	Iatrogenic pneumothorax
23	Selected infections due to medical care
24	Postoperative wound dehiscence
25	Accidental puncture or laceration
26	Transfusion reaction
27	Postoperative hemorrhage or hematoma

Table 2. Prefixes for the Patient Safety Indicator (PSI) Variables

Prefix	Contents	Examples	
		Provider Indicator # 8, Postoperative 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
E	Expected rate	EPPS08	N/A
R	Risk-adjusted rate	RPPS08	N/A
L	Lower limit of confidence interval of risk-adjusted rate	LPPS08	N/A
U	Upper limit of confidence interval of risk-adjusted rate	UPPS08	N/A
S	Smoothed rate	SPPS08	N/A
X	Standard error of smoothed rate	XPPS08	N/A

Table 3. Patient Safety Module Contents

SAS programs (syntax files)	ASCII text files (data)
CONTROL_PSI.SAS	POP95TO06.TXT
PSFMTS.SAS	COVPSP30.TXT
PSSAS1.SAS	MSXPSP30.TXT
PSSASP2.SAS	
PSSASP3.SAS	
PSSASA2.SAS	

The ASCII text files are data files provided with the Patient Safety Indicators 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. The parameter reference file of MSXPS30.TXT is not interchangeable between SAS and SPSS software.

Users should verify they are running the software with the ASCII text files as listed in Table 3 of the applicable, e.g., SAS or SPSS, software manuals.

4.0 Background

The PSI module contains 27 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 **Provider-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 Provider-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. Seven of the Provider-based Patient Safety Indicators (PSIs 3, 9, 10, 11, 12, 14), 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 these indicators will be slightly lower than if the information was available. Admission type is used by four of the PSIs: postoperative physiologic and metabolic derangements, postoperative respiratory failure, postoperative sepsis, and birth trauma (PSIs 10, 11, 13, and 17), to identify elective surgeries and newborn admissions.

   Note that PSI 2 (Death in Low Mortality DRGs) is reported as a single provider level measure (observed and risk-adjusted). A single measure is necessary to insure adequate reliability of the provider level rates by pooling an infrequent event over a large group of patients. However, the denominator for the indicator is very heterogeneous, and the mortality rate among the low mortality DRGs varies by DRG type. For instance, adult medical DRGs account for about 60% of the deaths, although they account for only 25% of the discharges in the denominator. Conversely, obstetric DRGs account for about 5% of the deaths and 45% of discharges in the denominator. Users should compare the observed rate to the risk-adjusted rate, which accounts for differences among hospitals in patient case-mix (i.e., age, gender, DRG and co morbidities). For example, a hospital may have a high Death in Low Mortality DRG observed rate only because the hospital has a higher-than-average share of adult medical DRGs.

2. There are seven **Area-based** Patient Safety Indicators, where geographic areas can be defined at the user's option in one of four ways:
   - County level with U.S. Census FIPS[2]
   - County level with modified FIPS
   - Metro Area with OMB 1999 definition
   - Metro Area with OMB 2003 definition.

   The MSALEVL parameter has been renamed to MALEVL to reflect the change in OMB definitions for areas. Refer to page 9 for information on these area definitions and MALEVL parameter settings.

These indicators are identical to Provider-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 27 indicators in the PSI module are listed in Table 1 on page 5. The data required for measuring these indicators come from hospital discharge abstracts or billing claims (administrative data) which are

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

readily available within hospitals or from many state data organizations. The residential population data for the Area Indicators are from the U.S. Census Bureau.

The software generates observed rates for the area-based patient safety indicators and observed, expected, risk-adjusted, lower and upper 95% confidence limits for risk-adjusted rates, smoothed rates and standard errors of the smoothed rates for each indicator at the provider level. Observed rates are the raw rates. Expected rates are the rates the area would have if it performed the same as the reference population given the provider's actual case-mix (e.g., age, gender, modified DRG and comorbidities). Risk-adjusted and expected rates are derived from applying the average casemix of a baseline file that reflects a large proportion of the U.S. hospitalized or residential population. Smoothed rates are estimates with removal of fluctuations over time due to random variation. The observed rates for the area PSIs are extremely low, and as a result age-sex adjustments are not necessary.

5.0 Data Elements and Coding Conventions

5.1 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 AHRQ 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. Additional information on HCUP is available at the website http://www.ahrq.gov/data/hcup.

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

It is strongly recommend that users recode data elements in their input files to be consistent with the coding expected by the software. We do not recommend changing 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) should be done rather than attempting to 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, only two of the discharge disposition (DISP) data elements values are used in the software (DISP value "2" for short-term hospital and value "20" for died in the hospital). However, the complete set of standardized values is included, based on HCUP specifications, to assist users of the uniform HCUP data files.

Four of the indicators (PSIs 10, 11, 13, and 17) use admission type (ATYPE) to identify elective surgeries. 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 elective 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 **all** of the SAS and SPSS QI modules. When a variable is not required for the PSI SAS program the notation "Not used by the QI program" will be present in the Comments column. Standardizing the variables and data values in the input data file will be helpful for users who have access to both statistical software packages as well as users working to standardize their input file specifications for use with any of the AHRQ QI software modules.

The data element HOSPSTCO has been renamed to PSTCO to emphasize the importance of calculating the area PSIs by the location of the patient residence. If the user wants to calculate the area PSIs based on the population of the Metro Area 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 patient information is not available or 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 state/county codes.

If the provider FIPS code is used in PSTCO, 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 Metro Area, county or even the state in which the facility is located.

Users no longer have to use the Modified FIPS codes assignment for area denominators. However, that option is still available. In the modified FIPS codes certain independent cities (Baltimore City, Carson City and St. Louis City), and areas within Hawaii and Virginia, are assigned to different area groupings.

Using the patient FIPS state/county code for analysis may more accurately reflect the true population at risk. Using the provider FIPS state/county code for analysis should be done with caution, and at larger levels of geographic area (i.e. Metro Area) to minimize the bias with patients that come from a different county than the hospital location.

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 PSTCO data field) are excluded from the calculations of observed, risk-adjusted and smoothed PSI area rates. They will be included in the output from the first program (PSSAS1.SAS).

The software will generate area PSI rates for each county included in the PSTCO 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 Metro Area or by county. When Metro Area is selected, urban areas are always defined by Metro Areas. When county is selected urban areas will be defined by county. Rural areas are always defined by county.

In the software programs, the MALEVL parameter should be set as follows:

0-County level with U.S. Census FIPS
1-County level with modified FIPS
2-Metro Area with OMB 1999 definition
3-Metro Area with OMB 2003 definition.

The metropolitan area definitions are from three different sources. 1) The "modified FIPS" definition is from the Area Resource File. The mapping is from county to modified FIPS county (e.g., Baltimore city to Baltimore county); 2) The "1999 OMB" definition is from the federal Office of Management and Budget (OMB) circular 99-04, (Last Revised May 6, 2002). The mapping is from county to Metropolitan Statistical Area (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; and 3) the "2003 OMB" definition is from the federal Office of

Management and Budget (OMB) circular 03-04, (Last Revised December 4, 2005). The mapping is from county to either Metropolitan Statistical Area or Micropolitan Statistical Area.

5.2 Coding of Diagnoses, Procedures, DRGs and MDCs

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 software 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.

- Diagnosis-Related Groups (DRGs) and Major Diagnostic Categories (MDCs) 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 and MDC effective on the discharge date. The software now refers to data elements DRG and MDC. Your data should be coded accordingly.

Version 3.0a of the software accounts for ICD-9-CM, DRG and MDC coding effective through FY 2006 (or through September 30, 2006).

5.3 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 documents *Guide to the Patient Safety Indicators* and *Patient Safety Indicators Technical Specifications* (http://www.qualityindicators.ahrq.gov/psi_download.htm) for additional information.

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 QI programs, but should be present to facilitate possible exploration; allows user to link the records from the PSSAS1.SAS program output file back to the original input data file.
AGE	Age in Years at Admission	Numeric	Age in years	If this data element is missing the discharge record will be excluded from the analysis.
AGEDAY	Age in Days (coded only when the age in years is less than 1)	Numeric	Age in days	Used to identify newborns in PSI 17.
RACE	Race of Patient.	Numeric 1 2 3 4 5 6	 White Black Hispanic Asian or Pacific Island Native American Other	The values 1through 5 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 this data element is missing the discharge record will be 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. This data element is used to stratify only the Provider-level PSIs (PSI01-PSI20).
PSTCO	Location of Patient Residence or Hospital Location (FIPS State/County Code)	Numeric ssccc	Modified Federal Information Processing Standards State/county code[3]	Available at: http://www.census.gov/popest/geographic/codes02.pdf If this data element is missing the discharge record will be excluded from rate calculations.
HOSPID	Data Source Hospital Number	Numeric	Hospital identification number	Used to facilitate data exploration and possible trouble shooting. May also be selected as a stratifier (see Table 6. PSSASP2 Aggregation Possibilities).

[3] Federal Information Processing Standard, as defined by the U.S. Department of Commerce, National Institute of Standards and Technology (formerly National Bureau of Standards). Note: Certain independent cities (Baltimore City, Carson City and St. Louis City), and areas within Hawaii and Virginia, are assigned to different area groupings in the Modified FIPS categories as compared to the U.S. Census Bureau groupings. The AHRQ QI software uses the Modified FIPS code assignment of these areas. Failure to use the Modified FIPS codes assignment will result in the use of incorrect denominator estimates for area indicators.

Variable name	Description	Format	Value description	Comments
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 QI 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 Trauma Center[4] 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 identify transfers from another hospital or facility)
LOS	Length of Stay	Numeric	Number of days from admission to discharge	
APR_DRG	APR_DRG Category	Numeric	APR-DRG from 3M software	Not used by the PSI program. If not present in the input data file it is not necessary to create a dummy variable.
SEVERTY	APR_DRG Severity Score	Numeric	APR-DRG Severity Score from 3M software	Not used by the PSI program. If not present in the input data file it is not necessary to create a dummy variable.
RISKMORT	APR_DRG Mortality Score	Numeric	APR-DRG Risk of Mortality Score from 3M software	Not used by the PSI program. If not present in the input data file it is not necessary to create a dummy variable.
DRG	Diagnosis Related Group	Numeric	DRG from federal (CMS) Grouper	
MDC	Major Diagnostic Category	Numeric	MDC from federal (CMS) grouper	
DX1 – DX30	ICD-9-CM Diagnosis 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 characters, left-justified (e.g. 020.2 -> 0202_ where _ indicates a space)	Diagnosis codes	Users must specify the number of diagnoses in the parameter &NDX in the CONTROL_PSI.SAS program to reflect the number of diagnoses.

[4] The ATYPE value "5" was used to indicate delivery only in the 1988 to 1997 HCUP data files. The UB standards currently use "5" to indicate Trauma Center.

Variable name	Description	Format	Value description	Comments
NDX	Count of the Number of Diagnoses (DX) on the Discharge Record.	Numeric	Count of diagnoses (principal and all secondary diagnoses)	Not used by the SAS program (used by the SPSS program). If not present in the input data file it is not necessary to create a dummy variable. Definition is: 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.
PR1 – PR30	ICD-9-CM Procedure Codes. PR1 is the principal procedure, PR2-PR30 are secondary procedures.	String, 4 characters, left-justified	Procedure codes	Users with more or fewer secondary procedures should modify the parameter &NPR in CONTROL_PSI.SAS to reflect the number of procedures.
NPR	Count of the Number of Procedures (PR) on the Discharge Record.	Numeric	Count of procedures (principal and all secondary procedures)	Not used by the SAS program (used by the SPSS program). If not present in the input data file it is not necessary to create a dummy variable. Definition is: 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.
PRDAY1 – PRDAY30	Days from Admission to Procedure. PR1 is the principal procedure, PR2-PR30 are secondary procedures.	Numeric	Days from admission to procedure[5]	Necessary variables if the user sets the &PRDAY parameter in CONTROL_PSI.SAS to equal one. In this case, it is expected that the number of PRDAY variables agrees with the number of Procedure codes present. (See note below for method of calculation). These variables are not needed if the user sets the &PRDAY parameter in CONTROL_PSI.SAS to equal zero, indicating that there is no procedure day information available.
YEAR	Year of discharge. The patient's year of discharge. For example, a patient discharged on July 7, 2004 would have a discharge year of '2004.'	Numeric	YYYY Discharge year should be within the range of 1997 to 2006.	
DQTR	Quarter of discharge. The calendar quarter of the patient's discharge. For example, a patient discharged on July 7, 2004 would have a discharge quarter of '3.'	Numeric	1 January-March 2 April-June 3 July-September 4 October-December	

[5] Variables PRDAY1 to PRDAY30 are defined as the number of days from date of admission to date of procedure for each procedure. For example, if the patient was admitted on June 15th and had two procedures - the principal procedure on June 15th and a second procedure on June 18th – then the value of PRDAY1 would be zero (0) and the value of PRDAY2 would be three (3). For more information, consult the HCUP data documentation at http://www.hcup-us.ahrq.gov/db/vars/prdayn/nisnote.jsp.

Variable name	Description	Format	Value description	Comments
	AHRQ comorbidity variables*			Required if Risk-Adjusted rates are desired.

* See http://hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.

5.4 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.

5.5 Treatment of Missing Data

The software is designed to handle missing data in a particular manner; specifically the software requires confirmation for the assignment of a poor outcome or negative event. For instance, in order to be assigned as a death, each case must actually be coded as a death. Missing data is considered neutral. Missing data for some elements results in the exclusion of that case from the denominator. For a few other elements, the case is retained. Table 5 lists the impact of missing data for each data element.

Table 5. Treatment of Missing Data Elements

Variable	Label	D	N	E	S	Treatment of Missing Data
AGE	Age In Years At Admission	X	X	X	X	Case excluded from all analysis (e.g., dropped from the denominator of the discharge based indicators and from numerator of all population based measures).
ASOURCE	Admission Source			X		Case excluded from denominator where used in specification (e.g., PSI 3).
ATYPE	Admission Type	X				Case excluded from denominator where used in specification (e.g., PSI 10).
DISP	Disposition Status		X	X		Case excluded from denominator where used in specification (e.g., PSI 4).
DRG	Diagnosis Related Group (CMS DRG) in Effect on Discharge Date	X	X	X		Case excluded from denominator (e.g., PSI 1) and from numerator (e.g., PSI 21) where used in specification.
LOS	Length of Stay	X		X		Case excluded from denominator where used in specification (e.g., PSI 3).
SEX	Patient Gender	X	X		X	Case excluded from all analysis (e.g., dropped from the denominator of the discharge based indicators and from numerator of all population based measures).
PSTCO	Location of Patient Residence or Hospital Location Modified FIPS State/County Code	X				Dropped from denominator in rate calculations (stratified by county or Metro Area), case will appear in calculation of the overall rate.
MDC	Major Diagnostic Category (CMS MDC) In Effect On Discharge Date	X		X		Case excluded from denominator (e.g., PSI 3) and from numerator (e.g., PSI 22) where used in specification.
RACE	Race				X	Classified As “Other.”

D – Denominator; N – Numerator; E – Exclusion; S – Stratification

6.0 User Options

The PSI software reflects the development and implementation of the software with discharge data available to AHRQ through the HCUP program. 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, users are encouraged to consider how AHRQ may modify the PSI software to better serve their measurement needs and 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. Users are encouraged to identify ways to improve the PSI methodology and to share their suggestions with AHRQ for future updates.

AHRQ provides public access to HCUPnet - an interactive tool for identifying, tracking, analyzing, and comparing statistics on hospital care. HCUPnet queries generate statistics in a table format using data from the Nationwide Inpatient Sample (NIS) and State Inpatient Databases (SID) for those States that have agreed to participate. HCUPnet includes statistics based on the AHRQ Quality Indicators (QIs) which have been applied to the HCUP NIS. If users change definitions of the PSIs, it will not be possible to compare users' results to the national estimates in HCUPnet. HCUPnet may be accessed through the HCUP web site at http://hcup.ahrq.gov/HCUPnet.asp.

7.0 Producing Patient Safety Indicator Rates: 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.

Users should have already downloaded and run the AHRQ Comorbidity Software to define the comorbidity category variable on the input data file.

7.1 Step 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 1.

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. This output file also contains the original input variables, with the exception of the diagnosis and procedure variables which have been removed to reduce the size of the output file.

7.2 Step 2. Identify populations at risk

For the Provider 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.

7.3 Step 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 providers, age groups, race/ethnicity categories, sex, and payer categories for the Provider PSIs, and areas (Metro areas/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 some performance measurement work, it is often recommended that rates be suppressed when there are fewer than 30 cases in 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, Provider PSI observed rates could be output at the hospital level, at the payer level, or at the hospital level by payer.

7.4 Step 4. Risk adjust the Patient Safety Indicator rates: Provider PSIs only

Overall file means and regression coefficients from a baseline database (reflecting a large proportion of the U.S. population) are applied to the observed rates in the risk-adjustment process. These baseline file means and regression coefficients are provided as part of the PSI module. The risk-adjusted rates will then reflect the age, sex, modified 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 overall means and regression coefficients were derived from the AHRQ State Inpatient Data (SID) for 38 states. The code to generate these baseline means and coefficients are not part of the PSI module.

Users should have already downloaded and run the AHRQ Comorbidity Software to define the comorbidity category variables on the input data file. Failure to provide these variables available will result in expected and risk-adjusted rates that are not interpretable.

7.5 Step 5. Create MSX smoothed rates: Provider 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 38 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 section "Using Different Types of QI Rates" in the *Guide to Patient Safety Indicators* available at http://www.qualityindicators.ahrq.gov/psi_download.htm. 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.

8.0 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 Figure 1 and Figure 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 Provider 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.

8.1 Program 1: Modify Statements in the CONTROL_PSI.SAS code

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

All of the changes needed for the CONTROL_PSI.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_PSI.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_PSI.SAS file.

CONTROL_PSI.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_PSI.SAS changing "C:\pathname" to the single directory location that you wish to use.

There is a global PRINT parameter in CONTROL_PSI.SAS that allows you to print 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 on, set PRINT to have a value of 1 in CONTROL_PSI.SAS.

The global MALEVL parameter in CONTROL.PSI.SAS by default instructs all programs to define geographic areas by county for all areas in the input datasets. Refer to Page 9 for a list of values for the MALEVL parameter.

8.2 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.

The first few formats in this program are for the stratifiers (age, sex, race/ethnicity, payer). These are followed by formats that are used for the identification of outcomes of interest in the PSSAS1.SAS program, and by formats that map FIPS county codes to Metro Areas in the PSSAS1 and PSSASA2 programs. At the end of the program are formats used to assign age, modified DRG and comorbidity categories for the risk adjustment process implemented in PSSASP3.

The PSI module Version 3.0a contains formats that incorporate ICD-9-CM and DRG coding through September 30, 2006.

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_PSI.SAS code.

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

8.3 Program 3: Run PSSAS1

The PSSAS1 program processes hospital discharge abstract data 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 the document *Patient Safety Indicators Technical Specifications.*

Input:

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.

Output:

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.

Changes:

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

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

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

4. In CONTROL_PSI.SAS, set "COMOBFG" to 1 if AHRQ comorbidity variables are available. (These variables will be in the data file if the user has run the AHRQ Comorbidity Software, Version 3.0, available at http://hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp).

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_PSI.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.

8.4 Program 4: Run PSSASP2

The PSSASP2 program calculates the observed or raw rates for the Provider-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" (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 23 new flag indicators for the PSI Hospital outcomes of interest.

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

Output:

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 "Changes" 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 "Changes" section below. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL_PSI.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_PSI.SAS code.

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

3. In CONTROL_PSI.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_PSI.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 6. The default values of 0 and 16 will provide an overall total and provider-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.

Table 6. PSSASP2 Aggregation Possibilities

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	**Provider**								
17	Provider	*							Race
18	Provider	*					Payer		
19	Provider	*					Payer	*	Race
20	Provider	*			Sex				
21	Provider	*			Sex	*			Race
22	Provider	*			Sex	*	Payer		
23	Provider	*			Sex	*	Payer	*	Race
24	Provider	*	Age						
25	Provider	*	Age	*					Race
26	Provider	*	Age	*			Payer		
27	Provider	*	Age	*			Payer	*	Race
28	Provider	*	Age	*	Sex				
29	Provider	*	Age	*	Sex	*			Race
30	Provider	*	Age	*	Sex	*	Payer		
31	Provider	*	Age	*	Sex	*	Payer	*	Race

0 and 16 TYPELVLP (overall and provider) 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 providers within your state
24 – provides rates for age groups within these providers

5. In CONTROL_PSI.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_PSI.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.

8.5 Program 5: Run PSSASP3

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

If risk-adjusted rates are desired, download and run the AHRQ HCUP Comorbidity Software, Version 3.0, available at http://hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp before running PSSASP3. Also, in CONTROL_PSI.SAS, set "COMOBFG" to 1.

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 6 on page 23.

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 (COVPSP30.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 (MSXPSP30.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 area-level summary records that contain the four types of indicator rates, along with the components of the initial raw rates, appropriate confidence intervals and standard errors. Specifically, the file contains the observed rates (OPPSxx variables),the expected rates (EPPSxx variables), the risk-adjusted rates (RPPSxx variables), risk adjusted rate confidence intervals (LPPSxx variables for lower bounds and UPPSxx variables for upper bounds), the smoothed rates (SPPSxx variables) and the smoothed rate standard errors (XPPSxx). Also included are the counts of outcomes that formed the numerators of the observed rates (TPPSxx variables), and the residential population 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 components, the EPPSxx expected rates, the RPPSxx risk-adjusted rates with upper (UPPSxx) and lower (LPPSXX) limits, and the SPPSxx smoothed rates with their standard errors (XPPSxx). Each record or row in the text file will correspond to a different area.

3. A PROC MEANS (with N, NMISS, MIN, MAX, MEAN, and SUM) of the area-level summary records that shows statistics for the OPPSxx observed rates and their TPPSxx and PPPSxx components, the EPPSxx expected rates, the RPPSxx risk-adjusted rates with upper (UPPSxx) and lower (LPPSXX) limits, and the SPPSxx smoothed rates with their standard

errors (XPPSxx). These means will only be generated if the user included a value of 8 for the TYPELEVL parameter discussed in item 4 in the "Changes" section for the previous PQSASA2 program. See Table 6 on page 23.

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. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL_PSI.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_PSI.SAS code.

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

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

4. In CONTROL_PSI.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 COVPSP30.TXT.

5. In CONTROL_PSI.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 MSXPSP30.TXT.

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

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

8. In CONTROL_PSI.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_PSI.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.

8.6 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 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. The file POP95TO06.TXT is currently provided along with the IQI module software. The user should set POPYEAR to the year that best matches the user's discharge data file.

   *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 "Changes" 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 "Changes" section below. If the user does not wish to generate this printout, then the global "PRINT" parameter in CONTROL_PSI.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_PSI.SAS code.

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

3. In CONTROL_PSI.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_PSI.SAS, specify the path (including the file name) for the ASCII population text file in the "FILENAME POPFILA2" statement. The file POP95TO06.TXT is currently provided along with the PSI module software. The user should set POPYEAR to the year that best matches the user's discharge data file.

5. In CONTROL_PSI.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 7. 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 7. PSSASA2 Aggregation Possibilities

TYPELVLA	Stratification						
0	**Overall**						
1							Race
2					Sex		
3					Sex	*	Race
4			Age				
5			Age	*			Race
6			Age	*	Sex		
7			Age	*	Sex	*	Race
8	**Area**						
9	Area	*					Race
10	Area	*			Sex		
11	Area	*			Sex	*	Race
12	Area	*	Age				
13	Area	*	Age	*			Race
14	Area	*	Age	*	Sex		
15	Area	*	Age	*	Sex	*	Race

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_PSI.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_PSI.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.

9.0 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 section "Using Different Types of QI Rates" in the *Guide to Patient Safety Indicators*.

The final output of the PSI module is a PROC PRINT from PSSASP3 (for Provider-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 Provider Indicators, then the final Provider 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.

9.1 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 Provider Indicators (TPPS01-TPPS20,) will have a value of one, zero, or missing ('.'). For these indicators, a value of zero was assigned to the 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.
- For the Provider Indicators, the MEANs will contain a close approximation of the eventual overall observed indicator rates. The values will change slightly after PSSASP2 has applied additional parts of the indicator definitions.
- N lists the number of observations in the dataset with non-missing values. For the seven Area Indicators, N for TAPSxx will be the same as the SUM. For the Provider Indicators, 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.

9.2 PSSASP2

The purpose of this printout is to provide the observed rates for all Provider-level Indicators. The default printout shows results by provider, but other levels of output (as shown in Table 6) 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 provider-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 5 in "Changes" under the PSSASP2 program on page 27). In this case, _TYPE_ always assumes the value of 16, since only the provider-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 for some of the providers. Similarly, a PPPSxx denominator variable with a lower value for N than _TYPE_ indicates that for some providers, there were no hospital discharges with the outcome of interest.

- The MINIMUM value for the TPPS01-TPPS20, TPPS26-TPPS29 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_PSI.SAS program is set to 1, 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, the 20 EPPSxx expected rates, and the 20 OPPSxx observed rates.

9.3 PSSASP3

*The **PROC PRINT** at the end of this program provides your **final output**. (This printout appears if the "PRINT" parameter in the CONTROL_PSI.SAS program is set to 1.)*

The following table lists the column headers shown on the printed output and describes each. Each indicator is reported in a separate section. Values of "xx" correspond to the two-digit PSI number.

Table 8. Provider Level Printed Output

Column Heading	Description
Obs	Observation 1 (with HOSPID = ".") is the overall average for the entire dataset (TYPELVLP = 0). The remaining observations are individual providers, or hospitals (TYPELVLP = 16).
HOSPID	Identifier for each provider in the dataset.
AGECAT	Age stratification category - See Table 6 for TYPELVLP settings.
SEXCAT	Gender stratification category - See Table 6 for TYPELVLP settings.
PAYCAT	Payer stratification category - See Table 6 for TYPELVLP settings.
RACECAT	Race stratification category - See Table 6 for TYPELVLP settings.
TPPSxx	Number of cases in the numerator.
PPPSxx	Number of cases in the denominator (population at risk).
OPPSxx	Observed (raw) rate - Numerator divided by Denominator.
EPPSxx	Expected rate - Rates the provider would have if it performed the same as the reference population given the provider's actual case-mix (e.g., age, gender, modified DRG and comorbidities)
RPPSxx	Risk-adjusted rate - Accounts for the difference between the case-mix of the reference population and the provider's case-mix.
LPPSxx	Lower limit of confidence interval of risk-adjusted rate.
UPPSxx	Upper limit of confidence interval of risk-adjusted rate.
SPPSxx	Smoothed rate - Rates with removal of fluxuation over time.
XPPSxx	Standard error of smoothed rate.

Data will appear under the column headers, AGECAT, SEXCAT, PAYCAT, and RACECAT, if you specify these levels of aggregation (shown in Table 6).

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 provider-based output file and is provided for trouble-shooting and understanding your data, but not for reporting. The means are provided just for the provider level summary records.

- The N for all but the TPPSxx counter variables should contain the number of providers in the users database.
- The MEANS, MINIMUMs, and MAXIMUMs have their normal meaning and provide comparisons among the different hospitals or providers 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_PSI.SAS program is set to 1, at the end of the printout is a **PROC PRINT** on the final provider-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.

9.4 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 7) 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 _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 5 in "Changes" under the PSSASA2 program on page 27). 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 areas 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 for some of the areas

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

*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 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.

If the "PRINT" parameter in the CONTROL_PSI.SAS program is set to 1, the subsequent **PROC PRINT** output contains a complete dump of the output summary file. Listed for each record are the stratification values, the PAPSxx population denominators for the seven indicators, the TAPSxx outcome numerators for the seven indicators, and the seven OAPSxx observed rates.

Table 9. Area Level Printed Output

Column Heading	Description
Obs	Observation 1 is the overall average for the entire dataset (TYPELVLA = 0). The remaining observations are individual areas (TYPELVLA = 8).
Area	Identifier in the dataset for area.
AGECAT	Age stratification category - See Table 7 for TYPELVLA settings.
SEXCAT	Gender stratification category - See Table 7 for TYPELVLA settings.
PAYCAT	Payer stratification category - See Table 7 for TYPELVLA settings.
RACECAT	Race stratification category - See Table 7 for TYPELVLA settings.
TAPSxx	Number of cases in the numerator.
PAPSxx	Number of cases in the denominator (population at risk).
OAPSxx	Observed (raw) rate - Numerator divided by Denominator.

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).

10.0 Benchmark Timings

The benchmark runtimes given below are from runs made on a Microsoft Windows 2000 workstation, with Pentium 4, 2.8 GHZ processor, and 1 GB of RAM. The dataset used contained 498,515 observations with 15 diagnosis fields and 15 procedure fields.

Step	Run time (in seconds)
Run PSFMTS to create the format library	4
Run PSSAS1	232
Run PSSASP2	2
Run PSSASP3	1533
Run PSSASA2	3

11.0 User Support and Information

Technical assistance is available, through an electronic user support system monitored by the QI support team, to support users in their application of the PSI software. The same e-mail address may be used to communicate to AHRQ any suggestions for PSI enhancements, general questions, and any QI related comments you have. AHRQ welcomes your feedback.

The Internet address for user support and feedback is: support@qualityindicators.ahrq.gov

AHRQ also offer a listserv to keep you informed on the Quality Indicators (QIs). The listserv is used to announce any QI changes or updates, new tools and resources, and to distribute other QI related information. This is a free service. Simply follow the process described below to begin receiving important QI information. 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. You should receive an automatic response e-mail message confirming receipt of your e-mail. If you do not receive a confirmation message, call (888) 512-6090.

Appendix A: Links

The following links may be helpful to users of the AHRQ Patient Safety Indicators.

Patient Safety Indicators Version 3.0x Documents and Software

Available at http://www.qualityindicators.ahrq.gov/psi_download.htm

Title	***Description***
Guide to Patient Safety Indicators	Describes how the PSIs were developed and provides detailed evidence for each indicator.
Patient Safety Indicators Technical Specifications	Provides detailed definitions of each PSI, including all ICD-9-CM and DRG codes that are included in or excluded from the numerator and denominator. Note that exclusions from the denominator are automatically applied to the numerator.
PSI Covariates used in Risk Adjustment	Tables for each PSI provide the stratification and coefficients used to calculate the risk-adjusted rate for each strata.
SAS® PSI Software Documentation	This software documentation provides detailed instructions on how to use the SAS ® version of the PSI software including data preparation, calculation of the PSI rates, and interpretation of output.
SPSS® PSI Software Documentation	This software documentation provides detailed instructions on how to use the SPSS® version of the PSI software including data preparation, calculation of the PSI rates, and interpretation of output.
Change Log to PSI Documents and Software	The Change Log document provides a cumulative summary of all changes to the PSI software, software documentation, and other documents made since the release of version 2.1 of the software in March 2003. Changes to indicator specifications that were not a result of new ICD-9-CM and DRG codes, are also described in the Change Log.
Fiscal year 2006 Coding Changes	This document summarizes the changes to the indicator definitions resulting from FY 2006 changes to ICD-9-CM coding and DRG changes. These changes will only affect data from FY 2006 (October 1, 2005) or later.
SAS® PSI Software	Requires the SAS® statistical program distributed by the SAS Institute, Inc. The company may be contacted directly regarding the licensing of its products: http://www.sas.com
SPSS® PSI Software	Requires the SPSS® statistical program distributed by SPSS, Inc. The company may be contacted directly regarding the licensing of its products: http://www.spss.com

AHRQ QI Windows Application

The AHRQ QI Windows Application calculates rates for all of the AHRQ Quality Indicators modules and does not require either SAS® or SPSS®. It is available at:

http://www.qualityindicators.ahrq.gov/winqi_download.htm

Additional Documents

The following documents are available within the "Documentation" section of the AHRQ QI Downloads Web page:

(http://www.qualityindicators.ahrq.gov/downloads.htm).

Refinement of the HCUP Quality Indicators (Technical Review), May 2001
Refinement of the HCUP Quality Indicators (Summary), May 2001
Measures of Patient Safety Based on Hospital Administrative Data - The Patient Safety Indicators, August 2002
Measures of Patient Safety Based on Hospital Administrative Data - The Patient Safety Indicators (Summary), August 2002

In addition, these documents may be accessed at the AHRQ QI Documentation Web page:

http://www.qualityindicators.ahrq.gov/documentation.htm

- *Guidance for Using the AHRQ Quality Indicators for Hospital-level Public Reporting or Payment, August 2004*
- *AHRQ Summary Statement on Comparative Hospital Public Reporting, December 2005*
- *Appendix A: Current Uses of AHRQ Quality Indicators and Considerations for Hospital-level*
- *Comparison of Recommended Evaluation Criteria in Five E*xisting National Frameworks

The following documents can be viewed or downloaded from the page:

http://www.qualityindicators.ahrq.gov/newsletter.htm

- *2006 Area Level Indicator Changes*
- *Considerations in Public Reporting for the AHRQ QIs*
- *June 2005 Newsletter* - Contains the article, "Using Different Types of QI Rates"

Other Tools and Information

The PSI SAS software no longer incorporates the AHRQ Comorbidity software. Before running the PSI software, users who intend to calculate risk-adjusted rates using PSSASP3will need to download and run the program that creates the comorbidity variables in the user's data file. The program is available at:

http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp

Area indicators can be calculated using the modified Federal Information Processing Standards (FIPS) State/county code. A list of codes is available at:

http://www.census.gov/popest/geographic/codes02.pdf

AHRQ provides a free, on-line query system based on HCUP data that provides access to health statistics and information on hospital stays at the national, regional, and State level. It is available at:

http://hcup.ahrq.gov/HCUPnet.asp